# Orientation &
# Selected Guest Lecture Models

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MIT 15.879

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# 15.879 Focus this Term: Agent-Based Models for Public Health

- Purpose of models
- Model strength & limitations
- Diversity of classes of models available
- How models are built, refined & analyzed
- Model tradeoffs & complementarity with classic stock & flow models
- Software & analytic tools for working with models
- How models mesh with traditional techniques
  - Linkage databases
  - Real-time data collection (EMA)
  - Biostatistics

# Goals of Class

- To expose participants to basics of building agent-based models (ABMs) in AnyLogic
- To convey a sense as to the capabilities, strengths and weaknesses of agent-based modeling
- To train AnyLogic users so that they are comfortable running, understanding many elements of, and performing small modifications on ABMs
- To provide aspiring modelers with hands-on familiarity with the capabilities & functions of AnyLogic and sufficient exposure to Java programming to navigate within models
- To help create informed consumers of Agent-based models

# Non-Goals of the Class

- To serve as a comprehensive survey of Agent-Based modeling
- To give a thorough conceptual or theoretic framework for understanding and analyzing Agent-Based Models
- To review the tradeoffs between AnyLogic & other ABM platforms
- To create a set of fully proficient Agent-Based modelers
- To render participants into Java programmers
- To sell participants on the superiority of AnyLogic, or the desirability of buying AnyLogic licenses

# Anticipated Class Coverage

- Motivations
- System science concepts
- Qualitative sketching of ABM
- Agent dynamics
- Inter-agent interaction
- Hybrid modeling
- Agent environments
  - Irregular topologies (networks)
  - Regular (e.g. CA)
  - Irregular geometries
- Debugging
- Best practices in model building
- Understanding Individual-based & aggregate differences

# Class Coverage Cont'd

- Modeling process
  - Scoping
  - Formulation
  - Parameterization
  - Calibration
  - Validation & Confidence building
  - Model analysis tools & techniques

# Class will Be…

- Interactive & Informal
- Adapted to student interests
- Project based
- Demanding
- Highly interdisciplinary
  - Aimed for accessibility to diverse audience
  - Some material presented in additional sessions for certain backgrounds
  - Required: Patience in dealing with diverse peers

# This Class is Not for Everyone

- The class will be demanding in different ways from different people
  - Health Sciences: A willingness to take on quantitative & computer challenges, and to acquire new skills and approaches
  - Computer Science:  Patience with challenges of modeling real-world phenomena, and understanding textured health science concepts, terminology & aspects of public health practice.
- The skills learned in the class have broad applicability, but here have a domain focus
- We encourage students not convinced of their desire to confront challenges to look elsewhere

# Class Diversity

- Our class is expected to be diverse in many ways
  - Students/Faculty observers
  - Student backgrounds in Health Science & STEM
  - Participant interests
- The instructor will make efforts to address diverse backgrounds & interests
- Please
  - Be respectful of those from all backgrounds
  - Recognize need to re-hear things you know

# Extra Resources for Students

- Office hours
- Focused tutorials (upon student agreement)
  - Extra background & context
  - More advanced material (upon student interest)

# What is Expected of Students

- Attendance & Participation
- Modeling exercises
- Project
  - With instructor guidance
  - Interdisciplinary teams required
- End-of-Term Presentation

# Administrative Info

- Office Hours: Wed 10-11am (E62-436) & by appointment
  - Especially important b/c of diversity of backgrounds & limited time
- Course website in STELLAR at either

  https://stellar.mit.edu/S/course/15/sp12/15.879/

  or

  http://tinyurl.com/MIT15879

# Project Information

- Project can be
  - Modeling application (in area for which data is readily available)
  - Methodological study
- Instructor can help facilitate
- Meet early with the instructor (after return) to discuss progress
- Staged deliverables
- Where possible, we suggest inter-disciplinary, multi-person projects

# Project Phases

| Phase | Description | Date |
|---|---|---|
| 1 | Informal description of area in which you'd like to work for your model, resources you may use. | Mar 9 |
| 2 | Informal estimate of scope of model to be implemented. Further details on any data sources planned for use. Identification of major properties/attributes for agents and major modes of agent interaction | Mar 22 |
| 3 | Discussion of agent interaction. Preliminary descriptions of scenarios & sensitivity analyses that you plan to investigate. | Apr 12 |
| 4 | Final report | May 17 |

# Possible Project Ideas

| Area | Description | Contact/Stakeholder |
|---|---|---|
| **Chronic Disease** | Osteoarthritis through the continuum of care, drawing from existing populated aggregate stock & flow model. Agent based and possible discrete event extensions | Deborah Marshall, University of Calgary damarsha@ucalgary.ca |
| | Interaction of Gestational & Type 2 Diabetes | See instructor |
| **Zoonoses** | Stray Dogs (Rabies as important illness of concern) | Gustavo Monti Universidad de Chile gustavomonti@uach.cl |
| | Leptospirosis | |
| | Bovine Tuberculosis | |
| | Chronic Wasting Disease (Mule Deer focus, extension to exiting model) | Cheryl Waldner University of Sask. cheryl.waldner@usask.ca |
| | Animal Human Interface | Iqbal Jamal AMC Consulting iqbaljamal@aqlmc.com |
| | Animal Health/Supply Chain | |
| **Transportation** | Patterns of Home-To-Work Travel behavior: Reproducing observed US patterns | Asim Zia, Univ. of Vermont Asim.Zia@uvm.edu |

