2022 PORTFOLIO GUIDE

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National Science Foundation
Directorate for Technology, Innovation and Partnerships

TIP OVERVIEW

For more than seven decades, the U.S. National Science Foundation, or NSF, has been at the forefront of the research, innovation and education that has transformed American lives, powered the economy, and elevated the nation's competitiveness on the global stage. NSF investments have given the world tangible solutions such as bar codes, the modern internet, laser eye surgery, and DNA analysis. Now, the Foundation is looking to do more to speed the development and deployment of future technological advancements and focus on addressing the foremost challenges that society and the economy face today – from climate change to equity to critical infrastructure – affecting every corner of the country.

In March 2022, NSF launched the Directorate for Technology, Innovation and Partnerships, or TIP, NSF's first directorate in 32 years. The TIP directorate's mission is to maximize NSF's impact by harnessing the nation's vast and diverse talent pool to advance critical and emerging technologies, addressing pressing societal and economic challenges, and accelerating the translation of research results from the lab to market and society. TIP will improve U.S. competitiveness, grow the U.S. economy and train a diverse workforce for future, high-wage jobs.

Through the TIP directorate, NSF is seizing a generational opportunity to focus on pivotal challenges and is doubling down the Foundation's support of use-inspired research and the translation of research results to the market and society. In doing so, the new directorate strengthens the intense interplay between foundational and use-inspired work, enhancing the full cycle of discovery and innovation, the development of new technologies and solutions and provides opportunities for all Americans to contribute to the workshop in science, technology, engineering and math jobs.

Accelerating Research and Innovation Toward Impact

TIP meets the nation's priorities by providing researchers and innovators with education, tools and funding to spur innovation, accelerate the development of breakthrough technologies and speed solutions forward. The directorate works closely with the entire agency to leverage ongoing research investments and grow them at speed and scale—leading more rapidly to economic and societal benefits across the nation.

- **Fostering Innovation Ecosystems**—TIP brings together teams of researchers, practitioners and users to shape research directions, catalyze iterative co-design and co-creation, develop game-changing technologies and solutions to address the nation's societal and economic challenges, and grow the future workforce.
- **Establishing Translational Pathways**—TIP accelerates the translation of research results to practical use through its Lab-to-Market Platform. Programs within the directorate provide pathways for researchers, startups, small businesses and aspiring entrepreneurs to move their ideas from the lab to society while gaining access to a range of NSF resources. TIP's highly integrated programs support new pathways for translating research results to society as well, including new, open-source ecosystems, government services or at-scale educational innovations.
- **Partnering to Engage the Nation's Diverse Talent**—Ignites partnerships among academia, industry, government, nonprofits, civil society and communities of practice to blend expertise and resources, advancing research, innovation and education.

TIP Programs

TIP's impact is embodied in its dynamic innovation programs to advance use-inspired and translational research in all fields of science and engineering, giving rise to new industries and engaging all Americans — regardless of background or location — in the pursuit of new, high-wage jobs in STEM.

- **America's Seed Fund powered by NSF**— Invests in early-stage startups, transforming scientific discovery into products and services with commercial and societal impacts. America's Seed Fund powered by NSF provides up to $2 million to startups working across almost all areas of science and technology to support research and development for commercial success.
- **Convergence Accelerator**— Builds upon NSF's investment in basic research and discovery to accelerate solutions toward societal and economic impact. Convergence Accelerator multidisciplinary teams use convergence research fundamentals and innovation processes to stimulate innovative idea sharing and development of sustainable solutions to address complex societal challenges.
- **Innovation Corps™**—Provides experiential entrepreneurial education to further the nation's innovation ecosystem. NSF Innovation Corps, or I-Corps™, connects the technological, entrepreneurial and business communities — addressing skill and knowledge gaps to reduce the time it takes to bring technologies from the lab to the marketplace.
- **Partnerships for Innovation**—Partnerships for Innovation, or PFI, provides NSF-funded researchers the opportunity to increase the impact of their discoveries. PFI teaches researchers how to develop and implement a technology roadmap, create a business model, and develop their technology into a prototype or proof of concept.
- **Pathways to Enable Open-Source Ecosystems**—Offers researchers a novel pathway for translational impact. Pathways to Enable Open-Source Ecosystems, or POSE, fosters open-source communities and models — from software systems and data systems to climate modeling and CRISPR — to create products and artifacts that help to solve societal and economic challenges.
- **Regional Innovation Engines**—Bolsters innovation ecosystems across the U.S. The Regional Innovation Engines, or NSF Engines, program supports the development of diverse, regional coalitions to engage in use-inspired research, drive research results to the market and society, promote workforce development, and ultimately stimulate the economy and create new jobs.

To learn about the TIP directorate, including the latest funding opportunities and information about ways to partner across its portfolio of technology, innovation and translation, visit beta.nsf.gov/tip/latest.

NSF's Convergence Accelerator

CONVERGENCE ACCELERATOR OVERVIEW

Solutions for today's national-scale societal challenges are hard to solve within a single discipline. Instead, these challenges require convergence to merge ideas, approaches, and technologies from a wide range of diverse sectors, disciplines, and experts.

Launched in 2019, the National Science Foundation's Convergence Accelerator builds upon research and discovery to accelerate use-inspired convergence research into practical application. The program funds a cohort of teams to work interactively toward solving grand societal challenges that impact thousands of people positively. In March 2022, NSF launched the Directorate for Innovation, Technology and Partnerships and aligned the Convergence Accelerator program to the directorate.

Funded teams begin in phase 1; a fast-paced nine-month hands-on journey, which includes the program's innovation curriculum, formal pitch, and phase two proposal evaluation. The innovation curriculum includes customer discovery, human-centered design, team science, communication skills, and pitching. Teams apply the curriculum to help develop their use-inspired solution, create communication and outreach products to connect with partnerships and stakeholders, and prepare teams for the next phase. The program's team-based approach creates a co-opetition environment; stimulating cooperation by the sharing of innovative ideas toward solving complex challenges together, while also working in a competitive environment to try and progress to phase 2.

Teams are composed of disciplines and expertise from academia, industry, government, nonprofit, and other communities of practice. Disciplines

include all science and engineering fields, but also other disciplines like law, healthcare, communications and media, and business management to accelerate the solutions forward. As teams apply the Program's convergence research fundamentals and innovation processes, the teams' pioneering ideas are transformed along the journey—converting it to a low-fidelity prototype, then prototype, and finally a solution. Catalyzed partnerships are also vital the teams, providing end-user insights, resources, services, infrastructure and transition-to-practice pathways. Teams foster and nurture partnerships to support their solutions toward sustainability and societal and economic impact.

The Convergence Accelerator is a unique NSF program. While the program is focused on advancing research toward societal impact; the program is intentionally designed around four key components to provide the highest impact. The four components include a convergence research approach, strong multi-organization partnerships, high-impact deliverables, and track alignment.

- **Convergence Research**—Each research effort includes a multidisciplinary approach to accelerate use-inspired research into practice in ways that benefits society at scale.
- **Partnerships**—Funded teams must create partnerships with many types of organizations from academia, industry, government, nonprofit, and other sectors, to ensure that the research efforts are use-inspired and have a clear transition path. Each partnership is different and may provide needed expertise, represent end-users; or provide resources, services, and infrastructure to advance the solution forward.
- **Deliverables**—Deliverables or solution outputs can take many forms; such as hardware, software, data, services, processes, protocols, standards, and more, but each solution must provide a positive impact on society at scale.
- **Track Alignment**—Each funded effort must align to the program's identified convergence research track topics and have the potential for strong integration with other efforts.

To date, the Convergence Accelerator program is composed of three cohorts. The 2019 Cohort, launched in September 2019, is the pilot cohort, funding 42 phase 1 teams to develop solutions in Track A: Open Knowledge Networks and Track B: AI & the Future of Work. Currently, the cohort features seven phase 2 teams, whom are near the end of their phase 2 award. All teams have strong partnerships and are focusing on finalizing their sustainability plans to ensure the solutions' impact beyond NSF support.

The 2020 Cohort, awarded in September 2020, included 29 phase 1 teams and features 10 phase 2 teams developing solutions in two transformative research areas—Track C: Quantum Technology and Track D: AI-Driven Data Sharing & Modeling. The 2020 Cohort is midway through the 24-month phase. Teams have developed prototypes and many have developed beta versions, robust partnerships and are in the process of developing sustainability plans.

The 2021 cohort, awarded in September 2021, includes 28 phase 2 teams focusing on Track E: Networked Blue Economy and Track F: Trust & Authenticity in Communication Systems. Over the last nine months, the teams built proof-of-concepts, fostered partnerships, participated in the Program's innovation curriculum, and completed the formal pitch and phase two proposal evaluation. Selected teams for phase 2 are to be announced in September 2022. Phase 2 teams will continue to apply the Program's fundamentals to develop use-inspired solutions and to build sustainability plans to continue to deliver impact.

The Convergence Accelerator is expanding with its upcoming 2022 cohort. Instead of two convergence research track topics, the program is funding four convergence research tracks: Track G: Securely Operating Through 5G Infrastructure; Track H: Enhancing Opportunities for Persons with Disabilities; Track I: Sustainable Materials for Global Challenges; and Track J: Food & Nutrition Security. Partnering with the Department of Defense's Office of the Under Secretary of Defense for Research and Engineering, OUSD(RE), the Convergence Accelerator anticipates Track G awards in Fall 2022. Tracks H, I and J are in the final planning stage and are to be announced in January 2023. Additionally, the Convergence. Accelerator is excited to have partnered with the Commonwealth Scientific and Industrial Research Organisation, or CSIRO, an Australian Government agency responsible for scientific research, on Track I.

More information about the Convergence Accelerator can be found on the NSF's website at beta.nsf.gov/funding/initiatives/convergence-accelerator.

TRACK A:

OPEN KNOWLEDGE NETWORKS

Vast amounts of data are produced every day, yet many organizations lack the ability to draw insights from these data and make data-driven decisions. Knowledge networks (or repositories) with massive amounts of world knowledge help to power the next wave of AI exploration, driving innovations from scientific research, to the commercial sector. Knowledge networks/graphs provide a powerful approach for data discovery, integration, and reuse, but require an investment in their creation and maintenance. Today, only the biggest tech companies have the resources to develop and exploit significant knowledge graphs and networks.

To enable data to be freely accessible, especially to government, academia, small business, and nonprofit organizations, NSF's Convergence Accelerator is funding the creation of nonproprietary infrastructure for building Open Knowledge Networks (OKNs). Using artificial intelligence and machine learning, teams are building infrastructure, tools, and applications to identify data, link data points, describe relationships, and gather information at speed and scale—providing data to knowledge, knowledge to insights, and insights to understanding.

The OKNs connect people, events, places, environments, health, and more. They remove domain boundaries in order to link data, its attributes, and relationships to other data to be accessible for decision-makers, analysts, researchers, and the American public to answer

interesting and pressing questions. Currently, teams are focusing on urban flooding, judicial court records, biomedical health, geospatial information, and technology infrastructure for knowledge network creation and use.

The Open Knowledge Networks phase 2 efforts include:

AI and Machine Learning Infrastructure Tools and Applications

- **OKN Infrastructure**—Led by the University of Michigan/MIT, the OKN Infrastructure is building infrastructure for constructing novel OKNs and OKN-powered applications. This solution provides tools to make the creation and maintenance of high-quality datasets and apps more cost-effective and more widely accessible.
- **KnowWhereGraph (KWG)**— Led by the University of California, Santa Barbara, KWG provides knowledge graph and geo-enrichment services for environmental intelligence applications. The solution enriches data with pre-integrated custom-tailored knowledge about any locale of interest, thereby reducing the time to find, combine, and reuse data. The initial application areas are focused on decision support related to food systems, supply chains, and humanitarian aid, but can easily be expanded to other application areas as well.

Domain-based Open Knowledge Networks

- **SCALES**— Led by Northwestern University, the SCALES open knowledge network is designed to be a public resource to help provide insights based on judicial court records. SCALES is creating tools to decode court records and transform this data into actionable information that aids a variety of uses, including legal scholars, journalists, policymakers, judiciary, and citizens.
- **Urban Flooding Open Knowledge Network (UF OKN)**—Led by the University of Cincinnati, the UFOKN is addressing urban flooding impacts to assist decision-makers and urban planners in real-time response and long-term planning.
- **Biomedical Open Knowledge Network**—Led by University of California, San Francisco, the Biomedical Open Knowledge Network, or OKN, features SPOKE, an OKN connecting millions of biomedical facts including molecules, pharmacological compounds, organs and diseases, food nutrients, and more. Centered around knowledge representation and reasoning, the team is developing applications using graph theory, advanced visualizations, and real-world clinical evidence to advance drug development and precision medicine.

Integrating the Knowledge Networks

Data2Knowledge Consortium—Knowledge graphs are rapidly emerging as key infrastructure to integrate the diverse information needed to solve complex societal challenges—from climate change and human health to capturing business value from the AI revolution. The Open Knowledge Network phase 2 teams are collaborating on "track integration" to create the Data2Knowledge Consortium to ensure that the outcome from the Convergence Accelerator Track is "greater than the sum of the parts". Composed initially of the current Open Knowledge Network phase 2 teams, the objective of the Data2Knowledge Consortium is to facilitate a thriving ecosystem for open knowledge graph development and use

Biomedical Open Knowledge Network

Connecting The Dots To Advance Precision Medicine For Everyone

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Overview

The human brain cannot possibly integrate the vast and rapidly growing amount of information modern societies have been able to amass. This hampers the generation of new knowledge, specifically in the biomedical sciences and its implications for human health, where the subject complexity is vast and stakes are high. Our knowledge network will incorporate billions of factual relationships among biomedical concepts, providing a discovery engine that will enable doctors, researchers, the pharmaceutical industry and the citizen scientist to explore biomedicine in its whole might.

Description

Human health has become so complex that even doctors turn to Google to understand difficult cases. Then, based on their extensive training, they can better interpret, diagnose and treat illnesses. Clearly, Google is neither based purely on accepted science nor is it specialized enough to handle rare or complex conditions, find a cure for a given disease, or discover the root of a biological process. For those cases, specific information needs to be integrated by skilled researchers into formulating the right hypothesis (consistent with previous evidence and maximizing utilization of current knowledge), which then needs to be tested experimentally.

The response to each of the previous scenarios requires navigating a deluge of complex data and information and connecting the dots in a meaningful way. Our knowledge network (SPOKE) integrates millions of biomedical concepts into a knowledge engine to enable doctors, drug developers and citizen scientists connect the dots and produce a biologically meaningful answer to these questions. Healthcare and related industries represent 1/5 of the entire U.S. economy. We recently incorporated Mate Bioservices, a company that will commercialize applications of SPOKE. We anticipate extensive adoption of this platform will have a significant societal impact by reducing healthcare costs, health disparities and accelerating therapeutics, ultimately improving the quality of life for every American.

Differentiators

Even as high-throughput modern technology in biomedicine has facilitated the acquisition of vast amounts of data, it has only widened the chasm between its generation and its interpretation. Those approaching such a complex task based on individual strengths are bound to fail. While few efforts have been devoted to addressing this vacuum, we are pioneering the paradigm of Knowledge Networks in Biomedicine - a paradigm amply proven in Web Search- into a discipline that is inherently graph-theoretic. Our experience with systems biology, graph theory (LLNL), PI participation in NCATS Biomedical Translator, and the long track record of creating SPOKE are testaments to our vision and commitment to transforming data into knowledge. This has been acknowledged even by the National Institutes of Health Office of Data Science Strategy.

Mate Bioservices aim to revolutionize the way we conduct research in the healthcare industry through: i) harmonizing biomedical research into a central knowledge network (KN); ii) designing the AI/ML tools needed to answer complex scientific questions; and iii) integrating knowledge networks (KN) and AI/ML tools into sophisticated user interfaces that are specifically designed for various customer profiles.

Road Map

As part of our Phase 1 program, we have already developed and made available a fully functional biomedical KN. Our Phase 2 proposal involves continuous development of the engine and four products powered by the KN throughout the 2-year period with a commercialization plan to ensure sustainability. Over the first year of Phase 2, we have established a Governance Committee for SPOKE,

expanded the KN with additional knowledge sources, developed a prototype of the open access network visualization tool, secured rights for commercialization of SPOKE-powered products, and completed a number of analyses that will validate the network's quality and utility. In the remaining year of Phase 2, we will:

- Apply for non-dilutive funding. (Q3, 2021)
- Secure first contract with Pharma via Mate Bioservices (Q4, 2021)
- Release a web-accessible network visualization tool aimed at citizen scientists. (Q1, 2022)
- Produce a report outlining recommendations for mitigating risk associated with ethical, legal, and social implications of network use. (Q3, 2021)
- Obtain seed funding. (Q1, 2022)
- Deploy the first clinical decision support system (alpha) in the UCSF neurology practice with real patients (Q2, 2022)
- Develop and apply computationally intensive analyses to the network, enabling sophisticated validations of the network against real-world observations. (Q2, 2022)

Partnerships

ISB will continue to work with us both in the scientific development of the KN and with resources to expand its utility and reach.

LLNL will continue leveraging its extraordinary computing power and technical knowhow on graph theory and analytical approaches to guarantee an organic and balanced growth of the graph.

IU: A partnership borne from the Convergence Accelerator Phase 1 (Team B6656/7036), Katy Börner's team at Indiana University have been using their world-class expertise in complex graph visualizations and analysis to develop an open access network visualizer aimed at citizen scientists.

UCSD: Another partnership formed in Phase 1 of the Program, Peter Rose from the San Diego Supercomputer Center is using his expertise in protein domain and structure, as well as geolocation information, to further expand the network.

UCSF Innovation Ventures: Having already provided seed funding for the establishment of Mate Bioservices, they will continue to provide support for the handling of intellectual property matters.

NCATS: Our KN is an active participant of the NCATS Translator Program as an Autonomous Relay Agent Team.

ELSI: In Phase 2 we have partnered with Camille Nebeker (UCSD) and Erin Kenneally (Elchemy) to formally advise on ethical legal and social implications of our project.

NASA: We have secured a strategic partnership with NASA's GeneLab to process biological datasets acquired during spaceflight with SPOKE and will programmatically link the two platforms.

Intellectual Property

Invention disclosures related to uses of the network (not the network itself) have been filed with UCSF Innovation Ventures. This will ensure proper documentation of the resulting IP from this project for those application areas.

KnowWhereGraph

A Knowledge Graph for Environmental Intelligence Applications

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Overview

We are developing a cross-domain knowledge graph for environmental intelligence applications. Our KnowWhereGraph supports data-driven analytics and decision making by answering questions such as "What is here?" or "What happened here before?" anywhere on Earth within seconds. We have developed multiple geospatially-aware graph analytics services and tools, e.g., for graph integration, geo-enrichment, and visualization to support pilots in disaster relief, agriculture and food supply chains, and finance. However, our graph and services generalize to all application areas that benefit from rapid access to contextual information about people, places, and the environment.

Description

Geospatial data, be it about people, places, or events, are critical to understanding where and when things happen and, more importantly, why they happened or will happen. Today, nearly 80% of the resources invested in any data-intensive project are still spent on data discovery, retrieval, entry, integration, cleaning, and apportionment. Hence, only 20% of a project's overall resources are left for the analytics that will ultimately determine the quality of the derived insights. This significantly hinders the rate and cost of data-driven decision-making in industry and government. Our KnowWhereGraph addresses this challenge by providing (1) a 12 billion facts-strong open knowledge graph that interlinks over 30 cross-domain data layers, and (2) a set of geo-enrichment services that enable rapid access to well-curated, location-aware data from this graph.

The team has made significant progress over the past 18 months in developing the seed graph using expressive knowledge graph schemata that connect multi-source data in terms of disaster, air quality, climate hazards, crop history, soil characteristics, experts and expertise, administrative boundaries, health, transportation infrastructure, and so forth. Overall, our graph provides 10 different kinds of geographic identifiers and over 20 data layers that provide millions of past and present facts about any of these regions. We expect this number to continue growing as more automated graph generation and integration approaches are being developed.
Our team members are also pioneers in developing spatially-explicit machine learning models to provide GeoAI-ready data to empower intelligent decision making. In Year 2 of the project, we centered our efforts on supporting project verticals including the disaster relief subteam to assemble quickly needed datasets for rapid disaster response and evacuation after major devastating events, such as hurricanes, have occurred. We are also developing graph solutions for understanding and sustaining food supply chain resilience. As a technology-driven project, our goal is to demonstrate how novel geospatial solutions can inform downstream stakeholders from industry, nonprofits, and government agencies

Differentiators

Spatial is special. Our team provides unique expertise in representing and integrating geospatial data using knowledge graph technologies and GeoAI-based services: We have contributed to international semantic standards; our partner Esri offers the market's most advanced spatial analytics technology, while Oliver Wyman and partner companies provide expertise in applying remotely sensed imagery and machine learning models to global food markets, supply chains, and farms. The academic team has a track record in technology transfer, the development of vocabularies, and lifting geospatial data to the graph, while our partners National Center for Ecological Analysis and Synthesis (NCEAS), U.S. Geological Survey (USGS), and U.S. Department of Agriculture (USDA) are among the largest providers

and integrators of geospatial data. This combination enables us to rapidly develop our enrichment services, connect them to vast amounts of data, and apply them to real-world applications, including disaster relief and food supply chains.

Road Map

Year 1 milestones: (M1.1) We developed a knowledge graph with data at the human-environment nexus, including remotely sensed imagery; (M1.2) published a semantically enabled schema for data alignment and deduplication (M1.3); developed a geo-enrichment service that integrates with Esri's ArcGIS and QGIS; and (M1.4) prototyped and graph-tested with disaster relief, food systems, and supply chain pilots. **Year 2 milestones:** (M2.1) We refined the graph & schemata with inputs from partners; (M2.2) enhanced end-user interface and visualization tools; (M2.3) significantly reduced the cost of lifting data to the graph and making the result available; (M2.4) We are deploying our graph and services to partners and are now looking for new opportunities to apply our methods to your use case(s).

Partnerships

Academia Partners - University of California, Santa Barbra's Center for Spatial Studies, NCEAS, Kansas State University's Center for AI and Data Science and Arizona State University offer expertise in knowledge engineering, GeoAI, data synthesis, and environmental modeling. Michigan State University contributes expertise in precision and digital agriculture and graph-based applications for the humanities. University of Southern California provides expertise in environmental economics.

Industry Partners - Esri will provide expertise for developing and testing the knowledge graph-based geo-enrichment services. Oliver Wyman and start-ups will test project capabilities with its customers in supply chain optimization and commodity markets.

Nonprofit Partners - The Food Industry Association will provide access to the food industry with a focus on sustainable agriculture. Direct Relief will apply project work to humanitarian aid supply chains.

Government Partners - USGS will provide expertise in lifting its National Map portal data to the graph, while USDA ARS & NRCS will provide data and expertise about sustainable agriculture and soil data.

Intellectual Property

We are committed to openness and international standards. While encouraging the least restrictive licensing, data or software licensed under more restrictive conditions will be accommodated to allow for broad industry participation.

OKN Infrastructure

Open Knowledge Network Tools for developers

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Overview

Knowledge Networks are a novel and potentially transformative form of data, but building applications on top of them is too difficult, time-consuming, and expensive. We are building a Knowledge Network Programming System that makes it far easier to build novel knowledge-powered applications, while also improving the knowledge resources themselves.

Description

Knowledge Networks like Wikidata are a compelling new type of data – akin to a "structured world wide web" – that have enabled new applications, such as structured web search and voice assistants. Unfortunately, only the most technically sophisticated organizations have had the resources to build these difficult-to-engineer applications. As a result, most of these next-generation applications never actually get built, and users cannot benefit from them. Our Knowledge Network Programming System will dramatically reduce the cost of building knowledge-powered applications by combining programming tools with recent advances in data management and machine learning. This will happen in several ways. First, it will use knowledge network methods to capture provenance from common data operations, enabling users to examine and debug data resources far more quickly than is possible today. Second, it will include new tools for quickly creating accurate knowledge networks from raw information sources such as text corpora. Finally, it will take the social curation methods pioneered by Wikidata and other knowledge networks and apply them to all kinds of data, not simply graph-structured information. This system will combine elements of Wikidata and a traditional database system. It makes standard data objects (tables, files, functions, and so on) amenable to Wiki-style social versioning, improvement, and sharing. With these thrusts, the Knowledge Network Programming System makes data easier for developers to use and easier for developers to curate in the first place. Source code for our prototype system is available online.

We are testing the system using several knowledge networks developed as part of this project. The first is the CORD-19 network, which describes over one million scientific papers on COVID-19 and related historical coronavirus research. This is already public and has been covered in the Wall Street Journal, the New York Times, and elsewhere.

The second is a network that describes macroeconomic statistics in the United States, including recent budgetary and economic responses to COVID-19. We believe these networks will be useful for our project at the same time they support national priorities. Concretely, this project will yield new software, in the form of the programming system and toolset. It will also yield novel data resources, in the form of the above knowledge networks. Finally, it should yield novel applications that both illustrate the programming system and are useful on their own.

Differentiators

All knowledge network applications that we are aware of rely on traditional software engineering tools. We are unaware of any system that addresses application development per se, even though other data types (say, relational databases) have extensive dedicated tooling. The programming system is unusual in its application of data management and machine learning methods to goals traditionally associated with programming languages.

The knowledge networks help with validating our system and with crucial social needs, but are especially notable for the agility with which we can create them. The CORD-19 Knowledge Network was initially released in March, 2020. In the program so far we have made several advances that make new knowledge networks faster and easier to develop, especially those extracted from document corpora.

The research team is unusual in its level of experience

with shipping data development systems, knowledge network production, and relevant domain expertise. PI Michael Cafarella is a principal research scientist at MIT CSAIL. He has published on databases and is one of the co-creators of the Hadoop system. PI Oren Etzioni is the CEO of the Allen Institute for Artificial Intelligence. The Allen Institute is a nonprofit research organization that arguably employs the largest set of knowledge network engineers outside a major tech firm. PI Matthew Shapiro is the Lawrence R Klein Collegiate Professor of Economics at Michigan, and an expert in macroeconomics and public finance. He serves as chair of the Federal Statistics Advisory Committee.

Road Map

There are several core deliverables for this work: (1) the programming and provenance system, (2) the scientific and economics knowledge networks, (3) infrastructure used to produce those networks, and (4) application code built to demonstrate the programming system.

The programming system is under active development and a useable prototype is online. The Allen Institute has released regular updates to CORD-19 and continues to do so. The Economics Knowledge Network is under development now. The infrastructure software is under development; it is also being deployed with several test partners. We are translating the working data pipeline for CORD-19 to run entirely using the programming system, both to test the system and to exploit the new features it enables.

Partnerships

In the long term, we believe the system potentially has many users in the scientific, policymaking, and corporate worlds. We are collaborating with several large institutions, including financial and engineering firms, to test the system. We have spoken with several venture capital firms about ensuring the project and funding beyond this program.

Additional Senior Personnel from the University of California, Berkeley are working on front-end software for adding data to a Knowledge Network. Personnel at the University of Washington, Seattle are working on integrating the programming language with back-end data resources. Finally, we are also working with researchers in the social sciences to evaluate the system's ability to help in varied research settings.

Intellectual Property

Code and data created for this project has been and will be released into the public domain. The only exceptions will be when some purchased source datasets (say, containing certain economic statistics) have restrictions that prevent us from doing so.

SCALES

Transforming The Accessibility And Transparency Of Federal Courts

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Overview

The U.S. court system produces millions of records per year. These records are supposed to be open to the public, but in practice they are trapped behind paywalls and dysfunctional, outdated software. Our project's goal is to enable a broad spectrum of public stakeholders to efficiently access, evaluate, engage with, and understand the work of the courts. Our mission is to create an Open Knowledge Network (OKN) that will serve as a foundation for advocates and researchers to analyze court data systematically. Our platform will also enable data gathering and integration that, in turn, supports intelligent analysis and meaning extraction so all citizens, entrepreneurs, journalists, lawyers, potential litigants, policy makers, scholars, and even the judiciary itself, can better understand and evaluate how the courts function.

Description

Data drives information and insight. Government agencies, central banks, health organizations, and law enforcement agencies all gather data in order to better understand and communicate the events, trends, and relationships between them that define our world. All of this is in service of the twin goals of understanding and transparency.

While the US court system collects similar data sets, those data are rarely used in support of the goals of understanding and transparency. This shortfall is the result of three features: availability of data, lack of data integration, and limited tools that support intelligent information analysis for non-technical users. Availability is hampered by the fact that much of the relevant court data resides behind a federal pay-for-use firewall. While individual case information is affordable, the data needed to do system level analysis would cost tens of millions of dollars to access. Integration is limited by data availability as well as the tools and skills required to support this work at scale. Understanding and insight, even if one had full access to the documents, is thus hindered by the lack of available tools for the journalists, legal scholars, and decision-makers who most need it.

With these issues in mind, we have brought together a team of computer and data scientists, legal scholars, journalists and policy experts, to develop a suite of tools to enable access to court records and analytics. The Systematic Content Analysis of Litigation EventS Open Knowledge Network (SCALES OKN) aims to provide access to both the data and the insights contained within them to a broad range of users with diverse technical skills. Our project encompasses five complementary elements. Data Access: We make all of the data we incorporate into SCALES and the integration of such data freely accessible to the public. Data Integration: We integrate relevant data sets (e.g., judicial, firm, and corporate profiles) and continually update these models and their source datasets. The aim of this integration is the development of a dynamic knowledge graph that supports information access, analysis, and inference. Extraction of Insight: We developed a public facing information access system that allows users to explore the data to answer questions about trends, comparisons, and correlations by simply asking questions. Expanding on work in language processing, information goals, and intent guided analytics, the system provides access to not just the data, but the information and insight contained within. Education: We develop materials aimed at providing users with an understanding of both the data, the integration, and analytics methods. Community: We continue to foster the nucleation and organic growth of a community of stakeholders that both add to and use the data and the system supporting it.

Differentiators

There are limited alternative sources of judicial records and none that enable systematic access and analysis for the public. Commercial legal services such as Westlaw, LexisNexis, and others have purchased many judicial records, but they limit access through their own fees and prohibit bulk downloads—foreclosing systematic analysis even for those who pay the hefty fees. A pioneering open alternative, The Free Law Project, maintains a user-generated free repository of court records, but it is not designed to support systematic analysis.

We are unique in that we are providing users with not just access to raw data but also the meaning that it supports through access to intelligent analytics learned from across the legal system.

Road Map

During year two of Phase 2, we developed an ontology of civil litigation events to systematically identify what occurs in a case and how it resolves, as well as the models necessary to automatically predict these labels at scale. We also further expanded the core technology and facilitated organic growth by working with external contributors to add data and annotations to SCALES that cover the types of parties involved in a case and their potential connections to corporate filings. This is in addition to identifying and connecting lawyers and law firms across the entire corpus of cases. We have also expanded our query/analytics capabilities following user needs. The SCALES OKN will launch on the Satyrn platform this summer and allow the public to conduct systematic analysis on court records.

The SCALES OKN will continue to exist as a public platform and received continued updates to its core data and annotations into the future. As additional partners are added and new research directions are pursued by the community, the SCALES OKN will grow in both the breadth and depth of the core court record data as well as its connections to other OKNs and knowledge repositories.

Partnerships

During Phase 2, we will engage partners in academia, law, industry, and journalism. We are forming an advisory board comprising prominent experts to evaluate technical, legal, and ethical aspects of the SCALES OKN. The Free Law Project will continue to contribute data and will serve on the SCALES advisory board. Our other partners (including the MacArthur Justice Center; American Bar Foundation; Jenner & Block; The Center on Wrongful Convictions; NYU Law, Technology, and Policy Clinic; and more) have contributed their time to help us define SCALES as a product and will continue to provide their time in testing SCALES as it is developed and expanded.

Intellectual Property

We license all intellectual property we create under standard open-source licenses.

Urban Flooding OKN

Delivering Flood Information to AnyOne, AnyTime, AnyWhere

UF-OKN

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Overview

On average flooding causes more than 100 billion dollars of economic loss and 500 deaths per year in the U.S. Some of this could be avoided if people had access to flood-related information such as flood inundation depth at any location or evacuation routes during a flood event. We are developing an Open Knowledge Network that people can use to find out how flooding impacts them so they can take actions to mitigate it.

Description

Recent studies have shown that approximately 41 million people (~13% of the population) are at risk of severe flooding in the U.S. Despite such high risk of flood exposure, it is hard to find answers to simple questions such as "What is the total impact of flooding on a city?". This is because, while urban infrastructure is connected, data and models that describe them are not. We call this connected urban infrastructure the Urban Multiplex. It includes the power grid, transportation network, surface water and groundwater systems, storm water and sewage systems, drinking water systems, inland navigation and dams, all intertwined with the socioeconomic and public health sectors that form the fabric of modern cities. So, when one part of the Urban Multiplex fails from a flood, its cascading impacts across the city are unknown.

Our project aims to address the issue of quantifying flood impacts on an Urban Multiplex by developing a publicly accessible National-scale Urban Flooding Open Knowledge Network (UFOKN). The proposed UFOKN will connect multiple datasets, tools and models across the Urban Multiplex to ascertain and forecast the true impact of flooding.

Product design, implementation and delivery are guided by user needs and partnerships with local, state and federal agencies and private industries. The UFOKN can be used to answer questions such as: "Which route can I take to work during a storm?" or "Will my house lose power during a storm?". At an organizational level, a decision maker can ask questions such as: "Which neighborhoods and when to evacuate to minimize human loss?" or "How flood risk will change in my city in the next 20-30 years?".

We expect that the UFOKN will directly and indirectly serve millions of people impacted due to flooding - by providing the necessary tools and resources to enable real-time response and long-term planning and decision making.

Differentiators

Currently, flood related information is available from different sources - and in different forms. The two most common ones are flood insurance rate maps (FIRMS), produced by FEMA and available as static GIS files or paper maps; and dynamic flood forecasts and water levels provided by the U.S. Geological Survey and the National Weather Service. All these datasets are available only through the respective agencies and require some knowledge of how to navigate their systems. Additionally, these datasets cannot be easily integrated to create a holistic view of a flood impact on an Urban Multiplex at different temporal and spatial scales.

Road Map

We are delivering key technologies and products to serve the needs of two user archetypes representing emergency responders and federal planners involved in planning and coordination to mitigate flood impacts. Our strategic framework consists of five planes: user relations and product development; technology development; research and development; transfer to

practice and sustainability model development; and urban flooding scientific community development. Activities and milestones achieved in each plane inform decisions throughout the strategic framework.

Month 15 Deliverables: A national scale UFOKN data fabric which is designed to be flexible in accommodating static geospatial data as well as dynamic flood forecasts. A key deliverable is the Urban Multiplex Inventory (UrMI) which is the geospatial data warehouse for indexing and describing over a 140 million features of the urban infrastructure.

Month 18 Deliverables: A national scale flood forecasting service that provides flood depth predictions across UrMI features leveraging the National Water Model (NWM) hydrologic forecasts. Additionally, a self-describing, cloud-native service to access and map this data.

