On The Potential Hostility of Alien Species

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Abstract

In this article we discuss the possibility that an extraterrestrial species could be hostile to humanity, and present estimates for the probability that visitors to the Earth will be aggressive. For this purpose we develop a generic model of multiple civilizations which are permitted to interact, and using randomized parameters we simulate thousands of potential worlds through several millenia of their development. By reviewing the species which survive the simulation, we can estimate the fraction of species which are hostile and the fraction which are supportive of other cultures.

1 Introduction

We live in a very exciting time for science and humanity. Over the first decade of the third millenium, man-made probes have visited the outer planets of our solar system and journeyed into interstellar space. Over two thousand planets have been discovered outside of our stellar neighbourhood, with a reasonable number being potentially inhabited. The SETI project[1] harnessed the power of distributed computing[2] to search the skies for signs of intelligent life, and it is quite possible that they will detect extraterrestrial life in the near future[3, 4].

However this expansion into space is not without risk. While it is unlikely that either manned or unmanned probes will encounter other lifeforms soon, electromagnetic waves generated on Earth have been travelling through space for over a century and could signal our presence. There have also been proposals to actively direct such signals to regions of space known to host possibly habitable planets. What if the recipients are not friendly? What if they are violent conquerors who would seek to destroy or enslave humanity?

Such concerns have been discussed numerous times, with different models being applied [5, 6, 7, 8, 9]. The simple fact is that it is impossible to know what extraterrestrial lifeforms will be like, as astrobiology is still in its infancy and we have limited experience with non-human intelligence[1].

In this article, a generic model of a habitable planet is introduced in which minimal rules are applied to the evolution of each species. These rules are assumed to be common to any intelligent society, while accomodating all possible interactions between two species. By simulating several thousand such worlds, and classifying each species as either friendly or hostile, the risk of a specific alien species being a threat to humanity is estimated.

2 Model

The model for this simulation contains a very simple world and a number of civilizations which have evolved on the world. For the purpose of this study, the world affects its inhabitants through only four random parameters:

- G_I - The Global Innovation Factor, with a random value between 0.00 and 0.10. This parameter determines how quickly each society on the world gains new knowledge and technology without interacting with its neighbours. In practice this could represent the presence on the world of metals or other resources for technology, or an environment that allows creatures to spend more time on education and research.

- G_K - The Global Knowledge Factor, with a random value between 0.00 and 0.01, which measures how much information is shared between different societies on the same world. In practice, this could represent a trade system in which academics move between cities, or in which scientists are safe to travel between cultures.

- G_H - The Global Health Factor with a random value between 0.00 to 0.01, which determines how quickly inhabitants heal. In practice this

[1]It could be argued that some animal species could be used as models for different types of lifeform, however we contend that they are still too closely related to humans due to shared environments and interactions to be considered a true sample of an alien species.

could represent the amount of food in nature, or the presence of clean water, or the relative danger of the environment.

- G_M - The Global Medical Factor, which is between 0.00 and 0.01, and which represents the availability natural healing methods on the planet. This could represent medicinal plants, or other environmental factors that improve healing.

On each world, there are between ten and twenty intelligent species. Each species is described by five parameters which are also randomly generated. These are:

- C_A - Aggression Factor. A real number between 0.00 and 1.00 which determines how aggressive this culture is towards its neighbours. Civilizations with high values of C_A are more likely to attack their neighbours.
- C_D - Diplomacy Factor. A real number between 0.00 and 1.00 which determines how diplomatic this culture is towards its neighbours. Civilizations with high values of C_D are more likely to trade information with their neighbours.
- C_H - Health Factor. A real number between 0.00 and 1.00 which determines how healthy the species is. A species with a high health factor is more difficult to kill than a species with a low number.
- C_K - Knowledge Factor. A real number between 0.00 and 1.00, although initially limited to be less than 0.1, which determines how much knowledge and technology this culture possesses. A low value signals a primitive culture, while a value of 1.00 signifies a culture which is capable of interstellar travel.
- C_S - Strength Factor. A real number between 0.00 and 1.00 which determines the strength of the culture's military. A high value represents a stronger military force or a stronger defensive position allowing the civilization to survive battles with its neighbours.

Each species forms a civilization, which is connected with three to five other civilizations with which it can interact. On real worlds, these connections represent either shared physical boundaries, or civilizations which can interact through other means of transport such as flying creatures or creatures who travel through a planetary ocean. However such connections are kept generic, with no consideration of the specific mechanism used.