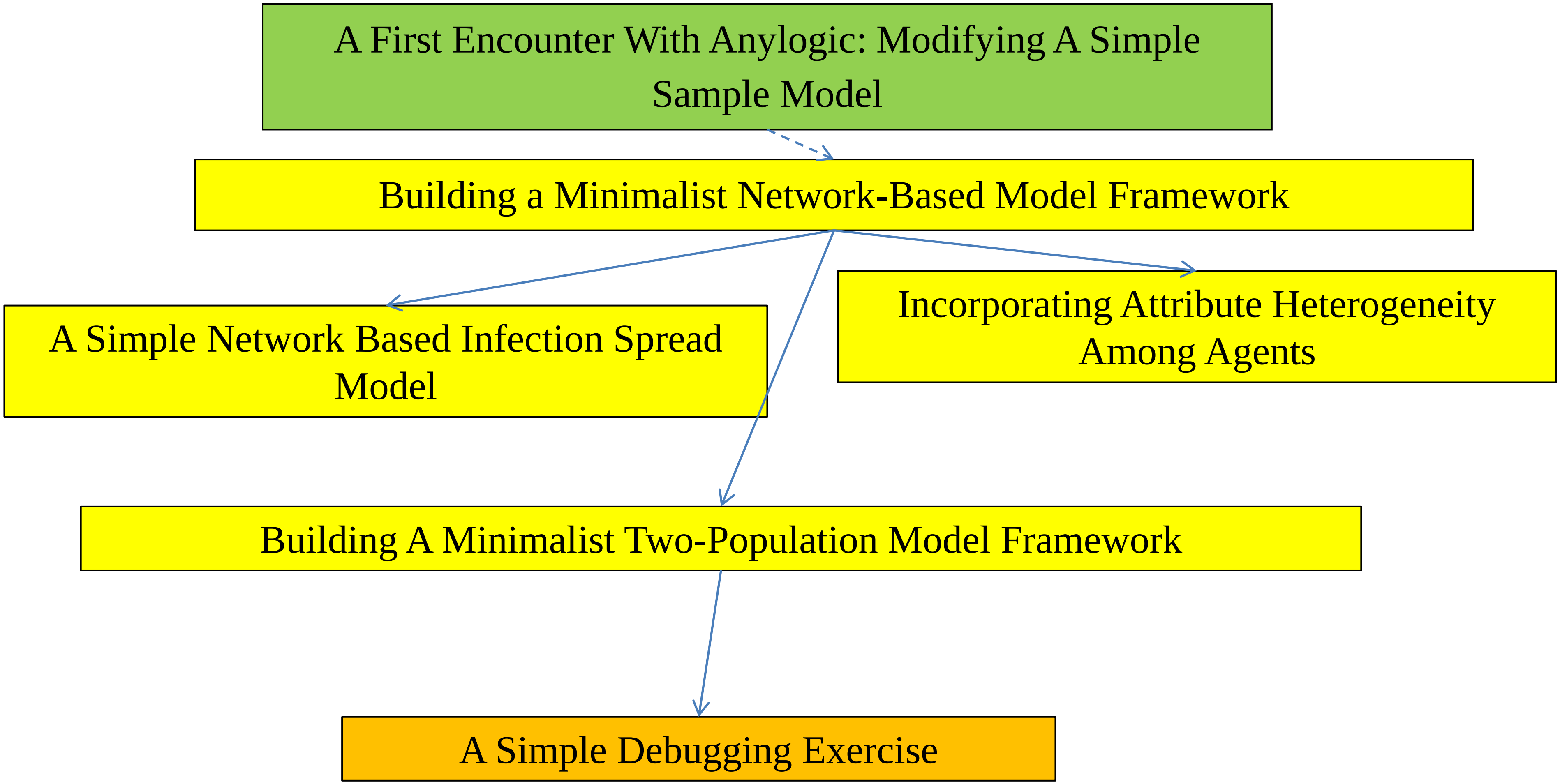
# Course Schedule

- Due to instructor time travel constraints, the course schedule will have some gaps
  - Despite  gaps, 3-hour Wednesday & Friday class times will provide a full-length course
  - Biggest gaps in schedule
    - February 9-28 (starting tomorrow!)
    - April 16-20
- Not all weeks will contain both Wednesday & Friday sessions
- **Please check your schedule before coming to class**

# Tasks for the Next 2-3 Weeks

- AnyLogic
  - Download
  - Install
  - Request permanent key
  - Active using permanent key
- Investigate projects of interest (awaiting my return for finalization, if required)
- Complete Problem Set 1
  - A First Encounter With Anylogic: Modifying A Simple Sample Model
  - Building a Minimalist Network-Based Model Framework