Month 24 Deliverables: User-interfaces around UrMI and flood forecasting services, for example, FlowFinder, FloodFinder and ImpactFinder. Milestones: draft business canvas; refined UFOKN ready for deployment; partner training, UFOKN testing, add new features/ functionalities; collect potential user/buyer feedback.

Month 30 Deliverables: Final business canvas. API-based access for UrMI. Application called UrMI Explorer to allow interfacing with the data.

Month 36 Deliverables: A thoroughly validated, and improved UFOKN forecasting service with a user-friendly interface to access different applications. Milestones: UFOKN opens to general users; soft launch.

Final Deliverable: Viable product/service, market evaluation.

Partnerships

Our partners contributed personnel time, data, model results, prototype testing, evaluation, and feedback. Many Phase 1 partners will adopt UFOKN for their operations, thus becoming our first users.

New Phase 2 partners will contribute at the same level as Phase 1 partners. They include U.S. Environmental Protection Agency (National repository of underground and above ground fuel storage tanks; National drinking water infrastructure data; Joint modeling of flood impacts in these critical facilities; real-time sensing data); U.S. Geologcal Survey (real-time sensing data; will participate in sustaining UFOKN past Phase 2); National Oceanic and Atmospheric Administration (personnel time); six additional FL counties.

Intellectual Property

We anticipate that significant intellectual contributions will result from this project. Given the collaborative and multi-institution nature of our team, IP created by this project may be jointly owned. Participating project team members have agreed to work together on the protection, maintenance, and commercialization of any jointly owned IP according to applicable laws and policies. As the lead institution, the University of Cincinnati will coordinate these efforts.

Data2Knowledge Consortium

Building a Proto OKN

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Overview

The Data2Knowledge collaboration of the five Open Knowledge Network projects in Track A of the NSF Convergence Accelerator seeks to facilitate an open ecosystem for knowledge graph development, use, and maintenance – helping to build a Prototype OKN infrastructure. Knowledge graphs are rapidly emerging as key tools to integrate the diverse information needed to solve complex societal challenges – from climate change and human health to capturing business value from the AI revolution. The goal of Data2Knowledge is to facilitate an open system approach that helps deliver the power of knowledge graphs to the public.

Description

Open knowledge networks, powered by knowledge graphs, are poised to fuel the next wave of AI exploration—enabling insights from massive amounts of world knowledge and driving innovations from scientific research to the commercial sector.

The Open Knowledge Network (OKN) Convergence Accelerator track—including the Data2Knowledge track integration activity—envisions an open, inclusive, community-oriented graph structure as a trustworthy knowledge infrastructure that facilitates and empowers a host of applications and opens new research avenues. The next stage of this interconnected infrastructure will be the Proto-OKN.

The 2021 Final Report from the National Security Commission on AI calls for the establishment of "a National AI Research Infrastructure composed of cloud computing resources, test beds, large-scale open training data, and an open knowledge network that will broaden access to AI and support experimentation in new fields of science and engineering". The Data2Knowledge effort is a key building block for realizing this vision.

From Feb – June 2022 NSF and the White House Office of Science and Technology Policy hosted the OKN Innovation Sprint, building on the ongoing work of Track A and Data2Knowledge, to define public-sector use-case opportunities and parameters for a proto-OKN infrastructure. Each of the Track A OKN projects brings together data from existing specialized information sources, including government data platforms, and incorporates additional real-world knowledge and context. The OKN Innovation Sprint use-cases have envisioned tools and communities of users that could be developed if resources are allocated to build the Proto-OKN.

Differentiators

While massive knowledge graphs have been created and are in use in proprietary applications, an open platform for heterogeneous data integration using knowledge graph technologies – the Proto-OKN – does not yet exist. This track integration activity brings together the complementary knowledge networks, tools and technologies being created by the Convergence Accelerator Track A teams to create the beginnings of an integrated Open Knowledge Network. User-centered design is central to this vision. Efforts are driven by use cases and users, rather than being technology-driven.

Road Map

The Data2Knowledge effort seeks to facilitate the development of an integrated, continuously updated OKN that hosts open, curated data to support development of AI applications; provide open, transparent access to data; empower the larger community to extend the OKN with additional information and knowledge from new sources and new domains; and facilitate training in the development and use of knowledge graph technologies.

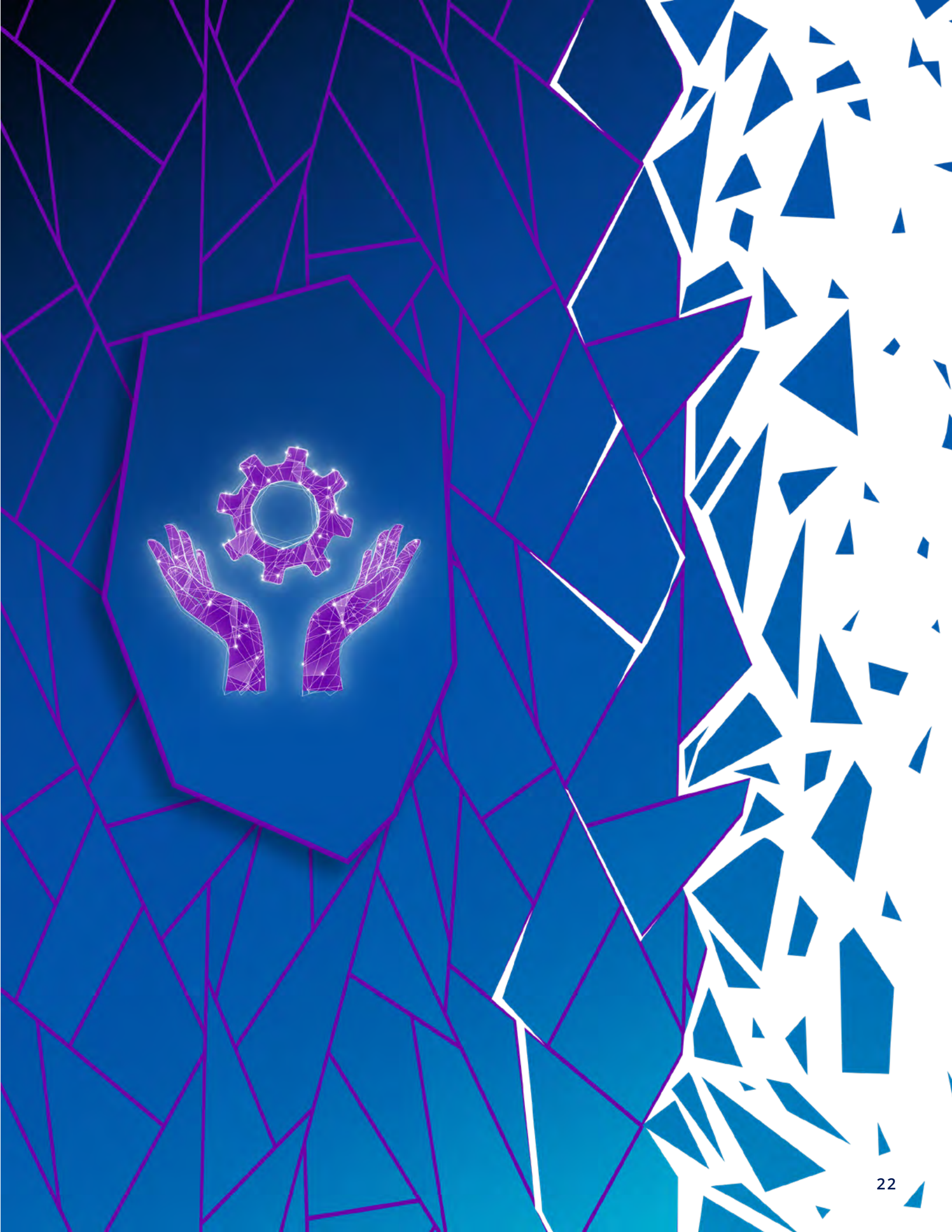
The Data2Knowledge effort is leveraging the Track A projects, with their extensive expertise and networks, to enable the development of the proto-OKN that will be described by the OKN Innovation Sprint Roadmap Report, anticipated in September 2022. The overall Proto-OKN seeks to ensure the sustainability of each application use-case and of the overall infrastructure through a variety of partnerships, including public-private efforts, so that the OKN can persist well into the future, for as long as it is needed.

Partnerships

Each Track A team has an extensive network of partners and collaborators available to contribute to Data2Knowledgeefforts and to the overall goal of creating a Proto-OKN. Partners from all sectors interested in creating the Open Knowledge Network—from academia, industry, government, non-profit, and others – are welcome and encouraged to join the movement! Look for a roadmap report in September 2022 from the OKN Innovation Sprint with more insights on how to develop the Proto-OKN.

Intellectual Property

Each entity participating in Data2Knowledge and the OKN Innovation Sprint maintains all claims to existing IP, including proprietary data, and to IP developed as part of their individual efforts. As the Proto-OKN is developed, the intention is that most tools and resources will be posted publicly, with the end goal of creating a shared resource that anyone can build upon.



TRACK B:

AI AND THE FUTURE OF WORK

The world's technological advancements in AI, machine learning, and robotics are shifting the future of work in unanticipated ways. NSF's Convergence Accelerator is focusing on solutions to train, reskill, upskill, and prepare the current and future workforce with industry needs and jobs of the future, as well as build a national talent ecosystem to stimulate the U.S. workforce and ensure continuing global competitiveness.

Teams composed of academia, industry, nonprofits, and end-user partners are converging together to develop disruptive future of work solutions that envision a positive national-sale societal impact. With these solutions, technology is utilized to create a STEM talent pipeline relevant to industry needs, keep workers safe and help them perform their jobs better, create new jobs, and facilitate accessibility and inclusivity. Solutions include developing the U.S talent pipeline through competency-based training intelligent tools to connect academic institutions with industry needs to prepare students for the workforce, improving workforce training and safety for emergency responders through human augmentation, and creating virtual reality and augmented reality (VR/AR) tools to identify unique skills of neurodiverse individuals thus preparing them to thrive in the workforce.

The AI and the Future of Work funded phase 2 projects include:

- **SkillSync**— Industry 4.0 is changing the skills that workers need and companies require, leaving businesses vulnerable and colleges behind. SkillSync, led by Eduworks Corporation, uses AI and national skills data to help companies identify required skills, connect them with college continuing education departments, and enable colleges to respond with efficient, effective, and equitable reskilling programs.
- **LEARNER**—Led by Texas A&M, is an agile and adaptive Human Augmentation Technologies (HAT) integrated Emergency Response (ER) training platform that accelerates HAT adoption for safer and more efficient ER work, supports adaptive learning sensitive to ER workers' socio-technical opportunities and budgetary constraints, builds and retains skilled ER personnel, and accelerates next-gen workforce development.

Integrating the Future of Work Ecosystem

STEP UP!—To guarantee the convergence research Future of Work track focus is greater than the "sum of its parts", phase 2 team solutions converge toward track integration, creating STEP UP the Skills-Based Talent Ecosystem Platform for Upskilling.

Composed of the Future Work teams, STEP UP connects the skills and talents of individual workers to the opportunities that most need them. By inclusively engaging America's human skill and talent, and the technologies that support, augment, and develop that talent, the group is ensuring every American may partake in the benefits of a thriving economy and the dignity of meaningful work.

LEARNER

Learning Environments For Augmenting Next Gen Emergency Responders

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Overview

The COVID19 pandemic reinforces that Emergency Response (ER) workers do dangerous work while adapting to novel situations. Training institutes and organizations have reported a steep decline in ER trainings that are essential to the nation's critical infrastructure. A critical need exists to accelerate ER expertise development through adaptive, personalized learning platforms that deliver next-generation skills while integrating emerging human augmentation technologies (HATs). LEARNER, an agile and adaptive HAT-integrated ER training platform, will accelerate HAT adoption for safer and efficient ER work, support adaptive learning sensitive to ER workers' socio-technical opportunities and budgetary constraints, build and retain skilled ER personnel, and ultimately accelerate next-gen workforce development across other industry domains.

Description

LEARNER is a novel mixed-reality learning platform that has physical, augmented, and virtual reality components, where ER personnel will learn to work effectively with two HAT classes: powered exoskeletons (EXO) and head-worn AR interfaces (AR) for two ER skills curricula (e.g., Triage and Patient Handling). These HATs will showcase the modularity of LEARNER across physical and cognitive augmentation that have distinct learning requirements. We will develop, integrate, and assess EXO and AR learning modules into the LEARNER system across different access levels (home to field house to training centers). Our industry partner SARCOS Robotics has designed an upper-body EXO emulator interface integrated into the core LEARNER system. Concurrently, we remain engaged with our other industry partner Knowledge Based Systems, Inc. (KBSI), who are developing a working LEARNER prototype that utilizes a unique paradigm for learning by adapting to a variable set of learners' characteristics and contexts, through the incorporation of physiological, neural, and behavioral markers of learning into real-time AR/VR scenario delivery. Finally, we plan to test and evaluate the HAT- integrated LEARNER prototypes at a National ER Training Center (Texas A&M Engineering Extension Service; TEEX) in close guidance from our government partner (National Institute for Standards and Technology; NIST). Completion of customer/market needs assessment and determination of LEARNER business model will move the prototype towards achieving scale in the ER community. We will work with existing and future partners to submit non-dilutive grants and to license copyrights to the LEARNER curriculum across ER and broader industry domains. LEARNER will serve our responders by building a more capable and skilled ER workforce, safeguarding their health, improving their career longevity, and ensuring our nation's emergency preparedness.

Differentiators

Current VR based training platforms in ER are focused on extensively simulating the environment. LEARNER will enable quick integration of emerging HATs (EXO and AR) into its platform enabling an individual or a group of users to learn and collaborate in tomorrow's human-technology ER teams. Access to training resources (i.e., facilities, technology, budget, time away from duty) remains a critical barrier for effective and continued ER training. LEARNER provides multiple training delivery methods, from the home to embodied immersive training, that offer affordable and abundant opportunities for rapid repetition and skills refinement. ER workers are diverse in their makeup, in terms of their demographics, experiences, trust, and learning rates. In contrast, current ER training paradigms are static, with a one-size-fits-all approach. LEARNER utilizes personalized learning algorithms to reduce skills gaps across ER teams that enhance team operations. LEARNER is scalable across other work domains; affording HAT learning in, for e.g., manufacturing, thereby creating opportunities for broader industry adoption.

Road Map

Milestones: At Month 8, we completed the development of the curricula for two HAT-integrated ER courses: 1) Triage using AR tool (e.g., virtual triage tag); and 2) Patient Handling using EXO. By Month 24, we will have tested and embedded the adaptive learning algorithms into the LEARNER prototype. By Month 26, the courses will be embedded in the LEARNER prototype, and will be coupled with immersive VR environments with realistic scenarios and multisensory feedback (e.g., visual, haptic). By Month 28, LEARNER pilot test will be completed with ER workers in a high-fidelity ER benchmarking study at TEEX. Key inflection period will be during the pilot test evaluation (Months 27-28), followed by refining the prototype.

Key deliverables: ER-based training curricula, personalized learning algorithm for ER training and AR/EXO learnings, AR/EXO-specific learning modules, and a functional LEARNER prototype.

Partnerships

We have assembled a team of academic researchers across three universities, industrial (SARCOS Robotics; EXO integration), government (NIST; training standards/testing), and non-profit ER workforce development (TEEX; ER training and evaluation) partners. Our advisory board is composed of leaders from ER stakeholder organizations (International Association of Fire Chiefs, National Volunteer Fire Council, NFPA; to advise on ER training needs/constraints), government institutions (FEMA, US Naval Research Lab, Texas Division of Emergency Management; to guide on achieving scale in ER), and industry partners (Eksobionics, IHMC, Boeing, Ford, and ASTM; to share experiences in transition to practice, commercialization, and training and assessment in diverse industrial sectors).

Intellectual Property

The IP will include the LEARNER training platform, ER training scenarios, personalized learning algorithm, and EXO/ AR learning modules that would be protected in the form of copyrights and trademarks, registered through filings with USPTO to minimize infringement and illegal copying of materials. Licensees will be responsible for preventing infringement or illegal distribution of IP.

For additional information and to contact the LEARNER team visit www.projectlearner.com.

SkillSync

Reskilling Workers at the Speed of Business

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Overview

AI, automation, and other technological changes are causing rapid shifts in the skills workers and companies need, leaving companies vulnerable and workers with skill gaps. College non-degree and technical programs are a natural place to turn to fill these gaps, but when companies engage with them, they find it difficult to identify and communicate their skills needs and that colleges have not kept up. Inaction is the result, which hurts colleges by reducing their impact, industry by reducing training capabilities, and workers by reducing training opportunities.

SkillSync is a web application that solves these problems. It uses AI and national skills data to help companies identify the skills their workers need. It then connects companies to college providers, facilitates communication between companies and colleges, and helps colleges create and offer programs that align with company needs. As Amazon, Uber, AirBnB, and similar apps have done in their market segments, SkillSync removes significant pain points in the $170B corporate training market by connecting reskilling consumers (companies) to reskilling providers (colleges) and enabling them to easily exchange just the right information.

Description

The SkillSync workflow starts with a company HR or talent professional. These users engage with SkillSync to identify and prioritize a set of skills needed for a new job or position or for employees to advance. SkillSync provides access to trending skills derived from national job data and can use AI to extract skill requirements from company job descriptions. Aided by a virtual assistant that helps them understand and make efficient use of SkillSync, company users build a detailed reskilling request and submit it to selected college training providers.

Upon receipt of a request, colleges use SkillSync to formulate training proposals. To ensure that proposals target the right skills in an efficient manner, SkillSync uses AI to score the alignment between a set of training opportunities and a company's request. Training proposals can include a college's existing or custom offerings, parts of courses or whole courses, and externally available educational resources. At the heart of SkillSync are AI services for (1) extracting and prioritizing knowledge, skills, and abilities (KSAs) from job descriptions and other unstructured sources, (2) removing unwanted, biased, or unallowable data from auto-generated KSAs, and (3) determining how well a set of course materials address a skills training request. SkillSync uses a transfer learning approach in which transformer-based, pre-trained language models are tuned through additional rounds of unsupervised learning to improve domain coverage. The resulting domain-specific models are then trained using labeled datasets to perform specific tasks. These AI services are available via APIs and can be used in other solutions.

Differentiators

SkillSync supports a two-sided, digitally enabled process that helps companies and colleges engage with each other to obtain and provide reskilling. Differentiators include: (1) making nationally derived skills frameworks available to companies and colleges; (2) a novel AI-based alignment scoring tool that calculates the match between required skills and a college's existing instructional assets; (3) use of the AskJill intelligent agent developed by Georgia Tech to help users understand and use the SkillSync app; (4) the ability to extract skills from job postings, position descriptions, and course materials; and (5) bias controls discussed next section.

Bias Control & Research Results

Throughout the research process, we focused on documenting and mitigating undesired bias in the

machine learning models used to create AI services. Large-scale language models can encode (and even amplify) societal biases. These biases have been particularly noted in relation to occupation and job-skill related terminology. When developing the Skillsync AI services, we identified four potential points where undesirable biases may be introduced or mitigated: (1) the large text corpora used to pre-train underlying language models may reflect biases; (2) labeled datasets used to fine-tune models to perform specific tasks may reflect biases; (3) labeled test sets used to measure performance of models during the research process may reflect biases; and (4) conscious or unconscious bias may be introduced by human raters used to label datasets (e.g., there is a strong correlation between gender of the human labeler and the frequency with which they detect soft skill KSAs in unstructured job descriptions).

SkillSync employs several techniques to mitigate biases in underlying datasets. These include counterfactual data augmentation (CDA) and REG (a gender bias reduction technique) We also attempt to reduce human bias by using a diverse set of data labelers. We were initially concerned that training models to minimize bias might reduce performance, but found that bias reduction often served to prevent overfitting, which improved performance.

Participatory Design & Trials

During the first year of Phase 2 development, Skillsync worked closely with corporate and college partners and team members such as the Business and Higher Education Forum, the Credential Engine, Dxtera, the Open Syllabus Project, the National Association of State Workforce Agencies, CAEL, and UPCEA.

Using resources provided by these partners, Multiple focus groups were run from September 2020 through March 2021. A prototype was tested in May of 2021 by global corporations Halstead and Southwire, Georgia Tech, and the University of West Georgia. In these tests, SkillSync functioned correctly, and its users validated its value and features. Subsequent trials were run with Global Foundries and Hudson Valley Community College. These trials have established the usability and general utility of SkillSync. Further trials and focus groups will look at specific market use cases to determine what is needed to provide the highest value.

Road Map

SkillSync continues to be developed using a participatory and user-centric design approach. An MVP release due in 2022 will address input received from users; include more AI; more fully incorporate the AskJill intelligent agent; and add marketplace features. In addition, SkillSync and its AI services have attracted attention from several federal agencies. We anticipate that the next year will be spent meeting the needs of these agencies for current, up-to-date data on skills trends and for the SkillSync KSA extraction and alignment services.

Intellectual Property

SkillSync uses open source skills management tools ("CaSS") developed by Eduworks. The AI services were developed under the Convergence Accelerator program.. Partner data is licensed under data agreements. AskJill is owned by Georgia Tech, with an agreement to license it as a service. Data produced by users belongs to the users.

For additional information and to contact the SkillSync team visit www.skillsync.com.

STEP UP

Skills based Talent Ecosystem Platform for Upskilling

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Overview

STEP UP! (Skills-based Talent Ecosystem Platform for Upskilling) connects workers, employers, and training providers to each other based on skills. Its goal is to provide diverse populations with equitable access to jobs and training and to help employers find, train, and hire workers in response to events that change the nature of work, ranging from the next pandemic to technological breakthroughs. STEP UP! maps jobs and training to skills frameworks and offers skill gap analyses, training, and skills-based credentials to ensure that (a) workers are judged by the skills they have rather than formal educational achievements and previous job titles; (b) workers have (and are able to) access training that fills gaps in both the soft and technical skills they need for modern work environments; and (c) employers can accurately express the skills they need and identify workers that have them. The goal of STEP UP! is to transition Convergence Accelerator work to practice so that it has positive and lasting impact on American workers, especially on underserved groups and the missing millions in parts of the country that are often overlooked, as is so crucial for Future of Work.

Description

STEP UP! is a collaboration among two "Track B" (future of work at the human technology frontier) Convergence Accelerator projects : (1) LEARNER, which is providing first responders with new forms of training to prepare them for the use of technologies such as exoskeletons and Augmented Reality (AR); and (2) SkillSync, which uses AI-based services to help companies understand and communicate the skills their workers need, to connect them to college programs, and to aid colleges in developing efficient, effective, and equitable reskilling programs that meet worker needs. As individual projects, LEARNER meets employer needs for upskilling emergency responders and SkillSync connects employers to training providers. STEP UP! combines the strengths of the two projects to create a virtuous cycle among workers, employers, and training. STEP UP! will (a) allow employers to create job profiles that identify the skills needed for in-demand jobs; (b) enable individuals to create (and validate) skills profiles that identify the skills they have; (c) use AI to match skills profiles to job profiles and to identify skill gaps; (d) enable individuals to find and enroll in training to fill skills gaps; (e) issue skills-based credentials that validate newly acquired skills; and (f) enable individuals to provide existing or potential employers with those credentials. All these functions are supported by AI that extracts skills from unstructured data and is used in matching and recommendation algorithms.

As a first step in STEP UP! the Track B projects have joined forces to create a National Talent Ecosystem Council (NTEC). This council, which held its first live symposium in June 2022, engages researchers, educators, practitioners, and policy makers who are working towards building a highly skilled and inclusive workforce. NTEC will provide oversight to the STEP UP! project and additionally manage and disseminate the research, guidelines, standards, skills frameworks, and data produced by current and future Convergence Accelerator projects that address issues in education, training, and workforce development.

As a second step, STEP UP! is creating guidelines for selecting the best training for acquiring a given set of skills under a variety of constraints, e.g., when physical access to a training center is not an option due to a pandemic or when an individual cannot engage in VR experiences due to motion sickness. These guidelines will help provide upskilling in response to unforeseen events. In parallel, STEP UP! is developing skills frameworks and associated skills-based credentials for technical areas covered by the LEARNER, which is a steppingstone to jobs that provide a living wage and an upward career path.

The third step is aligning training opportunities with skills frameworks and enabling them to produce skills-based credentials. The training will range from traditional eLearning to offerings that use VR/AR.

The final step is creating a proof-of-concept portal

that is intended to show the "art of the possible" and to inform the design and development of a full STEP UP! platform. The proof-of-concept will be a cross between a web site and a web application and will be guided by input from NTEC.

Differentiators

STEP UP! is designed to address under-served populations and to enable the talent ecosystem to respond to new skills needs and unforeseen events. It applies machine-learning algorithms trained to avoid bias, has access to national job data so that it can detect emerging skills, provides innovative training to populations with non-standard needs and that need to acquire newly emerging skills, and applies guidelines for selecting alternative modalities in response to worker circumstances. STEP UP! is designed for a national talent ecosystem and is based on national data, whereas today's talent management and talent marketplace systems are typically used by single employers. Furthermore, the sites and services that workers use to find jobs and that employers use for recruitment not use granular skills profiles, do not help workers identify and find training, and are not designed to eliminate bias. STEP UP! is a complete solution that closes the loop among workers, employers, and training providers and is overseen by an organization (NTEC) dedicated to creating a robust equitable talent ecosystem.

Road Map

The NTEC was formed in 2021 as an informal organization but will be incorporated in the future, likely as a 501©3 organization. The 2022 NTEC inaugural symposium was held in June 2022 in Texas. Follow-ups from this symposium include initial drafts of guidelines for training system selection and an initial set of skills frameworks and related skills-based credentials. This symposium also helped solidify plans for the proof-of-concept STEP UP! web portal. This portal is anticipated to be completed by the end of 2023. Thereafter, STEP UP! project will seek the funding and required to develop a robust, fully featured, extensible, and scalable STEP UP! platform. NTEC is expected to continue as an important organization that otherwise supports national skills and talent pipeline initiatives and increases the impact and sustainability of Convergence Accelerator and other projects via symposia, publications, and networking.

Partnerships

Each Track B project has its own extensive network of team members and partners. All are available to contribute to NTEC and STEP UP! Among these, key partners include the Texas A&M Engineering Extension Service (TEEX), the National Institute of Standards and Technology (NIST), the Boeing Corporation, the Credential Engine, the National Association of State Workforce Agencies, and the Business Higher Education Forum.

Intellectual Property

Much of the IP initially contributed to STEP UP! is owned by the Track B projects. This will be cross licensed for use in STEP UP! Longer term, the IP in STEP UP! will be licensed to NTEC by contributors or owned by NTEC. Data provided by STEP UP! users will belong to the users and will be protected in accordance with privacy and data rights laws.

TRACK C:

QUANTUM TECHNOLOGY

Many of today's technologies rely on computers to help with sensing, networks, data, decision making and more, but technology advancement in quantum technologies has become a focus for research and industry organizations, including the National Science Foundation, or NSF. As a longtime supporter of quantum technologies, NSF is building upon its investment to build upon basic research and discovery and to accelerate solutions through the Convergence Accelerator's Track C: Quantum Technology. Quantum technology has the potential to solve large-scale problems and at an even faster rate, but scaling for these challenges is critical. Teams within the NSF's Convergence Accelerator Quantum Technology track are developing quantum sensors, networks, and simulations to deploy new technologies for a variety of applications, such as the hardware and software that will be needed to deploy the new quantum internet, as well as applications in many areas including autonomous vehicles, and healthcare. Educating and developing the current and future workforce is also vital to ensuring a pipeline of future scientists and engineers are prepared to meet the rapidly growing workforce and education needs associated with the expected growth in quantum technology and application areas it would enable. In this regard, the Quantum Technology track teams are also working on creating innovative curriculum by leveraging strong industry-university partnerships that are diverse and inclusive.

Quantum Technology funded phase 1 teams include:

Quantum Sensors

- **Quantum Sensors**—Led by Arizona University, the Quantum Sensors is developing an entanglement-enhanced sensing architecture to benefit multitudes of domains, including secure inertial navigation, space and planetary terrestrial control, and healthcare monitoring.
- **PEAQUE**—Led by the University of Washington, the PEAQUE is addressing quantum computing scalability by innovating a chip-scale, multi-beam optical control system that empowers cold-atom quantum computing with 1000s of qubits. The use-inspired research on integrated photonic control engine can help scaling down of quantum computing hardware. This translational research could prove valuable for many other emerging areas of technology including LIDAR, holographic displays

Quantum Networks/Simulations

- **QuaNeCQT**—Led by the University of Maryland, the QuaNeCQT is developing hardware to transform the internet into a quantum internet, which is essential to connecting the anticipated rapid expansion of the use of quantum computers The quantum network will be able to interconnect different kinds of quantum computers and can enable opportunities to harness the power of networking and thus the ability to solve very complex and large-scale problems that cannot be handled by classical computers and networks.

Workforce/Education

- **QuSTEAM**—Led by Ohio State University, the QuSTEAM is a transformational undergraduate curriculum aimed at addressing critical workforce needs in quantum information science and engineering.

Integrating Quantum Technology

Quantum Photonic Technology Consortium, or PhoTeQ-C— Quantum photonics plays a pivotal role in future scalable quantum technologies for computing, communication, and sensing. Cutting-edge research conducted in labs needs to be exported to large-scale manufacturing facilities to impact the whole quantum industry and society. The Quantum Technology phase 2 teams are collaborating on "track integration" to create the Quantum Photonic Technology Consortium to establish quantum photonic device manufacturing standards and knowledge that will be adopted by industry, academia and will facilitate convergence to share know-how and infrastructure to accelerate lab to market translation.

PEAQUE

Enabling Scalable Cold Atom Quantum Computing With Integrated Photonics

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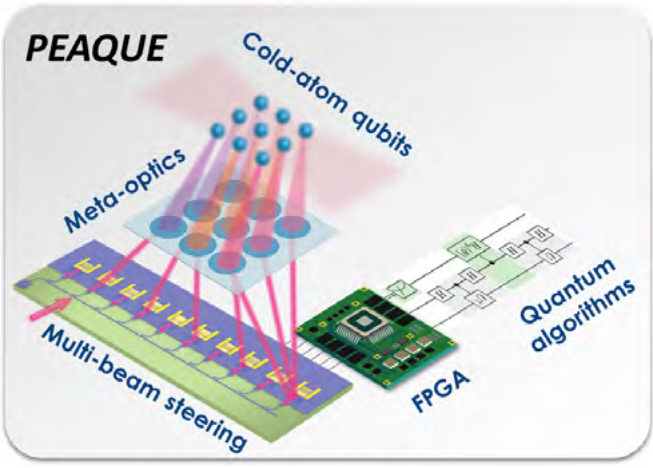
Overview

Quantum computing promises to solve critical problems that are intractable by classical computers, but currently it faces many scaling bottlenecks. We are developing a cold atom quantum control system in a miniaturized package, programmed with quantum software to empower quantum computing with 1000s of qubits and metrology with entangled atomic clocks. Dissemination of our system to the quantum technology industry will accelerate the realization of full-scale quantum computers capable of solving challenging problems from optimization algorithms to computational chemistry for drug discovery.

Description

The PEAQUE project addresses quantum computing scalability by developing a powerful optical control engine that interfaces cold atom qubits with quantum software. The core of this engine is a chip-scale Multi-Beam Illumination and Steering (MBIS) system, which leverages the latest advances in nanophotonics and optical materials to generate a multitude of laser spots and precisely focus them on a dense atom array. Each MBIS module includes a pixel array of 10 lithographically patterned devices each capable of emitting 10 individually steerable laser beams, creating a module with 100 beams from a package sized only ~10 cm3, a miniaturization by 3 orders of magnitude over existing technology. Multiplexed modules in an MBIS engine will be able to perform high-speed, parallel gate operations on large 2D or 3D lattices of cold-atom qubits, which is impossible with existing technology. The power of MBIS will enable execution of quantum error correction (QEC) codes specially designed for cold atom qubits toward fault-tolerant computing. The photonic engine will also power entangled atomic clocks in a large lattice to advance quantum metrology. The complete PEAQUE solution package will accelerate building of a cold-atom noisy intermediate-scale quantum (NISQ) computer with capable of solving optimization problems and performing quantum simulations.



Our solution package includes a full stack of hardware and software to enable scalable cold-atom quantum computing and metrology.

Differentiators

Cold atom qubits, compared with other qubits (e.g., superconducting circuits, trapped ions, solid-state spins, or photons), have the decisive advantage of the ease in creating a large number of naturally identical qubits. To use them for quantum computing, optical control of each qubit in a large array is indispensable but has been a challenge to the current technology. PEAQUE will overcome this bottleneck with MBIS's unprecedented multibeam control and modulation capability. The PEAQUE hardware will be mass produced at wafer-scale using industrial-scale foundries (Sandia National Labs), and disseminated, along with electronics and software, in a solution package to the quantum community. To achieve the useinspired research goals, our team consists of multidisciplinary experts in atomic physics, integrated photonics, MEMS, materials science, and quantum software.

Road Map

In Phase 1, we finalized the system design, developed the fabrication processes, and established a partnership with Sandia for foundry processes. In Phase 2, key milestones and deliverables include prototype MBIS modules, scalable manufacturing at foundries, control electronics systems, quantum software, and final atomic system demonstrations, in a timeline as listed below (starting from 09/2021):

Q2/Y1: Prototypes of single pixel MBIS

Q2/Y1: Field-programmable gate array (FPGA) control system with customized algorithm

Q3/Y1: MBIS integration with cold atom quantum system

Q4/Y1: MBIS integration with atomic clocks

Q3-4/Y1: Prototype of 10 pixel MBIS

Q4/Y1: Foundry process integration completed

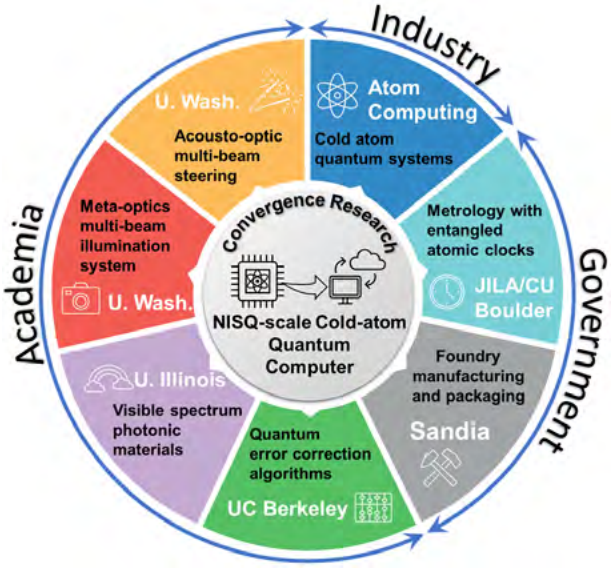
Q1/Y2: Fault-tolerate color code algorithms developed

Q3/Y2: Error correction executed in cold atom quantum system

Q4/Y2: Lattice atomic clocks developed

Q4/Y2: 8-inch wafer process completed

Q4/Y2: Test kit/package ready to deliver



Our multi-disciplinary, trans-sectorial effort to eliminate a bottleneck in scalable quantum computing.

