

Introduction to Agent-Based Modeling in Netlogo

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Amaluzing
ABM Data

Setting and Getting a Random Seed

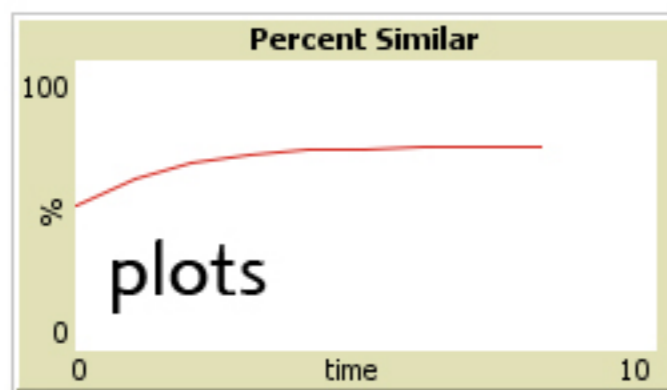
- If you want to reproduce a run, you need to know the random seed.
- You can set the random seed yourself: `random-seed #`
- You can get the next random seed Netlogo picks: `new-seed`
- Code in monitors and sliders do not affect the random numbers.
- More info in the Programming Guide and Code Example.

Data Analysis for Agent-Based Models

- First stage is immediate model feedback (display, plots, monitors).
- Data collection using Behavior Space.
- Data plotting and analysis in other software (e.g., Excel, Stata).
- Statistical considerations for ABM data.
- Informative comparisons and not just summaries.

Getting Data from Models

- Runtime Feedback:

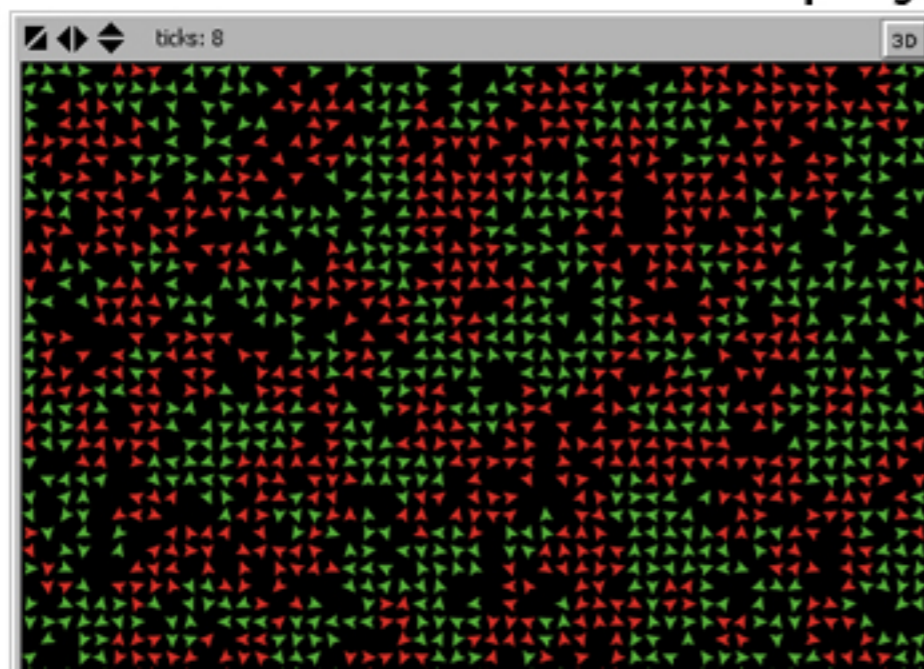


% similar
70.6

% unhappy
0

monitors

display



command center

```
Command Center  
observer> show [similar-nearby] of turtle 20  
observer: 5  
observer >
```

