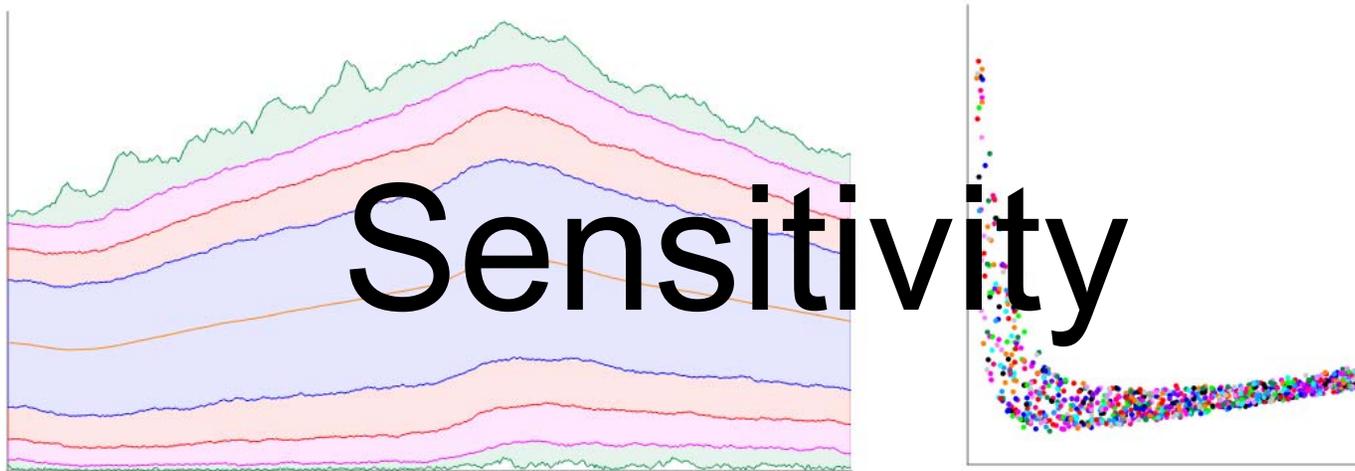


Sensitivity

with Stella®

the presentation will begin shortly...



Sensitivity

with Stella®

Presented by Bob Eberlein --- November 7, 2018

Webinar Mechanics

Grab tab

Enables you to hide or display control panel and toggle between full-screen and window mode



Audio setup

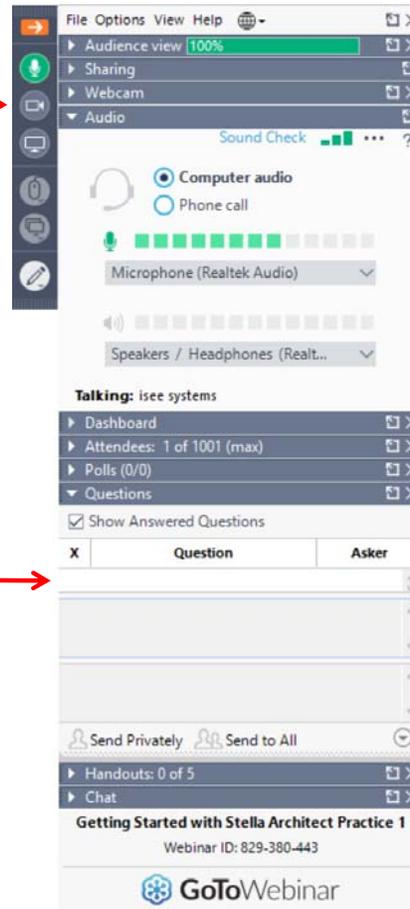
Allows you to test your audio

Also make sure your volume is turned up and your speakers are not muted.



