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Kin directed altruism and attachment behaviour in evolving neural networks of male and female agents.

Abstract

The idea of altruism has been seen by many, including Darwin himself, as the antithesis of the theory of natural selection, where individuals seemingly reduce their own fitness to increase others [1]. In other words, one could easily attribute a bat's survival/hunting mechanisms of advanced sonar object detection with Darwin's theory of evolution. On the contrary, a vampire bat's behaviour of regurgitating blood into another bat's mouth because it hasn't eaten for a day, is not necessarily "Darwinian" in nature. The emergence of these characteristics forced Darwin to the study of Beehives, where he found sterile worker bees helping their blood relatives, especially the queen, by giving blood. Darwin came to the conclusion that altruism may favour selection within related groups [2]. Although, within the theory of psychological egoism it is suggested that no act of sharing, helping or sacrificing can be described as truly altruistic, as the entity may receive an intrinsic reward in the form of personal gratification. The validity of this argument depends on whether intrinsic rewards qualify as "benefits" [3]. In contemporary artificial simulation research, *Parisi et al* analysed kin directed altruism in neurological agents in an ecological simulated environment. Throughout the lifetime of the agents a decision on food was proposed a fixed amount of times in which the agents have to either act egotistically, or altruistically [4]. Within the paper, *Parisi* proposes an extension to this study, an introduction of sex in the form of male and female agents that have to mate in order to reproduce. This is the main motivation of this project, to introduce sex and analyse the resulting behaviours of the agents and measure the emergence of groups through the temporal duration of their proximity to each other and the balance of egotism and altruism needed in order for individuals to survive.

Parisi's Model

Parisi et al provide a comprehensive description of their artificial social simulation, the set up as follows:

1. The environment is both social and non social, food (non-social) and other agents (social).

2. The agents turn from child to adult at a specific number of cycles

3. The agent have a gene make up that includes a 'blood line' to keep track of individuals and their children.

4. Agents behaviour is simulated by a feed-foward neural network with 4 input, 6 hidden, and 2 output nodes. Output nodes represent motor actions and the decision whether to give or consume the food, both are encoded into motor actions. This question is proposed to the agent at given intervals and if another individual is within a reasonable proximity.

5. An altruism measure between 0 and 1 indicates the probability of the agent acting egotistically or altruistically. The higher the value, the more altruistic the agent will be.

6. The agents have an energy variable and is decreased every cycle (time step) and can only be increased by finding or being gifted food. If the agent health hits zero it dies and is removed from the environment.

7. A child is created if an adult survives enough cycles and is spawned within a close proximity at random.

Project Aims

1. Parisi et al optimised the network of the agents through back propagation. The change in the weights only occurred when a child was produced, with its weights being a minor mutation of the parents. The proposal here is to evolve and optimise the weights of the neural network through a steady state genetic algorithm. Using the energy, altruism variable, proximity to family members, and family members energy in the calculation of the "inclusive" fitness of an individual agent.

2. As detailed in point 7 above, Parisi's model only has 5 different genotype 'sisters' and reproduce if they survive a specific number of cycles. To what effect does introducing sex into agents and reproduction only occurring between male and female agents in close proximity, have on agents attachment behaviour towards each other, specifically interactions between 'family' members. Additionally, the effects on egotistical and altruistic decision making of agents pertaining to giving/keeping food.

3. Parisi analysed the altruism measure implemented within the experiments, this variable was initially and randomly set to be around 0.5 but stabilised over generations in surviving individuals to between 0.8 and 0.9 [3]. To what degree does the altruism measure change within the sexes and children.

Implementation Methods

The world will be developed in Python using Pygame and object oriented programming. The method allows for the creation of minimalist agents with mutable sensorimotor loops. Parallel programming can be instilled within the neural network simulations with the Numpy Python package.

References

1. A. Domondon, "A history of altruism focusing on Darwin" *Endeavour*, vol. 37, no. 2, pp. 94–103, Jun. 2013.

2. C. R. Darwin, "Chapter 6, Difficulties of the Theory" in *On the origins of species: By means of natural selection or the preservation of favoured races in the struggle for life*, London: John Murray, 1859, pp. 130–162.

3. N. Burton, *Heaven and hell: The psychology of the emotions*. Oxford: Acheron Press, 2020.

4. N. Gilbert, R. Conte, D. Parisi, F. Cecconi, and A. Cerini, "Chapter 12 Kin-directed altruism and attachment behaviour in an evolving population of neural networks," in *Artificial Societies: The Computer Simulation of Social Life*, 1st ed., London: Routledge, 1995, pp. 238–251.