Partnerships

Our key partners include researchers across three universities (UW: acousto-optics, nanophotonics, nanofabrication; UIUC: wide bandgap materials, UC Berkeley: quantum error correction), two national labs (Sandia: foundry services for waferscale MBIS fabrication; JILA: metrology and atomic clocks), and one key industrial partner (Atom Computing: cold atom systems for quantum computing and simulation).

Intellectual Property

Our team has established a comprehensive IP management plan that delineates the treatment of background IP, new IP generated through this project, licensing negotiation options, and confidentiality. With our experience in creating start-up companies, we will explore possible spinoffs for the PEAQUE technology.

QuaNeCQT

Quantum Networks To Connect Quantum Technology

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Overview

The internet fundamentally changed every aspect of our lives by enabling computers to communicate with each other over long distances. But the current internet is not compatible with emerging quantum computers that store and process quantum information. QuaNeCQT will develop hardware that will enable the current Internet to communicate quantum information over a vast network infrastructure, an essential requirement for the emerging quantum ecosystem.

Description

The current internet cannot transmit quantum information. This limitation relegates emerging quantum technologies, which are currently limited in their computational power, to be stand-alone systems that cannot be expanded or reach a broad user base. A quantum internet that can transmit quantum information would significantly boost quantum computing power by connecting multiple small quantum computers into powerful distributed quantum computers that can solve problems with major societal impact. It would revolutionize numerous industries that take advantage of quantum computing including banking, chemistry, medicine, and data analytics. A quantum network would also greatly increase the user base for quantum computers by providing secure access to end users (blind quantum computing) as well as certifying the legitimacy of quantum computing providers (quantum verification).

QuaNeCQT will enable internet service providers and networking companies to immediately transform their classical networks into the next generation quantum internet that delivers unprecedented security, data rates, and performance. We will do so by developing a comprehensive hardware solution composed of two modules, the the quantum modem and the quantum router.

The quantum modem and router modules provide a complete quantum networking solution that handles both the quantum data and classical data required to run a quantum network. They will be fully integrated and equipped with a user friendly software interface for ease of operability. By connecting them to various peripherals (quantum computers, quantum sensors, detectors, etc ...) we can build quantum networks that directly connect emerging quantum technology and can be easily expanded. The two modules convert a classical fiber network it into a fully-functional quantum network that can transmit quantum information and connect quantum computers. They therefore allow the quantum industry to immediately take advantage of the vast existing infrastructure that is our current internet. We will deploy and test these modules in the MARQI network, UMD and the DC area's local quantum network footprint which we have established in Phase 1 of the project.

Differentiators

Currently, a quantum internet that connects quantum computers does not exist. Emerging quantum networks have focused almost entirely on secure point-to-point communication using quantum key distribution. These networks use quantum signals to exchange classical information with security guaranteed by quantum physics. But they cannot transmit quantum information between quantum computers. They therefore cannot interconnect them to scale computation power. A quantum internet that transmits quantum information would provide this essential and currently missing component.

Our hardware solution will establish the first interconnection of quantum computers over the internet. It will allow quantum computers to work collectively to increase their processing power, and provide quantum links to end users for blind quantum computing and quantum verification. We will achieve

this unprecedented objective by combining the most viable quantum computing architectures with advanced reconfigurable quantum photonic devices that can convert and route quantum signals in a network. It will also enable internet service providers to leverage existing classical internet infrastructure and coordinate with leading ISP and network companies.

Road Map

In phase 2 we are developing compact packaged quantum hardware and deploying it in the MARQI network.

- **Y1-Q1-** Begin development of the qFC and qROADM modules.
- **Y1-Q2 -** Test hardware components and integrate hardware delivered from our industry partners
- **Y1-Q3 -** Package and integrate hardware modules.
- **Y1-Q4-** Develop software interface for qFC and qROADM modules. Establish plan for expansion and future connectivity of the MARQI network.
- **Y2-Q1 -** Deploy hardware modules into the MARQI network. Install ion traps in MARQI end-nodes.
- **Y2-Q2 -** Establish a connected network of ion traps over the MARQI network
- **Y2-Q3 -** Distribute entanglement over end-nodes
- **Y2-Q4 -** Demonstrate quantum communication between ion trap quantum computers with reconfigurable connectivity.

Partnerships

Team QuanNeCT has several core partners: (1) **Cisco** is helping to develop compatible hardware packaging and integration for a potential future product line; (2) **IonQ** is building the ion trap and will serve as a node on the MARQI network; (3) **Brain Holding Ventures** continues to guide the commercialization and use case scenarios; (4) **Shinkuro's** CEO serves as the Chair of the MARQI advisory board with expertise in the development of the internet (5) **Army Research Lab** (Department of Defense) provides one of the central nodes of the MARQI network; (6) **Qrypt** provided secure networking expertise, and will guide the secure internet use case during Phase 2. (7) **Ciena** advises on networking and software. (8) **Juniper Networks** serves on the MARQI Advisory Board and advise on the general direction of the telecommunication industry (9) **NTT electronics** and **ADVR** are providing customized quantum frequency conversion crystals, and (10) AIM and LionIx will fabricate photonic integrated circuits.

Intellectual Property

QuanNeCQT developed and is in the process of patenting multiple key hardware components of a quantum network, including the qROADM and qFC modules. We have established IP agreements with our partners and the university entities.

Quantum Sensors

Advanced Navigation And Sensing

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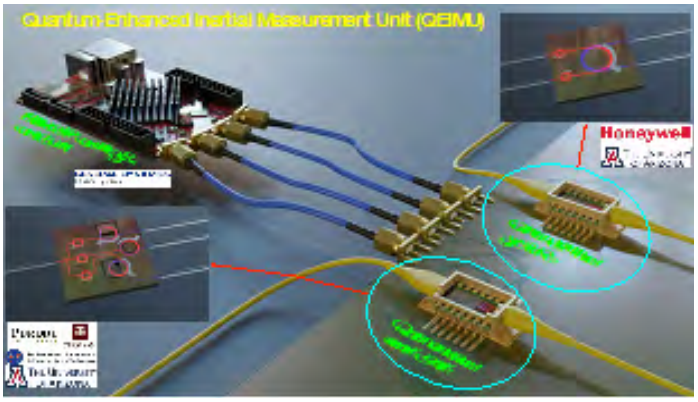
Overview



In this Convergence Accelerator Track C: Quantum Technology Phase 2 project, our highly interdisciplinary and cross-sectoral team will develop a quantum-enhanced inertial measurement unit (QEIMU) for positioning and navigation at a performance level well beyond the current state-of-the-art inertial sensors. Phase 2 will build upon the Phase 1 results, inputs from user interviews, and the concepts conceived with partners through prototyping meetings. The expected outcome of this project will be a landmark example of how quantum technologies can yield near-term societal impacts within a 5 to 10-year timeframe in diverse realms, such as aerospace navigation, self-driving cars, and space exploration.

Description

Phase 2 core team members are the University of Arizona (UA), General Dynamics Mission Systems (GDMS), Honeywell, NASA Jet Propulsion Laboratory (JPL), National Institute of Standards and Technology (NIST), Purdue University, and Texas A&M University (TAMU). The QEIMU prototype will comprise three principal pillars: 1) a quantum-enhanced gyroscope for angular velocity sensing (Honeywell, UA); 2) a quantum-enhanced accelerometer for linear acceleration sensing (Purdue, TAMU, UA); and 3) a backend processing unit for central control (GDMS). JPL will integrate the QEIMU components. Honeywell, JPL, and NIST will verify the QEIMU in their state-of-the-art calibration and environmental test facilities. The projected QEIMU performance for sensitivity, angle random walk, and bias is one-to-two orders-of-magnitude superior to the state-of-the-art classical inertial sensors. Therefore, QEIMU will enable unprecedented capabilities, including 1) spacecraft control and planetary terrestrial applications without a GPS-like system; 2) secure navigation for self-driving cars; and 3) precise measurements with entangled arrayed-weak force sensors for gravity, gravitational waves, and dark matter and energy, which have previously been scientifically unmeasurable. Since precise navigation and sensing are widely desirable and affect the daily lives of the general populace, we anticipate QEIMU will create a $2.5B market by 2035 and impact 700M people.

Differentiators

The high cost and large size, weight, and power (SWaP) of commercial optical gyroscopes and accelerometers prevent their market penetration for self-driving vehicles, autonomous robots, and various small-position and navigation platforms. While immense efforts have been dedicated to develop on-chip gyroscopes and accelerometers with reduced SWaP and production costs, due to weak signal-to-noise ratios their performance remains inferior to the navigation grade. The performance improvement from fabricating larger photonic components to strengthen the inertial sensing signal is saturated by material properties constraints. The noise floor is deemed a barrier dictated by the fundamental quantum noise.

This Phase 2 project will harness the revolutionary quantum sensing technology to break this noise barrier. We will miniaturize our quantum-sensing platform into a chip scale and integrate squeezed

and entangled light sources with gyroscopes and accelerometers. Such differentiation will lead to the QEIMU prototype and a paradigm shift in inertial navigation and sensing.

Road Map

The two-year Phase 2 timeline comprises parallel development of three key project components: 1) quantum-enhanced gyroscope (end-Q3 deliverable); 2) quantum-enhanced accelerometer (mid-Q4 deliverable); and 3) a backend processing and control unit (end-Q6 deliverable). The calibration and testing deliverables for the quantum-enhanced gyroscopes and accelerometers are both end Q6, after which we will converge all three components into the integrated and verified QEIMU prototype as the final, end-of-project deliverable.

Partnerships

The successful Phase 1 outcomes underpin Phase 2. In particular, UA's entanglement-enhanced optomechanical sensing proof-of-concept laid the foundation for the QEIMU prototype. In parallel, the Phase 1 team developed on-chip quantum-light sources (UA), wafer-scale optomechanical sensor arrays (Purdue), a test and calibration platform (TAMU and NIST), a backend processing and control unit (GDMS), and a modeling tool (UA). Phase 2 will readily integrate these functional modules to demonstrate QEIMU. Specifically, UA and Honeywell will develop a multilayer silicon-nitride platform to assemble QEIMU components. Honeywell will use its world-leading navigation sensor expertise to build quantum-enhanced gyroscope while Purdue and TAMU will collaborate to make triaxial accelerometers. GDMS, a certified electronics manufacturer for defense applications, will deliver QEIMU's backend processing and control unit. JPL will then integrate the individual components into the QEIMU prototype. The QEIMU calibration at NIST will be followed by environment tests at JPL to evaluate performance in future space-borne and aerospace applications.

Intellectual Property

UA and GDMS jointly own IP for an on-chip squeezed-light generation method and entangled radio-frequency photonic sensors. UA own IP for on-chip large-scale entanglement generation and has filed other quantum patent applications. Honeywell owns IP for integrated photonics and gyroscopes. We are coordinating with the tech transfer offices of each party to facilitate the success of the project.

Contribution to Quantum Ecosystem

Our project will help build a quantum ecosystem by distributing turnkey quantum-source modules to Convergence Accelerator teams and the broader community. Our contributions will include collaborating with Phase 1 projects QuPID and Hi-LINQS and Phase 2 project QuaNeCQT, and other labs on customized quantum photonics, working with Phase 1 project National Quantum Lieracy Network and Phase 2 project QuSTEAM on quantum education, and organizing workshops to engage stakeholders.

QuSTEAM

Launching An Equitable Solution To The Quantum Workforce Bottleneck

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Overview

We, QuSTEAM (Quantum Information Science, Technology, Engineering, Arts and Mathematics), are a team of researchers, undergraduate educators and education researchers, with experts across industry and our national labs. We are developing and improving an undergraduate curriculum and designing an inclusive scalable network so that all colleges and universities can offer their students access to modular interdisciplinary curriculum in quantum information science and engineering (QISE). We collaborate across 20 institutions spanning R1 research universities, national laboratories, 2-year colleges, and Minority Serving Institutions (MSIs) (e.g. HBCUs, etc.). Our focus: designing, implementing, and scaling research-based educational strategies to build a convergent and inclusive curriculum for a diverse community of future scientists and engineers.

Description

The development of QuSTEAM will rely on research-based educational practices to provide a convergent and inclusive curriculum to a diverse community of future scientists and engineers. The severe human-resource shortage in all areas of quantum science and engineering is projected to significantly slow the societal impact of the second quantum revolution. To address this need and accelerate the NSF Quantum Leap, a comparable leap in education strategy is required. The QuSTEAM curriculum will have a modular format with in-person, online, and hybrid delivery modalities to meet the educational needs of diverse stakeholders, including future quantum professionals and members of the current industrial workforce, community colleges, minority-serving institutions, and other bachelors and doctoral degree-granting institutions. We will draw on the extensive expertise of the core participants in both quantum research and STEAM education to create a new curriculum with multiple implementations at the module, class, minor, and certificate level to train a quantum smart workforce at the scale necessary to support economic development. QuSTEAM will incorporate professional development from two vantage points in order to successfully implement our research-based educational strategies. From the perspective of onboarding subject matter experts to incorporate research-evidenced pedagogical design (e.g. backwards and inverted curriculum design, etc.), we will convene workshops to support new QIS instructors within our team, and are preparing to scale that network of engagement to professors from additional institutions that want to join the network as the program scales. From the vantage point of faculty who are not subject matter experts in QISE (e.g. particularly not at R1 institutions) but wish to help implement QuSTEAM curricula, there are professional development programs focused on introducing QISE content and concepts to faculty being developed in parallel.

Differentiators

Our paradigm shifts away from the hierarchal model of most undergraduate STEM programs in the U.S., where the most engaging, enjoyable content (i.e. content focused on field-leading innovations and societal impact) is traditionally delayed until the later years and students are first introduced to basic skill-building exercises, contributing to student attrition. Further, traditional pedagogy isolates STEM from broader Arts and Sciences engagement. In contrast, the QuSTEAM curriculum will seamlessly blend fundamental skill building with engaging, innovation-focused content from the outset, resulting in an inclusive and student-centered convergent educational experience in line with both modern pedagogy and the workforce needs of the rapid expansion of the community working in quantum information science and technology.

We will continue to directly engage the STEAM education research community to employ evidence-based practices in our curriculum development

and will prioritize maximizing opportunities for diversity, equity and inclusion through targeted curriculum, instructor professional development, and independent external evaluation. By drawing from expertise at multiple institutions, students will have access to world-leading experts in QuSTEAM relevant disciplines - far broader access than is possible within a single university or college. This access will manifest in convergent course material and instruction, for example enabling hybrid in-person and virtual on-line environments that blend experts and students from multiple institutions, providing a unique teaching and learning ecosystem.

Road Map

During our needs finding and prototyping efforts, we have identified the establishment of a common template for an undergraduate minor and associated certificate programs as the key near-term target for workforce development. We are currently building out these degree and certification programs, including initial offerings of the critical classes and modules at our respective universities, while continuing with needs-finding and assessment to provide dynamic feedback on evolving workforce needs. Our introductory class was taught in Spring 2022 and the full slate of core classes for our minor are piloting at 15 institutions in 2022-2023. By Fall 2023, we anticipate having certificate and minor programs at all 5 of our R1 partners either approved or in-process as is locally appropriate. Additionally, QuSTEAM is developing cross-disciplinary materials for engaging with students outside of traditional STEM fields in the form of a seminar tentatively slated for autumn 2022, titled 'Quantumfor the Humanies', in partnership with QubitxQubit. We will continue to develop and improve QuSTEAM curriculum beyond NSF funding through our expanding network facilitated by the non-profit organization we are incorporating. This educational ecosystem is designed to be scalable to the national level and will provide a template for a novel approach to STEM education more generally.

Partnerships

Our team consists of academic, national lab, and industrial partners. The backbone of our 20-institution academic team consists of 5 R1 institutional partners that have committed to teaching QuSTEAM classes and developing degree programs (Michigan State Univ., Ohio State Univ. Univ. of Chicago, Univ. of Illinois, and Univ. of Michigan) and the IBM-HBCU Quantum Center which is coordinating faculty from 10 of their 23 member institutions led by North Carolina A&T Univ. In addition, each of the R1 universities have identified one or more partners with whom they have an existing transfer pipeline to support engagement with student populations beyond traditional STEM demographics for a total of 66 faculty with a mixture of STEAM subject matter expertise and discipline-based STEM education research. This academic team is supported by a network of 20 collaborators including academic centers such as the with NSF Quantum Leap teams (all 3 QLCI: CIQC, HQAN, and Q-SEnSE; QII-TAQS), connections to the Convergence Accelerator Phase 1 Track C cohort (Teams AQS, NQLN AI Powered Microcredentialing, QuPiD, and Quantum Sensors), and a DOE National Quantum Initiative center (Q-NEXT), as well as 14 industrial partners with interest in quantum workforce development, either as employers or as developers of educational content (or both): Applied Materials, GE Research, Honda, HRL, IBM, JPMorgan Chase, qBraid, Quantum Design, QED-C, Qubit by Qubit, Qutools, SRI, TOPTICA, and the Unitary Fund.

Intellectual Property

The IP generated by our program will be primarily in the form of copyrighted course materials and educational software in the form of simple simulators. We plan to make all of these materials publicly available using a standard Creative Commons agreement with attribution shared among contributing participants.

Photonic Technology Quantum Consortium (PhoTeQ-C)

Illuminating the Future of Quantum Technology

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Overview

Quantum photonics plays a pivotal role in future scalable quantum technologies for computing, communication, and sensing. Cutting-edge research conducted in labs needs to be exported to large-scale manufacturing facilities to impact the whole quantum industry and society. The PhoTeQ Consortium, to be founded by the four Track C: Quantum Technology teams of the NSF Convergence Accelerator (CA) program, seeks to establish quantum photonic device manufacturing standards in the format of a quantum photonic development kit (Q-PDK) that will be adopted by both the industry and academia. The Q-PDK and the knowledge base will facilitate the convergence of different quantum research fields to share the know-how and infrastructure and accelerate the lab-to-market of quantum technology.

Description

Photonic qubits and optically-addressed matter qubits (i.e., trapped ions, cold atoms, and defect centers) have many unique advantages such as compatibility with existing manufacturing infrastructure over electrically-addressed solid-state qubits for quantum computing, communication, and sensing. However, building scalable quantum systems with these quantum modalities universally requires scalable approaches and instrumentation to achieve optical control and integration on a large scale to reach extreme performance metrics in speed, fidelity, and efficiency. While such demands pose unprecedented challenges to current photonic technology, they also provide tremendous opportunities and spur pathbreaking innovations in photonic and optoelectronic materials, devices, and systems. Significant synergistic efforts in both academia and industry are necessary to make this vision a reality.

The Track C teams work on different critical quantum photonic technologies but share the need for scalable and standardized manufacturing of photonic devices. The PEAQUE team needs a large number of photonic modules to control neutral atoms and trapped ions to realize scalable quantum computers. The QuaNeCQT team requires stable and repeatable turn-key photonic devices to route and frequency convert single photons. The Quantum Sensors team desires scalable manufacturing of quantum light sources and sensors. The QuSTEAM team bridges these technical capabilities by focusing on education and workforce development for the emerging quantum economy.

Differentiators

Establishing a fabrication standard is critical to the development and proliferation of new technology by enabling large-scale, low-cost manufacturing. The success of semiconductor technology is the most prominent example and should be a guide for quantum technology. The various quantum photonic devices currently developed at individual labs use similar semiconductor processes that can be readily standardized. However, there has not been a collective effort in the research community to establish such a standard. Under the framework of CA program, the PhoTeQ Consortium leverages the ongoing collaborative efforts and established partnerships among academia, industry, and national agencies, to initiate the effort of establishing the manufacturing standard of quantum photonics devices.

Road Map

We will kick off the Consortium with a workshop on quantum photonics technology in Fall 2022. Our first step will be to build a library, in industry-standard formats and tools (e.g., KLayout, Python, ANSYS/Lumerical), of devices, design, simulation, and fabrication processes that our teams are developing respectively. The library is compatible with those used by the semiconductor industry. In parallel, we will identify the skills and capabilities needed for the emerging quantum workforce to engage with these

design and fabrication processes. The initial version of the Q-PDK will be based on the technology capability of government facilities such as Sandia National Laboratory and NIST's nanofabrication facility, and later will be translated to commercial foundries. The major goal is to build an expandable, open-box framework such that the Q-PDK can be readily amended by all users (even students) to include the technologies provided by new fabrication foundries.
The PhoTeQ Consortium will ensure the sustainability of this effort through partnerships with public and private institutions so that the Q-PDK can be broadly adopted. The knowledge base will be disseminated to education and workforce training programs through curriculum and learning modules. The Q-PDK will evolve and adapt responsively to cutting-edge research and propel the advance of quantum photonic technology.

Partnerships

Each Track C team has already built its own extensive network of partners and collaborators, who will become the founding members of the Consortium and contribute to Q-PDK. Those partners include academic institutes, government agencies and labs (Sandia, NIST, Lawrence Livermore, Argonne), and industry (Honeywell, IonQ, Atom Computing, IBM). As an open-approach organization, the PhoTeQ Consortium welcomes new members and partners from all sectors interested in utilizing and expanding the Q-PDK—from academia, industry, government, non-profit, and others.

Intellectual Property

The IP management of the Consortium will be governed by an overarching agreement. The Semiconductor Research Corporation (SRC) has been a good model. Generally, each entity participating in the Consortium maintains all claims to existing IPs, including proprietary data. The IPs developed as part of the integration activities will be jointly owned by the contributors and made available for licensing to the members of the Consortium. Each team member will retain IPs developed as part of their individual efforts.

TRACK D:

AI-DRIVEN DATA SHARING AND MODELING

Today's modern technological and logistical systems acquire large amounts of data, requiring organizations to protect the and respect the data as a whole, and at the individual privacy level. AI research and development requires access to high-quality datasets and environments, testing and training resources, and collaboration between academia and industry to develop technical solutions to address this large-scale challenge.

The NSF's Convergence Accelerator Track D: AI-Driven Innovation via Data and Model Sharing is funding solutions to address data and model-sharing challenges through tool and platform development to enable easy and efficient data matching and sharing, and privacy protection tools and processes to ensure secure access to sensitive data. NSF-funded projects are also developing technical solutions to enhance power grid reliability, reduce the risk of wildfires and biological threats, enhance animal health, and interact with vast amounts of data to improve hydrologic scenarios and polymer materials research.

AI-Driven Innovation via Data and Model Sharing funded phase 2 teams include:

- **AI-Grid**—Coordinated networked microgrids provide significantly enhanced power grid reliability and allow for more green energy solutions to go online. Led by Stony Brook University, AI-Grid is an AI-enabled solution for managing networked microgrids. Using a programmable platform that integrates deep learning, reachability analysis, formal control, and high-assurance software architectures, AI-Grid is being deployed at three highly influential networked microgrids, where it will demonstrate its capabilities to modernize and decarbonize America's power sector.
- **BurnPro3D**—BurnPro3D enables safe and effective prescribed burns at the scale required to proactively reduce the risk of devastating megafires. The platform, led by the University of California, San Diego and powered by WIFIRE Commons, transforms the work of burn bosses and land managers through access to AI, high-resolution data, 3D fire modeling, and visualization capabilities for collaboration and optimization.
- **Computing the Biome**—The world needs intelligent systems for detecting and predicting biological threats. Led by Vanderbilt University, Computing the Biome is creating a data and AI platform for monitoring and predicting biothreats in a major U.S. city, and to drive economic sustainability by empowering businesses and advanced science missions to deliver valuable consumer apps and breakthroughs.
- **CRIPT**—Led by Massachusetts Institute of Technology, CRIPT, an AI-enabled cloud application and database, allows polymer scientists to easily find and interact with complex data. Delivered by a team of experts in materials, information systems, and computer science, CRIPT accelerates material innovation tenfold, reducing research and development costs by more than $1B.
- **HydroGEN**—Led by Arizona University, is a web-based machine learning (ML) platform, generating custom hydrologic scenarios on demand. The solution combines physics-based simulations with ML and observations to provide customizable scenarios from the bedrock through the treetops. Without any prior modeling experience, users can manipulate state-of-the-art tools to explore scenarios that matter to them.
- **Precision Epidemiology (pEPIC)**—Sustainable livestock production requires proactive and refined best management practices that enhance animal health at the farm. Led by the University of California, Davis, The Precision Epidemiology Consortium converges data, AI models and expertise across the livestock production and health space, providing an online user-friendly platform, The Disease BioPortal, for prediction and effective management of animal health problems.

Integrating AI-Driven Innovation via Data and Model Sharing

Convergence Research (CORE) Institute—The AI-Driven Innovation via Data and Model Sharing phase 2 teams are collaborating on "track integration" to create the Convergence Research Institute or CORE Institute. The CORE Institute provides graduate students and early and mid-career researchers and professionals with a foundational experience to position them for impact on the most challenging societal issues of our time. The program gives participants the skill sets and networks to identify use-inspired problems and build convergent teams to deliver impactful solutions.

AI-Grid

AI Enabled Programmable Networked Microgrids

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Overview

Coordinated networked microgrids (NMs) promise to significantly enhance power grid reliability. Three main challenges prevent their wide adoption: 1) Lack of understanding of NM dynamics; 2) Big data but limited/unscalable analytics; 3) Cyber-infrastructure bottlenecks and attacks. This project aims to develop AI-Grid: AI-enabled, provably resilient NMs. Key innovations are a programmable platform integrating reliable NM modeling under uncertainty, reachability analysis, formal control, high-assurance software architectures, and cybersecurity technologies to enable scalable, autonomic, and ultra-resilient microgrids and NMs.

Description

Microgrids are a promising new paradigm for electricity resilience. In August 2017, for example, multiple microgrids kept critical community services running in Houston despite utility grid outages caused by Hurricane Harvey. Coordinated NMs, which allow microgrids to coordinate to support various smart city functions, are expected to provide increased electricity resilience during extreme events. As anticipated by the U.S. Department of Energy, Reseaerch & Development of NMs will lead to the next wave of smart-grid research, which will help achieve the vision of a highly resilient grid. NMs are also expected to empower our nation's digital economic engine – the swiftly growing data centers. Recently, global Internet traffic surged by 40% between February and mid-April 2020 during the height of Covid-19 containment measures, as a result of social activities moving online. This growth, coming on top of an exponential growth in demand over the past decade for data and digital services, makes uninterrupted data services of paramount importance.

Three main challenges have prevented NMs from serving as dependable resilient power resources and thus prohibited their wide adoption: 1) Lack of understanding of NM dynamics under frequent changes in status, ubiquitous uncertainties, fast ramping, low inertia, and non-synchronism; 2) Big data but limited and unscalable analytics as current technologies are unable to handle the volume of dynamic data needed for real-time decision making; and 3) Bottleneck in cyber-infrastructure due to delays, congestion, failures, cyberattacks, and the ever-increasing pace of functional/structural changes that can plague microgrid cyber-networks.

To address these challenges, this project is developing AI-Grid: AI-enabled, provably resilient NMs. Key innovations are a programmable platform that integrates reliable modeling and prediction of system states under uncertainty, reachability analysis, formal control, high-assurance software architectures, and cybersecurity technologies to enable scalable, self-protecting, autonomic and ultra-resilient microgrids and NMs capable of coordinating ultra-scale distributed energy systems and cultivating America's smart communities and cities.

Differentiators

AI-Grid is a hardware-independent, software-defined platform that will enable previously unseen low CAPEX/OPEX and improved social welfare for communities in need. It optimizes the use of real-time modeling and analysis to provide low power and energy costs with guaranteed high reliability, resiliency, and cybersecurity. It achieves AI-enabled microgrid operation, learning-based microgrid modeling, and a neural Simplex architecture for runtime safety and security assurance

Road Map

A functional AI-Grid prototype platform will be fully tested and verified on Stony Brook University's networked microgrids testbed by September 2022. Field testing will be completed on ComEd's Future

Grid Lab in Chicago by December 2022. AI-Grid will be demonstrated in ComEd's Bronzeville Community Microgrid in 2023 and will be implemented in the Energy Management Systems of Energy & Innovation Park (EIP, a $1B microgrid in Connecticut) by September 2023. Finally, AI-Grid models, data, and training materials will be made accessible to US communities by August 2023.

Partnerships

Strong, cross-cutting partnerships are pivotal to AI-Grid's success. The AI-Grid team has established 29 partnerships with America's leaders in all relevant sectors. The team's end-user partners include *Commonwealth Edison's* world famous networked microgrids in Chicago City, the U.S. Navy's microgrids, and *Energy and Innovation Park*, a $1B data center microgrid project. The team is developing an open-access programmable AI-grid platform with industry partners such as Hitachi America and Schneider Electric. Major power utilities, including ComEd, ISO New England, PSEG Long Island, National Grid, and Eversource Energy, will provide data, guidance on grid integration and risk management, and assistance in the evaluation. Industrial partners include prominent companies in the power industry: RLC Engineering, RTDS, SEL, Schneider Electric, Quanta Technology, and Bloom Energy. These partners will provide equipment, data, dynamic models, and technical support. Connecticut Center for Advanced Technology (CCAT) will coordinate engagement between the academic and industrial partners. Brookhaven National Lab, with its New York Center for Grid Innovation, will collaborate on research, evaluation, and dissemination of AI-Grid.

Intellectual Property

The intellectual property used in the AI-Grid platform is being developed by the PIs' research groups. So far, the team has submitted 20 invention disclosures, 1 U.S. patent application, 1 international patent application, and several provisional patent applications. The AI-Grid platform will be publicly released to promote broader adoption and impact. IP agreements covering shared data, models, etc., will be negotiated with each relevant partner.

BurnPro3D

Fighting Wildfires Proactively With WIFIRE Commons

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Overview

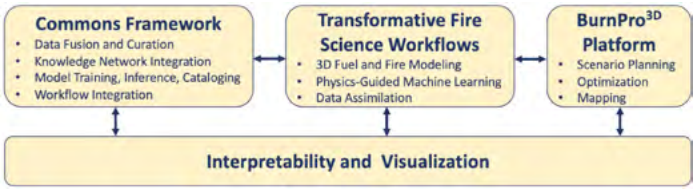
A century of suppressing wildfires has created a dangerous accumulation of flammable vegetation on landscapes, contributing to megafires that risk human life and property, and permanently destroy ecosystems. Small controllable fires can dramatically reduce the risk of large fires that are uncontrollable. BurnPro3D is a decision support platform to help the fire response and mitigation community understand risks and tradeoffs quickly and accurately to more effectively manage wildfires or conduct controlled burns.

Description

In 2020, wildfires swept across 10 million acres in the western U.S., killing dozens, destroying 10,000 structures, and causing $15 billion in property damage. Tens of thousands of firefighters risked their lives to fight the fires. The 2019-2020 fire season in Australia was a warning that the problem can worsen worldwide. Almost 50 million acres burned, driving some species to extinction, and emitting 300 million tons of CO2.

Over the last decade, the WIFIRE team developed the first digital infrastructure to accelerate fire science and management through data, computing, and artificial intelligence (AI). Our initial efforts transformed the way fire response is being managed in California during the first six hours of a fire. However, even the most sophisticated approaches to fighting fires are reactive and cannot always control fire under extreme weather conditions. There is an urgent need to turn to proactive approaches to reducing the risk of severe fires by removing dangerous accumulations of vegetation.

Our platform, BurnPro3D, is powered by the next-generation WIFIRE Data and Model Commons. The platform provides diverse users a common ground for understanding risks and tradeoffs related to controlled burns and wildfire management through detailed models of vegetation and fire behavior. BurnPro3D can be used in fire mitigation by land managers and burn bosses to prioritize land for treatment and conduct controlled burns. It can also be used in fire response to evaluate unplanned fires for opportunities to work with incident commanders to manage wildfires to benefit ecosystems, instead of focusing solely on suppression. BurnPro3D provides unique capabilities for active collaboration among these users, providing 3D, high-resolution models to increase the proactive use of fire to end devastating megafires. In both fire mitigation and fire response, BurnPro3D can support users in communicating risks and tradeoffs to regulators and the public.



Differentiators

Currently, wildfire related data, models and interfaces exist in silos. WIFIRE Commons is a community-facing data system to bring these resources together. As an example, with our partners, we generated the first 3D fuel datasets at the continental scale at 1m resolution to ingest into next-generation fire models and connect to the BurnPro3D platform. The Commons enables the AI innovations necessary for users to optimize controlled burns and improve wildfire management using fire model predictions made accurate by 3D weather and vegetation data at a 30X higher resolution than previously available.

To achieve this vision, we are developing specific AI innovations to: (i) Use *knowledge management*

techniques to fuse data coming from diverse sources and prepare it for fire modeling; (ii) Conduct *physics-based machine learning* within next-generation fire models to use deep learning to understand complex processes that drive fire behavior; (iii) Apply *constraint optimization* methods to address complex tradeoffs in the decision process for the placement and timing of controlled burns; (iv) Employ *explainable AI* to increase the interpretability of data and models by diverse users all along the decision-making chain.

Road Map

Our platform supports users as they create 5-year fire management plans, prepare burn plans, and implement prescribed burns. Over the last year we have finalized the user experience for burn planning. In the coming year, we will finalize the user experience for creating fire management plans and implementing burns. We will continue to work closely with our test users in our demonstration network to fully scope requirements and build out the proof of concept for the platform, showing that our users can collaborate more effectively via BurnPro3D. Our work next year will also focus on efforts with our collaborators to prepare plans to disseminate our minimum viable product for broad use among federal users in the fire management community. In parallel, we will continue to develop the WIFIRE Commons framework that BurnPro3D is built on, creating a space for the scientific user community to collaborate on AI-enabled fire science. We will also host sessions with potential future users who would benefit from platforms developed to solve related challenges, e.g., making decisions about how to manage power lines to prevent fires or when it is safe to send mutual aid during a fire. Last, with our federal and NGO partners, we will solidify a model for long-term sustainability

Partnerships

As exemplified by our 50+ collaborators and partner institutions, our multi-disciplinary team is supported by a consortium of influential advisors and users from 12 academic, ten for-profit, 16 government, and eight nonprofit entities, in addition to other NSF Convergence Accelerator teams. Through these partnerships, we are building a culture of creating public/private partnerships as a vehicle to extend reach and use, while ensuring integration into existing systems for fire response and mitigation.

Initial partners contributed expertise, data, models, model products, prototype testing, evaluation and feedback. These core partners will adopt WIFIRE Commons for their operations and serve as the beta users of the BurnPro3D platform. They will be joined by an expanded list of partners focused on transitioning our research to practical use, including various U.S. Foreset Service Stations, U.S. Geological Survey, California Governor's Office of Emergency Services, Orange County Fire Authority, Los Alamos National Laboratory, Sandia National Laboratory, U.S. National Oceanic and Atmospheric Administration, and the U.S. National Aeronautics and Space Administration. Our convergence research effort focuses on accelerating solutions by transferring technology to agencies in ways that complement existing focus and strategic direction

Intellectual Property

The WIFIRE Commons team is committed to open-source development and embraces the FAIR principles. The data and models in the Commons will be made available for use through open license for researchers. We will create restrictive data and software distribution and use agreements when necessary. All other data and models will be publicly available. Commercial applications built on top of the Commons by our external partners and others will be encouraged.

