

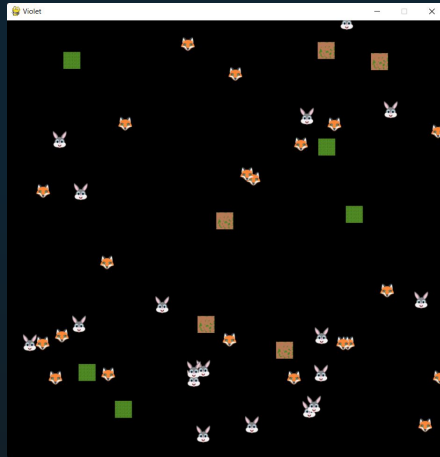
Collective Intelligence

Assignment 2: Fox-Rabbit competition modelling

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THIS WEEK'S CONTENT

Extend the predator-prey (fox vs. rabbit) system based on the Lotka-Volterra.



Energy model



Flocking with chaser

INTRODUCTION

PURPOSE OF THE SIMULATION:

- **Study behavioural patterns and environmental effects through visualization**

QUESTIONS ANSWERED WITH THE SIMULATION:

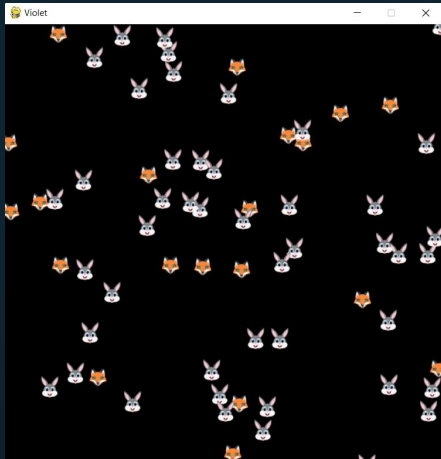
- **What effect does reproduction based on low energy as survival mechanism have on preservation of the two populations?**
- **How does flocking behaviour of the preys affect their survival rate?;
Is competitiveness stimulated if active hunting is applied to the predator?**
- **How is the population sizes affected if replenishment is applied for both species meaning preys become energy-dependent?**



