Eckhart Arnold

Explaining Altruism

A Simulation-Based Approach and its Limits

Contents

Figure 4.3: An evolutionary simulation of the reiterated Prisoner's Dilemma.
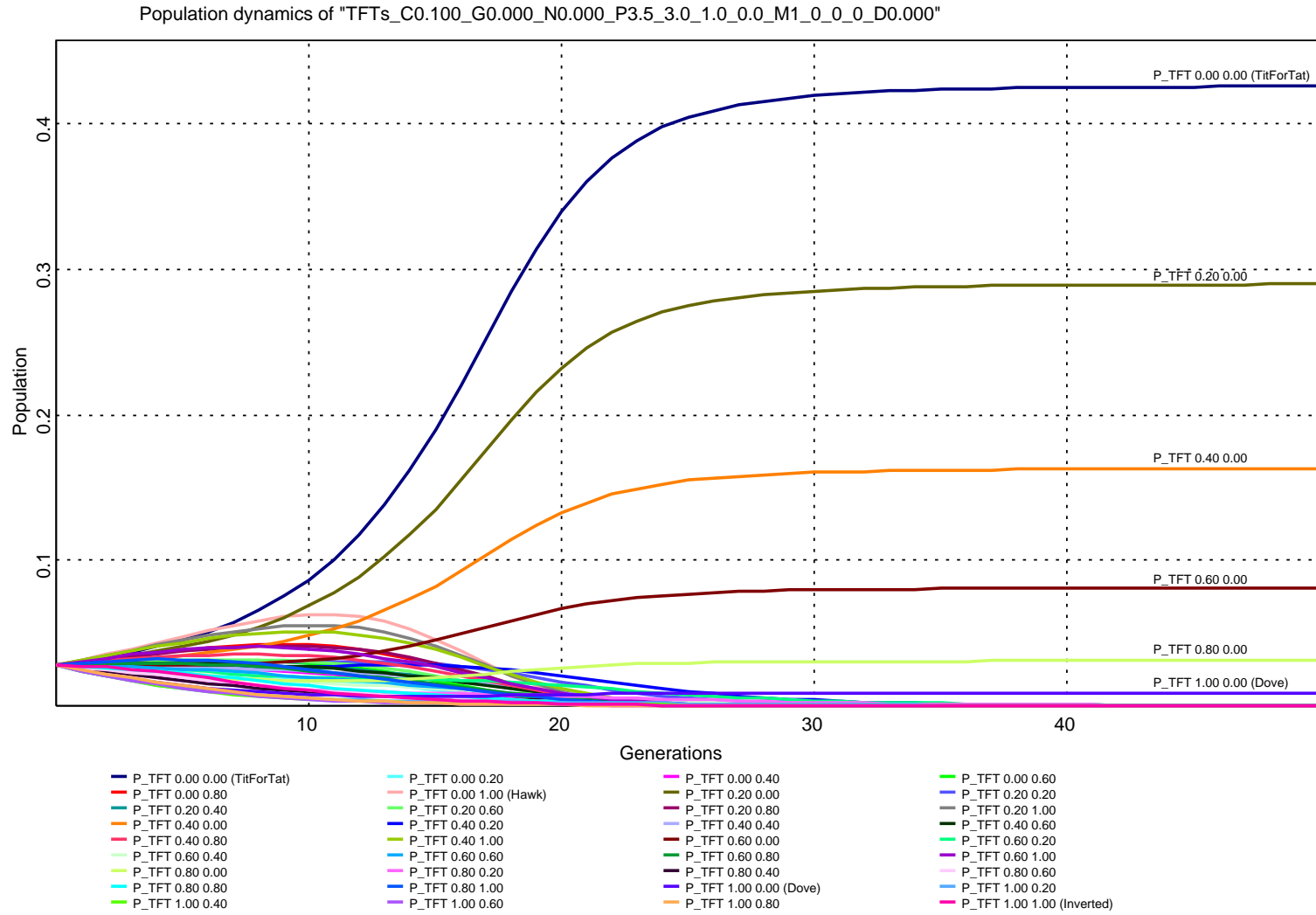
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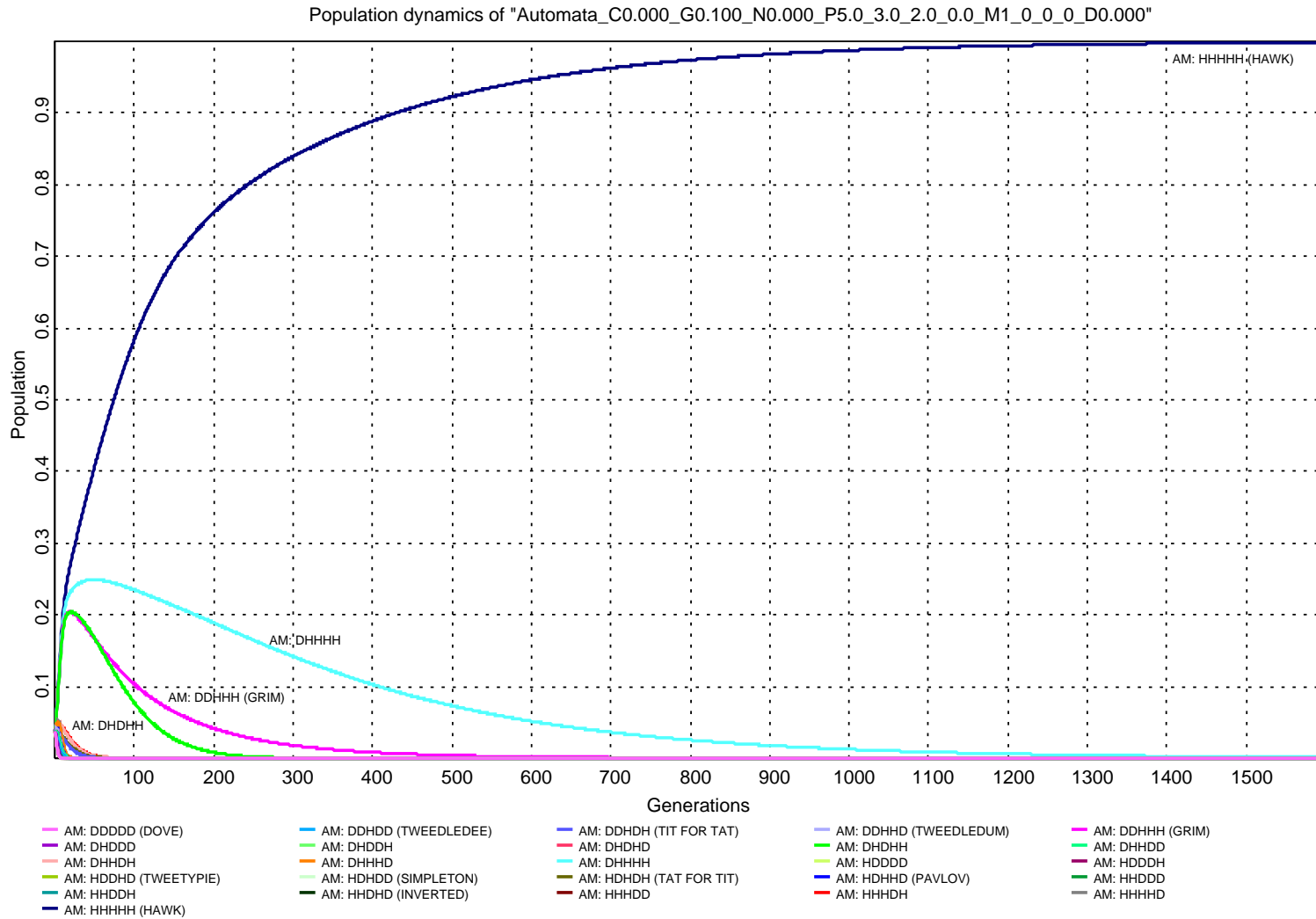
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Population dynamics of "Automata_C0.000_G0.050_N0.000_P5.5_3.0_1.0_0.0_M1_0_0_0_D0.000"
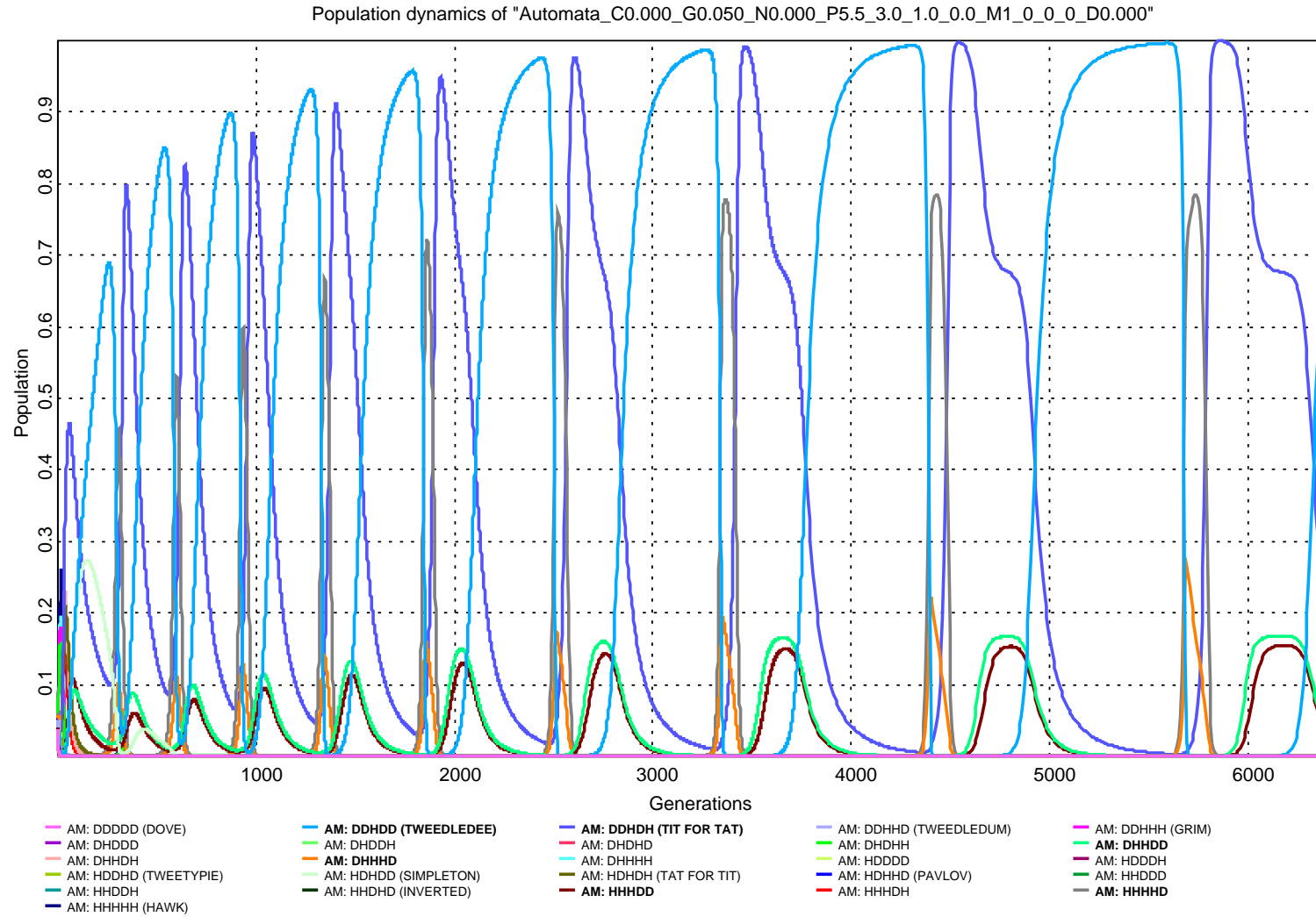
Figure 4.7: Example of strategies dominating the population in interchanging cycles. The result occured in simulation no. 55 of the "big series" under a game noise of 5% and the payoff parameters T=5.5, R=3, P=1, S=0.

