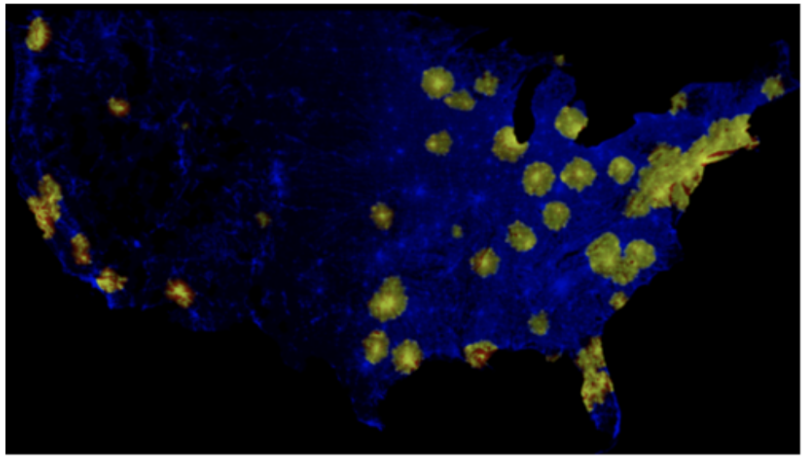
Case study: an epidemiological model

ExModelo Summer School

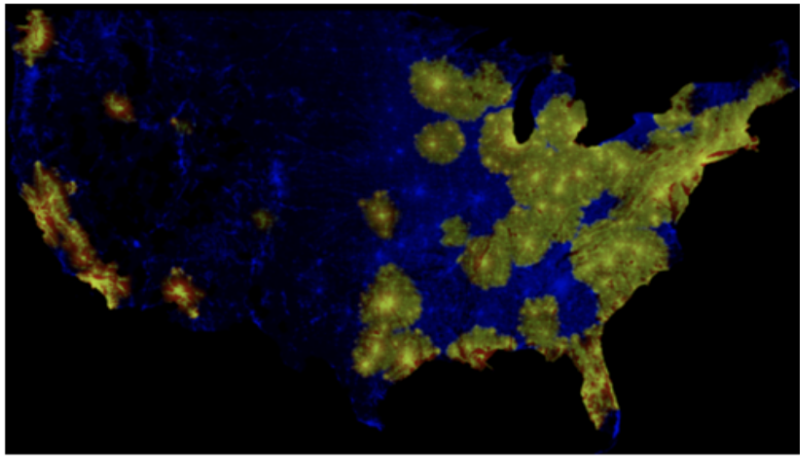
OpenMOLE

June 24, 2019

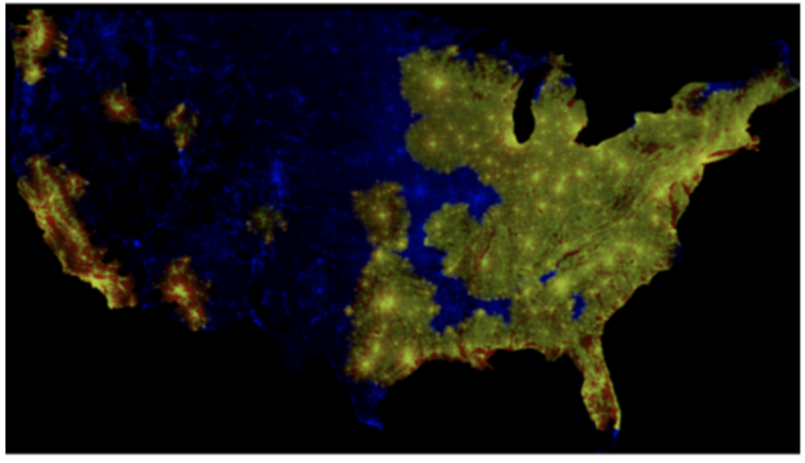
Decision making in a chaotic world



