

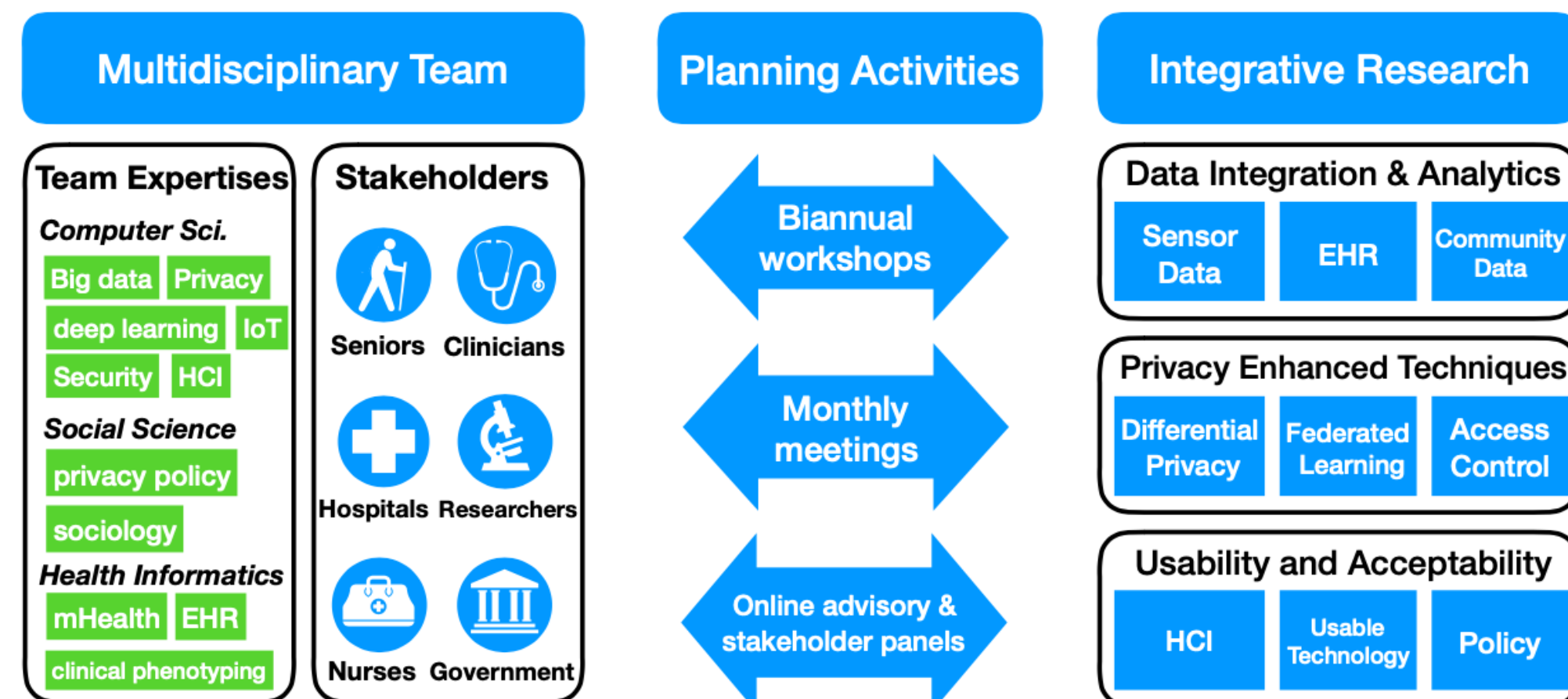
SCC-PG: JST: Privacy-Enhanced Data-Driven Health Monitoring for Smart and Connected Senior Communities

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Research Problems

The global aging problem presents tremendous healthcare challenges, which motivated a series of works on remote health monitoring. In order to develop privacy-enhanced integrated systems, this project focuses on the following three problems:

- **Data Integration and Analysis.** How to collect, integrate, interoperate and analyze various sources of data.
- **Privacy-Enhancing Technologies.** How to address the privacy concerns and regulation compliance in US and Japan.
- **Social Implications and Usable Technology.** How to understand the critical challenges and barriers in the usability and acceptability of the technology in the senior communities.



Intellectual Merit

The integrative research has the potential to advance various disciplines for smart and connected communities including data management, data privacy, HCI, mHealth, and sociology.

