CHOICES:

*What do the inputs look like?*

- spectral vision (like our eyes, with 3 color receptors), or ‘food radar,’ ‘creature radar’ etc.

- Inputs should be simple for the neural net to interpret. For example, have different inputs for each possible object that the creature could be seeing, rather than having a single vision input, where 0.1 means food, 0.2 means wall etc.

*What to the outputs look like?*

- Basic tasks should not require memory. For example, having acceleration as an output is a bad idea because without memory, it is difficult for the creature to ascertain its velocity.

*breeding all at once to update generations, or dynamical breeding that derives from behavior and environment?*

*Can creatures die?*

- this gives a good way to add cost functions. For example, a bigger brain can take up more energy, so it needs more food.

*Can creatures train their networks (i.e. learn) during their lifetimes?*

- This might take up too much computing power

- Just like some species are programmed with more instincts than others, creatures could also evolve a parameter which controls how flexible their neural networks are over their lifetimes. Real species which learn a great deal in their infancy usually require parents. This is a whole extra level, and probably a bit much.

- do creatures inherit the learned weights, or the original weights (like in biological evolution)?

*Direct or indirect encoding of weights for genetic algorithm?*

- trade-off between search space size and potential diversity

THINGS TO INCORPORATE:

\* different species

\* physical separation between creatures, which can then break to introduce competition between creatures that evolved separately

\* ability to interact with different kinds of environments and objects

\* Ability to save session AND species. Save them and then let them compete later

\* Variation in environment and abundance of resources.

\* Concept of energy: creature gains energy by eating, loses by moving, thinking etc. Neural net contains an input equal to the creature’s energy. Food can contain different amounts of energy (different inputs for different kinds of food, or one for all, with the magnitude corresponding to the energy?) This determines success when it comes time to apply the genetic algorithm. Integrated over lifetime, or fitness is just end energy?

\* Internal states, which can function as memory and emotions (fear, tired, planning etc.)

\* Let them evolve other parameters, like color, and parameters coded in but not controlled directly by the neural net (speed, turning style, size etc.). Maybe even evolve types of inputs and outputs, which simulates evolution of the creature’s physical structure. More challenging, requires more thinking.

- vision could evolve by changing the way colors are converted to signals which enter the neural network. This allows them to evolve to see food better in different environments, defeat camouflage strategies, and divert attention

\* In the beginning, they have access to many abilities and senses, but using these resources somehow costs energy, so that they don’t use them until they have evolved more and can sustain supporting organs like eyes or high speed

IDEAS:

\* Brain size: If we find a way to genetically mix neural nets of different sizes, we could introduce a cost function that guarantees they don't get too complex for the computing resources we have. It would also be interesting to see how much a species is willing to sacrifice for a big brain.

\* allow for collective behavior, and set up environments and interactions which encourage this. Can they protect from predators? Can the work together to reach hard-to-access food? Need ideas on how to implement this!

- predators fitness is determined by how much its energy is depleted, so whether or not it dies. Prey fitness is determined by how long it survives, presumably to make offspring. But this is already incorporating an idea that had to evolve in nature. To make this behavior emergent, rather than programed in, dynamic breeding with some cost functions

\* Creatures can leave markers in their environment (pheromones)

\* Is it possible to encode neural networks in a non-redundant way? This may benefit the genetic algorithm (or not)

\* Allow for speciation? Can use 2-Means algorithm to cluster population into 2 separate species (idea from EcoSim)

\* Moving food: either have predators and prey (and it could even change dynamically who is predator and who is prey based on size or something), or have food that follows a simple rule, like move away from nearby creatures. Try to set this up so that the optimal strategy is cooperative (corner the food, or something like this)

\* We want to allow for large environments and number of creatures with a linear scaling in computing resources used if possible (must be sub-exponential)

- Environment can be divided into regions, and collision detection is only checked between creatures in the same region. Rendering only shows a subset of the environment in general

\* Worms! Requires writing a basic physics engine…

LINKS:

<http://en.wikipedia.org/wiki/Artificial_life>

<http://en.wikipedia.org/wiki/Neuroevolution>