

Intro to agent-based modelling for social scientists

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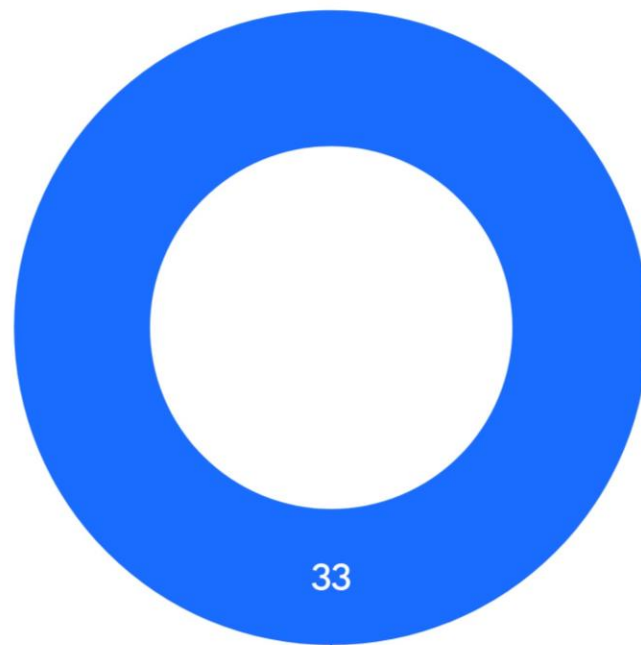


Interaction in this workshop

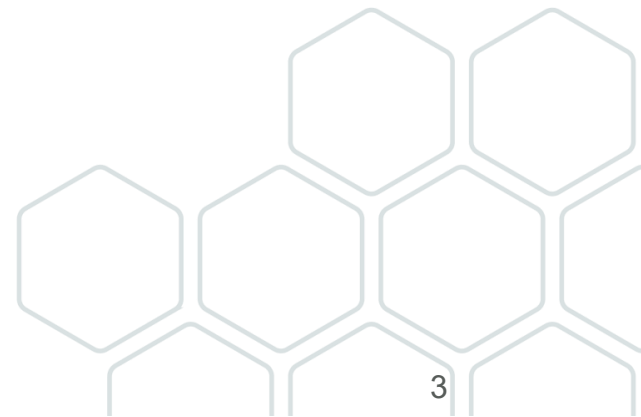
- Zoom chat -> technical questions for facilitator
- Zoom Q&A -> content questions for the host, upvote questions of others
- Mentimeter -> anonymous on screen votes/short answer/etc. at clear key moments

Go to menti.com, enter 8 digit code at the top of the screen

Can you hear us?



Yes ●



Troubleshooting audio problems

- Check your speaker/headset is plugged in / volume is on.
- Click on audio to change to listening via phone
- We are recording this webinar and will post it on YouTube

(<https://www.youtube.com/user/UKDATASERVICE>)

You might be interested in other UKDS events

- ABM workshop on using real-world data - Feb 2
- ABM workshop on running experiments - Feb 16
- ABM guest researcher seminar - Mar 9
- CSS Drop-ins – Every 2nd Tuesday of month at 13:00

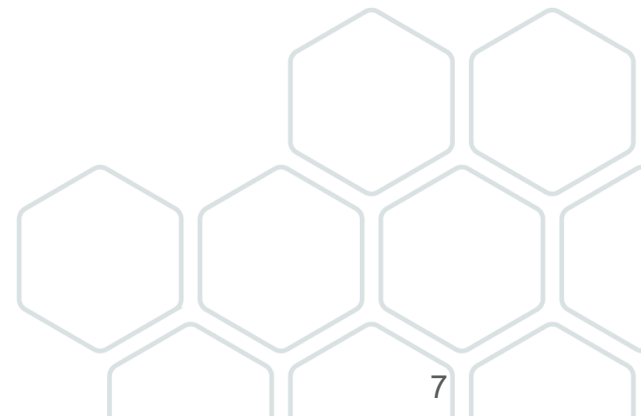
- <https://ukdataservice.ac.uk/news-and-events/events.aspx>
- <https://www.ukdataservice.ac.uk/news-and-events/events/past-events.aspx>

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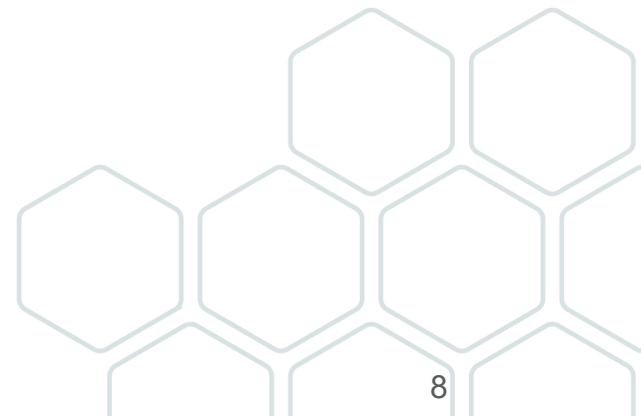
- Top-down vs. Bottom-up
- Agents and agent-based models
- Simple example
- Complex example
- What to do with the output
- Pros and cons of ABM, platforms/ languages, resources, etc.
- Q&A

A problem 'is' top-down if:

