COMMUNITY OF PRACTICE

Computational Social Science

What we are doing: Using computational techniques and big data to address concerns related to human behavior, or to gain insights into basic social processes that cannot be identified with conventional methods. We hope to facilitate research within the social sciences and team science between disciplines, and to develop methodological tools to evaluate novel theories that cannot be evaluated with conventional tools. In doing so, we hope to see the development of novel methods and the formation of solutions that could not be identified with conventional methods.

Examples include:

- Developing or applying data science tools to understand digital trace data
- Computational models of complex systems and their emergent outcomes
- Large-scale or crowd-sourced experiments on human behavior or interventions

Why we are doing it: Social scientists are interested, either directly or indirectly, in topics with societal relevance. Leveraging computational methods and big data offers insights that can challenge existing narratives and offer new explanations.

Why at Ohio State: TDAI offers an integrative infrastructure to facilitate such work, and the recent TDAI hires, coupled with strong affiliates, give us strong human capital for such work.

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What we are doing: This CoP aims to build a community at OSU focusing on the foundation of data science. It will center around the theoretical and algorithmic foundation of data science, with core members spanning across Computer Science, Statistics and Mathematics. It will also build connections to the broader data science community in a radial manner: starting from more fundamental areas such as machine learning and geometric/topological data analysis, to other data analytic areas and application domains.

The cluster will focus on new fundamental methodologies as well as new analytics algorithms for analyzing diverse data. To achieve this goal, this CoP also aims to reach out and bridge researchers from application areas, such as neuron science, GIS, material science, and medical imaging, etc., so as to tackle fundamental questions arised from the application domains. It also aims to connect to researchers from other data analytic and data management areas, such as cybersecurity and data governance. These goals also align with those of the TRIPODS center TGDA@OSU that has been funded by NSF for Phase I, as well as the theme for potential Phase II of this TRIPODS center.

Why we are doing it: The CoP will produce effective and efficient algorithms for modern data analysis, as well as understanding for the structures behind data analysis problems. These fundamental algorithms can potentially be used to a broad range of application domains, from science to engineering, such as neuron science, material science, GIS, biomedical image analysis and so on. These algorithms have potentially important impacts on several aspects for societal challenges in fields such as cybersecurity, health, manufacturing, and engineering.

Why at Ohio State: OSU has a strong team in Topological and Geometric Data Analysis, consisting of faculty members from Computer Science, Mathematics and Statistics. OSU also has strong researchers in (statistical) machine learning, data privacy, security, and optimization. Through this cluster, we hope to combine our strength. The methodologies developed can be applied to a broad range of application domains, including material science, neuroscience, medical images analysis, GIS, and so on.

This CoP envisions to utilize the strength of research and developmental activities already existing at OSU both at the technical and organizational fronts. OSU hosts strong groups in algorithm design, topological and geometric data analysis, machine learning, and optimizations which can form the core of this CoP. There is no dearth of application domains at OSU which can connect to this core. For example, OSU has strong presence in material science (MRI center), medical science, and geography among others. This CoP along with the initiative of NSF funded TRIPODS at OSU is a timely undertaking. The presence of various centers such as TDAI itself, MBI, MRI can help shaping the outreach activities.
What we are doing: Our mission is to translate data science and engineering for real problems addressing smart campuses, cities, and communities. Examples of initial projects in this CoP (some funded by the NSF or TDAI Seed Grants) include:

- Community-driven data engineering for opioid abuse in rural Midwest
- Smart services for transportation, food, and healthcare support for preventing Infant Mortality, with customized delivery for community subgroups
- Data driven science based on sensing of stress events and, more generally, factors associated with social determinants of health
- Enabling active transportation by discriminating and understanding activity patterns of pedestrians and cyclists on campus

These efforts involve more than bringing together technologists and domain experts. They proactively engage stakeholders from policy, governance, law, privacy, cybersecurity, outcomes assessment, and/or user communities. Team leadership is shared when convergent advances across disciplines are needed for realizing shared goals. TDAI offers several facilitation mechanisms and resources for the CoP that help to bootstrap and support large teams, which might otherwise be challenging to effect from within individual departments or domain-specific centers.

