MAPPS [Mobility Analysis for Pandemic Prevention Strategies]

Using mobility and social network data to predict and prevent future pandemics

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BROWN UNIVERSITY

NSF

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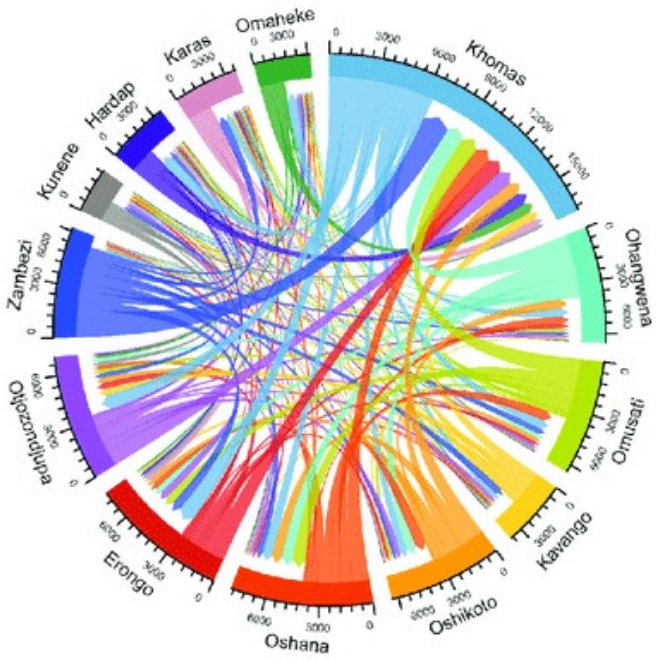
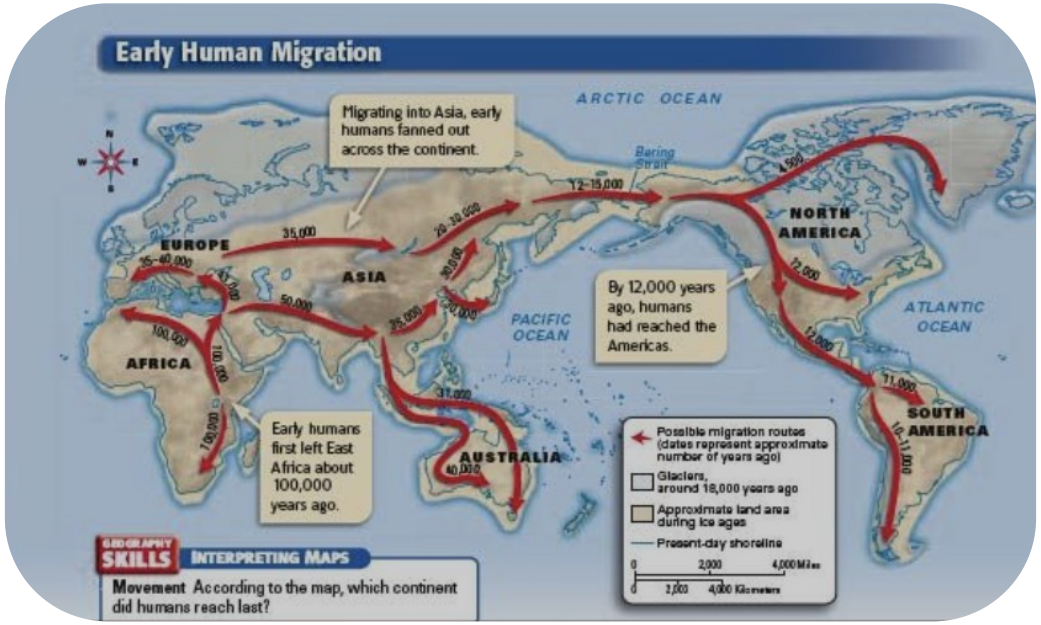
Why Study Mobility and Social Mixing?





