Unnatural Selection Final Write-Up

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AI as Opponent, AI as Natural Selector

Github Link: https://github.com/WillyWoosley/UnnaturalSelection

Overview:

Unnatural Selection is a text-based command line game which places you in control of a species newly introduced into a foreign environment, along with several other AI controlled species also freshly arrived, and all of whom must attempt to survive to be the last species. You attempt to do this by "evolving" your species to better compete with the other species in the environment, as well as to ensure that there are enough resources within the environment that your species will not starve.

The game is turn based, with a general turn playing out as follows: first, the player is presented with the list of all evolutions they can currently apply to their species. Which evolutions can "be applied" is dependent upon how many "evolution points" the player species has to "purchase" the evolution with and whether or not they have satisfied the prerequisites for a certain type of evolution (for example, you must first evolve arms before you can evolve long arms). Evolution points are accrued on a turn-by-turn basis, dependent upon the "size" of the species, with larger animals generating points more rapidly, but at the cost of increasing the amount of food they must consume per turn to survive. Once the player has selected their desired evolution, the AI's make their decisions in the way prescribed in the "Problem Addressed and Method Employed" section below. Then the "competition" portion of the game occurs, where both the player species and the AI species all must gather enough resources to sustain their population from the naturally occurring resources in the environment as well as by "hunting" other species--processes also described in the "Problem Addressed and Method Employed" section. Populations are updated based upon, for a given species, whether they gathered enough resources, how many of them were killed during hunting, how many died due to the species natural "death rate" (a status which can be modified through the purchase of evolutions), and how many were born due to the species "birth rate" (another status like "death rate"). Any species whose population dropped to zero is of course removed from competition.

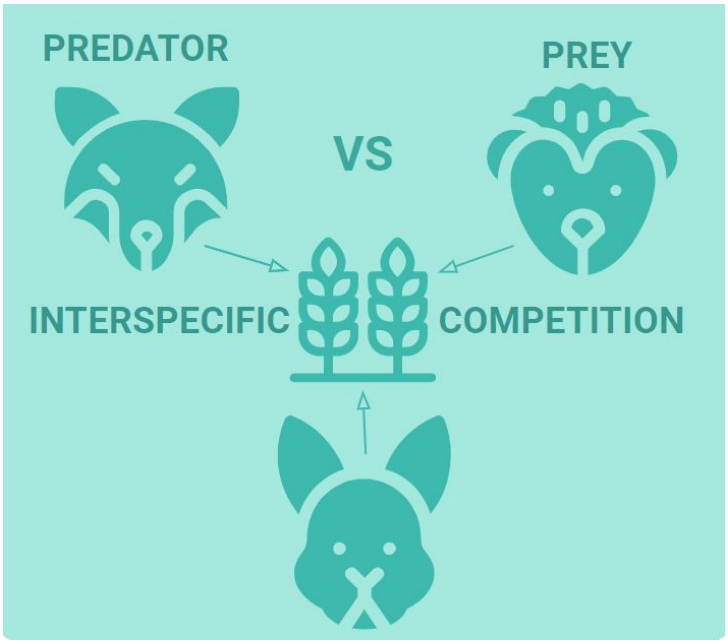
This turn-based process is repeated until either the player is the last species remaining in the environment, or the player species dies out, at which point the game ends.

Problem Addressed and Method Employed:

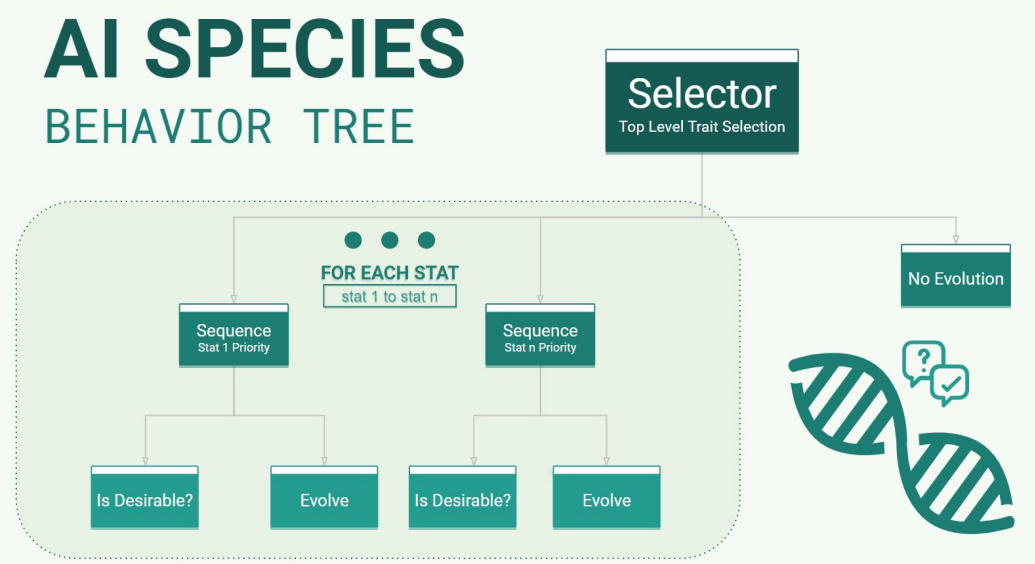
In the game, there were two main technical problems which we had to address: how would we construct the AI species which would compete with our player, and how would we model competition between these species?

The latter was achieved using (as recommended when we reviewed our proposal slide) a Lotka-Volterra predator-prey model combined with the Lotka-Volterra interspecific model. Each species would get the chance to play the predator if the environment had at least another species that could act as its prey. Every round each species would hunt one other, the amount hunted inspired by the predator-prey model where the population of each of the species is multiplied by a constant determined by their stats. This would be done before the interspecific model, and the amount of prey hunted would be an addition to the food from natural resources that each species acquires. The change in population of a species with population N1 then is determined by the

formula `r*N1(K - N1 - c*N2)/K`, where N2 is the population of all other species, r is the rate of growth of species N1, K is the carrying capacity for that species, and c is the competition constant between this species and all others. The carrying capacity is determined by how many of the species can survive with the natural resources and the food from the prey, and the competition constant is calculated from the species stats.



The former proved somewhat more troublesome in terms of finally arriving at a suitable way to address it. Our initial intention of using genetic algorithms to develop new AI species each turn did not prove to be feasible, as any sort of "crossover" between species did not really fit within the context of our game. After briefly experimenting with using Monte-Carlo Simulations to determine the next move--which proved to have its own issues revolving around difficulties experienced with implementation as well as extension to include competition between quite a few opponents--we finally arrived at creating a set of "desires" for each of our AI characters, which would then be used to generate generally similar but unique behavior trees for each AI character, dependent upon their respective rankings of their "desires". For each AI, the behavior tree is executed, and for each individual desired traits (with the most desired obviously being executed first), all satisfactory and available evolutions (i.e. one for which the prerequisites for evolution are satisfied and for which the AI has enough evolution points to purchase) are gathered and ranked based upon their "utility" to the AI (how much they improve different traits, and how much those traits are desired by the AI). Whether a given trait is "desirable" enough to be evolved is determined by how the AI species ranks in that trait compared to all the other species (i.e. how many are better than it in a stat, and the magnitude by which they exceed it). So long as they exceed a given threshold of utility, that is the evolution taken for the turn. If no sufficiently satisfactory evolutions are found, the AI will elect to instead wait a turn, to accrue more evolution points and to attempt to evolve again during the next round.



