Contents

0 Introduction

FlatLand intends to simulate a natural world featuring an environment with limited resources, populated by simulated animals which require these resources to move around and create more of themselves.

FlatLands environment is a 2d grid of tiles, each with an energy level. FlatLands animals live on these tiles and need this energy to eat. They can see, move, eat, breed, and die. The purpose of FlatLand is to try and make a very simple simulation of the natural world. The environment is populated with some animals, who move about and try to eat energy from the environment. When they have enough energy, they will try to breed with nearby animals of the same type. Some animals can also attain energy from other animals, simulating predation.

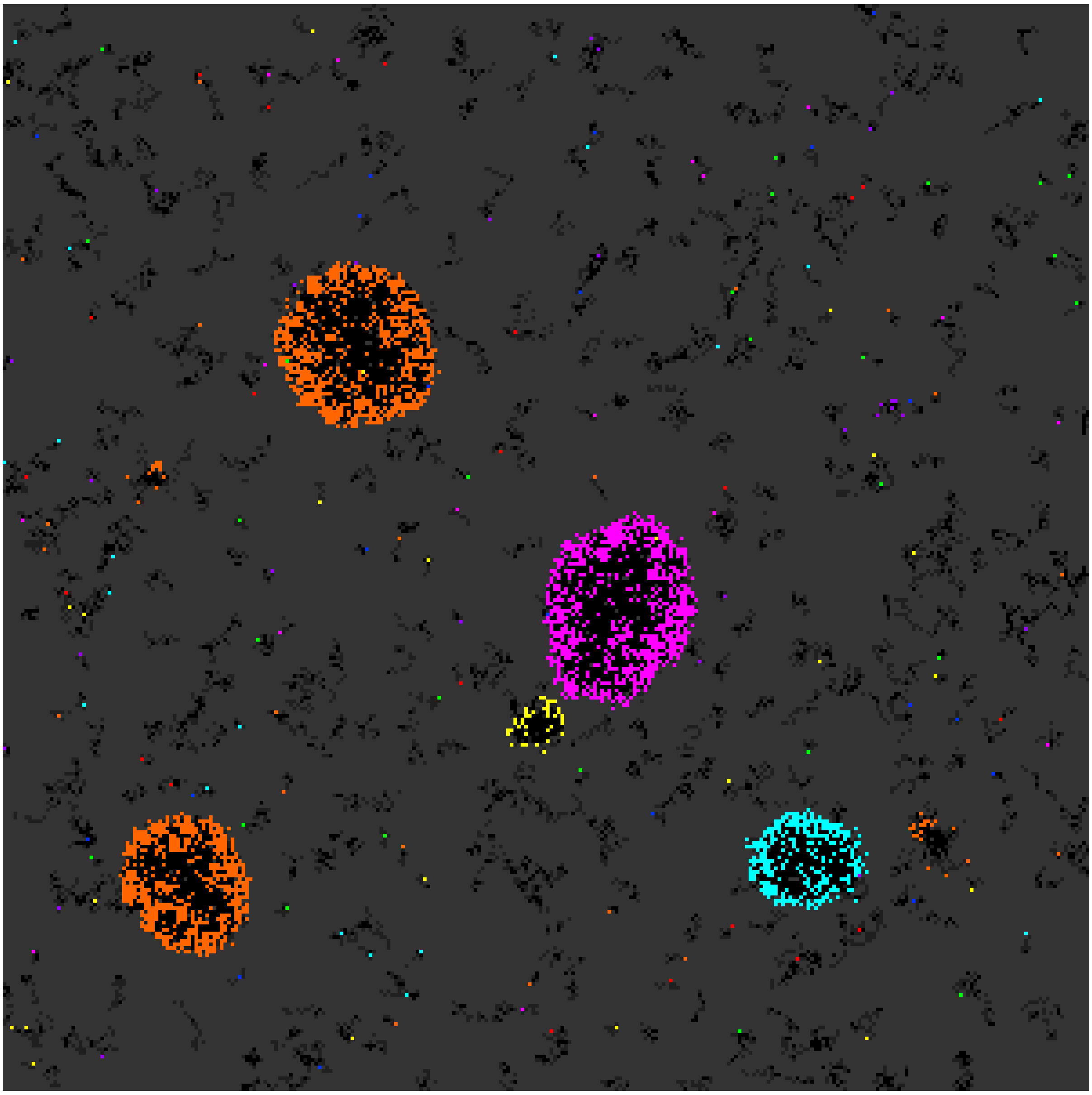
Agents possess 3 attributes: **Size**, **Creation Size**, and **Range**. Size is used for things like calculating how long agents live for, how much energy they need, or if they can or can't be predated on by others. Creation Size controls how many children an agent will have, this ranges from 1 to 8. The more children an agent has the less energy each child starts with. Range controls how many tiles the agent can move in one turn, moving more tiles costs more energy.