Figure 4.8: Example of strategies dominating the population in interchanging cycles. The simulation was taken from the "Monte Carlo series" (simulation Nr. 634). It uses the standard payoff parameters of T=5, R=3, P=1, S=0 with a correlation factor of 0.079301, a game noise of 0.025585, 0.09998, an evolutionary noise of 0.99980 and degenerative mutations that occur with a proability of 0.01191.

Results for strategy set: "TFTs"

| Tournament Ranking | Evolutionary Ranking | Average Final Population |

Tournament Ranking:
P_TFT 0.00 1.00 (Hawk)
P_TFT 0.20 1.00
P_TFT 0.40 1.00
P_TFT 0.00 0.80
P_TFT 0.60 1.00
P_TFT 0.20 0.80
P_TFT 0.00 0.60
P_TFT 0.80 1.00
P_TFT 0.40 0.80
P_TFT 0.20 0.60
P_TFT 0.00 0.40
P_TFT 0.60 0.80
P_TFT 0.40 0.60
P_TFT 0.20 0.40
P_TFT 0.00 0.20
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.80 0.80
P_TFT 0.60 0.60
P_TFT 0.20 0.20
P_TFT 0.20 0.00
P_TFT 0.40 0.40
P_TFT 0.40 0.20
P_TFT 0.60 0.40
P_TFT 0.80 0.60
P_TFT 1.00 0.80
P_TFT 0.40 0.00
P_TFT 0.60 0.20
P_TFT 0.60 0.00
P_TFT 0.80 0.40
P_TFT 1.00 0.60
P_TFT 0.80 0.20
P_TFT 0.80 0.00
P_TFT 1.00 0.40
P_TFT 1.00 0.20
P_TFT 1.00 0.00 (Dove)

Evolutionary Ranking:
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.00 1.00 (Hawk)
P_TFT 0.20 0.00
P_TFT 1.00 0.00 (Dove)
P_TFT 0.40 0.00
P_TFT 0.80 0.00
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.00 0.80
P_TFT 0.20 0.40
P_TFT 0.60 0.00
P_TFT 0.40 0.20
P_TFT 0.60 1.00
P_TFT 0.40 0.40
P_TFT 0.60 0.20
P_TFT 0.80 1.00
P_TFT 0.40 1.00
P_TFT 0.20 1.00
P_TFT 0.00 0.60
P_TFT 0.80 0.20
P_TFT 1.00 0.20
P_TFT 0.80 0.40
P_TFT 0.20 0.20
P_TFT 0.60 0.40
P_TFT 1.00 0.40
P_TFT 0.00 0.40
P_TFT 0.80 0.60
P_TFT 1.00 0.60
P_TFT 0.00 0.20
P_TFT 0.60 0.60
P_TFT 0.40 0.60
P_TFT 0.20 0.60
P_TFT 0.80 0.80
P_TFT 0.20 0.80
P_TFT 0.60 0.80
P_TFT 0.40 0.80
P_TFT 1.00 0.80

Average Final Population:
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.00 1.00 (Hawk)
P_TFT 0.20 0.00
P_TFT 1.00 0.00 (Dove)
P_TFT 0.40 0.00

Figure 4.9: The aggregated results of the 432 simulations from the "big simulation series" using the set of *Parametrized TFT* strategies.
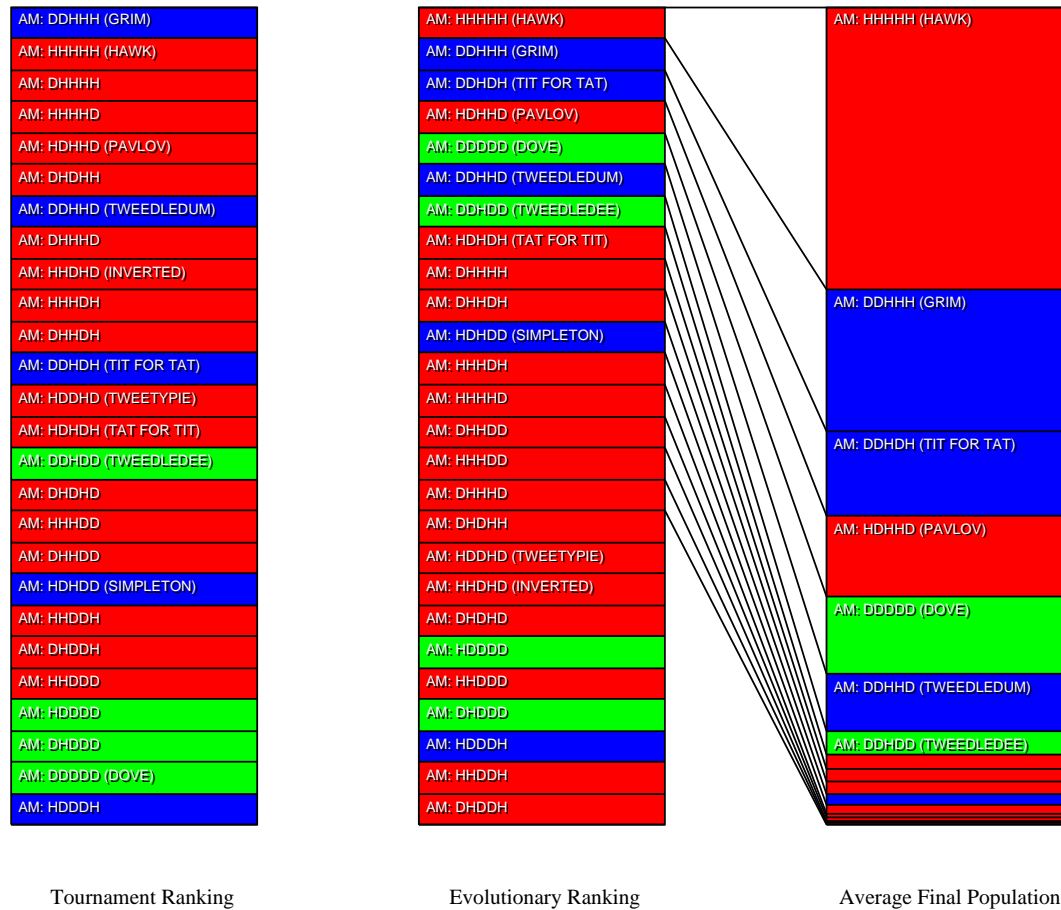
Figure 4.10: The aggregated results of the 432 simulations from the "big simulation series" using the set of *Two State Automata* (see appendix 8.1.3) strategies.

Results for strategy set: "Automata"

Tournament Ranking

AM: DDHHH (GRIM)
AM: HHHHH (HAWK)
AM: HHHHD
AM: HDHHD (PAVLOV)
AM: DHHHH
AM: DDHHD (TWEEDLEDUM)
AM: HHDHD (INVERTED)
AM: DHHHD
AM: DDHDH (TIT FOR TAT
AM: DHHDH
AM: HDDHD (TWEETYPIE)
AM: DHDHH
AM: DDHDD (TWEEDLEDEE)
AM: HHHDH
AM: HHHDD
AM: HDHDD (SIMPLETON)
AM: DHHDD
AM: HDHDH (TAT FOR TIT
AM: HHDDD
AM: DHDHD
AM: HHDDH
AM: HDDDD
AM: DHDDH
AM: DDDDD (DOVE)
AM: DHDDD
AM: HDDDH

Evolutionary Ranking

AM: DDHHH (GRIM)
AM: DDDDD (DOVE)
AM: DDHDH (TIT FOR TAT
AM: HHHHH (HAWK)
AM: DDHHD (TWEEDLEDUM)
AM: HDHHD (PAVLOV)
AM: DDHDD (TWEEDLEDEE)
AM: HDDHD (TWEETYPIE)
AM: DHHHH
AM: DHHDH
AM: HHHDH
AM: HDHDH (TAT FOR TIT
AM: DHDHH
AM: HDHDD (SIMPLETON)
AM: HHHHD
AM: DHHHD
AM: DHHDD
AM: HHHDD
AM: HHDHD (INVERTED)
AM: DHDHD
AM: HDDDD
AM: HHDDD
AM: DHDDD
AM: HDDDH
AM: HHDDH
AM: DHDDH

Average Final Population

AM: DDHHH (GRIM)
AM: DDDDD (DOVE)
AM: DDHDH (TIT FOR TAT
AM: HHHHH (HAWK)
AM: DDHHD (TWEEDLEDUM)
AM: HDHHD (PAVLOV)
AM: DDHDD (TWEEDLEDEE)

Figure 4.11: Absence of *game noise* strongly increases the success of reciprocal and altruistic strategies. (See figure 4.10 in comparison.)