METHODOLOGY

Recap of Last week and new implementations

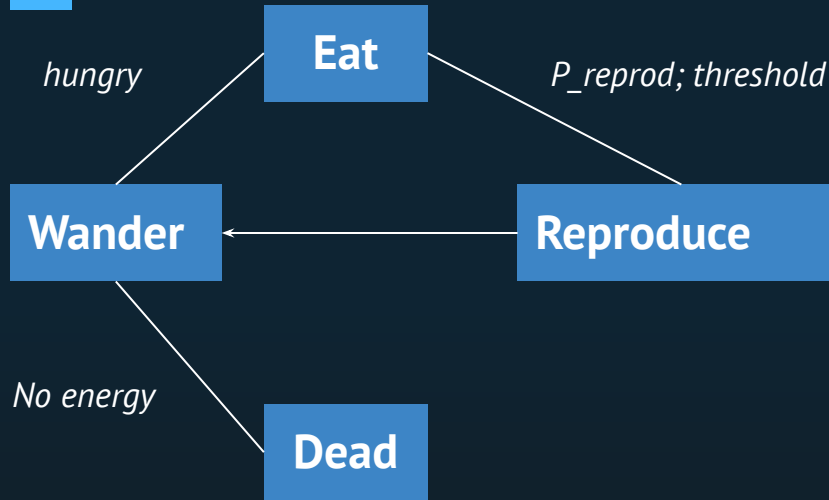
RECAP



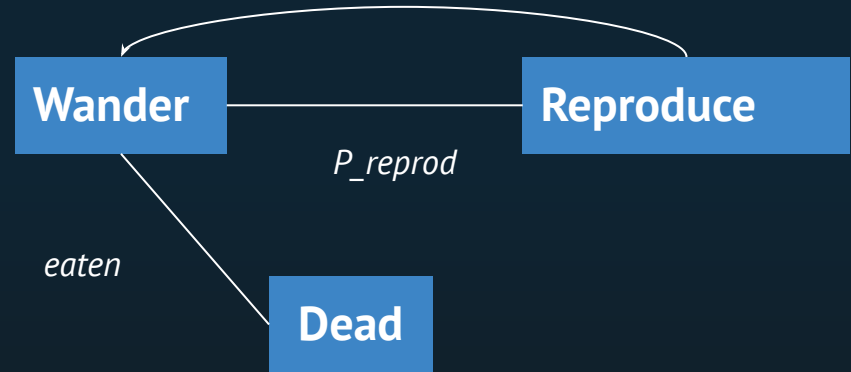
Basic model, no
additions



RECAP



Fox

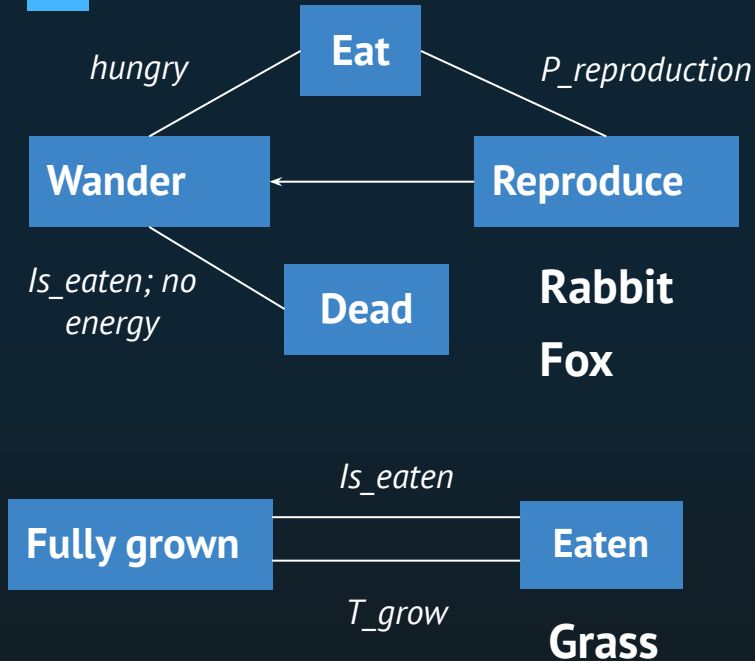


Rabbit

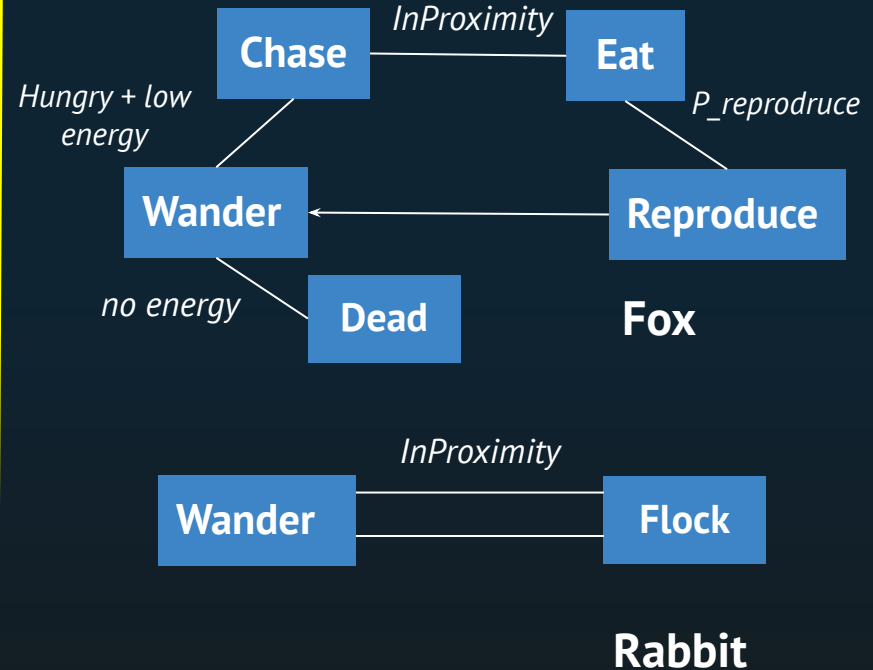
[1] Predator-Prey Models, Stephanie Forrest, Dept. of Computer Science, Univ., of New Mexico, Albuquerque, NM

