

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

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

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

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.

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

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.