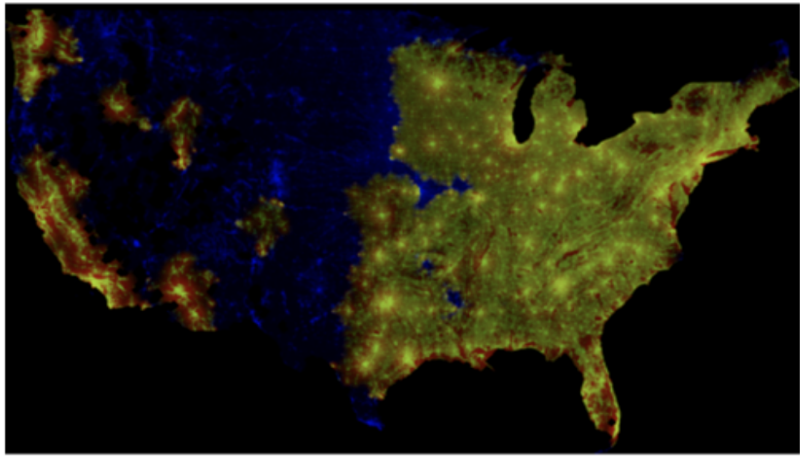
(c) 1 Week



(d) 2 Weeks



(e) 3 Weeks



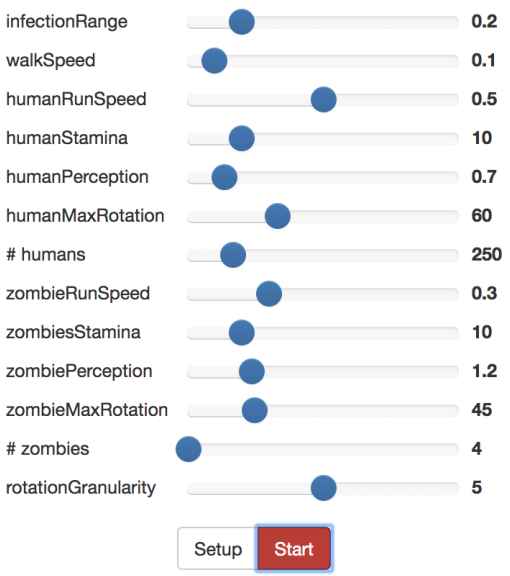
(f) 4 Weeks

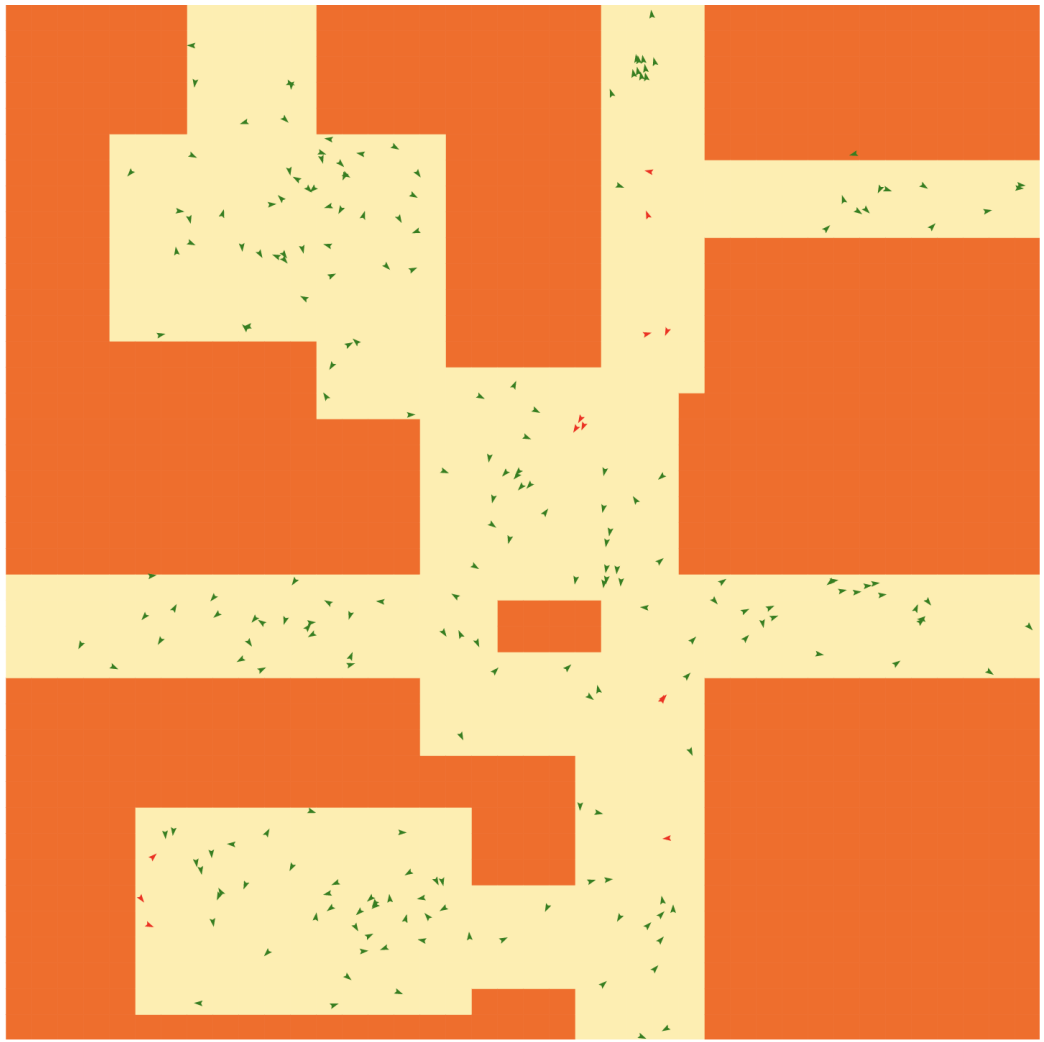
Simulation of the 2010 Zombie outbreak in the US [Alemi et al., 2015]

