Project 1:
FOXES AND RABBITS

Game by M. Nguyen

Contents

Summary

‘Project 1: Foxes and Rabbits’ is inspired by predator-prey systems. A simple version of the Lotka-Volterra equations is shown below:

$$\frac{dx}{dt} = \alpha x - \beta xy \qquad \frac{dy}{dt} = \delta xy - \gamma y$$

To summarise, the rate at which prey reproduces is decreased by the presence of predators. Conversely, the rate at which predators reproduce is dependent on the presence of prey; without prey, predator population decreases to zero.

In this game, the predators are foxes and the prey are rabbits. A game lasts for ten rounds, where each round consists of a day, dusk and night phase.

The predators and prey have different win and lose conditions:

The predators (foxes) win if either:

- **[+1]** Their species can survive ten rounds (i.e. after the tenth round is over, there are at least two foxes still alive); or
- **[0]** At the end of the tenth round, there is only one fox remaining (if the game were to continue indefinitely, there will only ever be at most one fox remaining in the environment; the foxes are effectively extinct at this stage).

However, they lose if:

- **[-1]** The fox population drops to zero (i.e. all the foxes have starved and died).

Basic Fox Token

The prey (rabbits) win if either:

- **[+1]** The fox population drops to zero before the tenth round (i.e. all the foxes have died, and two or more rabbits remain); or
- **[+1]** Their species can survive ten rounds (i.e. after the tenth round is over, there are at least two rabbits still alive); or
- **[0]** At the end of the tenth round, there is only one rabbit remaining (if the game were to continue indefinitely, there will only ever be at most one rabbit remaining in the environment; the rabbits are effectively extinct at this stage).

However, they lose if:

- **[-1]** The rabbit population drops to zero (i.e. all the rabbits have been eaten by foxes).

Basic Rabbit Token

Note: The numbers in the square brackets indicate how many points are earned by each team at the end of a game.

Setup

The following materials are required for the game:

- 40 Fox Tokens
- 40 Rabbit Tokens
- 5 Bowls
- A Coin and a Pair of Dice
- Random Events Deck

The game requires two teams of players: Team Rabbits and Team Foxes. Before the game starts, teams are encouraged to discuss strategies amongst themselves.

Begin the game with the following initial populations:

Version	Foxes	Rabbits
(Current) 3	6	30

Basic Rules

Teams alternate taking turns during the game. Team Rabbits start by deciding where to hide their rabbits.

NOTE: A maximum of eight rabbits can hide under each bowl.

During this time, Team Foxes are instructed to close their eyes or to turn around.

Once Team Rabbits are done, Team Foxes are allowed time to discuss which bowl each fox should search for rabbits. If there are rabbits under the bowl, foxes eat a rabbit. If there are no rabbits, foxes become hungry (or if they were hungry, they die).

See advanced rules (including those for Breeding and Events) later in this game manual.

Tokens

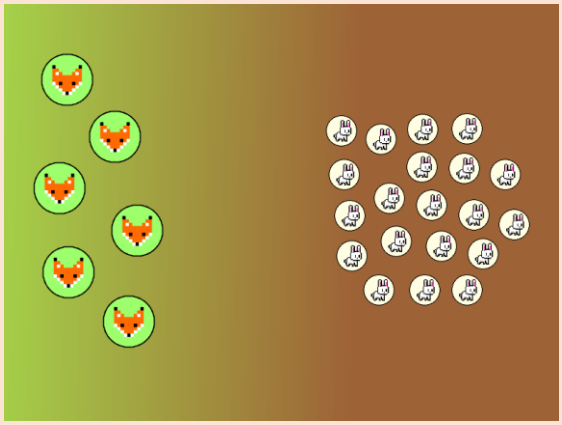
Healthy Fox Token (Green)

Hungry Fox Token (Red)