Computing the Biome

Sensing And Predicts Biothreats With AI

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Overview

Individuals, industries, societies, and governments want to stay healthy. They need cost-effective systems to detect biological threats and predict future disease outbreaks as early as possible. COVID-19 acutely and painfully demonstrated the impacts of the unpredicted. The goals of this program, *Computing the Biome*, are twofold: (1) demonstrate an extensible data and AI platform that continuously monitors and predicts biothreats in a major U.S. city, and (2) create a framework for economic sustainability and global scalability of these results, by empowering businesses and advanced science missions to consume predictions and produce valuable consumer apps and breakthroughs.

Description

Predicting biological threats is hard. Earth's *biome* is home to hundreds of millions to possibly a billion species ranging from nanometer-sized viruses to kilometer-sized forests. These species are interconnected, co-evolving, and *moving* at breathtaking scales and speeds. As a result, biological threats such as emerging diseases, invasive species, and agricultural pathogens can appear unexpectedly and quickly harm our societies and ecosystems. They already cause hundreds of billions of dollars per year in economic damages.

Predicting these will require: (1) *continuous data* streams not yet available today, (2) *detailed models* harnessing expertise from across the science domains, and (3) modern *AI platforms* that use data and models to *compute the biome* in real-time – just as we continuously *compute* weather forecasts using real-time data streams and models.

Fortunately, revolutions in sensing technology and AI, coupled with cross-sector demand are about to transform how we compute the biome and predict threats. First, this team will produce and interconnect novel data streams ranging from kilometer-scale *hyper-local* weather, to *autonomously identified* disease transmitting insects (millimeters in size), to *genomically recognized* known and novel viruses (nanometers in size) – demonstrating that cross-cutting continuous data streams for biothreat detection and prediction can be rapidly unlocked.

Next, the team will combine their expertise in ecology, epidemiology, and virology to design new predictive models and anomaly detectors. Our team will develop the first of these high-impact AIs focused on predicting mosquito-borne diseases, which are difficult to control and impact over 600 million people per year. More broadly, the resulting data platform will empower development of new foundational methods for use by the AI community – based on real-world data and grounded in the societal challenges of our age.

Finally, economic sustainability will depend on a vibrant ecosystem where businesses and global missions can consume state-of-the-art models and produce applications and insights that people want to use. Even before COVID-19, the U.S. spent >$1 billion per year on biothreat mitigation. We want to deliver solutions that benefit these critical efforts.

Differentiators

Our main premise is that only a modern sensor network – that continuously monitors species at geographic scales across environments – will be capable of predicting complex biothreats early enough to manage risks. This perspective is based on the successes of existing sensor networks and AI models to monitor and predict other complex phenomena (e.g. weather systems, smart power grids, and transportation systems).

Today, outbreaks of human disease are usually detected through clinical case data, news reports, and other digital data. WHO's GOARN system is a global aggregator of many of these data sources. It has successfully detected outbreaks early, but generally not early enough to stop their spread.

On the other hand, efforts like USAID's PREDICT program preemptively sampled the environment to look for future novel threats, even sampling coronaviruses in bats in China prior to COVID-19. However, these programs rely on manual sampling. We believe new platforms and AI could empower and help scale these important efforts.

Road Map

Our first user is Harris County, Texas – home to the city of Houston and 4.7 million people.

First six months (foundations): (1) a unified data platform housing new biome data streams and tools for simulating biomes, (2) an equitable AI that uses simulations to design fair sensor networks – to be released as a global health planning tool, (3) initial command and control systems for Harris County.

First year (protect against known): (1) socially equitable deployment of a sensor network into urban areas with high risk at West Nile Virus (WNV), (2) streaming of biome data into continuous predictions, and (3) release of initial data snapshots for use by public health, science, and AI research communities.

Year 1.5 (detect unknown): (1) development of biome baselines for detecting anomalies such as insecticide resistance and invasive species, (2) release of upgraded tools that guide insecticide use to reduce dangerous resistance and maximize sustainability, (3) sensor network guided just-in-time deployment of genomic capabilities to detect unexpected and novel threats optimally.

Year 2 (sustainability): (1) real-time biome models going beyond WNV to other threat classes such as emerging human and agricultural pathogens, (2) AI-based biodiversity models, (3) creation of a non-profit to manage infrastructure and support business and science access.

Partnerships

(1) *Microsoft:* sensor nodes, species recognizers, models, and industry leadership. (2) *Tomorrow.io:* hyperlocal local climactic models for habitat suitability including newly launched satellite-based weather radars. (3) *Harris County Public Health*: equitable deployment and management of systems over the 1,800 mi2 of Harris County, Texas. (4) *Vanderbilt University:* open-source data platforms and application design studios for the wider community, and academic leadership. (5) *Johns Hopkins University*: AI-ready disease control policies and coordination with global health missions. (6) *University of Pittsburgh*: genomic data analytics for microbial threat detection and liaison with biotech stakeholders. (7) *University of Washington:* AI-enable epidemiological models and forecasts built on top of the above capabilities.

Intellectual Property

Open platforms will be utilized, and arrangements have been made for data and code releases under open data and code licenses.

CRIPT

Bringing The Age Of Information To Polymers

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Overview

Polymer materials, ranging from clothing and personal protective equipment to construction materials and food packaging, are fundamental to providing for our basic needs for food, shelter, health, and transportation. However, developing new polymers for next-generation products takes decades, and we must move faster to remain competitive. To accelerate this process, we are developing CRIPT, a *polymer* data ecosystem consisting of a web-based application and cloud database that allow polymer scientists to easily find, archive, and interact with complex polymer data. AI-driven chemistry tools and data-driven workflows within CRIPT will reduce the development time for polymer materials by an order of magnitude, creating a transformative impact on both the producers and buyers of the nearly $600 billion of polymers sold each year.

Description

The diversity of polymers and their properties has enabled them to fill critical roles in nearly every sector of our modern economy. However, this diversity also yields an incredibly large chemical design space, making it extremely challenging to navigate. To make the development process tractable, scientists often search locally, starting from known solutions and exploring new chemical designs around proven polymers. Being able to quickly review existing material designs and identify those having optimal properties is critical to accelerating polymer development.

Currently, searching among existing polymers is a daunting task because polymer data exists as small, disparate sets, making the navigation a complex process combining the harmonization of different data formats and the reconciliation of metadata, both of which currently require expert intervention. CRIPT offers a cloud database based on a new polymer-specific data model that simultaneously provides interoperability across different domains of polymer science and engineering, while retaining critical metadata that allows domain experts to correlate information across many independent records. A series of chemically inspired AI innovations, including a chemistry-based query language, a graph-based schema preserving temporal structure in data, algorithms for automatic data validation, AI-human cooperative tools for data ingestion, and the integration of machines into the data ecosystem are also provided to add FAIR principles, trust in data, and ease of use to the system.

We anticipate extensive adoption of CRIPT will have a significant economic impact by leading to a more than $1 billon reduction in R&D costs for new material innovation and a societal impact by accelerating the speed of discovery twofold of the next generation of medical therapies, sustainable packaging, lightweight transportation materials, recycling technologies, and advanced textiles directly improving the quality of life for all Americans.

Differentiators

Current digital data solutions for polymers are fragmented and presented without adequate context to make data findable, interoperable, or reusable. Polymer data is provided as disparate, specialized sets each containing, at best, hundreds of polymer samples. In most cases, metadata associated with the reported properties, such as how physical or chemical measurements were carried out, as well as how each material sample was made, are not explicitly provided, limiting the data's utility.

CRIPT resolves these issues by structuring data so that connections can be easily drawn between polymers, processes, and properties. This data structure documents and indexes the heretofore lost

history associated with the making of a material. This feature alone provides a key advantage over existing polymer data solutions, wherein scientists must rely on rare domain expertise and multiple data sources to obtain the same information. As materials history provides a rich context for how a material is made and characterized, this allows CRIPT to assimilate data across sources with highly different standards, reconciling data and providing universal access.

By implementing new advances in AI, CRIPT's ecosystem enables an intuitive workflow: a new chemical structure query language provides for intuitive data search, natural language processing is used to translate users written descriptions into the standard data format, and validation tools help users to trust the data that they are encountering within the ecosystem. Coupling these features with visualization, analysis, and data set construction tools enables teams to share, collaborate, and communicate like never before to accelerate their innovation.

Road Map

Q4-Q1 2021/2022. ***Partner-centered design phase (Complete):*** CRIPT team did refine our data model, developed ingestion tools, visualization tools and is continuing to develop more the platform. We had our fist CRIPT launch on April 28th, and currently is open only to our early-adopter partners.

Q2-3 2022. ***Community adoption phase:*** Design informative workflows and datasets with community users. Develop security infrastructure for housing open datasets. **Milestone:** Release CRIPT as a public tool with ingestion and visualization features for the community.

Q4-1 2022/2023. ***Industrial expansion phase:*** Develop data privacy infrastructure for working with industrial partners and ability to use tools across disparate data collections. **Milestone:** Develop private instances of CRIPT and integrate tools from Track D partners for data privacy and federated learning.

Q2-3 2023. ***Incorporation phase:*** Establish corporate structure for start-up overseeing continual development of CRIPT. Milestone: Spin CRIPT into an independent non-profit that continues to maintain and improve the ecosystem.

Partnerships

Our multidisciplinary program brings together experts across academia (MIT and University of Chicago: polymer domain experts & computer scientists in AI/ML), industry (Citrine Informatics: database specialists & software development; Dow: industrial polymer experts), and government (NIST: expert in informatics and standards). Our partnership with six academia research laboratories, four multi-institute research centers, three government labs, five materials manufacturers, and three industrial polymer consumers spans the full spectrum of stakeholders. We will also directly collaborate with four other teams within Track D: AI-Driven Innovation via. Data and Model Sharing, both leveraging their tools for searching data sets and models, federated learning, data privacy, and 3-dimensional modeling developed in the Convergence Accelerator program within our own ecosystem. Conversely, our tools for validation, schemas for organizing and integrating small data, search tools, and data extraction algorithms will make valuable contributions to their efforts. To help catalyze further collaboration and community engagement, we will host several symposia and short courses for Track D and the polymer community.

Intellectual Property

CRIPT's AI innovations will be freely distributed. The data models and conceptual designs will be openly licensed; the associated code will be distributed open source under the MIT license. The code to operate the CRIPT app will be proprietary to CRIPT. Data will be FAIR compliant.

HydroGEN

A machine learning platform for hydrologic scenario generation

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Overview

HydroGEN is a web-based machine learning (ML) platform to generate custom hydrologic scenarios on demand. We combine powerful physics-based simulations with ML and observations to provide customizable scenarios from the bedrock through the treetops. Without any prior modeling experience, water managers and planners can directly manipulate state-of-the-art tools to explore scenarios that matter to them.

Description

Water is the driving force behind extreme events like floods, droughts and wildfires. These events have cost the US $234.3B in damages just in the past three years, and this figure is projected to increase. Recent events like the record setting wildfires in California and the mega drought on the Colorado River are merely the latest illustrations. Historical data are no longer a reliable guide for the risks we will face in the future. This uncertainty poses a huge challenge for decision makers.

The scientific community has developed models that can simulate complex changing systems. However, they are too computationally expensive for non-modelers to develop and use. As a result, the tools used for decision making lag behind the science and are often severely limited in their ability to predict evolving systems.

HydroGEN places sophisticated models in the hands of planners and decision makers. We train ML emulators on advanced physically based simulations and the observations, letting our users build customizable scenarios without any prior ML experience. Our platform goes beyond streamflow and is designed to provide spatially distributed simulations of complete watersheds.

Early adopters include water management agencies and resource managers interested in wildfire risk. Our external advisory board of second-generation users include water utilities, management districts, consultants, state officials and nonprofits.

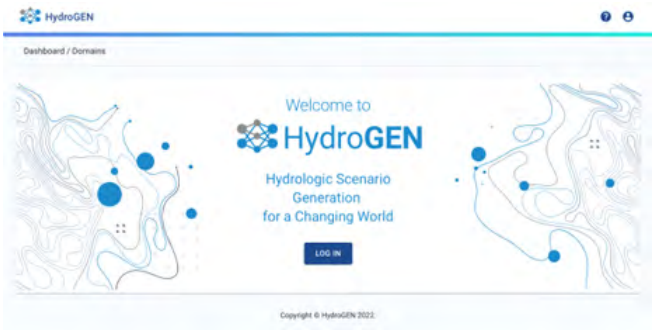

Figure 1: The splash screen of the HydroGEN platform

Differentiators

We know that data-driven models are not well equipped to predict out-of-sample behavior. What sets our team apart is our ability to train ML models for extreme events. HydroGEN builds off the first and only physics-based high-resolution groundwater surface water model in the US. This gives us a unique ability to train ML models using state of the science tools with a proven ability to capture watershed changes in both the surface and subsurface for events that have not yet happened.

Another major barrier to entry for advanced simulations are compute and data requirements. We have designed a scalable approach that allows our users to bring their own compute allocations and apply them directly in workflows without requiring any expertise in cloud computing. Thus, we can rapidly grow our user base with minimal hardware requirements.

Finally, we have integrated two early adopters directly into our team and provided funding for them to closely engage in our design process. This means that

in addition to our broader pilot studies, we will have immediate and direct input on our development from early adopters with projects that are already reaching millions of Americans.

Road Map

We recently launched our minimum viable product (MVP) and are in an internal testing phase. This MVP runs our end-to-end workflow nationally.

- We will release our platform for beta-testing in September 2022. This will launch our first pilot user experience. The beta web interface will provide a platform for our first user experience tests.
- By December 2022, we will have our first public release: a national platform that can execute our end-to-end workflow using internal and external compute resources. We will launch additional pilot studies using the first national platform release.
- Our second release in 2023 will custom user applications and dashboards, as well as performance improvements for our ML architecture.
- Our second national platform is slated for release in August 2023. We will also focus on broadening our community of users for Phase 3.
- After Year 2, we envision Phase 3 operations rooted in subscription-based services.

Partnerships

Our core development team includes interdisciplinary experts from university, industry and government agencies. Software development is led by CyVerse; an NSF cyberinfrastructure project specializing in data and a workflow management with more than 100,000 users from thousands of institutions. Additionally, we have partnered with ViQi, a software company specializing in large-scale ML and data processing with interactive cloud-based visualization. Our modeling approach is built from the HydroFrame platform – the only high-resolution physically-based groundwater surface water model available for the US. Our ML team is led by the Princeton Center for Machine Learning with ML experts at three academic intuitions.

Our two early adopters are: (1) the Bureau of Reclamation, which is the nation's largest wholesale water supplier providing water to more than 31 million people and 10 million acres of farmland, and (2) WIFIRE, an operational fire response system for the State of California with more than 800,000 users. In addition, we have assembled an external advisory board that will guide our pilot studies and expanded user engagement. Our board includes federal agencies, regional and state-level water managers across five states, environmental consultants, national water programs and environmental groups (e.g., U.S. Geological Survey, Water Now Alliance, American Water, The Nature Conservancy).

Intellectual Property

All of the core tools of our platform are open source. Our sustainability plan follows a Software as Service model – we intend to implement a subscription-based model for access to the HydroGEN platform.

Precision Epidemiology (pEPIC)

Data Driven Disease Prevention and Control In Animal Health

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Overview

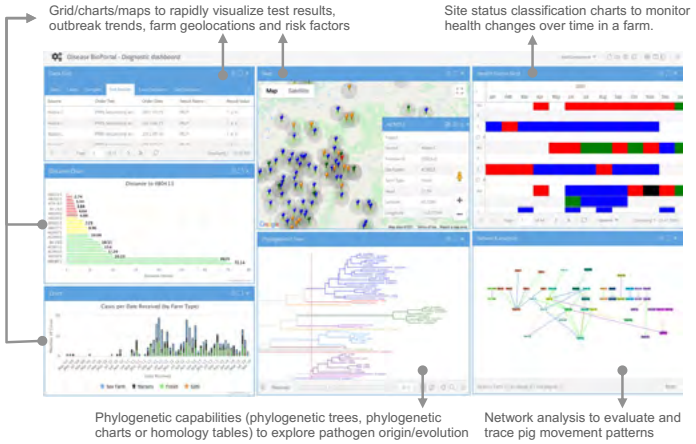
Sustainable livestock production systems are needed to feed a growing world while protecting the planet. Livestock farming systems, in particular pork production, play a significant role in addressing this global challenge. However, sustainability of the livestock industry hinges on the maintenance of elevated animal health and wellbeing, and high production efficiency. Our Precision Epidemiology Consoritum converges data, AI models and expertise across the livestock production and health space, providing an online user-friendly platform, called Disease BioPortal (*https://bioportal.ucdavis.edu*), for prediction and effective management of animal health problems.

Description

The US livestock industry has an enormous socio-economic impact with $195 billions in sales annually and >5.5 million jobs. In this project we focus on the swine industry, which is currently facing important global challenges with both endemic and emerging issues (e.g., swine influenza, antimicrobial resistance, African swine fever pandemic). However, our models and outcomes have been designed to be adapted to other disease and species by minor modifications in the data structure to strengthen the resilience of the livestock industry.

In swine production, disease outbreaks represent a significant economic loss for the industry, reducing productivity, compromising animal welfare, and leading to an overdependence on antimicrobial drugs. Furthermore, the introduction of foreign animal diseases, such as African swine fever, could have cost $50 billion in losses and would worsen the current protein gap. Therefore, early detection and mitigation of animal health issues become crucial not only to maximize production efficiency and food safety and security but also to mitigate catastrophic health and economic consequences.

Our end-user interviews revealed three main barriers to improve animal health: 1) lack of data availability, integration, sharing, and use 2) poor data efficiency, data governance and privacy, and 3) absence of explainable prediction models and accessible user-friendly visualization tools. Our Disease BioPortal platform integrates multilevel animal health data with advanced prediction models, providing end-users (including farmers, veterinarians, pharmaceutical companies, researchers and policy makers) an easy



and secure access to data and models through a simple user interface to support animal health decisions.

Differentiators

Current practices in the swine industry are usually reactive as most of the testing/interventions take place after having an outbreak or observing unusual clinical symptoms in animals. Ideally, we shall have a predictive early warning system that enables prevention, earlier detection, and faster control of problems both at animal and farm level. Our pEPIC approach and Disease BioPortal platform offers four unique value propositions: (1) a user-centered

design informed by interviews with more than 40 organizations from pig companies to veterinary clinics and diagnostic labs, (2) data standardization, integration, secure sharing and communication capabilities, (3) innovative AI-based prediction models, cutting edge visualization tools, and domain-specific applications of data and models, and (4) a convergent team and academic-industry partnerships that brings together leading organizations, data providers, end-users and experts in computer and data science, visualization and computer-human interaction, causal discovery, software engineering, bioinformatics, epidemiology and animal health, diagnostics and management.

Road Map

Accomplishments in year 1 include:

- Data collection, standardization, integration and curation to generate AI-ready datasets and facilitate data usage/sharing
- Development of AI models (including explainable machine learning models, causal discovery and reasoning and topic models), testing and selection of the best models.
- Expansion of our working groups with selected industry partners and end users to incorporate new data sources, increase our user cases, receive feedback and enhance user experience during the beta testing of Disease BioPortal new capabilities
- Development and testing the mobile version of Disease BioPortal, a key differentiator requested by many end users to be able to use it "on-the-go".

Plans for year 2 include:

- Integration of the best AI performing models into user-friendly dashboards within the Disease BioPortal to facilitate their use/visualization by stakeholders
- Development and implementation of a federated learning approach to collaboratively share models without sharing the data.
- Release of the new version of Disease BioPortal (new data, AI and visualization capabilities available for all end users)
- Organize Data challenges using large datasets to solve real-world problems in animal health
- Develop and implement new services as well as the outreach and training programs.

Partnerships

We have assembled a convergent research-industry team that is able to gather all crucial data, develop the necessary methods and test them in real-farm applications. Our team involves the top veterinarian schools in the U.S., the largest swine veterinary diagnostic laboratory (VDL at Iowa State University conducts 50% of all diagnostics in the U.S.), the world largest animal genetics company (PIC), the largest veterinary clinic in the U.S. (Pipestone), and several of the top 10 largest swine producers (Seaboard, Pipestone, Hanor, Iowa Select, Tosh farms) and the National Pork Board. We have also extended our partnership with other companies such as GlobalVetLINK, the US leader in digital animal records and data aggregation; pharmaceutical companies such as Merck & Co. (MSD), which is the world's seventh largest pharmaceutical company by market capitalization and revenue and; AWS research team to improve our data architecture. They all are key data providers and end-users.

Intellectual Property

Our Disease BioPortal code is already protected in the form of copyright, and we plan to seek other other types of IP protection and licensing in the future such as trademarks or patent applications for AI algorithms, processes, visualizations and the mobile App. We envision long term sustainability of our program using a subscription-base model with tiered pricing (by month or year) based on the type of customer/ end-user segment, the volume of data and the tools needed.

Convergence Research (CORE) Institute

Data Driven Disease Prevention and Control In Animal Health

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Overview

The Convergence Research (CORE) Institute, funded by the NSF Convergence Accelerator, will catalyze an impact network of researchers, practitioners, and industry and public policy professionals committed to collaboratively engaging in convergence research that is driven by a specific and compelling problem and requires deep integration across disciplines and sectors. The training program will provide graduate students and early and mid-career researchers and professionals with a foundational experience to position them for impact throughout their careers on the most challenging societal issues of our time. The curriculum gives participants the skill sets and networks to identify use-inspired problems and build convergence research solutions designed with intentional pathways to sustainable integration into existing societal systems.

How it Works

Each year the CORE Institute will have a specific thematic focus related to a societal grand challenge. The theme for the inaugural 2023 Institute is "Tackling Climate-Induced Challenges with AI". The Institute will host a virtual six-week bootcamp each winter where 100-200 participants will engage in a guided process of problem definition and solution ideation in cross-sector, cross-discipline teams. Supported by Institute mentors, a select group of 40-50 participants will attend a week-long, in-person incubator in the spring at UC San Diego to continue working together to submit proposals to prototype solutions.

Who Should Apply

Researchers who want to make an impact toward solving societal grand challenges; AI experts and technologists who want to work on problems at the intersection of science and society; public policy professionals and practitioners who want to better leverage science and technology; legislators and staffers who want to generate ideas based on societal needs; NGO and industry members working on problems at the societal scale.

Application Timeline

The application process will begin in summer 2022 with a request for nominations from stakeholders and decision makers from existing OIA Convergence Research Projects and foundational projects with an applied focus funded by programs across the NSF. In parallel, broad outreach efforts will ensure a diverse applicant pool.

What to Expect

In winter 2023, selected participants will engage in a six-week virtual curriculum including lightning talks, case studies, and opportunities to meet the cohort faculty and participants. The curriculum will consist of distinct segments for: (i) foundations of convergence taught by selected instructors working on this area; (ii) case studies on the annual institute theme, selected out of the NSF Convergence Accelerator and Growing Convergence Research programs; and (iii) hands-on breakout garage sessions for teams to engage in problem definition and new solution ideation. The CORE Institute is designed to create long-term engagement with participants. This will begin during the weeklong in-person session in spring 2023 for selected participants during which time 40-50 participants will be selected to move into a guided proposal writing and prototyping phase. Teams will continue to receive support after the session from Institute mentors.

Institute Management

The Institute will be guided by a Leadership Council composed of members who have participated in the NSF's Convergence Accelerator. The program will be managed by the San Diego Supercomputer Center at UC San Diego.

TRACK E:

NETWORKED BLUE ECONOMY

Ocean-related industries and resources, known as the blue economy, play a central role in addressing challenges related to climate, sustainability, food, energy, pollution and the economy. The National Science Foundation recognizes that the changes to our earth are occurring at an accelerated pace, requiring convergence across experts, organizations, and sectors to address societal, environmental, and economic challenges related to oceans. NSF's Convergence Accelerator Track E: Networked Blue Economy focuses on interconnecting the blue economy and accelerating convergence across ocean sectors — creating a smart, integrated, connected and open ecosystem for ocean innovation, exploration and sustainable use. Collectively, funded research teams are building strong multi-organization partnerships involving researchers, users and other stakeholders to develop solutions to pressing problems such as plastic waste; illegal, unreported, and unregulated fishing; coastal erosion; and the need for better monitoring of changing conditions. The teams will also produce tools, methods and educational resources to improve human engagement with the world's oceans as both an environment and a resource.

Networked Blue Economy funded phase 1 teams include:

- **Backyard Buoys—**Led by the University of Washington, Backyard Buoys empowers indigenous and other coastal communities to collect and use ocean data to support maritime activities, food security, and coastal hazard protection. Innovations include a sustainable process for community-led stewardship of affordable ocean buoys and a web-based application that renders data easy to understand and bridges to Indigenous Knowledge.
- **BlueGAP—**Led by University of South Florida, the BlueGAP project connects community organizations across watersheds to address economic and health challenges caused by nitrogen pollution. Co-designed by scientists, engineers, and community organizers, BlueGAP empowers people to reach well-informed decisions for better living through storytelling, reliable water quality information, and tailored decision trees that link to next steps for action.
- **CATCCH—** Oceanic climate change is changing fish habits and habitats, putting fisheries at risk. Led by Texas A&M University, CATCCH is supporting fisheries by combining the latest climate forecast technology with a spatial and temporal decision support tool. The CATCCH program will assist fishing policy makers in ensuring sustainable fisheries for the coming decades.
- **Digital Reefs—**Coral reefs provide livelihoods for one billion people globally-but are under increasing threat from human activities. Led by Woods Hole Oceanographic Institute, Digital Reefs delivers interactive 4-D visualizations of reef environments into the hands of local communities, helping to ensure a sustainable future for all-coral reefs.
- **FishLAT—**Led by Blue Latitudes LLC, FishLAT Location Assessment Technology is a web-based, interactive platform that builds consensus between fisheries and energy sectors. Developed by a team of ecologists, economists

and tech entrepreneurs, the platform- fueled by an intelligent, predictive model-is ensuring that the best science and data is used to make decisions about offshore energy.

- **FutureBlue—**The ocean environment is changing fast. Led by Rutgers University, FutureBlue is an intuitive dashboard built on next-generation climate science and ecosystem data analytics that empowers businesses and governments to succeed in future ocean conditions. FutureBlue enables climate adaptation to create a thriving blue economy that works for everyone.
- **iCatch—**Led by Michigan State University, iCatch is revolutionizing seafood sustainability by making in-the-field species identification possible. Composed of genomics, artificial intelligence, and fisheries management experts, the team's solution is empowering fishery managers, law enforcement, and seafood retailers by making species identification capabilities possible and advancing responsible ocean stewardship.
- **iCOAST—**Led by West Virginia University, iCOAST elevates the voices and needs of underserved communities and provides a portfolio of resources, empowering those communities to strengthen their connection to the Blue Economy. To achieve this, the team examines complex relationships between people and the Blue Economy through analyses of social, economic, and environmental data.
- **Micro2Macro—**Led by San Diego State University, Micro2Macro is a smart seaweed farming platform helping growers overcome barriers to entry and maximizes farm profitability. Through the solution's toolkit, Micros2Macro provides the best farming implementation practices to ensure the grower is supported from seed to harvest.
- **Nereid Biomaterials—**Led by the University of California, Santa Barbara, Nereid Biomaterials is enabling a healthier ocean through safe and rapid ocean degradation of plastic components of equipment. By merging marine microbiology, synthetic biology, material science, and robotics, the team is developing "ocean degradable" polymers with embedded additives to accelerate and control degradation. The project's initial focus is the ocean instrument industry, a rapidly-growing, and paradoxically plastic waste generating sector.
- **Ocean Vision AI—**Led by the Monterey Bay Aquarium Research Institute, Ocean Vision AI accelerates the processing of underwater visual data with a globally integrated network of services, tools, and a diverse community of users. Composed of data scientists, oceanographers, game developers, and human-computer interaction experts, Ocean Vision AI streamlines access and analysis of ocean visual data to enable effective marine stewardship.
- **ReCoast—**Led by Tulane University, ReCoast's vision is to create coastal community recycling programs to keep glass out of landfills and instead use it for glass sand products that support coastal restoration and preservation. Through extensive regional economic, social, cultural, and environmental research, ReCoast is ensuring ecological safety and mitigation of land loss.
- **SeafoodTracer—**Led by Loyola Marymount University, SeafoodTracer is a traceability platform enabling easy, transparent verification of seafood. Combining genomics and computer vision AI, this solution provides rapid, accurate validation of species identity and origin to aid seafood regulation compliance and combat illegal fishing. Co-designed with industry, SeafoodTracer ensures seafood supply chain integrity from ocean to consumer.
- **SPAN—**Led by the University of Maryland, SPAN- a nationwide Smart Precision Aquaculture Network - promotes sustainable oyster farming while enhancing marine ecosystem health. The SPAN framework combines IoT sensor networks, robotics, and AI technologies with data-driven production and economic models to provide oyster farmers with environmentally responsive, precision farming solutions that improve production and profits.
- **Tidepool Digital—**Led by Multiplier, Tidepool Digital enables sustainable ocean innovation by supporting data sharing across the public and private sector. The project's products and services create trusted data collaborations and train the next generation of ocean data stewards.
- **Urban Shorelines—**As climate changes, existing urban bulkheads must be replaced. Led by SUNY at Stony Brook, Urban Shorelines uses new design, engineering, and biological approaches to improve the blue economy in three ways: expanding engagement of people with the shoreline; increasing biodiversity and sustainability of marine life; and dissipating wave force and flooding.

Backyard Buoys

Locally Owned, Globally Connected, Building Resilience

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Overview

Backyard Buoys empowers Indigenous and other coastal communities to collect and use ocean data to support their blue economy: maritime activities, food security, and coastal hazard protection. Innovations include a sustainable process for community-led stewardship of affordable ocean buoys and a web-based application that renders data easy to understand and bridges to Indigenous knowledge.

Description

We bring together regional ocean observing networks of the U.S. Integrated Ocean Observing System (IOOS), underserved Indigenous communities, and a sensor company to work collectively to democratize local wave measurements and provide a solution to the existing hurdle of observing technologies that are too expensive to purchase and to sustain. Through co-design of an implementation and stewardship plan, as well as low-fidelity data servicing apps that we formulated in Phase 2, we now stand ready to revolutionize status quo by using lower-cost tools and deepening the human and data connections that collectively will allow for an effective system that has a focus on the hyper-local scale – sorely lacking in the design of existing ocean observing systems – while assuring it is within a globally-connected network.

Differentiators

Phase 2 of the project Backyard Buoys continues to advance the convergent achievements of the Phase 1 effort to sustain ocean intelligence for wave observing in underserved Indigenous communities. During Phase 2, the original Phase 1 cohort will continue to foster the original partnerships while adding new partners and collaborators to provide overall project management, expertise in Sofar wave buoy operations, training, data analysis, integrating Indigenous knowledge, wave and climate modeling, engagement, and education initiatives. The Phase 2 Indigenous communities engaged during Phase 1 will be the ultimate stewards of the observing platforms and observing initiatives within their own waters throughout the project and beyond. This means they will identify optimal locations for deployments and conduct the deployment and recovery tasks themselves (rather than sending a researcher to each community). This aspect is a switch from the typical ocean research model, where the communities are simply told what is going to happen in their community, without much consideration for their needs or broader goals.

Road Map

Our team will achieve success through a combination of collaborative events, web-based tools for sharing information, and empowering communities to steward wave buoys in their region. Working Groups will be established to provide a shared forum for technical support and to identify expansion opportunities including groups for Buoy Operations, Data Tools, Educational Development, and Co-Design. One of the primary goals is the development of Community Research and Implementation Plans (CRISPs) that will be used by community stewards to execute the Backyard Buoy project. CRISPs will be developed with a user-friendly web-based tool designed to encourage community involvement and will be available on the project website tailored for the Indigenous partners' needs. Low-bandwidth data tools such as Text-a-Buoy and a mobile app will be co-designed to provide the necessary real-time wave data. All partners will participate in the Summit on Integrating

Indigenous Knowledge with Western Science in the summer of 2023. To grow community participation in the project, each region will develop educational materials and provide internship opportunities. Based on the CRISPs and Working Groups, an Ocean Best Practices document will be developed.

Partnerships

We have a geographically, academically, institutionally, and culturally diverse groups of partners collaborating on the Backyard Buoys project. Phase 2 continues the partnership between 1) three U.S. IOOS Regional Associations; 2) Indigenous partners in each region; 3) a proven ocean float developer; as well as new educational partners.

- **Pacific Northwest:** Northwest Association of Networked Ocean Observing Systems (NANOOS), Quileute Tribe, Quinault Indian Nation, Western Washington University
- **Alaska:** Alaska Ocean Observing System (AOOS), Alaska Eskimo Whaling Commission, University of Alaska Fairbanks, Alaska Department of Natural Resources, Alaska Native Science and Engineering Program
- **Pacific Islands:** Pacific Islands Ocean Observing System (PacIOOS), Marshall Islands Conservation Society, National Park of American Samoa, Hawaii Sea Grant, Conservation International Hawaii
- **Sofar Ocean Technologies** (Sofar)
- **Project Management:** Weston Solutions, Inc.

Intellectual Property

The Intellectual Property (IP) will be freely shared within and beyond the partners. IP will primarily consist of data delivery systems and web intake surveys. The ocean observing buoy systems to be deployed during Phase 2 of Backyard Buoys are already mature and commercially available products and are wholly owned and patented by Sofar.

Additional Information

An additional benefit of getting wave buoys in the water at diverse and under-measured sites proposed here is the generation of data from highly-localized coastal areas available for large scale scientific research to improve climatologies and predictions, especially important in light of climate change. This is critical for effective advanced planning to ensure a safe blue economy for the communities. In Phase 2, we propose to implement the buoys in all three regions, along with the data dissemination applications to result from our Phase 1 low-fidelity prototypes. We will also add an education and translation layer to engage the communities more fully and inspire a younger generation in ocean observation.

Successful deployment of instrumented seabed mooring and Spotter. (C. Gruben-Elias, Only Way Outfitting)

BlueGAP

Bridging Communities Upstream And Downstream

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Overview

A strong and sustainable Blue Economy requires healthy watersheds. The Blue-Green Action Platform, BlueGAP, connects people and organizations across watersheds to overcome economic and health challenges caused by nitrogen pollution in their water and local environment. Our BlueGAP Alliance members share stories, scientific data, visual tools, and resources for watersheds. BlueGAP integrates these to empower people to create a more equitable and sustainable Blue Economy.

Description

Nitrogen pollution of water may cause severe health problems. Nitrogen pollution also harms local waters in a watershed, leading to high concentrations of unwanted bacteria, algae, and plants that can collapse entire ecosystems. Often, frontline communities are the most affected.

BlueGAP will bring new solutions to nitrogen management by: a) providing information, b) expanding communication networks, c) fostering community action, d) changing policy, and e) finding sources of financing. These leverage points were identified in a systems analysis of the Blue-Green economy during Phase 1 through a collaboration between scientists, engineers, and community organizers.

Pollution data and knowledge about impacts on health and the local economy are not easily accessible to people. Data on nitrogen loads in water are obtained differently by various government jurisdictions across the nation. For the general public, such data are challenging to comprehend. Opportunities exist to coalesce and account for missing data and to reduce confusion.