# Exercises: Available Now




## Legend

**Strength of Prerequisite Relationships**

**Recommended** **Required**

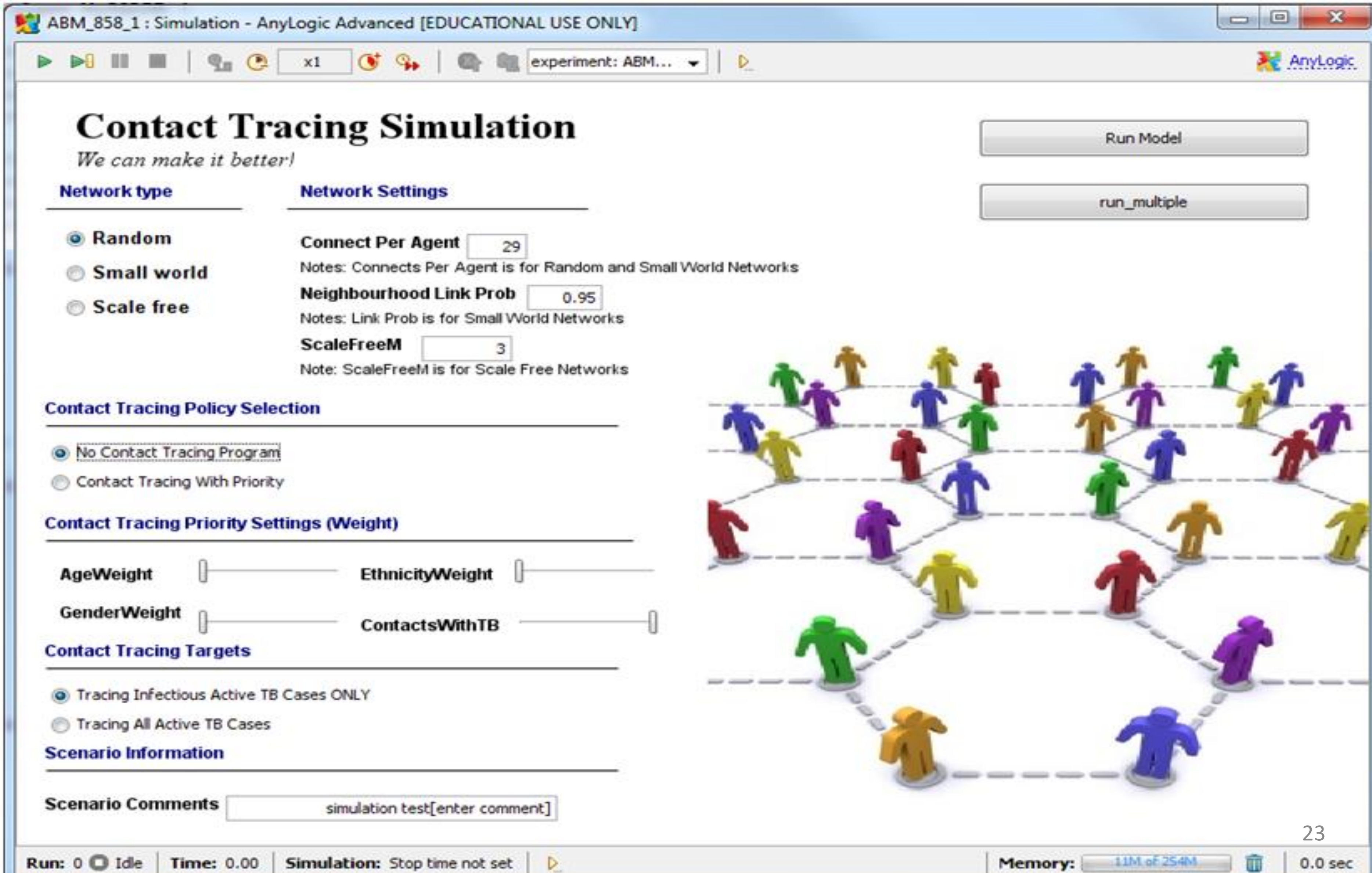
**Target Skill Level**

Introductory Basic Intermediate

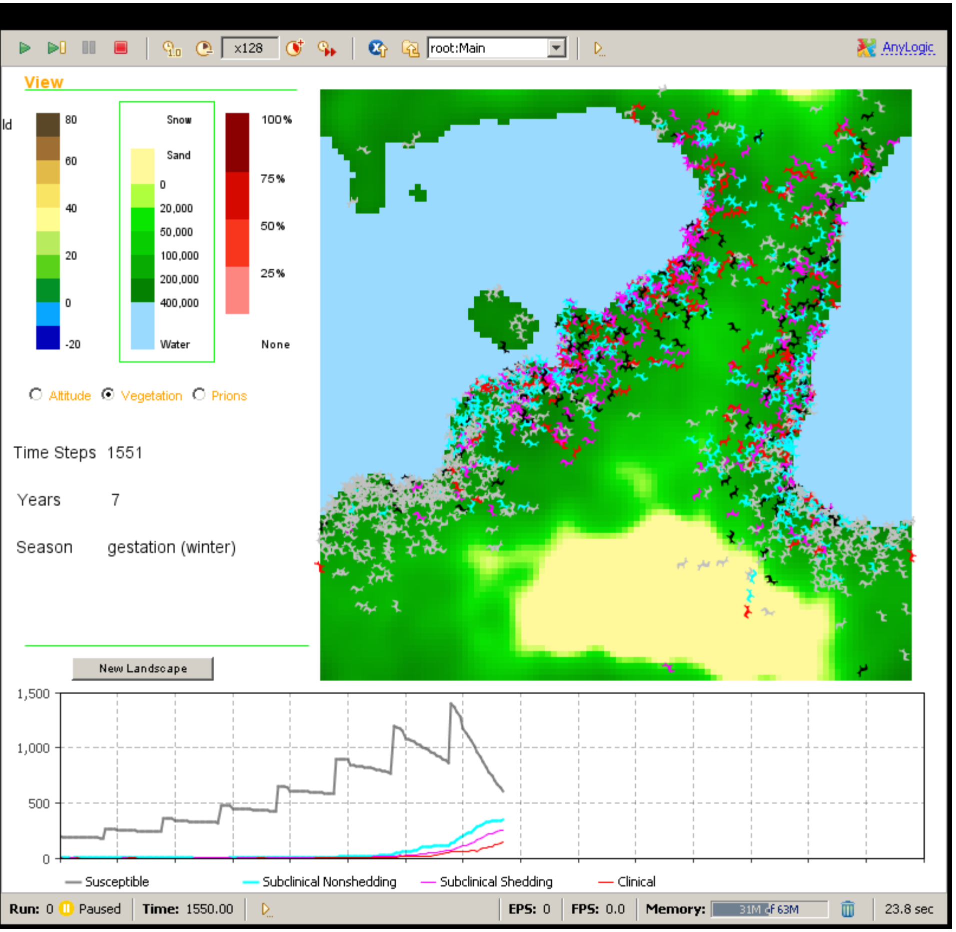
