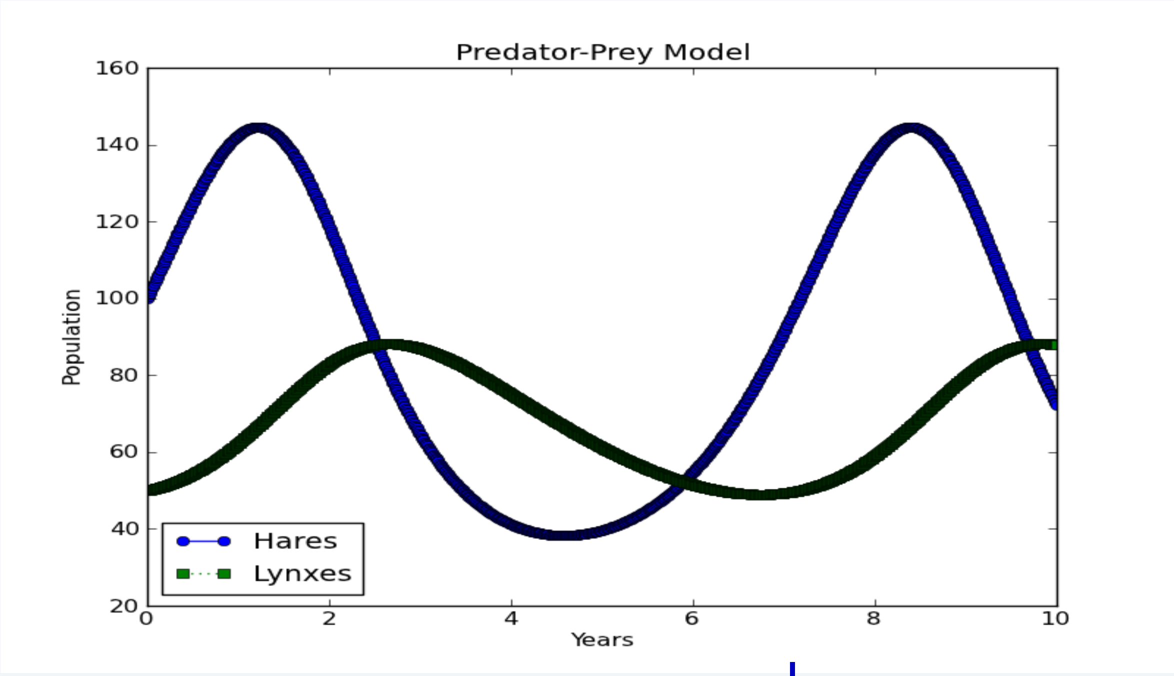
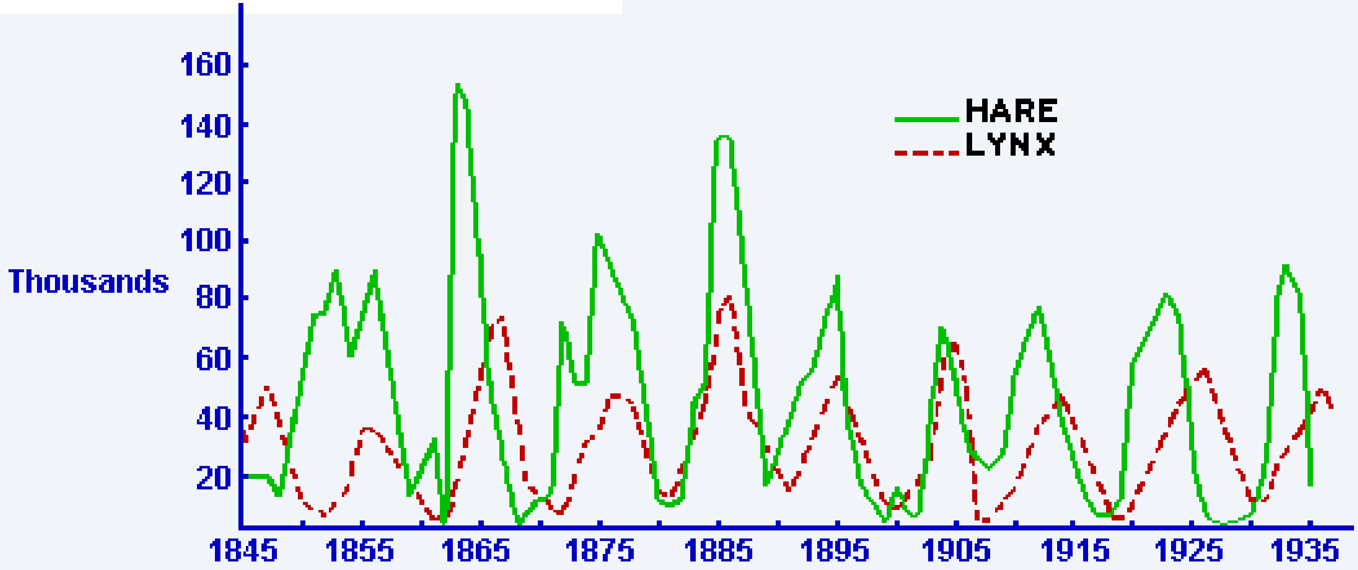
Predicting predator-prey populations