BlueGAP solves these problems by focusing on four objectives: 1. Advancing human-centered design of solutions to pollution. 2. Integrating storytelling with cutting edge scientific evidence to identify leverage points for action. 3. Creating inclusive educational materials to impact nitrogen management and inform communities.
4. Establishing a sustainability plan for BlueGAP.

BlueGAP focuses on solving information problems in three sites at three scales: the massive Mississippi watershed, the medium-sized Tampa Bay watershed, and a small watershed in the U.S. Virgin Islands. BlueGAP guides people to solutions by pairing stories of lived experiences of water pollution within a watershed with visualizations of water quality data, presenting short documentaries about Blue Economy "Champions" fighting to combat nitrogen pollution, sharing first-hand experiences of frontline communities, and providing resources on policy, law, financing, and science.

Differentiators

Many aspects of the Blue Economy depend upon clean drinking water and good coastal and estuarine water quality. BlueGAP's innovation is directly engaging communities in shaping their Blue Economy, which is very different from the top-down management strategies commonly applied . We use a human-centered convergence framework to foster coalitions to solve problems that communities cannot solve by themselves, keeping frontline communities at the forefront.

The core of BlueGAP is a systems model which focuses on local experiences and knowledge to show people the costs and benefits of actions at specific leverage points of nitrogen management.

The systems model reflects the needs we heard from people from Iowa, Florida, and the US Virgin Islands during Phase 1. They want to understand social and regulatory leverage points when applying the BlueGAP model to their watershed, and want to base decisions on reliable information.

Road Map

Our objectives are supported by tasks that engage users in co-developing, testing, deploying and revising the systems model. This happens through interviews and storytelling, film documentaries and a curriculum, all of which are integrated into our platform. The tasks include establishing the BlueGAP Alliance at the project start with six core partners whose experiences with nitrogen will guide curriculum and systems models that will be shared via our virtual platform and a watershed focused, in-person BlueGAP Academy. By early 2023, initial interviews and documentary films will be completed, but this effort will be continuing. A regulatory and management systems analysis will be advanced by early 2023 and the current systems model will be continuously revised based on user feedback. Nitrogen data will be located, made interoperable, served, and gaps identified by mid-2023. The Academy will be piloted in Tampa Bay in late-2023. The sustainability plan will be completed by late-2023. The digital platform will have a limited release in June 2024; software development will be continuing through the project. Transition to an independent not-for-profit is expected by the end of the grant period.

Partnerships

BlueGAP is co-developed by a diverse group of academic (University of South Florida, University of Iowa, Stetson Law School), non-governmental (Black In Marine Science), and quasi- governmental (Tampa Bay Estuary Program) organizations, and community and private sector organizations. This open partnership brings in BlueGap Champions as partners, initially from six community organizations from Iowa, Florida, and the US Virgin Islands, to co-design and build capacity across watersheds. BlueGAP will also be proposed as a contribution to the UN Decade of Ocean Science for Sustainable Development to further our global impact.

Intellectual Property

A cornerstone strategy of BlueGAP is the use of open science principles and methods. BlueGAP is a fully open platform and materials will be copyrighted and stories will be assigned Digital Object Identifiers (DOIs).

Converging on the Blue Economy

Our vision is to stimulate the Blue and Green Economies by accelerating convergence on best practices for nitrogen management. BlueGAP empowers local communities, particularly frontline communities who have encountered many overlapping barriers to participating in the Blue Economy, by integrating information, contacts, and legal and policy decision-making tools and placing these resources directly in the hands of people who need it most urgently.

Through collaboration with other Track E: Networked Blue Economy projects and extending the Blue Economy beyond the ocean to include watersheds, BlueGAP provides multiple pathways for frontline communities to engage in reshaping the Blue-Green Economy.

CATCCH

Informed decisions for fishery sustainability

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Overview

As the recent International Panel on Climate Change (IPCC) Sixth Assessment Report documents, the world's oceans are clearly changing, as a direct and indirect result of multiple ongoing climate stressors, in alarming ways that potentially put the world's ocean fisheries, a primary source of protein for billions of people, at risk. These impacts are already hitting the U.S. west coast fisheries of the California Current System (CCS) hard, and are expected to accelerate. What U.S. fisheries managers badly need are better predictive tools, based on the best available high-resolution climate change models, that help assess how climate change will affect the nation's valuable fisheries, and provide insight into how ocean ecosystems will most likely change over time, so that we can keep these fisheries both productive and sustainable in the face of accelerating climate change.

Description

Without better predictive models, fisheries managers are essentially flying blind. If we cannot improve our ability to use the latest climate change models to make fishery management decisions, we risk losing the California Current fisheries, including people's jobs and protected species. There are over 220,000 people whose jobs are involved in these fisheries, and our decision-making tool can impact $39 billion dollars of decisions each year. Once we demonstrate the effectiveness of this decision-support tool, the process can be extended beyond the CCS, and to the broader fishing industry.

Differentiators

The CATCCH project provides new fisheries management decision support systems (DSS), based on the latest high-resolution oceanographic climate change models that improve on existing predictive tools and also allow the incorporation of other human-environment impacts. Currently, fisheries management decisions are made using "best available data," but that rarely includes considering the impact climate change is having on the fishing industry. Furthermore, existing environmental and fisheries data are located in different places at different time and spatial scales, making it difficult for scientists to generate useful and accurate models. We will provide seasonal-to-decadal, high-resolution forecasts of environmental variables and fish distributions in the CSS, which stakeholders have told us is one of the prime needs for sustaining the fisheries.

To make our products available, we are also creating an interactive web-based decision-support tool that can better inform fisheries management decisions in the face of accelerating climate change by allowing stakeholders to access output from our high resolution climate-ocean-biochemistry-fish models in one centralized location. It may also be used for assisting with other ocean uses, e.g. identifying and reducing future conflicts between fisheries and offshore energy development or other activities, although at present we cannot provide the long-term (decadal) high-resolution outputs that such activities need. As high-end computing power becomes more accessible, we anticipate being able to make longer runs that meet this need, but this is unlikely before the end of this project. Having the highest resolution models that provide a unified set of products that match the real needs of stakeholders in the fishing industry would contribute greatly to providing improved information to fisheries managers and other ocean resource users.

Road Map

We anticipate that the high-resolution models will all be set up within six to nine months, and

that the model outputs will be made available within the first half of year 2 of the project. The decision support system will be developed in conjunction with the models, as it is needed to serve the outputs to the stakeholders and interested academic and public entities. Stakeholders will be involved in its development through an iterative process. Analysis of the model outputs will be ongoing throughout the time of the project.

Partnerships

Our interdisciplinary team brings together social scientists, commercial fishing industry leaders, world-leading climate modelers, experts in the local oceanography of the U.S. west coast, and decision-support tool designers. Together our team represents three different academic institutions, a major commercial fishing industry trade association (Pacific Coast Federation of Fishermen's Associations), and two government entities (National Oceanic and Atmospheric Administration and National Center for Atmospheric Reserach).

We also are working closely with the federal Pacific Fishery Management Council (PFMC), created by Congress in 1976 to bring together federal and state agencies with representatives of the West Coast fishing industry, scientists, fisheries managers, fishing-dependent communities and indigenous Native American Tribal governments to manage U.S. fisheries offshore California, Oregon and Washington. The PFMC is one of several Magnuson Act fishery management Councils managing the nation's ocean and Great Lakes fisheries.

Through these extensive fishing industry contacts, we have already obtained considerable information on the requirements of all these groups through a series of interviews, observations, and questionnaires, and have incorporated their answers into the development of our web-based management support tool. Their participation will continue during Phase 2 as we transfer from low-resolution models to high-resolution models, and we will continue to develop the support tool through an iterative process with these potential users.

Intellectual Property

Intellectual property developed through the project will be stored at Texas A&M University (TAMU) and generally be made freely available to outside users. Any commercial activities developed as a result of the project will be controlled through existing channels at TAMU, which has a separate department that works closely with faculty to commercialize inventions, in conjunction with the needs and requirements of other institutions involved in their development.

Summary

The increasingly high variability of climate systems in the ocean make this an ideal time for our team to provide access to the best predictive climate change models at higher resolutions than currently exist. Ocean "heat waves," such as we saw in 2014-2016 (nicknamed "The Blob") are highly destructive of fragile ocean ecosystems, and unless we have warnings further in advance of these events, we cannot maintain sustainable fisheries. Mistakes caused by lack of good data and accurate predictions could cause several important west coast fisheries to collapse.

Digital Reefs

Digital Reefs At Your Fingertips

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Overview

Coral Reefs support almost one billion people, yet development of a thriving Coral Reef Blue Economy is threatened by both unprecedented global climate change and lack of access to the actionable data needed to address 21st century challenges.

We pioneered Digital Reefs to transcend language and socio-economic barriers, exploiting recent advances in computational power and cloud technologies to provide millions of stakeholders access to interactive, actionable data via a common visual platform.

We anticipate within 5 years, Digital Reefs, scaled to the globally interconnected Digital Reefs Network, to be the go-to tool for effective management, conservation, and restoration of coral reefs in the 21st century.

Description

Despite their small global footprint, coral reef ecosystems play a disproportionately large role in the global economy, with an estimated annual value of $1 trillion. In the US, 4 million acres of coral reef support hundreds of thousands of jobs and protect vast expanses of coastal property, including strategic military infrastructure.

Yet the sustainable growth of the Coral Reef Blue Economy is threatened by unprecedented changes thwarting conventional management strategies. Efforts to overcome these challenges, as indicated by our market surveys, are hampered by lack of access to intuitive, actionable data, by the disconnect between the coarse scale of existing data products and the fine scale at which decisions have to be made, and by the absence of a single, universally accessible platform for sharing, accessing, and uploading data for each reef system. Digital Reefs bridges these critical gaps, applying Digital Twin technologies to enable rapid, universal access to intuitive, actionable data at relevant spatial and temporal scales, via a common visual language. Our functional, interactive Palmyra Atoll Digital Reefs prototype, delivered in two years, will include 4 Data Layers (4-D reef bathymetry, temperature, currents, and benthic communities) and 4 User Tools that facilitate climate risk assessment, ecosystem service optimization, and invasive species and plastics monitoring. A modular design will allow easy integration of additional data and tools, guided by user-inspired research conducted throughout the project.

We anticipate our application to be the go-to tool for millions of stakeholders around the world, at their desktops, tablets and mobile devices. Using gaming engine platforms to create immersive, Virtual Reality experiences with scientific data, we aim to bring Digital Reefs into homes, classrooms and boardrooms alike, to transform the conversation around coral reefs and the Blue Economy.

Thousands of coral reefs are scattered across the global tropics, connected by currents, mutually impacted by climate change, and linked by cultures, politics, and economies. As in life, Digital Reefs will scale to achieve a globally interconnected Digital Reefs Network. Building on a successful Phase 2 outcome, we envision the Digital Reefs Network by 2030 and a blueprint for expansion of Digital Twin technology oceanwide.

Differentiators

Digital Reefs is the first to apply Digital Twin Technology to create holistic, 4-dimensional, virtual representations of coral reefs, and to provide provide universal access to intuitive, actionable data via a common visual platform. Parallel efforts to construct Ocean Digital Twins

include the EU-funded Iliad Digital Twin of the Ocean, focused on European seas with far lower resolution than Digital Reefs. If successful, Iliad is a potential future partner for the Digital Reefs Network. ReeFi-DAO proposes to create a Digital Twin of the Great Barrier Reef from drone-captured imagery. If successful, this project could potentially be incorporated into the GBR Digital Reef as a Data Layer. Grenada is creating a whole-country digital twin, primarily land-based, using GIS imagery. If successful, this could be merged with the Grenada Digital Reef to produce an integrated land-sea Twin.

Road Map

- User research synthesis (1st quarter 2023).
- Technological framework for the DR Data Layers module (2nd quarter 2023).
- Technological framework for user-inspired User Tools module (2nd quarter 2023).
- Palmyra hydrodynamic model simulation forecasts (3rd quarter 2023).
- All field data for User Tools (3rd quarter 2023).
- Cloud infrastructure for data storage and distribution, review of potential cloud resource vendors (4th quarter 2023).
- Interactive User Interface (4th quarter 2023)
- Functional Digital Reefs Prototype (4th quarter 2023)
- Prototype trials and training (1st quarter 2024).
- Scale Digital Reefs technology framework to two other coral reefs (2nd quarter 2024).
- Business/sustainability plan, marketing and proposal plan, strategies for communicating and educating potential customers (2nd quarter 2024)
- MOU with potential user institutions to contract specific Digital Reefs development (2nd quarter 2024).

Partnerships

Digital Reefs merges expertise from academia, industry, management, and conservation to ensure we build an application with state-of- the-art science and technology that has universal, game-changing and long-lasting impact.

Industry: Siemens Technology Corporation's Simulations and Digital Twin team led technological development of the low-fidelity prototype, participated in user inspired research and the NSF curriculum. In Phase 2, our Siemens co-Is will develop the software architecture, define the cloud infrastructure, and the application of VR/AR in Digital Reefs.
Pending approvement of legal agreements, Tidal X of Google X will join the team to explore application of machine learning and artificial intelligence (AI) in the Digital Reefs Network.

Science and Engineering: Woods Hole Oceanographic Institution (WHOI), Scripps Institute of Oceanography (SIO) and the University of Guam contributed to development of the LFP, user-inspired research and Phase 1curriculum. We are joined in Phase 2 by the University of Stanford and the National Academy of Marine Research (NAMR), Taiwan, solidifying our expertise in coral reef ecology, physiology, fisheries, climate and oceanography. Together this team will lead the generation of field data and models for the Digital Reefs prototype, contribute to development of effective 4-D visualizations, decision-support tools, and user research.

Conservation, Management, Education and Restoration: The Nature Conservancy (TNC), a global leader in coral reef conservation, The Marshall Islands Conservation Society (MICS) and NOAA's Pacific Islands Fisheries Science Center participated in the Phase 1 curriculum and development of the LFP. We are joined in Phase 2 by the Mote Marine Laboratory, Florida and the The Ebiil Society, Palau. This team will ensure the development of a universally accessible, globally coordinated, Digital Reefs application that provides millions of people access to intuitive, actionable data in support of the Coral Reef Blue Economy.

Intellectual Property

Our IPMP has been agreed to by all co-Is. The basis of the plan is 1) background pre-existing IP will be owned by the originator, 2) project IP will have specific reporting requirements and will be reviewed for sole or joint ownership by the signatory parties, 4) requirements for any new parties to be signatories of the IP plan.

FishLAT

Enhancing Fisheries, Informing Offshore Energy Decisions

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Overview

FishLAT (Fisheries Location Assessment Technology) is a web-based, interactive platform that helps regulators, industry stakeholders, and fisheries managers predict how the removal, addition, or conversion of an offshore energy structure will impact fisheries. Fueled by intelligent, predictive models, FishLAT transforms the accessibility and transparency of fisheries data to build consensus between fisheries and energy sectors.

Description

The installation of offshore oil and gas platforms has transformed the marine landscape from a relatively featureless seafloor to a network of artificial reefs that provide critical fisheries habitats and fishing opportunities for many commercial and recreational fishers. However, as society begins to shift away from petroleum-based energy and towards renewables, offshore oil platforms are either removed or repurposed as reefs; and at the same time, development of offshore wind farms is one of the fastest growing energy sectors worldwide – all with significant impacts to fisheries.

Fisheries and offshore energy are two of the largest, yet most conflicted ocean users, and interactions between these two sectors will inevitably continue as offshore energy developments are recurrently decommissioned and installed. Typically, decisions regarding decommissioning and development of offshore energy structures are made using various comparative assessment tools which do not incorporate targeted fisheries metrics and rarely involve in-depth analyses of fisheries stakeholders as a component of the assessment. Without tools to provide visibility and context into multi-sector fisheries and ecological data, the implications to fisheries stakeholders of removing or constructing offshore energy structures remain unknown.

FishLAT provides a user-friendly web interface, fueled by inputs from FishLAT's models, that ensures users have access to the best available science and data to help them make decisions regarding oil platform reefing or removal and decisions on future wind energy development, siting, and installation. If an oil platform is identified as a viable reefing candidate, there's an approximate 50% reduction in decommissioning costs and these savings are shared by the oil company and the state. Over 300 reefed structures off Louisiana have generated more than $135 million for the state. Additionally, there are economic benefits associated with the fisheries which represents millions of additional dollars.

End-users can access FishLAT's free, interactive map on https://globalfishingwatch.org/ and will also have the option to purchase a subscription to access project-specific data and consulting services at www.FishLAT.com. These end-users include federal and state ocean management agencies and resource managers, who are seeking to streamline the development and decommissioning of offshore energy structures while minimizing impacts to fisheries.

Differentiators

One of FishLAT's greatest strengths is the unique vision and experience derived from its multifaceted team which brings together a variety of disciplines, from technology, science, industry, and social justice, to leverage new technology to improve societal engagement with marine fisheries and energy resources. The FishLAT team has also formed innovative partnerships within the science and engineering fields, coastal communities, and with organizations engaged within the networked Blue Economy which

provide important perspective to enhance and expand the vision for FishLAT. Collectively, the FishLAT team will develop avenues for a more sustainable engagement with the ocean as both an environment and as a resource and deliver an actionable and scalable web-based platform for use across sectors within the Blue Economy with global implications.

Road Map

In Phase 1, the framework for FishLAT and a mock prototype were developed. In Phase 2, the FishLAT platform will officially launch. The first year of Phase 2, we will finalize models and release a minimum viable product.

- Q1 & 2: Complete field work and finalize all models to serve as inputs for FishLAT.
- Q2 & 3: Release FishLAT as a beta web interface and examine user experience from federal and state ocean management agencies and resource managers.

The second year of Phase 2 is dedicated to advancing FishLAT capabilities and building FishLAT's user base for sustainable operations.

- Q1: Improve design and performance for FishLAT to prepare it for the final release tests. We will also focus on broadening FishLAT's community of users.
- Q2 & Q3: Develop a go-to-market strategy for use within the Gulf of Mexico region to refine ideal customers, coordinate messaging, and ready FishLAT for launch.

After Phase 2, we will focus on expanding FishLAT into other geographic regions and operations will be sustained through subscription-based services

Partnerships

FishLAT is supported by partners from a wide variety of disciplines, ranging from academics to non-profits to oil and gas companies. Texas A&M University is an important academic partner who supports FishLAT's model development. Nonprofit partners include Southern Shrimp Alliance, an organization of shrimp fishermen and processors, Charter Fisherman's Association, a group of charter-for-hire fishers with a mission of maintaining long term fishing access and sustainability, and the Parole Project, a Louisiana-based non-profit that supports the FishLAT team by broadening participation to formerly incarcerated citizens. Industry partners include Oceaneering, the largest ROV company in the Gulf of Mexico, and several oil and gas companies (i.e., Fieldwood Energy, Cox Operating, Maurbeni Oil and Gas, and W&T Offshore). The Louisiana Department of Wildlife and Fisheries provides insights to refine FishLAT so that it is optimally useful for artificial reef management councils. MBARI and others contribute Artificial Intelligence design to improve FishLAT's fisheries analysis.

Intellectual Property

FishLAT is an open-source spatial planning tool. High level data will be made freely available to the public and housed on Global Fishing Watch's interactive mapping portal. Additionally, a subscription-based model for access to project-specific data processing and consulting services made available through the FishLAT project website. Ultimately, the FishLAT team will apply for a utility patent to cover FishLAT's processes and prohibit other companies from using FishLAT's process without authorization. Any commercial licensing will be supported by the Louisiana State University Office of Intellectual Property.

FutureBlue

Actionable Climate Insights For The Blue Economy

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Overview

Governments, businesses, and coastal communities are being disrupted by the rapidly changing ocean environment, and existing data products fail to provide the future ocean conditions that decision-makers need. FutureBlue is an intuitive data dashboard built on next-generation climate science and ecosystem analytics that empowers businesses, governments, and communities to navigate future ocean conditions. FutureBlue enables climate adaptation to create a thriving blue economy that works for everyone.

Description

Without knowledge of the changing ocean, the blue economy is facing increased conflict, stalled development, stranded assets, and collapsed fisheries and species as changes happen faster than we can react. In contrast, the FutureBlue vision is a thriving blue economy that successfully adapts to rapid ocean change and in which diverse community members prosper, both today and in the coming decades (Figure 1). To enable this vision, we are creating an online platform that puts localized climate insights at the fingertips of blue economy businesses, governments, and communities. With FutureBlue, everyone can be prepared for the changing ocean. Our initial markets include state governments planning for the expected $100 billion in offshore wind energy development, conservation planners for the 1000+ U.S. marine protected areas, and community development officers for 1,000s of coastal towns and cities in the U.S. Our team includes world experts in climate science, public policy, science communication, and user experience design. Together, we translate complex climate data into accessible, intuitive, and place-based indicators to answer questions like, will protected species increase or decrease here? will there be more or less wind energy available here in the future? or which fisheries will become more or less productive? FutureBlue is enabling a transformation of ocean development from backward- to forward-looking and towards inclusivity by making the best available science on future ocean conditions relevant and usable.

Differentiators

FutureBlue will be the first product focused on delivering localized future climate insights for blue economy resources. While existing data portals effectively serve a wealth of spatialized data layers, they fail to provide climate insights that enable climate adaptation. Nationwide portals like the Marine Cadastre and Ocean Reports lack data on future climate and resource conditions. Regional data portals provide very limited climate change information, and do

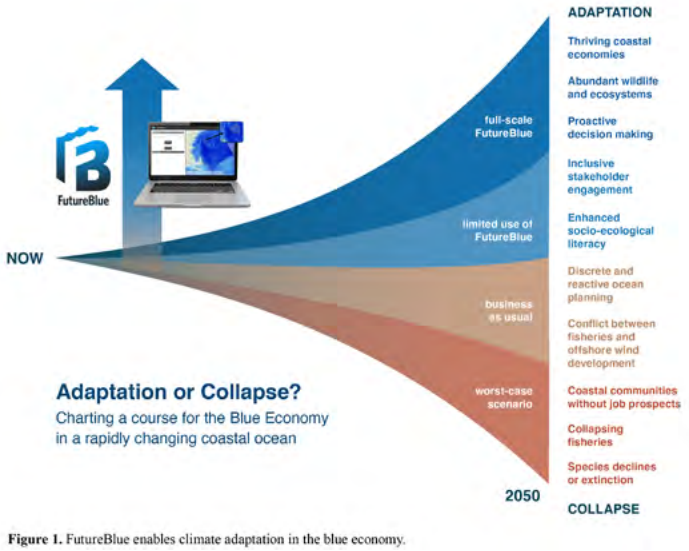

Figure 1. FutureBlue enables climate adaptation in the blue economy.

Figure 1. FutureBlue enables climate adaptation for business and government decision-makers in the blue economy.

not provide it in a place-based manner that allows localized insights for all users. Few portals make explicit the interconnections among social, economic, and environmental actors needed for effective communication and bottom-up governance. In contrast, FutureBlue is a place-based tool with climate insights for ocean resource-dependent community development, fisheries, offshore wind energy, and marine conservation. We are solving the inequity in access to climate change insights so all blue economy actors can make informed decisions for their future.

Road Map

We will finish developing climate products for marine species, fishing opportunities, and wind energy in the Northeast U.S. through June 2023. The FutureBlue data dashboard will launch publicly for the Northeast U.S. by September 2023. We will develop climate products for the U.S. West Coast by April 2024 with a launch of FutureBlue on the West Coast in summer 2024.

Partnerships

FutureBlue is a partnership of academic, civil society, and governmental partners. Climate data, species projections, and human community data are being developed through the collaboration of Rutgers University, the University of Connecticut, University of Massachusetts Dartmouth, National Oceanic and Atmospheric Administration, and the University of Wisconsin. New research partners in Phase 2 include Duke University, Stanford University, University of California Santa Cruz, the National Center for Atmospheric Research, Wellesley College, National Oceanic and Atmospheric Administration (NOAA) Northwest Fisheries Science Center, CSS Inc., and NOAA National Centers for Coastal Ocean Science (NCCOS). The Nature Conservancy leads the development of the FutureBlue web-based data dashboard. The Island Institute and the New Bedford Ocean Cluster will apply the insights from the FutureBlue tool to coastal community development in Phase 2.

The NOAA Office of National Marine Sanctuaries and the Virginia Coastal Zone Management Program will apply FutureBlue to conservation and ocean planning.

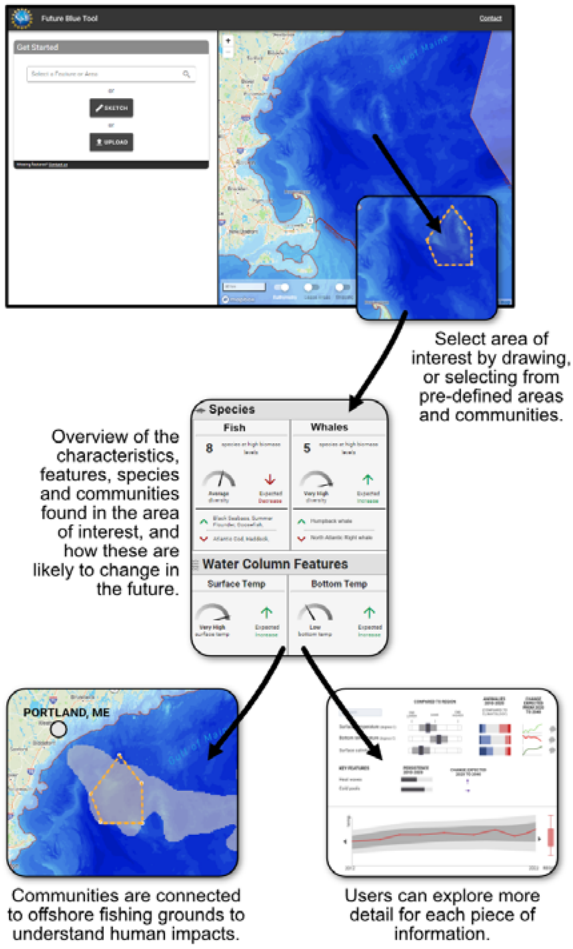

Figure 2. The FutureBlue data dashboard asks users to select an area of interest and then displays climate change impacts to that area for key resources like fisheries, protected species, and wind energy. (Alt Text: Figure with several boxes showing screenshots of FutureBlue tool, describing tool outputs with arrows)

Intellectual Property

The FutureBlue tools are based upon open, credible, and fully traceable data in the public domain. Intellectual Property commercialization is not a goal of this project.

iCatch

Species ID in a Snap

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Overview

Illegal, unreported, and unregulated (IUU) fishing compromises the sustainability of marine fisheries resources and causes global financial losses of over $36 billion annually. iCatch will revolutionize fisheries sustainability by making rapid species identification possible throughout seafood supply chains. iCatch empowers fisheries managers, law enforcement officers, and seafood retailers to combat IUU fishing by advancing responsible ocean stewardship.

Description

The seafood sector is playing a rapidly expanding role in global food security. However, in the last 30 years, the proportion of global marine fish stocks experiencing sustainable levels of harvest has declined from 90% to 66%. IUU fishing is a major cause of this decline and is responsible for 20% of fishery catches worldwide. A major roadblock to combating IUU fishing and promoting sustainable fisheries is the inability to conduct rapid and reliable species identification in the field. Fisheries monitoring and enforcement hinges on the ability to accurately identify species at all steps of seafood supply chains—on boats, at ports, and in stores. The focus of this Convergence Accelerator project is to harness the combined power of genomics and artificial intelligence to develop low-cost, fast, accurate, field-deployable species identification tools practical for implementation throughout seafood supply chains. Our iCatch species identification tools will allow supplychain actors—from observers on boats to authorities at ports to buyers at markets—to verify the species identity of seafood products, including whole fish, fillets, and other parts. Central to the iCatch solutions-building workflow is setting a foundation responsive to a dynamic market to meet user needs. iCatch species identification tools offer an innovative solution poised to revolutionize our ability to sustainably utilize marine fisheries resources, protect seafood supply chains, and strengthen the blue economy. We maximize this potential by developing iCatch tools for domestic marine fisheries of high economic and conservation value.

Differentiators

Species identification in fisheries settings requires a solution that is highly accurate, deployable under field conditions, user-friendly without requiring specialized skills, equipment, or expertise, and provides results in real-time. There is no species identification solution on the market today that fits this bill. Currently available technologies require specialized expertise, use expensive equipment, have limited accuracy, and/or cannot be done in real-time. This is what makes iCatch so powerful and necessary—iCatch can be easily used anywhere with just a smartphone and a rapid genomic test kit. With iCatch, samples will no longer need to be sent to laboratories for analysis. Users will have answers to their species identification questions, right in the palm of their hand, in under 30 minutes.

Road Map

We will accomplish the following:

Key technical milestones:
Year 1—Full development of rapid genomic assays for key high-value species (salmon, tunas, sharks, shrimp), iCatch test kit prototypes, iCatch workforce training modules; *Year 2*—Beta test rapid genomic assays, deploy iCatch training videos and iCatch mobile phone app, finalize iCatch database of interconnected digital image, DNA sequence, and tissue samples.

Key business sustainability milestones:
Year 1—Determine business model, protect intellectual property via patents; *Year 2*—Identify advisory board, execute business model, manufacture iCatch rapid genomic test kits.

Key Broader Impacts milestones:
Year 1— Develop educational curricula focused on IUU fishing and seafood sustainability; *Year 2*—Deploy educational curricula at the Georgia Aquarium and Monterey Bay Aquarium, and in K-12 and undergraduate classrooms.

Key Deliverables:
1. Rapid genetic tests for species identification of high economic value fisheries species
2. AI enabled iCatch smartphone app for extended species identification functionality
3. Species identification training modules for smart workforce development 4. Extensive database for rapid development of additional use cases

Partnerships

We have a broad and diverse network of partners that are active across fisheries supply chains. Our partnerships span state and federal management agencies (e.g., National Oceanic and Atmospheric Administration [NOAA] National Observer Program, Fisheries and Oceans Canada, Texas Parks and Wildlife, South Carolina Department of Natural Resources), federal law enforcement agencies (NOAA Office of Law Enforcement, United States Fish & Wildlife Service Office of Law Enforcement, United States Coast Guard), fishing industry (e.g., Hawaii Longline Association, United Fishing Agency), and conservation and capacity building organizations (e.g., Food and Agriculture Organization, Conservation International, World Wildlife Fund). Together, we will deliver iCatch tools to the fisheries community to make national-scale impact on the sustainability of ocean resources.

Intellectual Property

The iCatch team is working closely with the Michigan State University Innovation Center to protect the intellectual property of the team. We are currently applying for patents and copyrighting iCatch tools.

Additional Information

Without innovative tools for species identification, we will continue to see declining health of global marine fisheries, growing illegal trade, lost revenue to fishing communities, and growing consumer mistrust of seafood products. iCatch is the right solution to this problem by the right team of people at the right time.

iCOAST

Finding Your Place In The Blue Space

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Overview

Nearly 40% of the U.S. population lives on or near a coastal/waterway area and the Blue Economy (BE) in such areas supports roughly 58 million jobs and $9.5 trillion in goods and services each year. Despite these immense numbers, data show a lack of racial and ethnic diversity of groups accessing the Blue Economy for recreation and tourism. The iCOAST team is here to change this narrative with more relevant connections for underserved people.

Description

To gain a more comprehensive understanding of factors that influence engagement in the BE, especially amongst underserved populations, we are creating and maintaining a data-driven toolkit that includes storytelling, education, and accessibility features tailored to underserved populations. A modeling framework provides integration of recreational suitability and social vulnerability for BE accessibility evaluation and prioritization. Additionally, to encourage more engagement in the BE by underserved populations, new technology features and functionalities for educational augmented reality gaming applications are being developed and deployed. Natural resource STEM summer camps will also be created to provide adventure, experiential learning, and professional awareness/skills in BE settings. Also, the voices and stories of members of underserved communities which highlight historic and cultural connections to the BE will be highlighted and amplified with the goal of increased awareness and engagement in the BE. This will be accomplished using a multimedia approach including video, social media, audio, and live events. Through the completion of these objectives, we are producing a process and toolkit designed to provide stakeholders and community members with the means to capture cultural ties to the BE as a tool to increase environmental awareness, community well-being,
and economic growth.

Differentiators

Previous attempts to rectify this historic lack of inclusivity have failed by not approaching this challenge with a holistic view of community needs and current barriers. Social science that focuses on natural resources is often centered on evaluation of user experience or resource conditions. Economic studies in natural resources often favor a scope of management and valuation in present temporal scales. Studies of culture and racial/ethnic identity are rarely put in the context of broader natural resources and industry solutions. Technology and innovation research and products are not commonly applied to learning in natural resource and aquatic protected areas. The convergence and collaboration of the iCOAST project across social, ecological, economic, and educational components with both historical and contemporary scales make this project unquestionably unique. By utilizing new and emerging technologies, the iCOAST team aims to increase diversity through awareness, access, and attachment to the BE. We are bringing together academic, government, for profit and non-profit organizations and most importantly underserved communities to amplify their voices and improve opportunities to gain value and enrichment from the BE.

Road Map

The Phase 2 project is scheduled to occur between October 2022 - October 2024. Planning, hiring, and advertising activities associated with the project will occur quickly upon receipt of funds in the last quarter of 2022 and first

quarter of 2023. Experiential camps will occur in the summers of 2023 and 2024 and other cultural and communication events will occur during the summer of 2023. Data collection and collaboration between team members will occur throughout the life of the project. Modeling efforts and digital marketing spearheaded by partnership with Orbis, Inc. will be slated to begin quickly upon the start of Phase 2. Development of marketing materials is ongoing and will begin further in the fourth quarter of 2022 and the advertising campaign would be rolled out during the second quarter of 2023. Development of mobile gaming content created by partner Agents of Discovery, Inc. will also begin quickly upon the start of the project. Finished products as 1) modeling framework and process, 2) educational tech features, 3) experiential camps, and 4) storytelling content and events will be delivered before the end of 2024.

Partnerships

Experts from the public sector from West Virginia University, Clemson University, the University of Florida, National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries, University of New Hampshire, California State University - Monterey Bay, and the State University of Ponta Grossa will provide research and public outreach expertise in multiple realms such as social science, natural resources science, and racial identity and youth development. Private industry partners including Agents of Discovery, Inc. and Orbis, Inc. will provide expertise in development of electronic media such as mobile games, online community engagement, and natural resources modeling. During Phase 1 of this project, these industry partners provided low-fidelity prototypes of their products, and further engagement with potential partners in industry is a targeted outcome for Phase 2.

Intellectual Property

The iCOAST team is committed to providing open-access products for public use as deliverables of this project. Each project partner has brought their own suite of intellectual property (IP) to the convergence project plans and prototypes through Phase 1. Moving into the next Phase, all project partners shall be joint owners of project IP that is developed jointly by those parties. Any jointly created IP will be accessible by all partners for the purposes of the project, technical data will be shared, and additional agreements will be developed as needed for any licensing, patenting, or commercialization of products beyond the scope of the project. Any future partners not listed in the original proposed work and award documentation may be added through evolution of project needs will agree to be subject to content of existing IP plans and any additional agreements such as non-disclosure or non-compete as appropriate.