Getting Data from Models

- Using the [Behavior Space Tool](#) for “drone” runs:
- Sweeps Variables Setable from Interface
- Can Run Different Experiments on the Same Model
- Specify How Many Repetitions for each Variable Combo
- Specify Output Variables
- Specify Setup, Go, Stop and Post-Run Commands
- A Time Limit Can Be Specified Separately
- **NOTE:** for Excel specify “[Table](#)” format for output

Getting Data from Models

SegregationEnhanced v07 - NetLogo (E:\Academics\Complex Systems)

File Edit Tools Zoom Tabs Help

Interface

Edit Delete

setup

number-

number-

number-

%-similar-wanted-green 30 %

%-similar-wanted-red 30 %

%-similar-wanted-yellow 30 %

mutation-rate 0.0 %

Green 0.333

Red 0.333

yellow 0.333

normal speed

BehaviorSpace

Experiment

Experiment name

Vary variables as follows (note brackets and quotation marks):

```
[ "learning?" false ]
[ "%-similar-wanted-red" 30 ]
[ "number-yellow" 660 ]
[ "%-similar-wanted-green" 30 ]
[ "number-green" 660 ]
[ "mutation-rate" 0 ]
```

Either list values to use, for example:
["my-slider" 1 2 7 8]
or specify start, increment, and end, for example:
["my-slider" [0 1 10]] (note additional brackets)
to go from 0, 1 at a time, to 10.
You may also vary max-pxcor, min-pxcor, max-pycor, min-pycor, random-seed.

Repetitions
run each combination this many times

Measure runs using these reporters:

```
count turtles
```

one reporter per line; you may not split a reporter across multiple lines

Measure runs at every step
if unchecked, runs are measured only when they are over

Setup commands:

Go commands:

Stop condition:

Final commands:

the run stops if this reporter becomes true

run at the end of each run

Time limit
stop after this many steps (0 = no limit)

OK Cancel

Getting Data from Models

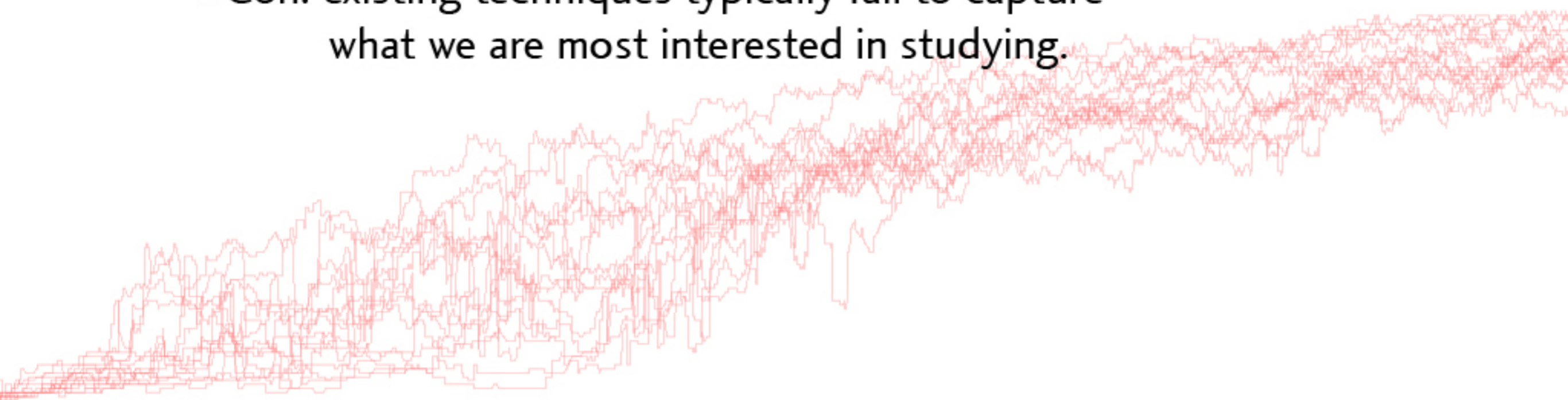
- How much data should you collect? As much as you can!
- The more runs you do for each parameter combination the more characteristic your sample is and the more confident your analysis will be on measuring the features.
- The more parameters combinations you run the more robust your analysis and the more likely you'll find interesting features.
- Recording at every time allows you to measure dynamics rather than just outcomes.