METHODOLOGY

Energy based model

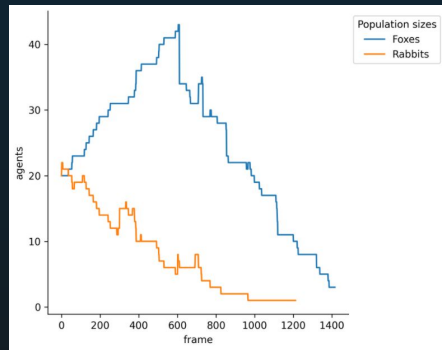
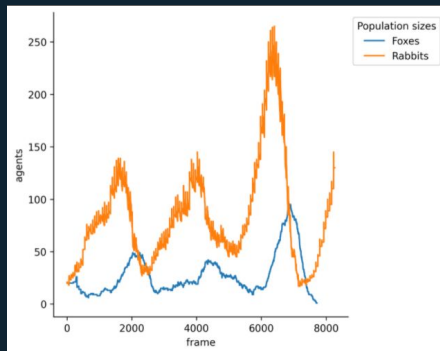


Flocking based model



Probabilistic approach

- Reproduction probability for foxes
 - Energy level:
 $\text{uniform}(1/\text{energy})$
- Set probability for rabbits
 - $\text{uniform}(\text{value})$



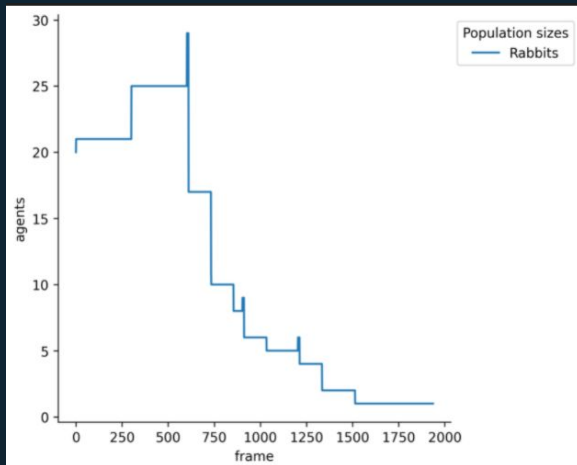
Parameters Grass Model

	Fox	Rabbit	Grass
radius	15	15	-
Initial population size	20	20	10
movement_speed	1.5	1.5	-
energy_gain	0.5	1	-
energy_decay	1	0.5	-
start_energy	5	5	
Max_energy	10	10	-
reprod_prob	1/energy	0.5	-
reprod_time	-	5s	(growth) 5s

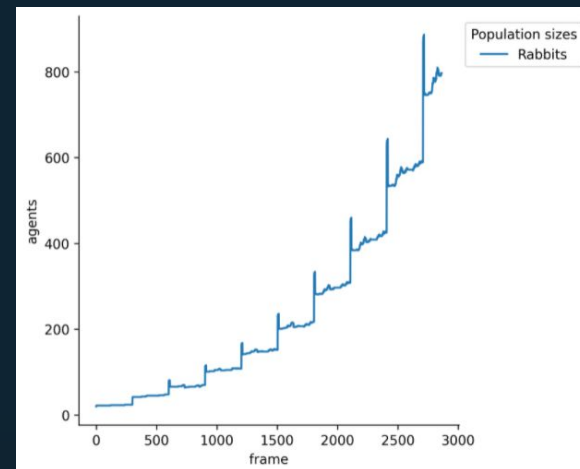
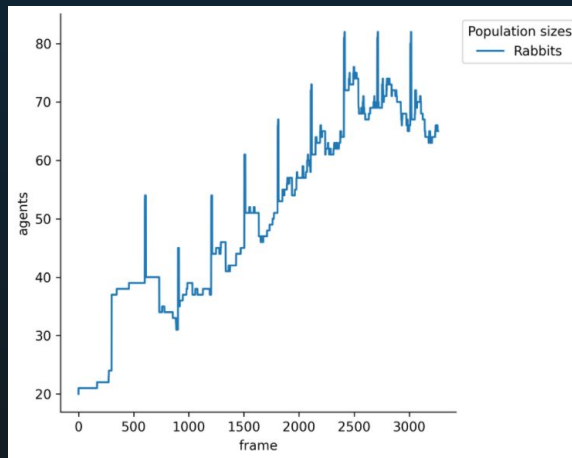
Parameters Flocking Model

	Fox	Rabbit
radius	15	50
chasing_radius	50	-
min;maxVelocity	1;1.5 (+0.05*rabbit)	1;1.5
Max_energy	10	10
reprod_prob	1/energy	0.5
reprod_time	-	5s
Alignment;Separation;Cohesion	-	2; 4.5; 4
RandomWeight	-	0.5

