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A Guide to Saving Lives with Computers

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GAIA Visualization Webservice

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Visualization of Epidemic and Public Health Data

Andrew Adams

https://midas.pitt.edu/gaia

Flu ABM Acknowledgments

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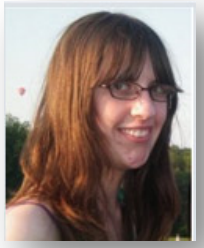
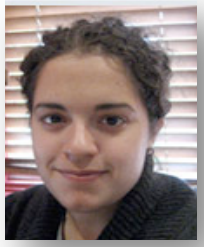


Rachel Bailey, MPH



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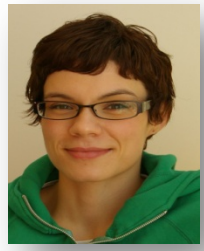
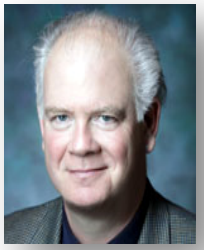


Alona Fyshe



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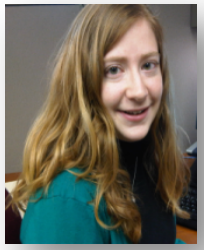

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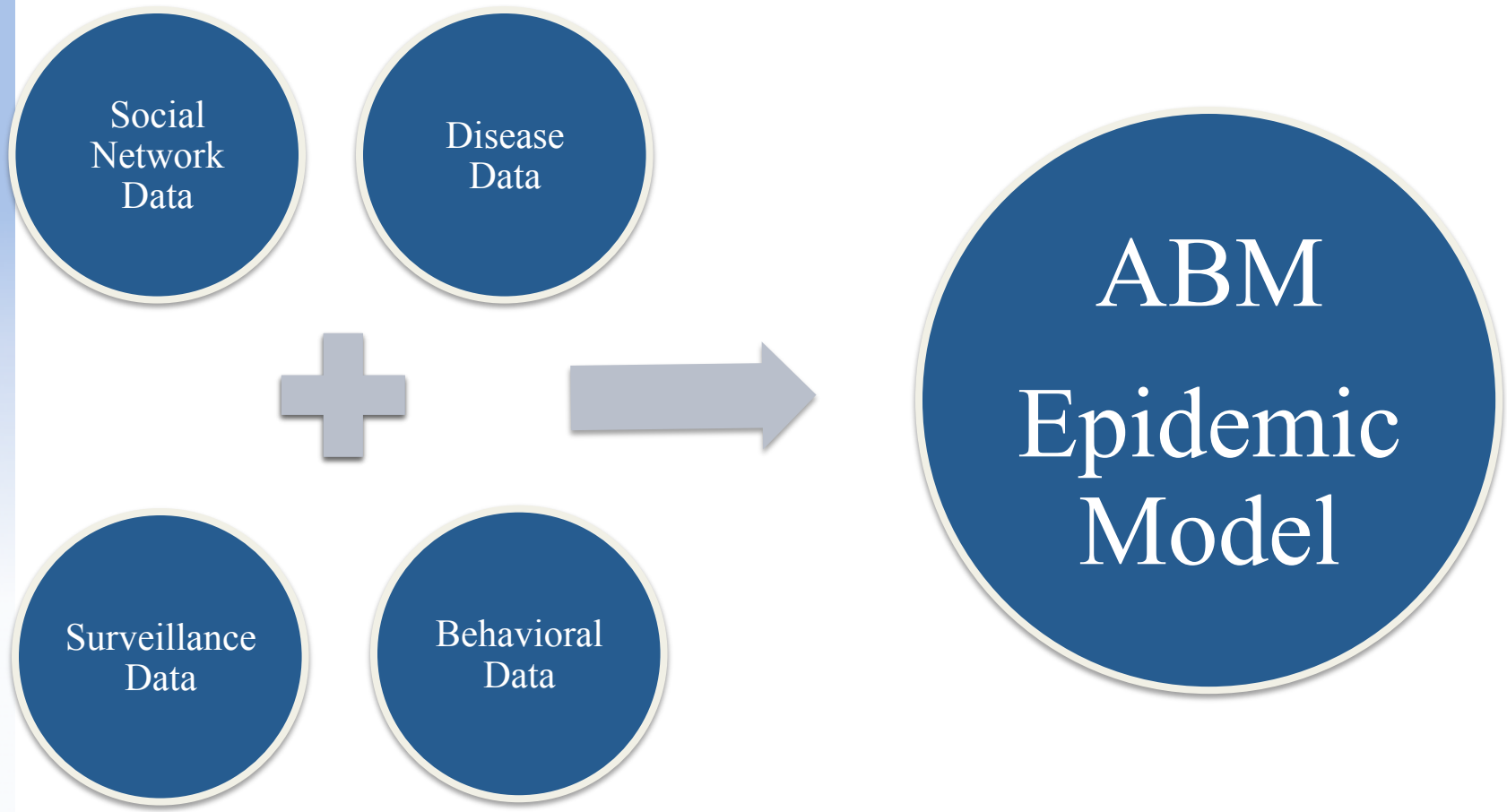
Building up an influenza model



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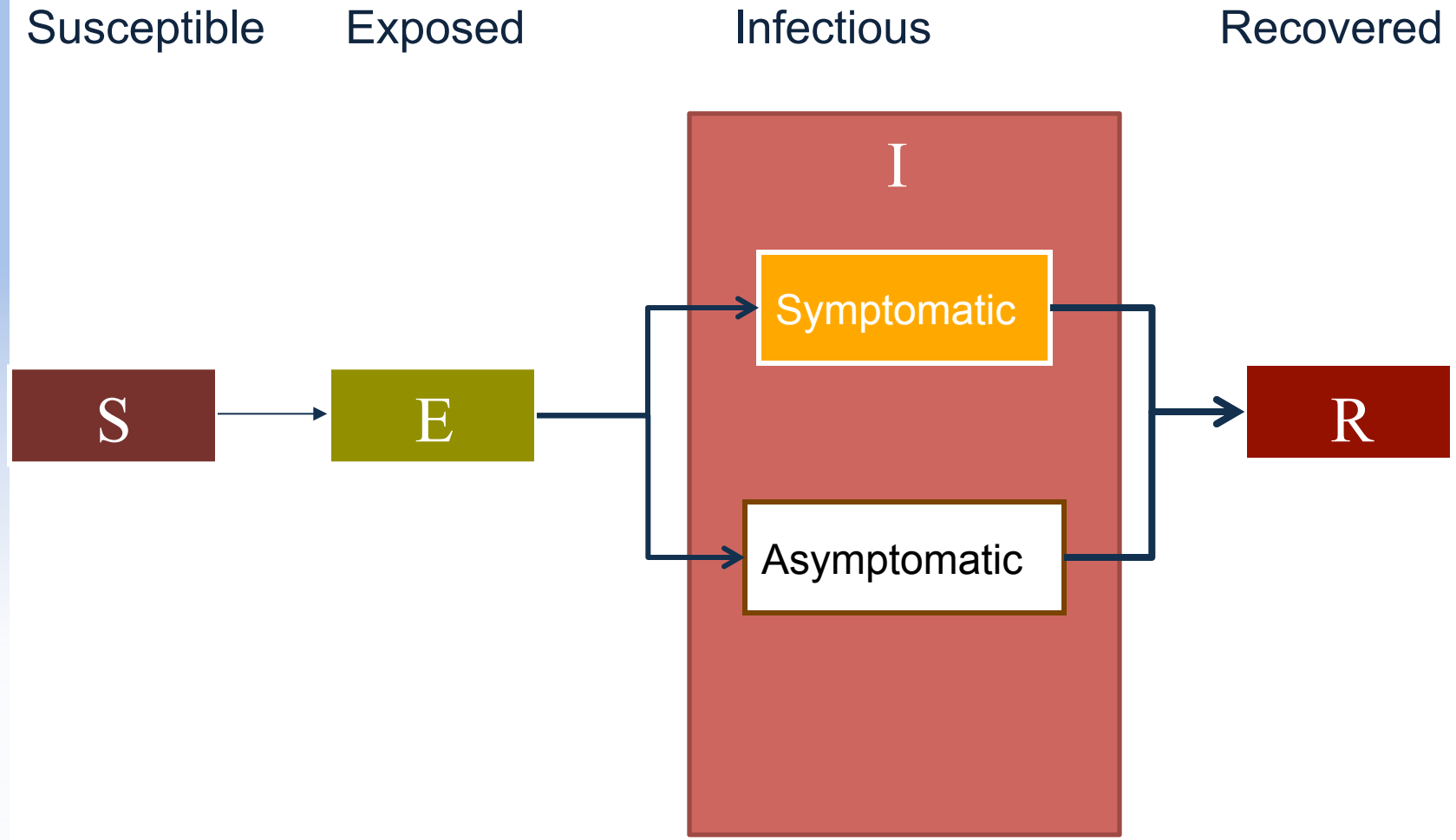
Base Influenza Model