Getting Data from Models

- Constrained by the runtime of your model.
- Constrained by the time to analyze the data.
- Constrained by your ability to analyze data.
- Informed by your purpose for collecting the data.
- Informed by how you are going to use and present the data.

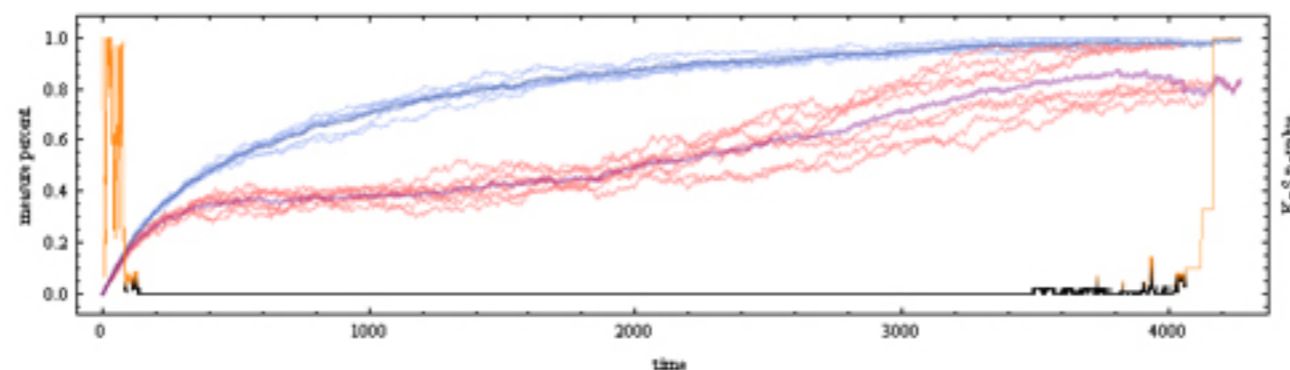
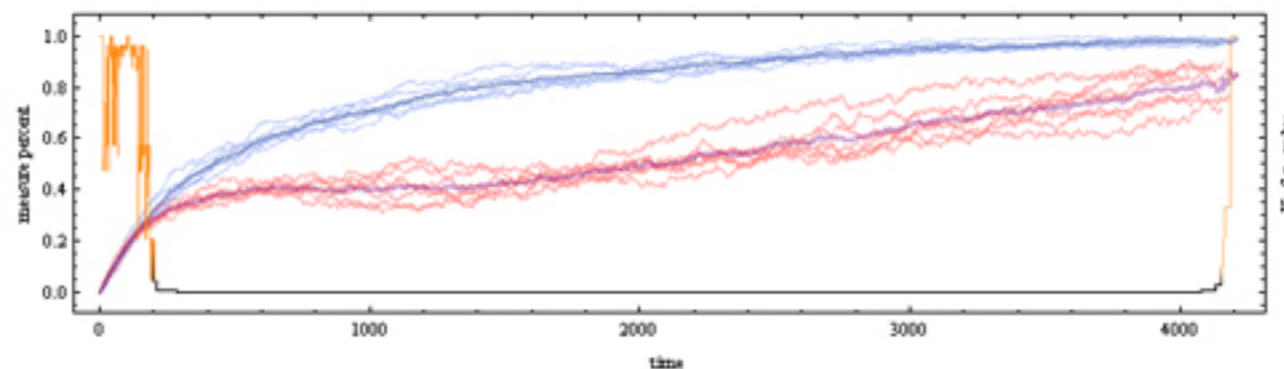
Data Analysis for ABMs

- Agent-based models are like empirical experiments.
- The output is time-series observational data.
- Pro: there already exists a plethora of techniques to analyze this sort of data.
- Con: existing techniques typically fail to capture what we are most interested in studying.



