Predator and Prey

A popular and generic model

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Lemmings and fox

- Predator: fox
- Prey: lemmings
- A lemming year
  - Some years the lemming is abundant.

1. Lemming year = good food supply for fox
   - the fox reproduce
2. After the lemming year
   - expect a rise in the fox population
   - ... which will cut down on the lemmings population
3. Typical predator-prey problem

Common pattern: alternating peaks of predator and prey

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The macro-level approach

Lotka-Volterra Equations

We can model population numbers.

- x – number of prey

$$\frac{dx}{dt} = x(\alpha - \beta y)$$

- y – number of predator

$$\frac{dy}{dt} = -y(\gamma - \delta x).$$

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A micro-level approach

Agent-based modelling

- Let's model each individual
  - each individual is an agent
  - predator agents
  - prey agents
  - other agents?
- Each agent has a well-defined behaviour
  - what does it do?
  - does it eat, reproduce, die?
  - where is it in the landscape?
  - does it move?
- Behaviour may be probabilistic or deterministic.

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Another micro-level approach

Cellular Automata

- Agent-based modelling makes the individuals active
  - predators and prey are active agents
  - agents move in a landscape
- A cellular automaton models the landscape
  - predators and prey are passive properties of landscape locations
  - landscape locations are active
- The landscape is a grid
  - each grid cell is a state machine (*empty*, *prey*, or *predator*)
  - state transitions governed by cell rules

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Summary

- Predator-prey models give interesting dynamics
- Many examples
  - literal interpretations — eco-systems
  - metaphorical, e.g. economics, predator investors
- Three approaches
  - system dynamics — macro level
  - agents — micro level
  - cellular automata — micro level

Agents well-suited for an object-oriented implementation.

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