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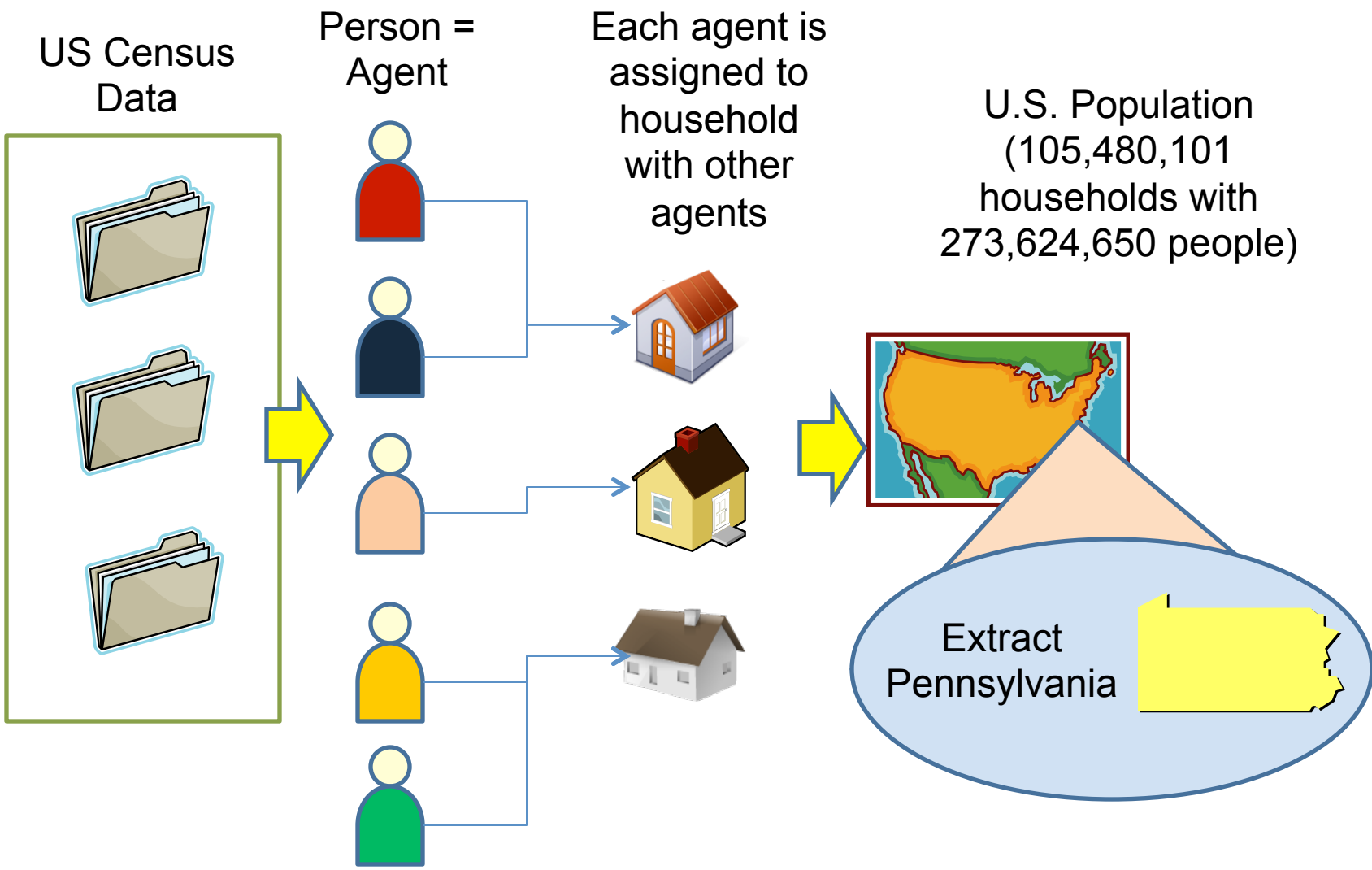
Synthetic Population



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Agent Movement

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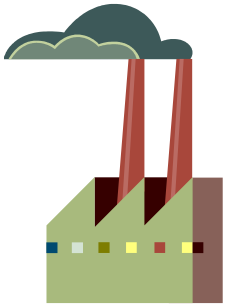
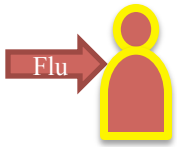
Communities

33%

Workplaces

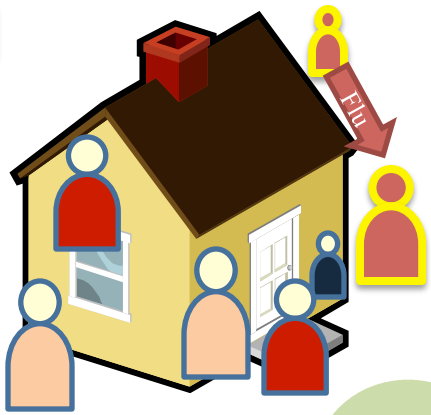


37%



16% infections in schools
21% infections in workplaces

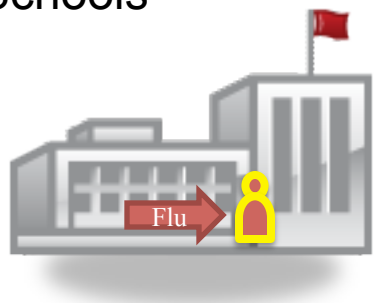
(Applies to an epidemic R0 = 1.9)



Homes

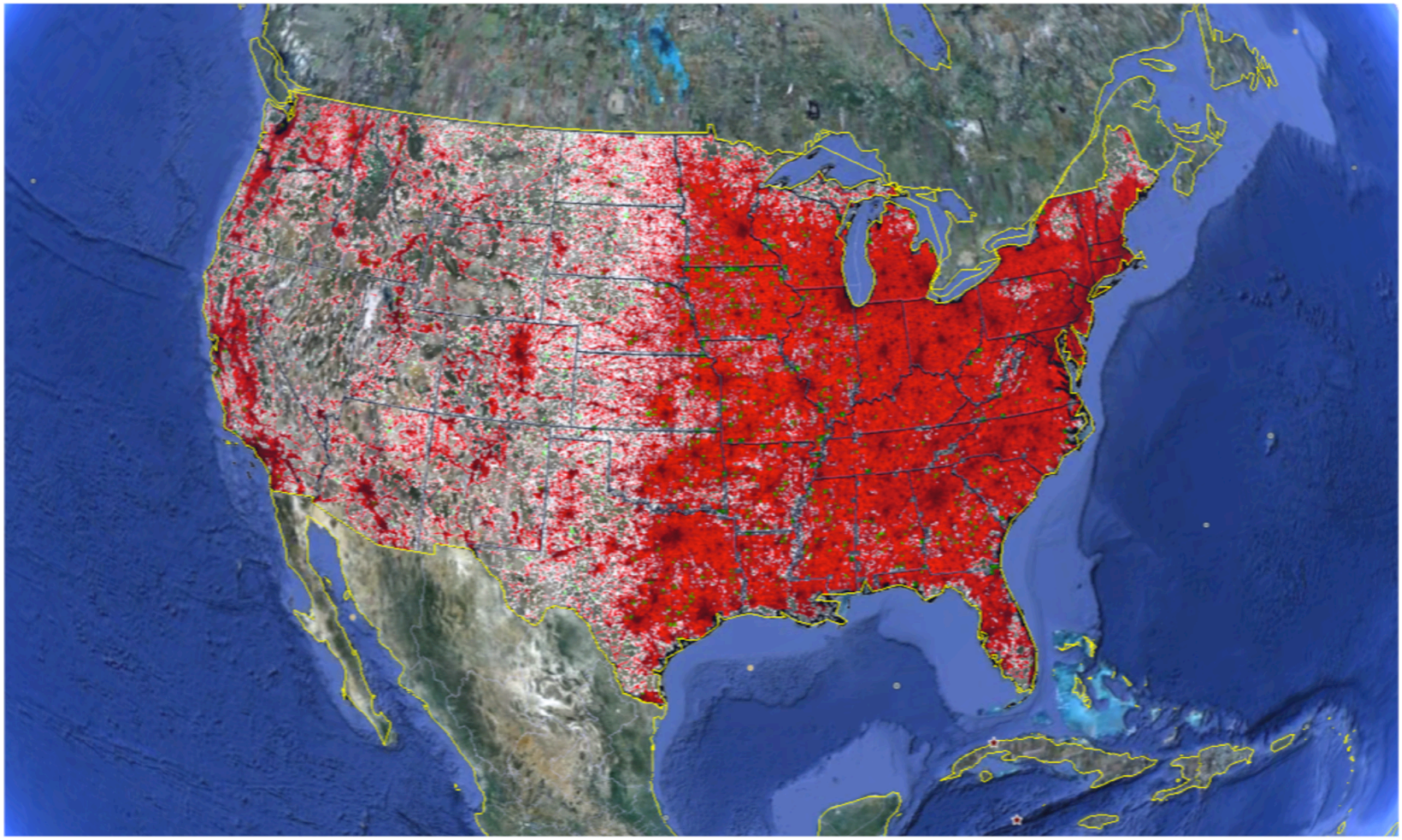
30%

Schools



Reference:
Ferguson N, Cummings DAT, Fraser C, Cajka JC, Cooley PC, Burke DS. Strategies for mitigating an influenza pandemic. Nature. July 27, 2006; 442:448-452.

