Case study: an epidemiological model

Yu Si-te[1]

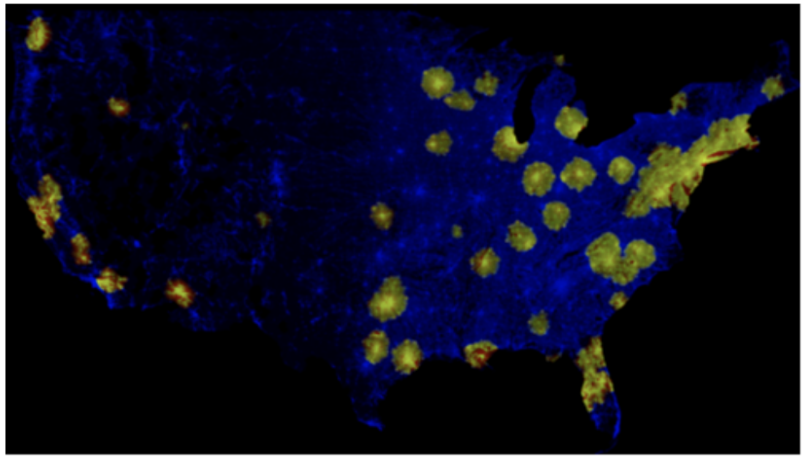
[1]College of Public Health, Chongqing University

