Carnegie Mellon

Ph.D. Program in **Computation, Organizations & Society**

Infectious Disease Modeling Using BioWar

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Studying Infectious Diseases

- Human clinical trials not possible
- Animal models (e.g. recent guinea pig work)
- General Simulation Models
- Historic human transmission experiments (unethical)
- "Let nature be and see what happens."

| Traditional Experiments	Agent-based Model Characteristics
Small or moderate number of factors	Large number of factors
Linear or low-order effects	Non-linear, non-polynomial behavior
Sparse effects	Many substantial effects
Negligible higher-order interactions	Substantial higher-order interactions
Homogeneous errors	Heterogeneous errors
Normally distributed errors	Various error distributions
Black box model	Substantial expertise exists
Univariate Response	Many performance measures of interest

Sanchez SM, Lucas TW. Exploring the World of Agent-based Simulations: Simple Models, Complex Analyses. In: Proceedings of the 2002 Winter Simulation Conference; 2002.

Contagious Disease Model within BioWar

- Multi-agent model, city-scale
- Discrete event – four hour periods
- Agents are people that interact and transmit diseases
- Demographics: age, race, health care worker, teachers, students, military personnel
- Includes interactions of multiple diseases
- Includes influence of social networks
- Diseases are: background, outbreak, attack (e.g. influenza, avian influenza, SARs
- Disease attributes: symptoms, incubation period, early/late symptom duration; contagious period; death rate; transmissivity
- Outputs include: Mortality, Demographics of infected population, Doctor, Clinic, ER visits, School/work attendance