Populations



The Entire United States

Approximately 300 Million Agents (74 – 300 GB)

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Running on the Supercomputer

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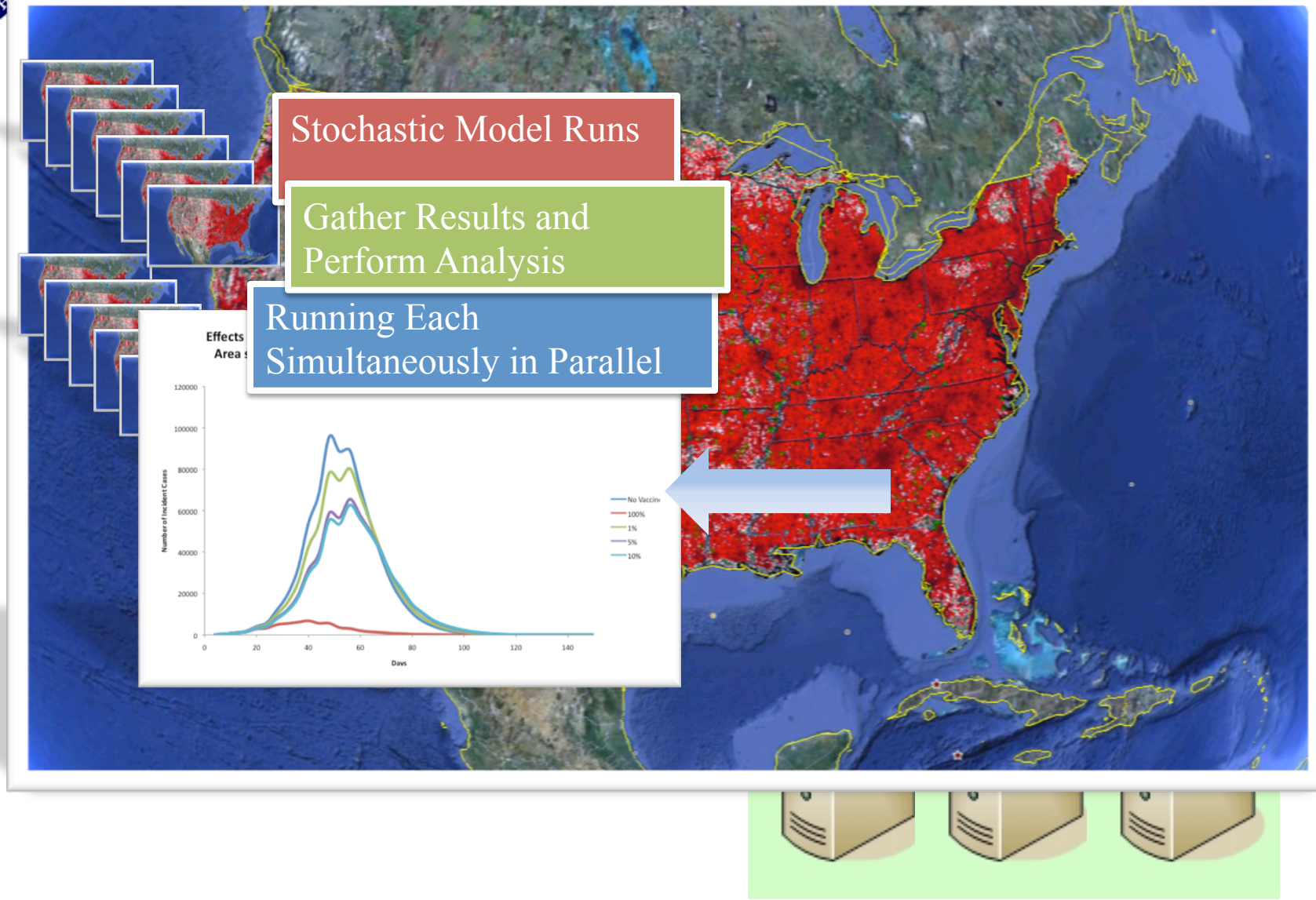
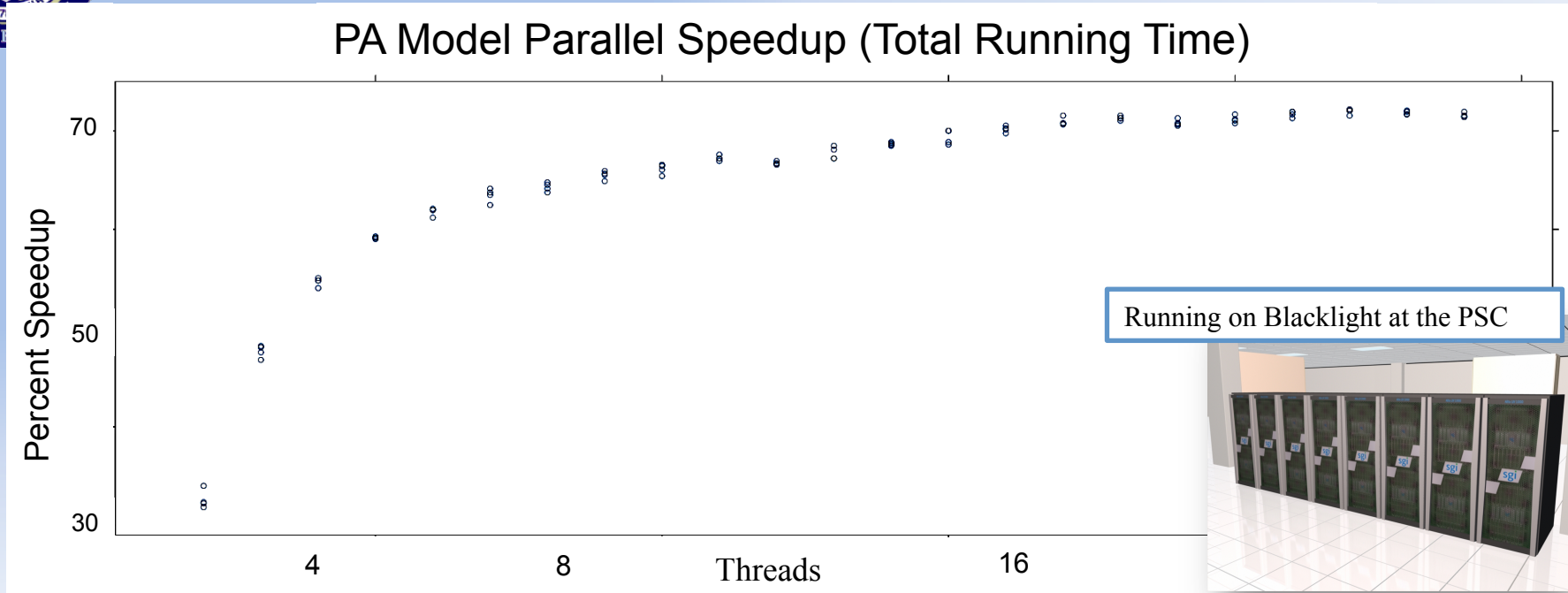


High-Performance Computing Cluster

Multi-Threaded ABM



Running on Blacklight at the PSC

Combination of serial memory performance enhancements and OpenMP implementation lead to dramatic performance enhancements.

PA model:
12 Million Agents

Before (Single Thread):	2 hours
After (8 Threads):	220 secs

US model:
300 Million Agents

Before (Single Thread):	90 hours
After (16 Threads):	3.7 hours

David O'Neal

Jay DePasse

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Brown et al. BMC Public Health 2011, 11:353
http://www.biomedcentral.com/1471-2458/11/353

BMC Public Health

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RESEARCH ARTICLE Open Access

Would school closure for the 2009 H1N1 influenza epidemic have been worth the cost?: a computational simulation of Pennsylvania

Shawn T Brown[1,2*], Julie HY Tai[1,3], Rachel R Bailey[1,3], Philip C Cooley[6], William D Wheaton[6], Margaret A Potter[1], Ronald E Voorhees[1,4], Megan LeJeune[1,3,5], John J Grefenstette[1], Donald S Burke[1], Sarah M McGlone[1,3] and Bruce Y Lee[1,3]

Abstract

Background: During the 2009 H1N1 influenza epidemic, policy makers debated over whether, when, and how long to close schools. While closing schools could have reduced influenza transmission thereby preventing cases, deaths, and health care costs, it may also have incurred substantial costs from increased childcare needs and lost productivity by teachers and other school employees.