# Some Featured "Real-World" Models

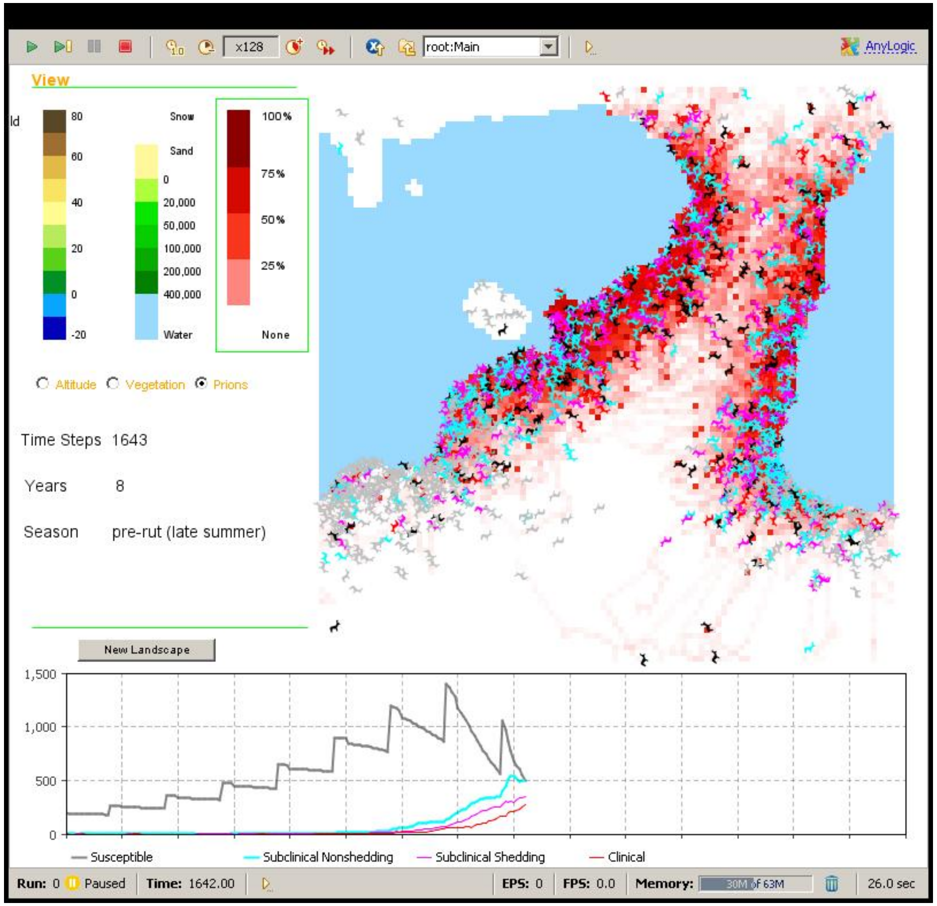
- TB
- CWD
- ESRD
- Treatment Prioritization
- ABMs for Evaluating Reliability of Statistical Inference
- HPV & Smoking
- Immuno-Epidemiology of H1N1 influenza
- Influenza-like illness & smartphone-based microcontact location-data