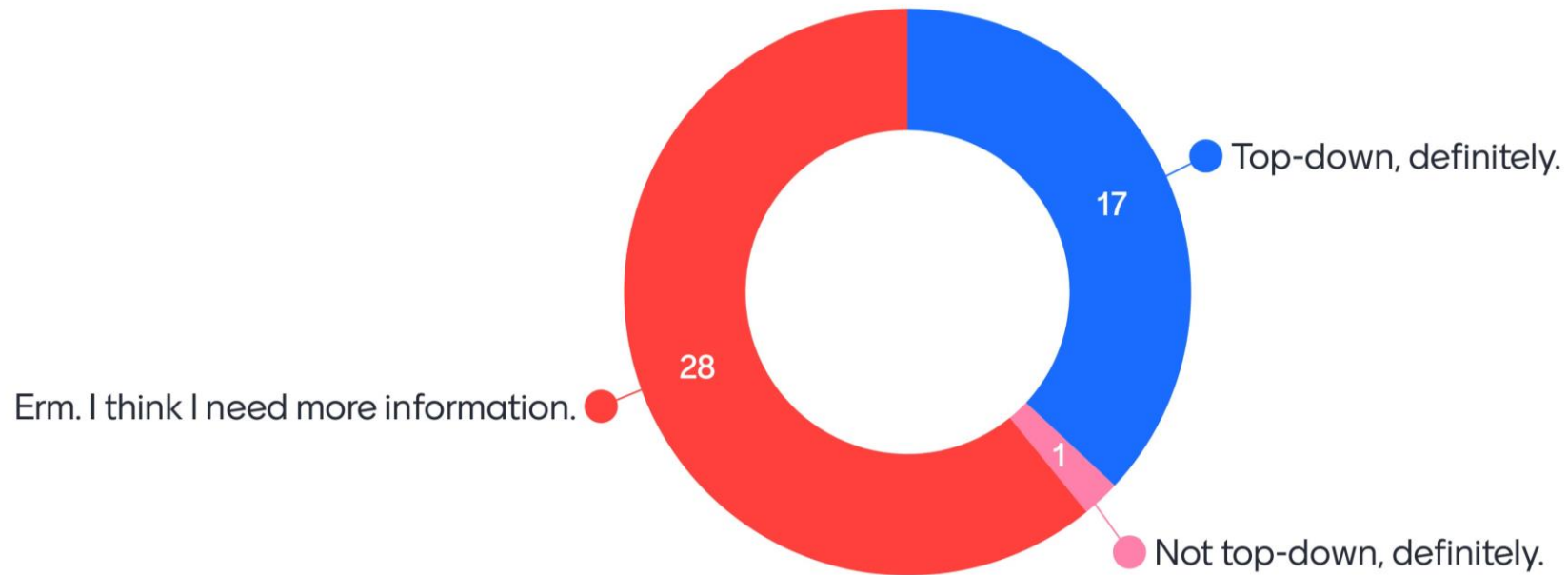
- Within a system that is 'whole', 'well-understood' and with central control or structure
- The 'cause' can be isolated to constituent parts, defined interactions, or specific problem areas
- It is well-suited to 'classic scientific method' which focusses on isolation, prediction, repetition, etc.



Top-down examples

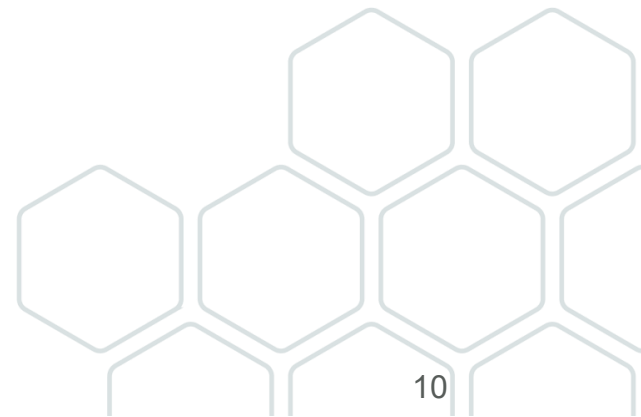


A school wants to know how many students it can accommodate. Is this a top-down problem?



A problem 'is' bottom-up if:

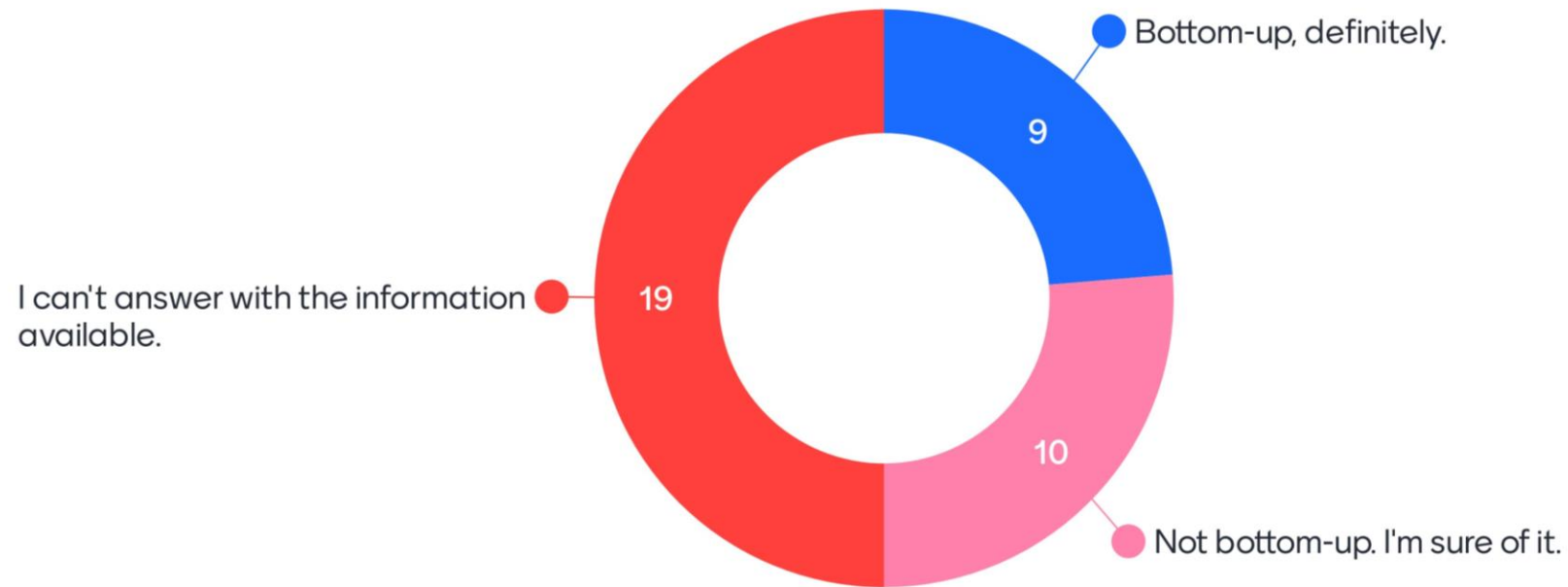
- Within a poorly-understood, open system with vague parts/interactions and partial/decentralised control
- Not reasonable to assume reducibility, linearity, time/context-independence, or closed/simplicity
- Not easy to apply classic scientific method
- Best understood by trying to recreate it