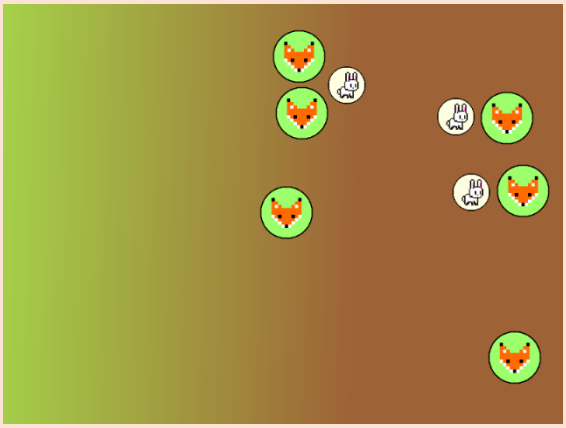
5x Rabbit Token

10x Rabbit Token

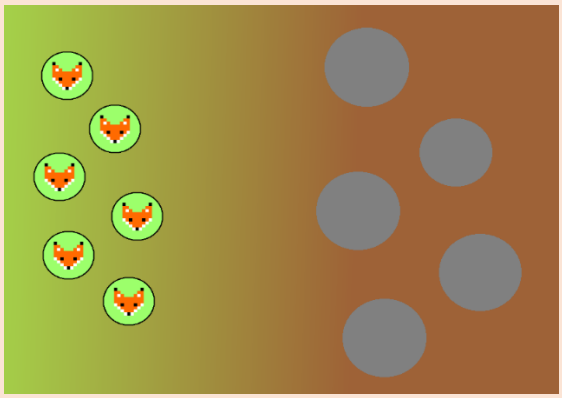
Example Round



Start: Six foxes and twenty rabbits.



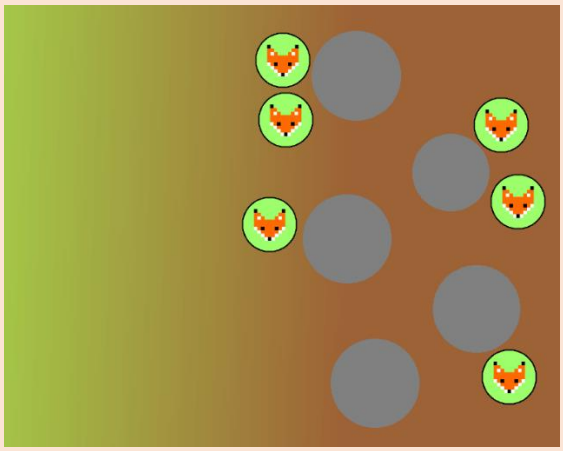
Dusk: Rabbits are revealed; for simplicity, only three are shown.



Day: Rabbits hide under bowls.

Evening: Foxes who were able to eat a rabbit remain healthy (green); those who were not become hungry (red).

Next round: hungry foxes either return to being healthy (by eating rabbits) or die by starvation.



Dusk: Foxes select which bowls they would like to check for rabbits.

Day Phase

TEAM RABBITS

At the start of a new round, Team Rabbits must decide where each rabbit should hide before dusk.

- Optional: use a one to two-minute timer to limit Team Rabbits' decision-making time.

There are five bowls (burrows) available for rabbits to hide in.

A maximum of eight rabbits may hide under a bowl.

- Optional: you may play without this maximum capacity rule; in lieu of this rule, I would suggest making burrows unusable for a round if more than ten rabbits were previously hiding in them.
- If there are not enough burrows available for rabbits, the excess rabbits are left outside for foxes to freely hunt (i.e. the rabbits are not hidden at dusk).

Example Scenario:

Team Rabbits has ten rabbits and five burrows available. They decide to hide three rabbits in the first burrow, five rabbits in the second burrow, and the remaining rabbits in the third burrow. The fourth and fifth burrows are left empty.

It is recommended during this time that Team Rabbits use non-verbal communication (however, you may decide to misdirect Team Foxes by discussing red herrings).

Once Team Rabbits has hidden all of their rabbits, the game shifts to Dusk.

Dusk Phase

TEAM FOXES

During Dusk, Team Foxes decide which burrow each fox should visit to hunt for rabbits.

- If playing the uncapped version of the game, unusable burrows are made known to the foxes before they make their decision.

Once each of the foxes have been allocated to a burrow, the game shifts to Evening.

Evening Phase

First, the bowls are removed, and the rabbits are revealed. The health of each fox is then resolved:

- Initial foxes begin Healthy (green); this side of the Fox token should be face-up.
- Healthy foxes that have been unable to find rabbits become Hungry (red); flip the Fox token.
- If a fox has found a rabbit, the rabbit is eaten and removed from the game; the fox remains Healthy if it was previously Healthy or becomes Healthy if it was Hungry previously.
- Hungry foxes that have been unable to find rabbits starve to death and are removed from the game.

Afterwards, Breeding is resolved:

- If a pair of healthy foxes locate a burrow with rabbits still alive after initially eating, they can eat an additional rabbit each and add a new fox to the game per rabbit eaten (up to two per pair).
- If a pair of rabbits successfully hid from the foxes, they can breed and add one* rabbit to the game.
- Hungry foxes cannot participate in breeding.