Desired results





Here's an approximation of reality:

The hare birth rate is constant, as their food supply is unlimited. Hares only die when eaten by a lynx, and the number of hares eaten is proportional to how often hares & lynxes meet, i.e., the chance of a lynx catching a hare.

The lynx birth rate is also proportional to how often hares & lynxes meet, i.e., the food available for each lynx family. Lynxes only die from natural causes, and their death rate is constant.

Dr. Siemann, EEB

Lotka & Volterra, 1926

Computational Thinking

Problem description

Abstraction

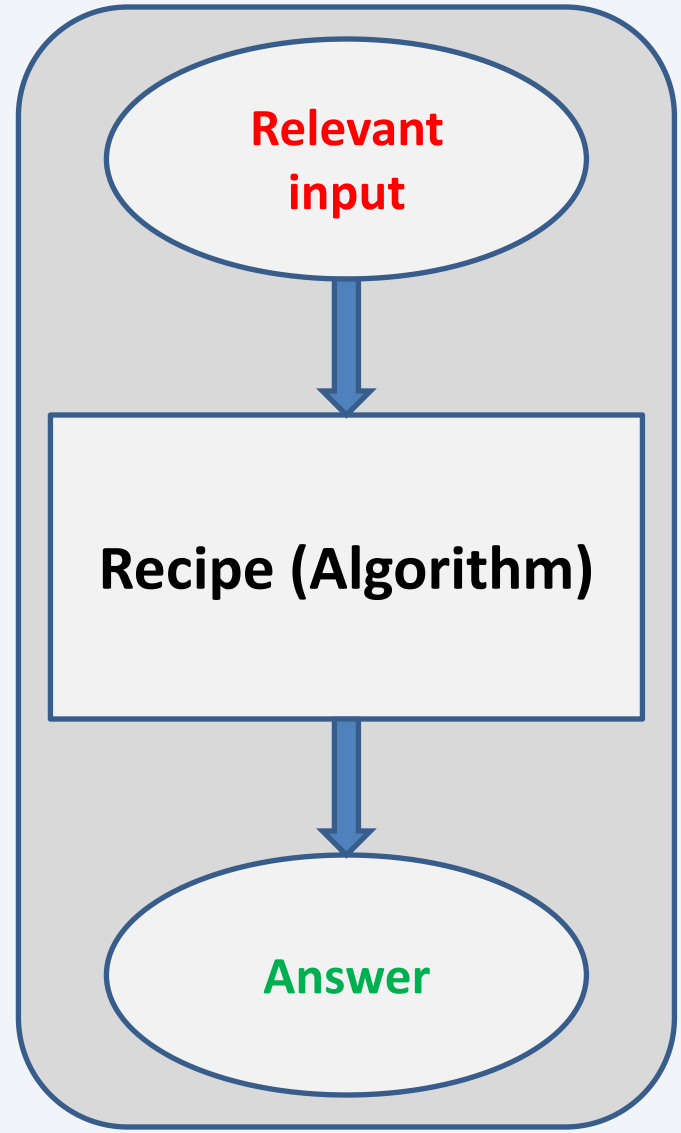
Automation

Computational goal

Information extraction

Algorithm design

Algorithm implementation



Hares' & Lynxes' Populations

Problem description

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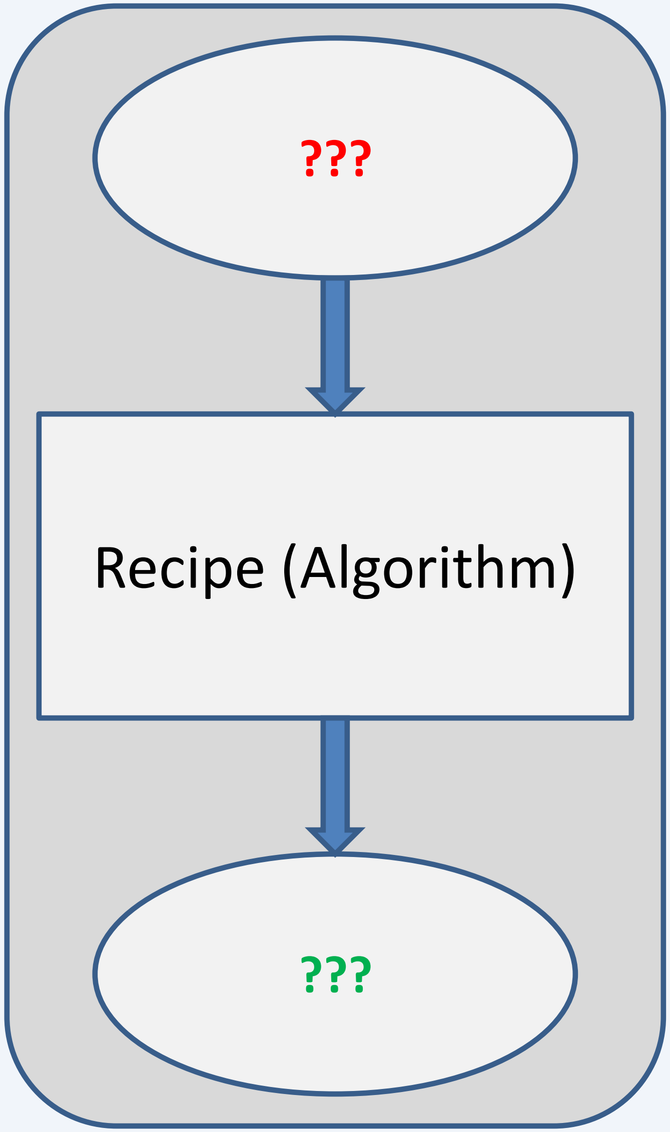

Algorithm Decomposition

1. Generate population data.
    a. Repeatedly, generate next population.

2. Display population data.

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Hare annual pop. change $= h \cdot (hareBirth - harePredation \cdot l)$

