Choosing between Modeling Types: Some Heuristics

Nathaniel Osgood

Using Modeling to Prepare for Changing Healthcare Needs
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Contrasting Benefits

Aggregate Models

Frequently, easier
- Construction
- Calibration
- Parameterization
- Understanding *model*

- Formal analysis
- Performance
  - Lower baseline cost
  - Population size invariance
- Less pronounced stochastics
  - Less frequent need for Monte Carlo ensembles
- More accessible skillset
- Quicker construction, runtime ⇒More time for understanding, refinement

Individual-Based Models

- Representation of situated decision-making, learning
- Stronger support for highly targeted policy planning
- Ability to calibrate to & validate off of longitudinal data
- Improved heterogeneity scability, flexibility, modularity
- Better for examining finer-grained consequences
  - e.g., transfer effects w/i pop.
  - Network spread
- Simpler & more accur. descript. of many causal mechanisms
- Multi-scale & -level modeling
- Capacity to examine different levels of aggregation

Motivations for Individual-Based Modeling

- Need to calibrate against information on **agent history**
- Need to capture **progression** of agents **along multiple pathways** (e.g. co-morbidities)
- Wish to characterize **learning by and/or memory** of agents based on experience, or **strong history dependence** in agents
- Need to capture distinct **localized perception** among agents
- Want to capture **decision making** in light of individual preferences, history, or local circumstance (e.g., spatial position,social network)
- When it is much simpler to **describe behavior at indiv. level**
- Seeking to intervene at points in, change behavior on, explain phenomena over or explain dynamics **across networks**
- Seek to **target distinct interventions for heterogenous categories, spatial/network position** or by individual history, character (e.g., past episodes of care, family history, risk factors)
- Need to **capture impact** of intervention across **many categories**
- Seek **flexibility** in exploring different **heterogeneity dimensions**
- **Stakeholders seek** to engage, visualize w/individual-based repres.
- Want to describe behaviour at **multiple scales/levels**
- We care about **stochastics/uncertainty** caused by indiv variabilit

Motivations for Aggregate-Based Modeling

- Characterizing evolution of system elements that are continous or lacking clear individual character (e.g., water) or that are highly interchangeable (e.g., doses of vaccine)
- Behavior for different subgroups **differs only in degree**
- Focusing on **changing mental models** of stakeholders
- Need to **execute quickly** (e.g. for user interaction)
- Understand/describe system behaviour across **all possible values for parameters**
- Seeking to mathematically **analyze the model** (e.g., to determine location or stability of equilibria) for insight
- To determine shape of **all possible trajectories**
- Want to **use mathematical tools** to identify high-leverage parameters, optimal policies or predictor-corrector methods
- **Desire of stakeholders** to work at higher level
- Lack recourse to **software engineering knowledge**
- **Lack of perceived relevance** of network structure/
- individual-level behaviour/Individual-level data

Motivations for Discrete Event Modeling

- When there is a defined workflow (linear or non-linear), involving several stages of processing
- When what is being operated upon in processes are discrete "things" (patients, cars, widgets, etc.) (as opposed to continuous flows e.g., of chemicals)
- When resources are required to process a given “thing”
- If queues and waiting times are a big concern
- If the primary way in which the “things” interact is through queues and resource avialability
- If there is a need for regular movement on defined paths