Parameters Testing



Example: Reproduction Probability
[0.25, 0.5, 0.75]





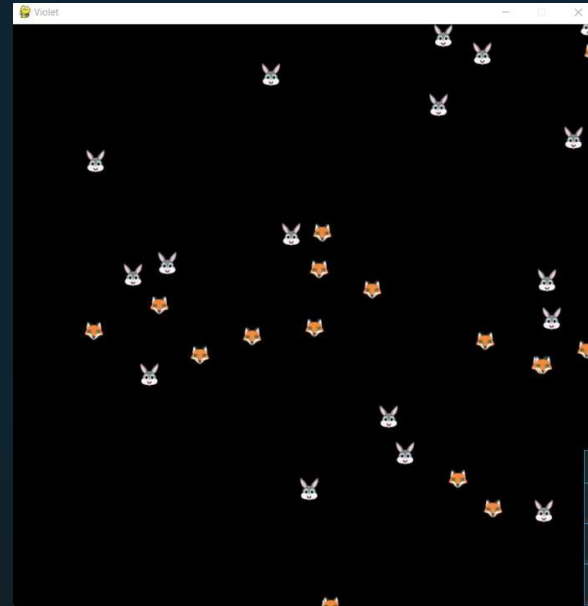
Results

Result Analysis

Demos

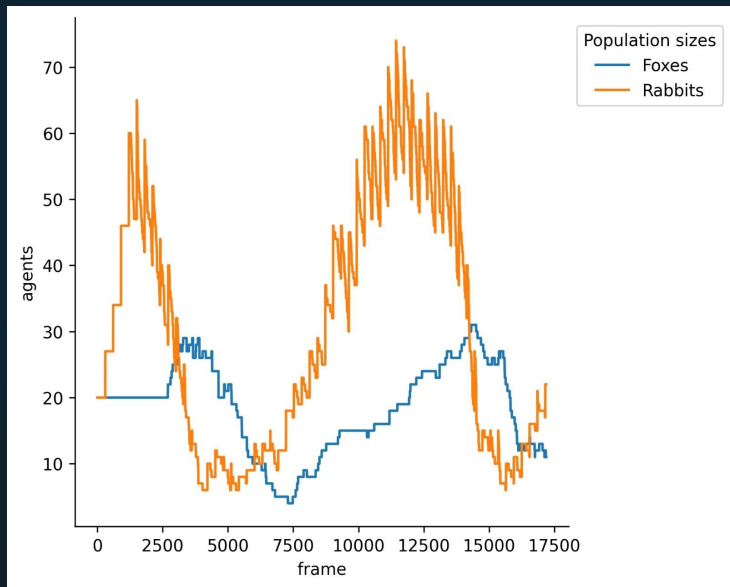


Energy-based model

