# VERIFICATION, VALIDATION AND REPLICATION

Case Studies

# THE THREE TESTS (QUICK RECAP)

- Model verification is the process of determining whether a given model corresponds to the conceptual model
- Model validation is the process of determining the implemented model corresponds to, and explains, some phenomenon in the real world.
- Model replication is the implementation by one researcher or group of researchers of a conceptual model previously implemented by someone else.

# IN OTHER WORDS

- Verification – Test if your implementation of the concepts is correct
- Validation – Test if your conceptualization itself is correct
- Replication – Peer Review

# VERIFICATION

- A general guideline for enabling model verification involves building the model simply to begin with, expanding the complexity of the model only as necessary.
- Two ways of designing
  - The onion
  - The Lego bricks
- Things to identify
  - Parameter space
  - Edge cases <-> consequences
  - Limit points / Leverage points
- Methods for Verification
  - In-model unit tests
  - External testing frameworks

# VALIDATION

- Validation is the process of ensuring that there is a correspondence between the implemented model and reality.
- Validation, by its nature, is complex, multilevel, and relative.
- Macrovalidation vs Microvalidation
- Face validation vs Emprical validation
- Face Validation – Graphical (expert verification), Tracing, etc.
- Empirical Validation – Data driven, Model - comparison

# REPLICATION

- Across times
- Across Platforms
- Across languages

# ANASAZI STUDY

- The Artificial Anasazi model (Axtell et al., 2002; Dean et al., 2000; see figure 7.10) is an agent-based model that is particularly renowned for the level of empirical validation it has undergone.
- The Kayenta Anasazi (now called Kayenta Ancestral Pueblo) was a group of people living in the Long House Valley in the Black Mesa region of modern-day Arizona.
- Lets see a quick motivation video for the study

# ANASAZI STUDY

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- Early as 1800 BCE, but disappeared very suddenly around 1300 CE.
- There is an extensive archeological record from about 200 CE until their disappearance.
- The Artificial Anasazi project was an attempt to discover why this group suddenly vanished from Black Mesa.

# ANASAZI STUDY

- Used an agent-based model of the Ancestral Pueblo inhabitants of the area.
- Validation of the Artificial Anasazi model was carried out by comparing the results of the model to the **historical data.**
- These comparisons were favorable, and it is now believed that the Artificial Anasazi model explains the disappearance of the real people as a combination of environmental and social causes.

# ANASAZI STUDY

- This agent-based model simulated the residential and agricultural practices of an artificial society at the unit of individual households. It used
  - Geographic
  - Rainfall
  - and various forms of archaeological survey data
- They achieved a high degree of verisimilitude
  - They found a reasonably good correspondence between the model and the real history, for both qualitative spatial settlement patterns, and population over time (Axtell et al. 2002).

# ANASAZI STUDY - AGENTS

- Environment consists of data driven creation of variable resource (or other) landscapes.
- The landscapes are populated with heterogenous agents.
- Each agent is endowed with various attributes
  - life span
  - Vision
  - movement capabilities
  - nutritional requirements
  - Consumption and storage capacities
- The model accounts for individuals and relevant social units such as households, lineages, clans, and villages.
- A set of anthropologically plausible rules defines the ways in which agents interact with the environment and with one another.

# ANASAZI STUDY – OBJECTIVE

- Archaeological records of Kayenta Anasazi provides an empirical data set against which simulations can be evaluated.
  - University of Arizona (Treering research lab)
  - Museum of Northern Arizona
  - Southwestern Anthropological Research Group (SARG)
- The actual **spatiotemporal history** is the "target" the model attempts to recreate
- Thus explain "the fall" with an agent based model

# ANASAZI STUDY

- A NetLogo version of the Artificial Anasazi model (Stonedahl & Wilensky, 2010b) can be found in the Social Sciences section of the NetLogo models library.
- Lets see the model and data

# AGENT BASED MODEL OF OFFICE OCCUPANTS BEHAVIOR

- Modeling Office occupants in the field of study
- Predict Electric appliances (related to climate control) and other amenities usage by individuals
- Validate against observed historical data
- Comparison at both aggregate and individual behavior pattern

# AGENT BASED MODEL OF OFFICE OCCUPANTS BEHAVIOR

- Subject Sample : 45 Occupants
  - Profiling
  - Daily Survey
  - Environmental and Behavior measurements
- The Simulation is compared to real life behavior patterns for four and a half work weeks
- The Model matches both individual level and aggregare level predictions
  - Impressive