重慶醫科大學
Chongqing Medical University

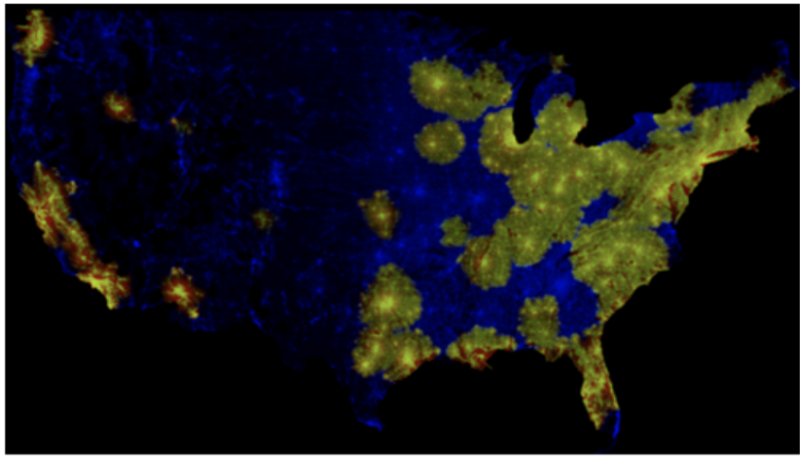
June 24, 2019

Decision making in a chaotic world

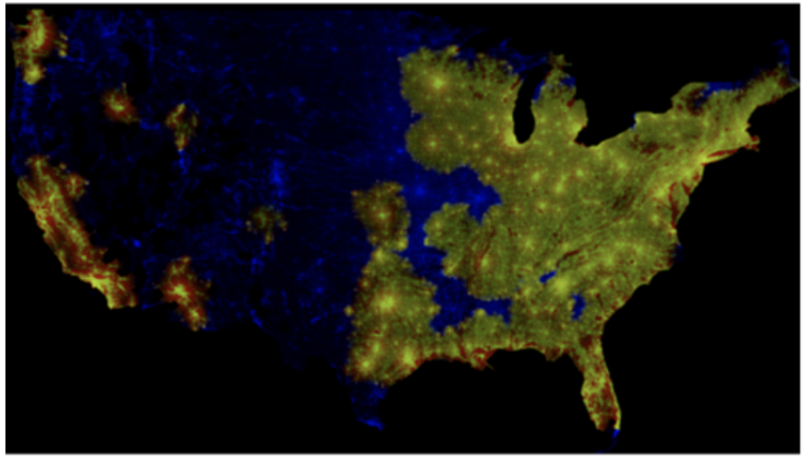
OpenMOLE



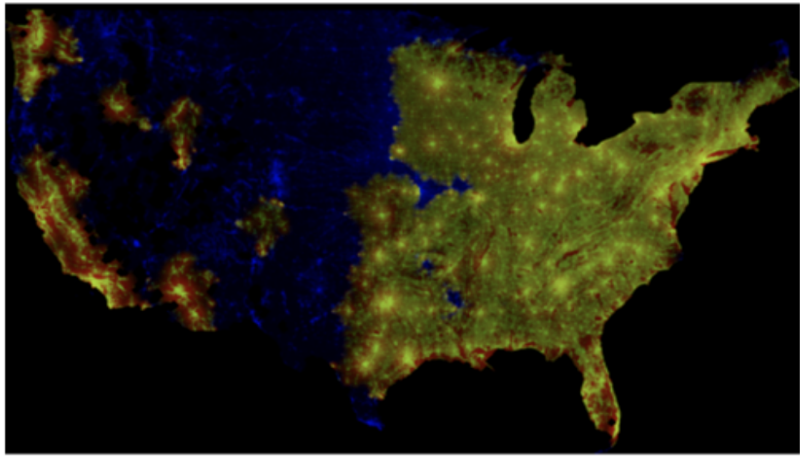
(c) 1 Week



(d) 2 Weeks



(e) 3 Weeks



(f) 4 Weeks

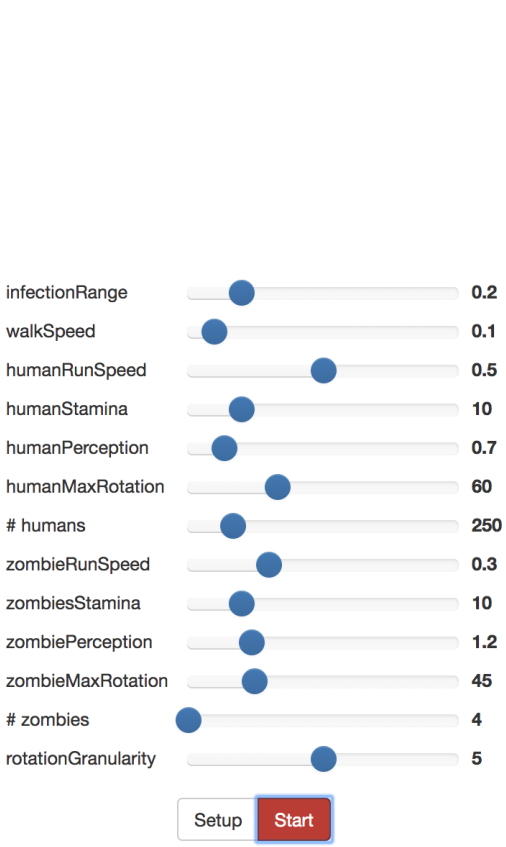
Simulation of the 2010 Zombie outbreak in the US [Alemi et al., 2015]

