Breakout Session 2: Track A

Cloud Computing in Opioid Policy Modeling

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Cloud Computing in Opioid Policy Modeling

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No conflict of interest

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Aims of the Parent Study

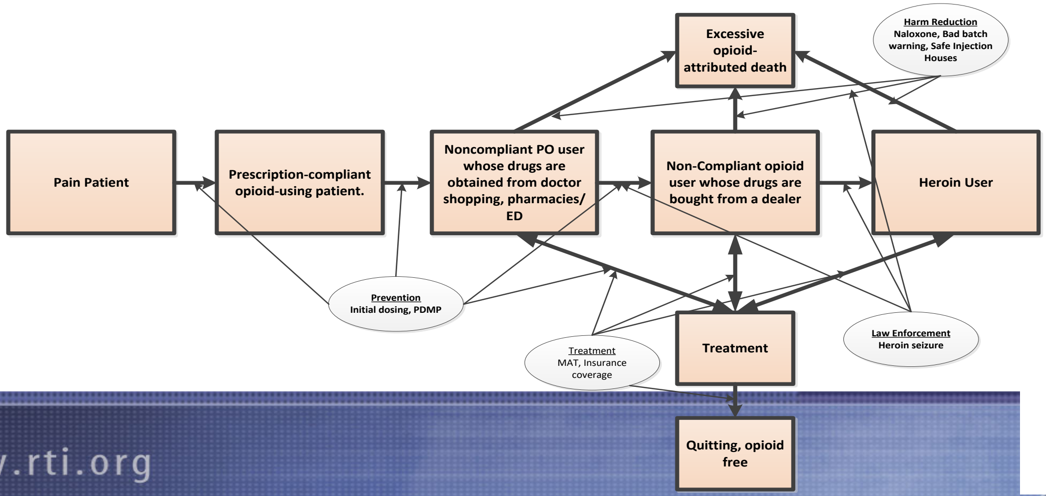
- **Aim 1.** To develop a North Carolina-specific ABM that describes multiple pathways of opioid use in the context of prescription practices, treatment modality and availability, the illegal drug market, prevention policies, and other factors that lead to opioid misuse and death.

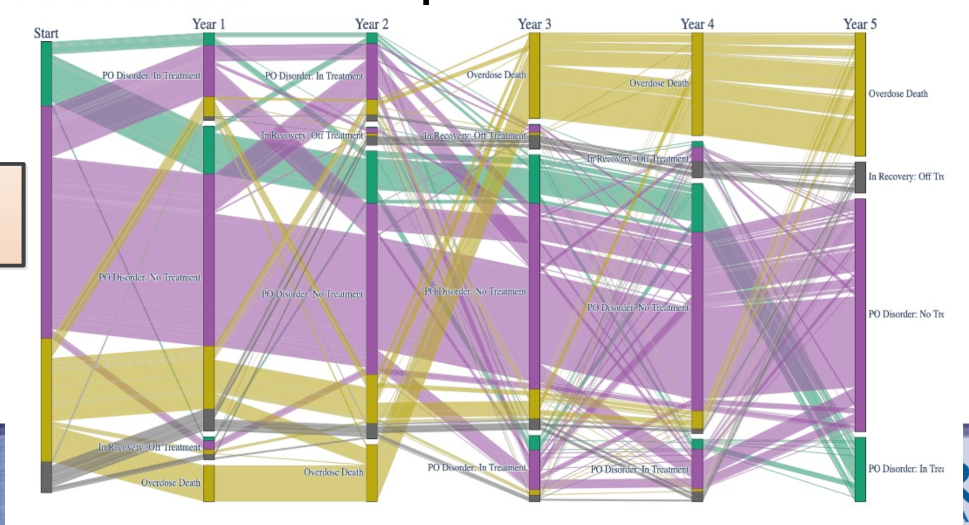
- **Aim 2.** To predict the **response to the mix of interventions specified in the North Carolina Opioid Action Plan.** We will **estimate the uncertainty of the forecasts** accounting for the changing policy and environmental factors….

- **Aim 3.** To estimate the cost and cost-effectiveness of the key interventions in Aim 2 and compare them with the status quo.

Approach

- Develop an Agent-based model (ABM) representing individual trajectories in the context of connected social environments.
- Use synthetic populations to represent North Carolina communities with multiple roles and social networks
- Calibrate the mode to represent historic data
- Evaluate policy scenarios through simulation experiments





