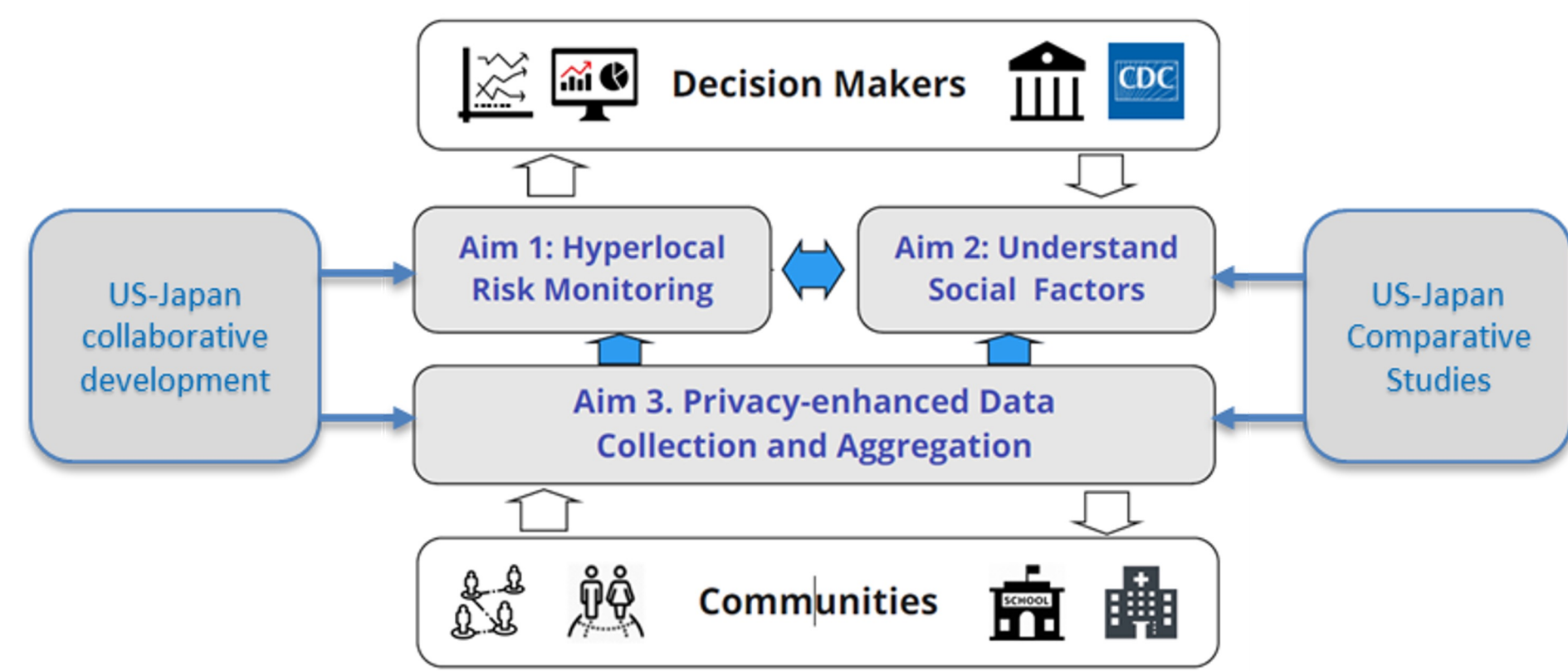


Hyperlocal Risk Monitoring and Pandemic Preparedness through Privacy-Enhanced Mobility and Social Interactions Analysis

