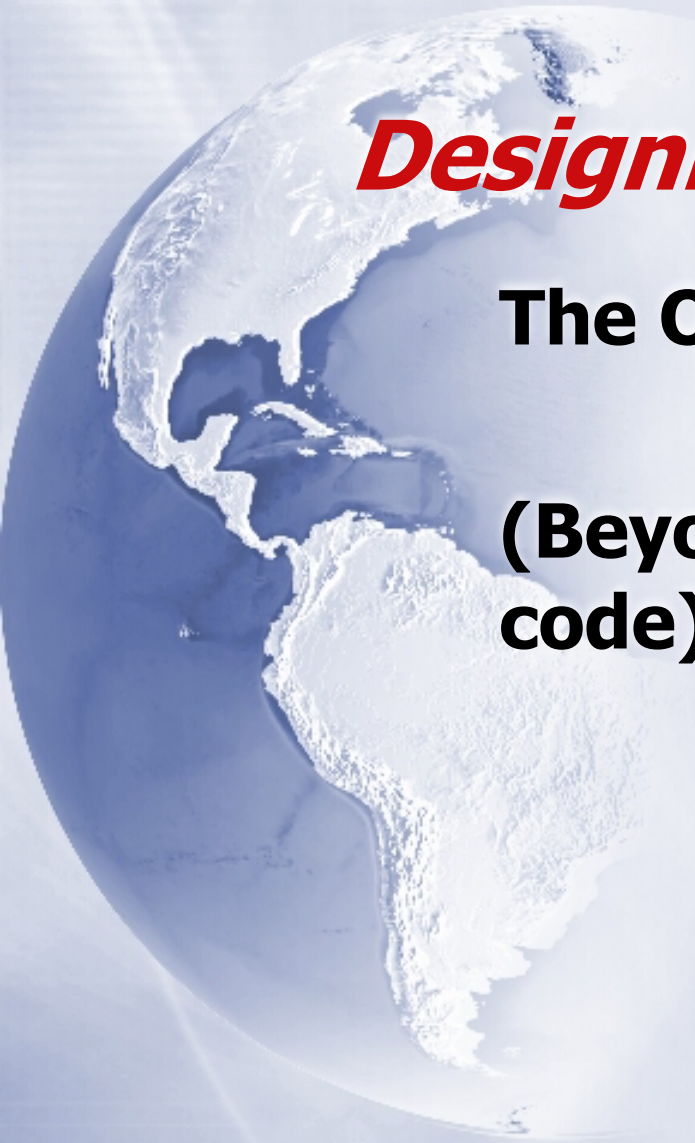


ABMs and IBMs

Designing a Worthwhile Model

The ODD protocol

(Beyond just writing NetLogo code)

Grimm & Railsback

Principles of "Individual-Based Modeling/Ecology"

1. Systems are understood as **collections of individuals**. Dynamics come from interactions of individuals with each other and the environment.
2. **Modeling/simulation** is the "primary tool"; emergent properties are key.
3. **Theories** provide models of individual behavior. They are developed from both field research and past knowledge, and evaluated experimentally.
4. **Observed patterns** are important observations used to test theories.
5. Behavior not defined by global equations. Instead, we study **emergence**, adaptation, fitness.
6. Models are implemented with **computer simulation**.
7. **Field studies** are crucial for IBEs.

Class Discussion

- Consider four models from yesterday: ants, flocking, wolf and sheep, traffic grid.
- Discuss:

1. What is simulated? What is purpose?
2. What are simplifications? How are (or are they not) reasonable considering the purpose? What different question might allow different simplifications?

ODD: *Overview, Design Concepts, and Detail*

Overview:

Purpose; Agents, Variables, and Spatial-Temporal Scale; Process overview and scheduling

Design Concepts

Principles, emergence, objectives, learning, prediction, sensing, interaction, stochasticity

Details

Initialization, input, structure and submodels

ODD Part 1: Overview

1. **Purpose**

   What is the model for?

2. **Entities, Variables and Scale**

   Identify the variables for… agents, patches and the observer.