Bottom-up examples



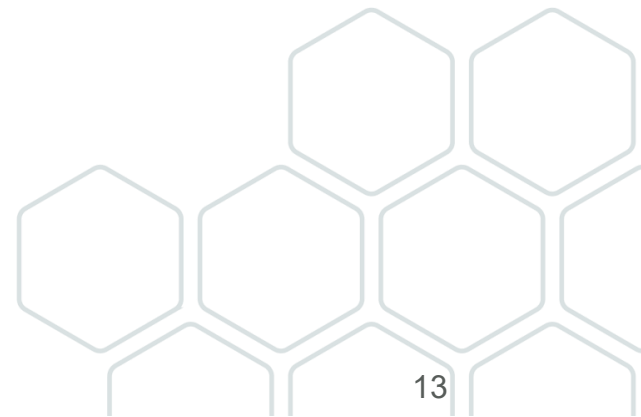
A school wants to know how to improve student attainment. Is this a bottom-up problem?



Agents – Artificial Intelligence

Artificial Intelligence

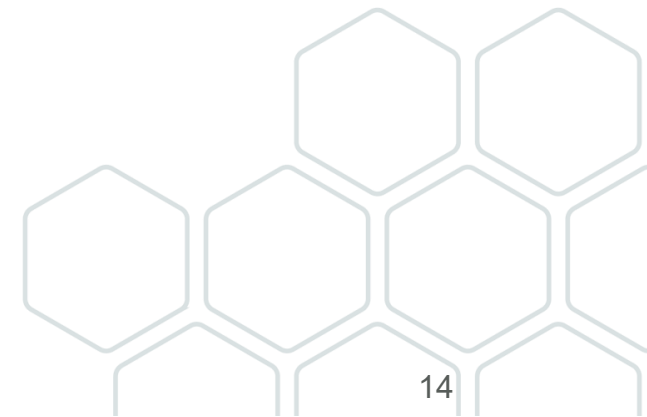
- Learners and/or problem solvers
- Autonomous
- Individual



Agents – Multi-agent systems

Multi-agent systems

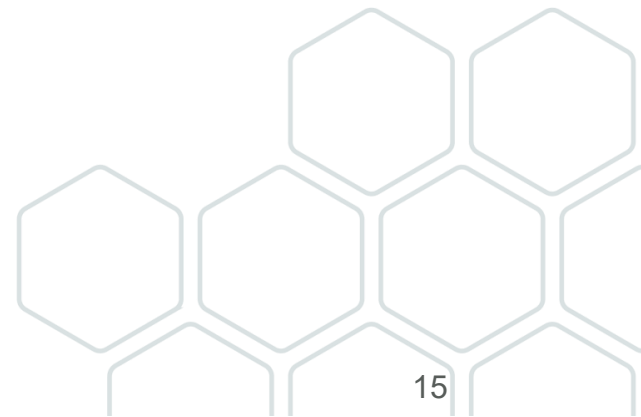
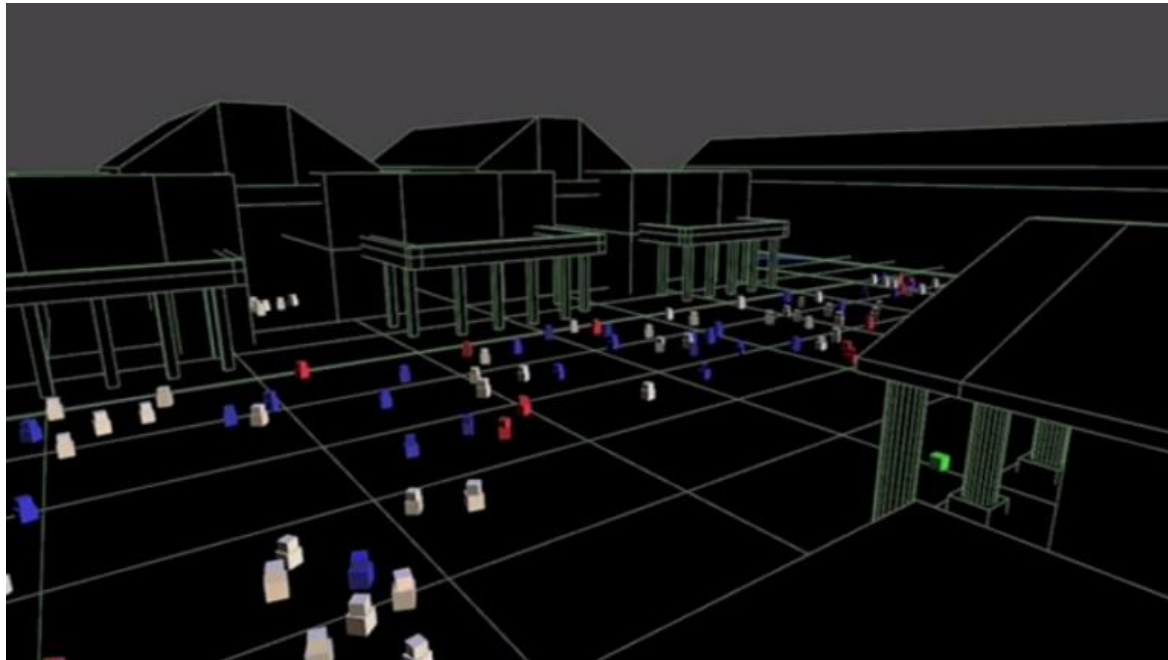
- Distributed control
- Specific problems