When a child agent is born, one of these 3 attributes may mutate. Whose parent attributes it inherits are decided randomly. Then there is a chance of these values will increase or decrease. This system can be used to simulate natural selection by means of inheritance and mutation.

1 The System

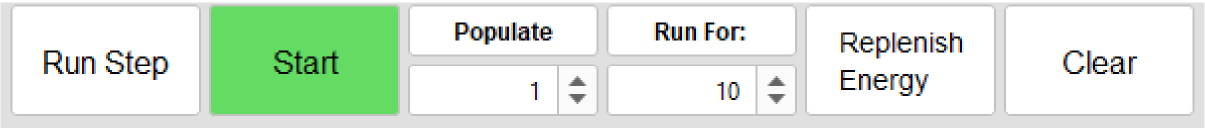
1.1 The Simulation

Below is an image of the simulation view. Here the environment is coloured dark grey, the less energy a tile has, the darker it is. You can see small patterns and shapes all over the simulation, these are tiles with less energy. An animal has visited them and eaten some of the energy. If you look closely, you may see some trails left behind animals as they move and eat.



You can see animals spread out all over the environment, however there are a few spots with a lot of the same colour. These are population explosions, enough animals of the same type met in a location with a lot of energy, causing a population boom. You can see the tiles towards the centre are considerably darker, showing how the population eats all the energy in one place before spreading out.

The below image is the simulation controls.



Run Step runs the simulation for one step. During one step every agent will have a turn and each tile has a chance of regaining energy.

Start runs the simulation indefinitely.

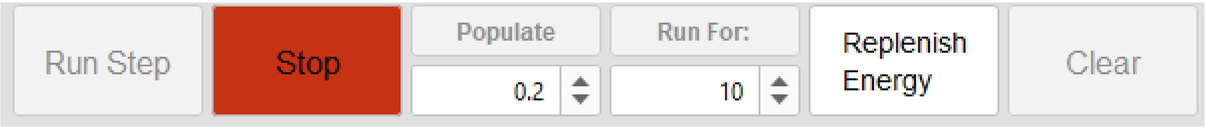
Run For lets you choose how many steps to run the simulation for. Defined by the number below.

Populate lets you place agents on the environment. The value below is the percent of tiles an agent should be placed on, i.e. at 100 an agent will be placed at every tile.

Replenish Energy resets the environments energy to its maximum amount.

Clear removes all agents from the simulation and resets the steps to 0.

The below image is the simulation controls when the simulation is running. You can only replenish the environments energy when the simulation is running.



1.2 Environment Settings

The below image is the environment settings, you can update aspects of the environment from here.