Results for strategy set: "Automata"

Tournament Ranking	Evolutionary Ranking	Average Final Population
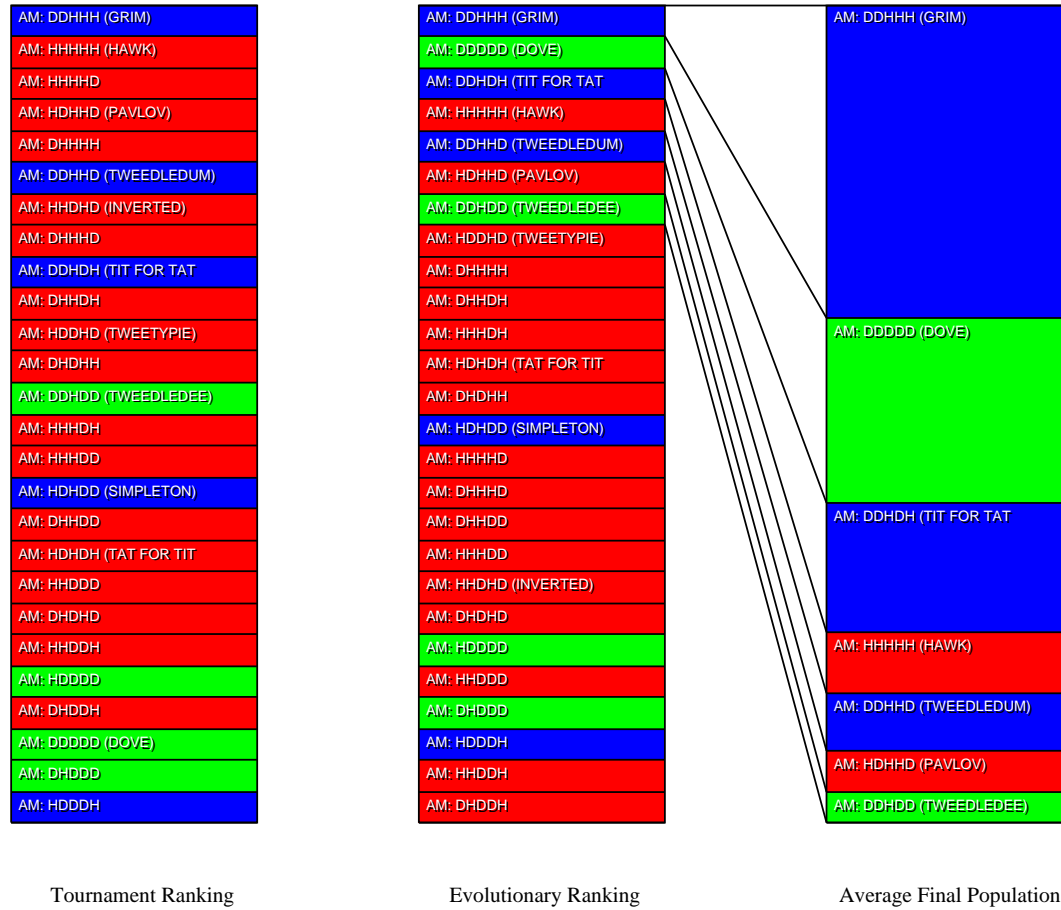
Figure 4.12: The absence of *game noise* has the same positive effect on the evolution of cooperation for the strategy set consisting of the *parametrized TFT* strategies. (See figure 4.9 in comparison.)
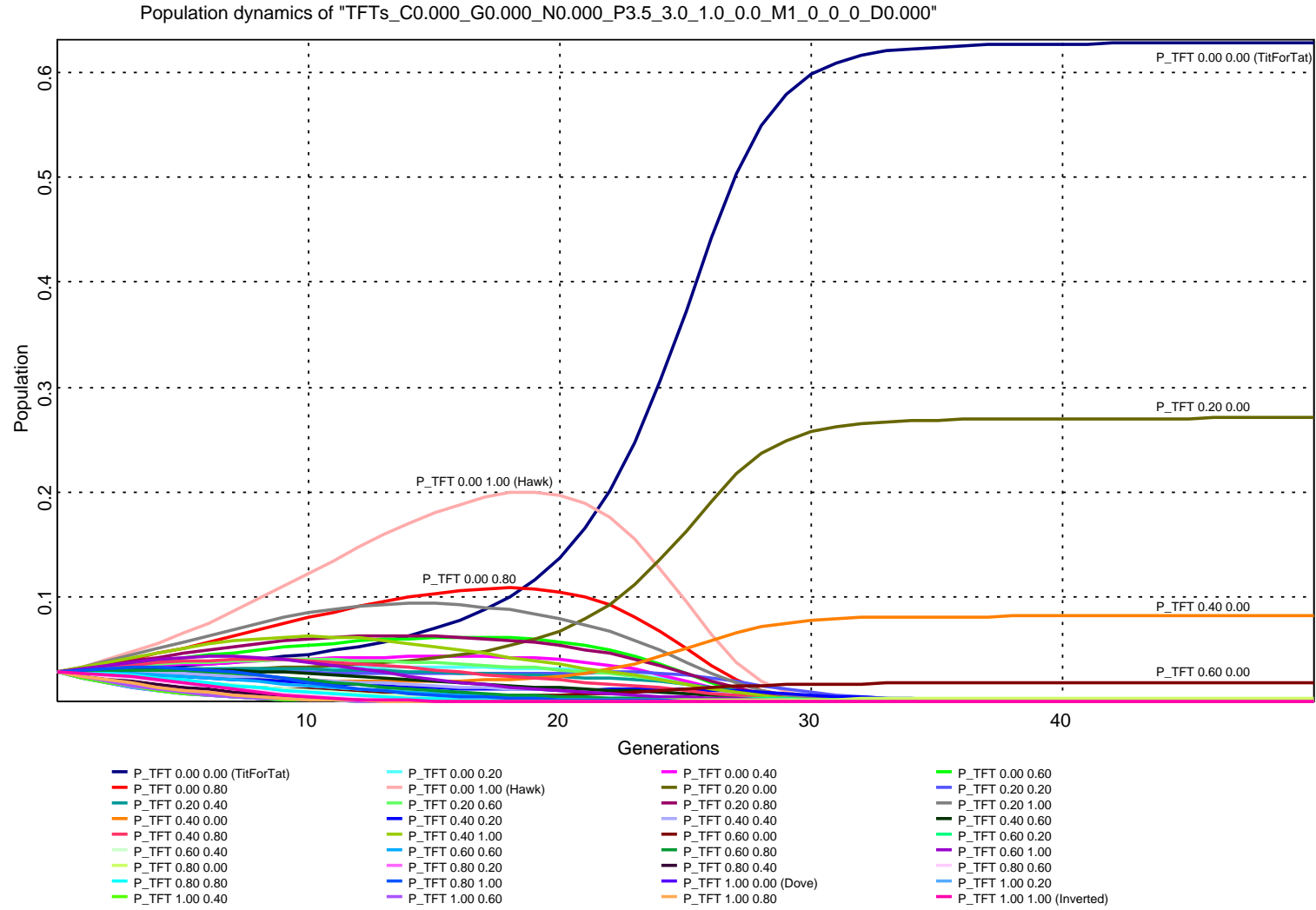
Figure 4.14: In the slip stream of reciprocal strategies like "Tit for Tat" more genuinely altruistic strategies thrive. (Simulation no. 436 from the "big series" with payoff paramters T=3.5, R=3, P=1, S=0.)

Population dynamics of "TFTs_C0.100_G0.050_N0.000_P3.5_3.0_1.0_0.0_M1_0_0_0_D0.000"

P_TFT 0.00 0.00 (TitForTat)	P_TFT 0.00 0.20	P_TFT 0.00 0.40	P_TFT 0.00 0.60
P_TFT 0.00 0.80	P_TFT 0.00 1.00 (Hawk)	P_TFT 0.20 0.00	P_TFT 0.20 0.20
P_TFT 0.20 0.40	P_TFT 0.20 0.60	P_TFT 0.20 0.80	P_TFT 0.20 1.00
P_TFT 0.40 0.00	P_TFT 0.40 0.20	P_TFT 0.40 0.40	P_TFT 0.40 0.60
P_TFT 0.40 0.80	P_TFT 0.40 1.00	P_TFT 0.60 0.00	P_TFT 0.60 0.20
P_TFT 0.60 0.40	P_TFT 0.60 0.60	P_TFT 0.60 0.80	P_TFT 0.60 1.00
P_TFT 0.80 0.00	P_TFT 0.80 0.20	P_TFT 0.80 0.40	P_TFT 0.80 0.60
P_TFT 0.80 0.80	P_TFT 0.80 1.00	P_TFT 1.00 0.00 (Dove)	P_TFT 1.00 0.20
P_TFT 1.00 0.40	P_TFT 1.00 0.60	P_TFT 1.00 0.80	P_TFT 1.00 1.00 (Inverted)

