

Introduction to Agent-Based Modeling

EES 4760/5760

Agent-Based & Individual-Based Computational Modeling

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Class #1: Tues. January 10 2018

Who Are You?

1. Who are you? (Name, year, major)
2. Computational skills (if any)
 - programming, statistical analysis, ...
3. What do you want to get from this class?
4. Ask me a question about computational modeling
5. Something interesting about yourself

Getting Started

For Thursday:

- Download and install NetLogo on your computer.
 - URL in syllabus and assignment sheet
- Set up Box account
 - Details in syllabus and assignment sheet
 - <https://vanderbilt.box.com>
 - Make folder for this class with your last name:
 - lastname_EES_4760 or lastname_EES_5760
 - Share it with me as Editor
 - Homework goes in subfolders:
 - HW_1, HW_2, ...

Agent-Based Modeling

- Simulate individuals:
 - Autonomous
 - Heterogeneous
 - Quasi-local
 - Bounded rationality
- Simulate environment
- Emphasize simplicity, minimal assumptions
- **Emergence:** Large-scale phenomena arise from small-scale individual interactions
 - Interesting when large-scale is not easily predicted from small-scale

Simple Experiments

- Play with economics
 - Simple agents trade with each other
 - Confirm 1st welfare theorem:
Trading leads to Pareto equilibrium
 - Find conditions for satisfying theorem:
 - Not necessary for traders to be completely rational
 - How much rationality do you need?
 - Equilibration can be slow
 - Time-varying preferences can prevent equilibration
- Dynamics of agent-based models connect to nonlinear dynamics and chaos

Economics of Cooperation

Game Theory

- Prisoner's Dilemma Game:

| A \ B | B Cooperates | B Defects |
|--------------|--------------|-----------|
| A Cooperates | (3,3) | (0,4) |
| A Defects | (4,0) | (1,1) |

- Nash Equilibrium:
 - No matter what player A does, player B is better off defecting
 - No matter what player B does, player A is better off defecting
 - **End result:** Both players end up worse off than if they had both cooperated.

Iterated Prisoner's Dilemma

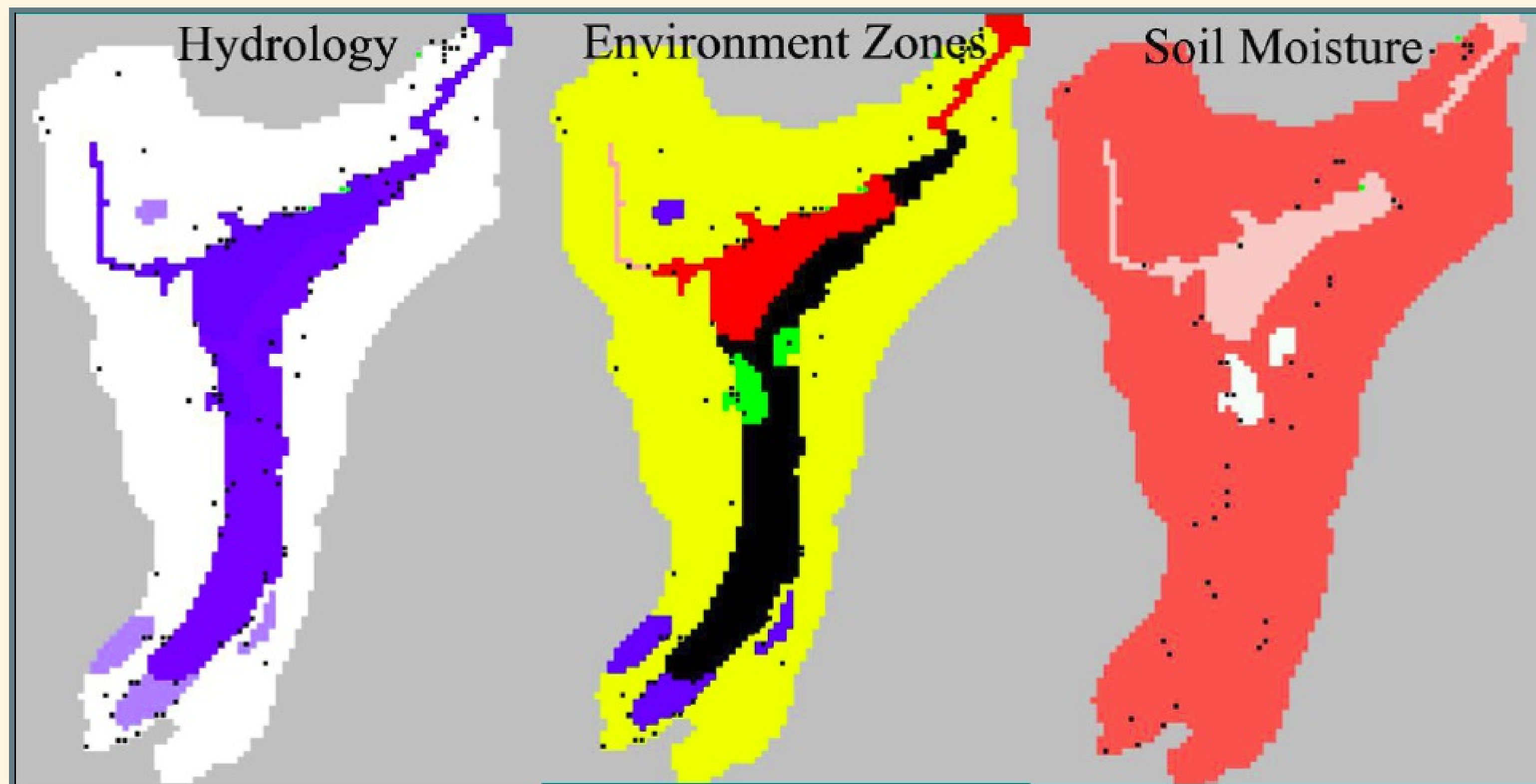
- R. Axelrod (1981)
- Tournament of algorithms
- Winner: "tit-for-tat"
- Evolutionary Game Theory:
 - Basic principles of good strategies:
 - Be nice
 - Be provocable
 - Don't be too envious
 - Don't be too clever
- Nay & Gilligan (2015)
 - Real-world strategies involve randomness, unpredictability