- **Novel data management and machine learning solutions.** The outcome will be a cloud-based system with algorithms both to allow users to view and track their own data integrated from multiple sources for monitoring and intervention.
- **Privacy-enhancing technologies (PETs).** An integrative risk mitigation strategy will be developed with various PETs. (federated learning and differential privacy)
- **Online surveys and qualitative studies.** identify critical barriers and challenges in health monitoring for senior communities.

Project Progress

- Workshops with researchers and community stakeholders
 - Across two days: 12/14 and 12/22 8-10am EST
 - 17 participants (US: 11, Japan: 6) including researchers (CS, sociology, BMI, medicine), clinicians, government/aging agency administrators.
 - Learn about related efforts, discuss opportunities and challenges (technology, social science and community deployment gaps). Identify potential themes for further discussion and collaboration, pilot projects (case studies) for preliminary studies and additional collaborators and stakeholders for future workshop.

Work Package 1: Privacy-Preserving Data Collection and Analysis for Health Monitoring

Policy-aware location privacy (ESORICS 2020):

We proposed Policy-Graph based Location Privacy (PGLP), a new local privacy model with rigorous and customizable privacy guarantee. We applied PGLP for Privacy-Enhanced Epidemic Surveillance.

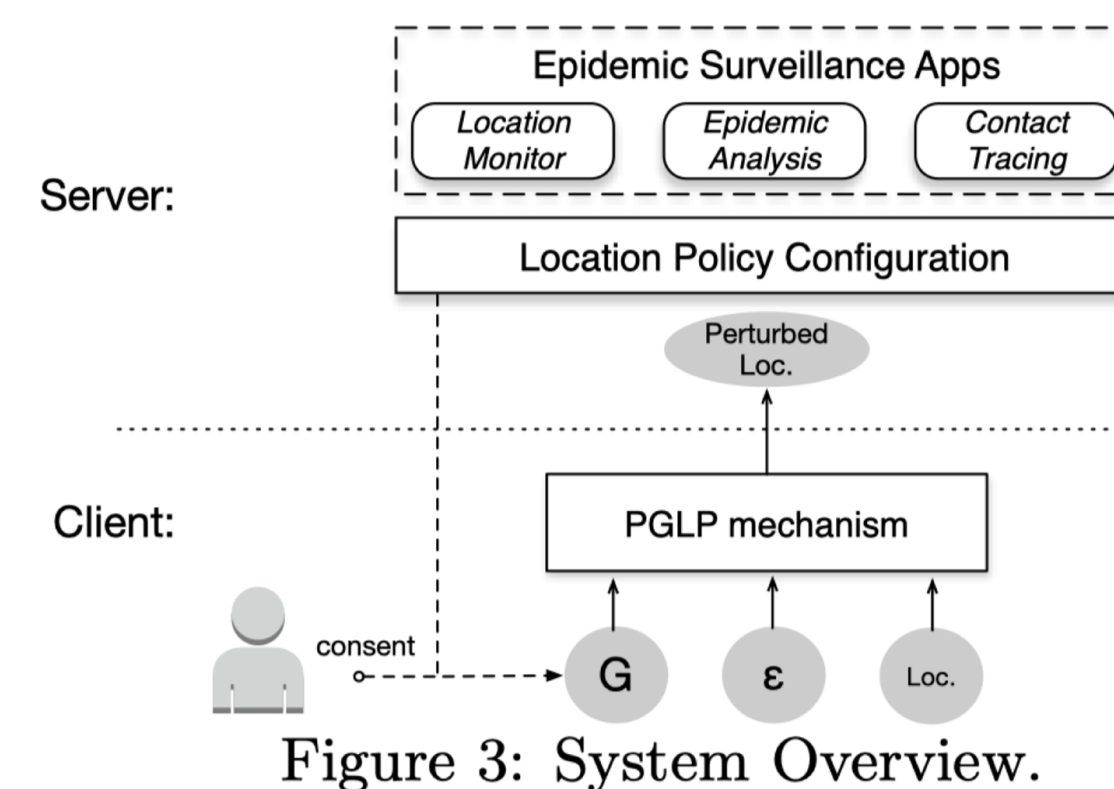


Figure 3: System Overview.

