

HOW RUNNING FROM ZOMBIES IS THE SAME AS MARKET BEHAVIORS

By Jacqueline Kazil

PyTennessee, February 9, 2018



Speaker notes

- I do a lot in the Python community.
- I will use this photo forever.

Before I get into my main part of my talk, there are two items of housekeeping.

PYTHON SOFTWARE FOUNDATION

<https://www.python.org/psf/>

- The PSF protects the Python trademark
- Gives out grants to support Python events and Python development
- Organizes and hosts PyCon US
- Provides fiscal sponsorship support

& Much much more

EDUCATION REQUEST FOR IDEAS

<http://bit.ly/PSF-RFI-EDU>

How to increase Python presence in education?

- Really open ended
- Small or big - \$10 to > \$10 million
- Deadline Feb 18

Speaker notes

- PSF Board Committee for Python in Education is looking for ideas...
- ...how the PSF can help members of our community increase the presence of Python in education.
- After we collect ideas, if we think something is exciting, we will come back and request a proposal.

PYCON 2019: CLEVELAND, OH

<https://us.pycon.org/2019/>

- Tutorials: May 1-2
- Talks & events: May 3-5
- Sprints: May 6-9

..and PyCon 2020: Pittsburgh, PA

Speaker notes

- Cleveland is a short non-stop flight from Nashville.
- You should stay for sprints - get experience.
- PyCon will probably move West
- PyCon brings me to mention the Maintainers summit

PYCON: MAINTAINERS SUMMIT

<http://bit.ly/maintain2019>

<https://www.papercall.io/pycon-maintainers-summit>

- First year thru hatchery program
- Discussion of tooling, community, funding, and sustainability
- CFP open until March 15 for lightning talks

Speaker notes

- The vast majority of libraries that exist have a fragile number of maintainers.
- In August 2017, all active Mesa core members fell off the face of the earth.

THINGS I JUST MENTIONED

- Python Software Foundation (PSF)
- PSF Education Request for Ideas (Feb 18)
- PyCon 2019: Cleveland, OH (May 1 to 9)
- Maintainers Summit & CFP (March 15)

Speaker notes

If you have questions about any of these things, please don't And now for the regular scheduled talk...

THE REAL TALK

... modeling the complex world we live in.

part tech talk, but also

part rethinking how you see the world.

Speaker notes

- I tried to pick something everyone can enjoy.
- part data science, part tooling, part rethinking how you see the world.
- I hope you all get something from this talk.



2020
Class of 2019?



Speaker notes

- Why listen to me? I am partially an expert
- Hoping to finish by 2020.
- Some of the work that I mention today IS my PhD
- At work, I model our IT infrastructure and app interactions and dependencies

OVERVIEW OF TODAY'S TALK

- Introduction to complexity systems
- What is complexity science or the study of complex systems
- Considerations for building models
- Some of the practical applications

Speaker notes

What I hope you will learn in this talk...

1. A general understanding of the practical application
2. Some might dig into the tools
3. If nothing else, u learn how to survive a Zombie attack

TOOLING

- Mesa (Python) - Agent-based modeling
- Networkx (Python) - Network/graph analysis
- Netlogo (Logo) - Agent-based modeling

Speaker notes

- Just in case you want to play around with some of the tools while I talk
- Mention examples

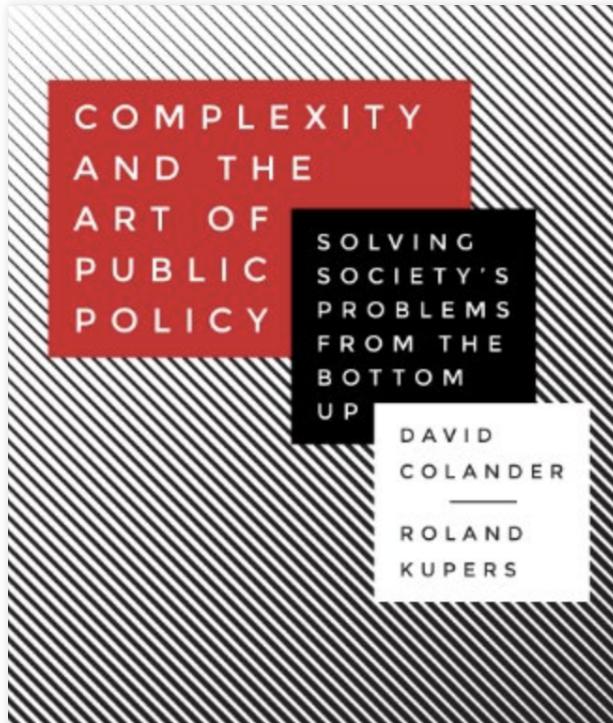
"YOUR WATCH IS COMPLICATED, YOUR FAMILY IS COMPLEX"

Said by David Krakauer, Evolutionary Biologist

Speaker notes

- A watch is predictable, a family is not
- The mechanisms in watch are perfectly rational
- I know my family is not
- Love you all!

But what does this mean?



Speaker notes

- Roland Kuper highlights a model in his book
- ... which tests the impact of adaptive cruise control on road capacity
- Who here is from a place with terrible traffic? (you are going to love this)
- If 100% of new cars had adaptive cruise control..
- .. how much would road capacity increase in 1 year?
- 30%