   Be explicitly about spatial and temporal scope.

3. **Process overview and scheduling**

   What happens at each step? What is the sequence of steps for each agent?

ODD Part 1: Overview

More on Variables

- Typically you don't store as a separate state variable (breeds-own) something that can be immediately deduced from other state variables.

More on Process Overview

- A model's schedule is simply a sequence of actions.
- What behaviors do agents execute as simulated time proceeds? What updates need to be made globally to the system?

[GR] Design Principles (What to Do Before You Code)

- **Think explicitly about all parts of the model**
  - identify the decisions
  - "To be translated unambiguously into computer code, the formulation has to be complete and explicit regarding each and every element…"
- **Think explicitly about the purpose**
  - "It is impossible to make any decisions about the model … if we do not first know what the model is for."

Questions to Ask Before Coding

Emergence

- What behaviors might be "emergent" and which are explicitly programmed into the system?
- Balancing ***predictability*** with ***chaos***!
- Simple Birth Rates vs. Flocking

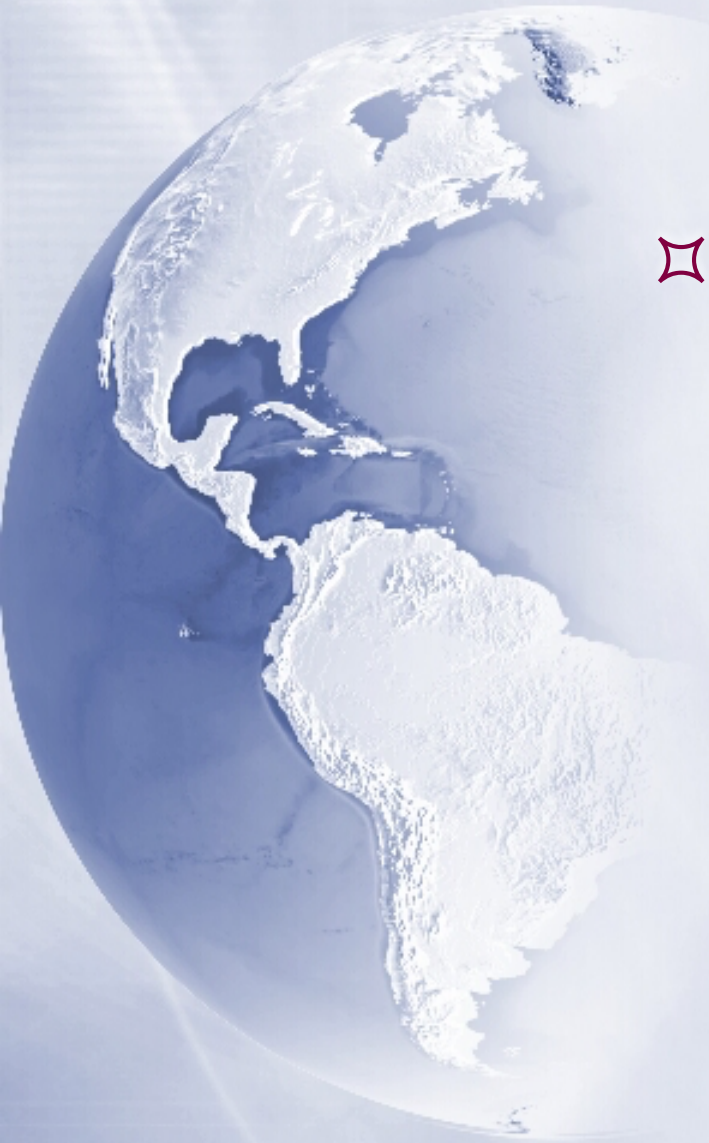
Objectives Why write the program? What do we want to learn?

Sensing What can agents sense? How is this modeled?

Interactions

Stochasticity What variability is there from one run to the next? What does this represent?

Outputs and Observations



Lab, Day 6

- In teams of 2, implement the firefly model.
  - Start with pseudocode
  - Discuss steps at each time step
  - Add a display to interface
  - Replace forever button with a button that runs until synchronization and then stops