2021 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING

CPS: CAREER: Co-Design of Information and Incentives in Societal-Scale Cyber-Physical Systems

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Aim 1: Algorithms for Learning in SCPS.

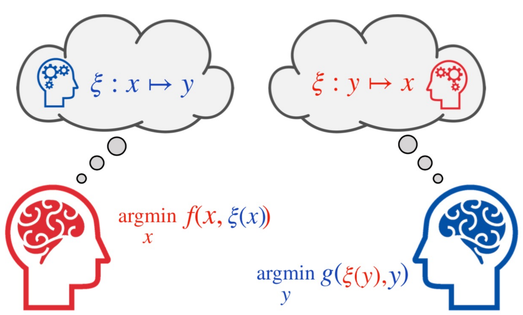
Challenge: human decision makers are integral parts of SCPS, yet their behavior is hard to predict since their decision-making processes are dynamic and depend on external inputs

Aim 2: Algorithmic Information & Incentive Mechanisms

Challenge: a) information asymmetries, b) modeling and predicting unintended consequences, c) developing measurable fairness and efficiency criteria.

Aim 3: Simulations & Living Labs

Objective: validation and testing via 3-tiered approach: (Tb.1) high-fidelity simulation environment built on data-informed models, (Tb.2) interactive lab constructed on top of the simulation platform for assessing policy performance, and (Tb.3) living labs (UW campus and in the city of Seattle).



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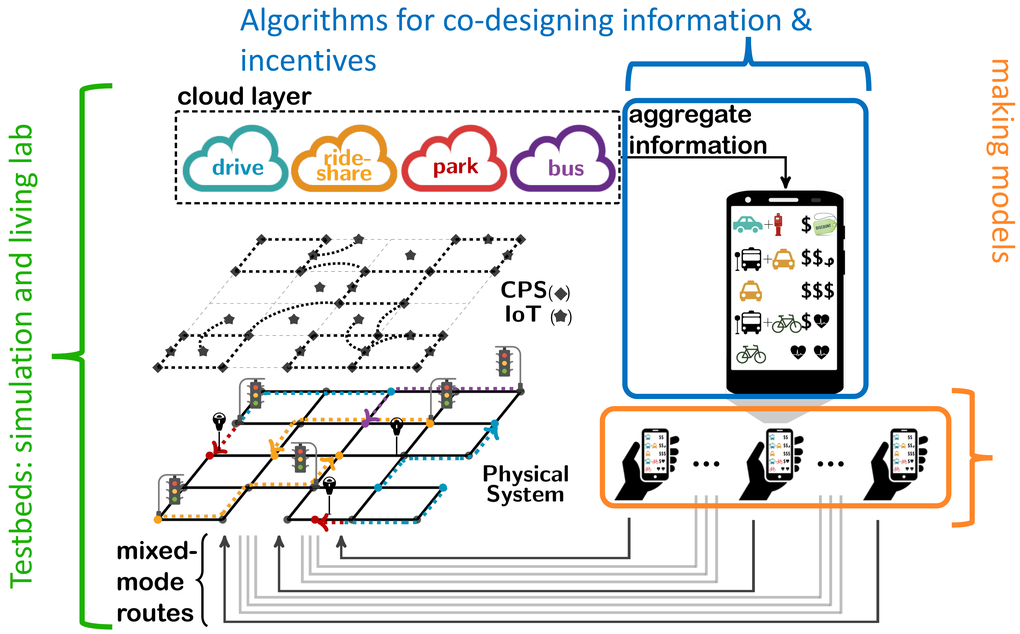

Selected Outcomes & Products:

- Introduction of a **novel differential approach to bounded rationality** which is amenable to computation [1].
- **Regret guarantees for algorithmic incentive design** with budget constraints and bandit feedback and where agents' types are dynamic and depend on the actions taken (i.e. incentives offered). [2-3]
- **Provable convergence of gradient-based learning** in zero sum games [6-8]
- **Policy Simulator**: With industry partner (IDAX) and Seattle DoT, designing experiments building simulation environments based on data [4] to test incentive and information mechanisms, as well as simulate policy changes.

Scientific Impact:

- This project aims to lay the theoretical and algorithmic foundations for the design of both information and incentive mechanisms in S-CPS

Broader Impact:

- SDOT has now adopted a data-informed model-based (e.g.,[4]) for occupancy which it uses to set parking policy including prices as opposed to basing decisions based on single-day samples once per year.
- Developing undergraduate course (Spring '22) on foundations of machine learning and optimization that highlights applications in SCPS
- REU:
  - undergrads working on platform for experimentally validating differential bounded rationality models via "games"
  - Aiding in the policy simulator development

[1] Chasnov, B., Fiez, T., Ratliff, L.J. NeuRIPs Workshop, 2019.
[2] Fiez, T., Sekar, S., Zheng, L., Ratliff, L., UAI, 2018.
[3] Fiez, T. Shah, N, Ratliff, L., UAI 2020
[4] Fiez, T., Ratliff, L.J. IEEE Trans ITS, 2019.
[5] Fiez, T., Jain, L., Jamieson, K., Ratliff, L., NeurIPS 2019
[6] Fiez, T. Ratliff, L.J., Mazumdar, E., Narang, A. Faulkner, E. 2021
[7] Fiez, Ratliff. ICLR 2021
[8] Fiez, Chasnov, Ratliff, ICML 2021