TRAFFIC IN ETHIOPIA



Speaker notes

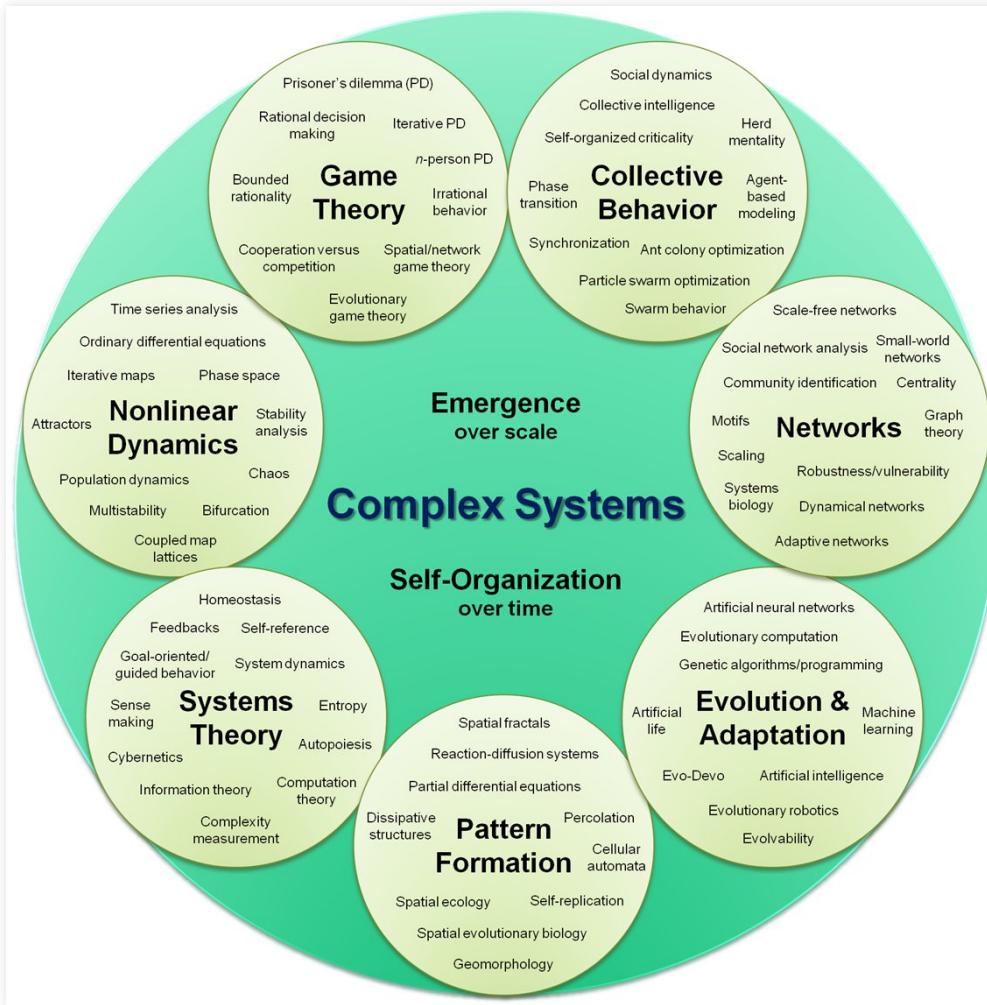
- This is an intersection in Ethiopia.
- It has no traffic lights. So, how does it work?
- Flocking. (Describe the behavior and individual decisions.)

BIRDS FLOCKING



Speaker notes

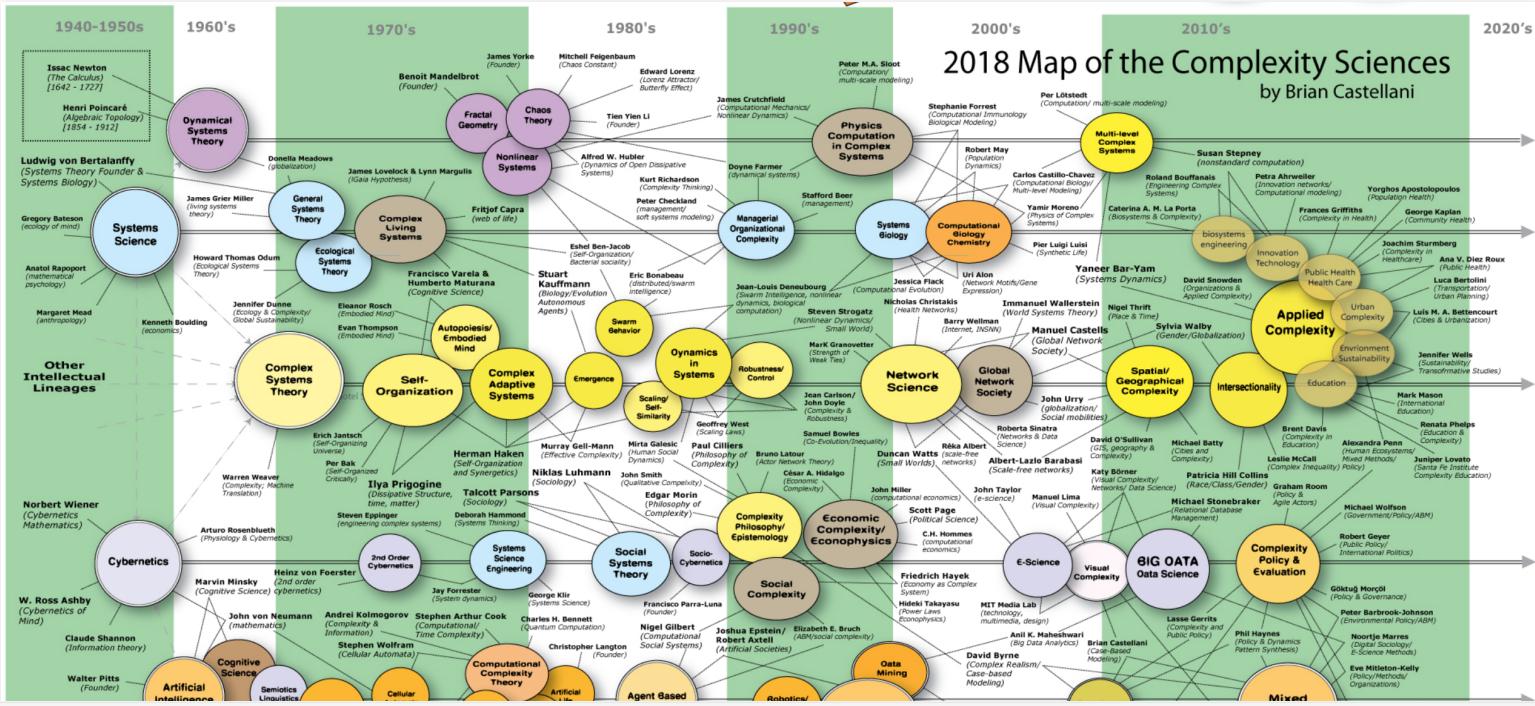
- Each bird is following the leader or their neighbor
- In some ways this systems are completely different
- But in others they are not



Speaker notes

- "Complex systems" means a lot
- It even encompasses Machine Learning

Source: https://en.wikipedia.org/wiki/File:Complex_systems_organizational_map.jpg