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National Science Foundation

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Predictive Intelligence for Pandemic Prevention Phase I: Development Grants (PIPP Phase I)

View guidelines
21-590

M—A——PPS [Mobility Analysis for Pandemic Prevention Strategies]

MAPPS: Central, simple premise

- Infectious disease follows the movement of people
- Understanding how humans interact and move through space and time is therefore fundamental to how disease spread through populations
- If we know who interacts with who and under what circumstances, we could potentially implement targeted interventions that slow or eliminate spread

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Epidemiological lens
R_0 the Basic Reproductive Number

R_0

- Important measure of epidemic potential
- **Answers the question: on average, how many new infections will a primary case produce when introduced into a totally susceptible population**
- $R_0 > 1$ means continued spread
- $R_0 < 1$ epidemic dies out

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The Basic Reproductive Number: How Fast Will An Epidemic Grow?

$$R_0 = D * C * \beta$$

Mean length of time infectious (Duration of infectivity)

Likelihood of transmission on any contact (Transmission Probability)

Rate at which infected people have contact with uninfected people (Contact Patterns/Networks)

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Outline

I. Rationale for MAPPS

II. Main components of MAPPS

- Brief overview of MAPPING@Brown Project

III. Overview and structure of the workshop

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MAPPS Project Components

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Our grand challenge:

How can we best measure and use human mobility and population mixing data to inform real-time pandemic responses across a range of pathogens and under conditions of uncertainty while balancing benefits, risks and harms?

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Data

Device

Modeling and Prediction

Ethics, privacy, confidentiality

Data

Collect, catalogue and make publicly available data on human mobility and social mixing

Federated database; data protections

Data clearinghouse for pandemic researchers

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Develop new technologies for measuring mobility, social interactions and biometrics

- wearables, phone apps

Develop methodologies for analysing and using “passive” surveillance data

- Swipe cards, wifi login

Device

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Modeling and Prediction

To use data from our devices and library of studies to model the impact of new pathogens spreading through a network and to identify potential interventions that could slow disease spread

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To infuse our work with a strong ethical foundation, addressing issues of privacy and confidentiality

To think critically and educate the Brown community about big data, privacy and confidentiality

To develop MAPPS ethics primer, a Q and A addressing likely ethical concerns of app users

Ethics, privacy, confidentiality

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Data

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Modeling and Prediction

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MAPPING@Brown

Modeling and Prediction

Ethics, privacy, confidentiality

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MAPPING@Brown: Main Goals

- Measure the social network at Brown University
- Use the social network data to populate flexible and realistic mathematical models of disease transmission
  - Intervention assessment: Explore transmission dynamics under different scenarios of social mixing and mobility
- Simulation exercise
  - Introduce a virtual pathogen with specific epidemiological characteristics into the network and observe spread through the network
  - Identify point of intervention/changes in social mixing that would be effective at elimination or containment of the virtual pathogen

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MAPPING@Brown: Overarching, proof-of-concept study

- 18-month goals:
  - Device development
  - Deep community engagement
  - Pilot in Brown School of Public Health in AY 2022/23

- 5-year goal:
  - To map the entire social network at Brown (!)

- 5-10 year goal
  - Add biometrics and other measurements;
  - Discover wider applications

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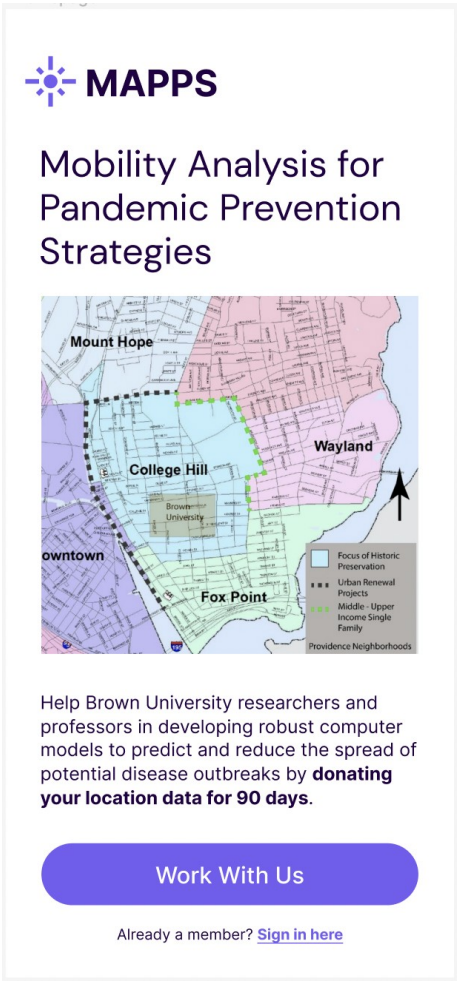
MAPPING@Brown

- More to come about this in the breakout sessions!