# Tuberculosis Spread, Prevention & Control
## (Earlier Version)

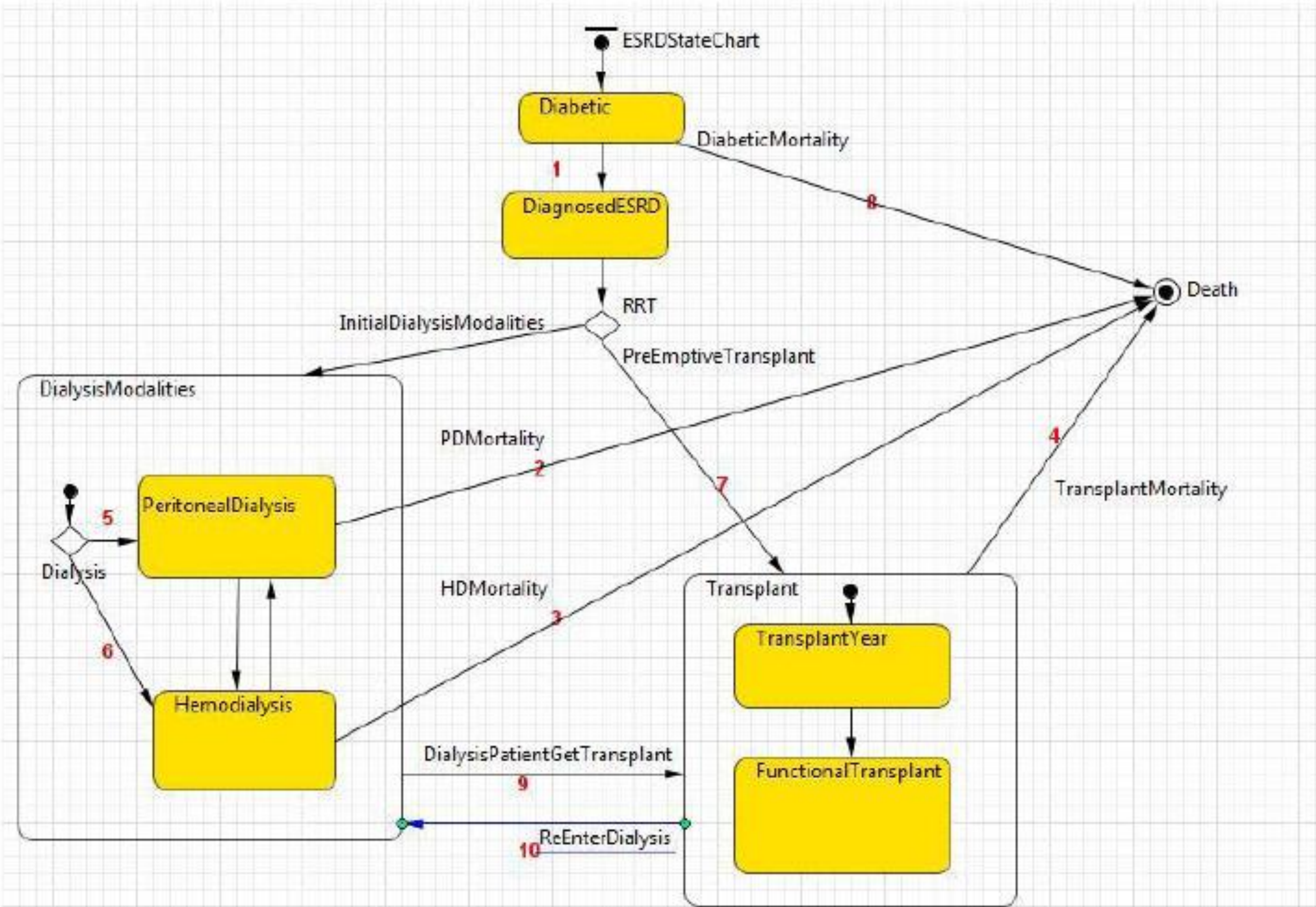


# Chronic Wasting Disease

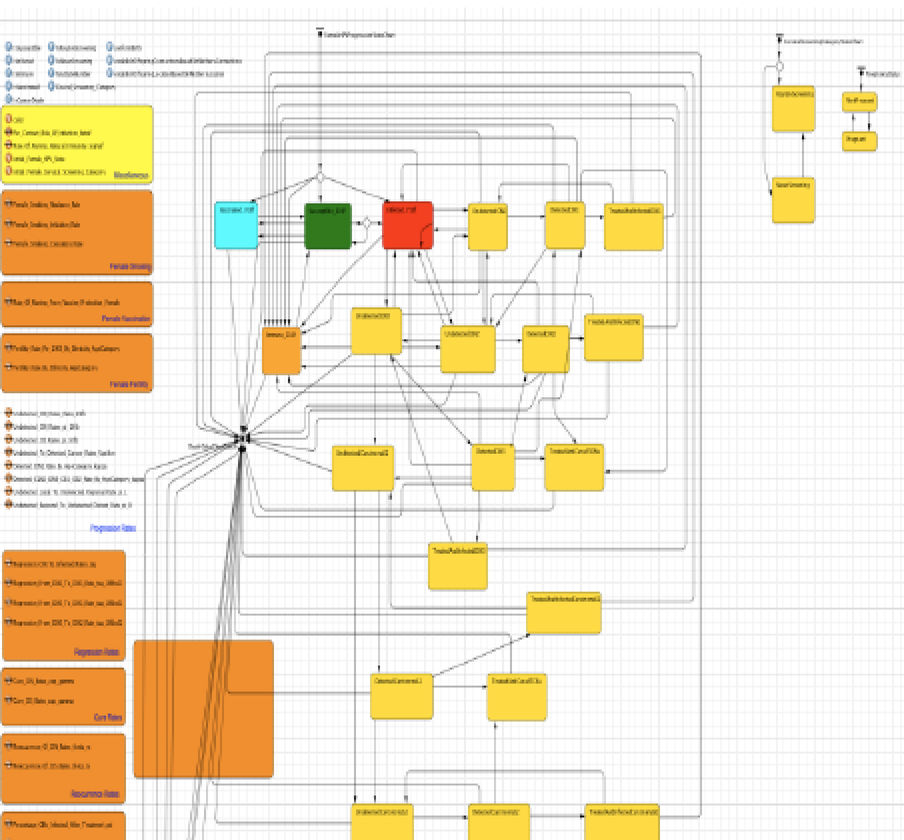


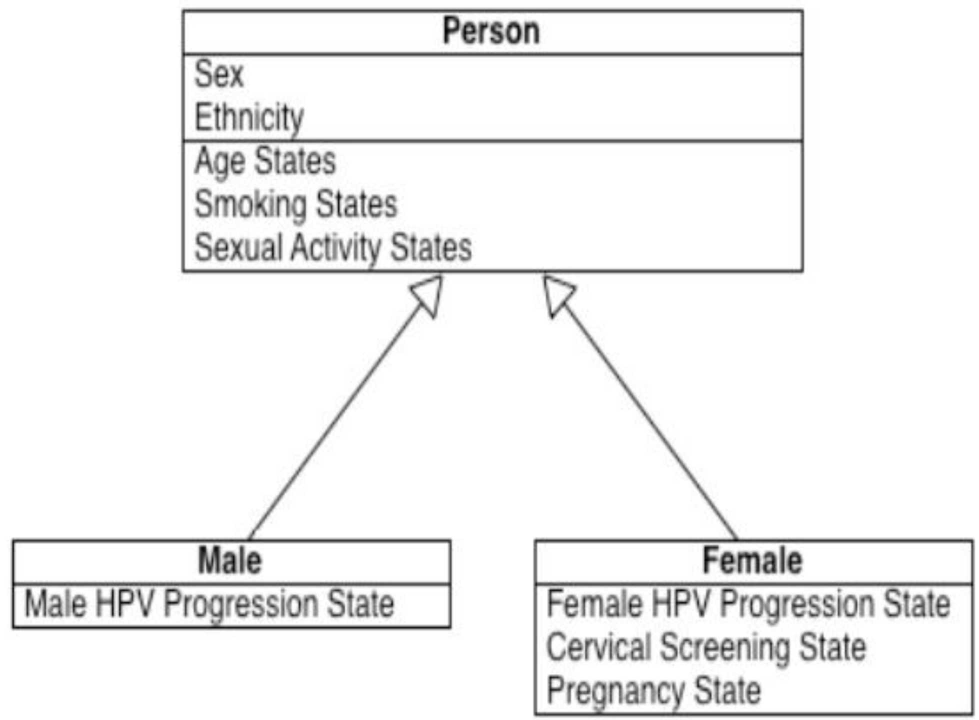