Figure 4.15: Another example of how genuine altruism may evolve in the "slip stream" of reciprocal altruism: After the reciprocal strategies have cleared the way the genuine altruists take over the population. (Simulation no. 628 from the "big series" with a correlation factor of 10%, a game noise of 5% and payoff parameters T=3.5, R=3, P=1, S=0.)
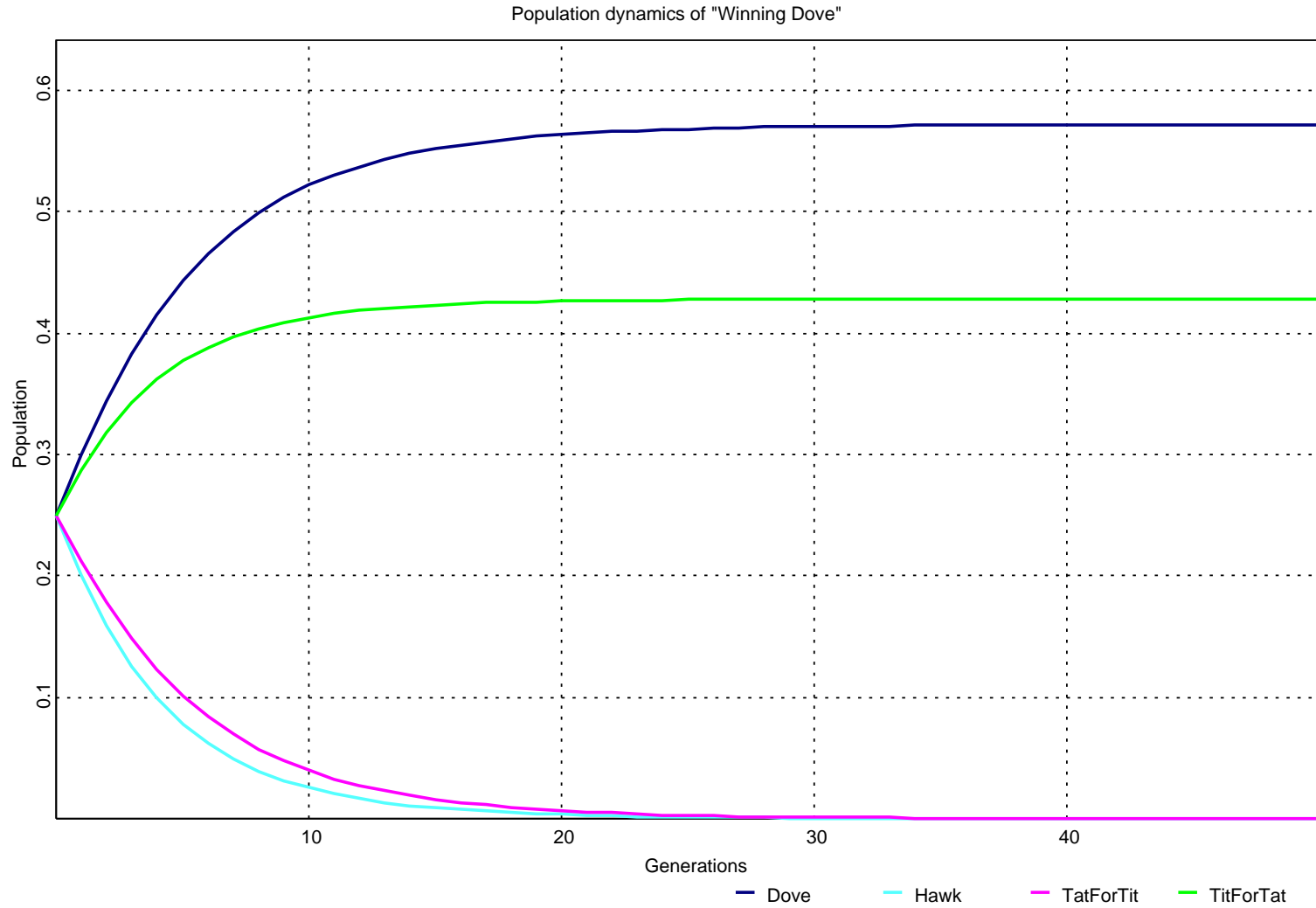
Figure 4.16: If the reciprocal strategies in the simulation are of conflicting types (like *Tit for Tat* and *Tat for Tit*) then "naive" or genuine altruists like *Dove* can become the "laughing third" and win the evolutionary race. (This simulation uses the payoff paramters T=5, R=4, P=1, S=0.)
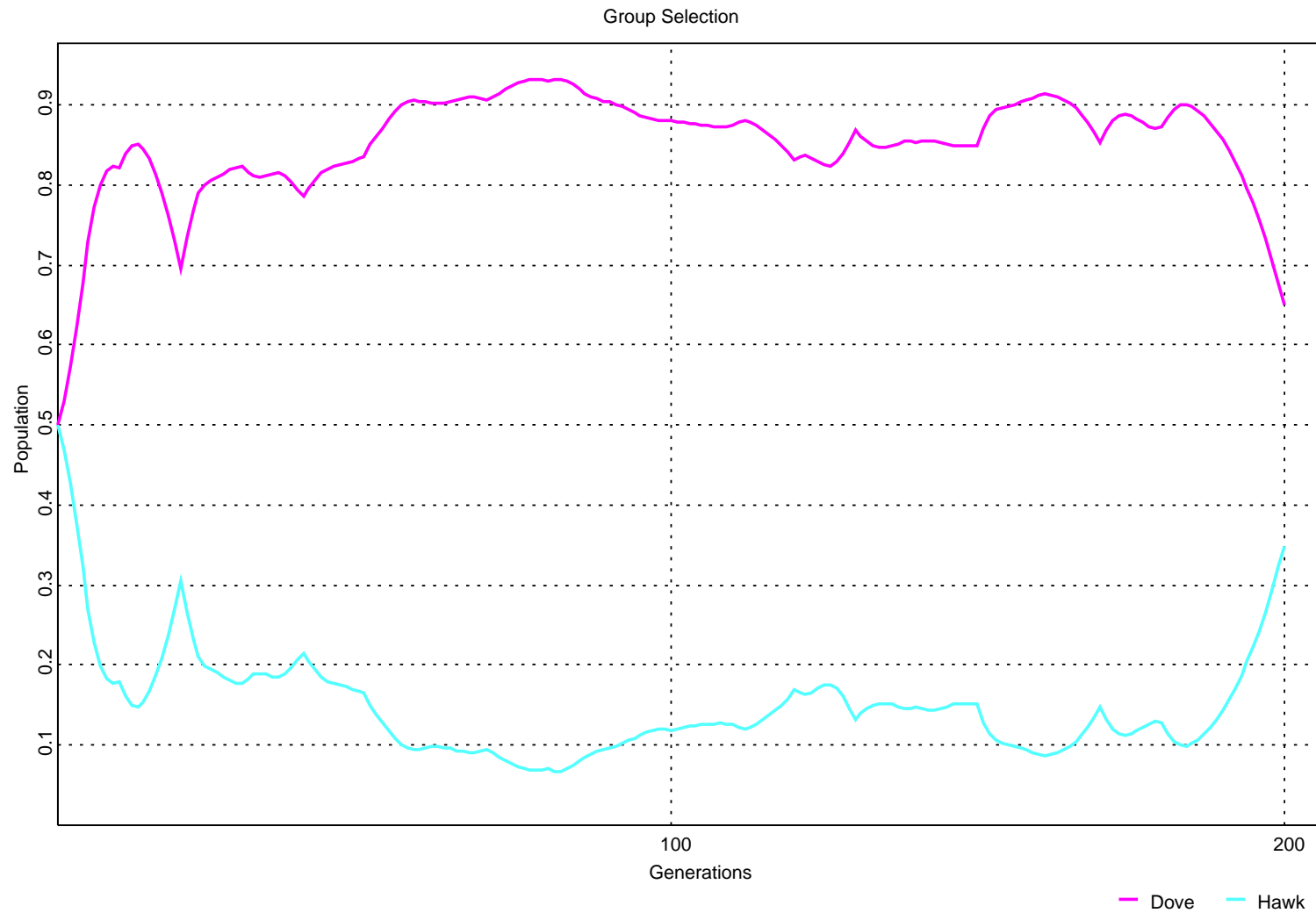
Figure 4.17: In a group selection model even genuine altruism can be a successful strategy. For this simulation of group selection the population was divided into 25 demes which are reshaped randomly every 10 generations.
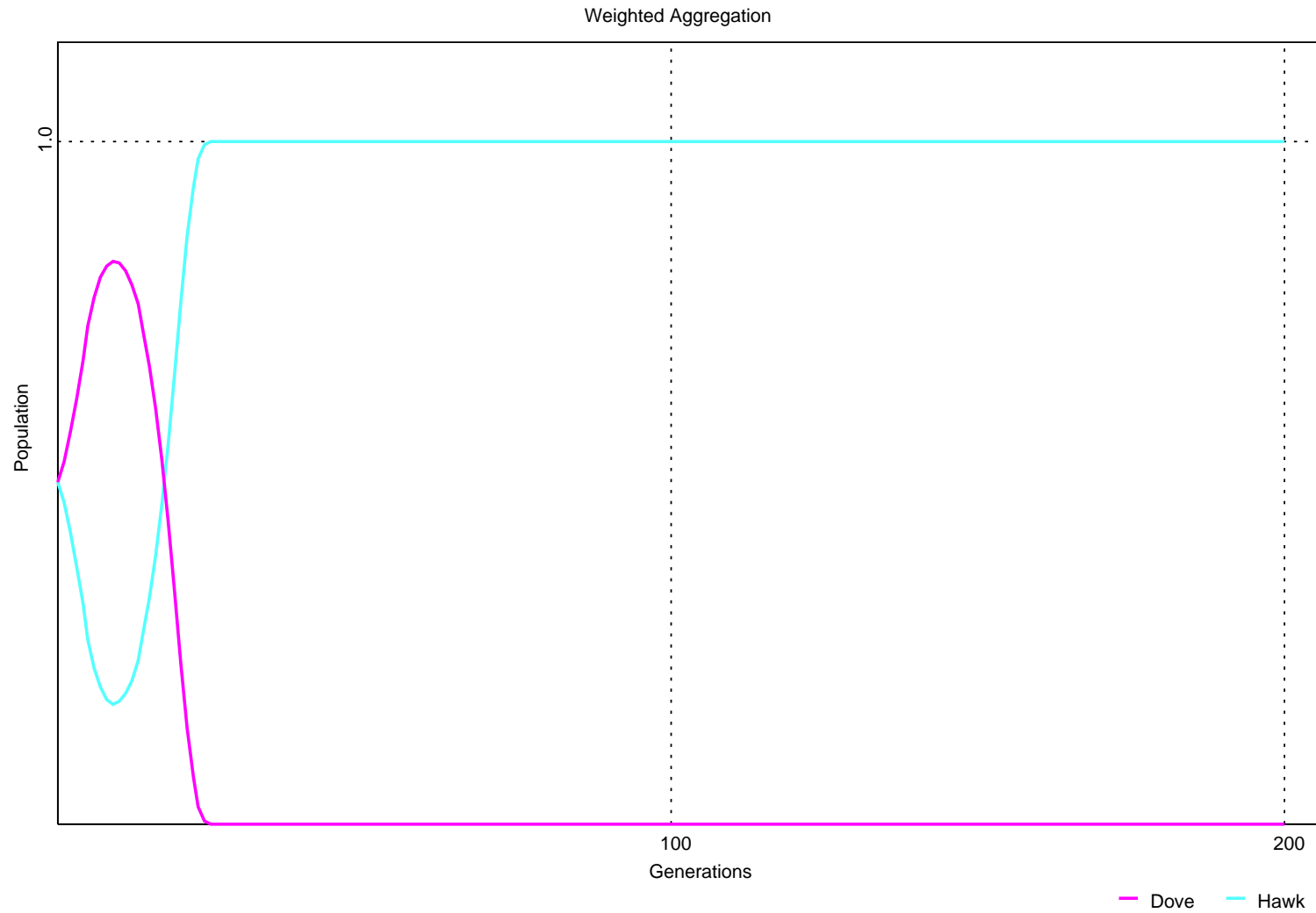