Virtual Experiment

- Define disease parameters
- Build virtual cities
- Introduce number of infected agents on specified data
- Track course of disease prevalence
- Run sensitivity tests
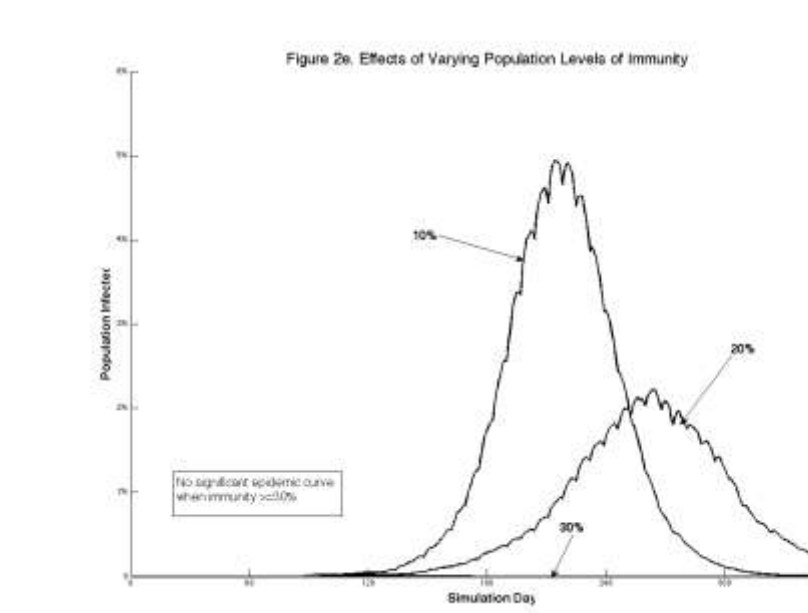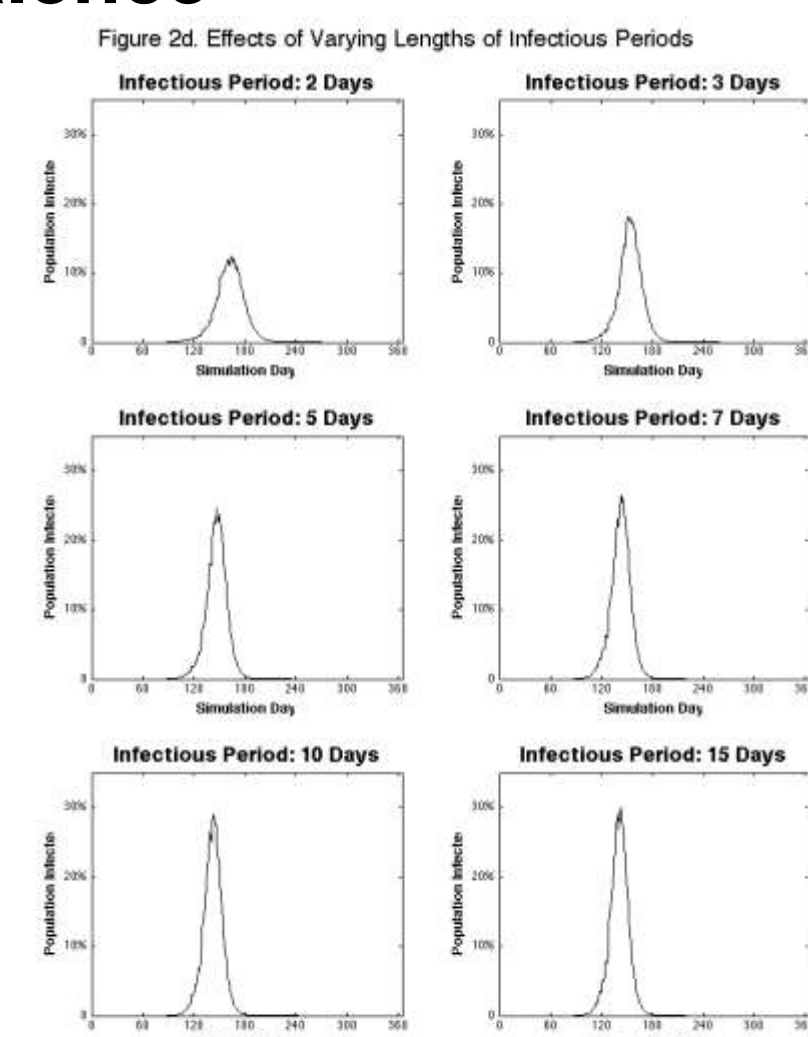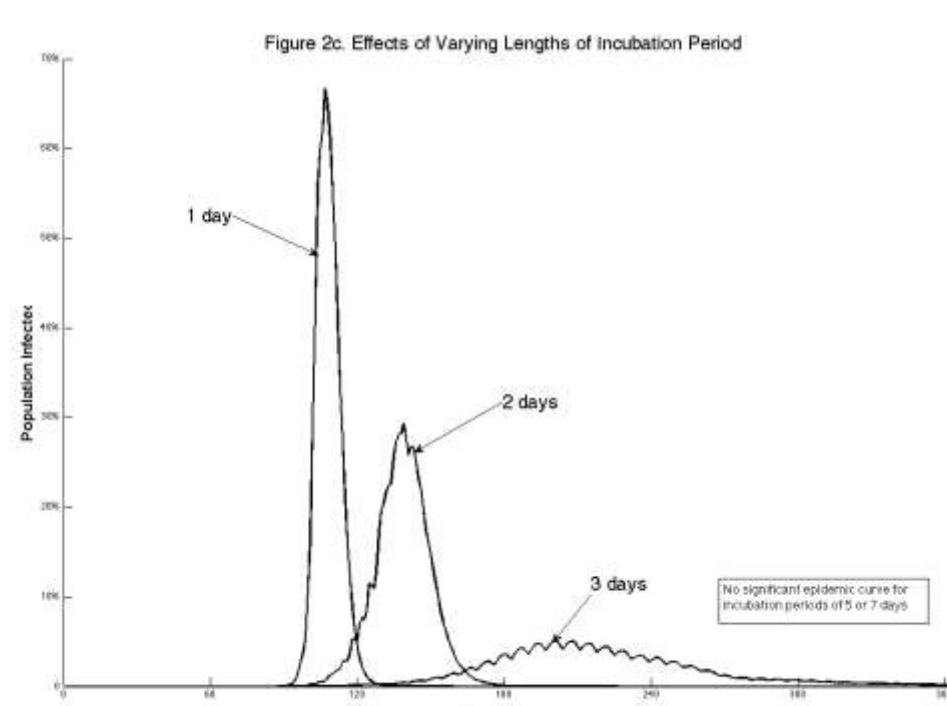
- Run sensitivity tests against disease parameters and virtual cities
- Include interventions:
  - Social distancing
  - Vaccinations
  - Quarantines
  - School closures