# Health & Cost Implications of Diabetic ESRD



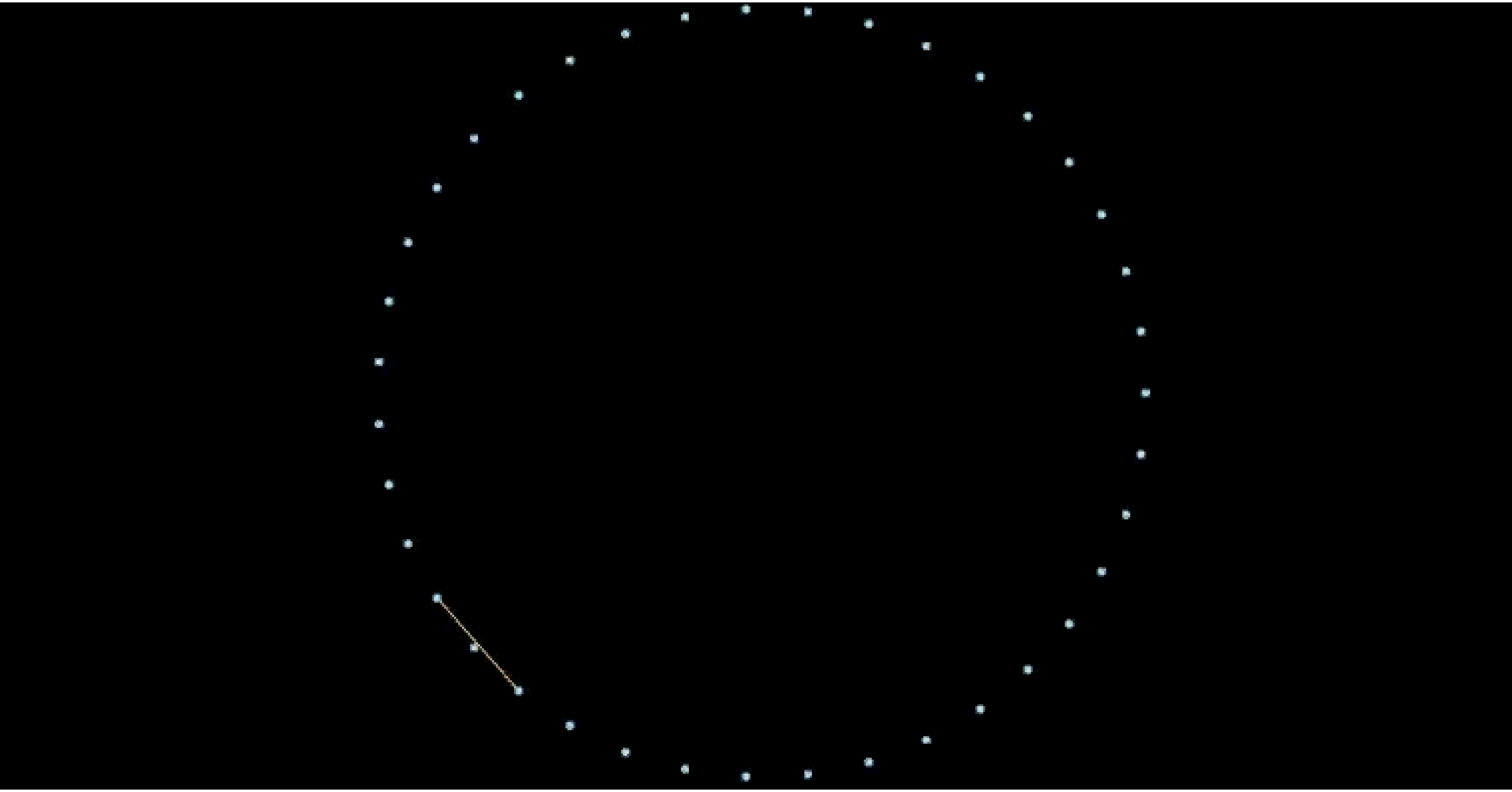
# HPV & Smoking





Person
Sex
Ethnicity
Age States
Smoking States
Sexual Activity States
Male
Male HPV Progression State
Female
Female HPV Progression State
Cervical Screening State
Pregnancy State