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Data

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MAPPS 18-month and 5-year goals

MAPPS	18 Month Vision	Five Year Vision
Thrust 1: Data 	Develop methods for collating, cataloguing and analyzing existing data streams on human mobility and social networks	Launch a secure human mobility and social network data clearinghouse with robust infrastructure for accessing and sharing data in real-time
Thrust 2: Device 	Identify core functions of and overcome technical impediments to developing a novel wearable device	Pilot test a wearable device capable of measuring social networking, mobility and biometrics in real-time
Thrust 3: Models & Decisions 	Develop modeling method-ologies leveraging existing data sources to describe the impacts of social networking and mobility on pandemic potential at multiple scales to inform decisions	Create an open-source mathematical modeling platform fed by new and existing data sources to predict pandemics in real-time
Thrust 4: Ethics & Community Engagement 	Support work across each thrust focusing on ethical applications of big data in pandemic preparedness; Select appropriate secure systems and integrate privacy algorithms	Operate as a center of excellence in pandemic preparedness and a leader in the ethical use of big data to guide pandemic preparedness activities

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NSF PIPP Phase 2

RFA not yet released

Approximately 7 years and $20-25 million

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Workshop Purpose & Structure

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Privacy and Ethics in Pandemic Data Collection and Processing

Websites

Workshop Website

https://mapps-brown.github.io/workshop2023/

The workshop materials can be found here. We will post materials to this website throughout the week.

ICERM Website

https://icerm.brown.edu/topical_workshops/tw-23-pep/

The daily agenda will be posted here, and ICERM will live stream the keynotes each day.

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Purpose

- Develop a framework for state of the art privacy and ethics protection in the context of pandemic data collection and processing;
- Develop protocol for MAPPING@Brown exercise;
- Develop new collaborations for Phase 2 PIPP Application.

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Desired Outcomes

1. **Data:** Prioritized list of data needs for measuring movement and social mixing during MAPPING@Brown

2. **Privacy and Ethics:** Concrete approaches to managing the ethical issues that arise from collecting, managing, analyzing, and sharing human mobility and social mixing data

3. **Technical Execution:** Outline the technical approaches to responsible use of shared data

4. **Modeling:** Outline modeling and simulation scenarios using MAPPING@Brown data to facilitate optimal prediction and prevention of future pandemics

5. **Data Sharing:** Identify techniques for ethically using multi-party computation to analyze mobility and social mixing datasets from multiple institutions at once

Structure

- Distinguished keynote speakers;
- Breakout sessions in which we ask for your input in the design, ethics, implementation and analysis of MAPPING@Brown

- Small, focused, interdisciplinary and participatory;
- Plenty of time for discussions
- Lots of unstructured time
- These walls can speak

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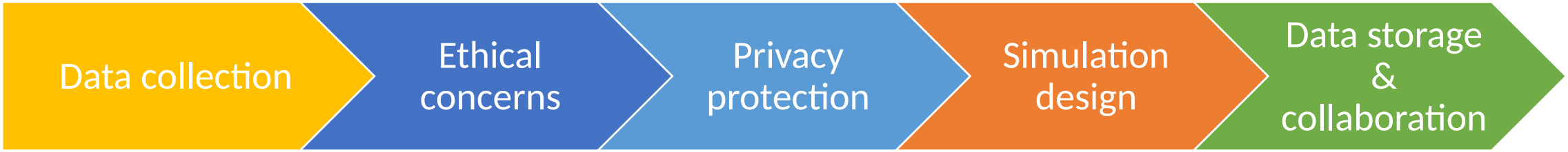
Breakout Sessions

Focus on MAPPING@Brown exercise



Solving specific ethical, technical and analytical issues arising in MAPPING@Brown exercise

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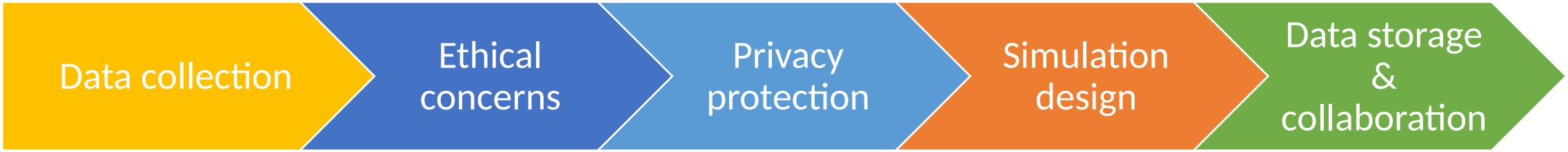
Breakout Sessions

Focus on MAPPING@Brown exercise



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Breakout 1

What data will we collect during MAPPING@Brown in order to map mobility and social mixing patterns within the Brown community? How and how often might these data be collected?