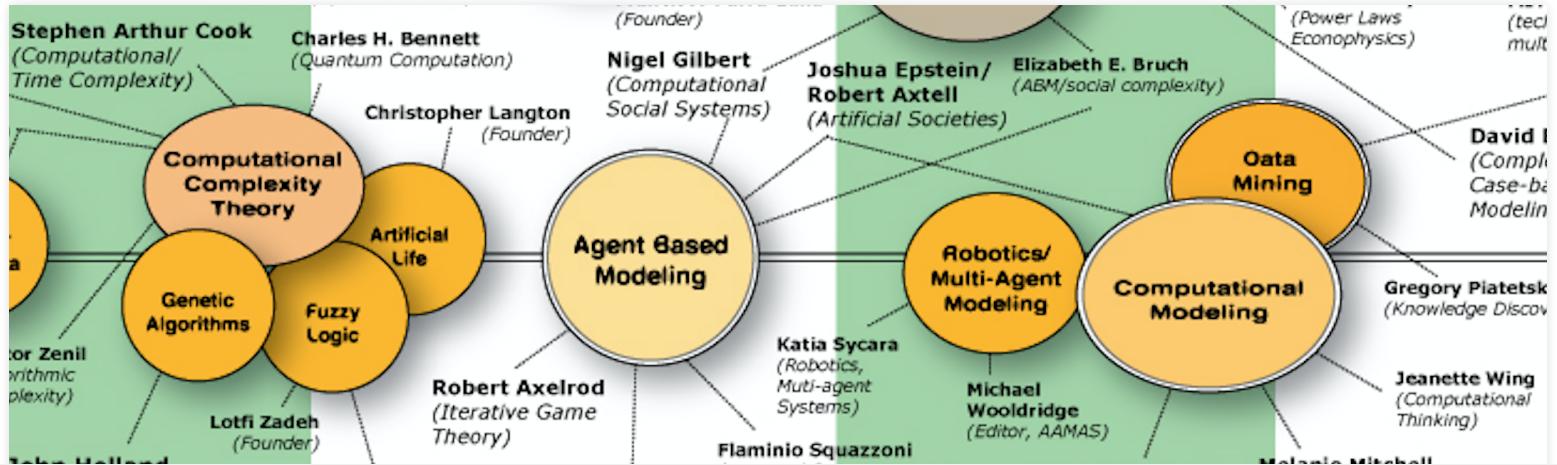


Speaker notes

- You can see how the science changed over time.
 - Started in 1960s/1970s.
 - Since then computational power has improved and so has software.
 - I can't cover everything, so I am going to focus on two areas

Source: http://www.art-sciencefactory.com/complexity-map_feb09.html

AGENT-BASED MODELS



Speaker notes

- Thomas Schelling built one of the easiest and well known models.
- Segregated neighborhoods can arise not just by active racism
- but also due to a mild preference for neighbors of the same ethnicity
- Rob Axtell (GMU) did a lot of work in economics modeling

Source: http://www.art-sciencefactory.com/complexity-map_feb09.html

WHAT IS AGENT-BASED MODELING?

ABMs, MAS, Game theory, Cellular automata,
Microsimulation, Individual-based models. Complex
Simulations

Speaker notes

- ABMs go by many names
- MAS related - Focused on solution, not simulation.
- Game theory: related, but we want less than perfectly rational agents, no closed-form solutions.
- CA: subset of ABM
- Microsim: used in GIS to mean ABM
- Individual: ABMs are called in ecology what ABM are sometimes called in ecology.

WHAT IS AGENT-BASED MODELING?

Computer simulation

Consisting of agents

... interacting with one another

... in order to study an overall system

COMPONENTS OF A MODEL

Space

Agents

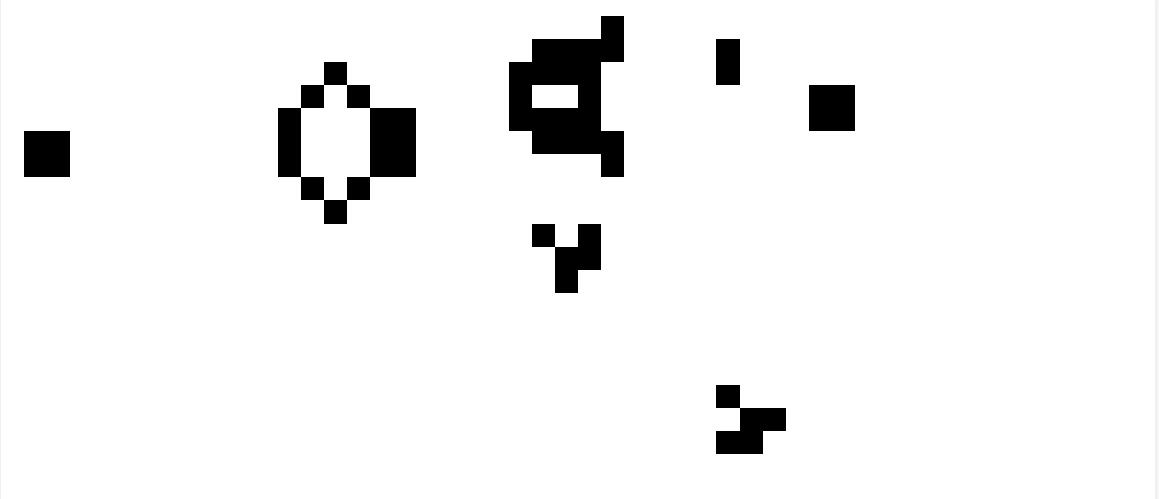
Time

Visualization (not required)

Speaker notes

- Models have space, agents, time, and possibly a visualization element,
- You can run headless, especially when you are doing parameter sweeps.