Data Analysis for ABMs

- Before you know what analysis is appropriate for your data you may need to do some exploratory analysis.
- Visualizations are often helpful guides to where to look closer.

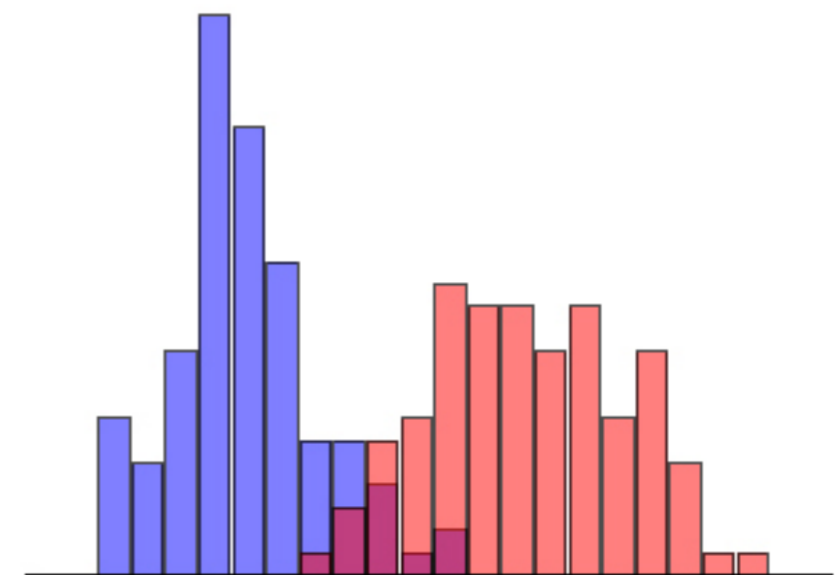


Data Analysis for ABMs

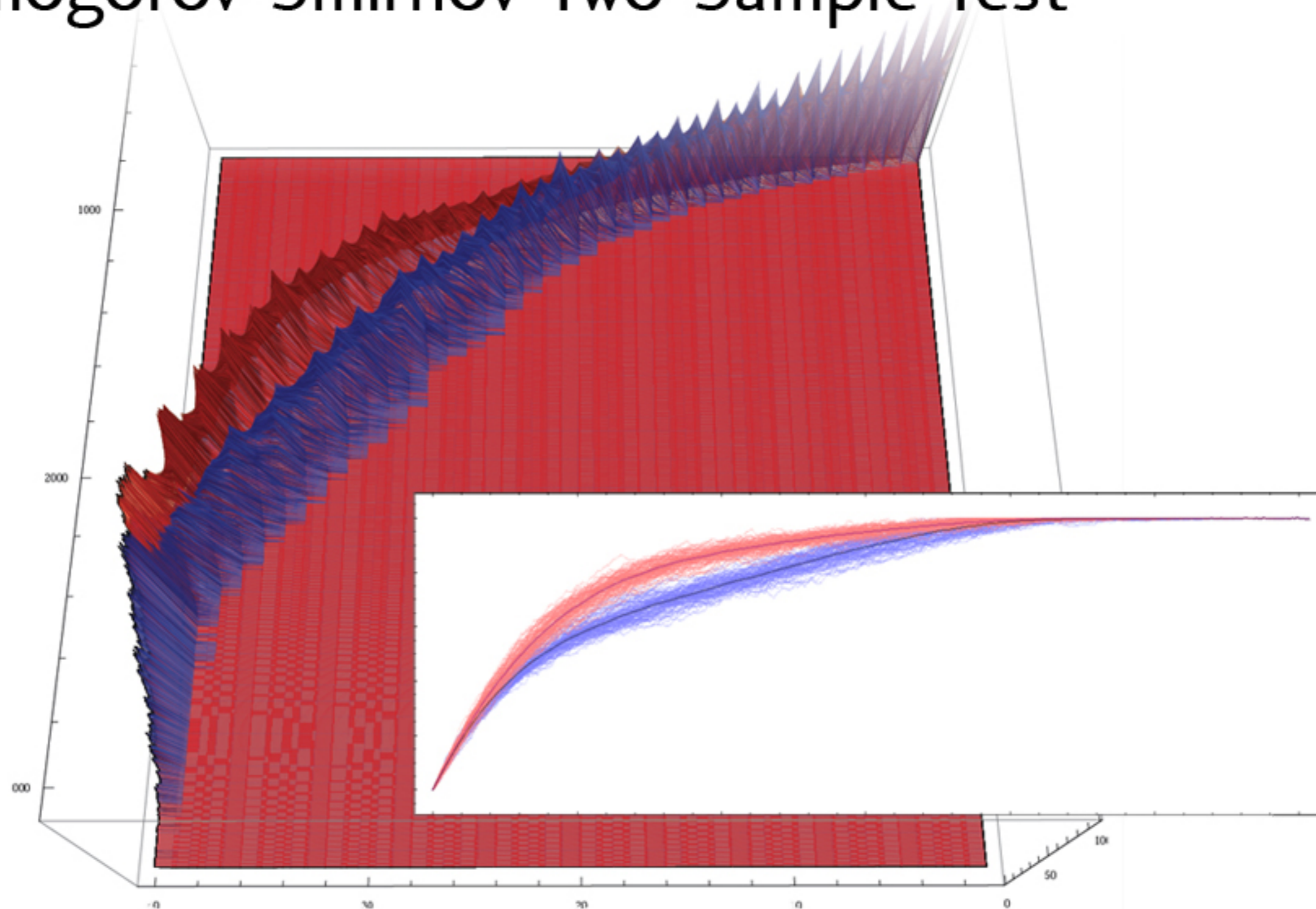
- **Don't Aggregate Your Data.**
- The mean is useful to smooth out random perturbations in your data, but variation in ABM output isn't just random.
- If there were good statistical models for complex systems, then you wouldn't have needed to build an ABM.
- Simplifying to "representative" cases or averages throws away data critical to understanding model complexity.
- Instead, use visualization and descriptive techniques that utilize all your precious output data.

Kolmogorov-Smirnov Two-Sample Test

- Nonparametric statistical technique.
- Generates the empirical cumulative distribution functions from each data sample.
- Compares each point from each sample to the other sample's distribution to determine membership probability.
- Yields the probability that the two samples could have been generated from the same continuous distribution.