Locations

Home
Work
School
University
Restaurants
Stadium
Store
Theatre
Military Base

Pharmacy
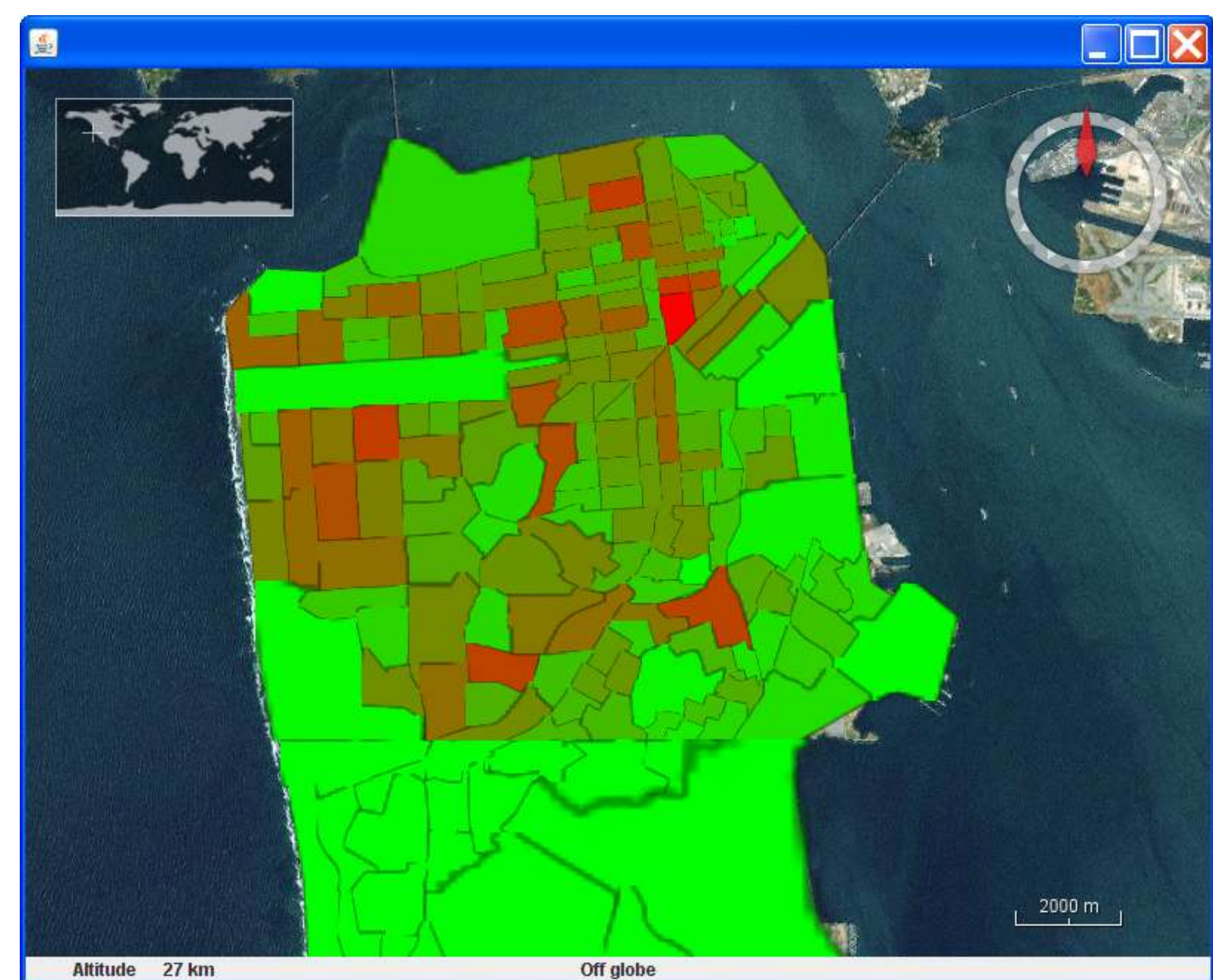Doctor (Clinic)
Emergency Room
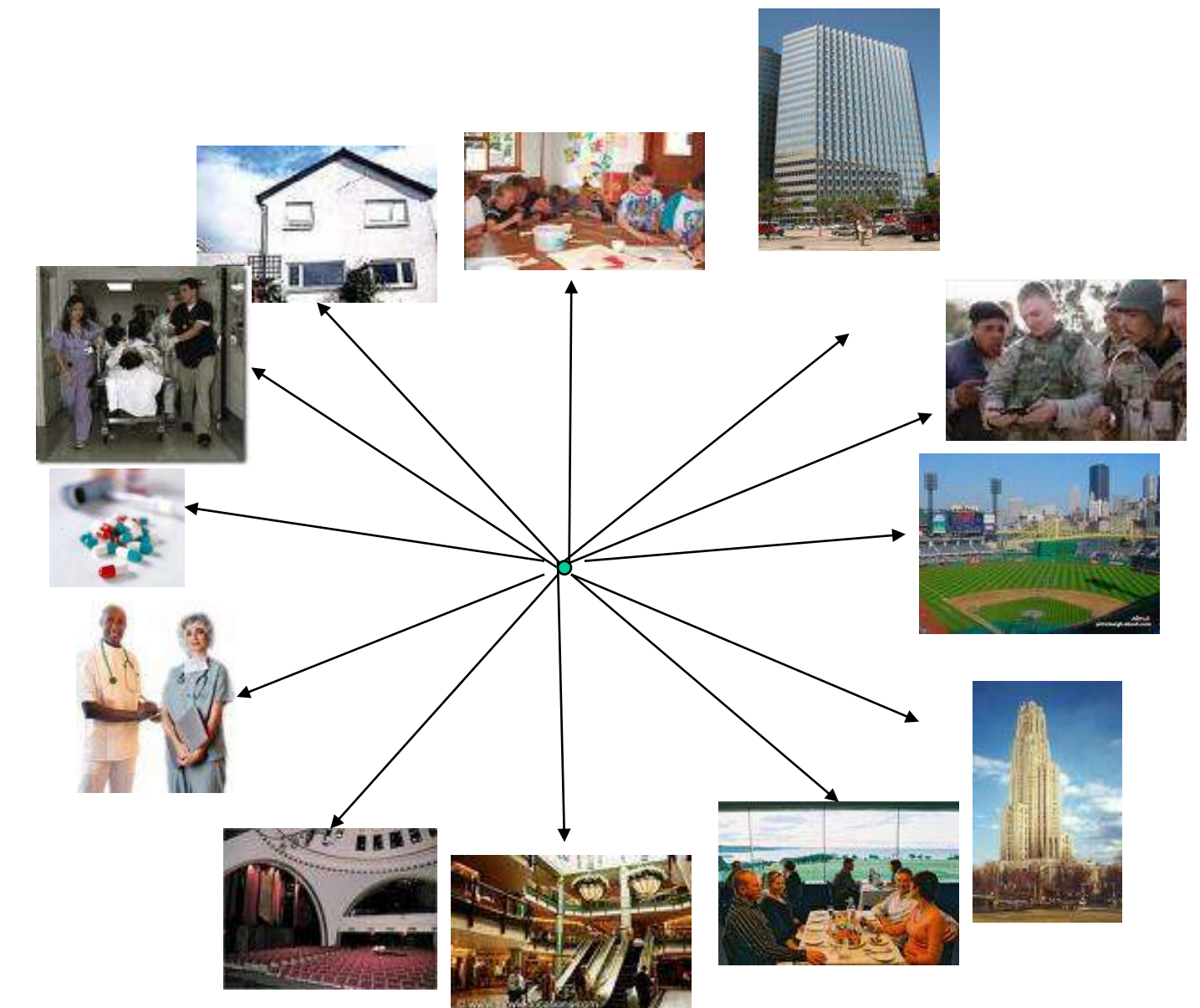
Virtual Cities

- Cities modeled using census and weather data
- Utilizes real data streams: Census (population and economic), School district, weather, geography, sub-model of military bases

Current Cities Modeled

Hampton Roads, Virginia
Norfolk, Virginia
Pittsburgh
San Diego
San Francisco
Washington, DC

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