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 SCC-IRG JST, FY2021



Aim 1 Hyperlocal risk monitoring

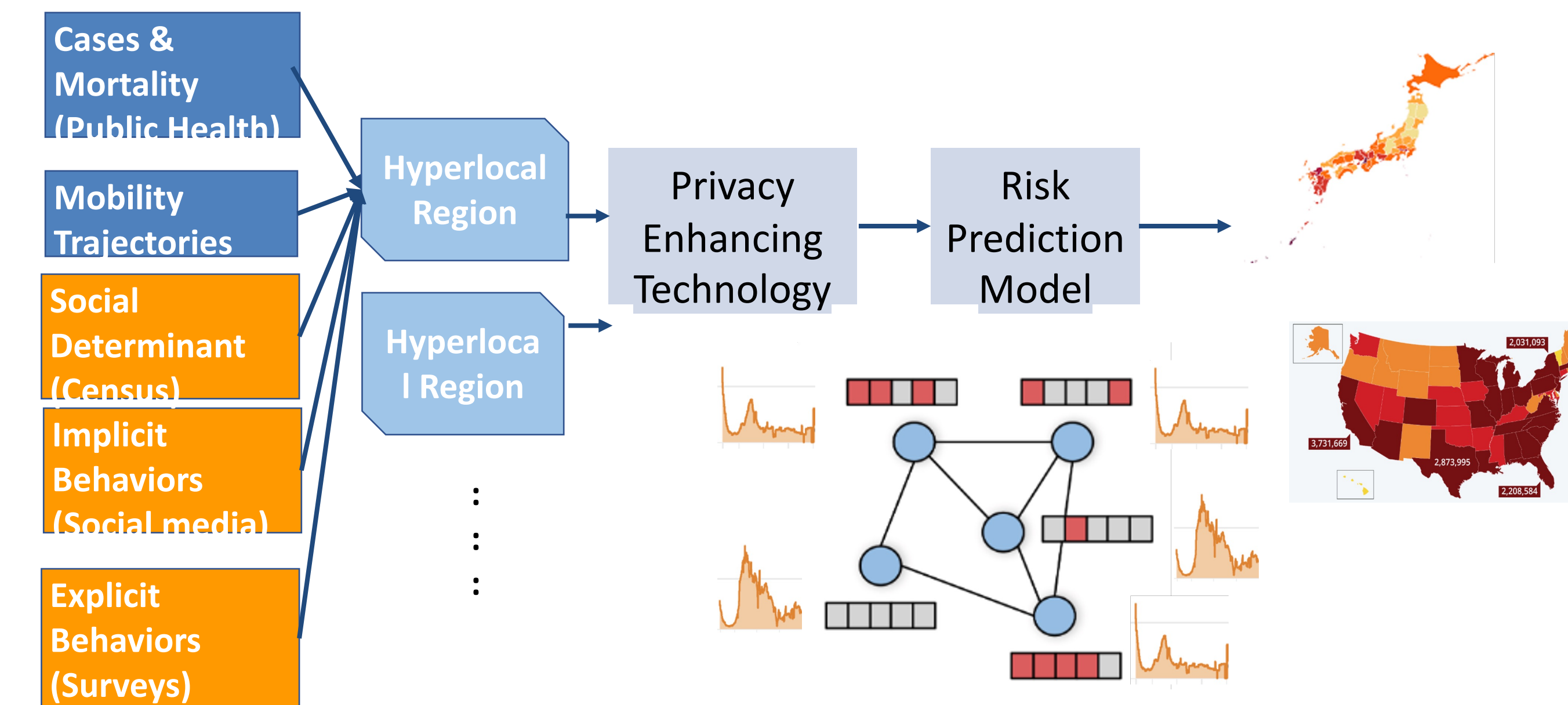
- Mobility data based risk estimation
- Social interactions and behavioral data

Aim 2 Understand social factors

- Social risk factors and disparity
- Psychological reactions
- Use and trust of information sources