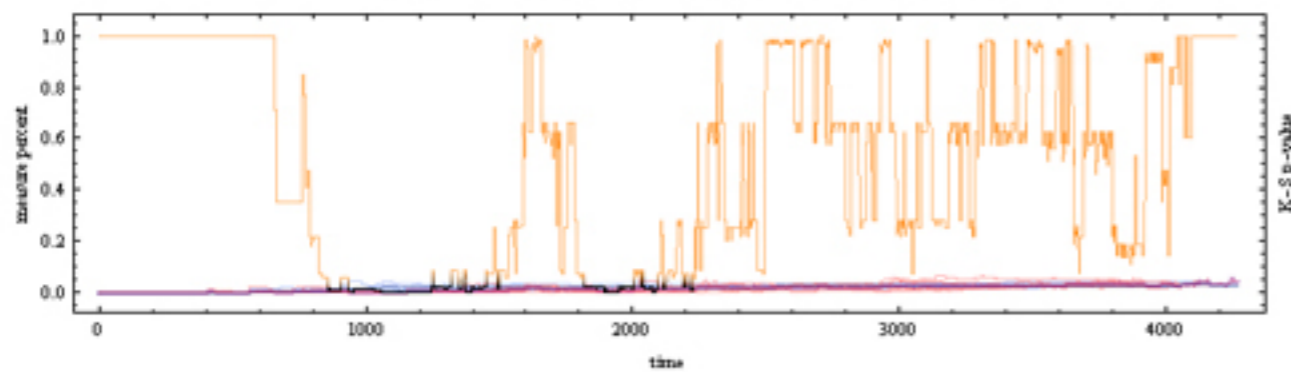


Kolmogorov-Smirnov Two-Sample Test

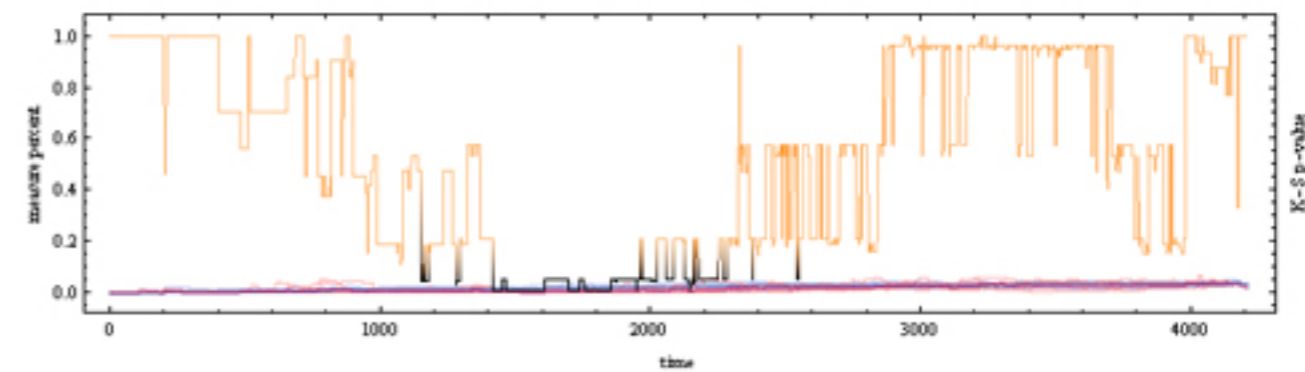


Kolmogorov-Smirnov Two-Sample Test

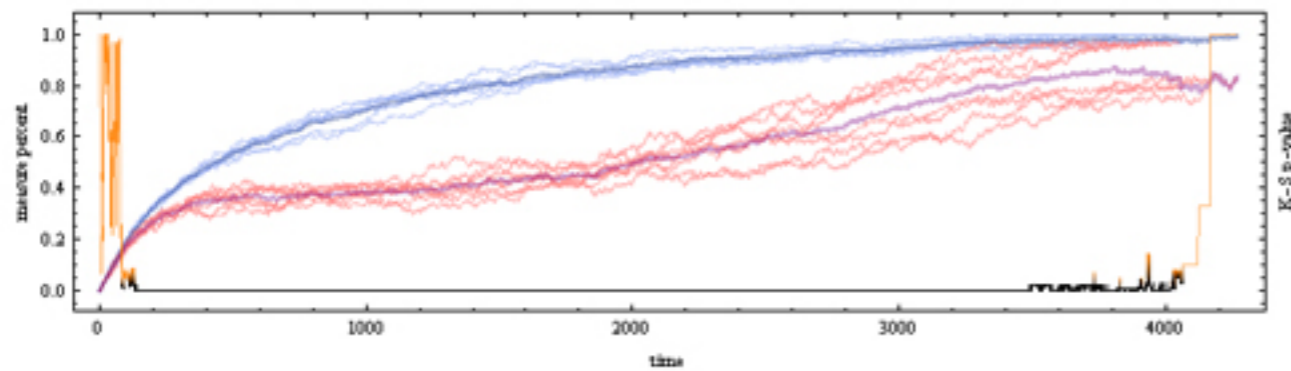
prisoners' dilemma: FALSE-FALSE-FALSE: mean clustering coefficient