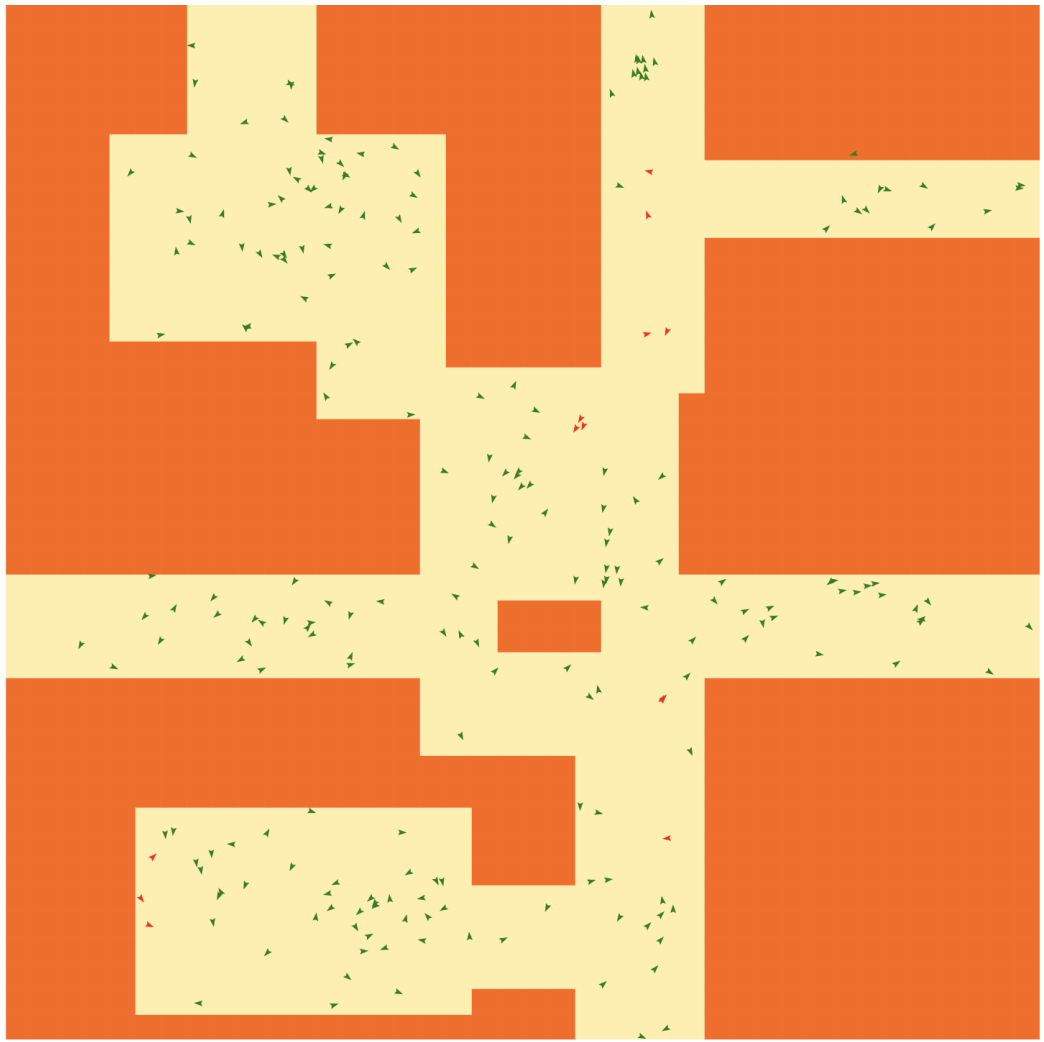
History of Zombie epidemiology

- 2007: first outbreak in Island, relatively contained through ad-hoc measures
- 2010: it becomes pandemic
- 2010-2015: no clear records of events
- 2015-2018: reorganization of institutions, the MOLE (Medical Overview of Ludicrous Experiments) center in Chongqing gathers observational from many local invasions across the world
- 2019: they released the first version of the model ZOMBIE (Zone of Optimal Management for Bacillus Infecting Everyone) and successfully applied

An operational model for local Zombie invasion

OpenMOLE





- Simulate agent-level collective movements at the scale of a district
- Include behavioral processes for human (panic, search for rescues, . . .) and zombies (self-organization, spontaneous attacks, . . .), which can be adapted to local settings
- Include realistic pedestrian dynamics and realistic spatial configuration, which can be applied to local configuration

Objective of the model: optimal policies and behavioral prevention to minimize the impact of recurring invasions

Issue with model application: model has many parameters and processes, model behavior is unknown, application may be strongly case-dependent

→ *we need YOU to understand this model to save the world*

Basic processes and parameters

- Humans and Zombies walk/run randomly (smoothed random walk) in an open urban space (movement parameters: rotation angle, walk and run speed)
- Interactions: human flee from zombie, zombies run for food, fight when encounter
- Humans can be rescued and information on the existence of rescues propagates between humans
- Additional processes in a multi-modeling approach (army, vaccination, . . .)