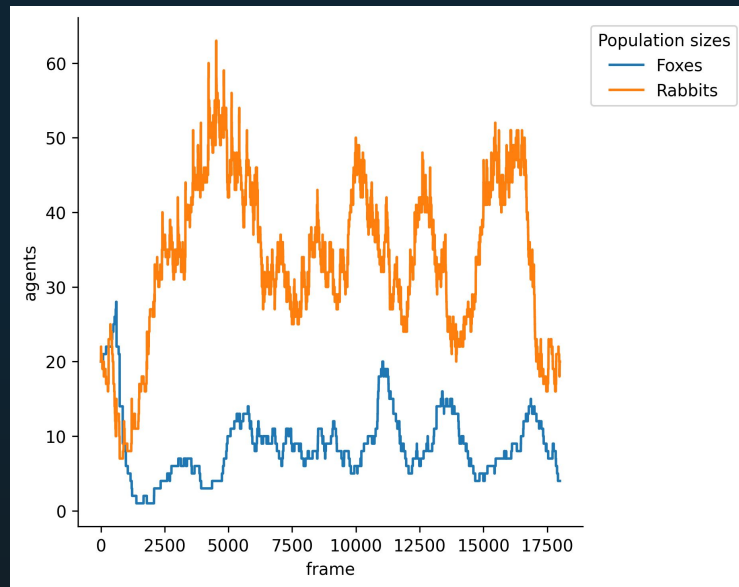


Flocking with chaser

Energy model

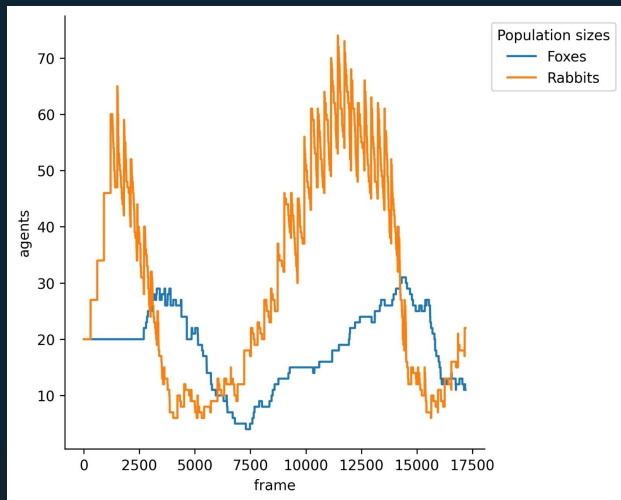


No extras



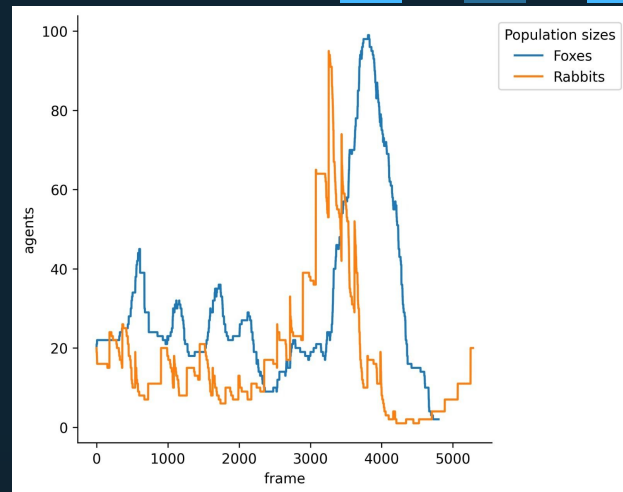
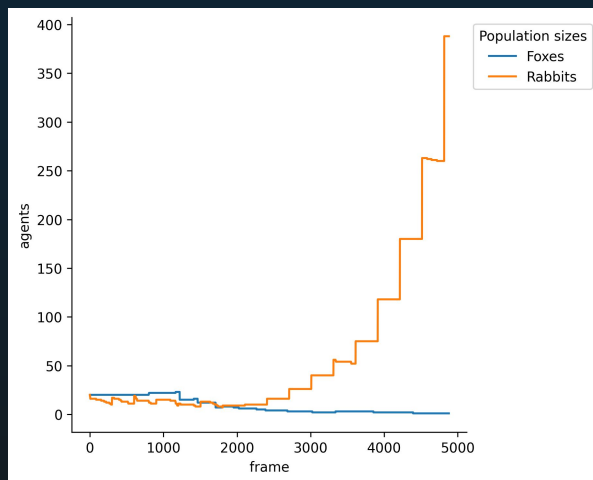
Energy-dependent preys