Figure 4.18: If the demes are completely isolated, any group selection effect remains transitory. Again, the population was divided into 25 demes in this simulation (with every deme containing at least some members of each species). But this time the demes were never reshaped.
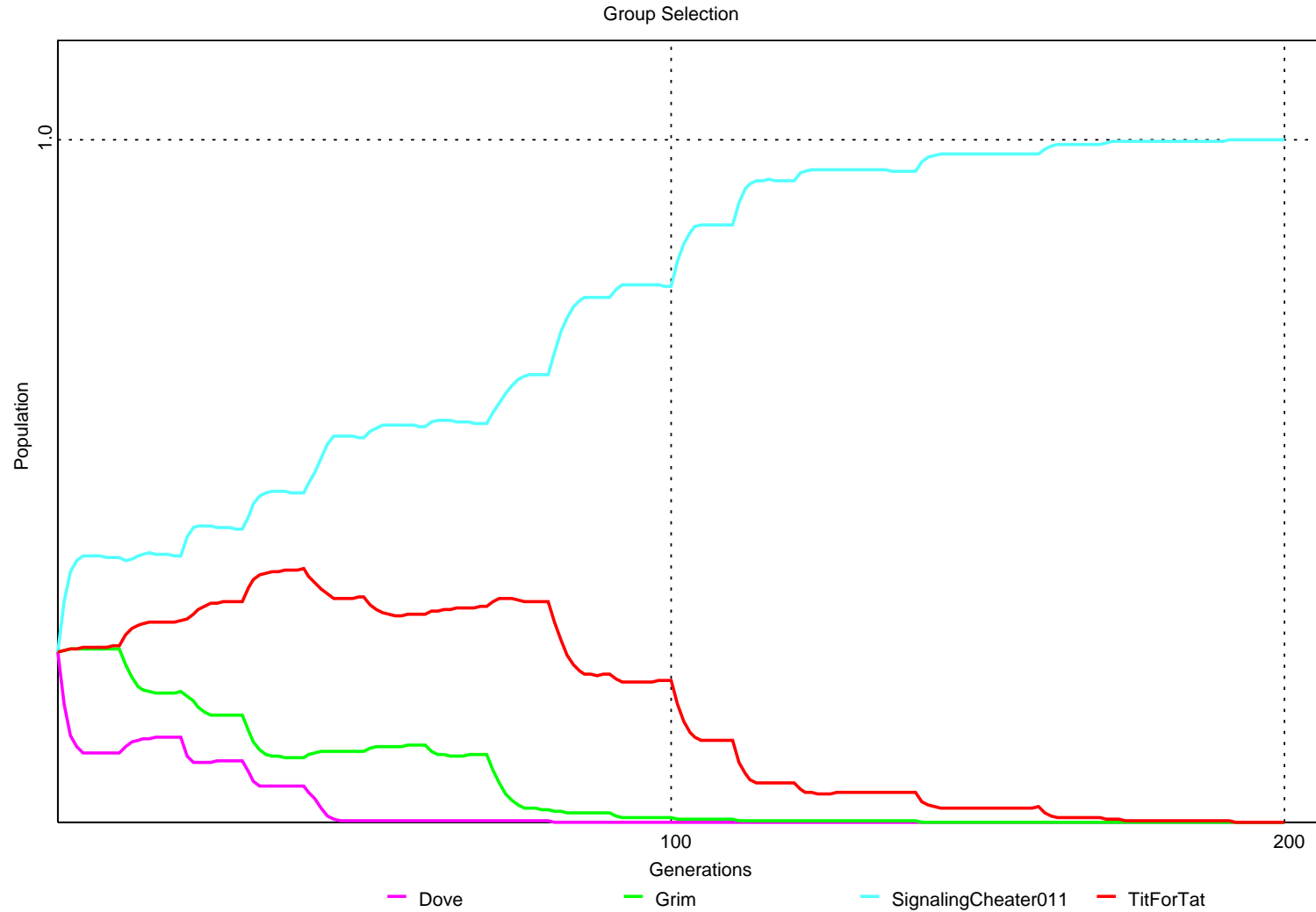
Figure 4.19: Under certain conditions group selection can work against the evolution of altruism. To produce this result the payoff parameters have been set to T=5.9, R=3, P=1, S=0. The population was divided into 10 demes which contain either one, two or three strategies and which were reshaped every 10 rounds.
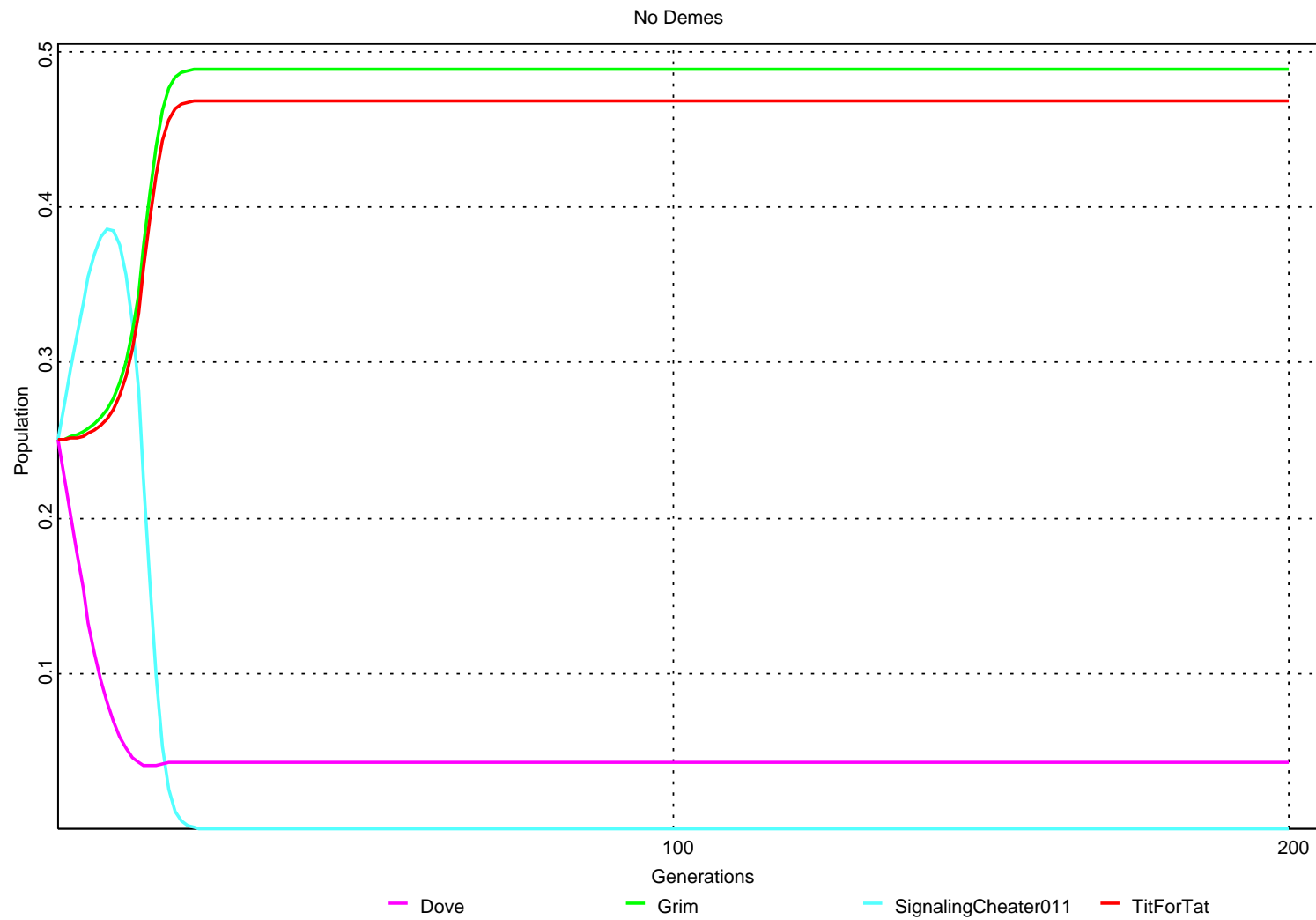
Figure 4.20: The same configuration as in figure 4.19, only without group selection. This time the altruistic strategies fare much better.
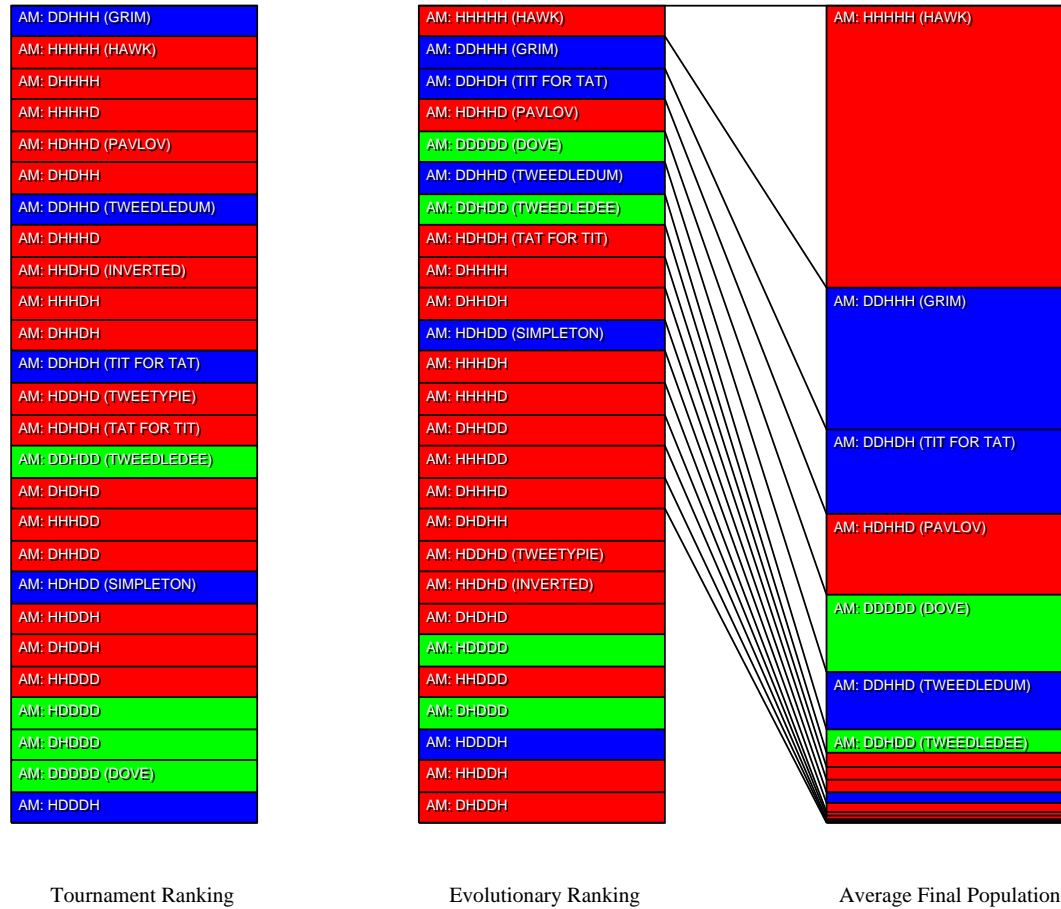
Figure 8.3: The aggregated results of all simulations of the "big series" using *Automata* strategies.
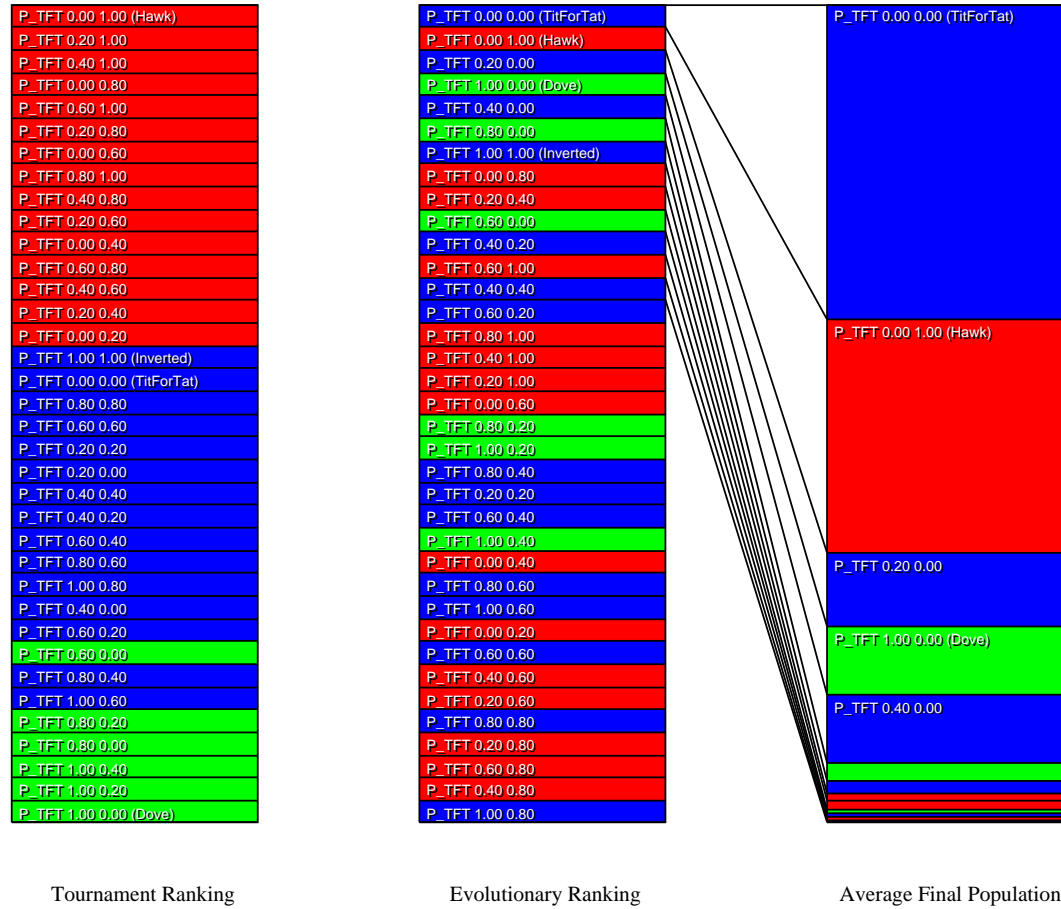
Figure 8.4: The aggregated results of all simulations of the "big series" using *Parameterized Tit for Tat* strategies.