Lynx annual pop. change $= l \cdot (lynxBirth \cdot h - lynxDeath)$

Lotka & Volterra, 1926

Hare annual pop. change $= h \cdot (hareBirth - harePredation \cdot l)$

.4 .003

Lynx annual pop. change $= l \cdot (lynxBirth \cdot h - lynxDeath)$

.004 .2

	Initially (Year 0)	Year 1	Year 2	Year 3
# Hares	100	125	152	177
Hares born	+ 40	50	61	71
Hares eaten	- 15	23	36	58
# Lynxes	50	60	78	109
Lynxes die	- 10	12	16	22
Lynxes born	+ 20	30	47	77

1. Generate population data.
    a. Repeatedly, generate next population.
2. Display population data.

Given h_0, l_0, $hareBirth$, $harePredation$, $lynxBirth$, $lynxDeath$, $years$.

Repeat these steps for $y = 0, \ldots, years - 1$:

$$h_{y+1} = h_y + h_y \cdot \left(hareBirth - harePredation \cdot l_y\right)$$

$$l_{y+1} = l_y + l_y \cdot \left(lynxBirth \cdot h_y - lynxDeath\right)$$

Plot $\left(y, h_y\right)$ for $y = 0, \ldots, years$.

Plot $\left(y, l_y\right)$ for $y = 0, \ldots, years$.

Suggested Readings

- Predator-prey models
- Lotka-Volterra equation
- Video of Canadian Lynx hunting Snowshoe Hare
- Wolves & Moose of Isle Royale
  - Esp. the Data section
  - A technical paper about population cycles