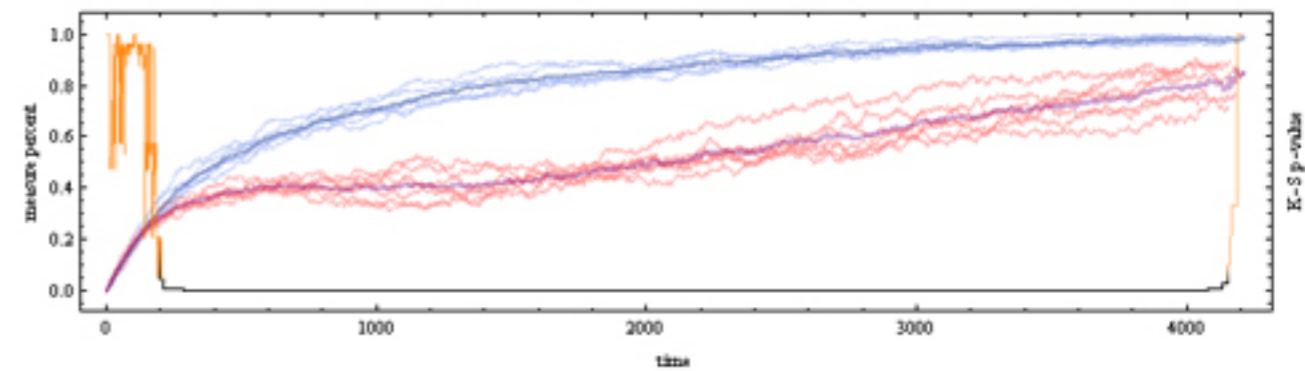
prisoners' dilemma: FALSE-FALSE-TRUE: mean clustering coefficient



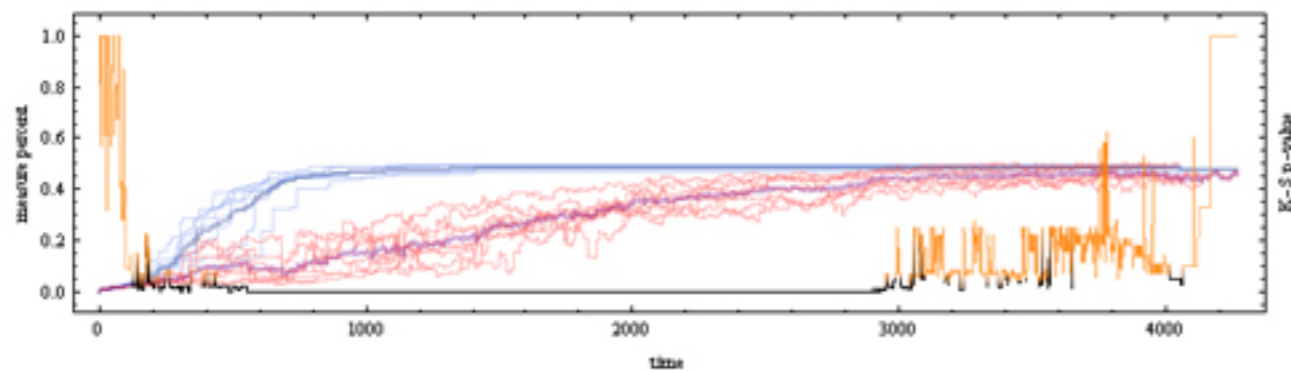
prisoners' dilemma: FALSE-FALSE-FALSE: mean same-type neighbor percentage