CONWAY'S GAME OF LIFE



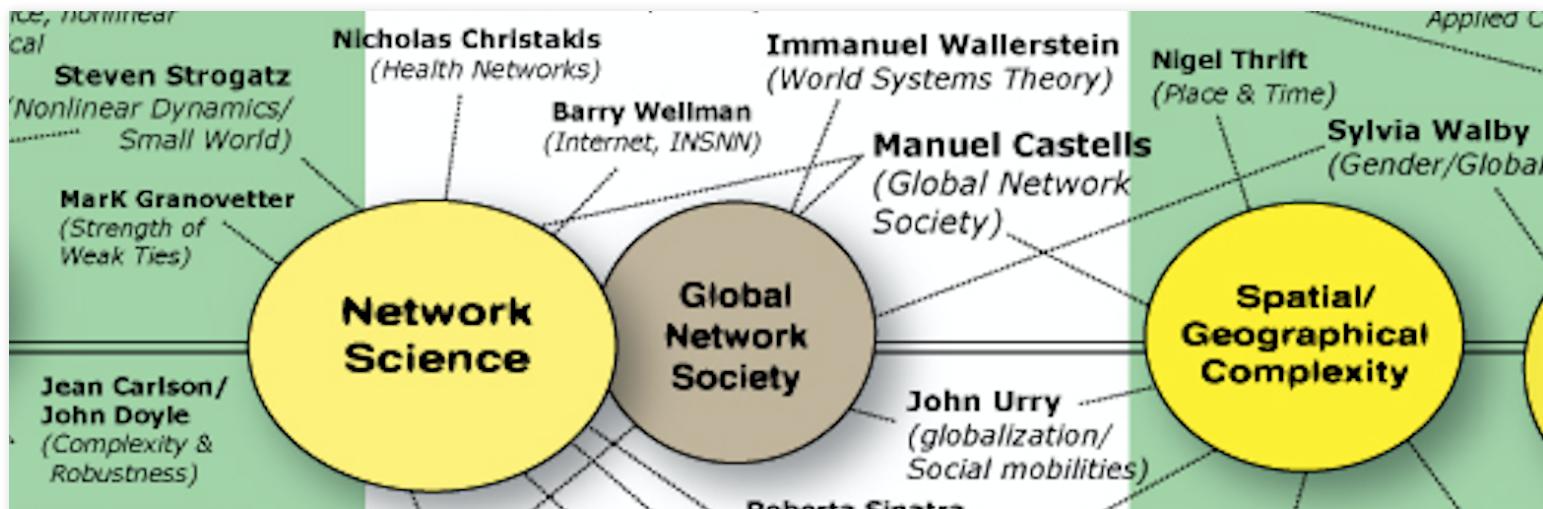
Speaker notes

- You could say this is an ABM in its simplest form
- These shapes are not agents, but each cell is one.
- Rule: Cells live or die based on the number of cells around them
- Early example where individual rules give rise to emergent behaviors

Let's look at another tool - network libraries

Source: https://en.wikipedia.org/wiki/Conway's_Game_of_Life#/media/File:Gospers_glider_gun.gif

NETWORKS



Speaker notes

- Two names to note here...
- Duncan Watts - Small Worlds
- Albert-Lazlo Barabasi - Scale free networks
- Both have written very accessible / easy reads on networks

Source: http://www.art-sciencefactory.com/complexity-map_feb09.html

GENERAL NETWORK TYPES

(a) Small-World Network (SWN)



(b) Scale-Free Network (SFN)



(c) Random Network (RN)

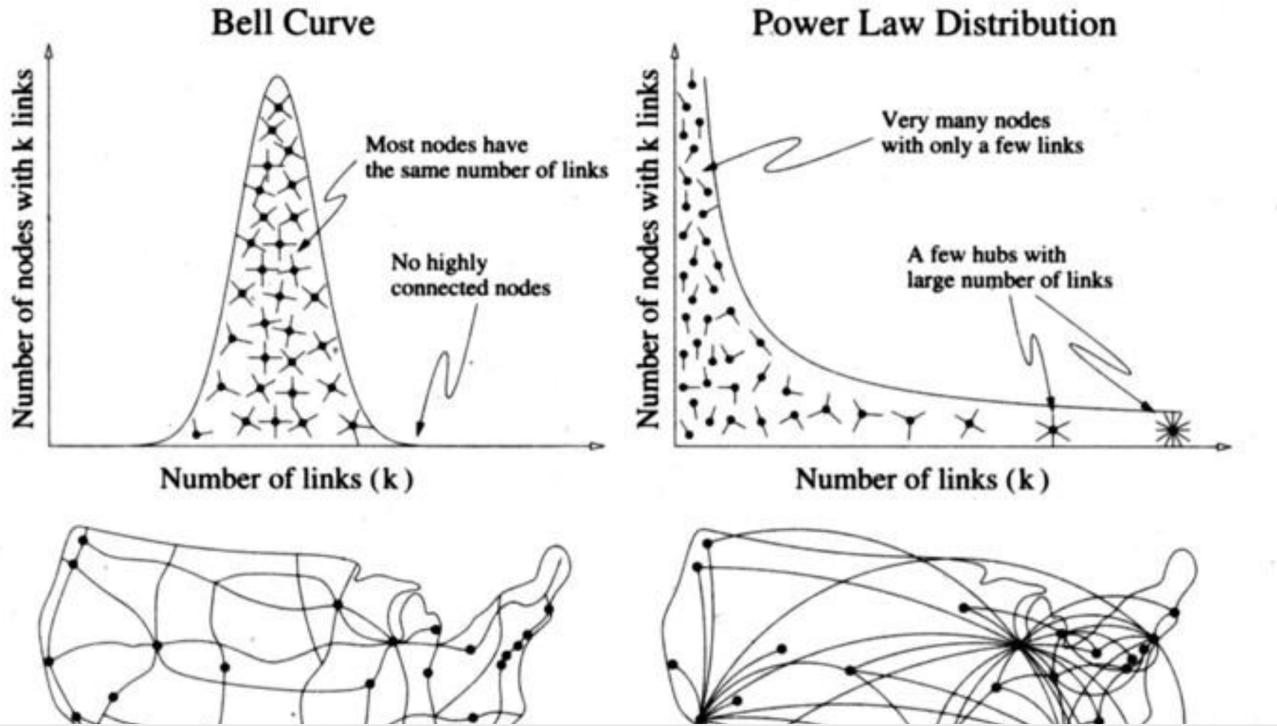


Speaker notes

- Small-world - 6 degrees of separation
- Stanley Milgram experiment 1969
- Milgram is also known for shocking obience experiments like you may have see in Ghost busters
- Kevin Bacon
- Scale free - internet; rich get richer

Source: Huang, Chung-Yuan, Sun, Chuen-Tsai and Lin, Hsun-Cheng (2005). 'Influence of Local Information on Social Simulations in Small-World Network Models'. Journal of Artificial Societies and Social Simulation 8(4)8

<http://jasss.soc.surrey.ac.uk/8/4/8.html>.