Results for strategy set: "Automata"

Figure 8.5: The aggregated results of those simulations of the "big series" for which the correlation value was 0%.

Results for strategy set: "Automata"

Figure 8.6: The aggregated results of those simulations of the "big series" for which the correlation value was 10%.

Results for strategy set: "Automata"

| Tournament Ranking | Evolutionary Ranking | Average Final Population |

Figure 8.7: The aggregated results of those simulations of the "big series" for which the correlation value was 20%.

Results for strategy set: "TFTs"

Tournament Ranking

P_TFT 0.00 1.00 (Hawk)
P_TFT 0.20 1.00
P_TFT 0.40 1.00
P_TFT 0.00 0.80
P_TFT 0.60 1.00
P_TFT 0.20 0.80
P_TFT 0.00 0.60
P_TFT 0.80 1.00
P_TFT 0.40 0.80
P_TFT 0.20 0.60
P_TFT 0.00 0.40
P_TFT 0.60 0.80
P_TFT 0.40 0.60
P_TFT 0.20 0.40
P_TFT 0.00 0.20
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.80 0.80
P_TFT 0.60 0.60
P_TFT 0.20 0.20
P_TFT 0.20 0.00
P_TFT 0.40 0.40
P_TFT 0.40 0.20
P_TFT 0.60 0.40
P_TFT 0.80 0.60
P_TFT 1.00 0.80
P_TFT 0.40 0.00
P_TFT 0.60 0.20
P_TFT 0.60 0.00
P_TFT 0.80 0.40
P_TFT 1.00 0.60
P_TFT 0.80 0.20
P_TFT 0.80 0.00
P_TFT 1.00 0.40
P_TFT 1.00 0.20
P_TFT 1.00 0.00 (Dove)

Evolutionary Ranking

P_TFT 0.00 1.00 (Hawk)
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.40 0.00
P_TFT 0.20 0.40
P_TFT 0.00 0.80
P_TFT 1.00 0.00 (Dove)
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.20 0.00
P_TFT 0.80 0.00
P_TFT 0.60 0.00
P_TFT 0.00 0.60
P_TFT 0.40 0.20
P_TFT 0.20 0.20
P_TFT 0.00 0.40
P_TFT 0.80 0.20
P_TFT 1.00 0.20
P_TFT 0.60 0.20
P_TFT 0.00 0.20
P_TFT 0.20 0.60
P_TFT 0.40 0.40
P_TFT 0.20 0.80
P_TFT 0.20 1.00
P_TFT 0.40 0.60
P_TFT 0.40 0.80
P_TFT 1.00 0.40
P_TFT 0.80 0.40
P_TFT 0.60 0.40
P_TFT 0.40 1.00
P_TFT 0.60 0.60
P_TFT 0.60 0.80
P_TFT 0.60 1.00
P_TFT 0.80 0.60
P_TFT 1.00 0.60
P_TFT 0.80 0.80
P_TFT 0.80 1.00
P_TFT 1.00 0.80

Average Final Population

P_TFT 0.00 1.00 (Hawk)
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.40 0.00
P_TFT 0.20 0.40

Figure 8.8: The aggregated results of those simulations of the "big series" for which the correlation value was 0%.

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Results for strategy set: "TFTs"

Figure 8.9: The aggregated results of those simulations of the "big series" for which the correlation value was 10%.