High-utility Federated Learning with the shuffle model (AAAI 2021):

Motivation: FL is promising but bad privacy-utility trade-off in existing DP-FL and LDP-FL. Our solution: FL with the shuffle model. Results: X1.8 model accuracy than DP-FL, X4.6 better than LDP-FL

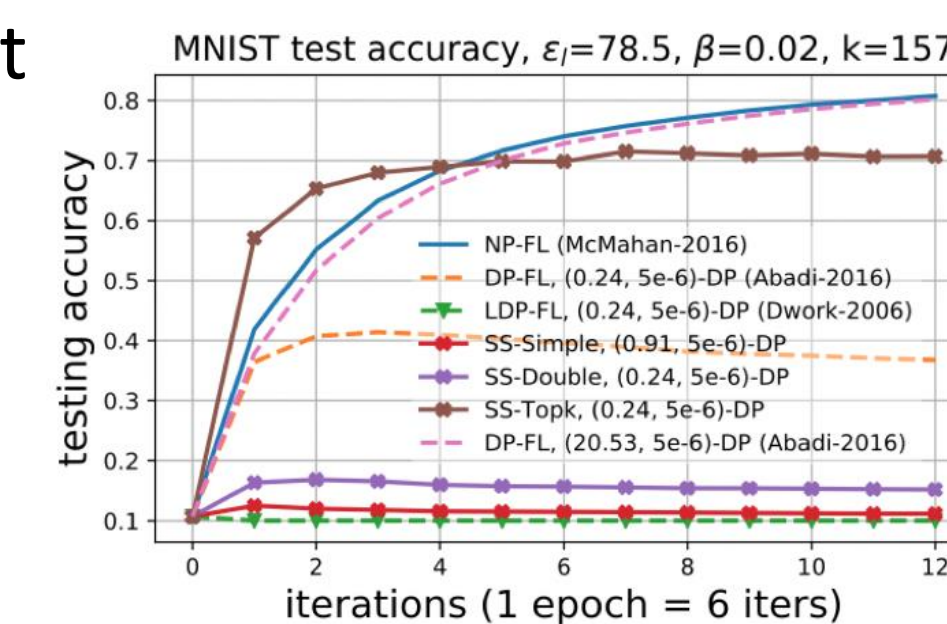
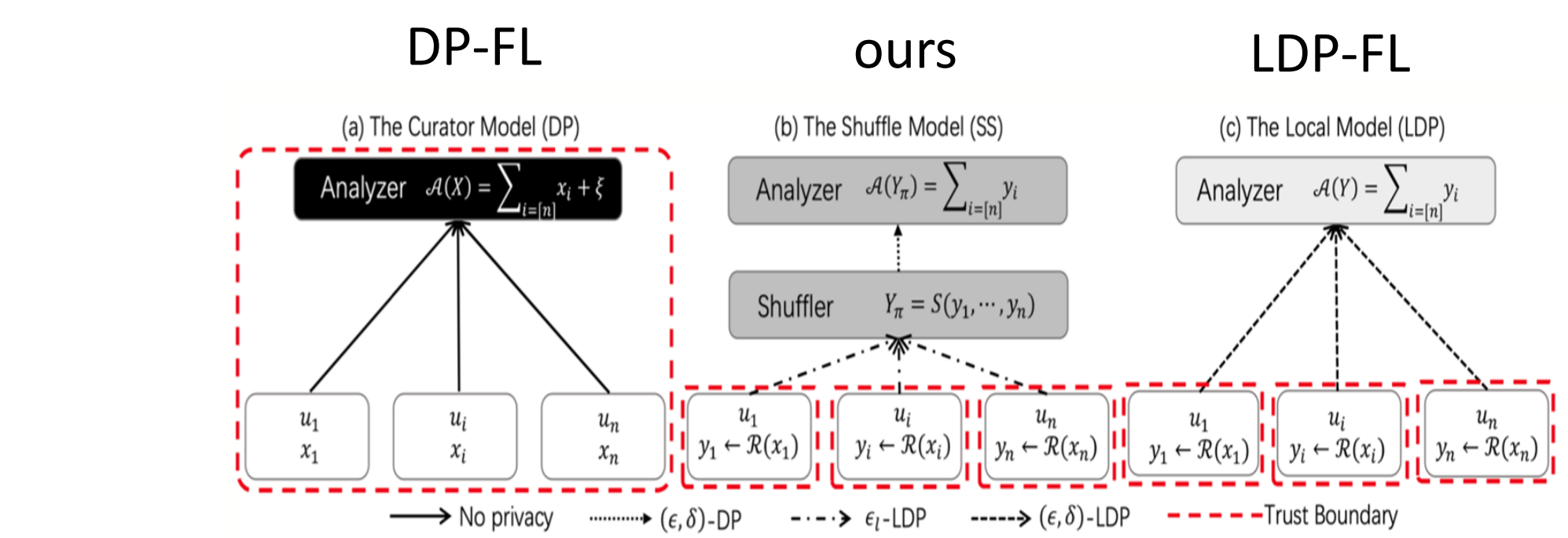
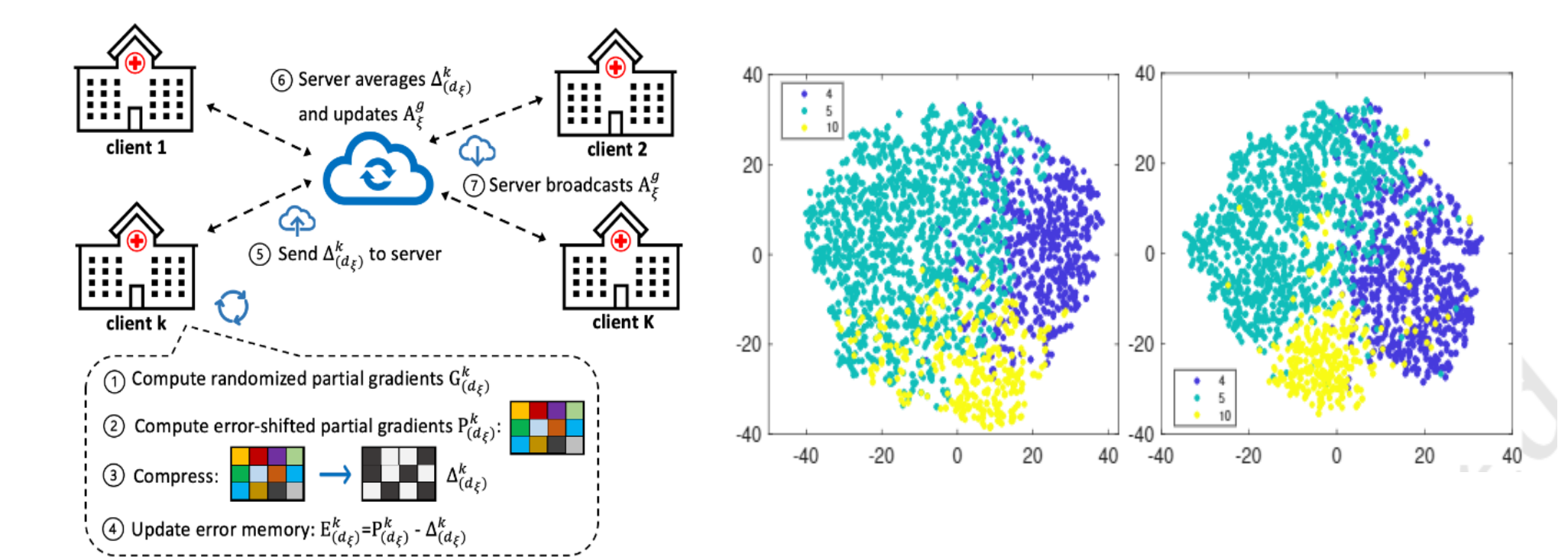


Figure 5: Test accuracy.

SS-Topk > DP-FL > SS-Double > SS-Simple > LDP-FL



Communication Efficient Federated Generalized Tensor Factorization for Collaborative Health Data Analysis (WWW 2021):



Work Package 2: User Survey on the Acceptability of Personal Data Collection

- Questionnaire for Senior Citizens (9737 participants in Japan)
- Online survey in planning for comparative studies of cultural and social differences on acceptability (to be conducted in summer 2021)

Broader Impacts

- The integrative research together with strong community engagement and multidisciplinary team-building, will have significant impacts on various disciplines for smart and connected communities.
- The resulting framework will assist seniors with privacy-enhanced health monitoring and connect them with their community and healthcare providers, which not only directly affects their quality of life while decreasing their healthcare expenses, but also contributes to data-driven medical research that improves population health at large.