In each simulation, a world is generated with random values of the parameters given above. Once the world has been generated, a random number of civilizations between five and ten are generated, also using random values for the parameters given above. The evolution of the civilizations is then determined using the following algorithm:

- 1. One civilization is chosen at random to evolved
- 2. One neigbour is chosen to interact with
- 3. A random real number is generated, with a value between 0.00 and 1.00. If it is less than C_A, the civilization declares war on its neighbour.
- 3b. If there is a war, the civilization with the higher value of C_S is considered to be the winner. The losing civilization has C_H decrease by a random real number between 0.00 and 0.1, as a result of injuries to its members and damage to medical facilities.
- 4. If $C_H < 0.0$ for either civilization, then that species is considered to be either eradicated or conquered by their neighbour. In this case, the surviving civilization is cloned and continues as a new species in place of the defeated civilization. In effect, the surviving species splits into two branches that each continue to evolve.
- 5. A random real number is generated with a value between 0.00 and 1.00. If it is less than C_D then the civilization decides to exchange information and technology with their neighbour.
- 5b. If there is a trade relationship between the civilizations, each civilization has an increase in C_K according to the formula

  $$\Delta C_K = f \times C'_K \times G_K \tag{1}$$

  where C'_K is the knowledge factor of their neighbour, f is a random real number between 0.0 and 1.0, and G_K is the global knowledge factor described above. (This same equation is applied to the neighbour's knowledge factor as well)

- 6. C_K is also increased through the civilization's own evolution (ie. the species develops scientists and engineers of their own) according to the formula

$$\Delta C_K = f \times G_I \tag{2}$$

where as before, f is a random real number between 0.00 and 1.00 and G_I is the global innovation factor.

- 7. The civilization heals itself through medical or other means, increasing C_H according to the formula

$$\Delta C_H = f_1 \times G_H + f_2 \times C_K \times G_M \tag{3}$$

with f_1 and f_2 taking random real values between 0.0 and 1.0. The first term represents natural healing and the second term healing as a result of medical sciences.

- 8. If any city reaches the end point $C_K > 1.0$ then it is considered to have achieved interstellar travel. At this point the ratio C_A/C_D is checked to determine the relative aggression of the species. If it is greater than unity, the race is considered hostile to other worlds. If it is less than unity, then they are considered peaceful visitors. It is also assumed that the first species on a world to reach this stage will dominate all others on their world, and the simulation of the world ends.

- 9. If every species on the world has $C_K < 1.0$ then another iteration of this algorithm is performed, and the civilizations continue to evolve.

3 Analysis

Using the world model and the evolution algorithm given above, three sets of data were generated. In each data set, 10,000 possible worlds were simulated and allowed to evolve until one civilization on each reached a technological level that allowed interstellar travel. Once that stage was reached, the relative values of aggression and diplomacy were recorded. If the civilization had $C_A/C_D > 1.0$ it was considered to be a hostile race that could be a threat. Otherwise it was considered a diplomatic race that would be friendly with other lifeforms. The results of these runs are given in Table 1.

	$Worlds$	Hostile	Friendly	Fraction
Run 1	10,000	1799	8201	0.180
Run 2	10,000	1743	8257	0.174
Run 3	10,000	1778	8222	0.178
Run 4	10,000	1812	8188	0.181
Run 5	10,000	1772	8228	0.177

Figure 1: Simulation Results. Each Run represents 10,000 possible worlds, with each world containing either a hostile or a friendly space-faring race of lifeforms

It should be noted in this model that only the first technological civilization is considered. It is possible that a single world could generate both a diplomatic and a hostile race, however we contend that in this model such a world is identical to two separate worlds which each produce a single race. It is also worth commenting that in this model a civilization is considered friendly or hostile based on the single criteria of which parameter is larger. This would mean that a culture for which $C_A/C_D = 0.99$ is considered friendly, in spite of having a high aggression. However we contend that this effect will at least partially be cancelled out by those civilizations in which $C_A/C_D = 1.01$, in which case they are labelled as hostile when they also have a high diplomacy.

While this model is quite generic and permits a wide range of possible worlds and civilizations, the resulting probability of an alien species becoming capable of interstellar travel and being a threat to humanity is relatively stable. In each of the five runs, approximately 18% of advanced alien species became hostile. Combining these five sets of data gives a probability of $(17.8 \pm 0.3)\%$ of an extraterrestrial species becoming a threat.

4 Conclusions

In this paper, a simple but generic toy model of cultural development on an alien world was presented. Using a set of ? parameters to represent the world, the civilizations were evolved following nine basic laws. When a civilization reached sufficient technological skill for interstellar travel, they were declared to be either friendly or hostile depending on the relative values of C_A and C_D.

This algorithm was run in five sets of 10,000 test worlds and the total numbers of hostile and friendly alien cultures were tabulated, for a total of 50,000 possible planets analyzed. Of these virtual worlds, it was found that $(17.8 \pm 0.3)\%$ of the worlds would generate a hostile, space-faring race which could be a threat to our planet.

It is notable in this result that a large variety of possible alien worlds and cultures was permitted, and yet the results were stable. In each run we completed, the same fraction of worlds became a threat. As such, this model predicts that the potential threat from alien species is not significantly dependent on the nature of the world or the specific nature of the lifeforms. If the rules of cultural evolution that we presented are considered valid models of real worlds, then this model predicts that most lifeforms capable of travelling through space are also peaceful.

References

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