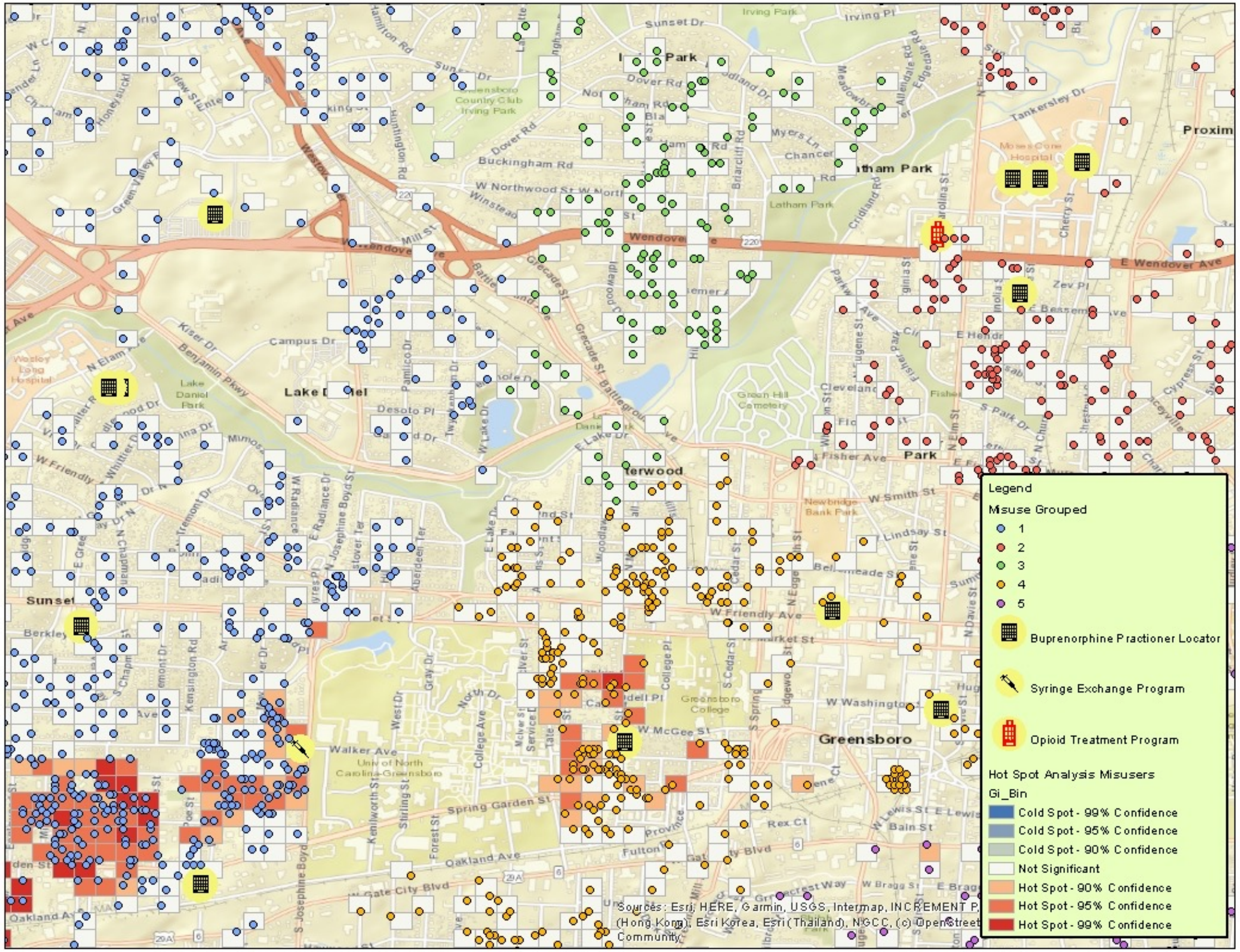
Interventions Affecting Disease States and Transitions

- Prevention
  - Impacts initiation, mortality from misuse
- Harm reduction
  - Impacts heavy use and disorder states, mortality
  - Can potentially impact transition from light to heavy use
- Treatment
  - Impacts disorder and recovery states, mortality
- Law enforcement
  - Impacts supply, punishment for use, access to treatment

Agent Roles in the ABM

- *Person who uses:* Follows the transition diagram
- *Physician:* Can choose to prescribe opioids to patients, selects the dose, can check patients' record in the prescription drug monitoring program (PDMP).
- *Emergency Department*: Can choose to give patients opioids and decides on the dose, can check PDMP and add info.
- *Pharmacy*: Can dispense the PO. Can check PDMP (policy compliance) to decide on dispensing a prescription.
- *Dealer*: Sells PO, heroin, bad heroin

Synthetic Population in a Local Context



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Computational Limitations

- Computational burden limits scalability
  - Software with heavy overhead (NetLogo)
  - Large number of agents needed
  - Need to consider many parameter distributions
  - Large number of replication is needed to deal with uncertainty
  - A number of scenarios to consider
    - Baseline, Ideal situation, Realistic scenarios
    - Multiple interventions conducted simultaneously
    - Client-facing simulation library

Supplement Aims

- **Aim1**. To evaluate cost-effective potential of cloud services (AWS, Azure with RTI Merge platform, Google cloud, IBM cloud, and AnyLogic) to scale up the computational capabilities of complex geo-spatial agent-based models to represent realistic impact of local and state-wide opioid policy.

- **Aim2.** Implement the most efficient approach based on price and efficiency and compare the scaled-up performance to the non-cloud benchmark.

- **Aim3.** Evaluate the impact of cloud computations. Incorporate cloud computing practices into multiple models of similar nature funded by this and other NIH projects. This Aim will result in SOPs for cloud computing practices into multiple models of similar nature funded by this and other NIH projects.

Three-way Scalability of Our Model

- Number of replications (Target 500 replications per scenario)
- Number of scenarios (5 levels X 20 policies X factorial combinations)
- Number of agents 10,000, 100,000, 10,000,000

Preliminary Results

- The **cluster** is a compute optimized machine with 36 CPUs, 72 GiB of memory
- The **AWS** r7i.48xlarge instance is a memory optimized instance with 192 vCPUs, 1,536 GiB of memory and 50 Gibps of bandwidth and costs $12.70/hr
- Time for 100 runs, 10,000 agents on cluster vs. 10,000 in the cloud:
  - **26.2 hrs** (cluster); **1.3 hrs** (AWS)
- Time for 500 runs on a cluster vs. cloud (10,000 agents):
  - **152 hrs** (cluster); **7.1 hrs** (AWS)
- Time for model optimization vs. computational time: model is already close to maximally optimized for NetLogo. Estimated at 300 staff hours to translate to alternative modeling language
- Translate time into $$ (In progress)
- MPI requires different software

Broader Impact

- ABMs are growing more popular but quickly become too complex
- Understanding issues associated with software type/optimization vs. technical scalability in the cloud
- Recommendations for the new ABM projects. What to consider when making choices of software, scenarios, etc.

Thank you

Questions/Contacts

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