

Agent-based and network models

Lecture 06

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Agent-based models (ABM)

Network models

Agent-based models (ABM)

- What are agent-based models

- When to use ABM

- When not to use ABM

- Some examples

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ABM \neq IBM

Early in the life of these models, they were called IBM
(individual-based models)

Over the years, a “philosophical” distinction has emerged:

- ▶ IBM are mathematical models that consider individuals as the units; e.g., DTMC, CTMC, branching processes, etc.
- ▶ ABM are computational models whose study is, for the most part, only possible numerically

ABM vs Network models

Network models endow vertices with simple systems and couple them through graphs

Can be ABM, but some networks can also be studied analytically

Agent-based models (ABM)

What are agent-based models

When to use ABM

When not to use ABM

Some examples

ABM are very useful to decipher contact processes

Classic mathematical models capture contact by using approximations of what contact could be like

Classic models allow some flexibility (see section about incidence functions in Lecture X but they remain limited

ABM can model actual trajectories of individuals, so given a definition of what a contact is (how close do you need to be for a contact to take place), can count them efficaciously

ABM are very useful to understand behavioural responses

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Some examples

As with *all* tools, beware!

There is a law of large numbers effects happening often: if you have many units, unless some emergent behaviour arises, you get the same results using ODEs...

With this specific tool, beware!

There is a certain tendency in CS people to create *yet another* system and seek *adoption* by users

Agent-based models (ABM)

What are agent-based models

When to use ABM

When not to use ABM

Some examples

Antibiotic resistance in hospitals

D'Agata, Magal, Olivier, Ruan & Webb. Modeling antibiotic resistance in hospitals: The impact of minimizing treatment duration, Journal of Theoretical Biology (2007)

An IBM that's almost an ABM

This work is a good illustration of the “cultural proximity” between IBM and ABM

Model is stochastic and individual-based, in good enough form that approximating ODE can be derived

Allows for very specific tracking of the status of individuals through the process (almost an ABM in this sense)

The setup

Three processes:

1. admission and exit of patients
2. infection of patients by HCW (health care workers)
3. contamination of HCW by patients

Contamination of HCW is "transient": they are carriers, if they wash their hands properly, they become OK

Each day has 3 shifts of 8h for HCW

Patients are put in contact by visits of HCW

Rules for contaminations per unit time

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Why use network models

Network models

Why use network models

EpiModel

R library providing tools to simulate and analyse network epidemiological models

Provides two types of approaches

- ▶ Simulation of ODE compartmental models (not so interesting)
- ▶ Simulation of network models

Their website has several useful tutorials

Part of the statnet meta-library