ALifeSim Report

**Experiment 1**

Settings:

* Updates: **100**
* Mutations enabled? **False**
* Population size: **10**
* Starting populations:
  + Cooperators: **1**
  + Defectors: **9**
  + Partial Cooperators: **0**

Results:

* Prediction:
  + We expect the cooperator to die, because it will share energy each tick without receiving > 1.
* Average cooperation mean for each replicate:

1. 0.014
2. 0.004
3. 0.024
4. 0.004
5. 0.004
6. 0.004
7. 0.014
8. 0.004
9. 0.009
10. 0.004

* Average cooperation value at end of experiment (average of averages): **0.0085**
* Comparison of results to prediction:
  + The cooperator died 10/10 times, which makes sense, since the 9 defectors all had at least 10 energy at one point, so the cooperator was extremely likely to get replaced whenever one of the defectors reproduced. This result supports our predictions.

Effect of enabling mutation:

* Defectors tend to win, but occasionally a final score of around 6-3 defectors to partial cooperators will occur.

**Experiment 2**

Settings:

* Updates: **100**
* Mutations enabled? **False**
* Population size: **10**
* Starting populations:
  + Cooperators: **9**
  + Defectors: **1**
  + Partial Cooperators: **0**

Results:

* Prediction:
  + The cooperators should win, since they will share energy with other cooperators as well as the defector, giving the cooperators a large advantage for chance of reproduction, due to their large starting proportion of the total population.
* Average cooperation mean for each replicate:

1. 0.997
2. 0.996
3. 0.998
4. 0.999
5. 0.998
6. 0.999
7. 0.999
8. 0.998
9. 0.999
10. 0.995

* Average cooperation value at end of experiment (average of averages): **0.9978**
* Comparison of results to prediction:
  + The cooperators won in 10/10 experiments, which makes sense, since there’s a larger chance for the first organism in the ListArray orgArray to be a cooperator, which makes a difference when all 10 organisms hit the required 10 energy to reproduce. If the first organism is a defector, it has a chance to reproduce, but otherwise, there’s a large chance that the offspring of a cooperator will replace it. This result supports our prediction.

Effect of enabling mutation:

* Defectors still tend to win, but occasionally the partial cooperators will win by a majority. Sometimes the experiment ends with a score around 2-4-4 or similarly even.

**Experiment 3**

Settings:

* Updates: **100**
* Mutations enabled? **False**
* Population size: **10**
* Starting populations:
  + Cooperators: **3**
  + Defectors: **3**
  + Partial Cooperators: **4**

Results:

* Prediction:
  + We expect the results of this experiment to be fairly random, with maybe a slight edge given to the defectors.
* Average cooperation mean for each replicate:

1. 0.114
2. 0.608
3. 0.542
4. 0.073
5. 0.456
6. 0.040
7. 0.069
8. 0.049
9. 0.068
10. 0.092

* Average cooperation value at end of experiment (average of averages): **0.211**
* Comparison of results to prediction:
  + The defectors won in 7/10 experiments, while the partial cooperators won the rest of the time. This result supports our prediction, because it is advantageous for an organism to gain without having to give up energy, which the defectors do best, and the partial cooperators sometimes do as well. The cooperators all died, which slightly differs from our prediction, but makes sense based on the previous assertion.

Effect of enabling mutation:

* The defectors still take the lead, but occasionally will share their victory with the partial cooperators (e.g. 1-5-4).

**Experiment 4**

Settings:

* Updates: **100**
* Mutations enabled? **False**
* Population size: **100**
* Starting populations:
  + Cooperators: **1**
  + Defectors: **99**
  + Partial Cooperators: **0**

Results:

* Prediction:
  + The defectors are likely to win.
* Average cooperation mean for each replicate:

1. 0.0009
2. 0.0018
3. 0.0004
4. 0.0009
5. 0.0009
6. 0.0019
7. 0.0004
8. 0.0009
9. 0.0009
10. 0.0065

* Average cooperation value at end of experiment (average of averages): **0.0019**
* Comparison of results to prediction:
  + The defectors won in every experiment, since they vastly outnumber the cooperators when it comes time to reproduce and will all reproduce before the cooperator. This result supports our predictions.