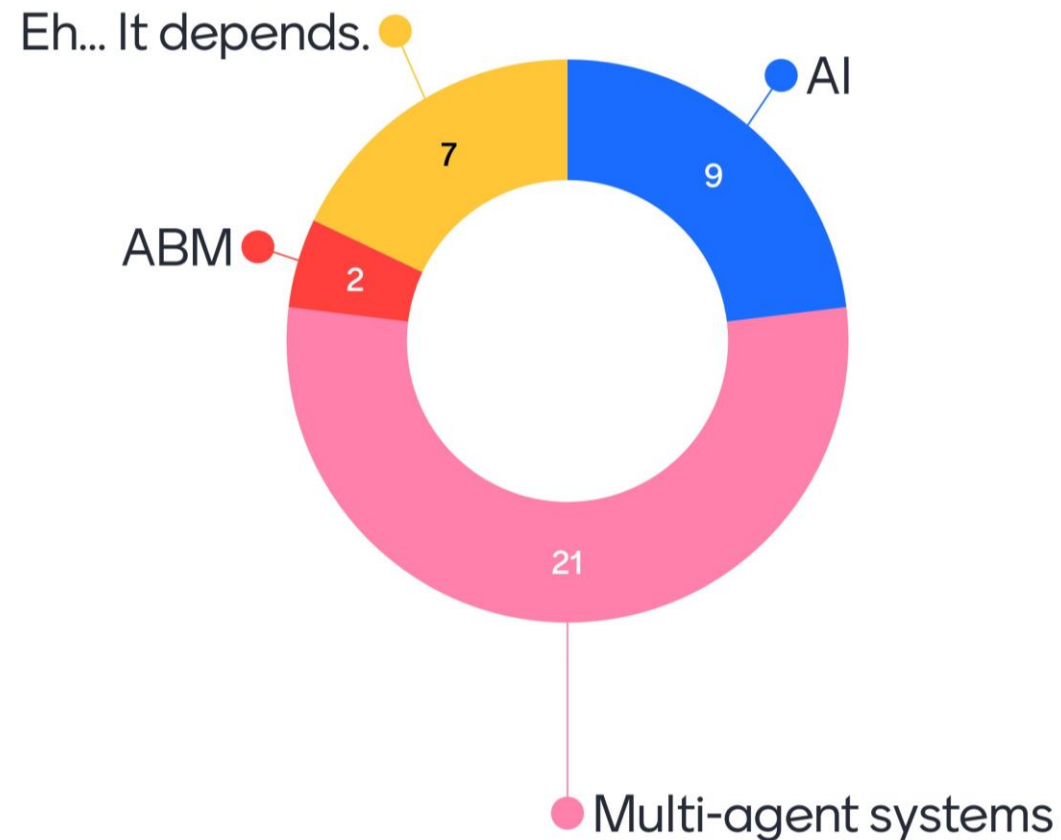
Agents – Three common views

Agent-based models

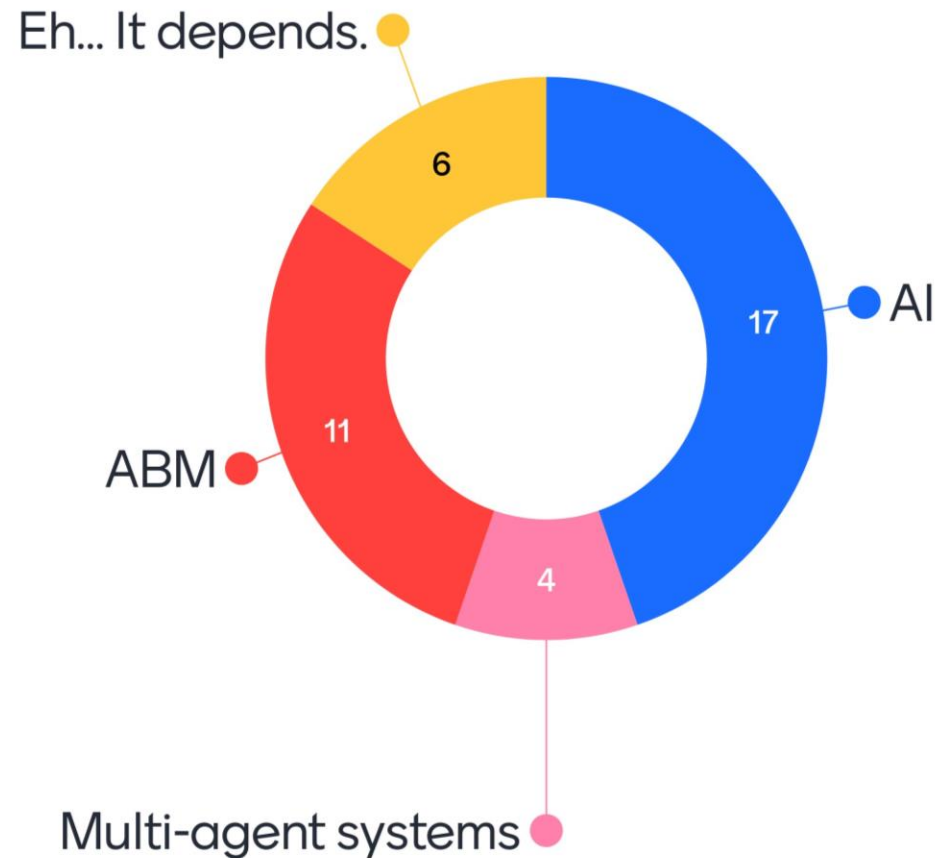
- Multiple
- Interacting
- Rule-based



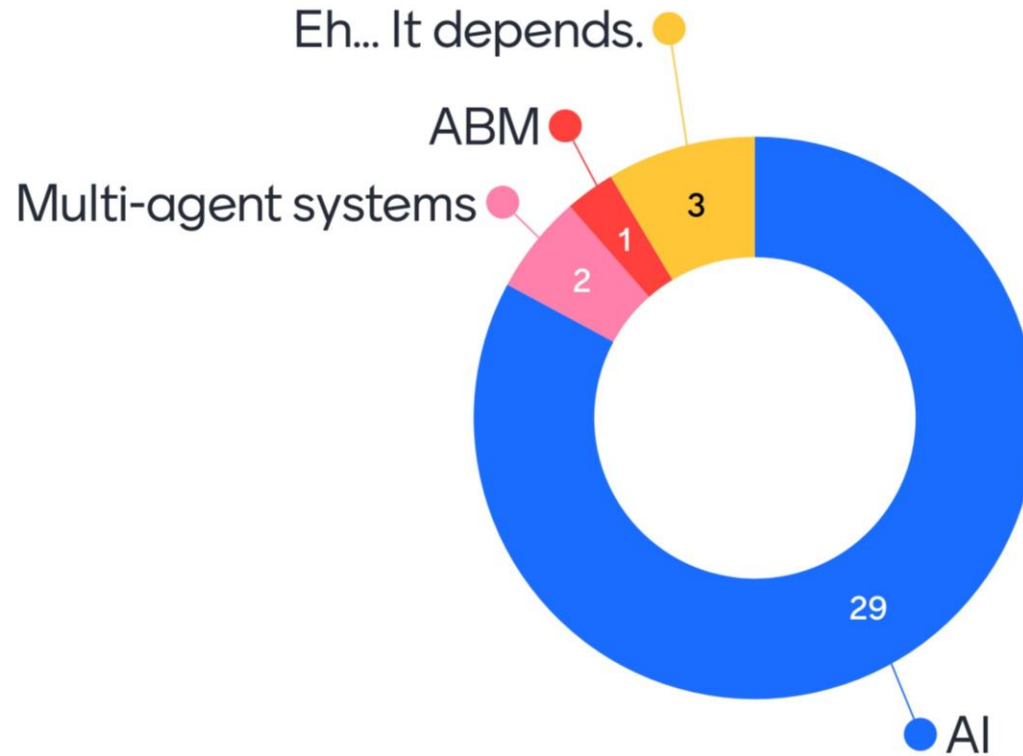
Are 'smart' traffic lights AI, multi-agent systems or ABM?



Are weather predictions AI, multi-agent systems or ABM?



Are self-parking cars AI, multi-agent systems or ABM?



Agent-based models have:

A simulated world that has:

- States
- Rules

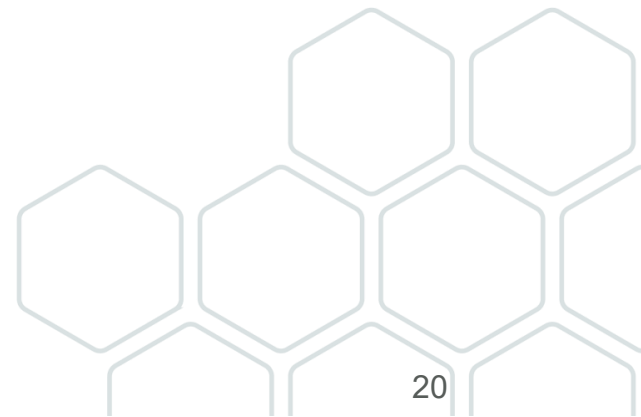
Objects and/or agents that have:

- States
- Rules



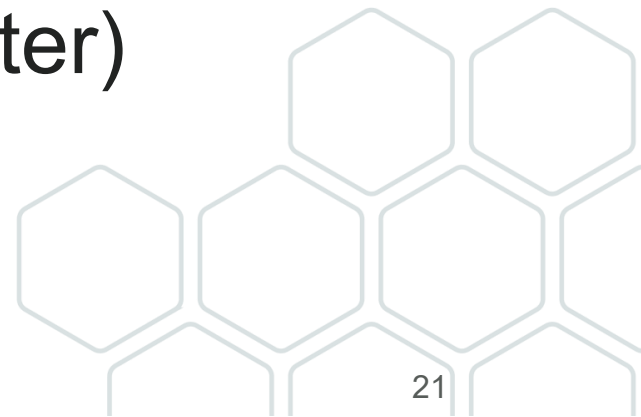
Agent-based models: The World can represent

- Any scale (family, city, country, etc.)



Agent-based models: The World

- Can represent any scale (family, city, country, etc.)
- Proceeds through time in discrete 'time steps'
- Includes potentially relevant factors (population, weather, infrastructure, laws, etc.)