Additional Information

The iCOAST project is an ongoing and adaptive process that relies on input from partners and co-development with underserved populations. Please feel free to connect with the team if you have questions, comments, or ideas you would like to share!

Micro2Macro

Growing The Seaweed Economy

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Overview

Global aquaculture production more than tripled from 1997 to 2017, creating a global market valued at $204 billion in 2020. Unfortunately, despite thousands of miles of nutrient-rich coastline, accessibility to top research institutions, established distribution channels, and large market sizes, the U.S. accounts for less than 1% of global seaweed production. The Micro2Macro platform is a digital dashboard designed to accelerate west coast seaweed farming by providing prospective farmers with high-touch guidance from start to finish. The core objective is to increase the number of farms along the U.S. West Coast by synthesizing and streamlining the logistically challenging process of initiating seaweed farming operations.

Description

(1) By providing free-to-the-public training videos and courses, interactive farm-design tools, kelp farming manuals, and budget checklists, as well as a live-chat means of connecting farmers to each other, our team will cultivate a healthy community of practice along the West Coast. (2) The creation of a permitting application tool will allow potential farmers to access appropriate space along the coastline to begin their operations. (3) Business courses created by our collaborators at the LIFT Economy will contribute to sustainable business practices and bolster kelp farming's emergence into the Blue Economy. (4) The facilitation of tribal engagement in the seaweed farming space is paramount to coastwide success of this industry. By working with coastal indigenous leaders to create an autonomous, tribal-led seaweed hub, parallel advancements can occur in this sector while sovereignty and unique permitting circumstances can be honored. (5) The cutting-edge technology component of this project lies in enhancing the Beneficial Seaweed Microbiome (BSM). Similar to how corn or soy crops have been enhanced through decades of microbe-host interactions, this relationship will be applied to seaweed crops through broad-scale experimentation with top researchers in the field

Differentiators

Many attempts to expedite the emergence of seaweed farming have been made in the U.S. However, these efforts have been primarily state-led, and are therefore limited in their ability to create convergence and consistency. This proposed project draws from decades of attempts at launching the seaweed farming industry, and synthesizes the most impactful efforts from each region. Our team is leveraging cross-sector collaboration to accelerate this sector of the blue economy, integrating academic, NGO, industrial, and tribal partners. Until now, this has not been done and resources for beginning farmers remain inaccessible and difficult to translate into action. Our deliverable, the Seaweed Farming Platform, will combine several existing platforms, up-to-date and interactive resources, and the best available science to propel the industry forward in a socially, environmentally, and economically responsible manner.

Road Map

The deliverables for this project are nested within the overarching, primary objective of creating and launching a west-coast seaweed farming consultation platform, in the form of a web-based dashboard. The timeline for the deliverables varies, and the platform itself will be public facing prior to the completion of all facets of it, as these will roll out throughout the course of the 2-year project period. As our team has already begun working with computer programmers, software developers, and other tech experts in this field, we believe that this rollout will fit within the 2 year period, and propose the following

major milestones be achieved through appropriate delegation into six main subcomponents led by: (A) Greenwave: Seaweed Farming Online Hub, (B) Kelpful: Permitting Application Tool (C) LIFT Economy: Business development tools and stakeholder outreach, (D) Sunken Seaweed: Seaweed Farming Manual and Best Practices Guide, (E) Sunken Seaweed: Tribal-led Pilot Projects and Network, and (F) SDSU: Beneficial Seaweed Microbiomes (BSM).

Partnerships

Our Phase 1 industry partners included Noble Ocean Farms and Ocean Rainforest, two seaweed farming companies located in Alaska and Southern California, respectively. These companies represent both the well-established and startup-phase seaweed enterprises, and have collaborated with us throughout the initial Phase 1 project by providing us access sample their farms, and by participating in several in-person and virtual meetings and interviews. For Phase 2, these companies will collaborate further by continuing monitoring of seaweed microbiome and tissue quality, and by contributing to the West Coast Seaweed Cultivation Handbook. Additionally, our Micro2Macro team will grow to include other industry partners, most predominantly the seaweed farming non-profit, Greenwave. Greenwave will have an integral role in constructing our online dashboard, as their recently launched "Farmer Training Hub" will comprise a large portion of our deliverable. This hub, currently aimed at farmers in the U.S. Northeast, will be expanded to accommodate the siting, permitting, cultivation species, and ocean conditions of the west coast. Additionally, a Central California-based seaweed company, Kelpful, will join our Phase 2 efforts by developing a farm permitting application that will be integrated into our dashboard and used by practitioners in the early steps of their kelp farm setup. This permitting app has already been envisioned and prototyped by Kelpful, and with Phase 2 funds can be executed in a timely manner for synthesis into the Micro2Macro dashboard. Additionally, Sunken Seaweed has participated in Phase 1 as a principal investigator and has largely undertaken the socio-political aspects of creating the seaweed farmer dashboard. By conducting the majority of stakeholder interviews with non-profits, tribal leaders, and industry representatives, Sunken Seaweed has gained an acute understanding of the needs of US seaweed farmers, and will leverage this knowledge in Phase 2 to execute the creation and launch of the platform along with the new and existing collaborators involved. Lastly, we have collaborated with researchers from five other academic institutions to create a geographically comprehensive team of scientists who will explore the role of the microbiome in seaweed farming. This group will run parallel experiments to assess the efficacy of developing a 'seaweed probiotic' than can enhance seaweed farming and profitability, while reducing many of biological obstacles that can reduce farm efficiency.

Intellectual Property

Currently, there is no intellectual property associated with our Phase 1 efforts, as all of the data collected are open source and accessible through online platforms. For Phase 2, the Micro2Macro team will be collaborating with both Greenwave and Kelpful, who will take on a primary role of generating web-based materials for stakeholders. Both groups will be tasked with managing these resources and in dealing with intellectual property management and access. As both of the platforms being developed by these entities are public facing, efforts will be made to promote accessibility, create transparency, and safeguard user experiences and privacy. Data licenses will be acquired by all parties generating user facing software in accordance with U.S. guidelines for copyright.

Nereid Biomaterials

Biodegradable Plastics for Tomorrow's Ocean

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Overview

Nereid Biomaterials develops ocean-degradable plastics, including products with embedded bacteria and enzymes that can accelerate biodegradation in seawater. Our team's initial focus is on single-use, expendable ocean instruments used by the scientific, merchant marine and defense sectors. These instruments are left to accumulate as waste long after their useful life. Instrument manufacturers are eager for purpose-built, innovative solutions that can meet the material needs of the Blue Economy, while protecting the health of our oceans.

Description

The weight of plastic waste in the ocean may soon be greater than the weight of fish. At the same time, we are increasingly reliant on plastic materials in expendable ocean instruments to predict the weather, guide maritime shipping, model climate, and, soon, to monitor climate interventions such as carbon dioxide removal. The trend toward using larger numbers of smaller, lower-cost sensors extends beyond the scientific community; privately-operated sensing networks enable data-driven decisions for global shipping and resource extraction and support a maritime data analytics market expected to reach $2.1 billion by 2028.

Our ocean-degradable materials are based on the biopolymer polyhydroxybutyrate (PHB), sustainably produced from waste methane gas. Because PHB is a compound naturally made by bacteria, many marine bacteria have evolved to fully degrade PHB to carbon dioxide and water, without the creation of microplastics or other harmful byproducts. In Phase 1, we showed that PHB biodegrades 100 times faster in seawater than the biopolymer PLA (polylactic acid), which is biodegradable only under specific composting conditions. Through incorporation of innovative "living materials" embedded with naturally-occurring microbes, spores or enzymes, we aim to control and trigger degradation for a wide range of instrument applications. By first focusing on a specialized application such as ocean instrumentation, where plastics represent a small fraction of the cost of the finished good, we will be able to scale up production of both PHB and our living materials, enabling contributions to reef restoration and bringing costs down for sectors such as aquaculture and fisheries that have incentives for ocean-degradability but are faced with tighter cost constraints.

Differentiators

We are a team of material scientists, microbiologists, and oceanographers working across industry, academia, and government with decades of experience in sea-going oceanography - a field where research and instrument development are closely intertwined. Plastic accumulation in the ocean is an urgent problem, and we need ocean-centered strategies to address it. Our implementation of living microbial additives for depolymerization of waste plastics is the first of its kind — in either marine or terrestrial settings. A similar, though different, approach is being taken by the French company CARBIOS, who deploy specialized enzymes to rapidly degrade PET (polyethylene terephthalate). Here, we focus on naturally-occurring marine microbes and growth factors that can enhance ocean-degradability in cold, deep environments that do not intersect land-based, industrial composting methods. Our use of Mango Materials' polymer - made by microbes and derived from waste methane - is truly sustainable since it does not compete with food sources such as corn and sugar. Our aim - to enable targeted,

tunable degradation rates - is also unique, a reflection of the broad range of instrument lifespans required by our end-users. By learning how to tune, or even trigger degradation, we will achieve a deep understanding of the opportunities, and limitations, of our approach.

Road Map

Manufacturers need data on material properties, degradation rates, and environmental toxicity to safely and effectively integrate new materials into their products. In year one, degradation rates of a range of PHB-based formulations will be quantified in laboratory and real ocean conditions. PHB-degrading microbes will be used to create prototype products that degrade by 80% carbon mass on three timescales: weeks, months, and years. In year two, we will evaluate the material properties of our prototypes and assess for toxicity and environmental safety. We will work with our industry partners to incorporate our materials into a range of expendable ocean instruments. Finally, we aim to create two applications for sectors beyond ocean observing, such as fishing and aquaculture, focusing on woven materials such as nets and line.

Partnerships

Nereid Biomaterials has over 15 partners spanning government, industry, military, nonprofit, communications, and education. Our customer discovery revealed a nearly unanimous enthusiasm and demand for ocean-degradable materials across these sectors. We learned that most ocean instrument applications involve rigid material, and that there are currently no commercially available ocean-degradable options. Concerns and questions revolved around manufacturing methods, material properties during degradation (strength, flexibility), shelf-life, and toxicity – areas that we can thoroughly address. Overall, our industry partnerships include some of the country's largest producers of expendable ocean instruments, with commitments to trial our materials in Phase 2. Most are ready to make a switch right now.

Intellectual Property

Our project combines formulated PHB (formulations are Mango Materials trade secrets) with un-patentable living microbes and enzymes. We anticipate that intellectual property (IP) will derive from our methods to embed or combine these living materials into scalable 'accelerant' products such as stickers, inserts, or packets that can be added to PHB products by the end-user to enhance degradability. We have laid the groundwork for an inter-institution IP agreement and have created an NDA among our core members.

Additional Information

Our Phase 1 collaboration with the Center for Science and Engineering Partnerships has produced a robust internship program focused on recruitment of students from populations historically underrepresented in STEM. In Phase 2, the internship program will expand to become a nine-student cohort, with a course curriculum and a year-long series of placements that span multiple institutions, culminating in a poster and networking session during our bi-annual in-person meeting of PIs and partners.

Ocean Vision AI

Accelerating Ocean Discovery

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Katy Croft Bell

Henry Ruhl

Ben Woodward

Overview

Ocean Vision AI (OVAI) accelerates the processing of underwater visual data with a globally integrated network of services and tools to serve a diverse set of users – from scientists to environmental managers to ocean enthusiasts. Composed of data engineers, oceanographers, game developers, and human-computer interaction experts, OVAI streamlines access and analysis of ocean visual data to enable effective marine stewardship.

Description

We are building a global-scale community of ocean visual data collectors, annotators, and users. OVAI is undergirded by a suite of innovative technology that allows individuals and organizations to rapidly translate their imagery into actionable data. Our service leverages FathomNet, our large-scale collection of annotated image datasets, while working to develop intuitive human-AI experiences and data portals to accelerate exploration. OVAI has taken concrete steps toward developing these collaborative workspaces that enhance access to ocean expertise, machine learning know-how, and visual data throughout the depth and breadth of the ocean.

Phase 1 of the Convergence Accelerator supported the beta launch of FathomNet, our open-source, distributed image database designed to ingest and serve annotated images to users around the world. The data in FathomNet are being used to inform the design of the OVAI Portal, our interface for ocean professionals to select concepts of interest, acquire relevant training data from FathomNet, and tune machine learning models. To inspire a diverse new generation of ocean explorers, we have begun development on a video game that will educate players while generating new annotations. OVAI's ultimate goal is to democratize access to ocean imagery and the infrastructure needed to analyze it. Our cost structure will reflect this aspiration, charging users on a per-project basis driven by the quantity of data uploaded and institutional need. The contributions of large, well-capitalized private and public institutions will support access for historically excluded communities. Providing data and tools to all will yield a more connected community of practice, better AI systems, support a growing Blue Economy, and encourage a more sustainable ocean.

Differentiators

OVAI is unique in the Blue Economy space: no other organization is working on a system for distributing annotated ocean visual data and providing analytic services. The closest analogs are for terrestrial ecology: Wildlife Insights – a commercial product for processing camera trap data – and iNaturalist and eBird, two community driven, freely available data aggregation and processing services. In addition to software and data architecture, these systems lean on existing networks of enthusiasts who provide contributions in the form of knowledge and imagery. Enthusiast knowledge networks do not exist at the same scale in the ocean domain. To address this gap, OVAI's scope goes beyond data aggregation and processing pipelines. We are working to build and educate an enthusiast network specializing in ocean life. We will seamlessly integrate the data analysis pipeline and global set of users, marrying state-of-the-art technology and community power to build an unprecedented resource for the ocean.

Road Map

OVAI has identified three core deliverables for Phase 2 of the Convergence Accelerator: expansion of FathomNet, launch of the Portal, and release of the video game. Currently FathomNet has been released in beta, the

Portal has a functional wireframe, and the video game is in early prototype testing. By Summer 2023 we anticipate version 1.0 of FathomNet will be active with contributions representing visual data collection in all ocean basins. In Summer of 2024 we will have a beta release of the Portal and will be in negotiations with potential project-based and institutional subscribers. By Spring 2024, we will have codified the export of machine learning enabled ecological survey data from FathomNet and the Portal to ecological metadata repositories, like the Global Biodiversity Information Facility, used to inform large-scale policy and management decisions. The video game will achieve three milestones during Phase 2 funding: (1) By Spring 2023 modules will be integrated into larger games like Into the Blue; (2) In Fall 2023 a version of the game will be built into museum and aquarium experiences; and (3) Findings from the first two versions will inform the final design to be released in Fall 2024 as a standalone, multiplatform game for high school aged and older players.

Partnerships

OVAI brings together public, private, and academic organizations. The Monterey Bay Aquarium Research Institute, a nonprofit with decades of ocean engineering and data management experience, provides infrastructure and leadership. The Central & Northern California Ocean Observing System, a federally accredited source for integrated ocean data, distributes data to stakeholders. CVisionAI, an industry leader providing machine learning and data science expertise in the ocean space, will finalize and improve the beta version tools produced in Phase 1. The Ocean Discovery League, a nonprofit that provides low-cost deep sea observational capacity to historically excluded communities, will lead development of the Portal. The Internet of Elephants, a conservation-focused video game company, has guided our development process and will build the final version of the game. Our partners at the University of California Santa Cruz will produce novel and engaging data visualization experiences. Education experts at the Monterey Bay Aquarium will continue to assist with game testing and K-20 curriculum development around OVAI. The National Oceanographic and Atmospheric Administration is providing data access and computing resources. The National Geographic Society has provided data access and will publicize OVAI's activities across their channels.

Intellectual Property

OVAI is an MBARI-led project and will follow the IP policies of the organization. IP developed as part of OVAI's activities will be licensed to our for-profit partners, and all non-embargoed data will be made open-source through our data partners as described in our Data Use Policy.

ReCoast

Recycling To Restore The Coast

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Overview

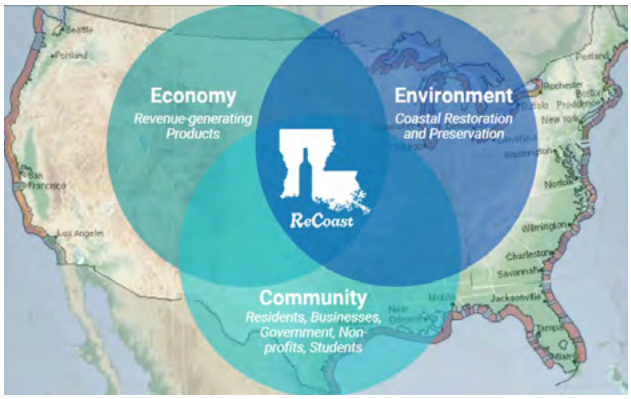
The ReCoast Team's vision is to create coastal community recycling programs to keep glass out of landfills and instead use it for glass sand products that support coastal restoration, preservation, and resiliency. Through extensive regional economic, social, cultural, and environmental research, we are ensuring ecological safety and mitigation of land loss.

Description

Louisiana loses a football field of land every hour while New Orleans alone landfills 60,000 tons of glass per year, costing taxpayers $1.8 million annually. The founding of Glass Half Full (GHF) by Tulane Alumni Franziska Trautmann, started as a backyard operation to bring glass recycling back to the city of New Orleans in 2020. GHF's ambitious mission to crush the glass into sand for use in coastal restoration catalyzed the formation of the ReCoast Team. Today, ReCoast consists of over twenty scientists and engineers conducting the research needed to ensure that recycled glass sand is safe to use in our waterways and in coastal environments—aiming to create a "blue economy network" centered on glass recycling and community engagement to restore coastal environments, including marshes, sandy beaches, and urban shorelines, and to promote smart and sustainable use of our ocean-related natural resources in the future.

Differentiators

Our convergent research approach brings together science, engineering, and business disciplines capable of engaging a broad range of stakeholder interests to identify pathways that lead to sustainability for glass recycling, improved approaches to coastal restoration, and resiliency for coastal communities (e.g., water purification and management). ReCoast leverages each team members' personal and professional network to create new opportunities related to glass recycling and the networked blue economy, and our team's ability to deploy recycled glass sand in two erosion-control projects within the first 9 months of Phase 1 is a testament to our effectiveness. In Phase 2, the interdisciplinary training afforded to new investigators and stakeholder groups will continue to advance our collective knowledge and understanding of the dynamic interconnections between technological innovation, economics, society, politics, history and the environment to create a sustainable blue economy network founded on glass recycling into sand to combat land loss.



ReCoast's vision for a Networked Blue Economy

Road Map

During Phase 2, we intend to address the following core deliverables:

- Carry out planned restoration projects, which are expected to attract investment in glass recycling and coastal restoration to sustain

the blue economy network in Louisiana beyond the project (Q4, 2022; Q1, 2023; Q1, 2024)

- Bring value-added products to translation-readiness (Q4, 2023; Q1 and Q2, 2024)
- Conduct techno-economic, life cycle, and multi-criteria decision analyses to support the economic and environmental case for our proposed blue economy network (Q4, 2022; Q1, Q3, Q4, 2023; Q1, 2024)
- Extend lessons learned from Louisiana's coastal marshes to other ecosystems (Q4, 2022 – Q3, 2024)
- Expand current broadening participation efforts to include residents of New Orleans' Lower Ninth Ward, a predominantly African American neighborhood that has been subject to environmental racism for decades, provide opportunities for citizen science, and redouble K-12 outreach efforts as schools begin re-opening to campus visitors (Q4, 2022 – Q3, 2024)

Partnerships

During Phase 2, the ReCoast Team visited the Pointe Au Chien Indian Tribe, allowing us to see firsthand the impact of land erosion on the daily lives of a frontline community and leading to our first demonstration project site. In Phase 2, we will continue to work with Tribe leaders to identify areas where recycled glass sand could be optimally utilized to protect and preserve culturally important locations.

By leveraging our professional networks during Phase 1, ReCoast has recruited additional partners in preparation for Phase 2 including representatives from the Pontchartrain Conservancy (which focuses on environmental sustainability and stewardship through scientific research, education, and advocacy) who will collaborate to bring value-added products to translation-readiness, as well as work with the Lower 9th Ward Center for Sustainable Engagement and Development to develop a water quality analysis plan and citizen science program for planned restoration projects. Additional partnerships for future implementation projects include US Fish and Wildlife, Wetland Resources, the Coalition to Restore Coastal Louisiana, Sankofa Wetland Park, Jefferson Parish Council, and Home by Hand.

We have recruited leaders in sustainable economics

to conduct a techno-economic assessment and life-cycle analyses; and will work with start-up Coastal Technologies Corp to implement and monitor deployment of temporary devices designed to attenuate wave action to protect recycled glass sand builds until grasses and trees take root.

Additionally, we have identified partners at the Meraux Foundation, Shreveport Aquarium, Surfrider Foundation, and the International Union for the Conservation of Nature who will collaborate with the ReCoast Team to evaluate opportunities to expand glass recycling to facilitate coastal restoration outside of the Greater New Orleans area.

Intellectual Property

An Intellectual Property Management Plan was created in consultation with Tulane's Office of Technology Transfer to ensure a fair balance between protection of project intellectual property and timely disclosure and dissemination of project results to the public.

Seafood Tracer

Seafood Sustainability from the Source

SEAFOOD TRACER

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Overview

Seafood fraud, illegal fishing, and fisheries mismanagement threaten the entire global seafood supply chain, with illegal fishing alone costing up to $36 billion globally each year. Seafood Tracer solves these problems. By combining genetic testing, computer vision, and machine learning, Seafood Tracer provides accurate, accessible, and near-real time verification of a seafood product's identity and origin, from fishery to fork

Description

Knowledge Networks like Wikidata are a U.S. consumers enjoy a wide range of seafood species harvested from U.S. waters, yet roughly two-thirds of the country's seafood, valued at $22.4 billion in 2020, is imported. But an estimated 32% of US seafood imports are from illegally fished sources, indicating major food security and stability concerns.

Seafood Tracer gives fisheries, processors, and distributors the means to meet regulatory and market requirements that ensure consumer protection, sustainability, and a supply chain free from illegal fishing and human trafficking. Seafood Tracer combines the emerging technologies of computer vision, environmental DNA (eDNA) metabarcoding, spatial distribution modeling, and machine learning (ML) into a single, use-inspired traceability tool. Seafood Tracer has been co-designed with our extensive global network of partners, including those from the seafood industry, and is well-positioned to transform seafood industry traceability practices.

Differentiators

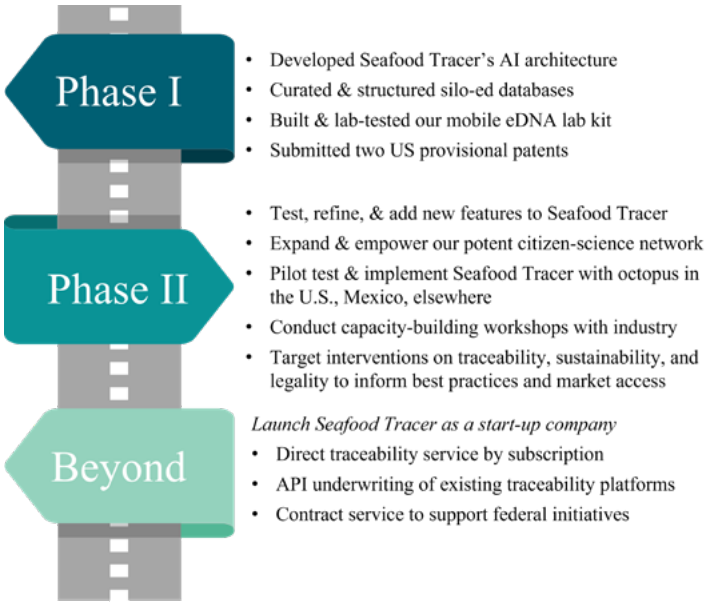
Our vision, our technology and our team set us apart from past efforts to combat illegal fishing and deliver on seafood traceability and sustainability.

Our Vision is to modernize seafood traceability from fishery to fork using emerging, innovative technology to improve food security, promote sustainable marine fisheries management, and accelerate the path to a networked Blue Economy.

Our Technology overcomes past shortcomings by modernizing seafood traceability using cutting-edge innovations to provide rapid, objective, and multi-level verification of seafood's identity and origin. Seafood Tracer's '3-signature' verification approach uses (1) eDNA metabarcoding to genetically identify the species and origin of all seafood present in a catch or shipping lot from a single water sample or surface swab, (2) computer vision AI to identify seafood at the species-level based on key morphological features detected in submitted photographs, and (3) Spatial Distribution Models that predicts the likelihood a sample came from the true ecological range of the identified species. Seafood Tracer unites this '3-signature' verification approach into a single app to deliver accurate, reliable, and near real-time traceability to the seafood industry and consumers. Phase 1 of the project saw the completion of a web application built, and Phase 2 will expand its functionality in a mobile application.

Our Team embraces convergence research, breaking down silos and uniting knowledge and expertise from (a) among the seafood industry, academia, government and non-governmental agencies, and (b) across the world to address the global challenges of food security, sustainable consumption, and marine life conservation.

Road Map



Substantial progress on the Phase 1 objectives has been achieved, including prototyping the Seafood Tracer web application, testing our mobile eDNA lab kit, and submitting two U.S. Provisional Patents for created devices.

Phase 2 will include data integration and field pilot tests with fisheries and industry partners in the U.S., Mexico, and elsewhere; multiple capacity building workshops; and advance development of the mobile app and web application features. These and other deliverables position Seafood Tracer to advance beyond NSF funding as a start-up company.

Partnerships

Seafood Tracer has established productive, potent, and diverse partnerships with individuals and organizations from academia, government and industry.

Core Team – A team of 18 experts in 9 countries using convergence research from the fields of fisheries science, marine biology, environmental anthropology, computer science, and trade policy to create one shared vision.

Academia Partners – Professionals from the Smithsonian Institute, IRIDIAN Genomics, Monterey Bay Aquarium and more expand our project's capacities and knowhow.

Seafood Industry Partners – Four fisheries Cooperatives, the CEOs & Chief Sustainability Officers at 10 U.S. seafood companies, and other industry members provide insight in the global seafood marketplace, with a commitment to test and implement Seafood Tracer across their supply chains.

Government & NGO Partners – Food and Drug Administration, National Oceanic and Atmospheric Administration Fisheries, Cephalopod Citizen Science Project, Vulnerability to Viability Global Initiative, Too Big To Ignore Fishing Network, Sustainable Fisheries Partnership, and others strengthen our capacity modernize both the U.S. and global seafood supply chain.

Intellectual Property

We submitted U.S. Provisional Patents for two re-usable eDNA membrane holder devices that solve the logistical problem of passively collecting eDNA directly from the fisheries. We have visibility on a suite of inventions that we will be working to patent in Phase 2.

Summary

Seafood Tracer delivers affordable, accessible, and accurate traceability answers to combat illegal seafood trade and help ensure a more secure, sustainable U.S. and global seafood marketplace from fishery to fork.

SPAN

Smart Aquaculture. Sustainable Future.

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Overview

SPAN, a nationwide smart precision aquaculture network, promotes sustainable oyster farming, while enhancing marine ecosystem health. The SPAN framework combines Internet of Things (IoT) sensor networks, robotics, and AI technologies with data-driven production and economic models to provide oyster farmers with environmentally responsive, precision farming solutions that improve production and profits.

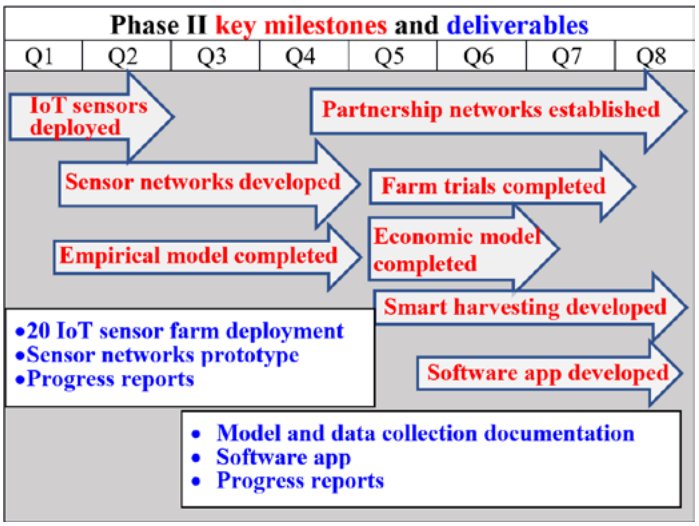
Description

As an important driver of blue economy, shellfish aquaculture is perhaps the most ecologically sustainable form of aquaculture. Shellfish aquaculture offers numerous environmental benefits like cleaning the water, creating benthic habitat, and providing a healthy source of protein. The United States has abundant coastlines, with great potential to achieve high-volume production of shellfish for the growing population. However, current domestic shellfish production is bottlenecked by outdated technology and tools. The industry lacks the basic technological advancement found in today's digital and automated world. On-bottom oyster farming has changed little in the past 200 years, using labor intensive and environmentally destructive practices. Our Phase 1 interviews of stakeholders revealed a great demand for new technologies. The team's vision for the proposed convergence accelerator project is to create a paradigm shift in shellfish aquaculture by developing a novel framework for a nationwide smart precision aquaculture network (SPAN) to achieve sustainable shellfish production, while preserving healthy marine ecosystems. The team will establish the SPAN framework by using revolutionary concepts empowered by advanced technologies including IoT, robotics, and artificial intelligence (AI), scientific discoveries in marine biology, environmental and ocean sciences, stakeholder-driven economic modeling, and integrated system deployments. SPAN-empowered shellfish aquaculture will enable growers to observe "underwater weather" and crop growing conditions similar to land agriculture. Moreover, SPAN will harness IoT and the digital world to enable growers to make growing, harvest, and economic decisions to provide ecologically sustainable seafood and environmentally valuable byproducts. When widely adopted, SPAN will promote blue economic development of rural coastal areas, not only by increasing production, but also by creating new business opportunities and jobs that provide smart technology tools and management services for farmers.

Differentiators

The societal challenge of shellfish aquaculture sustainability will be tackled through SPAN partnerships, which will foster user-inspired convergence research involving cross-disciplinary, cross-sector partners and deeply engaged stakeholder groups. A transdisciplinary team with decades of collective and broad ranging expertise in sensing and imaging, AI and computer vision, underwater robotics and controls, shellfish biology, climate and ocean dynamics, oceanography, data science, economics, and aquaculture extension, along with readily engaged stakeholders has been brought together. Collaborative stationary and mobile sensor networks will be established to bring transformative advances on the monitoring capabilities for future shellfish aquaculture. Novel smart, data-driven precision farming technologies will be developed to help farmers improve farming efficiency and productivity, reduce labor and energy used, and minimize environmental impact. Furthermore, an optimization framework

based on economic models will be established to provide farmers with decision support to gain environmental and economic benefits. Furthermore, a new modeling framework that leverages SPAN monitoring data will enable the development of farm management software that provides farmers with precision farming guides and decision support tools for business management and planning. Collectively, these technological tools and models will help facilitate better farm management, economic optimization, and better coping with climate change to enhance production and sustainability and promote a flourishing blue economy.



Road Map

The Phase 2 key milestones and deliverables are shown in the above figure. We will carry out the following objectives and tasks:

Object1. SPAN Infrastructure & Technology

- Task 1: SPAN monitoring capabilities: IoT sensor networks and mobile sensor networks
- Task 2: SPAN implementation & data collection
- Task 3: SPAN harvesting technologies

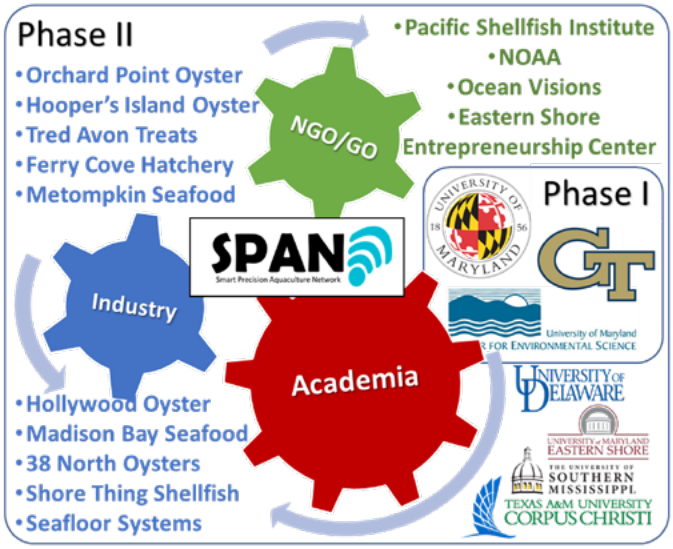
Object2. SPAN Models & Software

- Task 4: Habitat empirical models
- Task 5: Production economic models
- Task 6: Farm management software

Object 3. Education & Broadening Participation

Object4. Stakeholders & Partnerships

- Business partnerships & stakeholder networks



Partnerships

Our partnerships are shown in figure below.
The Phase 1 team has contributed the following:

- University of Maryland (UMD): Miao Yu (Lead PI, sensor networks); Yang Tao (System integration); Donald Webster (Stakeholder engagement)
- University of Maryland Center for Environmental Science (UMCES): Matt Gray (sensor network implementation and analysis); Lisa Wainger (Economic models)
- Georgia Institute of Technology : Fumin Zhang (Underwater robotics); Emanuele Di Lorenzo (Environmental modeling)

Intellectual Property

This project will result in IPs in the SPAN network system, new underwater digital information infrastructure, prototypes, smart apps and innovative tools to revolutionize oyster farming. The economic models, prediction and inventory real time reporting, and decision support system along with software are valuable IPs for licenses.

Tidepool Digital

Connecting Data For Ocean Insight

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Overview

With growing competition for ocean space, we need detailed, location-specific information to site ocean activities. Tidepool Digital will create ocean data collaboratives to safely share critical data sources that are sensitive, proprietary, or otherwise publicly unavailable. Our open source methods and toolkits are designed to reduce data gaps that can jeopardize ocean health and promote an inclusive approach to developing our Blue Economy.

Description

The United States has committed to 100% sustainable ocean management and the current Administration is seeking to develop 30 gigawatts of offshore wind energy by 2030. This shift to renewable energy has the potential to dramatically improve ocean health by reducing CO2 emissions and to transform the seascape by shifting the location of existing activities and limiting the space available for new ones.

Our current patchwork of ocean data systems makes it difficult for decision-makers to evaluate the economic, environmental, and social impacts of different activities and assess sustainability. Public ocean data portals have gaps and blind spots, with highly aggregated map layers that don't allow for in-depth analyses on how uses could coexist, such as co-locating aquaculture and energy facilities.

Over the last eight months, we listened to ocean businesses, researchers, agency staff, consultants, data managers and other stakeholders to understand the barriers to data sharing and how we could paint a more robust picture of the sea. We heard a demand for more local ocean information, a lack of trust across stakeholders, poor business incentives for data sharing, and a mix of technical and legal capacity constraints.

We believe data collaboratives can help by providing neutral spaces for industry and community members to share and explore data outside of government processes. Data collaboratives involve a participatory process to align on a purpose, build relationships and trust, and discuss risks as well as a technical platform to aggregate multiple data types, run analyses, and create novel data products. Our project will pilot two data collaboratives in regions with emergent and competing uses: the Mid-Atlantic and the West Coast. Our team of lawyers, scientists, educators, policy experts, and facilitators will partner with regional leads with local knowledge and relationships.