Methods: A combination of agent-based and Monte Carlo economic simulation modeling was used to determine the cost-benefit of closing schools (vs. not closing schools) for different durations (range: 1 to 8 weeks) and symptomatic case incidence triggers (range: 1 to 30) for the state of Pennsylvania during the 2009 H1N1 epidemic. Different scenarios varied the basic reproductive rate (R_0) from 1.2, 1.6, to 2.0 and used case-hospitalization and case-fatality rates from the 2009 epidemic. Additional analyses determined the cost per influenza case averted of implementing school closure.

Results: For all scenarios explored, closing schools resulted in substantially higher net costs than not closing schools. For R_0 = 1.2, 1.6, and 2.0 epidemics, closing schools for 8 weeks would have resulted in median net costs of $21.0 billion (95% Range: $8.0 - $45.3 billion). The median cost per influenza case averted would have been $14,185 ($5,423 - $30,565) for R_0 = 1.2, $25,253 ($9,501 - $53,461) for R_0 = 1.6, and $23,483 ($8,870 - $50,926) for R_0 = 2.0.

Conclusions: Our study suggests that closing schools during the 2009 H1N1 epidemic could have resulted in substantial costs to society as the potential costs of lost productivity and childcare could have far outweighed the cost savings in preventing influenza cases.

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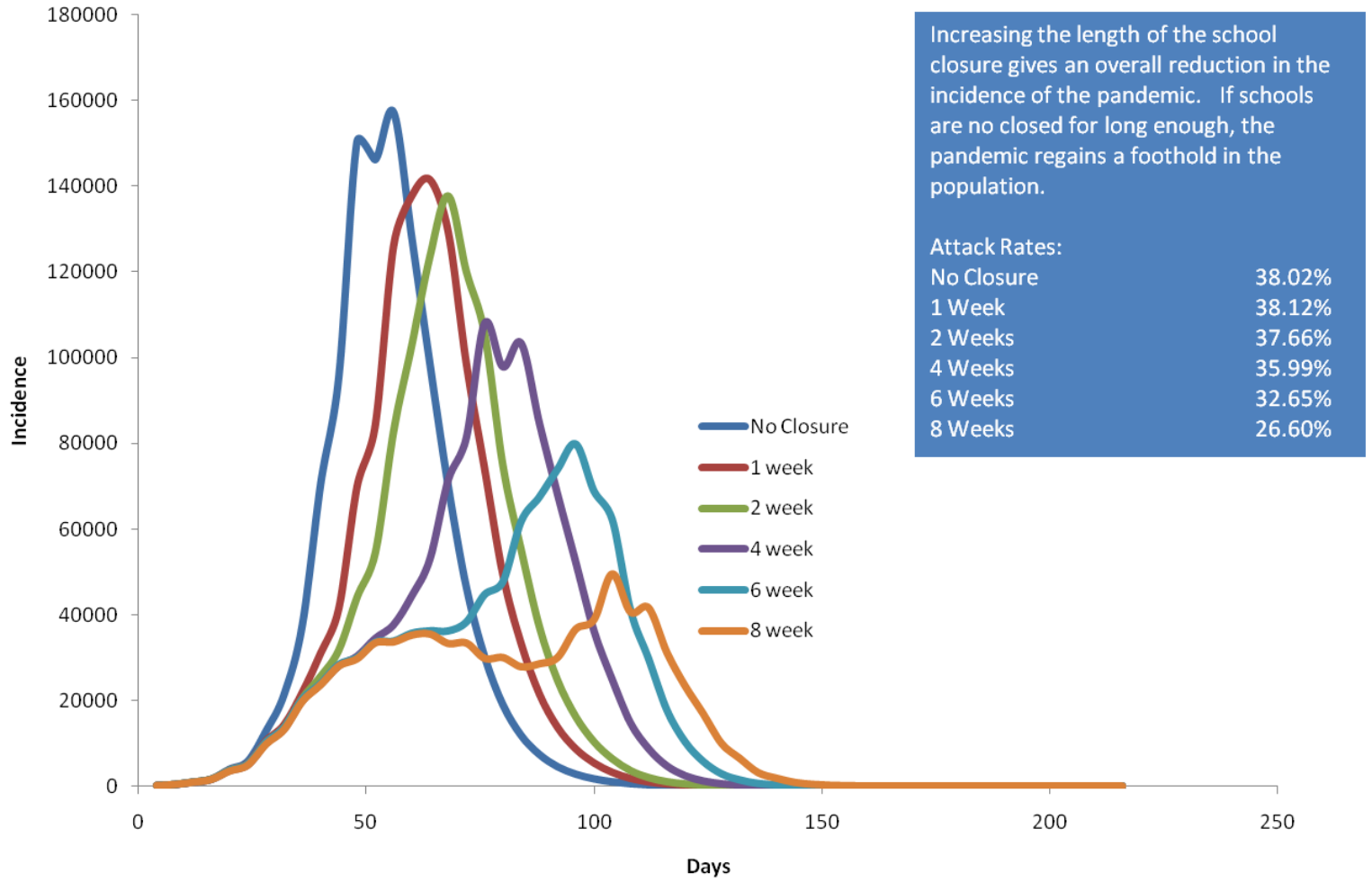
Individual School Closures of Varied Length for the State of Pennsylvannia During an Influenza Pandemic of R0 = 1.7



Increasing the length of the school closure gives an overall reduction in the incidence of the pandemic. If schools are no closed for long enough, the pandemic regains a foothold in the population.

Attack Rates:	
No Closure	38.02%
1 Week	38.12%
2 Weeks	37.66%
4 Weeks	35.99%
6 Weeks	32.65%
8 Weeks	26.60%

Economic Impact of School Closure

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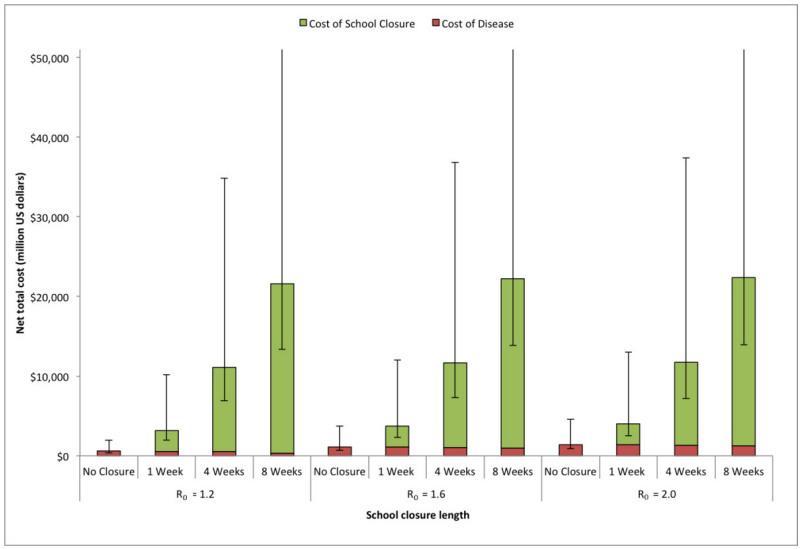


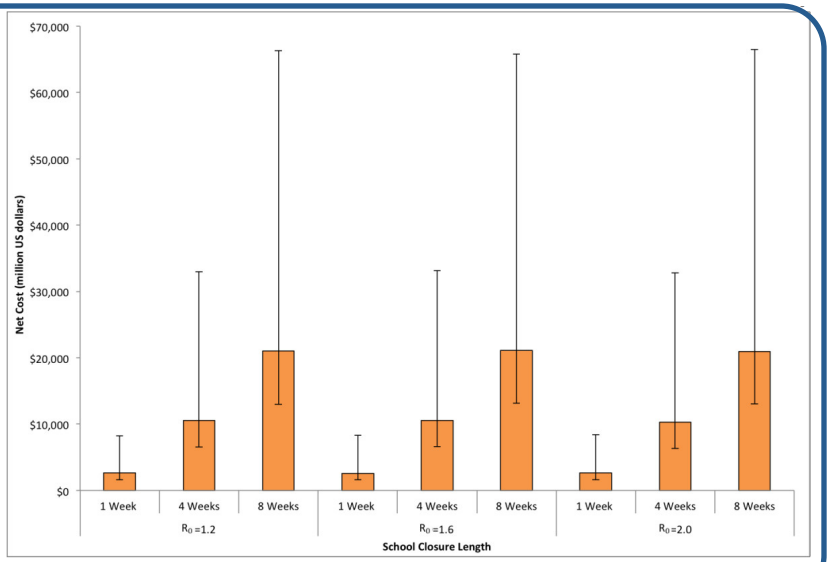
Estimated total overall costs for school closure policies of varying length for the three R_0's explored in the state of Pennsylvania. Error bars give the 5% and 95% distributions.