Speaker notes

- Scale free follow power law distribution
- Many have one connection, few have many

Barabasi, A. L. (2003). *Linked: How everything is connected to everything else and what it means.*

MODELING

"THE RIGHT THING"

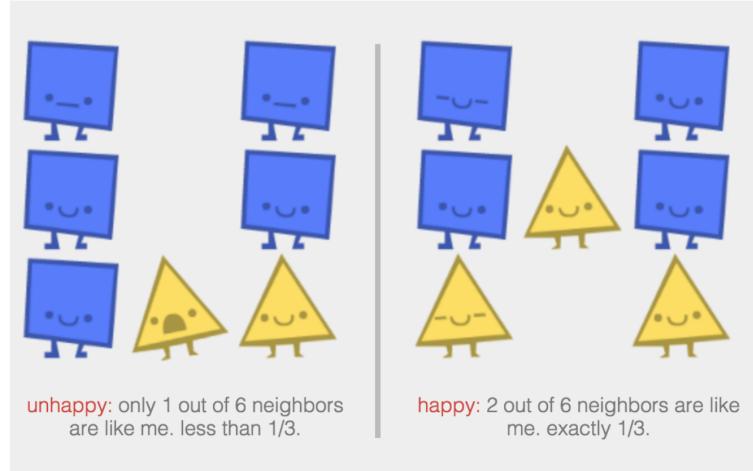
Speaker notes

- The world is big. How do you know what to include in your model? That depends.
- Take my example of modeling applications - deployment on hot chicken Tuesday
- Do we need to model Hot Chicken Tuesday?

SEGREGATION MODEL

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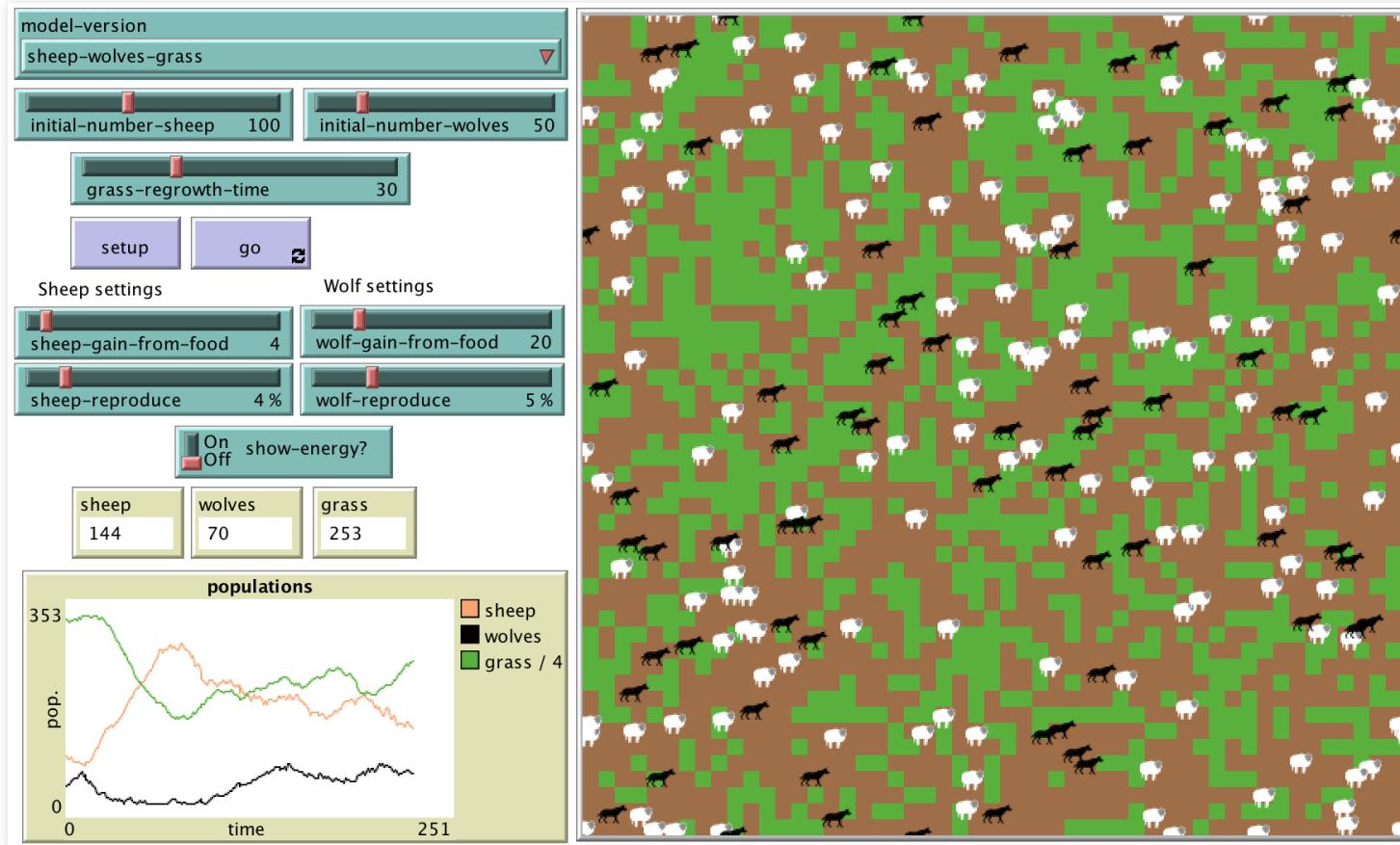


Source:

Speaker notes

- classic model from 1971
- Agents can be happy or sad based on their neighbors (javascript)
- This adds a level of agency above the game of life --
- the agent moves to another cell
- Small individual bias can lead to large collective bias.

PREDATOR-PREY DYNAMICS



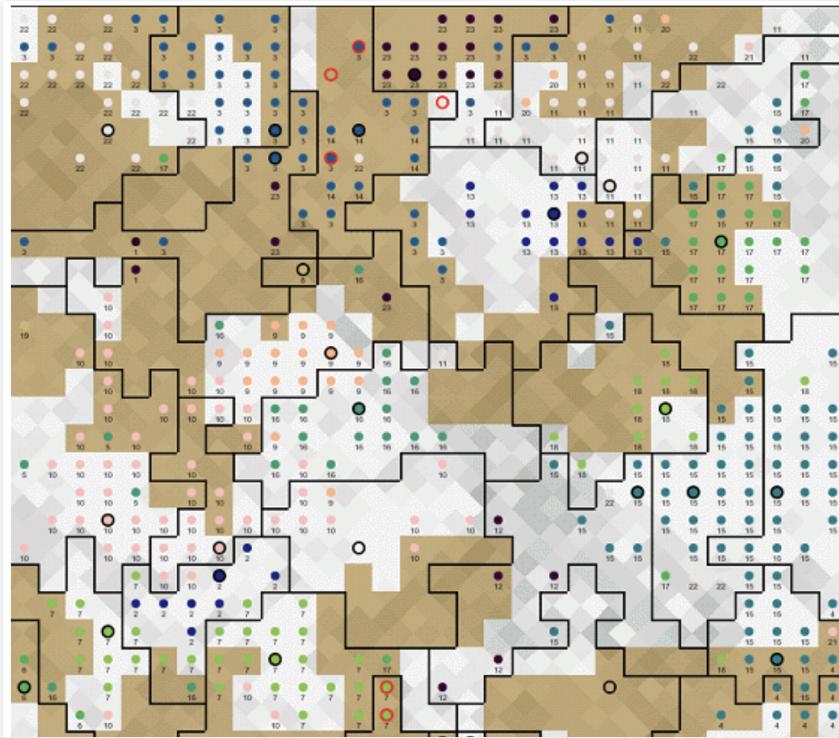
Speaker notes

- Ecological model
- Sheep eat grass, Wolf eat sheep, Both reproduce
- This adds interactions with environment

Source: Wilensky, U. (1997). NetLogo Wolf Sheep Predation model.