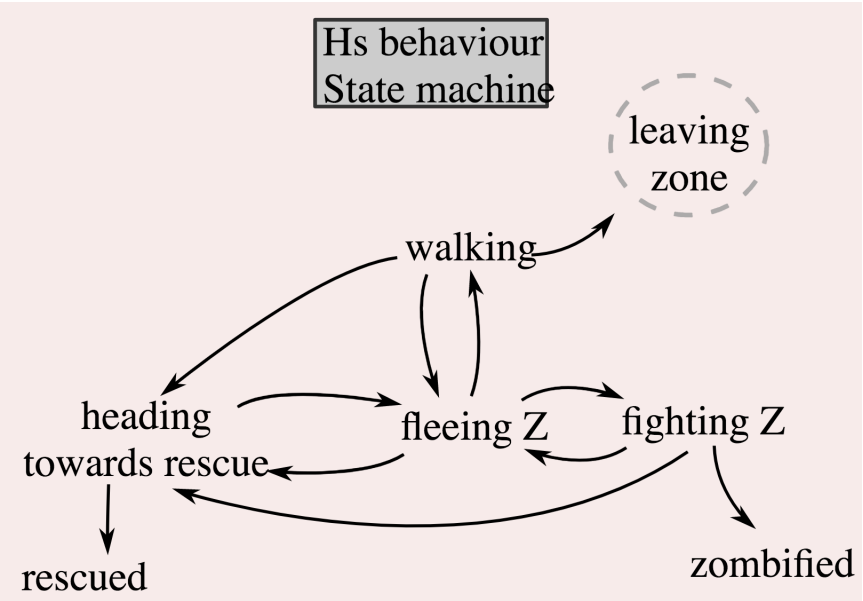
Multiple approaches to pedestrian simulations:

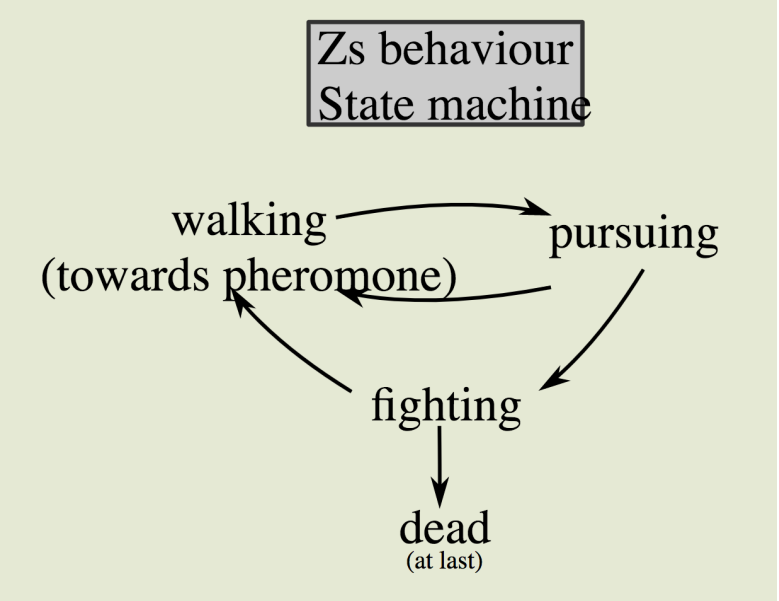
- Social force models (first and second order) []
- Granular flows
- Behavioral models
- Cellular automatons
- Potential

The ZOMBIE model takes the last approach, relatively realistic in a panic setting

Information and rescues

Agents state machines





A flexible and more general model

The model in practice

Let's get your hands on it

- Try the GUI and changing parameters
- Most of next courses will be based on that model (additional processes will be detailed when needed)

The scala model

References I

Alemi, A. A., Bierbaum, M., Myers, C. R., and Sethna, J. P. (2015).
You can run, you can hide: The epidemiology and statistical mechanics of zombies.
Physical Review E, 92(5):052801.