- Is unique for each agent as it contains everything *e/se* (including other agents)
- Has states and follows rules (more on this later)



Agent-based models: The Agents can represent

- Most things (people, cars, unis, etc.)



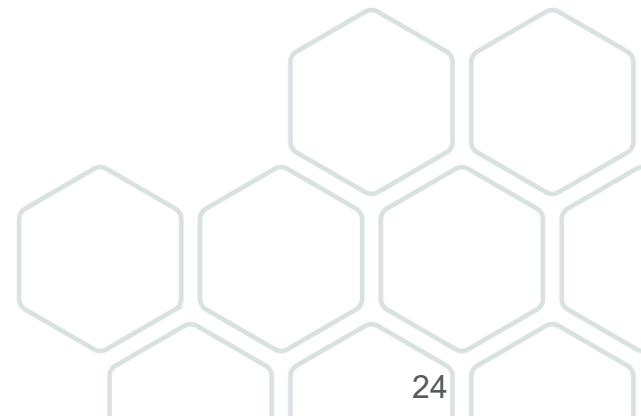
Agent-based models: The Agents

- Can represent most things (people, cars, unis, etc.)
- Includes potentially relevant factors (bank balance, age, colour, speed, competitive ranking, etc.)
- Are unique and behave uniquely
- Have states and follow rules
- Make decisions



Agent-based models: States are

- Sum of current features



Agent-based models: States

- Sum of current features
- Can be dynamic/static and can randomness
- Current state can **be influenced by previous state** (of self or others) according to rules
- Current state **can influence future state** (of self or others) according to rules