Demo:

```
Turn  1
Environment currently has 1100 units worth of food
Your species:
[ Name: Player's species; Population: 105 , Stats: {'attack': 1.0, 'defense': 1.0, 'speed': 1.0, 'stealth': 1.0, 'size':
 1.0, 'birthrate': 20.0, 'deathrate': 10.0, 'spotting': 1.0} ]
AI species:
[ Name: cncmwsfsxa; Population: 103 , Stats: {'attack': 1.0, 'defense': 1.0, 'speed': 1.0, 'stealth': 1.0, 'size': 1.0,
'birthrate': 20.0, 'deathrate': 10.0, 'spotting': 1.0} ]
[ Name: ogwccwkdva; Population: 106 , Stats: {'attack': 1.0, 'defense': 1.0, 'speed': 1.0, 'stealth': 1.0, 'size': 1.0,
'birthrate': 20.0, 'deathrate': 10.0, 'spotting': 1.0} ]
[ Name: bpjpuxwzky; Population: 104 , Stats: {'attack': 1.0, 'defense': 1.0, 'speed': 1.0, 'stealth': 1.0, 'size': 1.0,
'birthrate': 20.0, 'deathrate': 10.0, 'spotting': 1.0} ]
```

```
Executing Turn...
cncmwsfsxa GRAZES FOR 99 WORTH OF FOOD
ogwccwkdva GRAZES FOR 72 WORTH OF FOOD
Player's species GRAZES FOR 80 WORTH OF FOOD
bpjpuxwzky GRAZES FOR 118 WORTH OF FOOD
Player's species hunted for 15 ogwccwkdva
ogwccwkdva fed 3 of Player's species
cncmwsfsxa hunted for 4 ogwccwkdva
ogwccwkdva fed 4 of cncmwsfsxa
ogwccwkdva hunted for 7 cncmwsfsxa
cncmwsfsxa fed 7 of ogwccwkdva
bpjpuxwzky hunted for 59 ogwccwkdva
ogwccwkdva fed 10 of bpjpuxwzky
ogwccwkdva has perished!
Executed in less than one second
```

Novelty and Benefits:

Our goal with this project was to take the gameplay of existing games--such as Spore and Plague Inc.--and add more realistic evolution and species competition to them. Our “evolution” model of having people generate points every turn and then spending those points on evolutions which affect the players species comes directly from Plague Inc., and Spore starts from a conceptually similar position of dropping the players character into an environment with numerous other species evolving concurrently with the player species. However, in Plague Inc. there is only the player species attempting to kill the entire population of earth, which puts up

little fight, and in Spore the emphasis is more on evolving to exploit your environment rather than for direct competition with other species.

In addition to creating an engaging game and AI in its own right, the same underlying mechanics could hypothetically be employed to create a realistic ecosystem for a game environment, as well as respective roles for the creatures therein (for example, stealthy prey or very fast, large predator). Our game could potentially be used by ecologists to study how certain animals with certain characteristics would interact with other species.

Achievements, Shortcomings, and (Hypothetical) Paths for Further Development:

Overall, our game and AI set outs to accomplish what was desired of it: it creates an interesting gameplay experience in which the player is forced to balance the evolution of their creature with competing species which are all competing with one another to achieve dominance over their environment. After several iterations, the desire-based behavior tree model worked out quite well for our purposes, and had the added benefit of making further tweaking and development of the AI easier than could have been accomplished with an AI modeled around a "random playout and check fitness" (i.e. a Monte Carlo or Genetic AI).

Of course, there are also several shortcomings with our project. One of the most pronounced is that, unfortunately, it does model real life in the sense that at a certain point, once species pass a certain population threshold comparative to the other species, the population becomes too small to feasibly recover or compete with the other species, and is doomed to fail regardless of what evolutions are taken. When this happens to the player's character, it means that the player is forced through several turns of evolution, despite the fact that the game is essence already over and there is no way that they can alter its course.

As is almost always the case, due to time constraints, there were far more things which we could have/would have liked to add to the game, yet were unable to do in favor of focusing on those systems which we could create on time and with our current knowledge pool. For example, in our original specification, we intended to have the environment play a much larger role in the evolution of species than it currently does. The addition of environments which themselves have traits which pose as an additional "enemy" to player and AI species alike (such as being particularly hot or cold, very barren, extremely mountainous, etc.) could add another layer of depth to the game. In addition, it would obviously be nice to take the game from a text-based command line style game to a more fully realized game with some sort of species visualization and user AI (which we were prevented from impllementing due to the fact that most of us have no significant game development experience and/or artistic inclinations).