Before the start of the next round, a random event is drawn. This event must be resolved before beginning the next round.

Random Events

1. **Drought** – a string of hot, rainless months has left local bodies of water dried up; total carrying capacities reduced to 30 (six rabbits per burrow).
2. **Land Clearing** – the local human community has cleared some of the forest to make room for a new farm; remove one burrow from play (rabbit carrying capacity reduced).
3. **Disease** – Myxomatosis is running rampart in your local community; roll a pair of dice to see how many rabbits are affected, then for each rabbit flip a coin to see if they survive.
4. **Bushfire** – a human family left their campfire unattended and created a small bushfire; roll a die to see how many foxes do not make it to safety.
5. **Wet Weather** – heavy rain during the night temporarily floods a burrow; remove a burrow from play for one round (this will temporarily reduce the rabbit carrying capacity).
6. **Invading Prey** – the foxes feed on an invasive species and helps the local environment; increase the fox population by 50% (i.e. one new fox per existing pair of foxes).
7. **Winter** – all efforts must be directed towards collecting food; rabbit breeding is temporarily paused for one round.
8. **Day Hunters** – a pack of hunters enter the forest with their rifles; each team flips a coin to see if they are caught, and if so, rolls a die to see how many are shot.
9. **Food Surplus** – the foxes have found an abundance of fruits and berries to feast on; all foxes regenerate to Healthy status.
10. **Moles** – friendly neighbourhood moles help the rabbits to temporarily improve their burrows; select one burrow to make safe (i.e. foxes will be unable to hunt rabbits there).
11. **Ferrets** – a ferret is spotted working with the foxes to locate rabbit burrows; foxes can reveal one burrow during dusk before deciding where to hunt.
12. **Night Hunters** – while the rabbits are asleep during the night, a hunter shines a powerful light into the burrows; sacrifice three rabbits or roll a die to see how many rabbits are caught.
13. **Conservation** – a local environmental group visits the forest to help restore the natural environment; restore a burrow that has been removed (otherwise, do nothing).
14. **Magic** – an amateur magician visits the forest to obtain a rabbit for their show; lose one rabbit.
15. **Village** – foxes invade a nearby village and eat the farmer's chickens; roll a die to see how many foxes do not need to hunt next round (restore Hungry foxes to Healthy).
16. **Radiation** – the local nuclear plant has a catastrophic disaster; animal breeding permanently ceases.
17. **Dirty Water** – desperately thirsty, the foxes drink from stagnant water; roll a dice to see how many become sick (Hungry).
18. **Cunning Rabbits** – the rabbits work together to connect their burrows; after the foxes have selected the burrows they want to search, the rabbits can move rabbits from one burrow to another.
19. **Neighbours** – a pack of lost foxes from another forest join you; roll a die to see how many new friends are made.
20. **Full Moon** – whilst the others sleep, one fox decides to go hunting alone; Team Rabbits hide one rabbit in a burrow, the fox must locate this rabbit and eat it, or otherwise starve to death.

Additional Comments

The choice of foxes and rabbits as predator and prey was arbitrary; you can substitute them for any other animals.

The game is designed to have a few end-game outcomes:

- Foxes are unable to find rabbits to eat in time, and they starve to death while the rabbits thrive;
- Foxes hunt the rabbits to extinction, and they starve to death due to a lack of food (both animal species die out);
- Foxes survive by hunting the rabbits at a sustainable rate (both populations remain non-zero).

Games were originally designed to last twenty rounds, but after some testing, this seemed way too long (games usually ended between three to six rounds)

If both foxes and rabbits survive the ten rounds, the results of the entire game should ideally seem to oscillate.

Without the presence of predators (foxes), the rabbits can flourish via logistic growth, increasing in population before reaching the carrying capacity of the local environment (in this game, that is 40 rabbits).

40 was chosen as the maximum number of foxes and rabbits to represent the carrying capacity of the local environment for either animal.

Instead of tokens and bowls, you could use mini whiteboards by drawing five boxes, and writing numbers in each one to indicate where foxes and rabbit are being allocated (would need to discard healthy/hungry fox mechanic)

Previous initial population configurations:

Version	Foxes	Rabbits
1	5	20
2	6	20

Contributors

Ian Lizarraga & Mary Myerscough – taught the MATH3063 Nonlinear Ordinary Differential Equations with Applications unit (where predator-prey systems were covered)

Leyna & Kenneth – tested the initial version of the game and helped refine the mechanics related to breeding and carrying capacity