Agent-based models: Rules govern

- How states change or decisions are made



Agent-based models: Rules

- Govern how states change or decisions are made
- Use model generated info (states), modeller choice, randomness
- Can be simple or complex

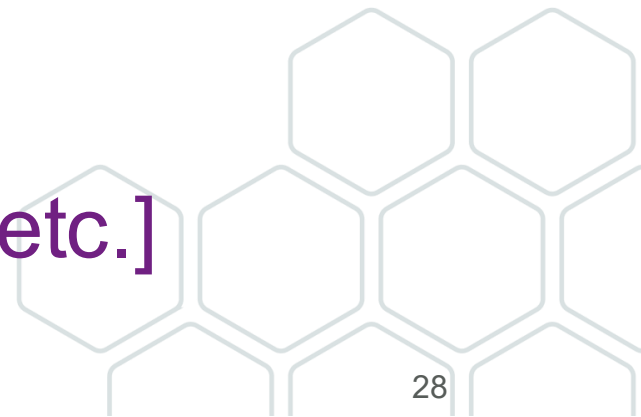


Example rules:

If [weather = raining] and [temp = cold]
 [travel by bus]
Else [travel by bike]

While [interest rates \leq X]
 [borrow and spend, do not save]

For each [school-age child in house]
 [spend X money on school fees/uniform/etc.]



A simple example - Virus

Virus - NetLogo

File Edit Tools Zoom Tabs Help

Interface Info Code

Edit Delete Add abc Button

normal speed

ticks: 96

view updates on ticks

Settings...

number-people 150

setup go

infectiousness 65 %

chance-recover 75 %

duration 20 weeks

turtle-shape person

%infected	%immune	years
4	43.2	1.8

Populations

248

people

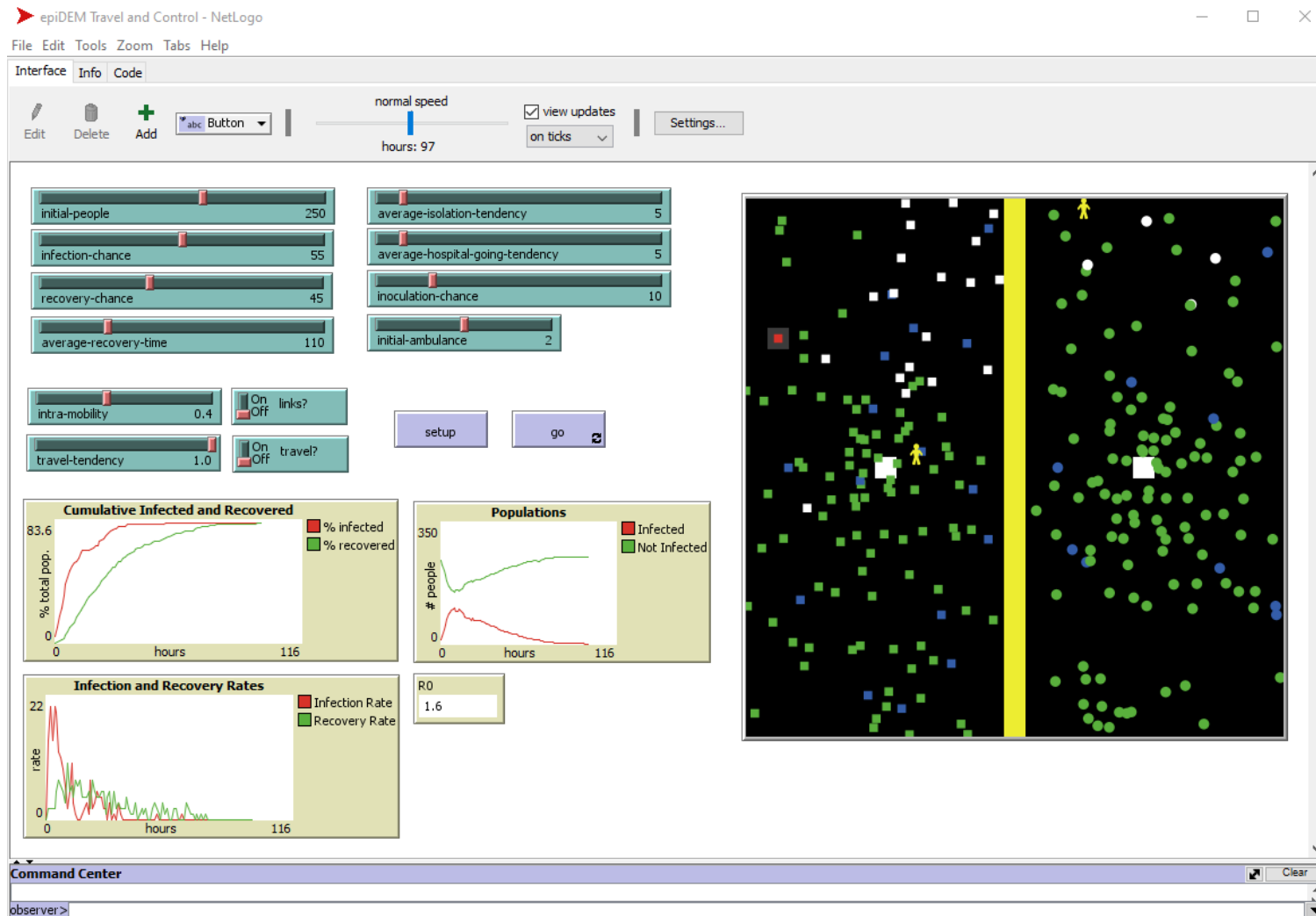
0 105 weeks

■ sick
■ immune
■ healthy
■ total

Command Center

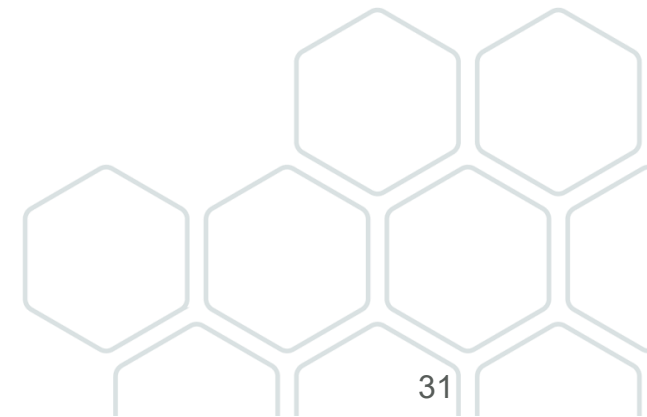
observer >

A complex example - Virus



OK... but why an ABM?