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 Ludicus 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) is released and successfully applied

An operational model for local Zombie invasion





Overview of the model

- 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

$\rightarrow$ *we need YOU to understand this model to save the world*

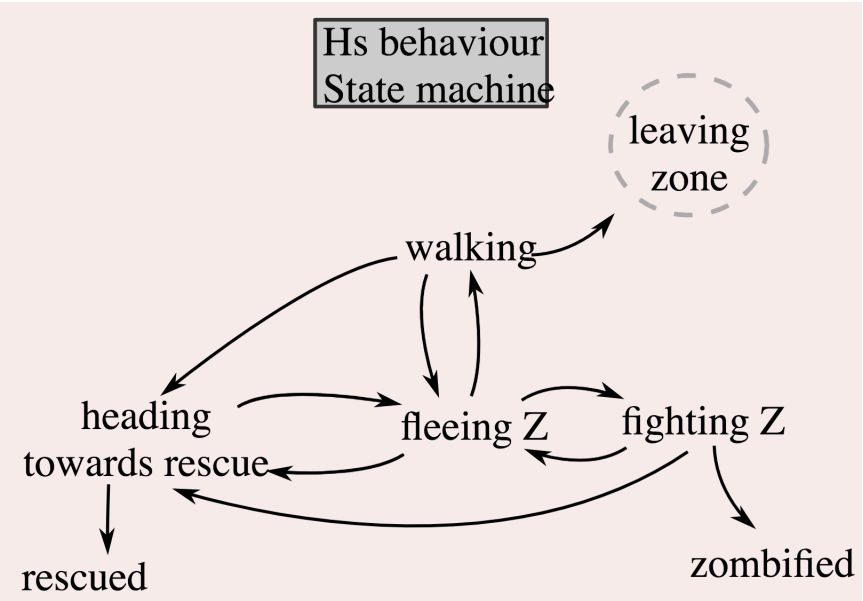
Basic processes and parameters

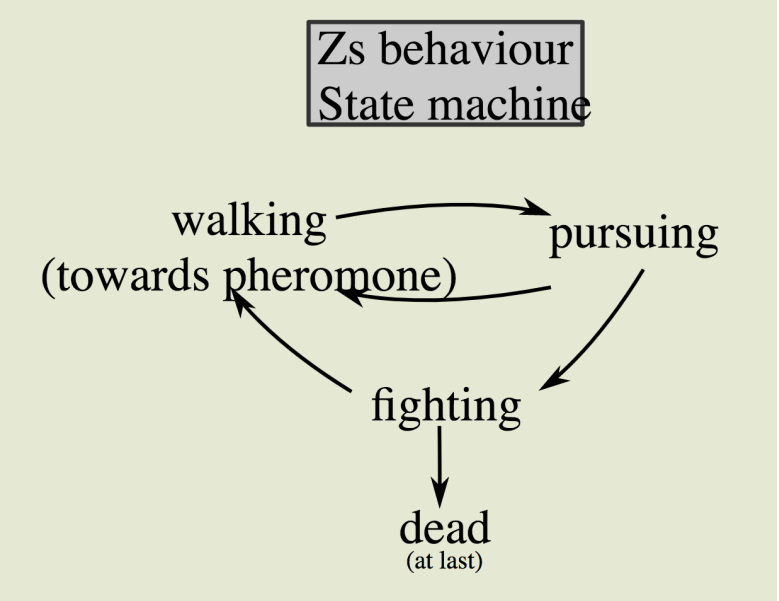
- Humans and Zombies walk/run randomly (smoothed random walk) in an open urban space (movement parameters: rotation angle, walk and run speed)
- Interactions: human flee from zombie, zombies run for food, fight when encounter
- Humans can be rescued and information on the existence of rescues propagates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

Pedestrian simulation

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.