Questions

Submit your questions here at anytime during the Webinar



Today's Topics

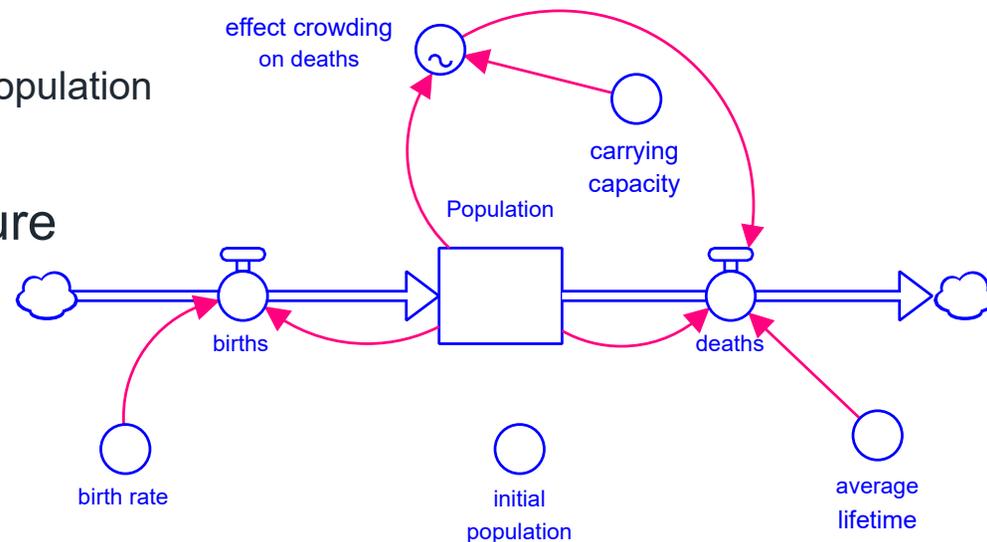
- Why we build models
- Comparative graphs, experiments and Stella Live™
- Formalizing experimental execution
- Viewing results
- Variation and randomness
- Characterizing system types
- Summary observations and extensions
- Q & A

Why we Build Models

- Models are a way to help us deal with the real world
 - Understanding
 - Explanation
 - Experimentation
 - Action
- Sensitivity has to support that endeavor
 - Experimentation
 - Understanding
- Sensitivity tells us about models
 - Models tell us about the real world
- It is also fun, and makes interesting looking graphics

Comparative Graphs, Experiments and Stella Live™

- Start from a simple carrying capacity model (SimpleCarryingCapacity.stmx)
- What happens when there are too many people in the room
 - See what happens when we adjust initial population
 - Carrying capacity
- What happens when there is pressure
 - Birth rate
- This is vehicle for understanding
 - The model
 - The underlying system

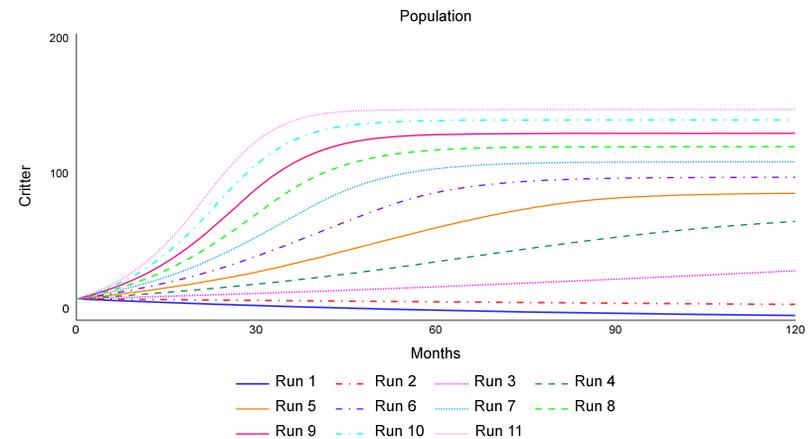


Basic Mechanics of Sensitivity

- Go to panel for the model
- Specify what parameters to vary (birth rate)
 - Distributions (incremental, 0 to 0.1)
 - Number of runs (11)
 - All combinations
 - Limited runs is the same here
- Do an S-Run
- Review results
- It is almost too easy
 - It is the variation that provides richness

Viewing Results

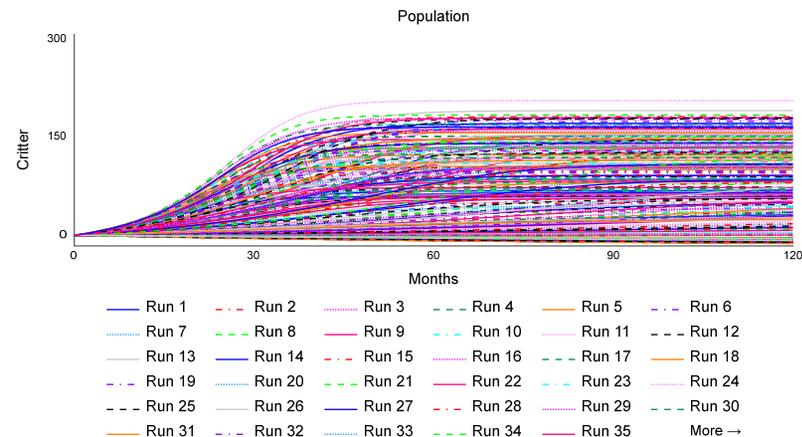
- The comparative graph
 - Close to full information
 - Can scrub to see values
- The comparative table
 - As much detail as desired
- Both work well with a small number of runs
 - Get confusing with many runs



	0	1	2	3	
Run 1: Population	15.0	14.8	14.6	14.4	^
Run 2: Population	15.0	15.0	14.9	14.9	
Run 3: Population	15.0	15.1	15.2	15.3	
Run 4: Population	15.0	15.3	15.5	15.8	v