Results for strategy set: "TFTs"

Tournament Ranking

P_TFT 0.00 1.00 (Hawk)
P_TFT 0.20 1.00
P_TFT 0.40 1.00
P_TFT 0.00 0.80
P_TFT 0.60 1.00
P_TFT 0.20 0.80
P_TFT 0.00 0.60
P_TFT 0.80 1.00
P_TFT 0.40 0.80
P_TFT 0.20 0.60
P_TFT 0.00 0.40
P_TFT 0.60 0.80
P_TFT 0.40 0.60
P_TFT 0.20 0.40
P_TFT 0.00 0.20
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.80 0.80
P_TFT 0.60 0.60
P_TFT 0.20 0.20
P_TFT 0.20 0.00
P_TFT 0.40 0.40
P_TFT 0.40 0.20
P_TFT 0.60 0.40
P_TFT 0.80 0.60
P_TFT 1.00 0.80
P_TFT 0.40 0.00
P_TFT 0.60 0.20
P_TFT 0.60 0.00
P_TFT 0.80 0.40
P_TFT 1.00 0.60
P_TFT 0.80 0.20
P_TFT 0.80 0.00
P_TFT 1.00 0.40
P_TFT 1.00 0.20
P_TFT 1.00 0.00 (Dove)

Evolutionary Ranking

P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.20 0.00
P_TFT 1.00 0.00 (Dove)
P_TFT 0.40 0.00
P_TFT 0.00 1.00 (Hawk)
P_TFT 0.80 0.00
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.60 1.00
P_TFT 0.60 0.00
P_TFT 0.60 0.20
P_TFT 0.80 1.00
P_TFT 0.40 1.00
P_TFT 0.80 0.20
P_TFT 0.40 0.20
P_TFT 1.00 0.20
P_TFT 0.00 0.80
P_TFT 0.80 0.40
P_TFT 0.60 0.40
P_TFT 0.20 0.20
P_TFT 1.00 0.40
P_TFT 0.40 0.40
P_TFT 0.80 0.60
P_TFT 1.00 0.60
P_TFT 0.20 0.40
P_TFT 0.60 0.60
P_TFT 0.40 0.60
P_TFT 0.80 0.80
P_TFT 0.40 0.80
P_TFT 0.60 0.80
P_TFT 1.00 0.80
P_TFT 0.20 0.60
P_TFT 0.20 0.80
P_TFT 0.20 1.00
P_TFT 0.00 0.20
P_TFT 0.00 0.60
P_TFT 0.00 0.40

Average Final Population

P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.20 0.00
P_TFT 1.00 0.00 (Dove)
P_TFT 0.40 0.00
P_TFT 0.00 1.00 (Hawk)
P_TFT 0.80 0.00

Figure 8.10: The aggregated results of those simulations of the "big series" for which the correlation value was 20%.
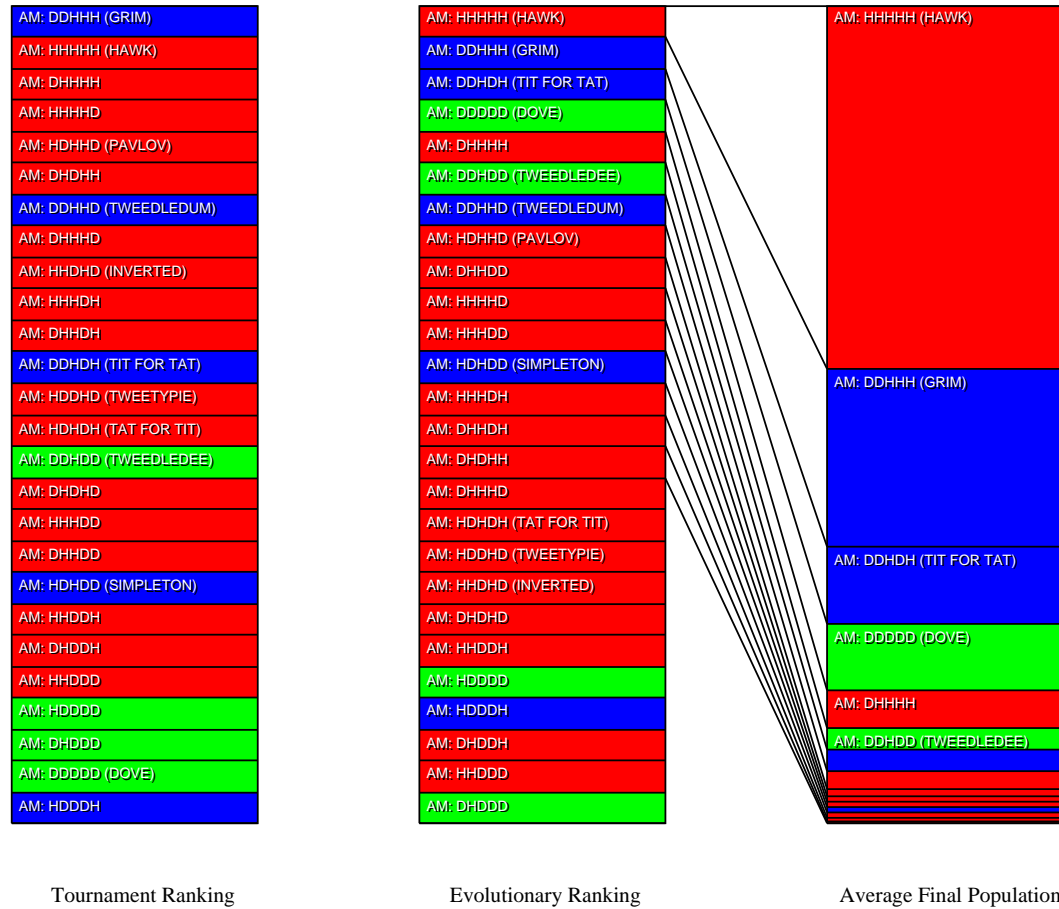
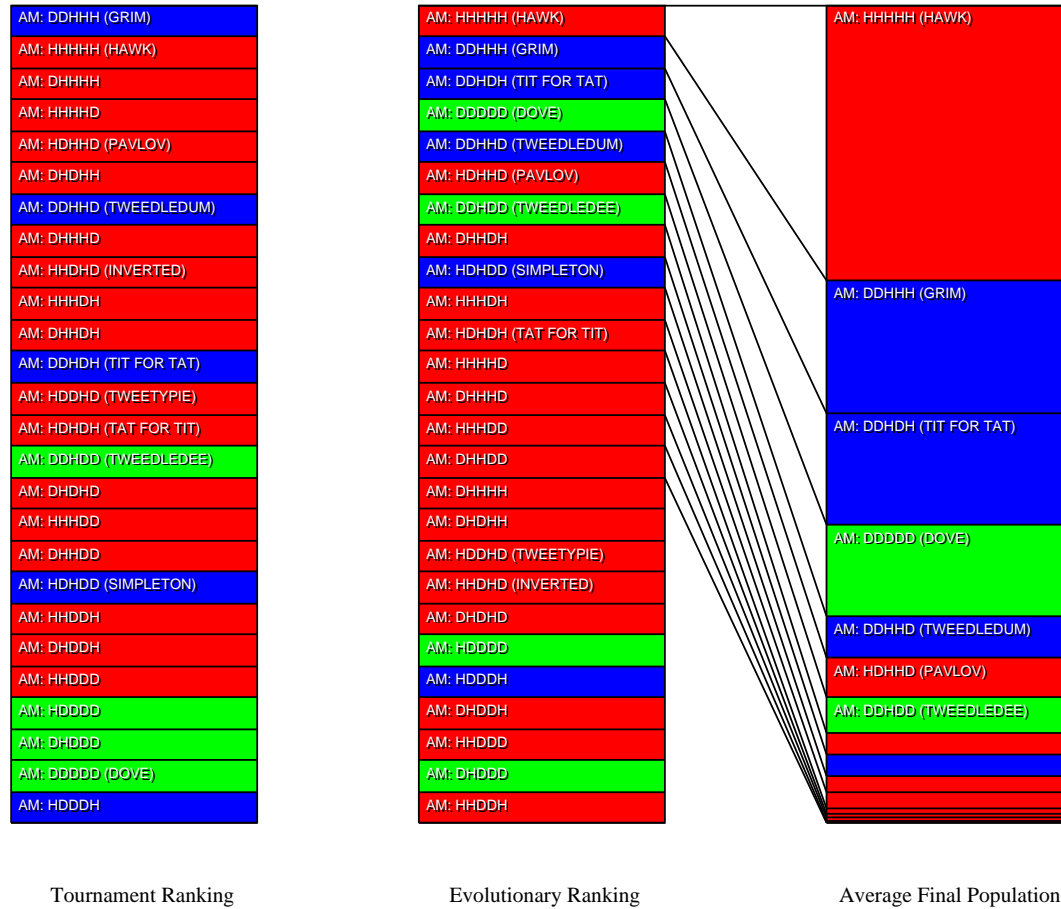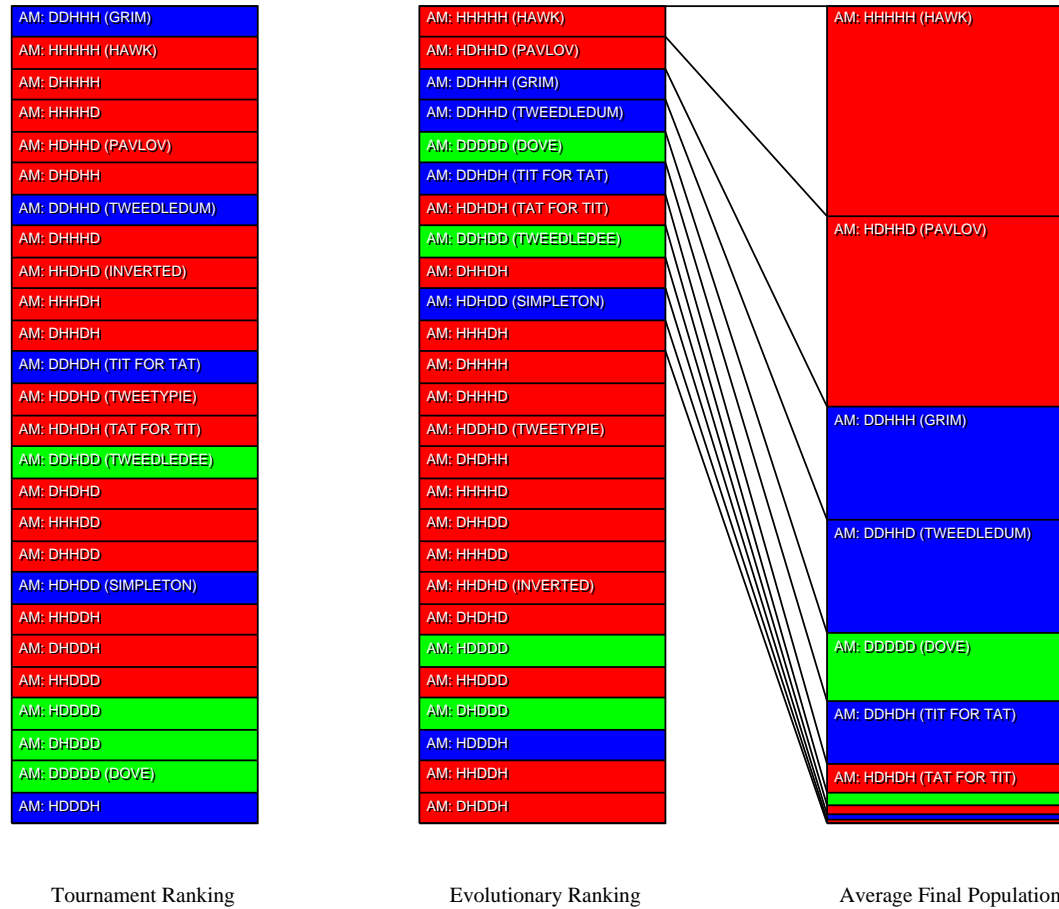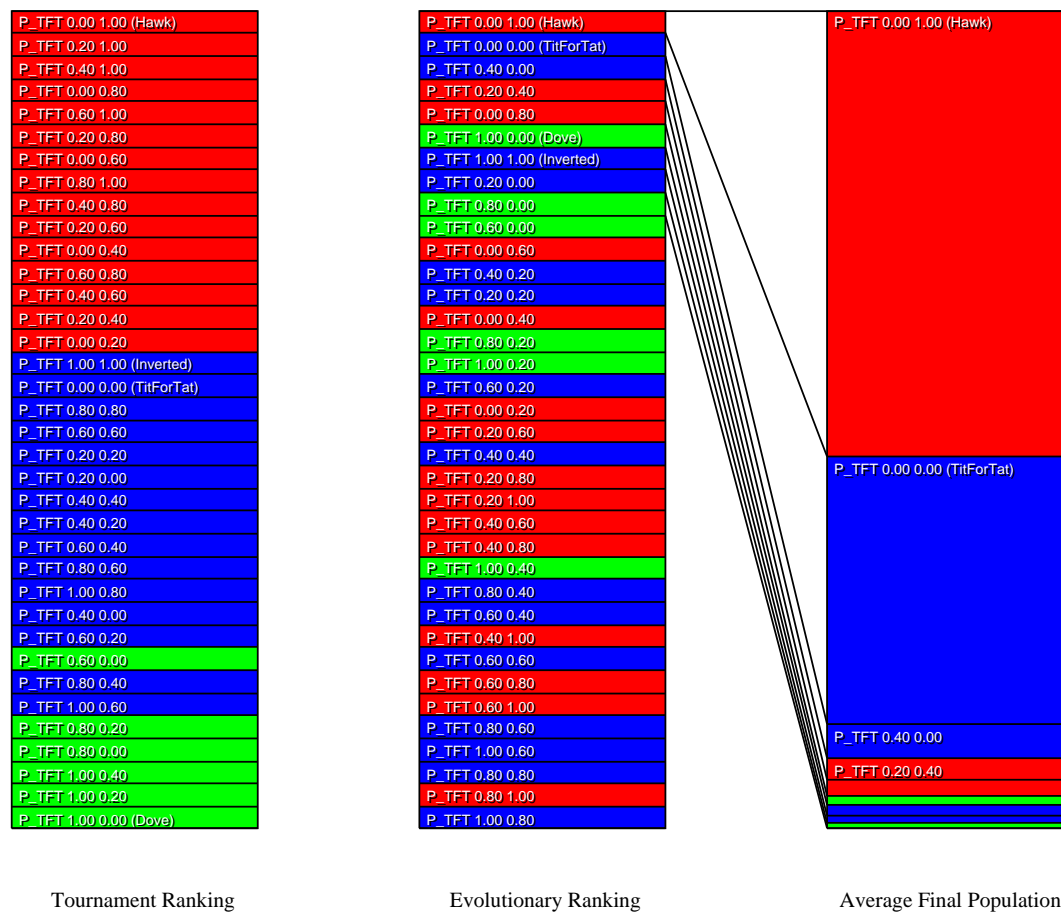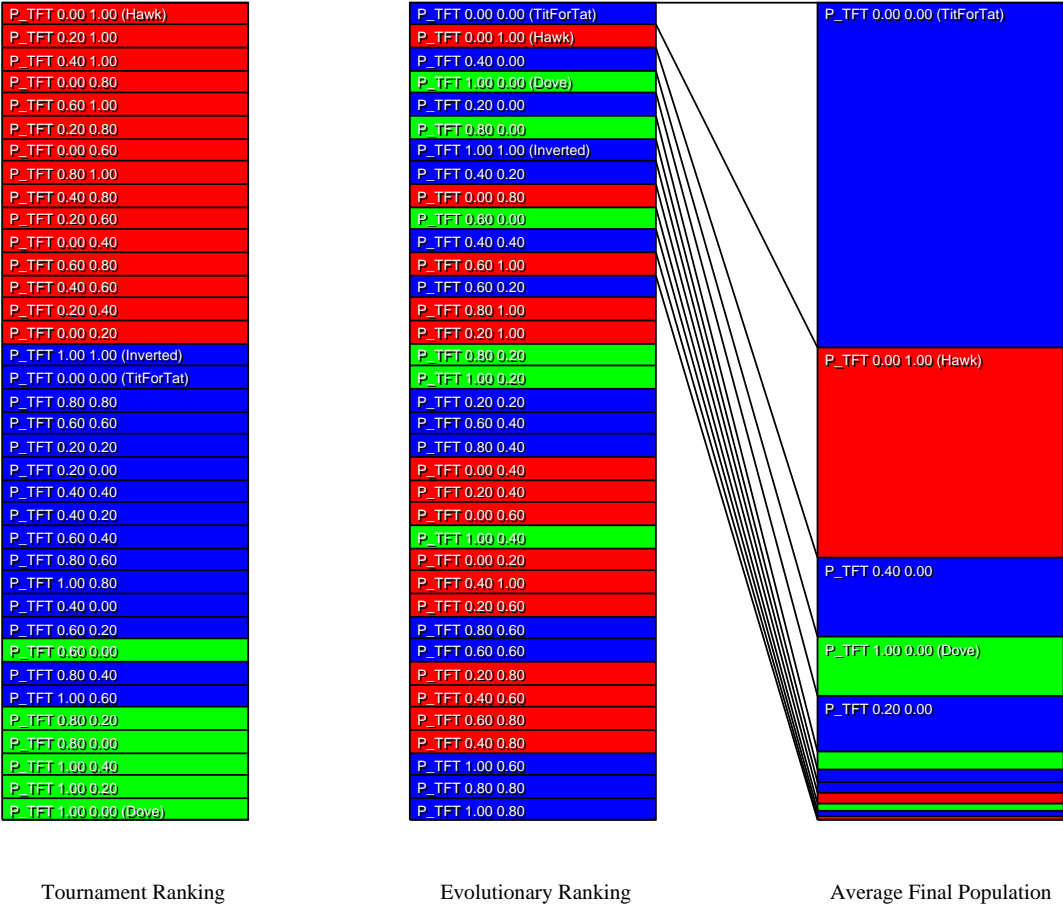Results for strategy set: "Automata"

