**Outline**

* Central Focus – Be able to analyze the population stability of a predator prey ecosystem.
  + In particular determining the desirable levels of mutation susceptibility that are required in order for the prey to avoid predators and more efficiently use available resources and for the predators to sustain themselves and their food source.
* Necessary aspects to accomplish this:
  1. Method of introducing energy into the environment and its conversion into useful nutrients.
     + This might be likened to light from the sun, where prey organisms would me more akin to plants attempting to more effectively utilize it.
  2. Method for generational development of increased efficiency in the conversion of energy to nutrients.
     + This is important for population size to grow since nutrients are required both for sustenance and reproduction in both prey and predators.
  3. Method to determine how nutrients will be used to sustain an organism and how they will be used to reproduce.
     + This will essentially translate into how quickly an organism reproduces. Thus population sizes are closely linked to this.
     + This also entails a description of how time will be modeled (i.e. what kinds of time steps will be used)
  4. Method of predation that will enables predators to maintain prey populations.
     + Without any prey, the predators have no food source and will starve. So when predators develop the ability to eat prey there must be a system in place that gives prey populations time to adapt to increased selective pressure. Likewise when prey populations adjust, predator populations also need time to adapt to the increased selective pressure.
  5. Method of reproduction.
     + How information will be passed form one generation to the next. This requires a system for how mutations will occur.
  6. Method for introducing death by mutation.
     + This is necessary to prevent a general trend where mutations will always increase survivability.

**Layout**

1. **Addressing the general mutation system for prey and predators**:
   1. The mutation system in prey will be more complex than the system in predators simply because the number of functions which the prey must perform are more numerous and complex. However both will have a fundamental probability element (FPE) ranging from 0-1 that will increase, decrease, or remain the same from generation to generation:
      1. The prey’s FPE will control:
         1. The mutation method in E to N conversion.
         2. The mutation method in its defense mechanism development.
      2. The predators FPE will control:
         1. The mutation method in its offense mechanism development.
   2. The probability that the two FPE’s will change remains unaffected with each passing generation. As such this probability, the system probability element (SPE), is the fundamental source of chance that all evolutionary routines rely on to produce change. Any other probability elements (PE’s) in the system will be dependent on the two FPE’s and by association the SPE.
2. (**A**) Introduction of Energy and it’s conversion into Nutrients:
   1. “Energy” comes in the form of a string of natural numbers. The amount of nutrients points that are gained from this “energy” is controlled by a simple rule:
      1. E = energy string = some arbitrary collections of numbers.
      2. X = (length the number string) – i.e. how many numbers there are in E.
      3. Y = (length of the set describing E) – i.e. the set which contains all the numbers in the string
      4. (X-Y)/Y = N = nutrient points (where nutrients are integers)
   2. Example:
      1. E = [4, 1, 2, 2, 4, 1, 3, 3]
      2. X = 8
      3. Y = 4
      4. (8-4)/4 = 1 = N
3. (**B**) Increased efficiency in the conversion of energy to nutrients:
   1. This is achieved in two ways:
      1. The rule allows for more energy points to be awarded to strings that are comprised of all the same numbers. In such an energy string the rule would yield an N of (X-1)/1.
      2. Now in order to introduce complexity we can allow the length of E to be increased, or for reduced complexity the length can be shortened.
      3. Additionally this addresses (**F**) by creating the possibility for harmful mutations that can reduce the amount of nutrients produced.
   2. Mutation method in E to N conversion:
      1. Mutation can change E values for the next generation prey by selecting a value at a random index in the string and either increasing, decreasing, or maintaining that value. The probability of a mutation is directly related to the prey’s FPE.
      2. Mutation can also change the length of E for the next generation of prey by introducing the prospect of reducing, increasing, or maintaining the length of E. Each of the three possibilities will have a PE whose value is dependent on, but not the same as the FPE. These PE’s will be modified as the length of E increases, however all three PE’s must sum to 1.
         1. The PE for increasing the length of E will decrease as the length of E increases.
         2. The PE for decreasing the length of E will increase as the length of E increases.
         3. The PE for remaining constant must then be 1 minus the FPE.
4. (**C**) Method for nutrient distribution between sustenance and reproduction:
   1. Prey Organisms:
      1. One nutrient point will be required to sustain an organism. From part (I) this means that Y must be at least half of X. If an organism is unable to meet that condition they will “starve” and be removed from the population.
      2. After meeting the sustenance requirements, all additional nutrients will be added to a stockpile at the end of each time step. Once that stockpile is large enough an organism can reproduce.
      3. It should be noted that the limitation on E to N conversion in (III.b.ii.1) is meant to put a cap on the rate of population growth.
   2. Predator Organisms:
5. (**D**) Method of predation:
   1. Prey Organisms
      1. Prey will have a list of numbers which can be modified with each generation