Total Cost Estimates of Disease and School Closure

$$\text{Cost}_{\text{Disease}} = \text{Cost}_{\text{Influenza - attributable Absenteeism}} + \text{Cost}_{\text{Influenza - attributable Mortality}} + \text{Cost}_{\text{Influenza - attributable Health Care Costs}}$$

$$\text{Cost}_{\text{School Closure}} = \text{Cost}_{\text{Lost Productivity of Teachers and Educational Professionals}} + \text{Cost}_{\text{Lost Productivity of Parents Affected by School Closure}}$$

$$\text{Net Cost}_{\text{Implementing School Closure Strategy}} = \text{Cost}_{\text{School Closure}} - \text{Cost}_{\text{No school Closure}} = (\text{Cost}_{\text{Disease With School Closure}} + \text{Cost}_{\text{School Closure}}) - \text{Cost}_{\text{Disease Without School Closure}}$$



Median net cost for school closure policies of varying length for the three R_0's explored in the state of Pennsylvania. Error bars give the 5% and 95% distributions.

Assisting Government with H1N1 Planning

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2009 | 2010

University of Pittsburgh Influenza Task Force

Washington, DC

April | May | June | July | Aug | Sept | Oct | Nov | Dec | Jan

ALLEGHENY COUNTY HEALTH DEPARTMENT

pennsylvania DEPARTMENT OF HEALTH

Commenced work with ASPR and PCAST

Bruce Y. Lee, MD, MBA

Shawn Brown, PhD

Continued work with ASPR and DHS

School Closure | Vaccination Strategy | Antiviral Estimates | 3rd Wave Scenarios

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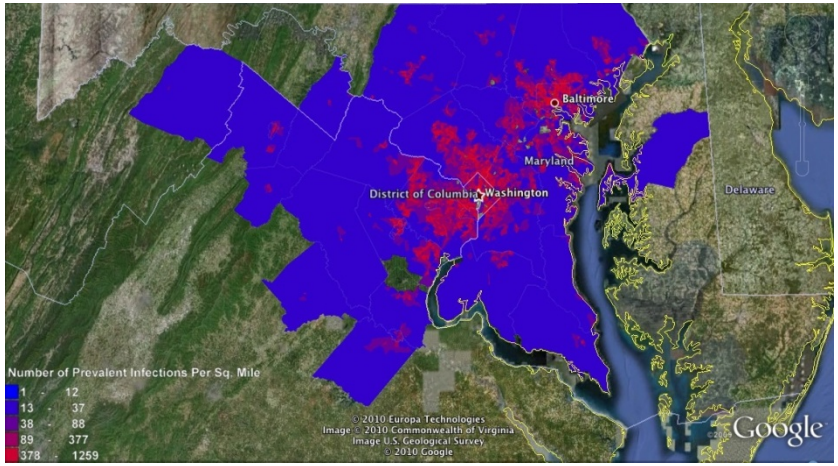
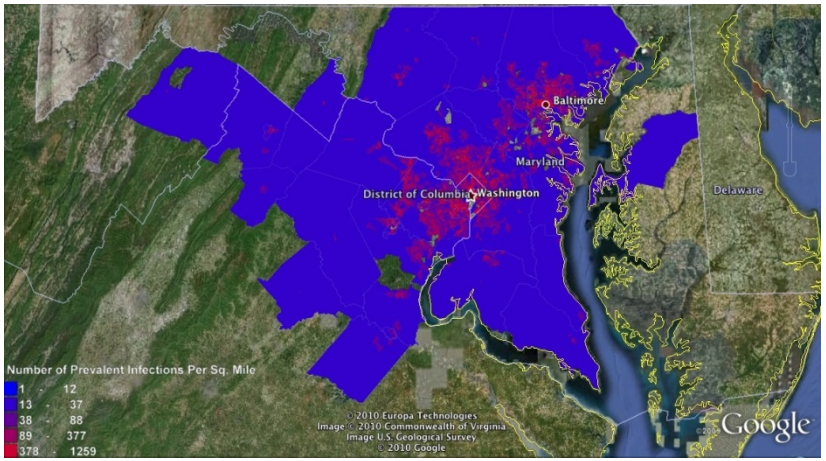
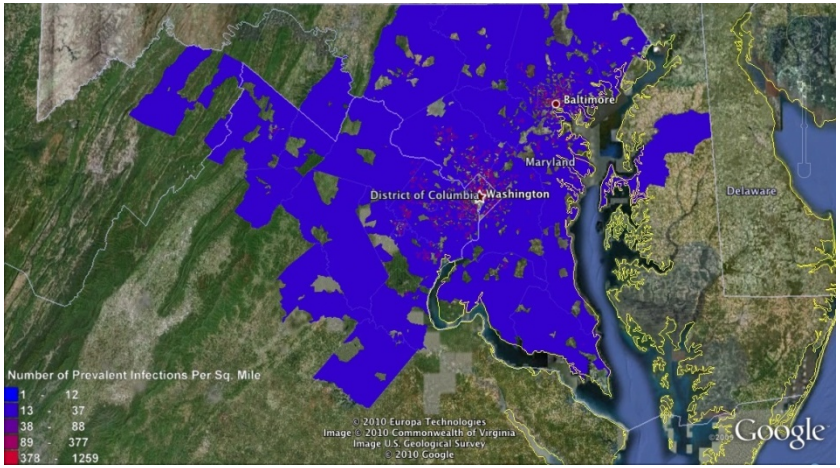
Visualizing the Epidemic Peak in Washington DC -- Four Scenarios



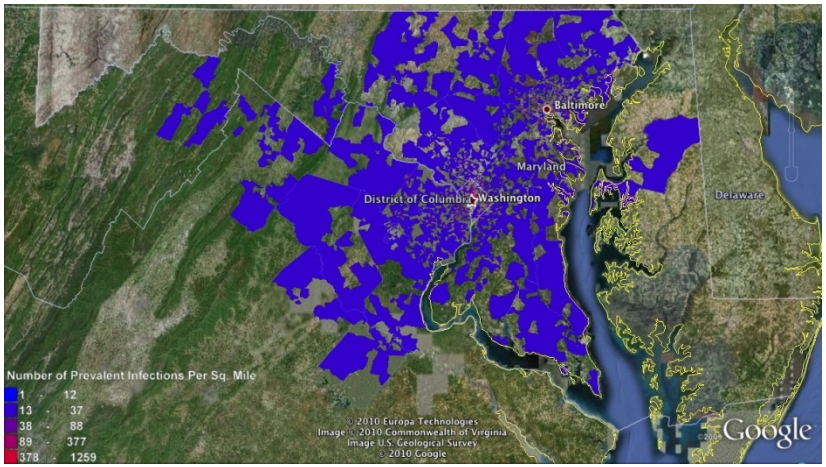
A. 15% serologic attack rate, no mitigation



B. Vaccinate a few weeks before peak



C. Vaccinate a month before the peak



D. Vaccinate a few months before the peak

CLARA – Modeling Dengue

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Dengue

- Mosquito-borne virus
- Tropical and sub-tropical regions
- Worldwide per year:
  2.5 billion people at risk
  500,000 hospitalizations
  2.5% fatality

CLARA – An agent based model

Represents both humans and mosquitoes

Full mosquito lifecycle modeled

Full human community structure

Derek Cummings

Nathan Stone

Distributed Memory Parallelism needed!

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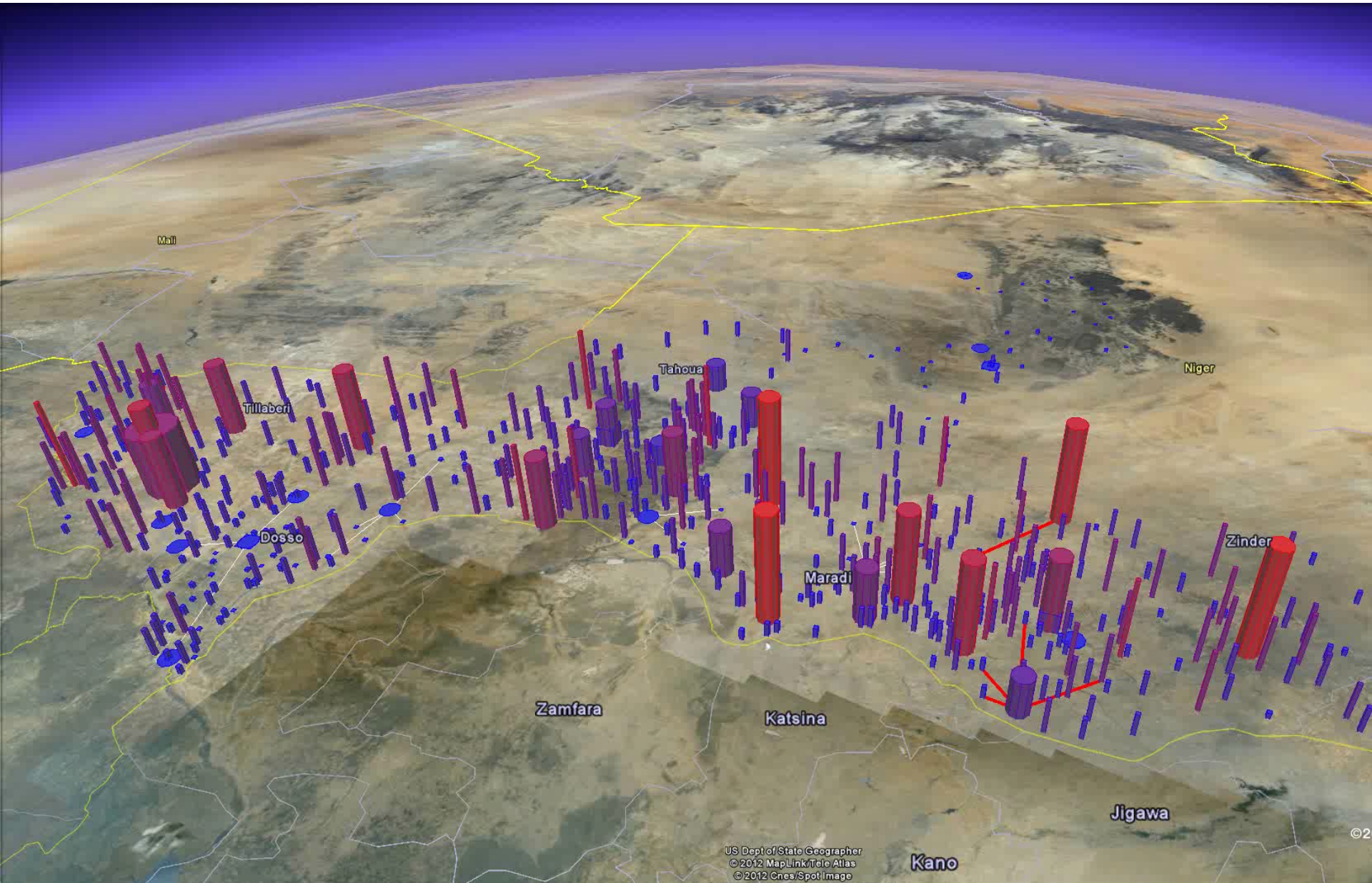
Modeling Vaccine Supply Chains