In addition to the data products created by each collaborative, we will develop a publicly-released toolkit with model processes and templates such as licenses for data sharing, checklists for goal alignment and risk assessment, and guidance for collaborative data analysis. This repeatable methodology could then be used by any ocean community seeking to design novel, data-informed solutions and lay the foundation for a more permanent ocean data-sharing institution.

Differentiators

Data collaboratives already exist in other sectors such as biomedical research, hospital safety, education, and agriculture. Tidepool Digital will create the first data collaboratives designed for ocean stakeholders. Our interdisciplinary breadth and place-based connections give us the skills to deliver a solution that integrates people, process, policy, and technology.

Road Map

We will conduct additional scoping for the Mid-Atlantic pilot in the fall of 2022, with the goal of identifying the participants and launching in early 2023. By the end of Q2 2023, we will have the purpose and initial collaboration agreement for Pilot 1 (Mid-Atlantic) and completed our scoping

for Pilot 2 (West Coast). In Q3 2023, we will launch Pilot 2 and run our first data stewardship training for collaborative participants and partners. Early 2024 will see our second stewardship cohort, the wrap up of both pilots, and the release of any data products from the collaboratives. By the end of the Convergence Accelerator in September 2024, we will have our methodology and toolkits ready for public release.

Partnerships

Our project team includes lawyers, data scientists, educators, ocean experts, and designers. Tidepool Digital is housed at Intertidal Agency, a non-profit consultancy focused on data strategy for conservation. The GovLab runs data collaborative masterclasses and trains people in data stewardship at agencies and corporations. Openscapes supports teams at National Aeronautics and Space Administration and National Oceanic and Atmospheric Administration in developing open science practices.

Our regional pilot partners have observed similar challenges in their work and joined us to explore how data collaboratives could address them. The Meridian Institute and the Special Initiative on Offshore Wind have been facilitating dialogues with sport and commercial fishermen, Tribal representatives, conservation organizations, and offshore wind in the Mid-Atlantic. The West Coast Ocean Alliance brings together three states, eight federal agencies, and eleven tribes, and supports a regional data portal.

Intellectual Property

Final work products, including our toolkits and methodology, will be released under a Creative Commons license. Intellectual Property created by the data collaboratives, such as maps, will be handled according to the terms of the licenses and agreements determined by the participants in each collaborative.

Urban Shorelines

Eco Designs To Connect And Protect

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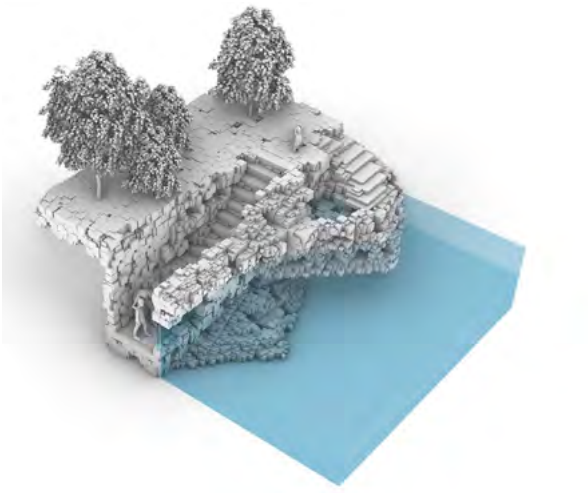
Christina Kaunzinger
Vincent Lee
Steven Handel
Sulan Kolatan
Philip Parker

Overview

Urban Shorelines fundamentally redesigns coastal infrastructure to better protect cities, support the blue economy, and improve social and ecological resilience. As seas roiled by climate change threaten coastal cities, the nation's aging bulkheads must be replaced. We pair knowledge from multiple disciplines with novel technologies to create an adaptable, place-based approach that connects, not separates, people and the shoreline.



Prototype with underwater window, tide pool and coastal vegetation. Urban Shorelines coastal infrastructure provides multi-species habitat, wave reduction and public engagement with the shoreline.

Description

Coastal zones host 33% of the global population and are our economic engines. Climate change threatens these coastal assets through sea-level rise and increased risk of storm surge. Urban Shorelines works with nature by supporting and connecting biological and social communities to create greater resilience for both. Urban Shorelines is a new form of coastal infrastructure for our time. We build on recent developments in science and technology to link advanced computation, material and structural engineering, digital fabrication technologies, ecology and social sciences in this design. How do we do this? We are a team of experts from many disciplines, including engineering, ecology, architecture, sociology, and economics. This unique combination of know-how enables our team to address multiple problems with our innovative design. Urban Shorelines reduces wave impact and increases marine biodiversity. Urban Shorelines invites and nurtures the growth of sea life, recreation, and education. Urban Shorelines enables sustainable forms of interaction between humans and coastal environments. Our work in Phase 2 will include proof of concept tests which culminate in a physical prototype of a full-scale wall segment and digital design manual useful in many urban locations. Together with a website, the physical prototype will be used to involve urban residents in the project and generate excitement and anticipation for future wide-scale applications.

Differentiators

In the past, walls have been the primary tool for protection against wave and tidal energy with little interest in ecological or social advantages. Our design process moves beyond this standard approach.

Novel concrete will be designed and printed into highly complex shapes that offer myriad niches for animals and plants and reduce wave strength. The complex structures will also attract human interaction with the marine edge. New shorelines, created using 3-D fabrication technologies, can take many forms; from flat

to shapes as complex as a coral reef, with embedded access paths or steps, tide pools, benches, and planting environments for coastal grasses, shrubs and trees that coastal animals, birds and insects, can use. The design work integrates opportunity from the street level to the seafloor, going well beyond the stop-gap approach of resurfacing current seawalls. The new design approach fundamentally rethinks coastal infrastructure.

Road Map

In Phase 1, ecologists, architects, engineers, and social scientists merged data and new inclusive design theories to understand what features and services urban shorelines should provide to urban populations as well as to improve marine ecological functioning. Interviews with stakeholders and users revealed highly specialized and localized concerns and perspectives. Data synthesis from the scientific literature across different disciplines revealed pathways to desirable forms, materials, surfaces, and context. Architects used geometries based in nature to develop a wide range of forms. Discussions with fabricators and material scientists revealed challenges and pragmatic opportunities of contemporary construction. Ecologists defined niche requirements of marine organisms. Meetings focused on environmental economy, cost estimation and whole-life-evaluation added feasibility and new models of accounting. Engineers built simulation models to test the architects' digital prototypes for the interaction of storm and wave forces with designs. Meetings with regulators helped understand permitting challenges, the motivations behind them, and ways to address them. Engagement of educators and community leaders provided opportunities to involve urban populations in pathways to the restoration of social opportunity and justice.

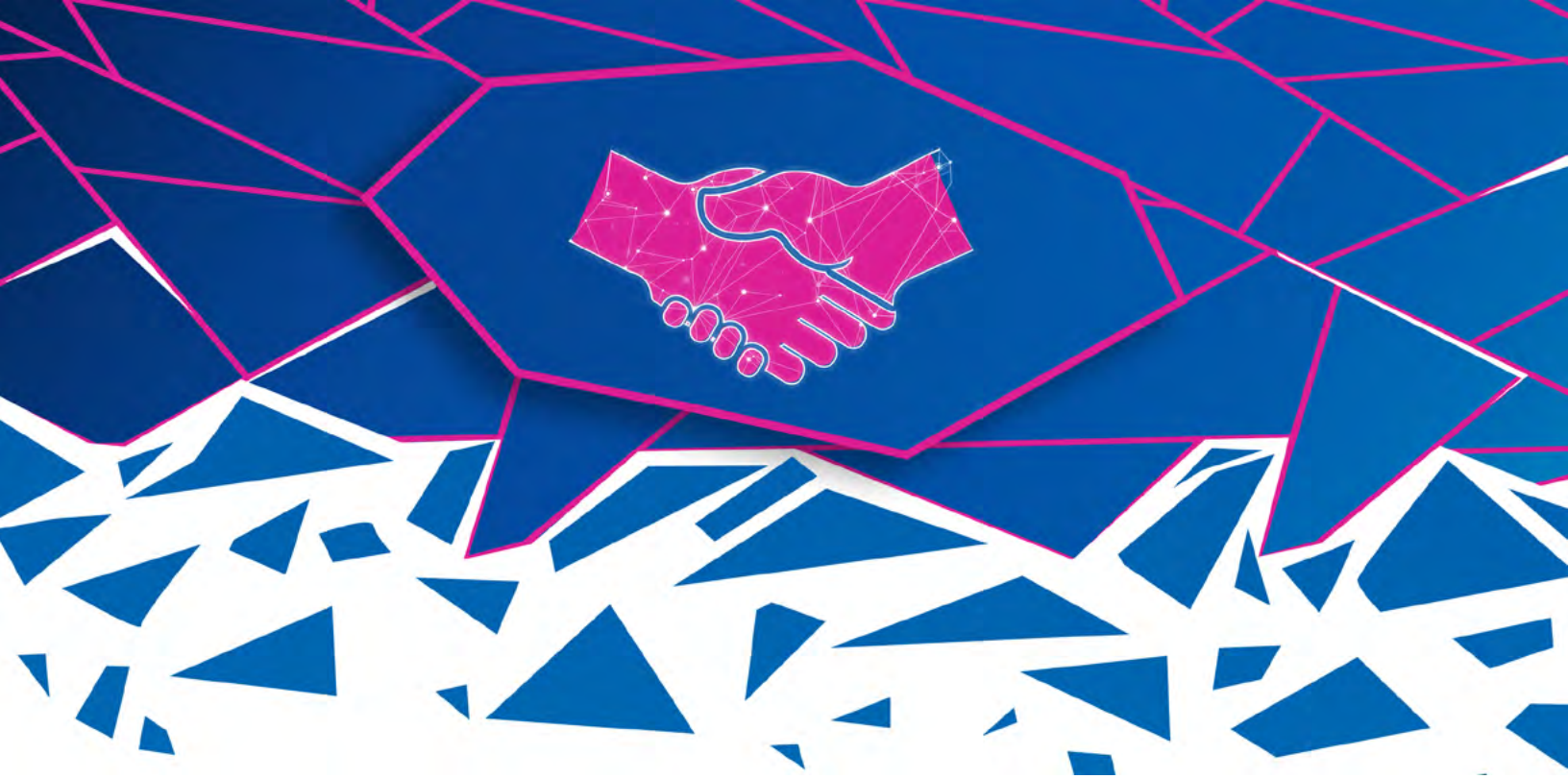
In Phase 2, Urban Shorelines will put these ideas to the test. Starting immediately, experiments in the laboratory and field will test new materials, surfaces, and shapes to determine best solutions for marine organisms. Test printings will challenge fabrication methods. Completed subsections will be subjected to tests of strength, wear and wave reduction in wave tanks. Test results will be incorporated into the iterative design process. By the end of Year 1, results will be encoded into a draft manual, while continuing design and experiments will lead to revisions until the end of Year 2.

Partnerships

Our team interacts with public agencies, industry, conservation groups and educators. Network partners will be brought directly into the processes of public space and infrastructure design, with special attention to inclusion of underserved communities and groups that are traditionally underrepresented. Harbor School, Rockaway Initiative for Sustainability & Equity - RISE, Billion Oyster Project and Eleanor Roosevelt High School, all of which serve underserved communities and students underrepresented in STEM, will partner in outreach to students at the high school and college level. RISE, Biobus, Black in Marine Science and Hudson River Park Trust will advise on a public plan for developing social engagement with the shore and STEM outreach in urban settings that can be used in any urban area where our new seawall designs will be adopted.

Intellectual Property

The team is preparing design methodologies to be shown in a design manual, consultancies for redesigning the urban shoreline, and specific wall system components for possible licensing.



TRACK F:

TRUST AND AUTHENTICITY IN COMMUNICATION SYSTEMS

Modern life is increasingly dependent on access to communications systems that offer trustworthy and accurate information. Economic growth and opportunity depend on dynamic innovation and transaction networks that connect American families, communities, and businesses to an expanding range of goods and services that improve the quality of life. Yet these systems face a common threat; communication systems can be manipulated or can have unanticipated negative effects. Introducing misinformation into communication flows can disrupt the performance of a wide range of activities and the functioning of civil society. Although false claims and other inauthentic behaviors have existed throughout history, the problems that they cause have reached critical proportions resulting from the massive scale of targeting and personalization, the rapid speed of information exchange, and the ability to automate information dissemination.

NSF's Convergence Accelerator Track F: Trust & Authenticity in Communication Systems is addressing the urgent need for tools and techniques to help the nation effectively prevent, mitigate, and adapt to critical threats to communication systems. The track is also focused on developing strategies to increase the verifiability of a wide range of data and content and to improve an understanding of incentives, organizational, cultural, and governance contexts associated with inauthentic behaviors. Finally, NSF-funded teams are focused on education and training to help information consumers become better equipped to find trusted sources and recognize questionable ones.

Trust & Authenticity in Communication Systems funded phase 1 teams include:

- **Analysis and Response Toolkit for Trust**—Led by Hacks/Hackers, Analysis and Response Toolkit for Trust, or ARTT, assists online communities with building trust around controversial topics such as vaccine efficacy. Users receive helpful approaches to engage, navigate, and analyze information. The toolkit's primary resource, ARTT Guide, provides expert-informed suggestions-for analyzing information and communicating with others to build trust.
- **Co-Designing for Trust**—Led by the University of Washington, Co-Designing for Trust builds community-oriented infrastructure that supports underserved communities to design, collaborate on, customize, and share digital

literacy approaches. Developed by academic researchers, community organizations, libraries, journalists, and teachers, Co-Designing for Trust re-imagines literacy to provide the cognitive, social, and emotional skills necessary to respond to problematic information.

- **CO:CAST**—During crises, decision-makers are challenged by information overload that is often exacerbated by misinformation. Led by The Ohio State University, CO:CAST is an AI-based system that helps decision-makers manage their information environment. CO:CAST personalizes, curates and separates credible from less credible information, presents it contextually within existing workflows, and leverages community-academic-government partnerships to mitigate misinformation impacts.
- **Co·Insights**—Led by Meedan, Co·Insights enables community, fact-checking, and academic organizations to collaborate and respond effectively to emerging misinformation narratives that stoke social conflict and distrust. Our easy-to-use, mobile-friendly tools allow community members to report problematic content and discover resources while cutting-edge machine learning analyzes content across the web to create valuable insights for community leaders and fact-checkers.
- **CommuniTies**—Today's news outlets are not always trusted as information sources by their communities. Led by Temple University, CommuniTies is changing the dialogue around distrust of media. Using an AI network science tool, CommuniTies provides actionable insights for local newsrooms to help them build digital lines of communication with their communities, preventing the spread of misinformation and disinformation.
- **Community Credit**—As consumer finance moves online, so do patterns of predation and exclusion. Led by University of California, Irvine, Community Credit is a participatory action toolkit for advancing racial economic equity and fostering community engagement in banking. Partnering with credit unions and local nonprofits, the Community Credit process jumpstarts consumer-driven innovation to guide inclusive product design and digital transformation.
- **Course Correct**—Led by University of Wisconsin – Madison, Course Correct is a dynamic misinformation identification dashboard to empower journalists to identify misinformation networks, correct misinformation within the affected networks, and test the effectiveness of corrections. Designed by mass communication, computer scientists, engineers, and social media experts, Course Correct rebuilds trust in civic institutions while helping journalists tame the misinformation tide.
- **DART**—Online deception disproportionately targets seniors to disastrous effects. Led by SUNY at Buffalo, The Deception Awareness and Resilience Training or DART platform helps older adults recognize threats so they can protect themselves. Developed by game designers, social media researchers and security experts, DART is unique in tailoring its curriculum and using gamification to make training accessible and engaging for older adults.
- **Expert Voices Together**—Led by George Washington University, Expert Voices Together, or EVT, is building a rapid-response system to assist journalists, scientists, and other experts whose work is being undermined by coordinated online harassment campaigns. Modeled on best practices in trauma-informed crisis intervention, the EVT platform provides a secure environment for experts to receive support from their professional communities.
- **Search Lit**—Led by Massachusetts Institute of Technology, Search Lit is a suite of customizable, human-centered, open-source interventions that combats misinformation by building the public's capacity at scale to sort truth from fiction online. The team brings expertise in large scale learning, ethnography, and digital search education, with partners in military, healthcare, and public libraries.
- **TrustFinder**—People need tools to filter misinformation and find trustworthy signals in a sea of noise and data. Led by the University of Washington, TrustFinder assists researchers in collaboratively de-risking information exchange by binding digitally-signed annotations to data on the web. TrustFinder empowers communities to co-create information structures, influencing systems and algorithms towards more human outcomes.
- **WiseDex**—Social media companies have policies against harmful misinformation. Unfortunately, enforcement is uneven, especially for non-English content. Led by University of Michigan, WiseDex harnesses the wisdom of crowds and AI techniques to help flag more posts. The result is more comprehensive, equitable, and consistent enforcement, significantly reducing the spread of misinformation

Analysis and Response Toolkit for Trust (ARTT)

The ARTT of Building Conversational Trust

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Overview

Motivated citizens strive to provide their communities with reliable information. While research shows their work is crucial for countering misinformation, the challenge is overwhelming. Our software tool will support these citizens by providing easy access to accurate information, tips for effective and trust-building conversations, and encouragement of their efforts. We will tackle vaccine efficacy first before addressing additional topics.

Description

"What do I say and how do I say it?" People participating in online communities wrestle with this question every day. The problem is that online information is often difficult to navigate—in addition to its sheer abundance, issues such as access, education, politicization, and disinformation campaigns waged at scale present challenges to citizens trying to identify accurate information. In a 2018 Gallup poll of US citizens, 65% said they believed online news contained misinformation, and 80% of news was biased.

Discussions around vaccine efficacy are a prime example of this information challenge. Hesitancy around vaccines is now a top-ten global threat identified by the World Health Organization (WHO). In a 2019 Pew survey, only 3-in-10 Americans felt confident when checking the accuracy of COVID-19 news found on social media.

Motivated citizens—including amateur volunteers, as well as local professionals such as health communicators or librarians—who want to provide accurate information on social media also need help themselves, not just in evaluating existing information, but fundamentally about how to best engage with others. They have three needs: 1) Resources for quickly determining trusted, reliable information to learn from, and to share; 2) Options for conversational responses that reflect the latest research, are effective, and build trust; 3) Encouragement to sustain their work amid draining conversations on contentious topics. Our software tool, ARTT Guide, will address these three needs together in an accessible format available on desktop and mobile devices.

Differentiators

The ARTT Guide software tool presents, for the first time, a unique framework of possible responses for everyday conversations, all informed by online information analysis, to help motivated citizens answer the question: "What do I say?" ARTT's guided responses are sourced from the latest research in psychology, conflict resolution, media literacy, and other fields. While our tool will offer suggestions on how to best correct information, it will also give users guidance on other response possibilities, including: co-verify, de-escalate, empathize, encourage healthy skepticism, encourage norms, listen, share, or take perspective. In this way, ARTT users are empowered to develop their own responses.

Major ARTT features will include: the ability to check if a news article comes from several quality source lists; Metrics around the post or message on social media; Templates for online responses based on research tips, and; The ability to share answers from diverse community resources on the most pressing questions related to vaccines that match authoritative guidance.

Road Map

Our main deliverable is the ARTT Guide software tool. We also have two supporting deliverables:

- A second edition of our research catalog, which powers the response tips used by the tool.
- A curriculum and facilitator guide that uses ARTT to teach social media analysis and response skills.

Our key milestones are built around the Guide and the testers who will use it:

- An "alpha" Minimum Viable Product in May 2023 for use by our testers.
- Field testing completed in November 2023.
- An updated version of the tool available for public release in August 2024 incorporating user feedback and cybersecurity recommendations.

To ensure our tool continues to reflect the needs of our stakeholders, we are organizing cohorts of users to help us finish the design of the tool, starting in late 2022. Cohorts include motivated citizens in online communities, local health communicators based in specific areas, and educators who want to use the Guide as a social media teaching tool.

Partnerships

This project is led by members of Hacks/Hackers, a nonprofit organization focused on journalism and technology, and the Paul G. Allen School of Computer Science & Engineering at University of Washington. Through Phase 1, we have collaborated and partnered with a variety of organizations including Wikimedia DC, MuckRock Foundation, and Social Science Research Council. In addition, advising has also come from members of WHO's Vaccine Safety Net.

Moving into Phase 2 we will be joined by members of the National Public Health Information Coalition, the Center for Humane Technology, Children's Hospital of Philadelphia, Georgia Tech Research Institute, Knowledge Futures Group, and many others to help us build the tool and create the cohorts.

Intellectual Property

ARTT will make its software and resources available under various open-source licenses. We are in the process of determining which licenses and will release them starting in mid-2022 with related products.

Co-Designing for Trust

Building Trust Through Community

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Overview

Our goal is to leverage a participatory approach to design to make locally contextualized digital literacy resources for Black, Indigenous, and People of Color (BIPOC) and rural communities. To increase the impact of our work, we will also develop an infrastructure that supports community stakeholders in the ongoing co-design of literacy resources.

Description

There are many community organizers, librarians, teachers, and other professionals (i.e. many digital literacy interventionists) who are working to reduce the impact of misinformation in their communities by helping people learn and talk to one another. Because the work of creating locally contextualized literacy interventions is hard and not well understood, a participatory approach is critically needed to create interventions that are more robust and likely to have impact.

With the participatory approach at the core of our project, we will achieve: (1) the co-design of digital literacy resources that serve as good starting points for interventionists; (2) the development and documentation of methods that help interventionists tailor educational resources to their own local contexts; (3) the development of best practices to support interventionists in sharing their resources with other communities; (4) the implementation of an online system to support scaled collaboration; and (5) the nation-wide dissemination of project resources to scale out this community-oriented infrastructure.

Our project will have an impact along myriad dimensions. The project will create 8 standalone resources for supporting digital literacy across BIPOC and rural communities. This will impact, at a minimum, over 200 people across 60 co-design sessions at least 11 different sites of practice. The project will also contribute social, information, and technical infrastructure for sustaining and scaling digital literacy interventions. Finally, the project's intellectual work will create a broader understanding of the types of skills required to build trust within communities, producing insights into how critical thinking, emotion, and sociocultural dynamics converge to shape trust and mistrust within communications systems.

Differentiators

Efforts to update digital literacy curricula are often designed with classroom strengths and weaknesses in mind, which do not perfectly translate to community settings. They also typically emphasize critical thinking over the sociocultural and emotional processes that shape how critical thinking translates into action. This project aims to equip people with not only skills to assess the facticity of information, but also skills to reflect on and regulate their sociocultural and emotional attachments to information. And it is doing this by co-designing digital literacy with diverse community stakeholders that typically fall outside of formal education, building them into the structure of the research team through significant subawards and leadership positions.

The true strength of the project lies in its ability to broadly scale these participatory approaches, beyond Phase 2 partner communities, to design digital literacy interventions tailored to their own needs. Efforts to update digital literacy

curricula frequently struggle with scalability and sustainability because they fail to account for how teachers, librarians and others discover, adapt, and use educational materials in practice. The end result is often static materials that don't inspire reuse. This project is developing a community-oriented infrastructure to help these different practitioners have sustained interactions and develop shared resources and practices.

Road Map

We have split this project into two major workstreams - one focused on co-designing and evaluating eight standalone resources for supporting digital literacy across underserved communities, and the other focused on scaling insights from that work in convergent and sustainable ways.

The co-design workstream's deliverables (and due dates) include: rural library materials for addressing difficult situations (January 2023); a rural high school version of the Teachers for an Informed Public (TIP) curriculum (March 2023); resources for supporting Heal the Healers (March 2023); digital literacy curriculum for Seattle Central College (SCC) courses (April 2023); curricula for Black and Hispanic K12 students (December 2023); rural library programming for teaching critical reasoning skills (January2024), and an elementary school version of the TIP curriculum (February 2024), and resources for extending SCC curricula into the broader community (April2024).

The second workstream's deliverables include initial (August2023) and final (August2024) drafts of a Community Playbook; an evaluation framework for assessing community-based digital literacy resources (September 2024); initial (May 2023) and final drafts (June 2024) of a style guide and template to support the sharing of resources; and an initial (November 2023) and final prototype (September 2024) of a Web service that supports collaborative work on educational materials. The project will also hold three Convergence Workshops (June 2023, January 2024, and September 2024) and will produce publications and conference presentations throughout the project timeline.

Partnerships

Partners involved in participatory design include the Black Brilliance Research Project, Seattle Central College, Teachers for an Informed Public, WA OSPI, Asotin County Library, Burlington Public Library, North Olympic Library System, Smithville Public Library, Whatcom County Library, and Yakima Valley Library System. These partners were all involved in stakeholder workshops in Phase 1. Partners supporting dissemination and advising include the Public Library Association (PLA), AARP, OCLC, Washington State Library, the Pacific Science Center, and Microsoft.

Intellectual Property

The Phase 1 project does not currently possess Intellectual Property (IP). Ownership of IP shall follow inventorship in accordance with United States patent law or authorship in accordance with United States copyright law, as applicable. Unless agreed otherwise, the project partners shall be joint owners of project IP that is developed jointly by the partners. The IP plan will be monitored and updated as necessary.

CO:CAST

Providing Credible, Actionable Sensemaking Tools

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Overview

From natural disasters to global pandemics, decision makers must navigate uncertain, rapidly changing, and often contradictory flows of information. Social media and the rise of misinformation only make the challenge more acute. Enter CO:CAST (Crisis Observatory: Credible Actionable Sensemaking Tools), a pioneering system designed to help decision makers at every level manage and make sense of information during a crisis.

Description

Our mission is to facilitate actionable sensemaking in the face of increasingly complex information environments. To this end, CO:CAST will provide a bundle of services tailored to end-user needs and developed in conjunction with a broad network of academic, governmental, and non-governmental partners. Services include:

- **Synthesis of information from diverse sources**, formal and informal, including government agencies, news media, social media, and the scientific literature.
- **A configurable dashboard** that allows users to track how a crisis is being talked about in various geographic areas. (Or, with the click of a button, users can switch to a network view and see how different social networks are treating the issue.) Who is discussing the crisis? What is the emotional tenor of their discussions? What kinds of claims are getting the most attention, and how and where are they spreading? The dashboard will act as an early warning system, alerting decision makers when dubious claims are gaining traction in their communities.
- **Real-time information assessment and curation.** CO:CAST will both identify dubious claims and place them in context, providing summaries of relevant evidence and trusted expert analysis, to help decision makers respond authoritatively.
- **Feedback visualizations,** allowing users to see how well their efforts to communicate and counter misinformation are working.
- **A crisis simulator (CriSim).** Not only will CriSim provide a low-stakes environment for training, it will represent a source of invaluable feedback for continuous improvement of CO:CAST services.

Differentiators

CO:CAST is not a fact-checking tool. It is a system for organizing information, assessing its credibility, placing it in context, and understanding how it flows through a community.

Our end users attest that misinformation is a mission-critical problem in crisis management. However, they also tell us they lack the tools to combat it. CO:CAST represents the first comprehensive product to remedy this crucial gap.

Our approach to training and evaluation is also unique. Deploying CO:CAST services within the crisis simulator (CriSim) module will provide unprecedented opportunities to train decision makers in information management during crises. Simultaneously, CriSim will allow us to evaluate and improve CO:CAST features.

Our team, the Crisis Observatory, combines expertise in public health and emergency response management with expertise in journalism, communication, natural language processing, social media analysis, misinformation research, and AI. Team members have extensive experience translating research into practice. We are uniquely positioned to bring CO:CAST to fruition.

Road Map

The first year will be focused on building out the CO:CAST system. We plan to engineer a functional prototype for use in two scenarios: public health response to COVID-19 in Ohio and emergency response to hurricane-induced flooding in South Carolina. Both scenarios will factor in downstream implications for emergency managers, public health officials, and educational and community leaders.

Team members will work to develop several software/AI tools: the central content retrieval system; a knowledge-graph-based system that organizes content according to crisis-specific concepts; relational models of source credibility; tools for tailored information curation; and tools that extract, present, and summarize credible evidence related to less credible claims. In parallel, other team members will work on developing scenarios for the CriSim crisis simulator. Throughout development, we will continue to engage in a human-centered design process.

Software development will continue into the second year, but attention will begin to shift toward deployment, user training, and testing. In this phase, CriSim will allow our partners to learn and explore the system—even as it helps us identify refinements and improvements.

Partnerships

Our extensive network of partners includes six regional- and state-level emergency management and public health organizations, as well as more than ten educational organizations, in three states: Ohio, South Carolina, and Kentucky. Additionally, the CO:CAST core team has established key partnerships with two national organizations: the National Public Health Information Coalition (NPHIC), which serves public information officers and directors of communications in all states and territories, and the Association of State and Territorial Health Officials (ASTHO), a nonprofit that supports the work of state and territorial public health officials. We have also identified consultants to assist in the development of crisis simulations.

Intellectual Property

CO:CAST intellectual property will comprise new methods for managing mis/information during crises, as well as the CriSim crisis simulator. Partner institutions may collectively agree to make such IP freely available to the public.

CO:CAST services, including the dashboard, will be licensed either to existing companies or to a nonprofit/startup created for this purpose. Team members have significant experience with both approaches. Licensing revenues will be used to further project activities.

Co·Insights

Fostering Community Collaboration to Combat Misinformation

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Overview

Co·Insights is a convergence of computational social science and ethnographic inquiry with a unique platform that enables community, fact-checking, and academic organizations to work together to respond effectively to misinformation targeting Asian-American and Pacific Islander (AAPI) communities. These communities are dramatically underserved by current misinformation interventions due to the variety of languages involved, use of alternative platforms, and limited understanding of the diverse social issues affecting the many ethnic groups within the broad umbrella of AAPI.

Description

Our easy-to-use, mobile-friendly tools allow AAPI community members to forward harmful content to tiplines and discover relevant context explainers, fact-checks, media literacy materials, and other misinformation interventions. Our Phase 1 research shows that misinformation claims often form around common themes, persistent stereotypes, and patterns of deception. By building taxonomies and using machine learning (ML) to map claims to them, we can move to a proactive model where interventions are available before claims spread widely. The Annenberg Public Policy Center (APPC)—home of FactCheck.org—has pioneered and validated this approach with infectious disease. Our team has been able to build ML approaches to accurately map claims to this taxonomy. In addition to crowdsourcing tiplines, we will crawl and analyze AAPI-specific content using ML to detect controversy and match similar claims. The insights from this data can enable community leaders and fact-checkers to create more effective, targeted misinformation interventions tailored to the needs of each community.

Differentiators

While some of our approach encompasses social listening (c.f. CrowdTangle, Meltwater), our approach is significantly differentiated by (a) platform coverage, (b) diversity of languages, and (c) preemptive taxonomies.

Platforms: We offer tiplines to directly connect community organizations with their audiences on WeChat, Viber, WhatsApp, and other end-to-end encrypted platforms popular among AAPI communities. We also improve coverage of content targeting AAPI communities

on unencrypted platforms. **Languages:** Misinformation response efforts in non-English languages are often far behind those in English, and many ML algorithms are trained only on English-language data. Our consortium is creating ML models specifically to support Asian-language misinformation response. As an example, we trained a model for matching similar misinformation claims in Tagalog and Filipino to support FactsFirstPH & Tsek.ph during Phase 1.

Preemptive Taxonomies: Our expertise in taxonomy development, community-knowledge, and ethnography contribute to a novel approach that enables rapid identification of harmful misinformation and cross-language misinformation responses.

Road Map

Tiplines on major messaging platforms will

be created for and promoted by our four community organizations within the first month of the project. Our community organizations will immediately use these tiplines to discover new content and more widely disseminate misinformation interventions. An updated

ecosystem mapping by our ethnographers will inform the development of data pipelines to crawl social media platforms. These will be integrated into the web interface by March 2023 with sources and keywords being updated monthly. Classifiers to map content to the APPC taxonomy will be in the product from January 2023 while additional classifiers centering AAPI issues will be added in May 2023. Additional classifiers will be trained and deployed in a similar fashion until Feb. 2024 when it will be possible for users to create their own taxonomies and train their own classifiers through the web interface. Shared feeds to pool data to collaborate with academics will be available by June 2023 when revenue sharing models will also be agreed. Each component has specific impact metrics to be tracked such as the percent of tipline conversations ending with a "useful" rating, human-in-the-loop feedback on the narrative theme classifications, and net promoter score surveys of the tipline and web interface.

Partnerships

The project is led by Meedan, a technology non-profit that builds leading fact-checking software supporting third-party fact-checking programs at major social media companies. In this project we are centering the voices and needs of AAPI community organizations—work led by ethnographers at UMass and strengthened by four AAPI community-organizations joining our consortium for Phase 2: Viet Fact Check (Vietnamese), Piyaoba (Chinese), Tayo (Filipino), and DesiFacts (Hindi, Bengali, Tamil). APPC will lead data collection, testing, and validation of the infectious diseases taxonomy as well as create resources to support community organizations engaging in fact-checking. CU Boulder will use discourse analysis and communication design to strengthen interventions. Rutgers University is pioneering community-led, data donation while AI startup AuCoDe is building data pipelines. UMass (Media Cloud) is doing this for news, blogs, and YouTube. UConn is developing narrative theme classifiers.

Intellectual Property

Data access is controlled by each community organization using Co·Insights, and these organizations have agreed to share data with the consortium and each other throughout the project. We will evaluate wider data sharing opportunities as part of our sustainability work. The core platform and software are being developed open-source as all Meedan's software is. Specific integrations funded by the grant (social media crawlers, data donation, etc.) are owned by their developers, and all consortium partners are given a license to the code. Background IP (e.g., AuCoDe's controversy detection) is proprietary and licensed only for the lifetime of the grant and ongoing access will be negotiated in our sustainability work.

Sustainability

Our interviews with social media platforms and academics found large demand for labeled and diverse datasets going beyond English. We are exploring two paths to sustainability: (1) selling data products to social media platforms with revenues sustaining community organizations, and (2) academics including data access fees in academic grants, although we plan to provide free access to our datasets to faculty and PhD students at accredited universities without external funding.

CommuniTies

Better Connecting Local Newsrooms With Their Communities

communities

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Overview

CommuniTies will be a dashboard with user interface containing state-of-the-art AI components (e.g., localized social graphs, text analytics) that can act as standalone components or be integrated into existing platforms used in newsrooms. The CommuniTies dashboard will allow regional, local, and hyperlocal news organizations to forge stronger connections with a diverse range of interest groups that exist in the communities they serve.

Description

CommuniTies will afford local news professionals an ability to see how their journalistic content is reaching different issue publics and impacting information exchange across social media platforms. CommuniTies will also provide news organizations with a better understanding of social network relationships between diverse issue publics nested in a locality. It will reveal a sense of not only what issues are being discussed, but how they are being discussed. CommuniTies functions like a team of beat reporters who seek to understand specific areas of interest. However, the beats are not just issues, but also diverse issue publics that are discussing these concerns. Nested within local issue publics are information gaps. By generating an understanding of where local journalistic content is reaching and the interests driving the formation of a diverse set of issue publics, local news can become further ingrained in their communities.