# Video: Aggregated Hourly Contact Data



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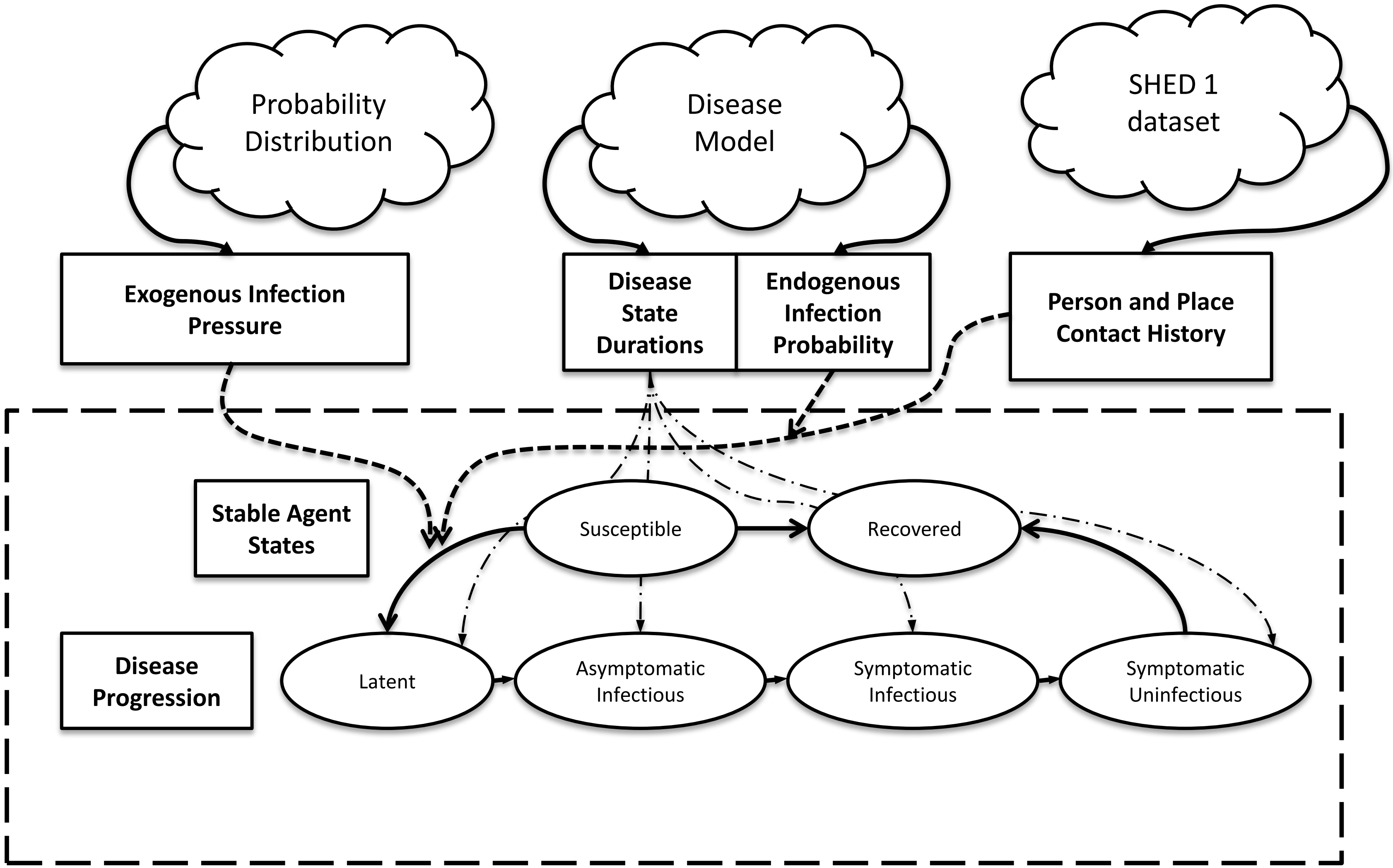
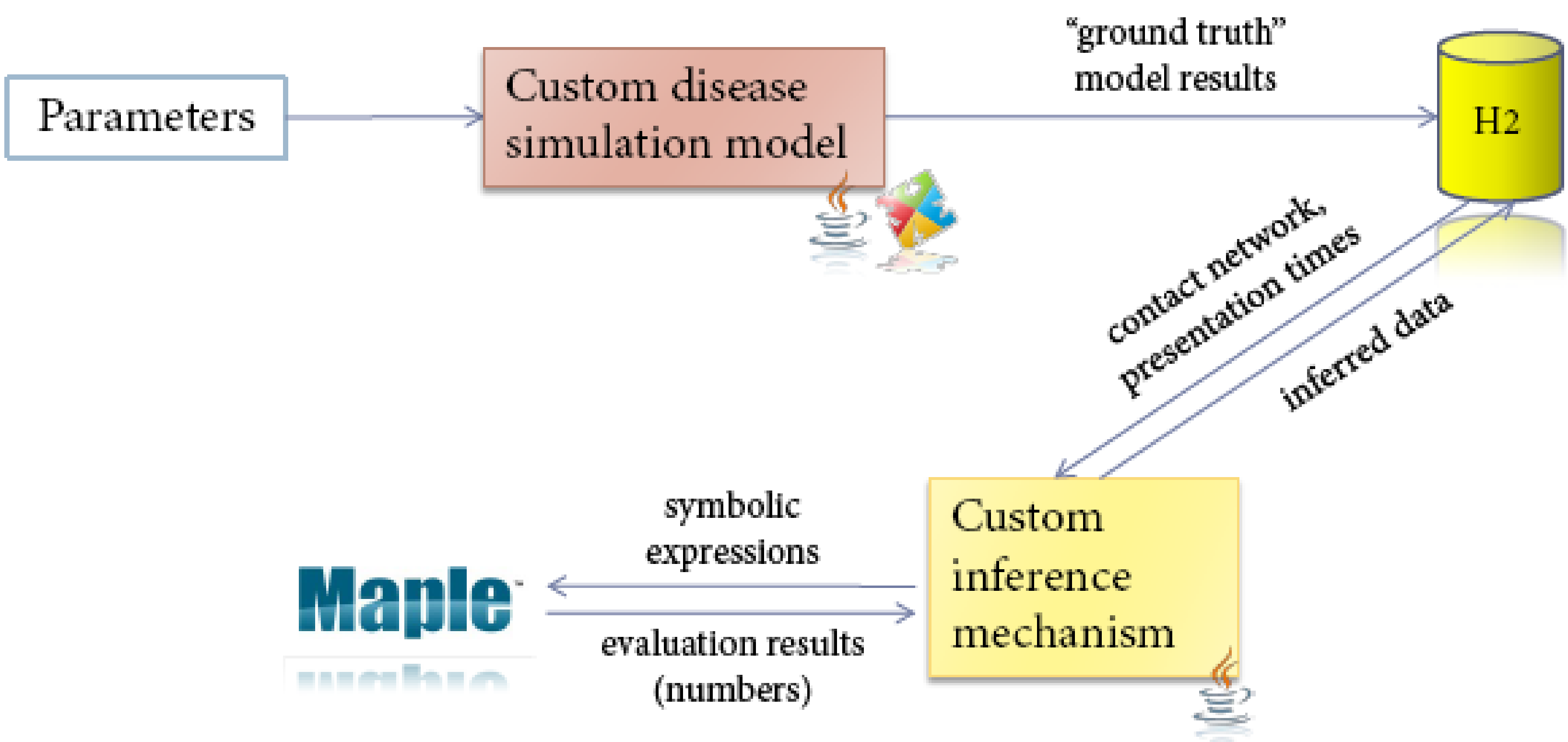