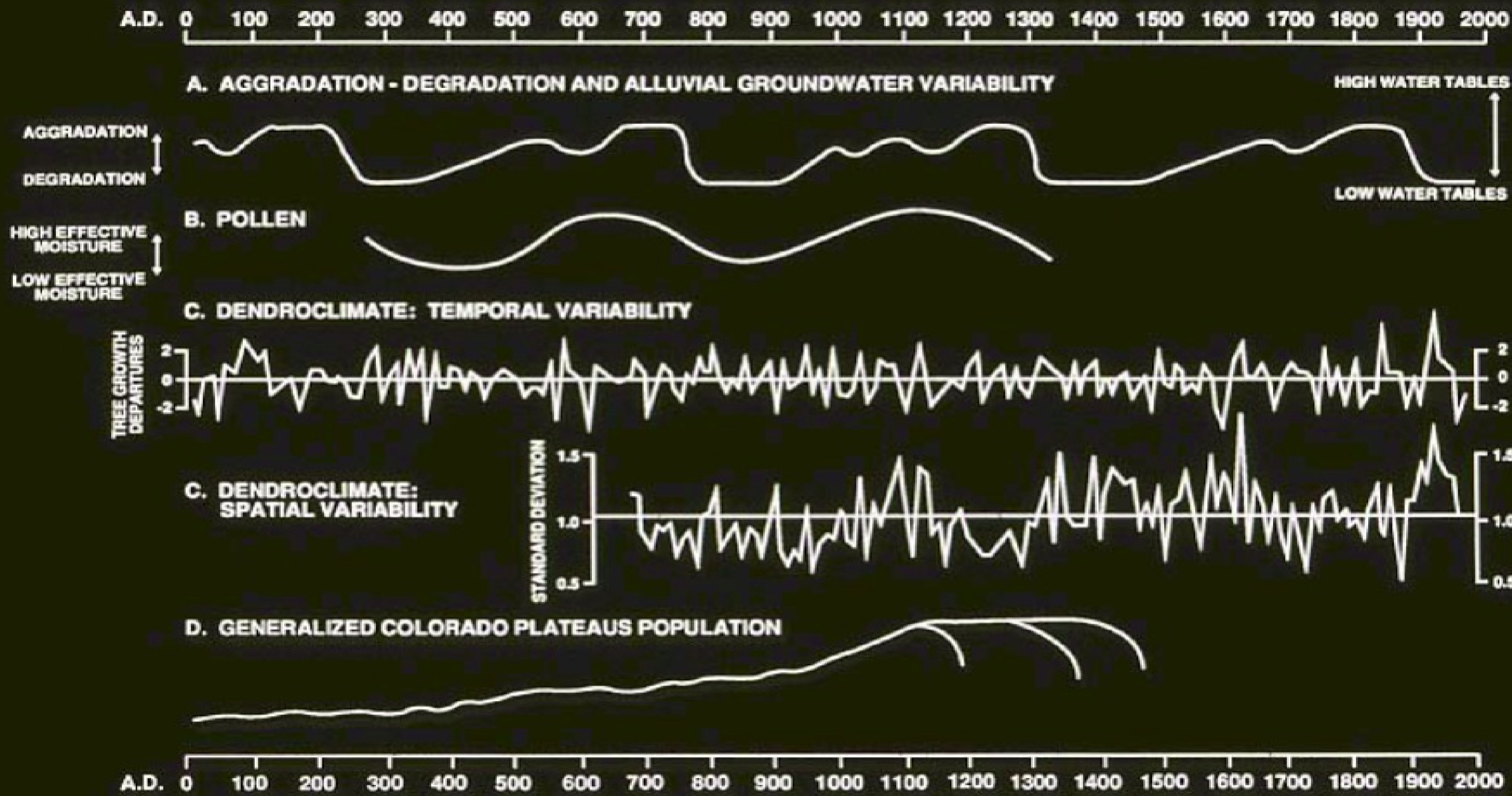
Example: Artificial Anasazi

Axtell, Dean, Epstein, *et al.*



Modeling Environment

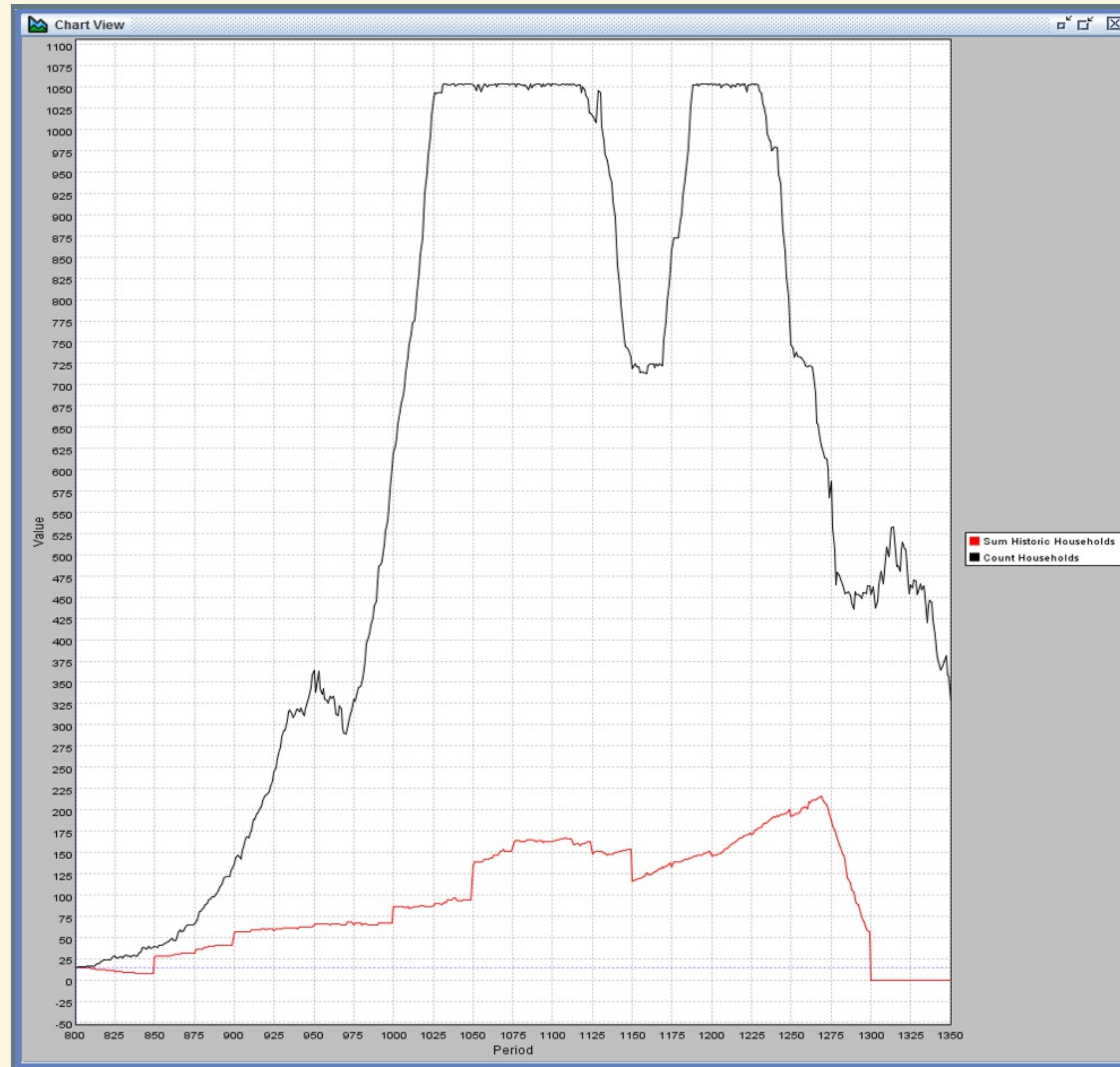




Constructing model