Data collection

Tuesday, 3:00-4:30 PM

Led by Mark Lurie

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Breakout 2

How might we approach the ethical issues that arise from collecting, managing, analyzing, and sharing the types of data identified in Breakout 1?

Ethical concerns

Wednesday, 1:15-2:45 PM

Led by Julia Netter

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Breakout 3

How can we protect participants' right to privacy on a technical level using cryptographic approaches like differential privacy, which guide what questions we can ask of our data without risking reidentification or other harms?

Privacy protection

Wednesday, 3:15-4:45 PM

Led by Anna Lysyanskaya

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Breakout 4

How do we make best use of he social network data we will gather in MAPPING@Brown and what can we use that to advance network science?

What is the optimal design of an embedded outbreak simulation using MAPPING@Brown data to inform our efforts to predict and prevent future pandemics?

Simulation design & analysis

Thursday, 10:30-12:00 PM

Led by Thomas Trikalinos, Jason Gantenberg, and Aditya Khanna

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Breakout 5

How can we use multi-party computation to enable researchers to analyze MAPPING@Brown-type datasets from multiple institutions in conjunction?

Data storage & collaboration

Thursday, 3:15-4:45 PM

Led by Anna Lysyanskaya

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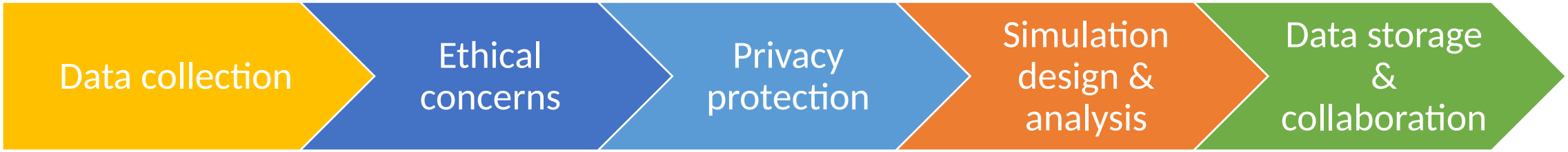
MAPPING@Brown Breakouts



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The MAPPS Team

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MAPPS Team: Principal investigator

Mark Lurie, PhD

Associate Professor of Epidemiology;
Interim Director, International Health Institute

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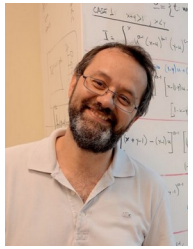
MAPPS Team: Co-Investigators

Sohini Ramachandran, PhD

Professor of Ecology, Evolution, and Organismal Biology; Director, Data Science Initiative

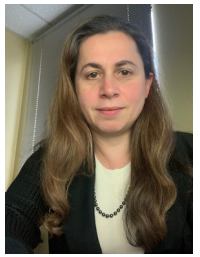
Kimani Toussaint, PhD

Professor of Engineering; Senior Associate Dean of Engineering



Thomas Trikalinos, PhD

Professor of Health Services, Policy and Practice and Biostatistics; Director: Center for Evidence Bases Synthesis in Health



Anna Lysyanskaya, PhD

Professor of Computer Science

Julia Netter, DPhil

Visiting Assistant Professor of Philosophy;

Coordinator: Social Responsible Computing Program

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MAPPS Team: Featured researchers

Jason Gantenberg, PhD

Research Scientist, Department of Health Services, Policy & Practice; Assistant Professor of Epidemiology

Aditya Khanna, PhD

Computational Epidemiologist and Statistician, Department of Behavioral and Social Science

Guixing Wei, PhD

Senior GIS Developer, Spatial Structures in the Social Sciences (S4)

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MAPPS Team: Workshop organizing committee

Peyton Luiz

MAPPS Project Manager

Betsy Stubblefield Loucks, ScM, MBA

Associate Director of Research Strategy,
Office of the Vice President of Research

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MAPPS Team: Knowledge keepers

- **Josi DeHaven**, MPH, BSN, RN, CCM
- **Scott Griffy,** PhD student in computer science
- **Jorge Ledesma**, PhD student in epidemiology
- **Aquielle Person**, RA with the Pandemic Center at Brown University
- **Maria Pieruccini,** MPH Student
- **Gage Reitzel**, MPH student
- **Leah Rosenbloom**, PhD student in computer science
- **Qiuhong (Anna) Wei**, BS/MS student in computer science
- **Marta Wilson-Barthes**, School of Public Health Project Coordinator
- **Isabella Zangari**, undergraduate student at Colgate University
- Mohammed Akel, Undergraduate computer science and public health student

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Questions?
Comments?
Concerns?

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