HERMES VISION

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Data on Supply Chain Structure, Storage Locations, Transport, Capacities, Personnel, etc.

Standard input deck

Create a *freely available* and *user-friendly software tool* for decision makers to generate an *interactive simulation model of any supply chain (= a virtual laboratory)*.

Discrete event simulation model of supply chain

Supply chain performance metrics

Supply chain function costs

OPTIMIZE supply chain costing tool

Economic Metrics

Total Costs

Unit Costs

Cost Drivers

http://vaccinemodeling.org/hermes

HERMES Team

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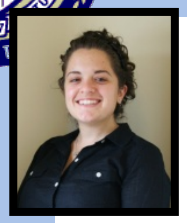

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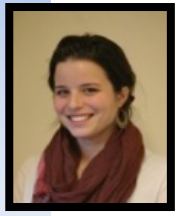

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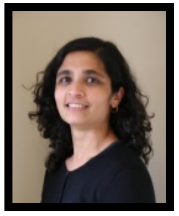

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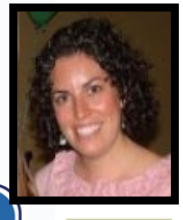

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http://vaccinemodeling.org/hermes

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Niger

- Additional storage and transport requirements for planned vaccine introductions (PCV and Rotavirus)
- Restructuring the suply chain (e.g. removing the regional level)
- Impact of changing from a 10 dose measles vial to a 5, 2 or single dose presentation.

Senegal

- Additional storage and transport requirements for planned vaccine introductions (PCV and Rotavirus)
- Impact of implementation of the moving warehouse transport system in Saint Louis Region
- Restructuring the suply chain (e.g. removing the regional and district levels)
- In-country hands-on training workshop with HERMES tool with OPTMIZE

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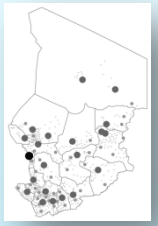
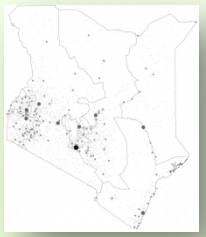
Chad



- Additional storage and transport requirements for planned vaccine introductions (PCV)

Thailand

- Additional storage and transport requirements for planned vaccine introductions (PCV and Rotavirus)
- Impact of changing from 10 dose measles vaccine to single dose

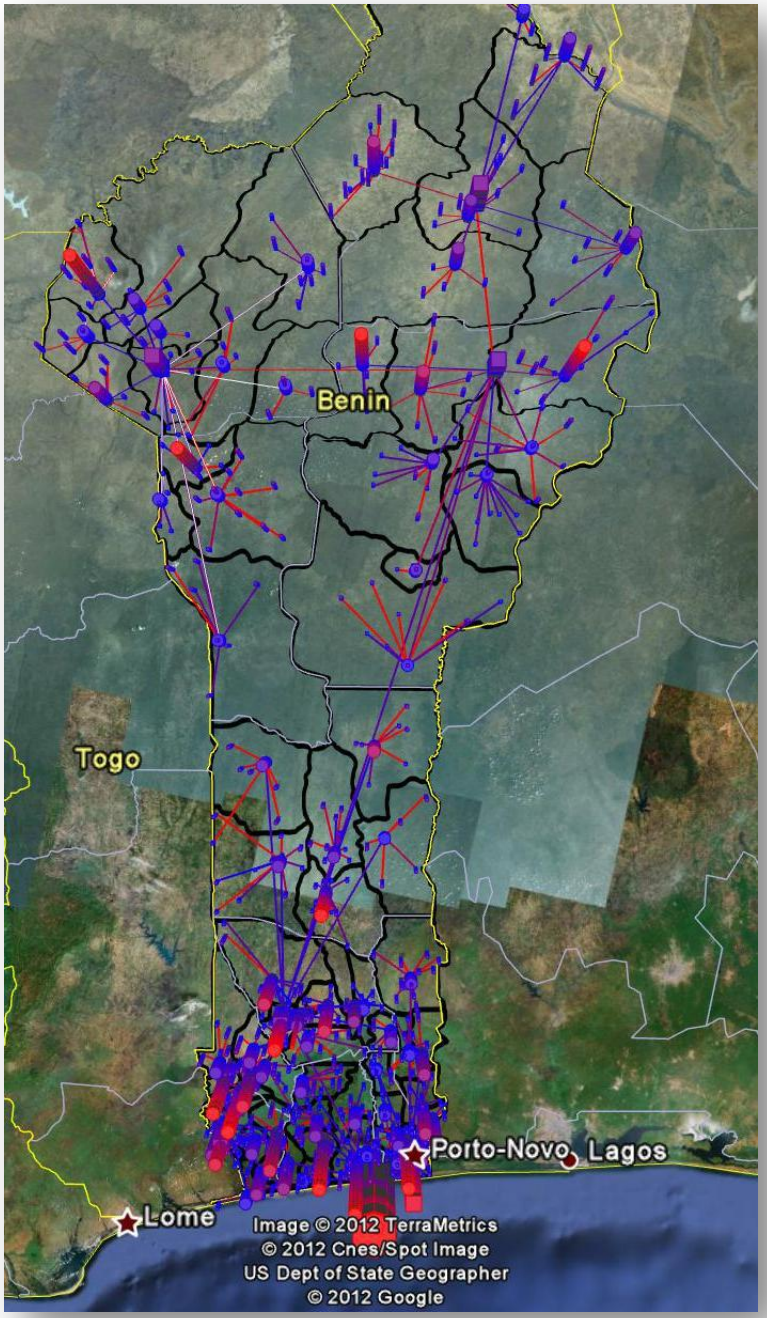


Kenya

- Additional storage and transport requirements for planned vaccine introductions (PCV and Rotavirus)

Vietnam

- Additional storage and transport requirements for planned vaccine introductions (PCV and Rotavirus)
- In-country hands-on training workshop with HERMES tool with OPTMIZE.



Benin

Working with WHO, UNICEF, BMGF, GAVI, PATH, and Transaid to advise the Beninese government on how to improve their supply chain

Not able to introduce needed Rotavirus and Meningococcal vaccines due to constraints in the current supply chain.

Coping, ad hoc transport to compensate for bottlenecks.

Workshop in September to develop recommendations for improving performance.

Government decided to pursue a consolidation of the Commune Level to a Zone Sanitaire.