Probability Distribution
Disease Model
SHED 1 dataset
Exogenous Infection Pressure
Disease State Durations
Endogenous Infection Probability
Person and Place Contact History
Stable Agent States
Disease Progression
Susceptible
Recovered
Latent
Asymptomatic Infectious
Symptomatic Infectious
Symptomatic Uninfectious

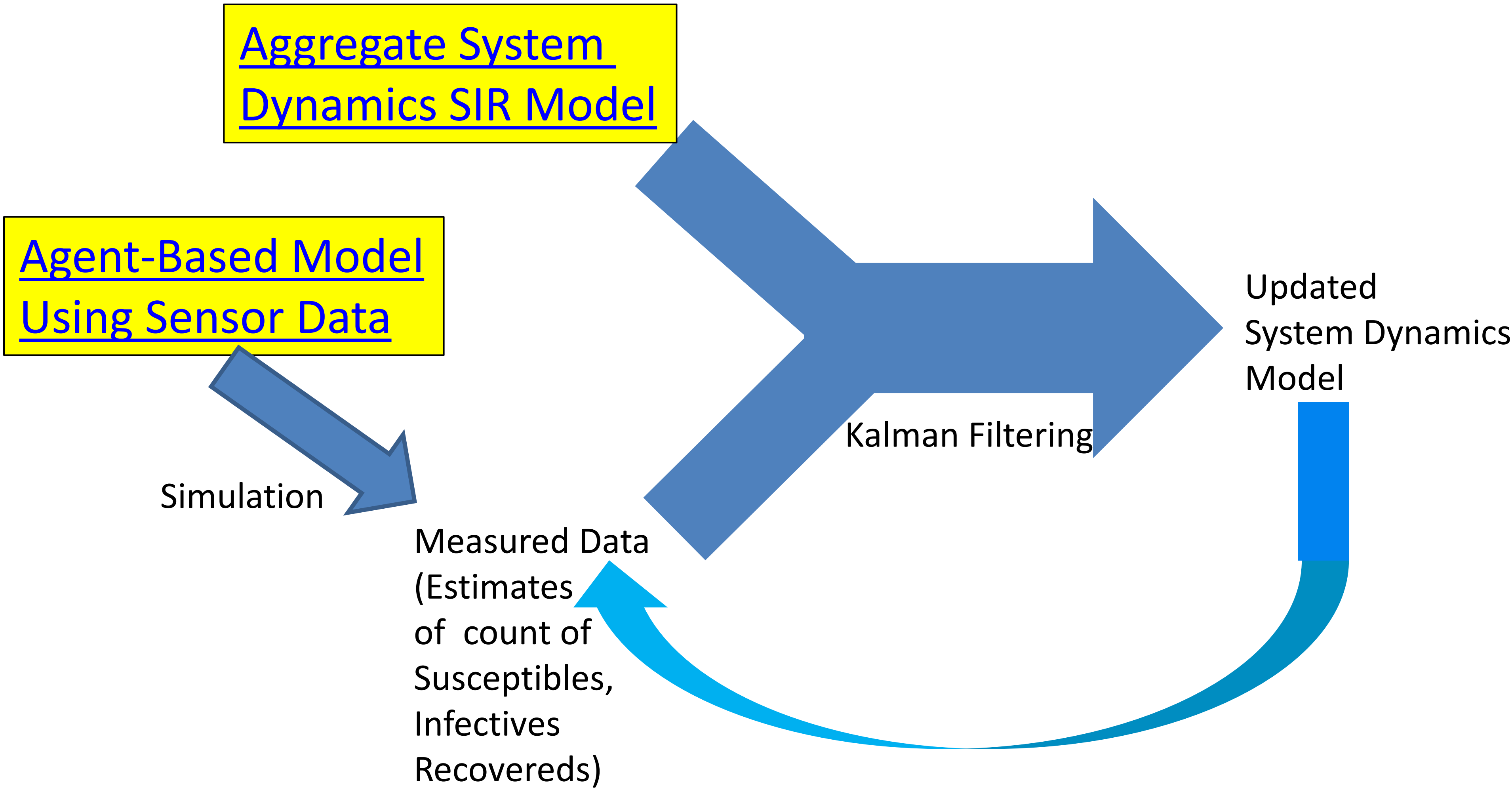
# Synthetic Population Studies

- Establish a “synthetic population” for a “virtual study”
- Perform simulation, simulating study design of interest
  - Actual underlying situation is blinded from researcher
  - Collect data from the synthetic population similar to what would collect in the external world
  - Optionally, may actually simulate roll out and dynamic decision protocols
- Analysis procedures being evaluated are applied to the data from the synthetic population
- We compare the findings from those analysis procedures to the underlying “ground truth” in the simulation model

# Use of Simulation in Evaluation of Statistical Models & Study Design



# Performing the Filtering



# Network Embedded Individuals