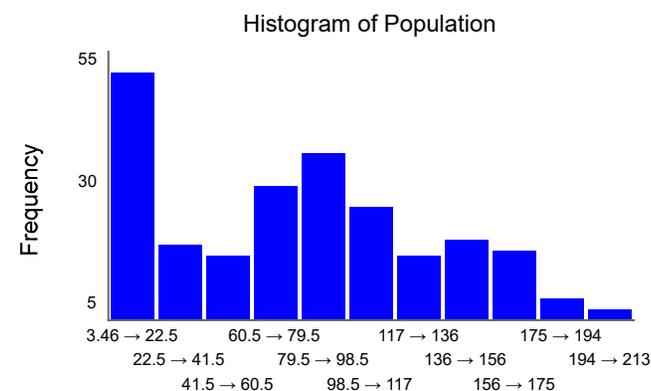
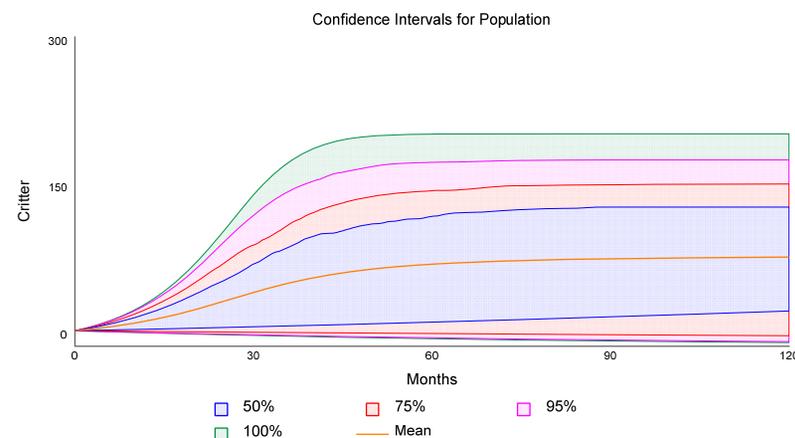
Setting up a Second Sensitivity Analysis

- Can have multiple sensitivity setups
 - Switch between them
 - Just a plus away
- Setup works the same way
 - birth rate 0 to 0.1
 - carrying capacity 50 to 150
 - Number of runs 250
 - Leave at random sampling for now
- Need to activate
 - Activate and run, or check and S-Run



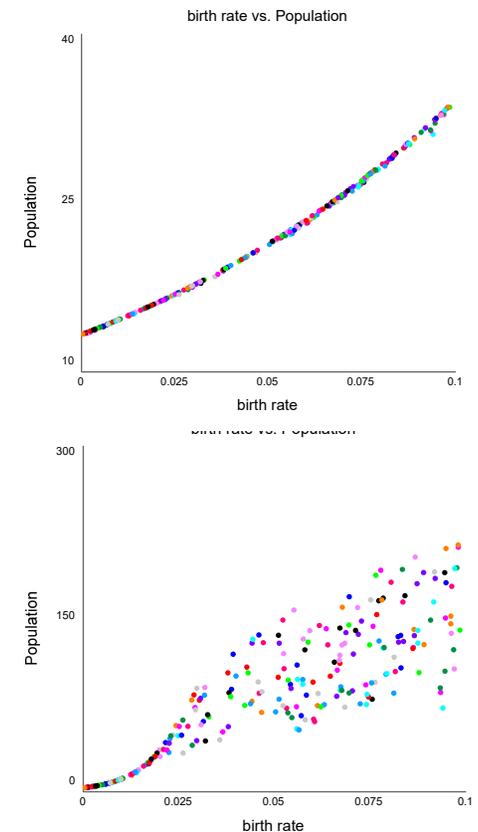
Different Types of Comparative Graphs

- Confidence (Percentile) graphs
 - Count the number of runs in different value ranges
 - Shade the different confidence bounds
 - Show the distribution over time
 - But not the individual runs trajectories
 - Individual runs will migrate between shaded areas
- Percentiles on Tables
 - Same content, but one sided
 - The 50% on a graphs starts at 25% and ends at 75%
- Histograms
 - A slice through a confidence plot



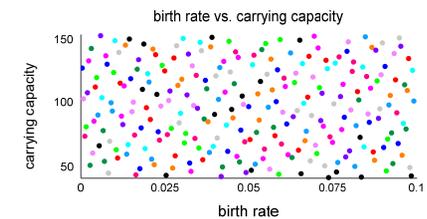
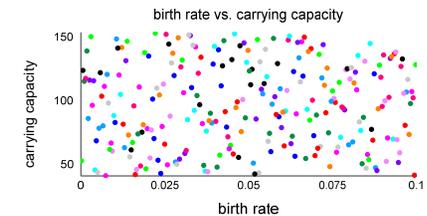
Comparative Scatter Graphs