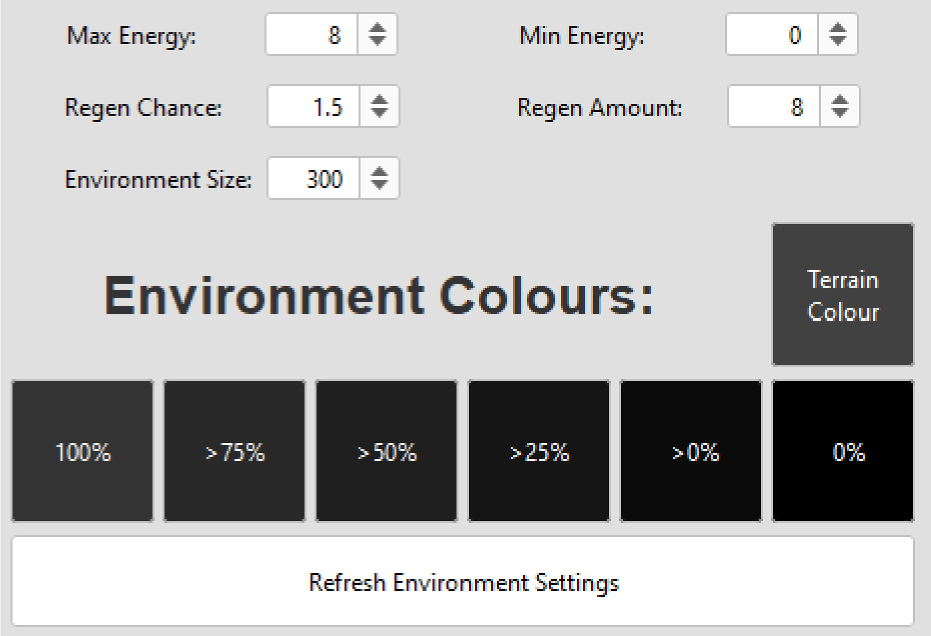
Max Energy is the maximum amount of energy each tile can store.

Min Energy is the minimum amount of energy each tile can store.

Regen Chance is the percent chance a tile will regain energy each step.

Regen Amount is how much energy each tile will regenerate by.

Environment size is how many tiles one edge of the environment has. This must be between 1 and 600 and must also be a factor of 600.



Max Energy: 8

Min Energy: 0

Regen Chance: 1.5

Regen Amount: 8

Environment Size: 300

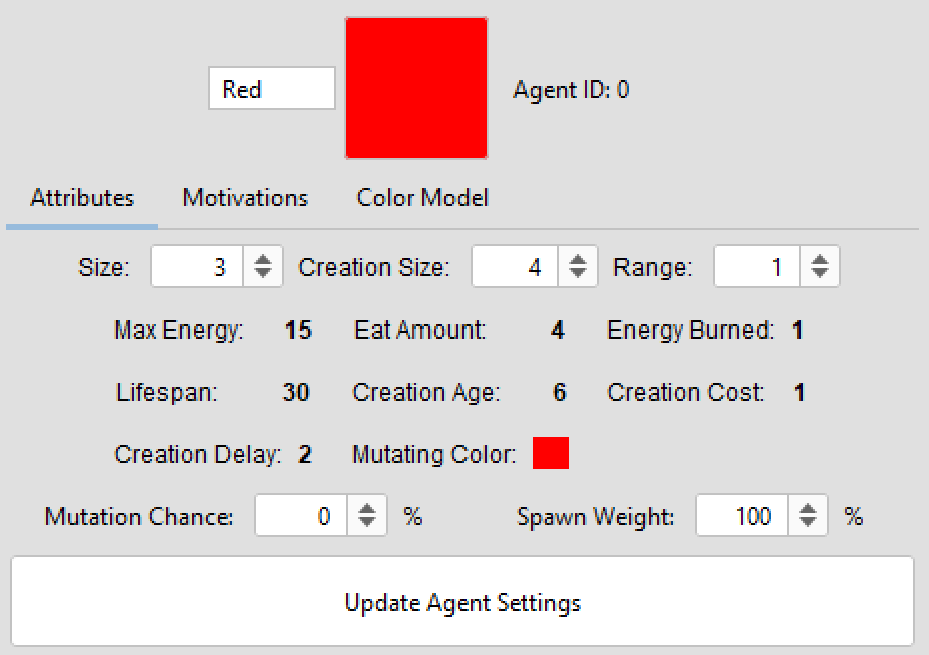
The 7 buttons below control the environment colours.