<http://ccl.northwestern.edu/netlogo/models/WolfSheepPredation>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

POLITICAL DYNAMICS



Source:
Cederman et al. "GeoSim"

Speaker notes

- Agents aren't individual people or animals
- They are simulated states that interact and fight
- Repast -- JAVA w/ custom IDE

Migration Modeling

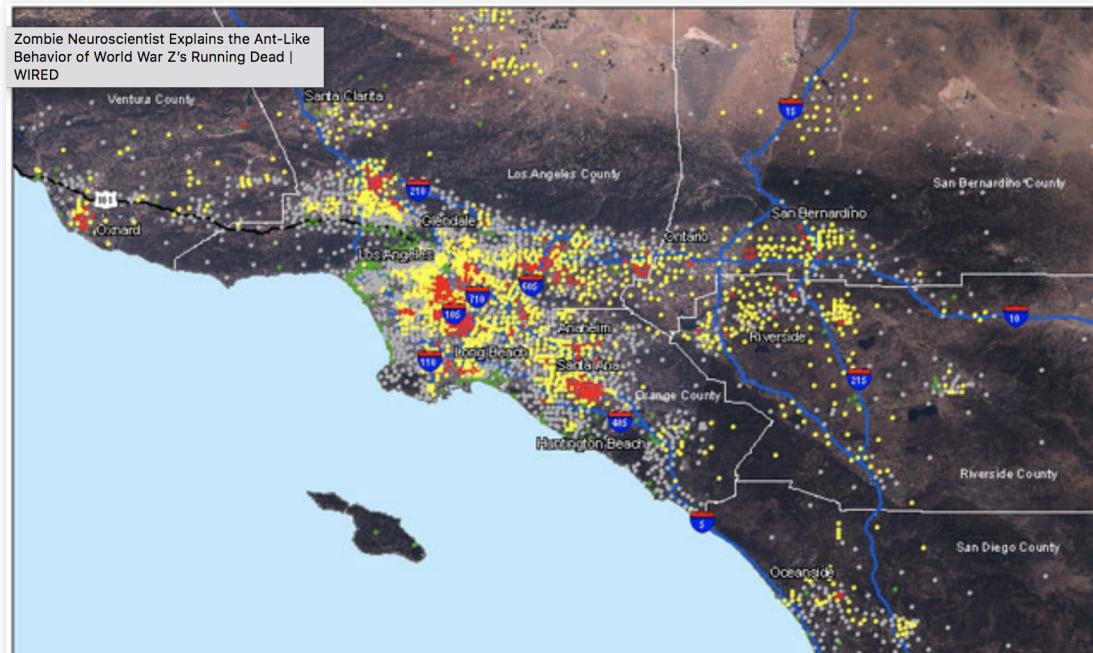


Speaker notes

- Simulation of displaced people flows in East Africa
- using real-world environmental, conflict and road network data.
- Example takes us from simulated worlds to the real world
- Real life simulation
- This is MASON - JAVA

<http://socialcomplexity.gmu.edu/projects/easternafrica/>

EPIDEMIOLOGICAL SIMULATION



Source:
Los Alamos National
Laboratory, OPPIE

Speaker notes

- Isn't hypothetical, actually used by CDC
- Model from Los Alamos National Lab
- This is a 1:1 model
- Infectious disease simulation using census data, clinic locations, etc.
- Hand coded

DEMOS

- Predator-Prey Dynamics in Netlogo
- Schelling in NetLogo
- [Schelling by Ncase](#)

MODELING ON THE FRONT-END

- Parable of the Polygons (Javascript) - ncase.me/polygons
- Agent Base (Javascript) - bit.ly/abm-ants
- Agent Script (CoffeeScript) - agentscript.org

MODELING ON THE BACK-END

- NetLogo (Logo), 1999 - bit.ly/abm-netlogo
- MASON (Java), 2003 - bit.ly/abm-mason
- RePast (Java), 2006 - bit.ly/abm-repast
- Mesa (Python), 2015 - bit.ly/abm-mesa

Speaker notes

- Guido Darpa grant 2001
- In the grant - Logo, was nice, but we are done with it.
- Netlogo was pulling a Madonna

CHESTERTON'S FENCE



Speaker notes

- Reference to G. K. Chesterton's 1929 book The Thing.
- If you are going to delete or overrid something, you should understand it first
- And aknowledge it is no longer valid

PYTHON RESEARCH

| Name | 2.7 | 3+ | Active Dates | PyPI | Description |
|-----------------------|-----|----|--------------|------|--|
| Simx | Y | N | 11/12-12/14 | Y | Framework for discrete simulations, optimized for parallel computing; no built in visualization |
| PyCX | Y | Y | 06/11-03/16 | N | Repository of ABM examples & GUI script for desktop visualization; Focused on ease of writing; Mostly pure python; not a framework |
| PyABM | Y | N | 09/12-03/14 | Y | Partial ABM framework, not working |
| Indra | N | Y | 12/14-Today | N | ABM framework to write models similar to Netlogo; lacks docs & tests; visualization ability in the future? |
| Mesa | N | Y | 09/14-Tod | Y | ABM framework to build models with |

Speaker notes

- There was nothing that existed when we got started.
- There seemed to a problem of libraries belonging to one person and dying
- Indra started the same time we did.

DEMO OF MODELS

- Docs: bit.ly/abm-mesa
- Code: github.com/projectmesa/mesa

Speaker notes

- Let's look at some models!