Journalists want to provide quality information to aid decision making. There are four forms of capital that can be utilized to achieve this goal: Financial, physical, human, social. The digital age has reduced local news' financial, physical, and human capital. However, local news remains among the nation's most trusted sources. People appreciate local news but indicate it could be doing more in their localities. Social capital (benefits derived from social connections) is generated from a "virtuous circle" consisting of trust and behavioral engagement. Local news' financial, physical, and human capital losses threaten their ability to retain a level of behavioral engagement to allow trust to be maintained and social capital to grow. Local news needs to build its social capital – the trust is there, but behavioral engagement is waning. CommuniTies will allow local news to be more efficient and effective in determining how best to engage the communities they serve and build the social capital needed to combat misinformation.

Differentiators

While most attention is given to national news, a shift toward local news offers several advantages: (1) The unique characteristics of a community (e.g., racial-ethnic diversity, economic stability) will impact how information gaps affect decision making. The local level will allow for a wide range of journalistic activities to be tested in varied settings and best practices to be adopted; (2) Just as various issue publics will have differential insights on a wide range of interests, so too will news organizations have varied levels of understanding of diverse issue publics. Local news is well positioned to form sustainable action plans for how to engage with issue publics, including those that have been historically underserved; (3) A shift to the local leads to a recognition of a need to focus on multilingual newsrooms for combating information gaps. We have the expertise and newsroom connections to work with local media outlets generating not only English-language content, but Spanish-language content as well (with an eye toward multilingual integration).

Road Map

Year 1 will focus on (1) articulating the hypotheses that serve as a foundation for the CommuniTies platform; (2) refining social network analyses and graphical interfaces to detect and visualize issue publics; (3) identifying the topics being discussed in diverse issue publics; and, (4) designing a system for collecting user-generated content across social media platforms. The first year will close with a focus on misinformation detection.

Year 2 will begin with getting CommuniTies into newsrooms and incorporating journalist feedback into the platform. We will be working English-only, Spanish-only and bilingual (i.e., English and Spanish) newsrooms. The second year will also involve workshopping with local newsrooms on the development and refinement of potential intervention strategies for addressing information gaps. Finally, the second year will involve platform evaluation and the exploration of forward-thinking sustainability strategies.

Partnerships

The USA Today Network (5,000 local journalists, 300 organizations) and the Institute for Nonprofit News (INN) (350+ newsrooms) will allow the CommuniTies platform to be in the hands of journalists. CárnedasStrategies will help forge strong Spanish-language media connections. Junkipedia will improve our access to user-generated content, ClustrX offers cutting-edge analyses of online social networks, and Graphistry will offer state-of-the-art data visualization. Partnerships with Newspack and Metrics for News will allow us to explore how best to insert CommuniTies into existing workflows. Bloomberg AI Group and IBM Research will aid us with the implementation and evaluation of advanced analytical tools. TrustingNews and the Poynter Institute will help us construct an ethical platform. We have partnered with Social Context to explore sustainability options via brand safety solutions.

Intellectual Property

There are no current CommuniTies-specific intellectual properties registered or trademarked. However, Phase 2 will involve the creation, registration, and trademarking of CommuniTies-specific intellectual property. Partners to date that have offered their own IP in the form of code, consulting, or other information include: Junkipedia, ClustrX, Graphistry, Newspack, Metrics for News, USA Today Network, INN, Trusting News, Poynter, and Cárnedas Strategies.

Community Credit

Redesigning Finance, Together

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Overview

As consumer finance moves online, so do patterns of misinformation, predation, and exclusion. Community Credit is a participatory action toolkit and curriculum for advancing racial economic equity and fostering community engagement in banking; it seeks to disrupt these patterns by centering community voices in the design of financial services. Partnering with credit unions and local community-based organizations (CBOs), the Community Credit process jumpstarts consumer-driven innovation to guide inclusive product design and trusted dialogue.

Description

As of 2019, nearly a quarter of Americans were unbanked or underbanked, relying on alternative financial services like payday loans to meet their needs. The use of these services is even higher in communities of color. Consumer financial services has been flooded with new apps and digital products promising access to credit, investment opportunities, mobile banking, and more at the click of a button. As more and more transactions take place online, it is easier than ever to target a struggling person with ads for predatory products. For minoritized communities historically excluded from banking, these often feel like the only options available. Yet, growing evidence shows that automating credit and other forms of financial decisions may deepen long-standing inequalities, a kind of algorithmic discrimination known as "digital redlining."

How can we address the challenge of distrust and systemic exclusion as banking goes digital? The solution is not to restore trust in banks—who never had it in the first place—the solution is to make banking more worthy of trust. Partnering with credit unions and CBOs, who are both rooted in their communities and have a mission to serve, the Community Credit process fosters trust-building and consumer-led product development to meet community needs, while helping credit unions compete in an increasingly digital financial services landscape.

We begin with an initial "service check"— expert evaluation of a credit union's relationship to local minoritized communities through facilitated listening sessions. Next, we develop pathways for trusted dialogue within a robust research framework, using a series of critical qualitative methods for human-centered design to elicit deep first-person insights into questions of trust, banking, and community resilience.

Finally, through a curriculum guide for co-creation, we offer strategic guidance for ongoing dialogue, so that credit unions can continue to build and maintain ethical, mutually beneficial relationship with minoritized communities. The goal is to make financial institutions a conduit for trustworthy information flow while developing products that actually serve rather than exploit.

Differentiators

Community Credit's bottom-up, interpersonal approach to combating digital redlining and misinformation by fostering financial inclusion sets it apart. Financial literacy approaches start from the assumption that people are ignorant or misinformed, and that they simply need to be provided with the "correct" financial advice. Other market actors, recognizing the realities of poverty that constrain even the most "financially literate," have sought to offer payday loan replacement products. However, our research shows that even if financial institutions offer products that fill a real need, there are still roadblocks to trust and inclusion.

We turn this dynamic on its head. Rather than top-down education or product provision, Community Credit seeks to analyze and understand sources of mistrust from an end-user perspective. Then, our platform brings the community directly into dialogue with credit unions to help put the community on the inside of the process of product development. While credit unions have historically excelled in serving marginalized communities, these efforts have been fragmented, and are increasingly limited by the pressures of consolidation within the industry. Community Credit activates the cooperative ethos of credit unions and the knowledge of CBOs, responding to calls from experts in AI-driven consumer finance to keep the "human in the loop."

Road Map

In Year 1 of Phase 2, we will pilot and refine Community Credit with our two CBO partners. This will run in parallel with the Filene Racial Economic Equity Incubator (REE) initiative to engage CBO and credit union partnerships in other markets nationally for trust building and co-creative solution building. In Year 2, Community Credit will be packaged into a minimum viable product in preparation for market launch, and the research team will host a series of public convenings to disseminate findings within the consumer financial services industry.

Partnerships

Filene Research Institute, a national nonprofit serving the credit union industry, will provide expert insight and consulting on community co-creation and partnership-driven innovation methods, including connections to Urban Strategies and Native Women Lead, two leading community development organizations. Leveraging their experience in financial services product incubation, Filene will help create and finalize the Community Credit product and conduct program evaluation to assess impacts.

Abrazar and The Cambodian Family, CBOs in Southern California, will collaborate with the research team to iteratively pilot the Community Credit training materials, host public engagement and advocacy events related to financial empowerment, and utilize human-centered research methods to identify misinformation and gaps in financial services in the Latinx and Cambodian communities.

Intellectual Property

The Community Credit toolkit will provide a mix of copyrighted and open-source material. Any additional IP developed as part of Phase 2 will be made available for free public access. Our sustainability plan follows the Red Hat business model— while the tools are freely available, clients will be charged for the socio-technical support services and training required for implementation. In cases where new IP issues arise, we will work with Beall Applied Innovation (BAI), the technology transfer and research translation arm of University of California, Irvine.

Course Correct

Precision Guidance Against Misinformation

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Overview

Democracy and public health in the United States are in crisis. These twin crises are exemplified by two major public problems: (1) vaccine hesitancy related to the COVID-19 pandemic and (2) widespread skepticism about American election integrity. Journalists are overwhelmed by the volume of misinformation about these issues that is flowing through social media platforms and, as a consequence, are not always sure which misleading claims merit their immediate attention. Course Correct helps journalists tame this misinformation tide, rebuilding trust in civic institutions by mitigating misinformation spread online.

Description

Course Correct – precision guidance against misinformation – is a flexible and dynamic digital dashboard that helps journalists to (1) identify trending misinformation networks on social media platforms like Twitter, Facebook, and TikTok, (2) strategically correct misinformation within the flow of where it is most prevalent online and (3) test the effectiveness of corrections in real time.

Course Correct uses cutting-edge techniques to help journalists to identify networks of people on social media who are sharing misinformation about critical public issues, like COVID-19 vaccines and the effectiveness of American electoral administration. Once journalists evaluate the size and reach of these misinformation networks detected by the dashboard, they work with Course Correct staff to develop and rapidly test messages that will reduce the flow of misinformation in at-risk social media networks. When Course Correct's rapid-message testing reveals to journalists which misinformation correction message(s) is working best, Course Correct will seed the affected misinformation network with sponsored social media posts, relying on a technique called observational correction to encourage the sharing of verifiably true information, rather than misinformation. Phase 1 testing revealed that Course Correct (1) accurately describes misinformation networks on social media and (2) provides effective intervention strategies to reduce the misinformation flow. Finally, Couse Correct tests the effectiveness of corrections in real time, giving journalists valuable feedback about whether their misinformation interventions are working.

Differentiators

Many efforts to curb misinformation focus on fact-checking partisan politicians. Research shows that while these fact checks are occasionally effective, people tend to view these efforts as biased; diminishing public trust in the authenticity of information seeking to correct misinformation. Other efforts seek to build media literacy in the citizenry but research consistently demonstrates that these efforts do not scale up from individuals to the public.

In Phase 1 of the NSF Convergence Accelerator Program, the Course Correct team conducted a set of experiments that demonstrated the value of observational corrections in reducing individual belief in misinformation. We also showed the sharing these messages via sponsored content performed just as well as non-sponsored messages. This means that our method to correct misinformation will scale up effectively as we leverage social media platforms' advertising infrastructure to reduce the flow of misinformation.

Our interdisciplinary team of journalists,

mass communication researchers, health

communication researchers, computer scientists, engineers, political scientists, and social media platform professionals is uniquely suited to help the verifiable truth flow freely across networks of citizens across the political spectrum.

Road Map

Month 3: Complete scalable misinformation detection system, across issues, that provides journalists impact scores for misinformation being shared on social media.

Month 6: Complete identification of best practices for misinformation correction; train journalist partners on our digital dashboard.

Month 9: Conduct randomized control trials with journalistic partners to demonstrate the causal value of Course Correct to potential partners.

Month 12: Introduce Course Correct to the 135 signatories of the International Fact Checking Network and revise our system based upon their feedback.

Month 18: Bring additional news organization end users on board after the Global Fact Summit.

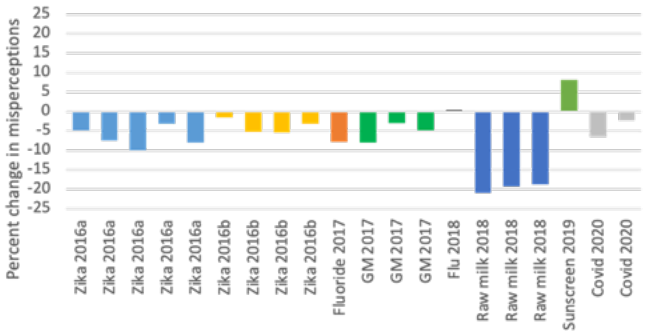
Partnerships

In addition to our team of interdisciplinary researchers and social media partners, Phase 2 will bring about four formal partnerships with news organizations at the local (Capital Times, Madison, WI), state (Wisconsin Center for Investigative Journalism), national (Snopes), and global (International Fact Checking Network (IFCN)) levels. Course Correct will fund a journalist for our local, state, and national partners in Year 1, providing further proof of concept and dynamic improvements to our system based on our partners' feedback. The IFCN has agreed to allow us to present our major deliverable, the Course Correct digital dashboard, to the Global Fact 10 conference in Year 2 of Phase 2. There, we will invite IFCN signatories to join our team.

Intellectual Property

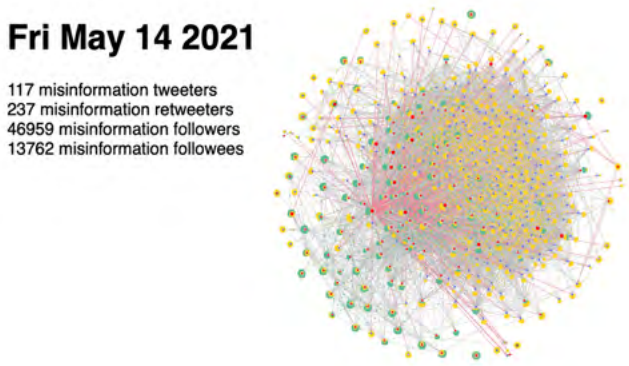
Course Correct is in the process of trademarking our logos and website, pursuing patents and copyright protection for our network detection system and our misinformation intervention process.

Observational Correction Works



Course Correct's strategy of observational correction reduces misperceptions across multiple types of issues.

Misinformation Network Maps are Helpful to Journalists



Course Correct identifies creators of misinformation (red), sharers of misinformation (yellow) and the people exposed to the misinformation sharing (green) so journalists can (1) productively choose what to fact check and (2) specifically target at-risk individuals with sponsored content. Journalists we interviewed in Phase 1 told us that Impact Score figures like this one, for those making false claims that COVID-19 vaccines cause infertility, are extremely useful when it comes to selecting what to fact check.

DART

Online Deception Awareness and Resilience Training

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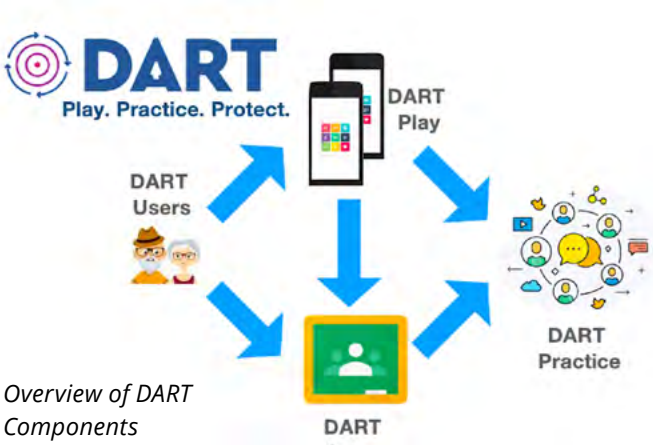
Anita Nikolich

Overview

The 54 million older adults (age 60 and up) in the US are particularly vulnerable and disproportionately targeted by online deception. Deception Awareness and Resilience Training or DART is designed to improve the awareness and resilience of older adult users to online deception, such as spear-phishing and catfishing scams, personal information hunting schemes, fake content, impersonation, and mis/disinformation.



Overview of DART Components

Description

According to a recent FBI report, in 2021, those aged 60 and older comprised the majority of victims of various forms of online deceptions (more than 92,000 victims, accounting for 22% of all victims) with the highest total financial losses (~$1.7 billion). This trend is growing at an alarming rate, with total financial losses jumping 74% from 2020. Through DART, we expect to achieve three general learning objectives for older adult users: (1) understand the motivation and impact of the specific type of online deception; (2) recognize its telltale signs, and (3) develop appropriate responses. DART comprises three interconnected components—DART Learn, DART Practice, and DART Play. Together, they provide flexible and multiple pathways for older adults to learn how to protect themselves against online frauds and scams.

DART Learn is the backbone learning platform that presents a structured environment with feedback, adaptive guidance, and customization. DART learn will afford simple user interfaces to facilitate experiential learning while reducing the cognitive load of older adult users. DART Learn is web-based and can be accessed from older adult users' smartphones, tablets, and personal computers. The curriculum followed by DART Learn will be designed by our team of domain experts in education, gerontology, communication, cybersecurity, and media studies. with the topics and contents periodically updated to adapt to new deception schemes or technologies.

DART Practice simulates a situation of helping others avoid falling victim to online deceptions. This has the advantage to avoid users' psychological discomfort of becoming the victim of online deception themselves. An example scenario may entail the user persuading a friend to see through a potential catfishing scheme while exposing a fake Facebook account profile image created using AI algorithms. The users can use DART Practice to exercise what they learned in DART Learn.

DART Play is a suite of lightweight, engaging, fun games designed to meet the accessibility needs and game type preferences of older adults. The games provide an entertaining, effortless, and intuitive introduction to online deception themes and serve as an on-ramp to DART Learn and DART Practice. Online deception-related themes help people cultivate basic awareness of the concepts and language of online deception. A unique feature of DART Play is the incorporation of the proven game design features of "reward mechanisms" and built-in "gameplay bonuses" that encourage players to stay engaged with the content.

Differentiators

While there are existing online media literacy training programs (e.g., MediaWise for Seniors) and gamified approaches for online disinformation and misinformation (e.g., Harmony Square, Bad News, Spot the Troll, BBC iReporter, The War on Pineapple, and Cranky Uncle), DART is an unprecedented system that combines the following features: (1) comprehensive coverage of a wide range of online deception schemes; (2) real world-relevant content updated as online deception schemes evolve; (3) development by professional game developers, including user experience (UX) experts, to ensure that DART is designed with input from older adults and for older adults specifically; (4) realistic simulation of social media environments and state-of-the-art media synthesis to emulate real-world online deception scenarios.

Road Map

DART deliverables will be developed using a software development lifecycle (SDLC) process. Major deliverable milestones are listed in the following:

- **Month 8**: DART Play MVP completion.
- **Month 12:** DART Learn MVP completion.
- **Month 16:** DART Practice MVP completion.
- **Month 24:** Completion of the products of all three DART components.

Partnerships

DART will be developed by an interdisciplinary team with both depth of research expertise and a breadth of experience in multidisciplinary collaborations and community outreach. The emphasis on the deliverable of tangible software systems necessitates the inclusion of a team of professional software/game developers, creatives with expertise in UI/UX design and art/sound, and promotional materials production.

We will also collaborate with local and national older adult serving organizations, including Amherst Center for Senior Services (west New York), Clemson Downs (South Carolina), to help "spread the word" about DART. Furthermore, our local partners, Clemson Downs, Amherst Center for Senior Services, and the Buffalo and Erie County Public Library will also serve as local user community liaisons for us to recruit older adult users for focused group interviews and usability feedback, and to host community outreach workshops and demonstrate DART through facilitated sessions.

Intellectual Property

Software created with DART funding that is intended to be released under an open-source software (OSS) license is encouraged by the team but not required to be released under an attribution style license, with a preference for BSD, MIT licenses, and Apache, using GitHub

Additional Information

PI Lyu is a global leader in synthetic media and media forensics research and has testified at the US Congress House of Representatives and New York State Assembly and served on a panel for the Federal Trade Commission on the spread and mitigation of online synthetic media. Co-PI Linvill and Consultant Warren developed the successful Spot the Troll quiz, which has been used by over a million users for online disinformation education, and their work in understanding social media disinformation has been cited by the US Senate's Select Committee on Intelligence. Co-PIs Bazarova and DiFranzo have successfully developed several online media literacy training platforms. Their Social Media Test Drive has been used by more than half a million users, has been integrated into Common Sense's Digital Citizenship curriculum, and has been implemented in hundreds of schools across the US.

Expert Voices Together

Taking Back The Internet

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Overview

Expert Voices Together (EVT) is creating a comprehensive system of care that addresses the harms journalists experience due to online harassment. Grounded in trauma-informed and consent-based research and drawing on expertise from a range of academic disciplines and sectors, EVT's mission is to support journalists in moments of crisis, while helping the media industry build resilience long-term.

Description

Online harassment campaigns reduce trust in communication systems by undermining confidence in expert sources of knowledge and by driving experts—especially members of marginalized communities—out of the public sphere. Although a majority of internet users report being aware of online harassment, and nearly half have directly experienced it, options for support remain few. Expert Voices Together brings together a diverse coalition of academic researchers, psychologists, technologists, civil society and newsroom representatives dedicated to addressing the impacts of online abuse on expert communities.

In its initial stage of development, EVT focuses on journalists as the expert audience for our system of care. Based on findings from interviews with scholars, advocates, clinicians, and journalists who have experienced harassment, the EVT team is developing a trauma-informed, rapid response means of connecting experts to the support they need. Journalists turning to EVT will find a rapid-intake system and a dedicated case manager. EVT's case managers will walk journalists through a menu of support options, ranging from help with digital security to support monitoring and reporting ongoing harassment. Case managers will also help journalists identify, interface with, and build a broader community of care, including other journalists who have experienced harassment, newsroom managers, and even the journalists' own friends and family.

By centering the individual's unique experience and leveraging an array of evidenced-based tools and approaches, EVT is designed to reach journalists—and later, other experts—who face a variety of circumstances and needs. Widespread adoption of the EVT system in the media industry will have broad societal impacts, not only reducing online harms for individual journalists but increasing trust in communication systems and building organizational capacity for prevention.

Differentiators

Efforts to understand and address misinformation and inauthentic behavior in online communication systems have largely focused on identifying, downranking, and removing misinformation; locating and minimizing the reach of purveyors; and correcting the misperceptions that result from exposure to inaccurate information. Relatively little attention has been paid to the link between the spread of misinformation and campaigns of abuse and harassment directed at members of expert communities. Expert Voices Together addresses this gap by focusing on means of support for journalists, whose efforts to provide vital information to the public are being undermined by online harassment campaigns.

The idea behind Expert Voices Together is rooted in the bystander intervention approach pioneered by our project partner Right To Be's online harassment response system, HeartMob. Using HeartMob's peer support model as a

starting point, EVT has been able to adapt existing strategies for responding to online abuse to meet the unique needs of journalists.

Road Map

The project team will collaborate to generate a number of deliverables—both technical and non-technical—that, together, comprise the EVT system of care. Technical deliverables include a web-based rapid-intake system, a case management system (developed by the project to avoid questionable data practices by third-party software providers), a peer discussion group system, and a database for logging data collected when monitoring ongoing harassment. Each of these components will be brought together in a secure technical platform.

Non-technical deliverables include educational materials for the general public and more specialized "best practices" materials for journalists and newsroom managers. The project team will also develop a series of training materials and step-by-step protocols for case managers and for members of the journalist's community of care.

All deliverables will be carefully user-tested. Near the mid-point of Year 2, we anticipate having sufficiently tested and advanced these deliverables to begin customer discovery research with the next expert community—scientists and other academic researchers.

Partnerships

The project team brings together a wide range of expertise from academia, media, and the nonprofit sector. Team members have backgrounds in decision-making; digital communication, including mis-/disinformation studies; data ethics; systems engineering; experimental and clinical psychology; human-computer interaction; information communication technology; case management; journalism and mass communication; post-traumatic stress disorder, resilience, trauma, and trauma-informed design. Academic team members join from George Washington University (Dr. Rebekah Tromble & Dr. David Broniatowski), Louisiana State University (Dr. Kathleen Searles), the University of Georgia (Dr. Denetra Walker), and Columbia University (Susan McGregor). The team also includes representatives from the non-profit organizations Right To Be (Emily May & Ana Velazquez), the Poynter Institute/Politifact (Angie Holan), and PEN America (Viktorya Vilk and JeJe Mohamed). In Phase 2 the team is joined by Dr. Kate Porterfield and Dr. Emily Sachs, clinical psychologists with with experience in trauma-informed care for journalists. We have also created a Newsroom Partnership Program and brought on seven small and medium-sized newsrooms from across the country.

Intellectual Property

We intend to operate and sustain EVT as a non-profit enterprise and do not intend to commercialize the intellectual property that results from the project. George Washington University will negotiate the appropriate copyright and use agreements for all products generated. Project partners will retain rights over their pre-existing materials and will acquire rights for new materials to which they contribute development. Educational materials intended for a public audience will be released under creative commons licensing.

Search Lit

Human Technologies For Mitigating Misinformation

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Mike Caulfield | Venus Ginés | Francesca Tripodi | Sam Wineburg

Overview

Misinformation threatens public health and the health of our democracy. Search Lit Nation is a national campaign to radically accelerate the adoption of effective search literacy techniques by Americans from all walks of life. Our team has developed curriculum materials for schools and colleges that are proven to make learners better at online search. In this project, we are shifting from public education to educating the public: our goal is to ensure that everywhere Americans go for information, there are resources and trained guides to help them sort truth from fiction online.

Description

Over the last decade there has been a revolution in our understanding of effective search practices. Most of the strategies that we currently teach in U.S. schools are demonstrably ineffective. Research shows that even very intelligent people, such as Stanford freshmen and tenured historians, routinely struggle with basic assessments of search literacy. They read websites closely and carefully but are misled by common misinformation tactics, such as obscuring the identities of the authors and funding for a website.

By contrast, we studied one group that routinely earned top scores on our assessments of search skills: fact checkers at the nation's leading news outlets. These competent searchers use strikingly different techniques than other web users, a set of strategies we call *lateral reading*.

Instead of evaluating websites through close reading, fact checkers quickly *get off the page* of an unfamiliar site. They open up new browser tabs and search for information about the organization behind the original site. Fact checkers read across the multiple open tabs, hence "*lateral reading*." Search experts *use the Web to evaluate the Web.*

These strategies are not difficult, but they are not intuitive. Most people in our research studies do not read laterally. But these skills can be taught. We have robust evidence from randomized control trials in schools and colleges that demonstrate that with relatively short training sessions people can become much better at online search.

In this project, we are adapting our school-based curriculum materials for three new sectors of American life: libraries, the military, and public health settings. From our Phase 1 research, we identified design features that are needed to make our program successful in new contexts: (1) High-engagement materials, like short videos, that generate urgency and interest in the topic; (2) Mobile-first approach to search literacy since outside of schools, most search happens on phones; (3) Programs to train Trusted Messengers in communities to teach search literacy skills; (4) Common assessments to evaluate search literacy efforts. Advancement in these innovation areas will support the rapid adoption of effective search literacy practices across the U.S.

Differentiators

Our team brings together interdisciplinary experts who have spent the last decade working to improve search literacy. Rigorous randomized controlled trials prove that our approach works, and our materials are widely adopted in schools and libraries.

We are committed to educational approaches because research shows that misinformation mutates far more rapidly than technological safeguards can adapt. Fact checking and content moderation are *reactive solutions* which cannot

alone break the misinformation cycle. Search Lit is a *proactive* suite of human technologies which builds resilience in human judgment and decision making to reduce the impact of dangerous digital content.

Road Map

Our program is driven by three partner convenings:

- **Design Launch (November 2022)**: Partners will gather to identify the needs of communities in each sector. Based on ethnographic research, we will collaboratively use human-centered design approaches to adapt new mobile-first educational tools for libraries, public health, and military settings.
- **Dissemination Launch (August 2023):** Through train-the-trainer programs, we will widely disseminate our materials across all three sectors.
- **Sustainability Launch (May 2024):** Existing sector partners will develop sustainability plans to ensure the continuance of this work, and we will invite additional sectors to engage with our new nonprofit: the Digital Education Project.

Partnerships

Key partners in this work include award winning **investigative journalists and documentarians at Retro Report**, who developed two high-engagement Search Lit videos with our team in Phase 1. They will scale these efforts through the creation of six videos. **Military-affiliated education groups with global reach** have been in discussion with our team about potentially using our materials in an organization-wide professional learning for as many as160 instructional specialists.. Community-based health organization **Día de la Mujer Latina**, will reach 125 health workers and thousands of clients through Spanish language Search Lit materials. **The Centers for Disease Control and Prevention** will reach 48 health communicators in their misinformation continued education training course. The **Department of Veterans Affairs** will scale these resources through connected telehealth initiatives. The **American Library Association**, which reaches 55,000 librarians nationwide, will disseminate materials to at least 2,500 members across the country through the Search Lit Trusted Messenger program.

Intellectual Property

We will aim for everything produced by the Search Lit team to be openly licensed. Technology will be made freely available under an MIT license, and media and educational resources available under a Creative Commons 4.0 Attribution license. The vast majority of existing intellectual property resources built by team members under Phase 1 of this project and prior, are openly licensed in ways compatible with their reuse in the Search Lit project. **Our goal is to have all Search Lit resources widely and freely available to the public** to reuse and adapt to new contexts.

TrustFinder

Restoring Confidence In Digital Interaction

TRUSTFINDER
RESTORING CONFIDENCE IN DIGITAL INTERACTIONS

TrustFinder.net
info@trustfinder.net

Overview

New tools are required to help people of all walks of life to judge the information they receive. We all rely on experts and researchers to help us to make sense of complex topics, but even they are drowning in information. TrustFinder gives researchers the ability to collaboratively enrich and evaluate information anywhere on the web, reducing inefficiencies and helping scale their individual impacts.

Description

TrustFinder is an application which provides a "Verified Information Environment" (VIE) for researchers where they can collaboratively enrich and link information at its source using web and document annotation. Annotations are not just comments, but structured communications designed as part of a crowdsourcing solution which enables search and summarization functions. These functions help researchers share knowledge, stay up-to-date, and move beyond search by keyword.

Differentiators

TrustFinder will use genuine presence testing and a digital wallet tied to real-world credentials to create a VIE free of bots and disruptive actors and will allow users to enrich, add, and link information anywhere on the web, without having to ask for permission – allowing them to contribute to a "lens" on the internet that only their community can see. An "Open Standards" approach means that underlying architecture can be used outside of research as well.

Road Map

TrustFinder's Macro Road Map can be broken down into 3 primary milestones: (i) finding alignment between partners on requirements across use-cases, (ii) developing VIE and web-annotation standards that are use-case agnostic, and (iii) an alpha version of TrustFinder.

Partnerships

The Phase 1 TrustFinder team, consisting of the companies MATTR and iProov and University of Washington – Applied Physics Laboratory, will be joined in Phase 2 by a diverse community of organizations with international representation including Open Identity Exchange (OIX), Digital ID and Authentication Council of Canada (DIACC), the Bill and Melinda Gates Foundation, and others. These partnerships will inform the development of TrustFinder, and the generalization of its underlying VIE architecture for use outside research, such as in journalism, fact-checking and harassment reporting, public health, food security, education, and open-source intelligence.

Intellectual Property

TrustFinder itself relies upon "End User" approaches to licensing of patent, copyright, trademark and related rights, consistent with industry practice. The VIE standards TrustFinder is built on will follow an "Open Standards" approach.

WiseDex

Enabling Fast, Comprehensive Misinformation Enforcement

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David Jurgens

Amy X. Zhang

Overview

Social media platforms have policies against harmful misinformation. Unfortunately, they enforce unevenly, especially for non-English content. WiseDex harnesses the wisdom of crowds and AI techniques to help identify more misinformation posts. The result is more comprehensive, equitable, and consistent enforcement, significantly reducing the spread of misinformation.

Description

Trust and safety teams at platforms like TikTok and Twitter have limited resources for developing custom software or machine learning models, despite sitting inside huge technology companies. They do, however, use keywords or regular expressions to search for posts purveying misinformation that is of special concern, with the results being queued for human review.

The core WiseDex innovation is to expand high-level, abstract policies into a large database of claims that violate the policies. Each claim profile will include keywords in multiple languages, making it easy for platform trust and safety teams to search for matching posts and flag them for human review. Claim profiles will also include instructive examples that help reviewers decide quickly and consistently.

A four-stage process leads to the addition of new claim profiles to the database. (1) Candidate content is collected from published fact-checks, reviewer escalations, and crowd workers searching for suspicious content. (2) Other workers articulate specific claims that cover some of the candidate content. (3) A subject matter expert assembles a casebook with arguments and evidence about whether a claim violates relevant policy criteria, and a representative lay jury considers that evidence and makes final judgments. Policy criteria are drawn from several platforms' policies, making it easy for a platform to determine whether posts matching that claim violate its policies. (4) More crowd workers, assisted by AI, identify keyword search terms in multiple languages and assemble examples with explanations.

Building on the claim profiles database, we will develop a Claim-Matcher API to help platform trust and safety operations surface content for human review, and a Reviewer Assistant plug-in to improve the speed and consistency of that human review. We will also develop benchmark datasets of public posts, labeled by human reviewers. This will allow evaluation of the efficacy of keyword search terms and form the basis for public report cards showing the fraction of harmful misinformation that platforms have acted on.

Differentiators

The industry already relies on similar databases to aid in the detection of other kinds of harmful content. The Global Internet Forum to Counter Terrorism (GIFCT), an industry consortium, maintains a database of perceptual hashes of images and videos produced by terrorist entities, and the Internet Watch Foundation maintains one for child sexual abuse images and videos. Platforms can check whether images and videos posted to their platforms match any in the databases by comparing hashes. By analogy, a WiseDex misinformation claim profile functions like an image hash in those systems. However, identifying matching posts is more challenging in the misinformation space. Thus, WiseDex has developed its four-stage process for formulating claims that are both searchable by computers and recognizable to human reviewers.

Journalistic organizations around the world publish fact-checks that will often be excellent starting points for WiseDex claim profiles, jump-starting the work of a subject matter expert assembling a casebook. The additional work of our final stage, to identify multi-lingual keyword search terms and gather posts with explanations, is still needed to enable consistent detection.

Several companies, such as Sentropy, Hive.ai, ActiveFence, and project partner Trust Lab, sell services to platforms to improve the coverage, speed, and consistency of enforcement against misinformation as well as other harmful content. WiseDex contributes several things to this ecosystem. First, because claims are judged with respect to a variety of policy criteria, platform trust and safety teams can choose only those claims that violate their own policies. Second, casebooks and judgments about claims are open to public scrutiny. Finally, WiseDex will produce benchmark datasets based on flagging and reviewing public posts. These will help vendors to improve their products, help platforms to compare the vendors' performance, and enable public accountability report cards.

Road Map

Year 1 will involve refining the four-stage claim intake process, culminating in the production of 400 claim profiles in English and Spanish. We will also develop commercial and research prototype software for claim matching and reviewing in Year 1. In Year 2, we will create 1,000 additional claim profiles, publish benchmark datasets and an accountability report card, and set post-grant licensing terms for the claims database. We will also settle on an organizational form, likely incorporating as a nonprofit organization or becoming a project of an existing industry consortium or nonprofit organization. In Years 3 through 5, following the end of the grant, we will continue to add claim profiles and expand to additional languages.

Partnerships

WiseDex contributors include: three universities, Michigan, Washington, and Massachusetts Institute of Technology; non-profit organization Meedan; and commercial vendor Trust Lab. Meedan will develop software that makes it easy for fact-checking organizations to share their user flags and fact-checks with WiseDex. The Election Integrity Partnership (Washington and Stanford) will provide a data stream of misleading content related to the 2022 U.S. elections that will serve as one source of claims to profile.

We welcome inquiries from government agencies and other organizations that surface claims that should be profiled as part of the WiseDex database. We also welcome inquiries from advocacy organizations, especially those focused on misinformation in languages beyond English, about potential partnerships around the preparation of public accountability reports.

Intellectual Property

Task workflow software and the claim profile database will be available for licensing royalty-free for non-commercial use. Trust Lab will be granted an exclusive, royalty-free license for commercial use during the two-year grant period. We welcome licensing inquiries.

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