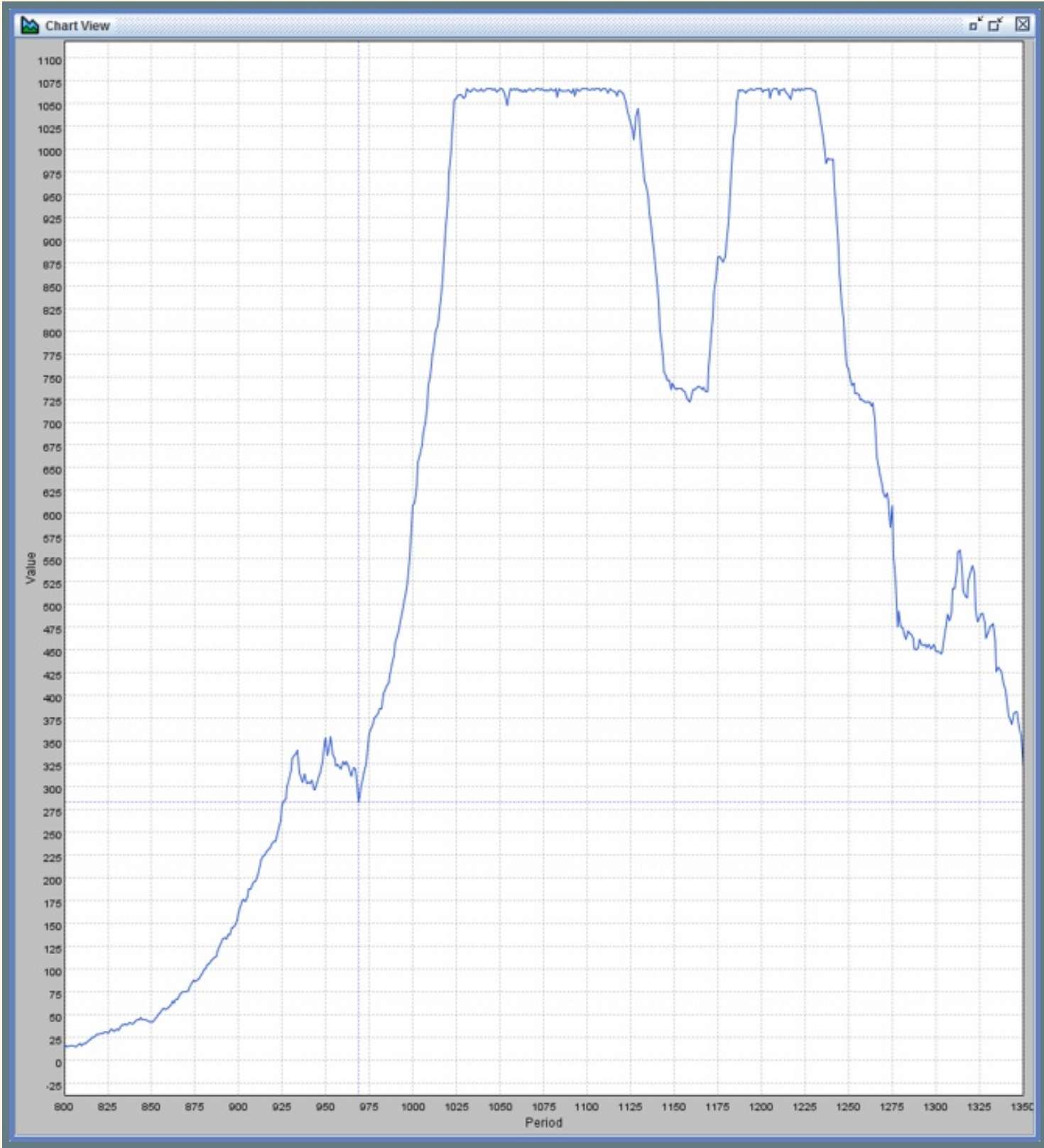
- Paleoclimate:
 - Assess different kinds of soil
 - Assess tree rings, pollen, etc.
 - Reconstruct drought severity index
- Society:
 - Archaeology gives #, location of households
- Make assumptions about:
 - # people per household,
 - Agriculture,
 - ...
- Devise rules for behavior:
 - Marriage, reproduction, migration, ...
- Simulate years 800–1300