Why we are doing it: A convergence of diverse themes has motivated this CoP. First is the exponential growth in our ability to sense fine-grain aspects of people, things, and environments. Then there is the ability to harness the resulting data, or better still, to “make” the desired information, on the Internet of Things. Open sharing of collations of data unleashes a network effect in the data itself, from which previously unanticipated value propositions can be discovered. This ability leverages advances in networking and computing, not just in the cloud but also at the sensing edge. It incorporates instrumenting layers of machine-learned intelligence across sensor-gateway-cloud-controller-actuator cyber physical systems, to not only automate inferences but also understand phenomena, automate manual tasks and amplify human/organizational processes. In turn, all this allows solutions to be created, validated, and refined in the field itself, rather than in the lab or in small pilots. A CoP with access to TDAI resources (access to datasets, Data Commons/Makery, cloud resources, industry partnerships, and space) provides the framework for enabling translation around these convergent themes.

Why at Ohio State: Our CoP is poised to leverage TDAI’s partnerships with centers, institutes, and discovery themes such as ESL and CISM in sensing and IoT; IMR in materials, CAR, TRC, and CRIS/UTC in mobility; CURA in urban studies, and SRE in sustainability. OARnet and OCIO are helpful in access to network and cybersecurity facilities. We draw upon broader connections with other CoPs in TDAI, with Research Coordination Networks at OSU, in the Midwest and beyond, and work with translational, commercialization, and survey support organizations such as CCTS, TCO, TechColumbus, and CHRR. Likewise, CoP principals are actively involved in the strategic planning in Smart@Ohio State, and we anticipate CoP members making substantial contribution to related activities. While the CoP’s ambitions are to have national and global societal impact through its translation efforts, what could be a better place to start than in Columbus itself? Several principals in the CoP have been involved in Smart Columbus since its conception and are actively contributing to City projects which are funded by the Department of Transportation/Vulcan Foundation, and by OSU.
COMMUNITY OF PRACTICE

Computational Life Sciences

What we are doing: Our overarching goal is to build research teams around various themes in life and health sciences. Each assembled team will include data scientists and experts from various coherent domain areas. We aim to develop big-data analytics that have translational values and can be deployed in health care and life sciences. Potential initial themes may include:

- Precision medicine and cardiovascular, diabetes, and metabolic sciences: disease prevention and treatment;
- Systematic mining of electronic health records to predict prognoses and treatment effects for common diseases;
- Integrated multiomics (e.g. genomics, transcriptomics, epigenomics, proteomics, metabolomics, metagenomics) to understand cancer biology and other complex diseases.

We will place emphasis on integrative approaches that connect domain scientists from interrelated areas and experts in data analytics to understand and solve problems from a broader perspective. Instead of addressing each isolated problem, we would strive to address the entire system. As an example, a team for addressing problems arising from the first theme may include experts from food science, nutrition, exercise physiology, microbiome, metabolism, diabetes, cardiovascular medicine, liver cancer, mathematics, statistics, and bioinformatics. To tackle problems of such complexity and range, discussions among team members are indispensable, which can be facilitated by TDAI, with mechanisms and resources to accommodate such activities. We envision that specific themes will grow out from such discussions; research topics and developments from teams will become competitive for large grant opportunities. Training will also be an integrative component of our effort.

Why we are doing it: There has been an explosion of data in all areas of life and health sciences. Big data is now the norm rather than the exception. Such huge sets of data in diverse areas may in fact be inter-connected, and big data analytics, including modeling and data mining methods, are essential for distilling information for convergence into the understanding of an array of phenotypes. Strong bonds between data scientists and domain area experts are needed more than ever. This CoP is conceived to bring the community together to address such challenging problems. Instead of fragmented efforts with limited resources, teams of researchers formed under this CoP can access shared resources facilitated by TDAI, including rich, in-house databases and repositories, to maximize their integrative efforts. This CoP is a platform that can provide researchers speaking different scientific languages a forum to communicate with one another, to exchange ideas, to come up with novel integrative ideas, and to turn such ideas into the development of new technology, new data, or new methodology. The translational values of the research from the teams will address real problems our society faces. The outcomes can have real impacts on life sciences and treatments/preventions of an array of health conditions, including obesity, cancer, and cardiovascular diseases.

Why at Ohio State: Ohio State is uniquely positioned to make fundamental and translational contributions to research in life and health sciences. It has great assets in its faculty, facility, and community. There are also other local research communities highly connected to OSU, including the Research Institute at Nationwide Children’s Hospital. At OSU, there are already many research projects, innovations, and established collaborations leveraging the power of machine learning and other data analytics for solving pressing problems. This CoP will be able to utilize TDAI’s resources to cement existing collaborative relationships and help cultivate new ones, to expand the scope of investigation, and to establish a community well-equipped with the resources to become a leader in synthesizing big data to address problems in life and health sciences.