Terrain Colour controls what colour terrain tiles are displayed as, while the rest control what an unoccupied tile looks like at the specified energy level.

All environment settings bar environment size can be changed while the simulation is running.

1.3 Agent Settings

This is the agent settings section. Here you can select an agents name and colour while seeing its ID. You can also change an agents **Size**, **Creation Size**, and **Range** here. You can see the resultant calculated attributes below. This is where you select how likely it is an agents child will mutate at birth, and the weight applied to this agent when the populate button is clicked.



Red 🟥 Agent ID: 0

Size: 3 Creation Size: 4 Range: 1

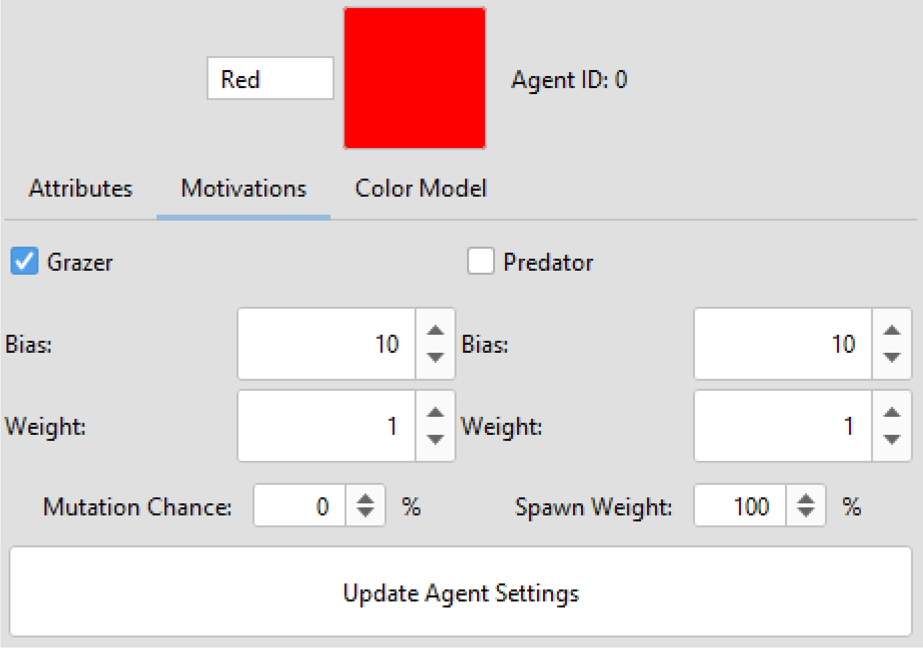
Max Energy: **15** Eat Amount: **4** Energy Burned: **1**

Lifespan: **30** Creation Age: **6** Creation Cost: **1**

Creation Delay: **2** Mutating Color: 🟥

Mutation Chance: 0 % Spawn Weight: 100 %

If you select the **Motivations** tab, you will be shown the below view:



Red 🟥 Agent ID: 0

☑ Grazer ☐ Predator

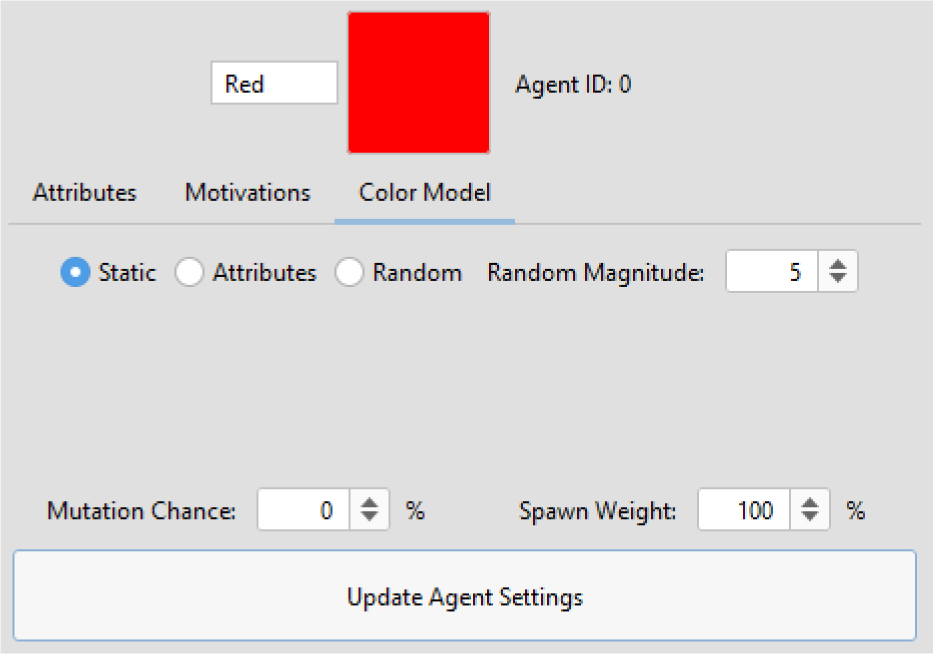
Bias: 10 Bias: 10

Weight: 1 Weight: 1

Mutation Chance: 0 % Spawn Weight: 100 %

Here you can select if an agent gets its energy from the environment (Grazer) or from other agents (Predator) or both. You may also select a bias and a weight for each motivation. The bias is an additive value and can be used to add a small bias between motivations, while the weight is multiplicative.

If you then select the **Colour Model** tab, you will be shown the following view:



Red 🟥 Agent ID: 0

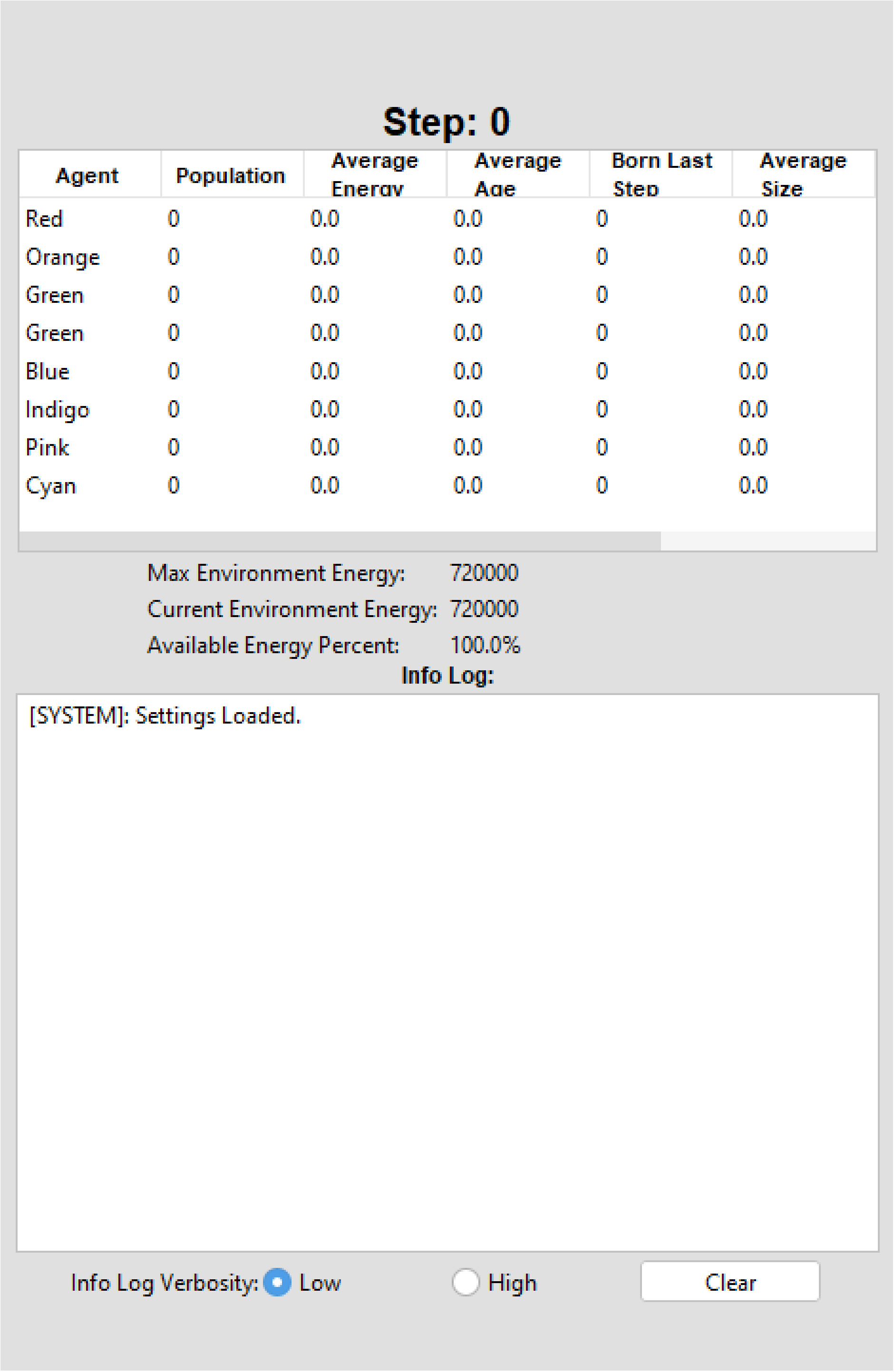
● Static ○ Attributes ○ Random Random Magnitude: 5