Flocking model

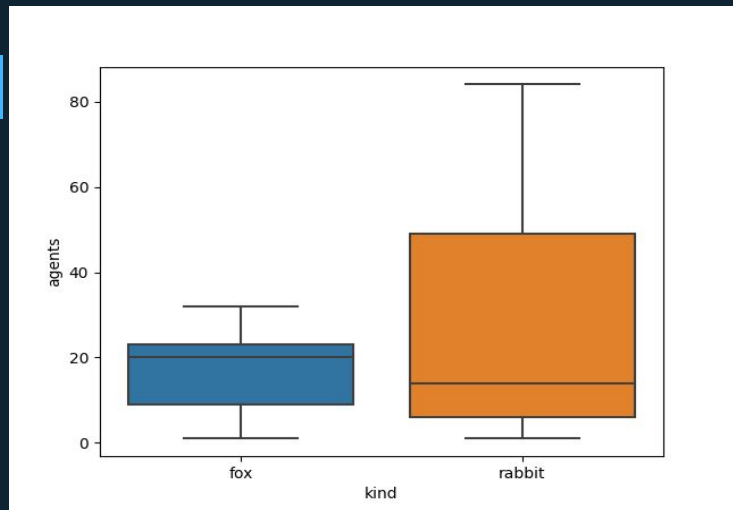


Basic Model

Flocking without chaser

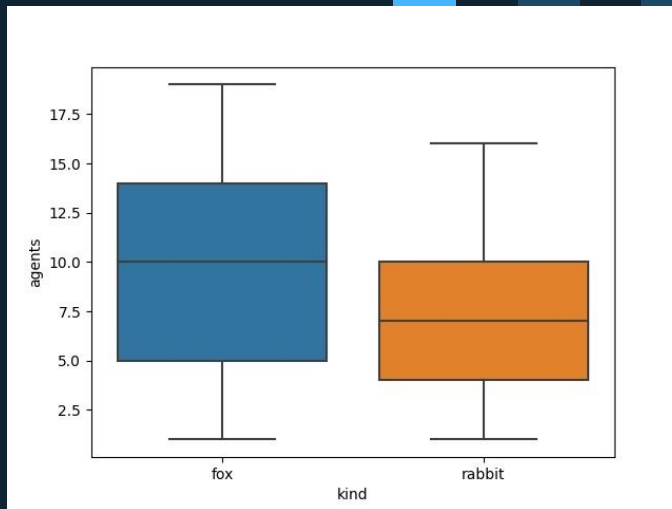


Flocking with chaser

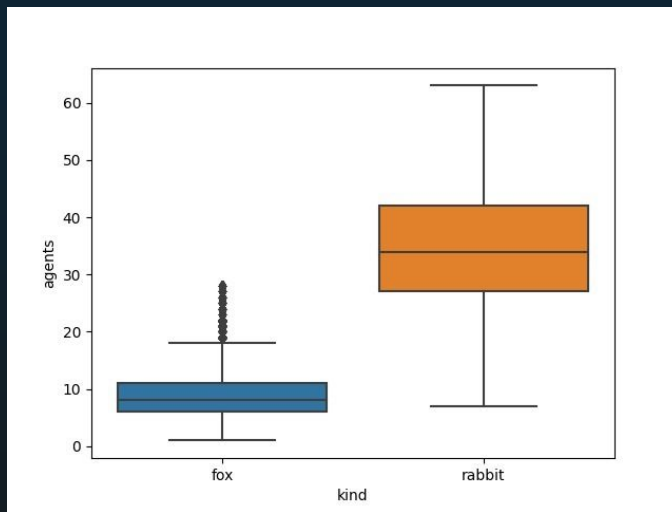


Basic model

Flocking
with
chaser



Energy-
dependency



Range of # Agents

Stats

H0: The avg # of agents is equal between the two groups

HA: The avg # of agents is not equal between the two groups

Basic Model

`WilcoxonResult(statistic=25535114.5, pvalue=6.033989331855553e-183)`

Energy-dependent model

`WilcoxonResult(statistic=17763869.5, pvalue=0.0)`

`(WilcoxonResult(statistic=5605.5, pvalue=8.583505472264416e-40))`

Flocking Model with Chaser

`WilcoxonResult(statistic=751353.0, pvalue=1.4531471365890308e-99))`

Conclusion



- Agent based Simulation of competitive behaviours observed in nature.
- Different implementation and approaches.

Expectations

- Populations alternating in size without extinction
- Constant interactions
- Flocking increases survival rate of rabbits
- Small number of outliers in stats
- Consistency in populations size

Results

- Extinction occurs
 - tuning and conditions on reprod
- Some outliers, but no effect on stats
- Energy-based model shows higher efficiency