VECNet – Providing Cyberinfrastructure for the Eradication of Malaria

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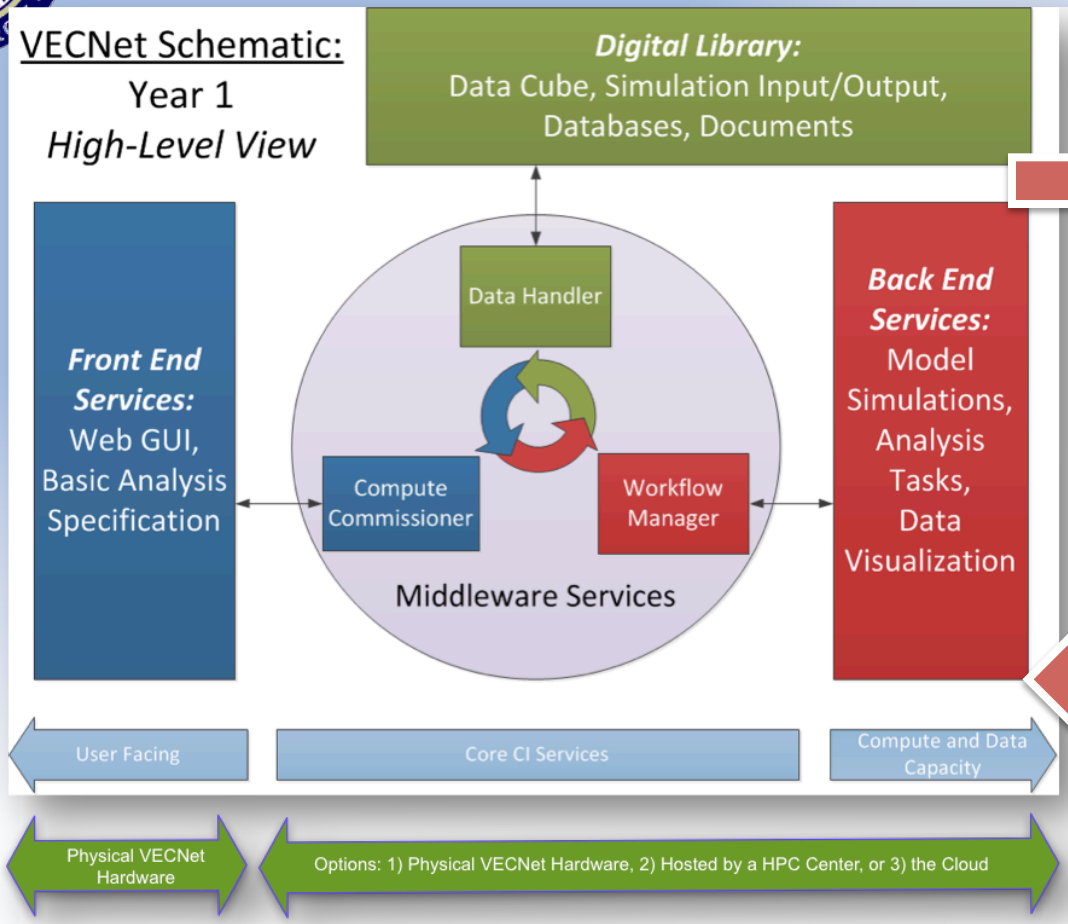

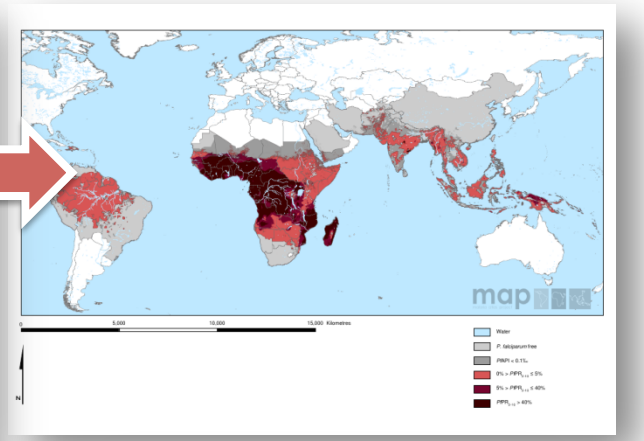

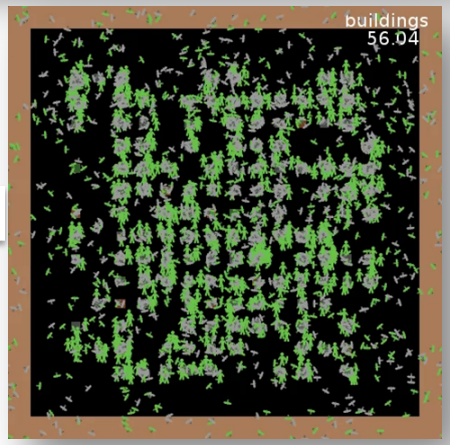

http://www.vecnet.org

VECNet

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PSC · INTELLECTUAL VENTURES · JAMES COOK UNIVERSITY AUSTRALIA · R. Farlow Consulting, LLC · Swiss TPH · University of Oxford · University of Notre Dame · University of Pittsburgh

Apollo: Providing Standard Webservice Infrastructure for Decision Making

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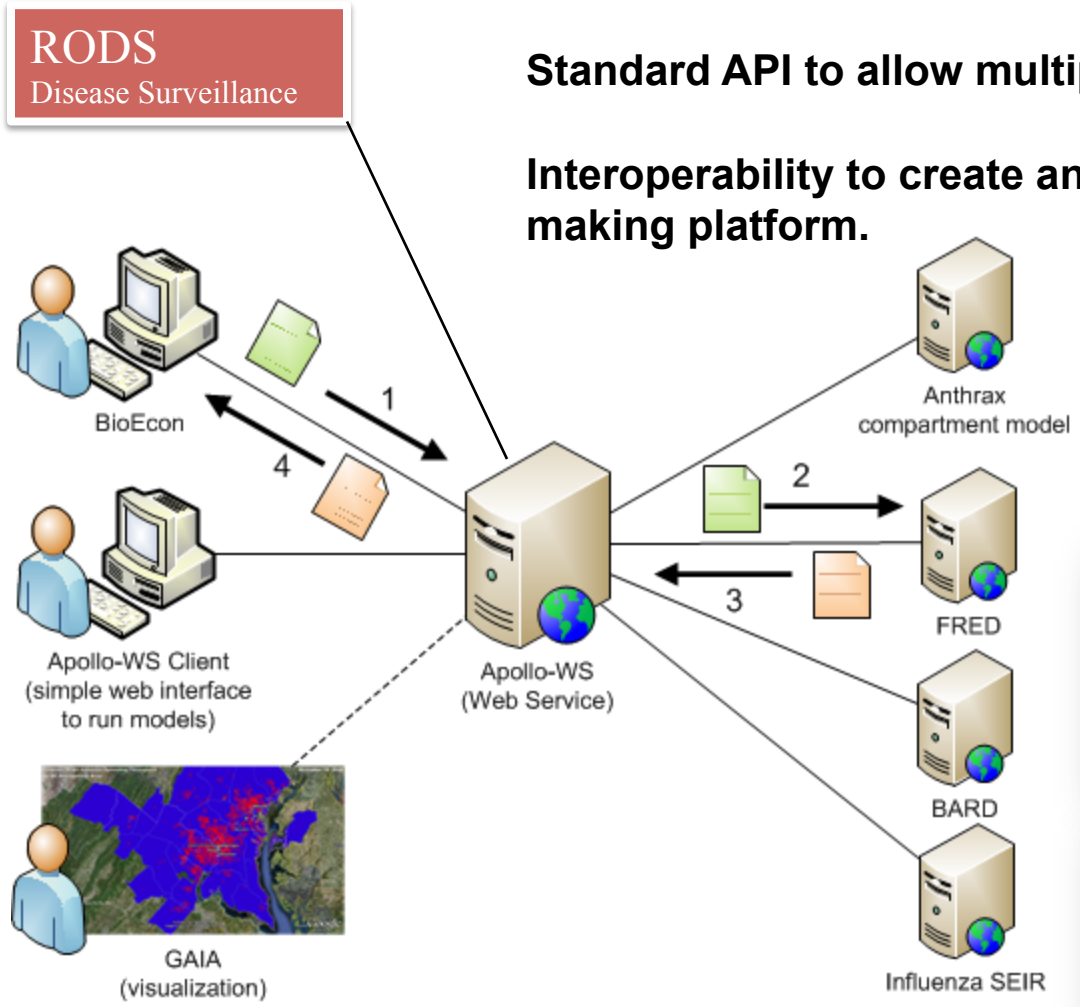
Creating an ontology for computational epidemiology

Standard API to allow multiple tools to connect

Interoperability to create an end-to-end decision making platform.