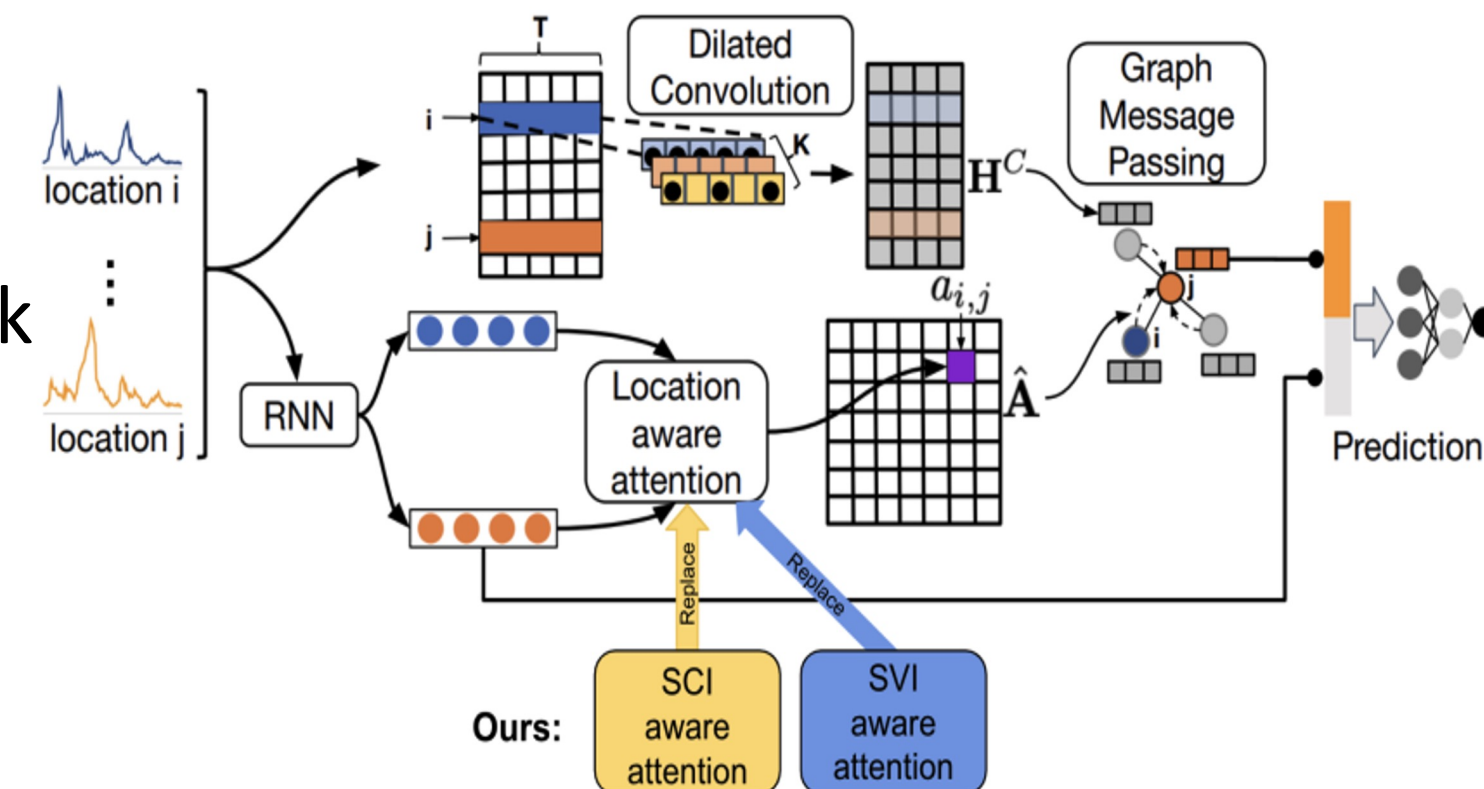
Aim 3 Privacy-enhanced data collection and analysis

- Privacy-enhanced technology
- Legal implications



Aim 1. Hyperlocal risk modeling

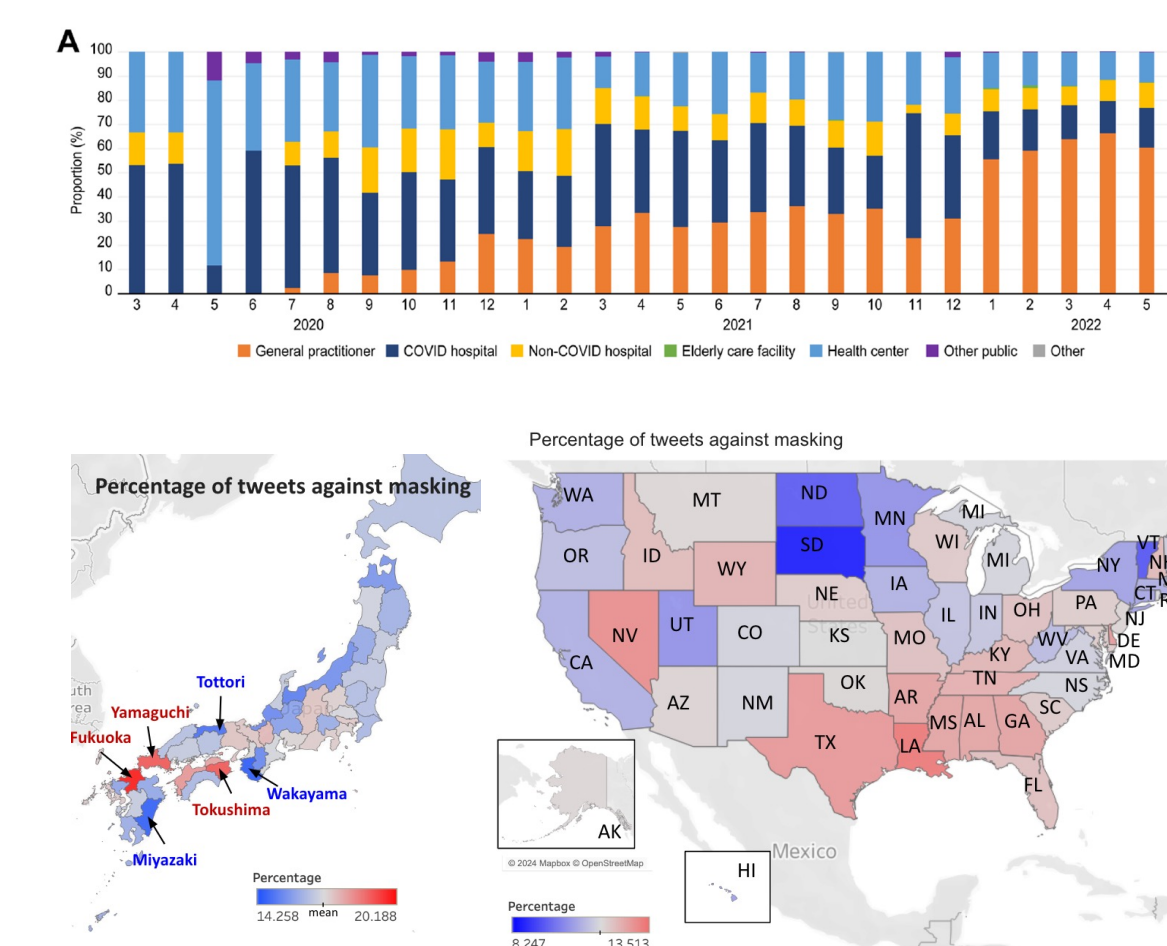
- Statistical models using mobility data [1,2,3]
- Graph neural network (GNN) models [4]
- Incorporating social vulnerability and connectedness [5]