Mutation Chance: 0 % Spawn Weight: 100 %

Here you can select the colour model used by the agent. **Static** means its colour never changes. **Attributes** means its colour is generated from the chosen colour and the agents attributes. It can be used to observe mutations as the simulation runs. **Random** will randomly add the random magnitude value to each colour channel every time an agent is born. This can be used to track different populations of the same type. It is useful in cavernous environments where populations can branch down multiple routes.

1.5 Diagnostics

The diagnostics view simply allows you to view useful simulation information that can’t be displayed in the simulation view. The **Info Log** displays useful messages.



Step: 0

Agent	Population	Average Energy	Average Age	Born Last Step	Average Size
Red	0	0.0	0.0	0	0.0
Orange	0	0.0	0.0	0	0.0
Green	0	0.0	0.0	0	0.0
Green	0	0.0	0.0	0	0.0
Blue	0	0.0	0.0	0	0.0
Indigo	0	0.0	0.0	0	0.0
Pink	0	0.0	0.0	0	0.0
Cyan	0	0.0	0.0	0	0.0

Max Environment Energy: 720000

Current Environment Energy: 720000

Available Energy Percent: 100.0%

Info Log:

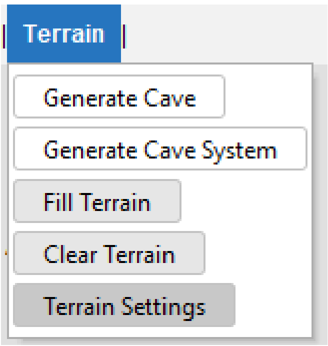
```
[SYSTEM]: Settings Loaded.
```

Info Log Verbosity: ● Low ○ High

Setting **Info Log Verbosity** to high will cause the system to log a message for every agent born.

