The protection periods of animats within increasingly varying environments.

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1 Background

Potts (1996) proposed a connection between evolution and climate variability, known as the variability selection hypothesis. This hypothesis indicates that climate fluctuation, and the consequent variation in the presence of vegetation and other vital resources, may introduce a bias towards the selection of adaptive genes, behaviours, and learning strategies.

Borg and Channon (2012) tested the variability selection hypothesis by evolving and employing different learning strategies of strings, using their Hamming distance as a measurement of fitness, within increasingly variable environments. However, this is a highly artificial task that is not seen in nature. Additionally, there has been little other theoretical work applied to Potts' hypothesis.

Thus, the current experiment aims to test the variability selection hypothesis in a more natural environment, by using animats to evolve behaviours that imitate those found in nature such as foraging and mating. Protection period durations will be used to measure learning as these have been shown to aid learning (Bullinaria, 2009).

2 Hypotheses

The variability selection hypothesis (Potts, 1996) suggests that increasingly variable environments will result in a higher prevalence of versatile behaviours and learning strategies.

Therefore, it is predicted that, in this experiment, learning will become more important for survival the more the environment changes. It is expected that this will equate to:

1. Longer protection periods in highly variable environments than in less variable environments.
2. Shorter protection periods in less variable environments than in highly variable environments.

Definition: a protection period is the duration of time when an infant is protected by its parent. Here, this is used as the time when an animat can learn but not mate. After its protection period is over, the animat will be able to mate but is no longer able to learn.

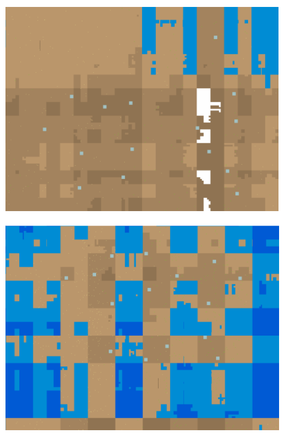
3 Methods

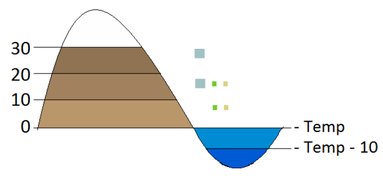
In an effort to create a simulation that is as realistic as possible, the following conditions have been implemented based on Marriott, Parker and Denzinger (2010):
(All coding done in Java 8 and JavaFX using the NetBeans IDE).

- The animats will have values for hunger, thirst, and rest, necessitating food (in the form of two types of plant), water, and shelters respectively. If any of these values drops to 0, then that animat will die and be removed from the simulation.
- The animats will move as if on wheels, with a left and right movement value affecting their speed and rotational direction. The animats may also perform an action depending on what is around them (e.g. eating next to a plant, drinking next to water or mating next to another animat).
- Animats may only mate with another mating animat, and only when they both mature and have hunger, thirst, and rest levels that are above a certain value.
- After mating, both animats will have a gestation period before giving birth. The subsequent children will be in their protection period for a certain amount of time before being able to mate.

Environment creation

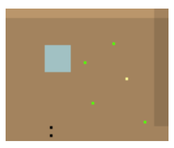
To further add an element of realism, the environment is created procedurally and will use multiple maps at each level of testing to ensure that no unique features are confounding the results (seeds can also be saved in order to reuse a map).
First, a height map is created by generating a line of values for X = 0 and Y = 0, and then averaging the two corresponding values for each point in the environment.
Afterwards, different types of terrain are assigned to the different bands of altitude, including water.
Then, the environment is checked for suitability, depending on the total size of each type of terrain, before being used. The images on the right are screenshots of acceptable environments that have very high (top) and very low (bottom) average altitudes.





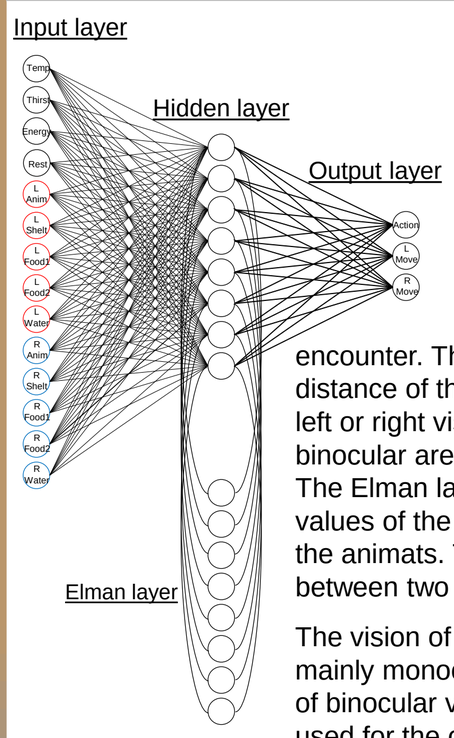
Above: image displaying heights of the different terrain types and the elements that can spawn within them.