[1] Zeighami et al. Estimating Spread of Contact-Based Contagions in a Population Through Sub-Sampling. VLDB 2021
 [2] Rambhatla et al. Toward Accurate Spatiotemporal COVID-19 Risk Scores Using High-Resolution Real-World Mobility Data. TSAS 2022
 [3] Anastasiou et al. ASTRO: Reducing COVID-19 Exposure through Contact Prediction and Avoidance. TSAS 2022
 [4] Hajisafi, et. al. Learning Dynamic Graphs from All Contextual Information for Accurate Point-of-Interest Visit Forecasting, SIGSPATIAL 2023
 [5] Qin. Data-Driven Fine-Grained Epidemic Modeling via Graph Neural Networks, Emory undergraduate honor thesis, 2023

Aim 2 Understand social factors

- Testing modality [6]
- Information use and trust
- Objective vs. perceived risks; risky vs. protective behaviors
- Mental health and sentiment (e.g., against masking on social media)



[1] Kyo et al. A population-based Study of the Trend in SARS-CoV-2 Diagnostic Modalities from the Beginning of the Pandemic to the Omicron Surge in Kyoto City, Kyoto, Japan. BMC Public Health, 2023
 [2] Ferawati et al. Monitoring Mentions of COVID-19 Vaccine Side Effects on Japanese and Indonesian Twitter: Infodemiological Study. JMIR Infodemiology, 2022
 [3] Uehara et al.: Measuring concerns about the COVID-19 vaccine among Japanese internet users through search queries, Scientific Reports, 2022
 [4] Ramos et al.: Emotion Analysis of Writers and Readers of Japanese Tweets on Vaccinations, WASSA 2022

Broader Impact (Immediate)