1.5 Terrain Generation

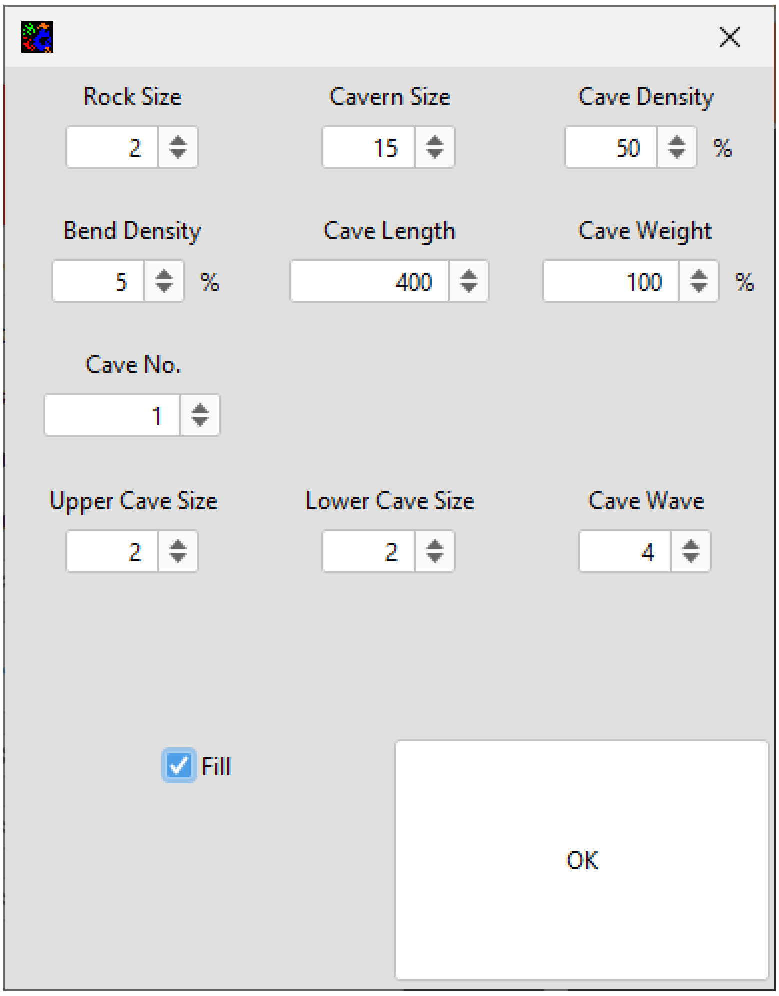
You can access terrain generation from the systems tool bar:



Generate Cave paints a cave, while **Generate Cave System** will generate a system of interconnected branching caves.

Fill Terrain and **Clear Terrain** will set all tiles to terrain or clear all tiles of being terrain respectively.

Terrain Settings opens the terrain settings menu:



Rock Size: 2

Cavern Size: 15

Cave Density: 50 %

Bend Density: 5 %

Cave Length: 400

Cave Weight: 100 %

Cave No.: 1

Upper Cave Size: 2

Lower Cave Size: 2

Cave Wave: 4

☑ Fill

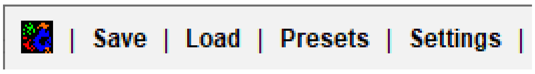
The checkbox **Fill** sets whether the shapes are painted as terrain, or the absence of terrain.

At the base level, terrain is generated by painting circles. Circles are then painted in clusters, of which the density can be controlled. At a low density, a sparse cluster of circles is painted. At a high density, rough circle like shapes are generated. **Rock Size** determines how large the base circles are. **Cave Density** determines how dense the clusters should be.

To generate a cave, these clusters are painted in a line with the direction randomly changing. The chance of the direction changing is controlled by **Bend Density**. As the clusters are painted, their size will oscillate between **Upper Cave Size** and **Lower Cave Size**. Cave Wave can be considered the frequency of the wave but inverted. The chance of a cluster being placed corresponds to **Cave Weight**. The amount of caves that will be placed and their length corresponds to **Cave No** and **Cave Length** respectively.

Caves within cave systems are connected using fixed density clusters. The size of which is controlled by **Cavern Size**.

1.6 System Controls



The system controls can be accessed from the tool bar. Here you can save/load agents, the environment, or the entire simulation. Access pre-set simulations and toggle the controls.

2 Known Issues

2.1 Controls do not respond.

During runtime, it has been noted that the simulation controls occasionally stop responding to user input. The workaround for this issue is to restart the software.