How things will interact is not intuitive.



Test your intuition.

Try to imagine what will happen in the complex virus model if we change:

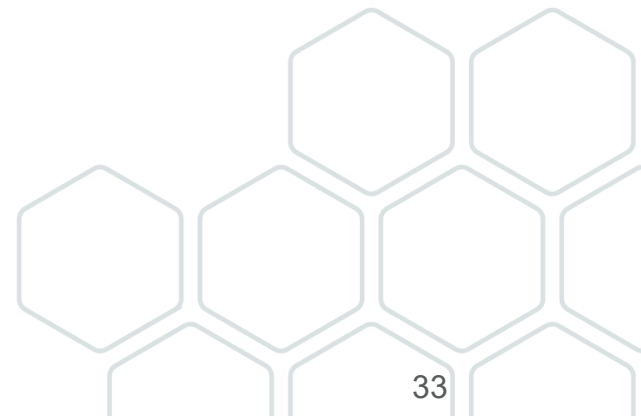
- Number of agents?
- Infectiousness?
- Change of recovery?
- Average recovery time/duration?
- Anything else not in simple model (e.g. likelihood of going to hospital, etc.)



What to do with the output?

Depends on the ABM, but common options include:

- Parameter sweeps and/or interaction testing
- Outcome probabilities
- Emergent phenomenon identification
- Export to other analysis method (e.g. social network analysis)

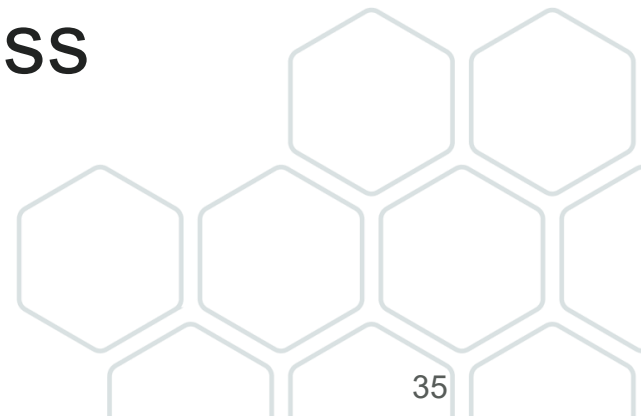


Pros of ABM

- No need to rely on intuition for complex behaviours
- Formalise mental models for inspection by others
- Force abstract concepts into concrete representation
- Relatively cheap/easy way to test the 'untestable'
- Potentially very fast
- Can show range of possible futures
- Can use real data, training data, random data, etc.
- Can run multiple times (with or without changes)
- Can be very intuitive

Cons of ABM

- Mental models (and ABM based on them) can be tricky to reflect critically on
- Concrete representations may not adequately capture abstract concepts
- Speed lends itself to ‘prediction’
- Possible futures are hard to turn into risk profiles
- Can give false sense of security and truthiness
- Computational methods may motivate distrust/unwarranted trust
- Easy to misunderstand



Platforms, languages, etc.

Free, open-source, relatively small download size, tutorials and info available on web

- Mason – focus on easy to learn, not most well recognised
- Repast – more powerful, steeper learning curve
- NetLogo – built in visualisation, not most powerful
- EMLab-Agentspring – modular, not most well recognised
- Object-oriented software (e.g. Python) – extremely powerful, not targeted, hard to learn/find answers

Resources for learning more

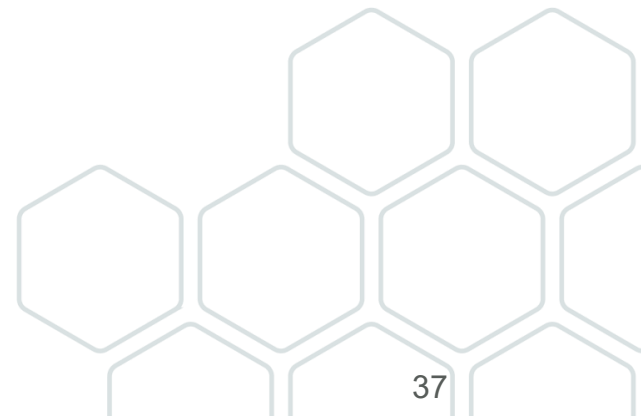
https://en.wikipedia.org/wiki/Comparison_of_agent-based_modeling_software

https://en.wikipedia.org/wiki/Agent-based_model

<https://www.comses.net/>

<https://ccl.northwestern.edu/netlogo/docs/dictionary.html>

<https://ccl.northwestern.edu/netlogo/docs/tutorial1.html>



Summary

Top-down: reducible, isolatable, straightforward

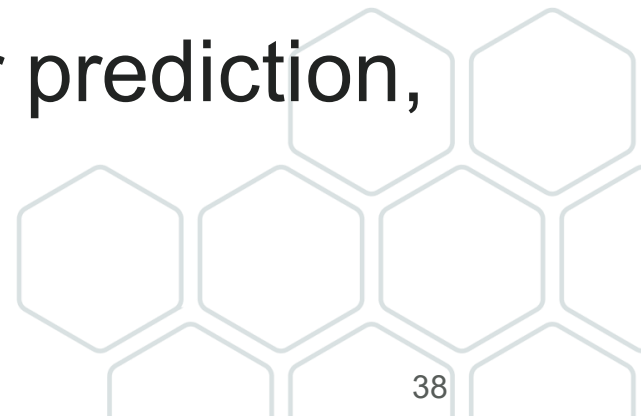
Bottom-up: non-intuitive large-scale effect of many small acts