HOW TO RUN DEMOS

You install the requirements for that model

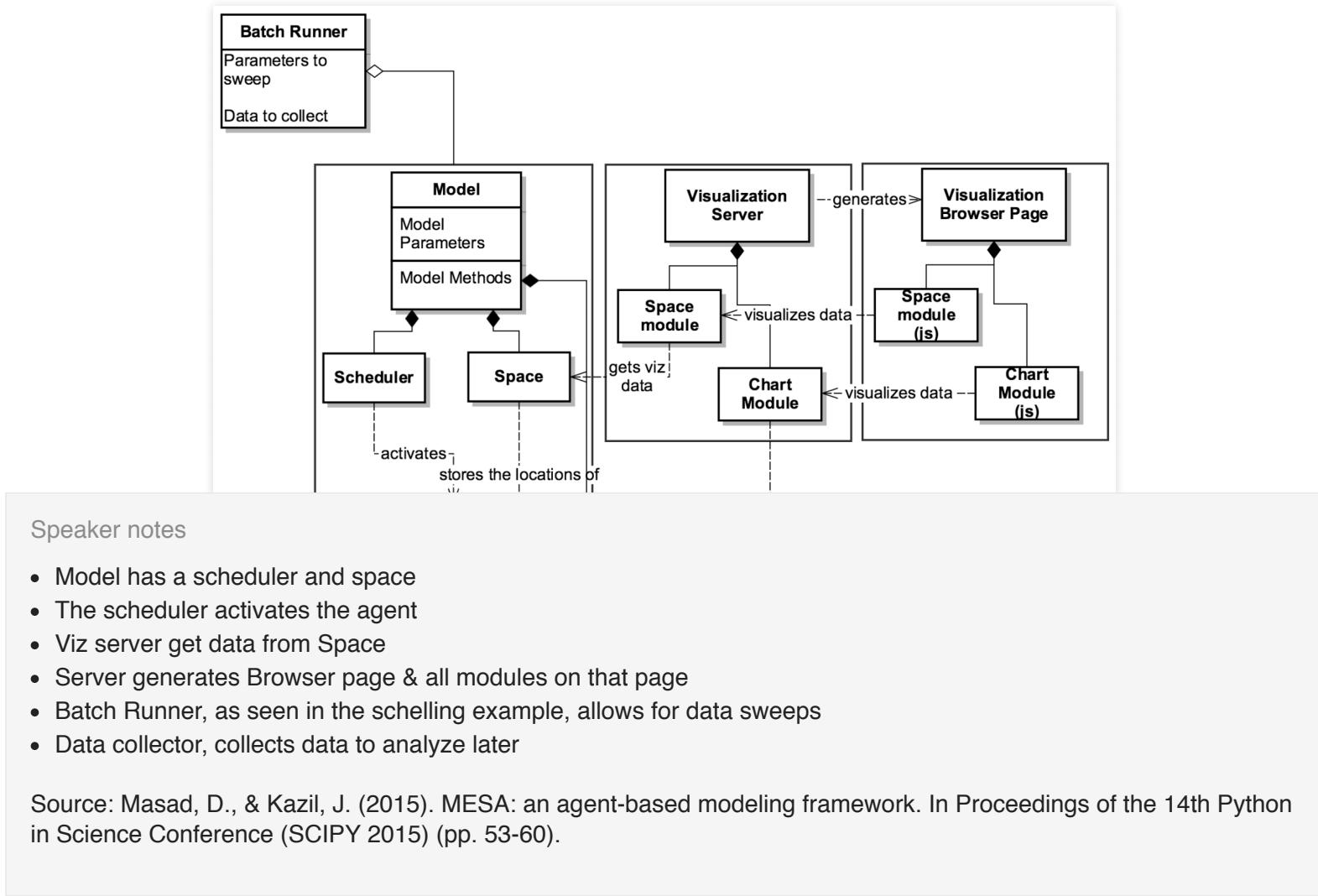
```
$ pip install -r requirements.txt
```

```
mesa runserver
```

Browser opens to <http://127.0.0.1:8521/>

Speaker notes

- Runserver - just like Django
- We used port 8521, because 8888 is used for jupyter notebooks
- Zipcode in AZ

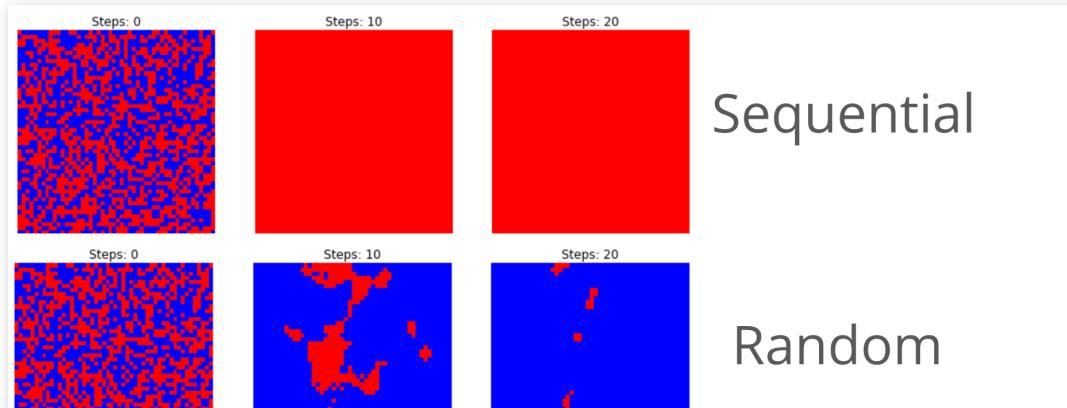


Speaker notes

- Model has a scheduler and space
- The scheduler activates the agent
- Viz server get data from Space
- Server generates Browser page & all modules on that page
- Batch Runner, as seen in the schelling example, allows for data sweeps
- Data collector, collects data to analyze later

Source: Masad, D., & Kazil, J. (2015). MESA: an agent-based modeling framework. In Proceedings of the 14th Python in Science Conference (SCIPY 2015) (pp. 53-60).

