Population size of 10

**1 cooperator and 9 defectors:**

Prediction:

Defectors will thrive since only the cooperator will always give its energy to other 8 defectors, which results in the cooperator's energy remaining 1 while defectors energy will constantly increase. Thus, the cooperator will be certainly replaced by the offspring of defectors after a while.

Result

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 10 | 0 | 1 | 9 | 0 | 0 |
| 10 | 1 | 1 | 9 | 0 | 0 |
| 10 | 2 | 1 | 9 | 0 | 0 |
| 10 | 3 | 1 | 9 | 0 | 0 |
| 10 | 4 | 1 | 9 | 0 | 0 |
| 10 | 5 | 1 | 9 | 0 | 0 |
| 10 | 6 | 1 | 9 | 0 | 0 |
| 10 | 7 | 1 | 9 | 0 | 0 |
| 10 | 8 | 1 | 9 | 0 | 0 |
| 10 | 9 | 1 | 9 | 0 | 0 |

The average cooperation mean for cooperator: 1

The average cooperation mean for defector: 0

The average cooperation mean for partial cooperator: 0.5

The average of 10 average cooperation value: 0

The result supports my prediction. Average cooperation value of 0 indicates that only defectors survived while cooperators went extinct.

**9 cooperators and 1 defector:**

Prediction:

Cooperators will thrive since cooperators will always give their energies to other 8 organisms, which results in the energies of cooperators and defectors will almost equally increase. Since there are more cooperators at the beginning, the probability of defectors being replaced is higher than the probability of cooperators being replaced.

Result

| Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 0 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |
| 9 | 1 | 0 | 1 |

The average cooperation mean for cooperator: 1

The average cooperation mean for defector: 0

The average cooperation mean for partial cooperator: 0.5

The average of 10 average cooperation value: 0.9

The result supports my prediction. Average cooperation value of 0.9 indicates that ,in most of the cases, only cooperators survived while defectors went extinct.

**3 cooperators and 3 defectors and 4 partial cooperators:**

Prediction:

Defectors will thrive since cooperators will always give their energies to other 8 organisms, while partial cooperators will give their energy half the time. Thus, the energies of defectors will increase faster than others, which results in defectors being likely to get enough energy to reproduce faster. As a certain type of organisms reproduces more, they are more likely to replace other organisms. Therefore, defectors will thrive.

Result

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 10 | 0 | 3 | 3 | 4 | 0.5 |
| 10 | 1 | 3 | 3 | 4 | 0 |
| 10 | 2 | 3 | 3 | 4 | 0 |
| 10 | 3 | 3 | 3 | 4 | 0 |
| 10 | 4 | 3 | 3 | 4 | 0 |
| 10 | 5 | 3 | 3 | 4 | 0 |
| 10 | 6 | 3 | 3 | 4 | 0 |
| 10 | 7 | 3 | 3 | 4 | 0 |
| 10 | 8 | 3 | 3 | 4 | 0 |
| 10 | 9 | 3 | 3 | 4 | 0 |

The average cooperation mean for cooperator: 1

The average cooperation mean for defector: 0

The average cooperation mean for partial cooperator: 0.5

The average of 10 average cooperation value: 0.05

The result supports my prediction. Average cooperation value of 0.05 indicates that defectors survived most of the time while few cooperators and partial cooperators survived.

Population size of 100

**1 cooperator and 99 defectors:**

Prediction:

Defectors will thrive since only the cooperator will always give its energy to other 8 defectors, which results in the cooperator's energy remaining 1 while defectors energy will increase by at least one after each update. Thus, the cooperator will be certainly replaced by the offspring of defectors after a while.

Result

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 1 | 99 | 0 | 0 |
| 100 | 1 | 1 | 99 | 0 | 0 |
| 100 | 2 | 1 | 99 | 0 | 0 |
| 100 | 3 | 1 | 99 | 0 | 0 |
| 100 | 4 | 1 | 99 | 0 | 0 |
| 100 | 5 | 1 | 99 | 0 | 0 |
| 100 | 6 | 1 | 99 | 0 | 0 |
| 100 | 7 | 1 | 99 | 0 | 0 |
| 100 | 8 | 1 | 99 | 0 | 0 |
| 100 | 9 | 1 | 99 | 0 | 0 |

The average cooperation mean for cooperator: 1

The average cooperation mean for defector: 0

The average cooperation mean for partial cooperator: 0.5

The average of 10 average cooperation value: 0

The result supports my prediction. Average cooperation value of 0 indicates that only defectors survived while cooperators went extinct.

**99 cooperators and 1 defector:**

Prediction:

Cooperators will thrive since cooperators will always give their energies to other 8 organisms, which results in the energies of cooperators and defectors will equally increase. Since there are more cooperators at the beginning, the probability of defectors being replaced is higher than the probability of cooperators being replaced. Compared to the population size of 10, the probability of being replaced by the offspring of cooperators is lower and therefore the probability that defectors will thrive is higher than the population of 10.

Result

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 99 | 1 | 0 | 1 |
| 100 | 1 | 99 | 1 | 0 | 1 |
| 100 | 2 | 99 | 1 | 0 | 1 |
| 100 | 3 | 99 | 1 | 0 | 1 |
| 100 | 4 | 99 | 1 | 0 | 1 |
| 100 | 5 | 99 | 1 | 0 | 1 |
| 100 | 6 | 99 | 1 | 0 | 1 |
| 100 | 7 | 99 | 1 | 0 | 1 |
| 100 | 8 | 99 | 1 | 0 | 1 |
| 100 | 9 | 99 | 1 | 0 | 0.01 |

The average cooperation mean for cooperator: 1

The average cooperation mean for defector: 0

The average cooperation mean for partial cooperator: 0.5

The average of 10 average cooperation value: 0.91

The result supports my prediction. Average cooperation value of 0.91 indicates that cooperators survived while defectors went extinct most of the time.