Agents: heterogeneous actors that observe, decide, act

ABM: bottom-up simulation with easy testing

Pros: can be inspected, cheap, easy, fast, can do 'impossible' experiments

Cons: simplify complex concepts, misused for prediction, misunderstood



What would you use ABM to explore? 1

Media Discourse

inequality

Language evolution

Covid spread

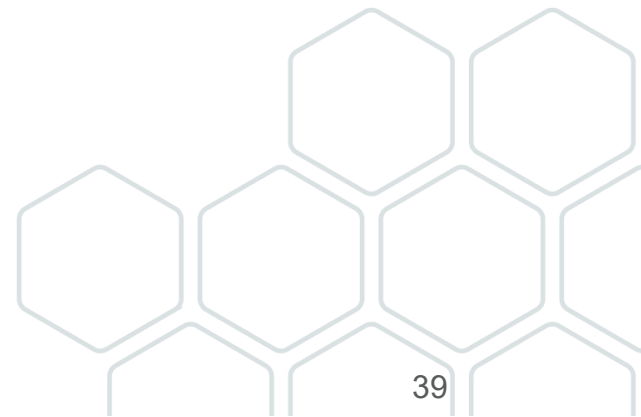
I'm a psycholinguist. So, if possible, the way in which different components of the processing system interact.

Obesity

Social systems - Pandemics, Racism, voting spreads

adoption of cycling

Spread of ideas in a population



What would you use ABM to explore? 2

social system

Pupils progress in the educational system

humanitarian system

Disease modeling in tropical region

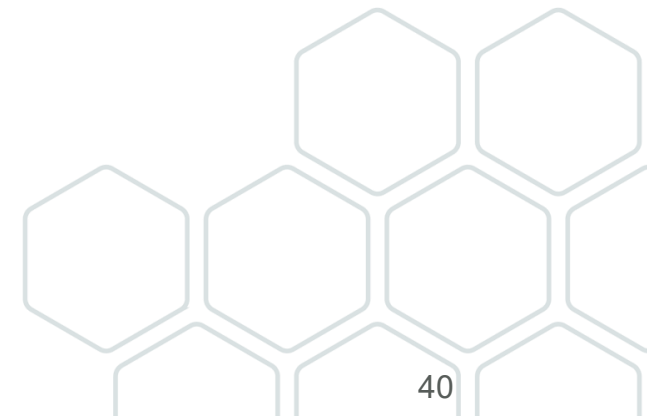
Complex system dynamics

technology adoption

Friendships, collaborations

survival

migration



What would you use ABM to explore? 3

How policies effect social phenomenon

conflict

Agri-Tech and animal farming systems

collective action

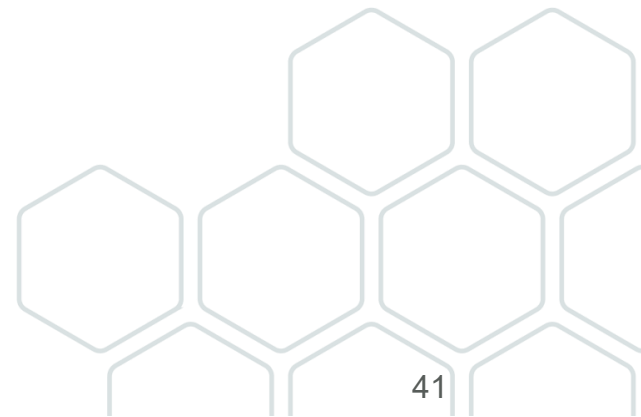
information dissemination

Pest suppression (insects) at the landscape scale by farmers?

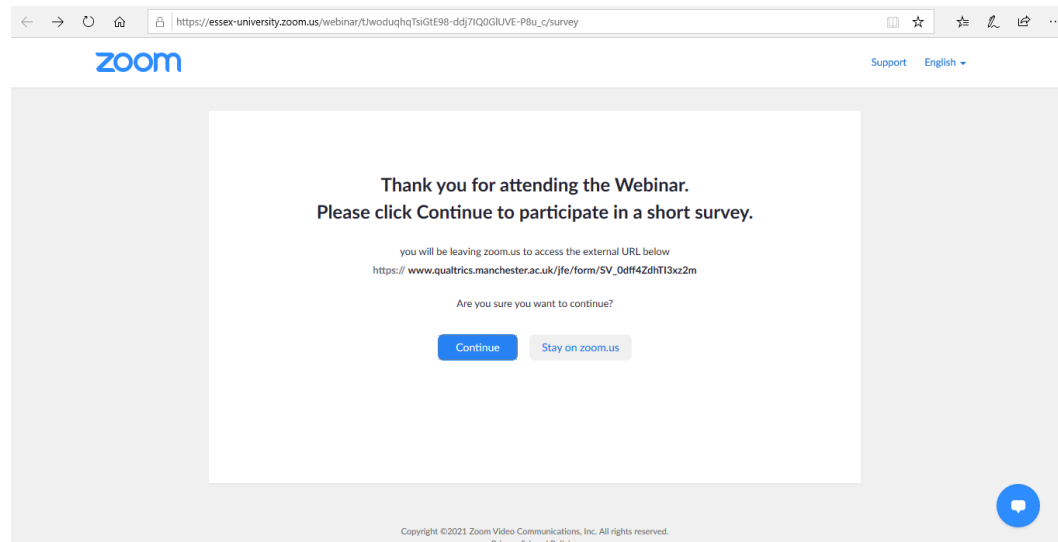
Interactions and affects of agents you can't predict the actions of - people, dogs, trams

Riots

Stress and mortality in certain groups



Evaluation



When you leave the webinar, please complete our short survey.

Just click on 'continue' to access the survey.

Thank you.

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