MESA'S SCHEDULING FEATURE

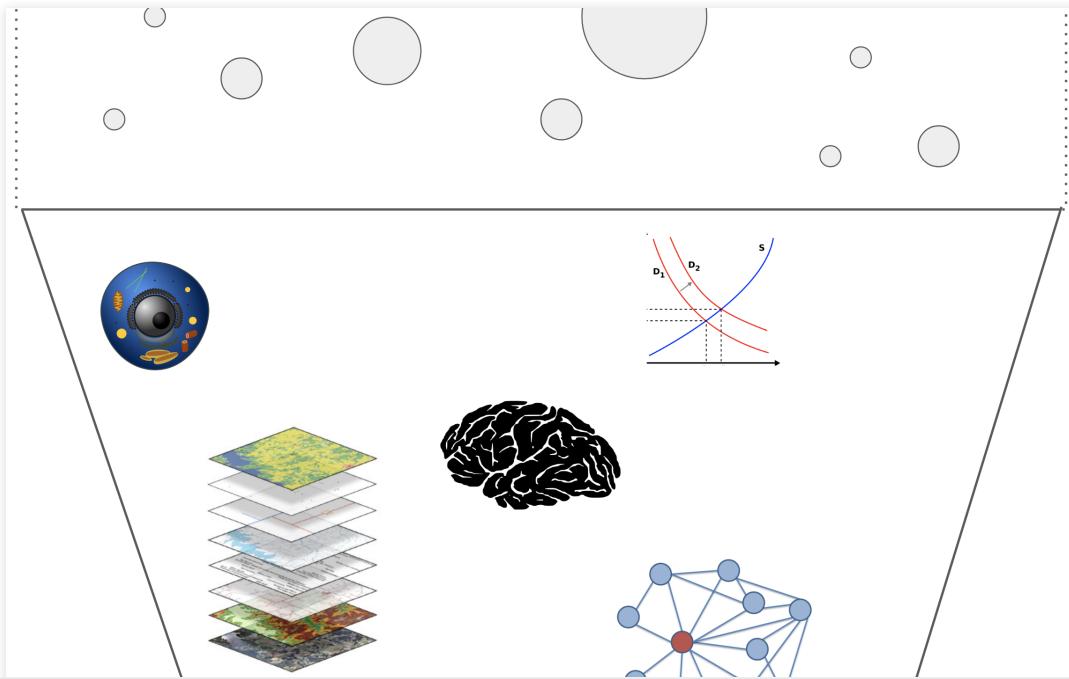


Speaker notes

- Notebook example & source: Prisonerâ's dilemma
- Sequential activation, where agents are activated in the order they were added to the model
- Random activation, where they are activated in random order every step
- Simultaneous activation, simulating them all being activated simultaneously.
- Inspired by Kenneth Commerâ's paper in 2014
- Consider your schedule works today when queueing up processes - system state

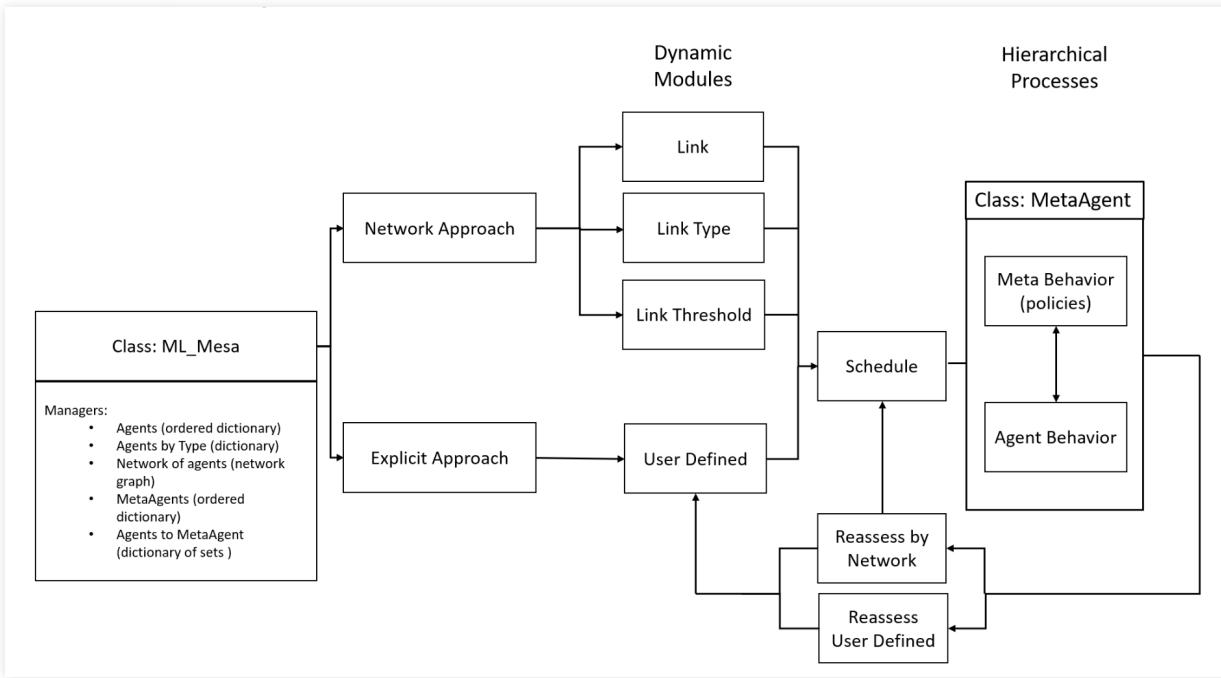
[Comer2014] Comer, Kenneth W. âWho Goes First? An Examination of the Impact of Activation on Outcome Behavior in AgentBased Models.â George Mason University, 2

MESA PACKAGES



Speaker notes

- Mesa functionality add - mesa-geo (not to be confused with GeoMesa)
- Agent & env based - econ-mesa
- Future goal is to have a whole ecosystem (like Django packages)
- People can mix and match schools of thought



Speaker notes

- Most recently created by Tom Pike, a colleague at George Mason.
- It is in progress.
- ML_Mesa allows for holonic (Tom taught me that word) organization to models
- Neighborhoods, houses, families, people, etc

OUR GOALS WITH MESA

- Framework for reuse
- Decoupled / decentralized
- Domain experts "own" components
- Reproducibility
- Building models on accepted truths

Speaker notes

- Decouple - Django versus Flask
- Well established models would be well tested and turn into "accepted truths"
- ie We accept that the Request library is going to do what it does
- If it doesn't then we submit a ticket or PR

SO, HOW IS RUNNING FROM ZOMBIES THE SAME

Speaker notes

- You learned a little about the domain, practical examples, tooling...
- So, how is running from zombies the same as market behaviors?
- It is the logic and reasoning in the decisions with make
- Play neuron video
- Short answer: actors are looking to survive, rational versus irrational
- Long answer is in this books

Mathematical Modelling of Zombies



Speaker notes

- This book is the long answer.
- I have a copy up front if you want to see it
- Yes, the author's real name is Robert Smith?

THE END.

Questions?

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github.com/projectmesa/mesa