**33 cooperators and 33 defectors and 34 partial cooperators:**

Prediction:

Defectors will thrive since cooperators will always give their energies to other 8 organisms, while partial cooperators will give their energy half the time. Thus, the energies of defectors will increase faster than others, which results in defectors being likely to get enough energy to reproduce sooner. As a certain type of organisms reproduces more, they are more likely to replace other organisms. Therefore, defectors will thrive.

Result

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 33 | 33 | 34 | 0.015 |
| 100 | 1 | 33 | 33 | 34 | 0.055 |
| 100 | 2 | 33 | 33 | 34 | 0.04 |
| 100 | 3 | 33 | 33 | 34 | 0.02 |
| 100 | 4 | 33 | 33 | 34 | 0.01 |
| 100 | 5 | 33 | 33 | 34 | 0.015 |
| 100 | 6 | 33 | 33 | 34 | 0.02 |
| 100 | 7 | 33 | 33 | 34 | 0.01 |
| 100 | 8 | 33 | 33 | 34 | 0.005 |
| 100 | 9 | 33 | 33 | 34 | 0.02 |

The average cooperation mean for cooperator: 1

The average cooperation mean for defector: 0

The average cooperation mean for partial cooperator: 0.5

The average of 10 average cooperation value: 0.021

The result supports my prediction. Average cooperation value of 0.021 indicates that most of the defectors survived while few cooperators and partial cooperators survived.

**Additional experiments**

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 80 | 20 | 0 | 0.06 |
| 100 | 1 | 80 | 20 | 0 | 0 |
| 100 | 2 | 80 | 20 | 0 | 0 |
| 100 | 3 | 80 | 20 | 0 | 0 |
| 100 | 4 | 80 | 20 | 0 | 0.02 |
| 100 | 5 | 80 | 20 | 0 | 0.02 |
| 100 | 6 | 80 | 20 | 0 | 0 |
| 100 | 7 | 80 | 20 | 0 | 0.42 |
| 100 | 8 | 80 | 20 | 0 | 0 |
| 100 | 9 | 80 | 20 | 0 | 0.03 |

The average of 10 average cooperation value: 0.055

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 90 | 10 | 0 | 0.19 |
| 100 | 1 | 90 | 10 | 0 | 0 |
| 100 | 2 | 90 | 10 | 0 | 0.02 |
| 100 | 3 | 90 | 10 | 0 | 0.12 |
| 100 | 4 | 90 | 10 | 0 | 0 |
| 100 | 5 | 90 | 10 | 0 | 1 |
| 100 | 6 | 90 | 10 | 0 | 0.08 |
| 100 | 7 | 90 | 10 | 0 | 0 |
| 100 | 8 | 90 | 10 | 0 | 1 |
| 100 | 9 | 90 | 10 | 0 | 0.01 |

The average of 10 average cooperation value: 0.242

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 95 | 5 | 0 | 0.15 |
| 100 | 1 | 95 | 5 | 0 | 1 |
| 100 | 2 | 95 | 5 | 0 | 0 |
| 100 | 3 | 95 | 5 | 0 | 0.48 |
| 100 | 4 | 95 | 5 | 0 | 0.07 |
| 100 | 5 | 95 | 5 | 0 | 1 |
| 100 | 6 | 95 | 5 | 0 | 0.1 |
| 100 | 7 | 95 | 5 | 0 | 1 |
| 100 | 8 | 95 | 5 | 0 | 0 |
| 100 | 9 | 95 | 5 | 0 | 0 |

The average of 10 average cooperation value: 0.38

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 96 | 4 | 0 | 0.47 |
| 100 | 1 | 96 | 4 | 0 | 0.48 |
| 100 | 2 | 96 | 4 | 0 | 1 |
| 100 | 3 | 96 | 4 | 0 | 0.01 |
| 100 | 4 | 96 | 4 | 0 | 1 |
| 100 | 5 | 96 | 4 | 0 | 0.09 |
| 100 | 6 | 96 | 4 | 0 | 1 |
| 100 | 7 | 96 | 4 | 0 | 0.01 |
| 100 | 8 | 96 | 4 | 0 | 0.97 |
| 100 | 9 | 96 | 4 | 0 | 1 |

The average of 10 average cooperation value: 0.603

| Total population | Random number seed | Cooperator population (Statring) | Defector population (Statring) | Partial cooperator population (Statring) | Average cooperation value |
| --- | --- | --- | --- | --- | --- |
| 100 | 0 | 97 | 3 | 0 | 1 |
| 100 | 1 | 97 | 3 | 0 | 1 |
| 100 | 2 | 97 | 3 | 0 | 0.56 |
| 100 | 3 | 97 | 3 | 0 | 1 |
| 100 | 4 | 97 | 3 | 0 | 1 |
| 100 | 5 | 97 | 3 | 0 | 0.89 |
| 100 | 6 | 97 | 3 | 0 | 1 |
| 100 | 7 | 97 | 3 | 0 | 1 |
| 100 | 8 | 97 | 3 | 0 | 0.71 |
| 100 | 9 | 97 | 3 | 0 | 1 |

The average of 10 average cooperation value: 0.916

**Conclusion**

The result shows that under these circumstances defect is the optimal choice unless there are a lot of cooperators in an initial setting. The threshold for prosperity of cooperators is the ratio of cooperators and defectors is roughly 96:4. If there are more corporations than the ratio, cooperators will be dominant. On the other hand, if there are more defectors than the ratio, defectors will be dominant.