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1. Introduction

Altruism is a behavioural phenotypic character defined as the sacrifice of one's fitness to increase that of another. Being a counterintuitive behaviour, many biologists have tried to explain it, but the more stablished explanation was put forward by **W. D. Hamilton**, the success of an altruistic gene is due to its benefit in the population rather than the benefit of the carrier. For altruism to thrive, the relatedness (r) between the actor and the recipient times the benefit (B) to the recipient must be higher than the cost (C) to the actor:

$$r \cdot B > C$$

Even though the fitness of the altruist does not increase, the **inclusive fitness** (referred as the direct fitness of an individual and the indirect of its related ones) does, thus increasing the group fitness. Indirect fitness is gained via **kin selection**.

2. Objectives

The main objective of this project is the study of altruism and its ability to thrive in a realistic population. Previous studies that include a simulation do not have enough population parameters to be extrapolated to a real scenario and cannot be modified, limiting the use of the program. They are also hardly accessible due to being coded in non-bioscientific languages and the code not being available.

The aim of this work is to expand the current available bioinformatic tools for population and phenotypical characteristic studies.

For further objectives, it will be more configurable to expand the simulation's capacities, it will be converted to a Python library to study other characters and artificial intelligence and a statistical analysis module will be implemented.

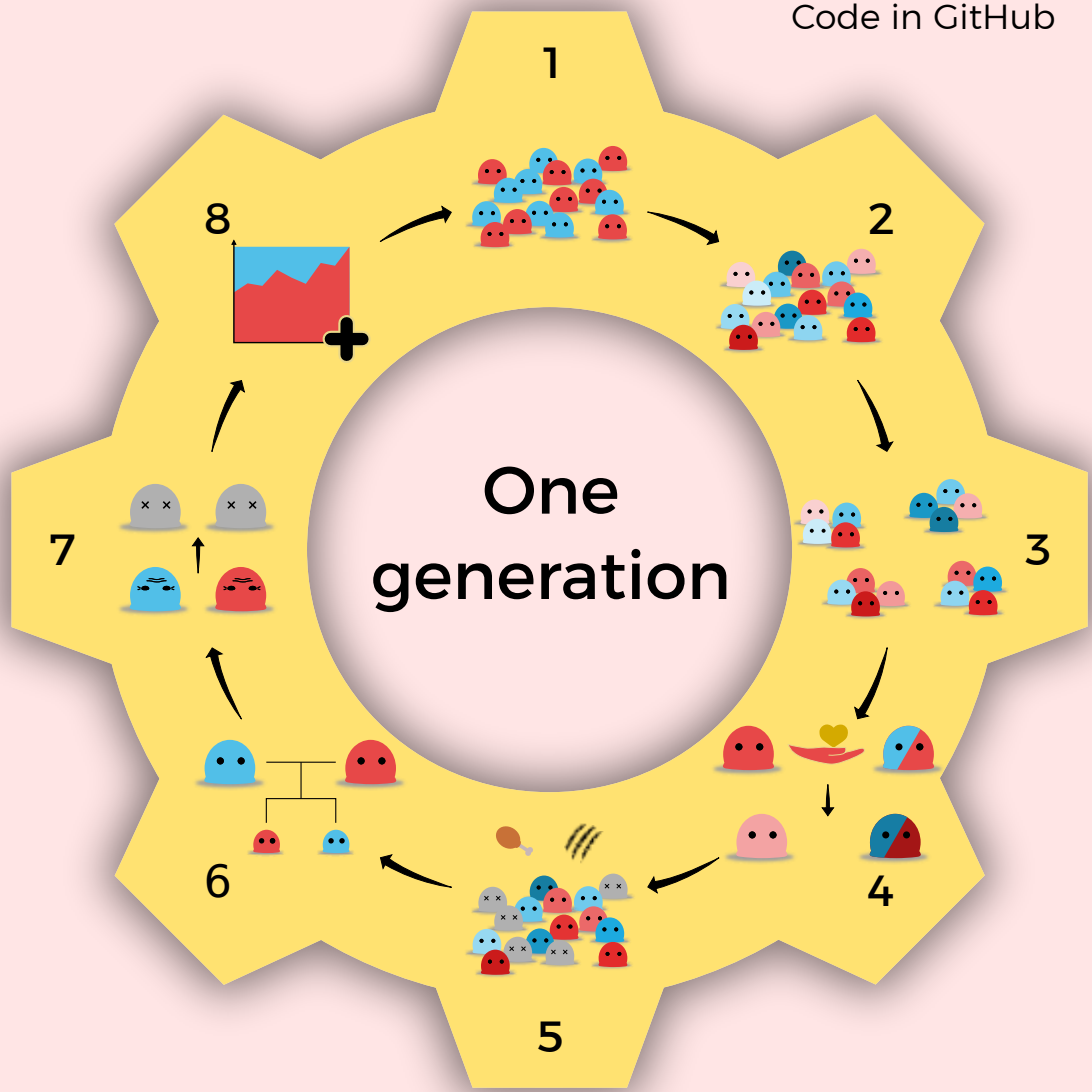
3. Methodology

The simulation has been coded in Python and its functionality tested by generating results using the plotter module. The population is made up of **altruistic** and **selfish** individuals. An individual's fitness is represented by a **survival probability**. Each generation's workflow is the following:

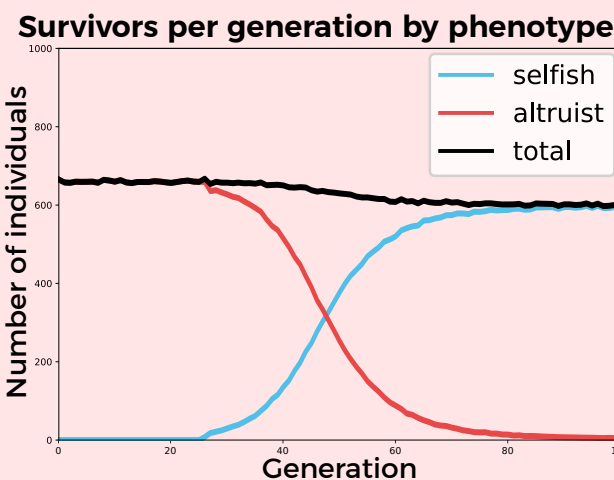
1. Population at the beginning of a generation
2. Assignment of fitness
3. Grouping of individuals
4. Reassignment of fitness after the altruistic act
5. Selection event
6. Reproduction
7. Death of old individuals
8. Save of generation data



Code in GitHub



4. Results and Conclusions

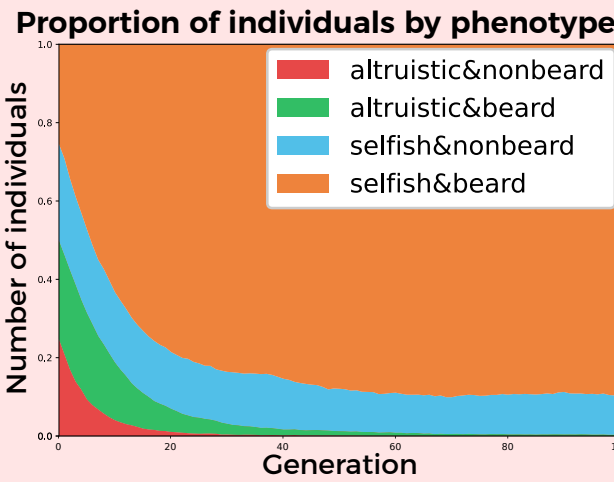
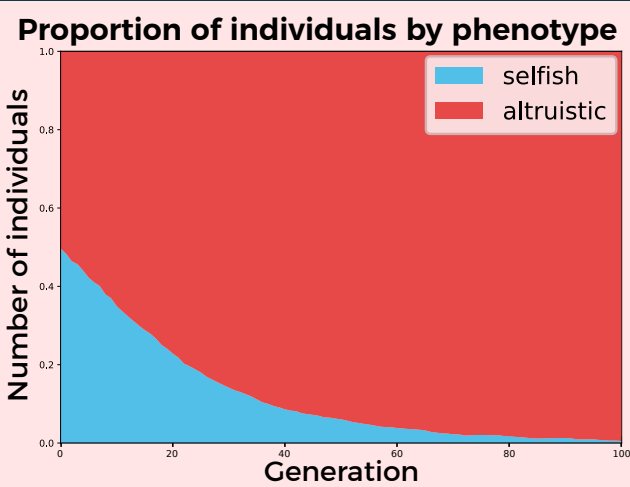


In a fully altruistic population a few selfish individuals are added. This leads to a decrease the number of survivors per generation.

An altruistic population's group fitness is higher than in a selfish one.

The altruism allele codes for a phenotypical trait recognisable by other altruists making the benefits of altruism exclusive to altruists.

In a population with only altruist-to-altruist interactions and a higher benefit than cost, the altruism allele thrives.

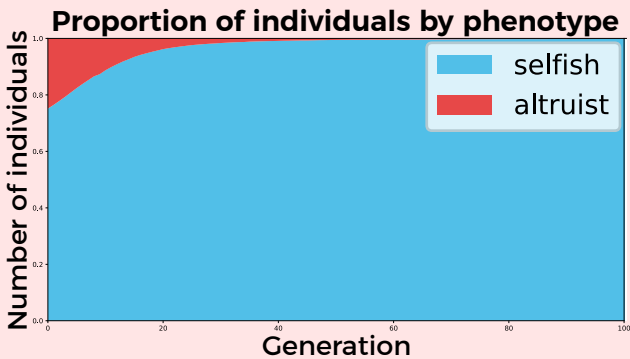


The recognisable phenotypical trait of the previous scenario is coded by another gene resulting in four combinations of alleles.

In a complex genetic model, altruists sacrifice themselves to the selfish individuals.

Finally, a simulation with realistic populations parameters has been run.

Under realistic population parameters, the altruism allele goes extinct.



Alts simulation has been succesfully coded, accepts a high number of fully configurable parameters, is expandable in order to add genetic models, open access in GitHub and programmed in Python.

5. Bibliography

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Kay, T., Keller, L., & Lehmann, L. (2020). The evolution of altruism and the serial rediscovery of the role of relatedness. Proceedings of the National Academy of Sciences, 117(46), 28894-28898. <https://doi.org/10.1073/pnas.2013596117>