Results

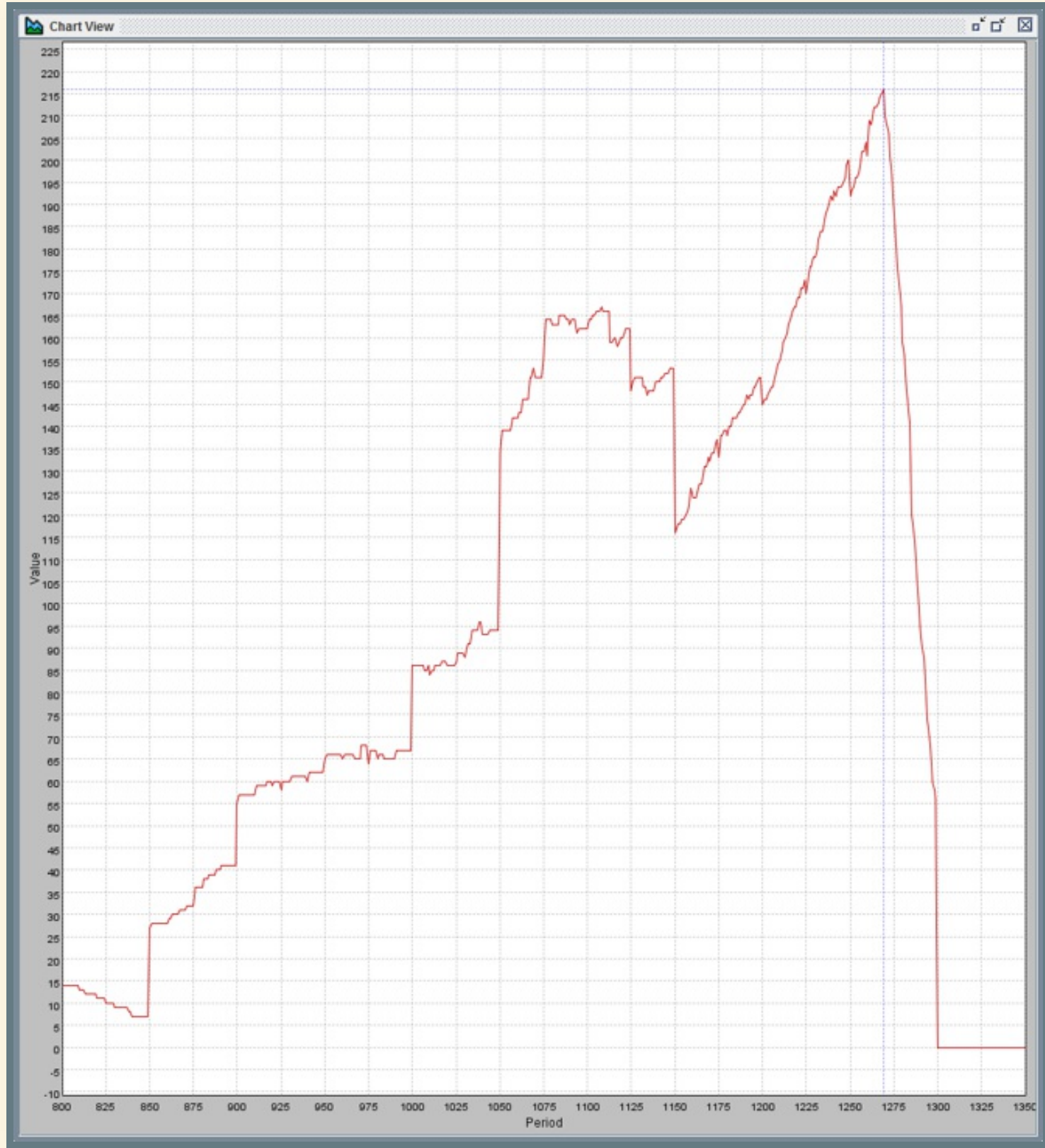


Comparison

Simulated



Historical



Improvements

- Make agents heterogeneous
- Fit parameters to historical data

Results