Effect of enabling mutation:

* Defectors still take the lead in this instance, but the partial cooperators occasionally have a large share of the final population, where before (without mutation enabled) they had no chance to exist.

**Experiment 5**

Settings:

* Updates: **100**
* Mutations enabled? **False**
* Population size: **100**
* Starting populations:
  + Cooperators: **99**
  + Defectors: **1**
  + Partial Cooperators: **0**

Results:

* Prediction:
  + The cooperators are likely to win, since they vastly outnumber the defectors.
* Average cooperation mean for each replicate:

1. 0.9998
2. 0.9996
3. 0.9983
4. 0.9995
5. 0.9992
6. 0.9998
7. 0.9992
8. 0.9992
9. 0.9998
10. 0.9995

* Average cooperation value at end of experiment (average of averages): **0.9994**
* Comparison of results to prediction:
  + This result matches our prediction, since the cooperators won in every experiment. The cooperators got a chance to reproduce early and more often than the defector, and many cooperators would have reproduced early.

Effect of enabling mutation:

* This was one of the more interesting examples of how mutation can skew results. The outcome frequently favored defectors over partial cooperators over cooperators, but a total victory for defectors was rare. Increasing the number of ticks to 1000+ gave the defectors enough time to build up a majority from an initial population of only one.

**Experiment 6**

Settings:

* Updates: **100**
* Mutations enabled? **False**
* Population size: **100**
* Starting populations:
  + Cooperators: **33**
  + Defectors: **33**
  + Partial Cooperators: **34**

Results:

* Prediction:
  + We expect the defectors to win most often, with the partial cooperators winning occasionally (much like Experiment 3).
* Average cooperation mean for each replicate:

1. 0.3338
2. 0.2919
3. 0.3217
4. 0.2793
5. 0.3989
6. 0.3161
7. 0.6199
8. 0.2616
9. 0.6370
10. 0.2479

* Average cooperation value at end of experiment (average of averages): **0.3708**
* Comparison of results to prediction:
  + This result matches our prediction to a moderate degree, since the defectors won outright (98-100 defectors remaining at the end) 8/10 times. The other two times, there were 12 and 27 remaining cooperators. No partial cooperators remained by the end of all simulations, with the exception of two (where 2 partial cooperators remained with the rest of the population entirely composed of defectors). This makes sense, since there’s a chance for cooperators to thrive for a while when given an equal proportion of the initial population, but partial cooperators appear weaker than both cooperators and defectors (when not given a majority share of the initial population).

Effect of enabling mutation:

* The results of this experiment were usually more random, but the defectors once again tended to take the lead. Cooperators sometimes did win, but the partial cooperators usually lagged behind both other species.

Conclusion:

When all three species have approximately the same proportion of the initial total population, defectors seem to win by a wide margin most often. Partial cooperators appear to be weaker than other species when starting with an equal proportion of the total population, while cooperators occasionally hold on to about a third of the final population. By and large, organisms that give away energy (when not starting as a majority) tend to be replaced with defectors. Defectors do best in experiments with few (but some) cooperators, as they have a chance to reproduce earlier (due to not giving away energy as well as receiving energy from cooperating cooperators), and do not give away energy. Cooperators do well most often when they have a starting majority of the population, or a somewhat even share. When cooperators are pitted 50/50 against defectors, the principle of selfishly hanging on to energy serves the defectors best most often (although the cooperators can occasionally scrape by with a ~52-48 victory). However, in such a 50/50/0 starting scenario, if the cooperators do win, it’s never as decisive as when the defectors win (usually total). Moral of the story: be selfish when others are generous.