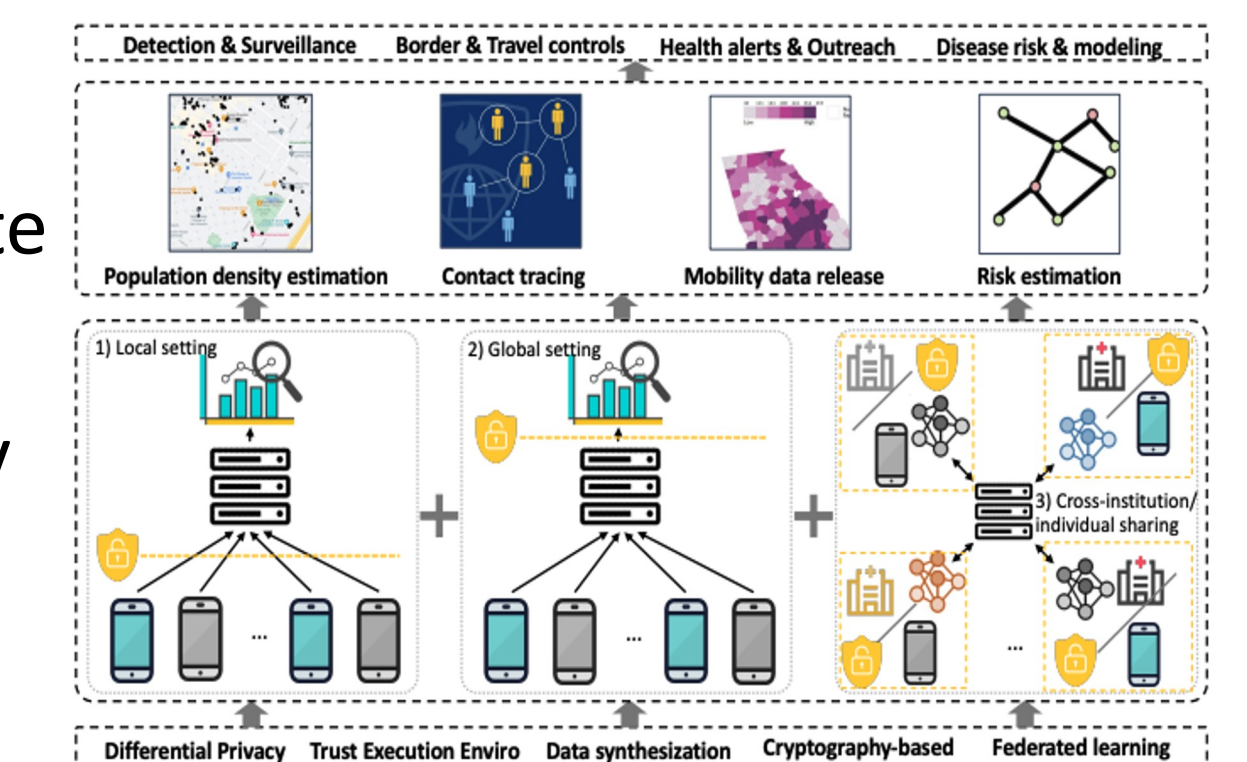
- Fine-grained risk estimation models and software toolkits for epidemiologists and decision makers
- Understandings of social factors for decision makers
- Privacy-enhanced data collection and analysis methods and toolkits for data collectors/providers, social scientists and epidemiologists

Broader Impact (Sustainability)

- Enables data-driven policy and decision making for local public health agencies, local government decision makers (e.g., partial lockdowns, business closures)
- Enables data-driven decision making for community members (e.g., avoid high risk areas)

Aim 3 Privacy-enhanced data collection and analysis [7]

- Local differential privacy for mobility data collection [1]
- Differential privacy for aggregate data release [2,3]
- Data synthesization for mobility and health records [8, 9, 10]
- Federated learning for cross-institution sharing [4, 5]



[1] Wang et al. PrivLBS: Local Differential Privacy for Location-Based Services with Staircase Randomized Response. CCS 2022
 [2] Zeighami et al. A Neural Database for Differentially Private Spatial Range Queries. VLDB 2022
 [3] Zeighami et al. A Neural Approach to Spatio-Temporal Data Release with User-Level Differential Privacy. SIGMOD 2023
 [4] Liu et al. Projected federated averaging with heterogeneous differential privacy. VLDB 2022
 [5] Liu et al. Echo of Neighbors: Privacy Amplification for Personalized Private Federated Learning with Shuffle Model. AAAI 2023
 [6] Zhang et al. CSGAN: Modality-Aware Trajectory Generation via Clustering-based Sequence GAN. MDM 2023
 [7] Liu et al. Supporting pandemic preparedness with Privacy Enhancing Technology (vision paper). TPS 2023
 [8] Harrison et al. Synthetic Information and Digital Twins for Pandemic Science: Challenges and Opportunities. TPS 2023
 [9] Wang et al. IGAMT: Privacy-Preserving Electronic Health Record Synthesization with Heterogeneity and Irregularity. AAAI, 2024
 [10] Synthetic Trajectory Generation via Clustering-Based Semi-supervised Generative Adversarial Networks (highest honors), 2023

Next Steps

- Integrate behavior data and findings (Aim 2) into risk modeling (Aim 1)
- Integrate privacy enhancing technology (Aim 3) into risk modeling (Aim 1)
- Community engagement and joint US-Japan workshops