- Scatter Graphs compare two value
 - At a time
- With sensitivity we can compare assumptions to outcomes
 - Over time by dragging the time slider
 - Early on capacity does not bind
 - Is this exponential growth?
 - Important property of exponential activity
- Bubble Chart add another dimension
 - Effect of crowding on deaths
 - Again most interesting dragging the time slider



Distributions, Latin Hypercube and Sobol Sequences

- We are selecting different points from distributions
 - I used incremental and uniform in the examples
 - Incremental covers a set of points always
 - Uniform was done with 2 variables and samples points
 - There are a number to chose from
 - Normal, Exponential, Weibull...
 - Which depends on purpose
- I used Limited Runs (random sampling)
 - Sobol sequences provide much better coverage in all dimensions
 - More complete exploration of the parameter space
 - Latin hypercube allows coverage with a much small number of runs
 - Guarantees that all subranges will be selected in all dimensions
 - Does not say anything about cross dimensional variety



Variation and Randomness

- So far we have studied a simple deterministic system
 - The sensitivity is around behavioral response of that system
 - Great way to learn about range of response
 - But not always about potential trajectories
- Consider the inventory workforce model (inven01.stmx)
 - We can see the response to increased sales
 - We can easily see the range of responses to the same input
- Suppose demand is random (inven02.stmx)
 - We can see the above sensitivities
 - But every run is different (NORMAL uses a seed of NAN)
 - How different can the different runs be
 - Sensitivity, with no inputs

Convergent, Divergent, and Stationary Systems

- **Convergent** (InfectiousDisease.stmx)
 - Variation in the infection rate
 - Final outcome is determinant
 - Project models have similar character
- **Divergent** (random01.stmx)
 - Variation in the return
 - Outcomes are dramatically different
- **Stationary**
 - The workforce inventory example
 - Everything looks the same at all times
 - We never know where we are

Summary Observations

- We are varying parameters to see how behavior changes
 - Automated, but fundamentally the same as hand experimentation
- We are seeing how result change as the assumptions change
 - Everything derives from trusty comparative graphs and tables
 - Often more about distributions than single outcomes
 - Can slice time with bar charts
 - Can use scatter graphs to link assumptions to final (or intermediate) outcomes
 - Can add nuance with bubble charts
- These are the foundational tools
 - What we do next is learn...

Questions?

Upcoming Webinar Topics:

Calibration and Data Handling

Using Stella to Trace Causality

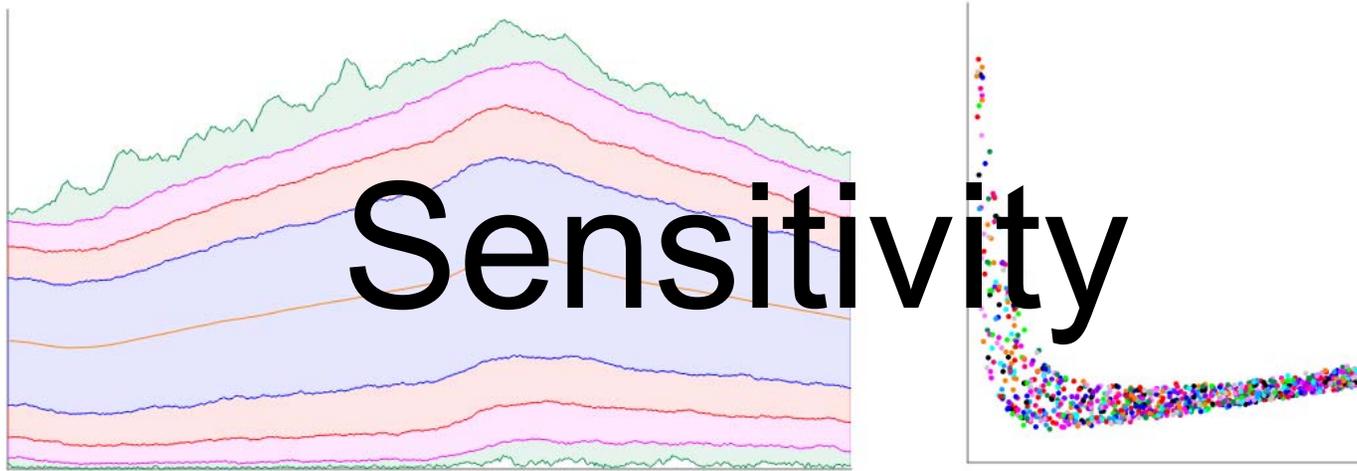
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Thank you!