Bands of temperature ranging from -5 to +5 will move across the environment. These affect the spawn rates of plants and the height of water, acting as dry and wet seasons. The speed at which these bands move will be used to measure the environmental variability.



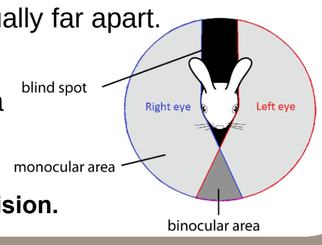
Left: screenshot showing a shelter (grey), the two plant types (green and yellow), and some animats (black) as they appear in the environment.

Neural network



The neural network consists of 14 input nodes, 8 hidden layer nodes (subject to change) with 8 corresponding Elman layer nodes, and 3 output nodes.
The output nodes control movement and action.
The input nodes are made up of 4 non-visual nodes, for temperature, thirst, hunger, and rest, and 10 visual nodes. There are two visual nodes, one for each of the two visual fields, or "eyes", of the animat, for each element that the animat may encounter. The input value for these nodes will depend on the distance of the closest corresponding element within either the left or right visual fields. If the closest element is within the binocular area then it will be affecting two nodes.
The Elman layer (Elman, 1990) maintains a copy of the previous values of the hidden layer, in effect providing very short term to the animats. This was implemented to avoid them getting stuck between two elements that are equally far apart.

The vision of most herbivores is mainly monocular with a small area of binocular vision. This model is used for the current experiment.



Right: a typical herbivore's field of vision.

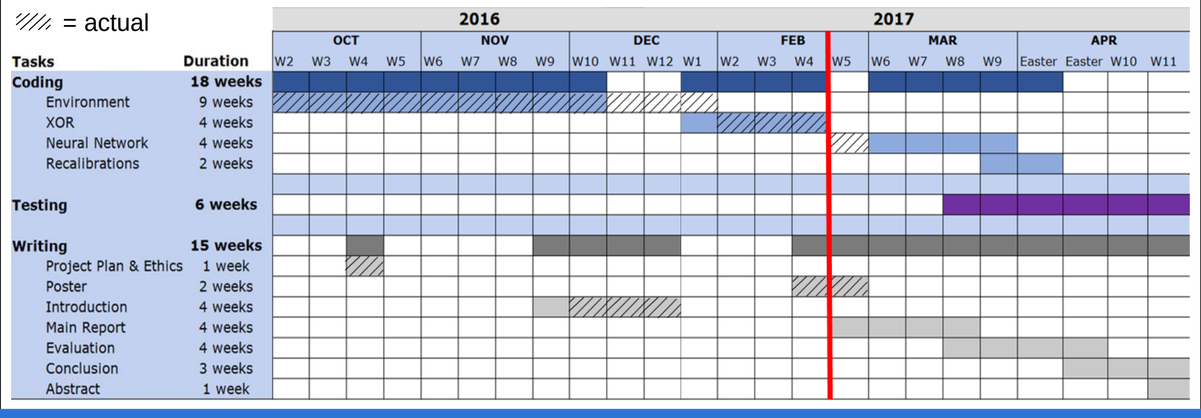
4 Progress

Done

- ✓ Coded a suitable environment generator, including multiple types of terrain.
- ✓ Created a seasonal cycle (dry/wet), which affects vegetation spawn rates.
- ✓ Implemented animats that require food, water, and rest.
- ✓ Wrote and drafted parts of the report.

GANTT chart

GANTT chart showing projected arrangement of work, separated into coding, testing, and writing sub-sections, as well as actual progress of work up until week 5 of semester 2.
While most tasks have been completed on time, the writing of the introduction section still needs to be completed at a later date.



To do

- ○ Code proper animat movement and vision.
- ○ Implement full neural network.
- ○ Implement mating and social learning.
- ○ Testing and recalibrations.
- ○ Finish writing up most of the report.

References

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