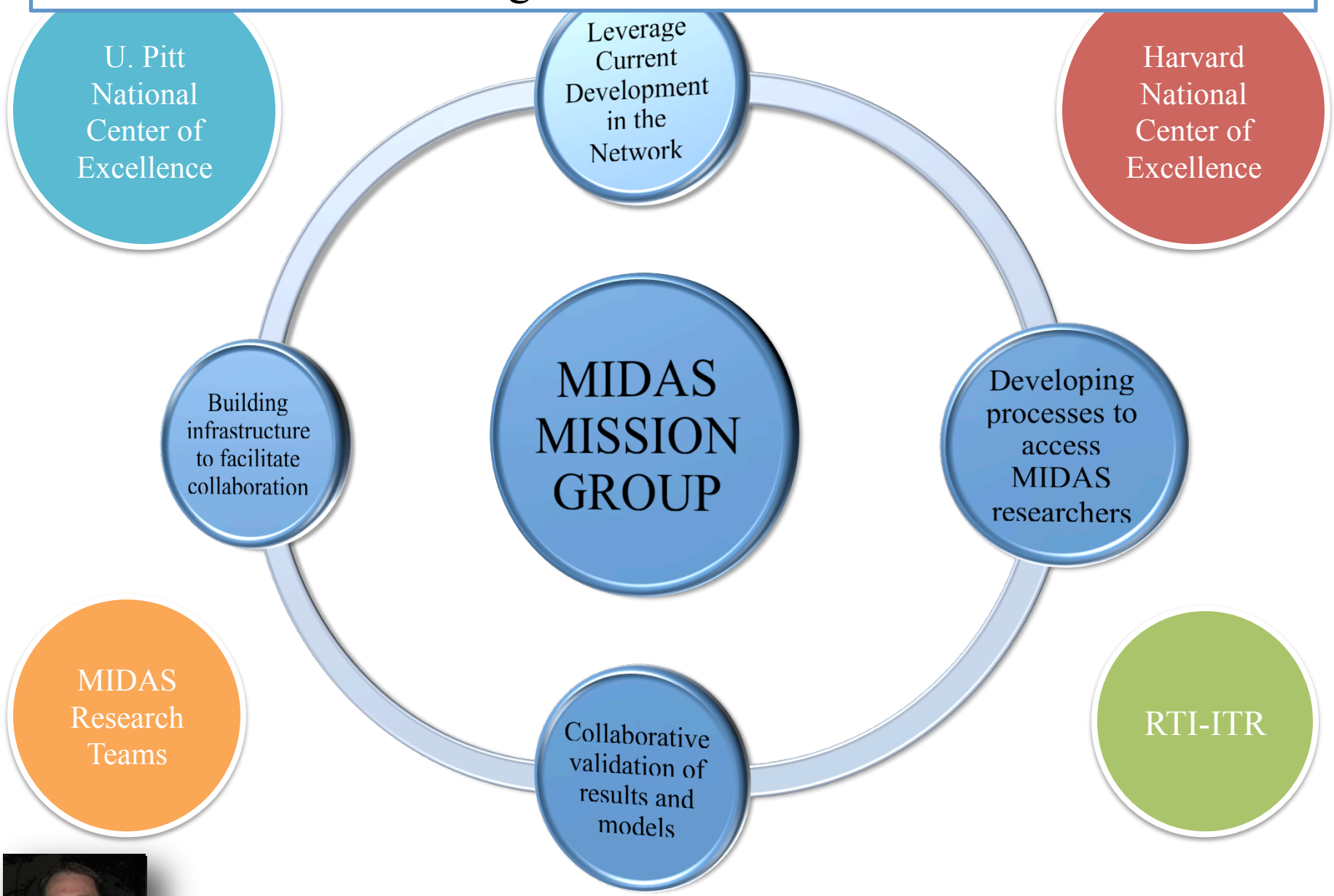


Michael Wagner

William Hogan

http://code.google.com/p/apollo/

MIDAS Software Sharing and Information Outreach Network

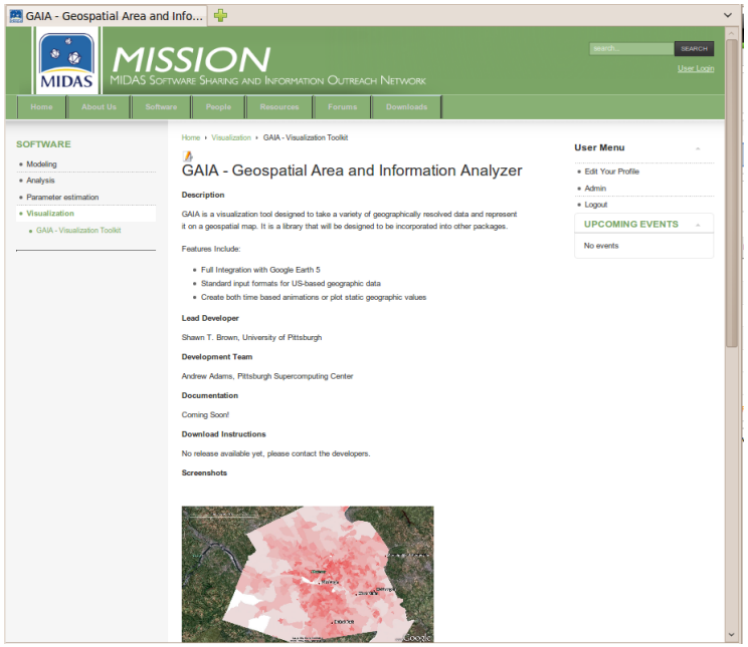


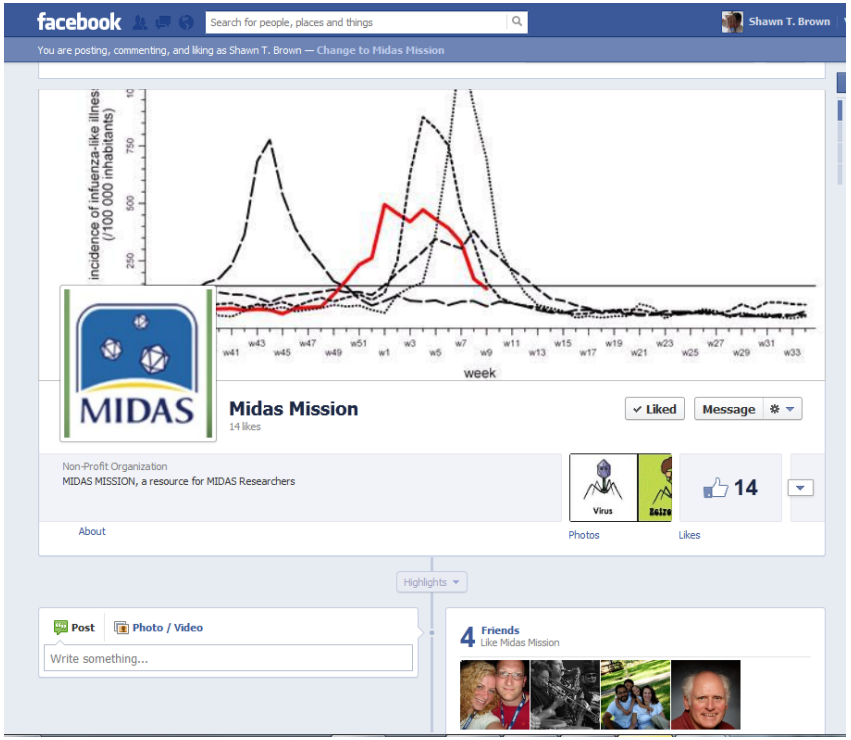
Thomas Maiden

MISSION Site

MIDAS National Center of Excellence

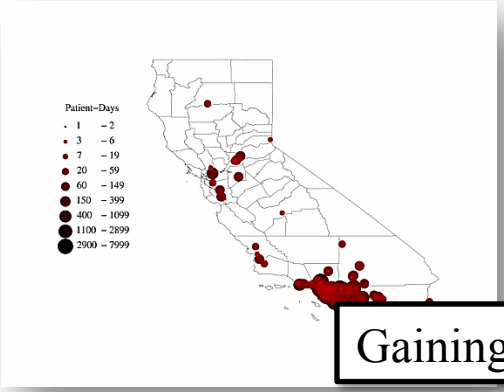
MIDAS Software Sharing and Information Outreach Network
http://mission.midas.psc.edu



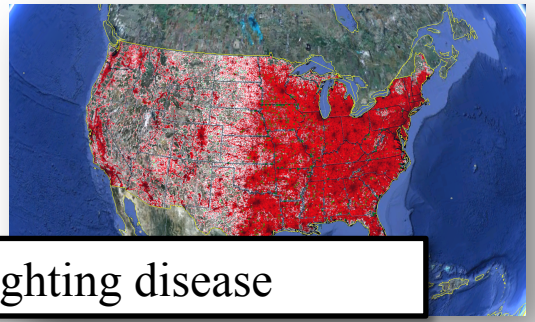


Deb Nigra

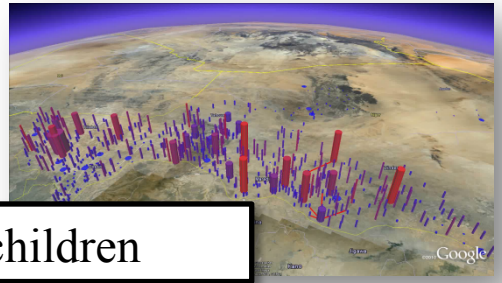
The University of Pittsburgh MIDAS COE Computational Core supports…



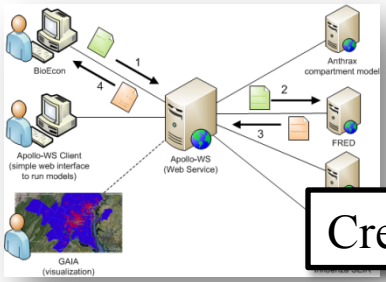
Gaining understanding through visualization



Preparing for pandemics and fighting disease



Getting needed vaccines to children



Creating communities through cyberinfrastructure and technology

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