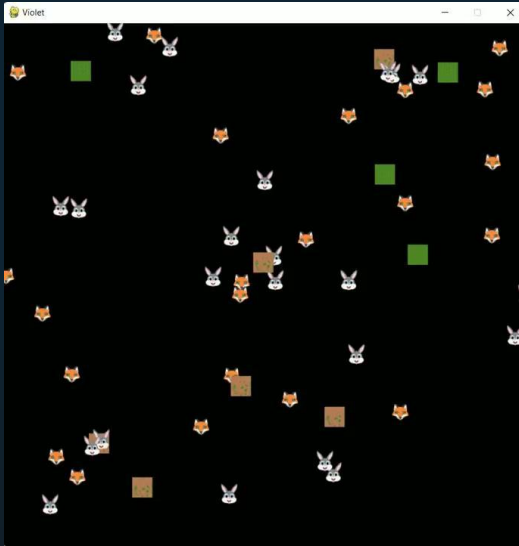
Conclusion



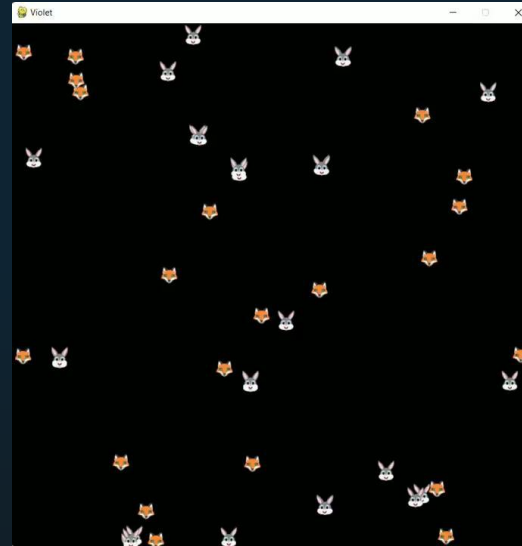
- Further research
 - Food web approach
 - Sexual reproduction
 - Age
 - Increased vision based on hunger level

Extras

Potential implementations for further research



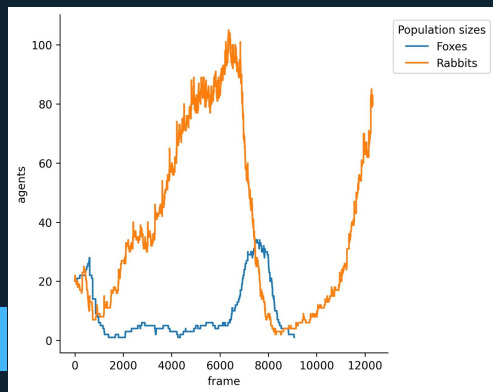
Age added



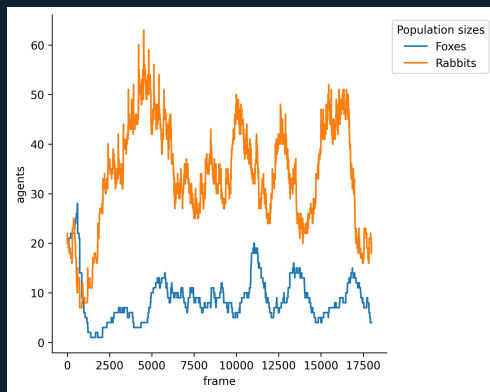
Increased vision- when
hungry

Extras

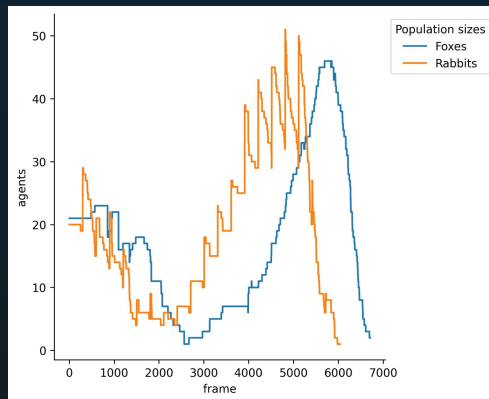
Age added to Prey



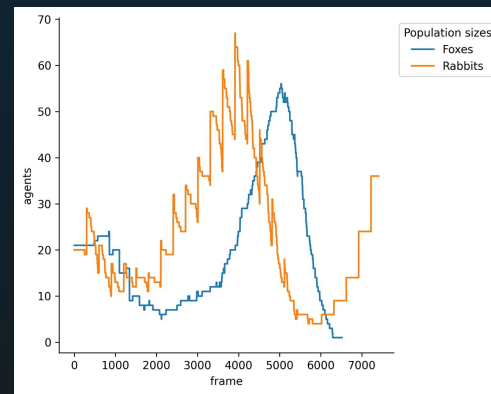
Age not added to Prey



Increased vision-when hungry



Unchanging vision



Sources

[1] Karsai, I., Montano, E., & Schmickl, T. (2016). Bottom-up ecology. Letters in Biomathematics, 3(1), 161-180.

[2] Bousquet, F., & Le Page, C. (2004). Multi-agent simulations and ecosystem management: a review. Ecological modelling, 176(3-4), 313-332.

Thank you!