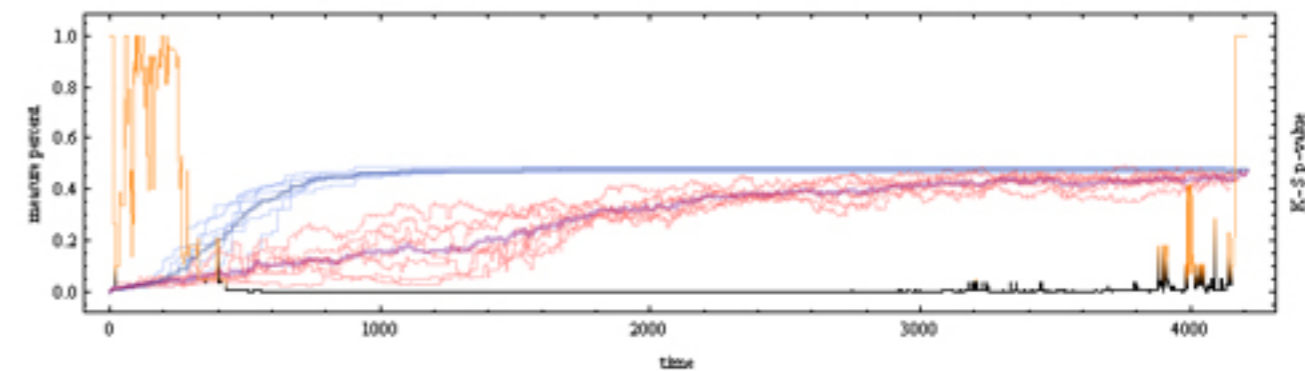
prisoners' dilemma: FALSE-FALSE-TRUE: mean same-type neighbor percentage



prisoners' dilemma: FALSE-FALSE-FALSE: giant component size

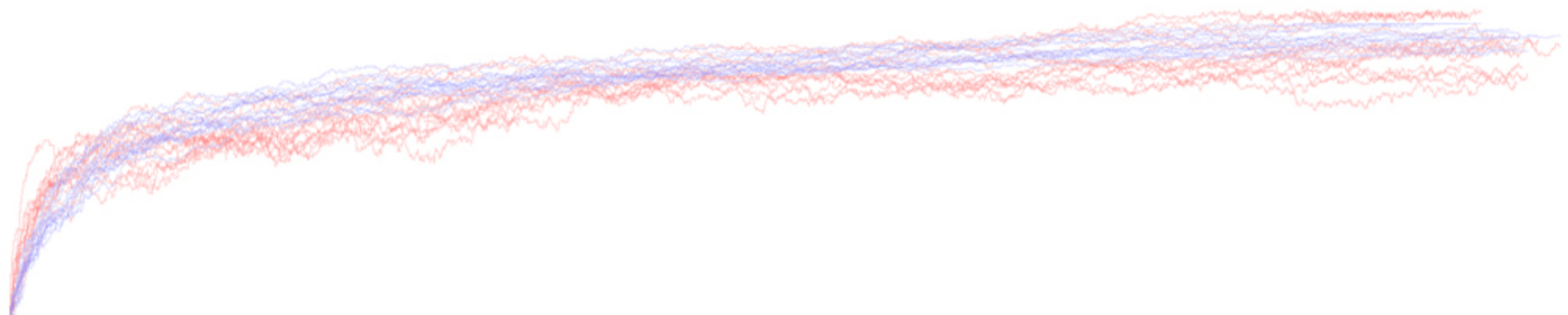


prisoners' dilemma: FALSE-FALSE-TRUE: giant component size



Siegel-Tukey Test of Differences of Variances

- Ranks values from two samples by how extreme they are.
- Sum the ranks within each sample.
- Lower score is more extreme (highly variable).
- Higher score means values clumped near collective median.
- Nearly same score (accounting for size) means no difference.



Compare Variables over Time

- For validation, verification, and calibration compare the same feature in ported/docked models or empirical data.
- Same characteristic of two or more populations in a model.
- Effect of a parameter change on a model variable, e.g. sensitivity through parameter sweeps.
- And of course there are more tests, measures, and applications already available and under development.