Tournament Ranking

| Evolutionary Ranking | Average Final Population |

Figure 8.11: The aggregated results of those simulations of the "big series" for which the game noise was 0%.

Results for strategy set: "Automata"

Tournament Ranking	Evolutionary Ranking	Average Final Population
AM: HHHHH (HAWK)	AM: HHHHH (HAWK)	AM: HHHHH (HAWK)
AM: DHHHH	AM: HDHHD (PAVLOV)	
AM: DDHHH (GRIM)	AM: DDHHH (GRIM)	
AM: DHDHH	AM: DDHHD (TWEEDLEDUM)	AM: HDHHD (PAVLOV)
AM: HHHHD	AM: DDHDH (TIT FOR TAT)	
AM: DHHHD	AM: DDHDD (TWEEDLEDEE)	AM: DDHHH (GRIM)
AM: DDHHD (TWEEDLEDUM)	AM: DDDDD (DOVE)	
AM: HDHHD (PAVLOV)	AM: HDHDH (TAT FOR TIT)	AM: DDHHD (TWEEDLEDUM)
AM: DHHDH	AM: HHHDH	
AM: HHHDH	AM: DHHDH	AM: DDHDH (TIT FOR TAT)
AM: HHDHD (INVERTED)	AM: HHHHD	
AM: DDHDH (TIT FOR TAT)	AM: DHHDD	AM: DDHDD (TWEEDLEDEE)
AM: DHDHD	AM: HDHDD (SIMPLETON)	AM: DDDDD (DOVE)
AM: DHHDD	AM: HHHDD	
AM: HDHDH (TAT FOR TIT)	AM: DHHHH	
AM: HHHDD	AM: DHHHD	
AM: DDHDD (TWEEDLEDEE)	AM: DHDHH	
AM: HDHDD (SIMPLETON)	AM: DHDHD	
AM: HHDDH	AM: HHDDH	
AM: DHDDH	AM: HDDDH	
AM: HHDDD	AM: DHDDH	
AM: DHDDD	AM: HDDHD (TWEETYPIE)	
AM: HDDHD (TWEETYPIE)	AM: HDDDD	
AM: HDDDH	AM: HHDDD	
AM: HDDDD	AM: DHDDD	
AM: DDDDD (DOVE)	AM: HHDHD (INVERTED)	

Figure 8.12: The aggregated results of those simulations of the "big series" for which the game noise was 5%.

Results for strategy set: "Automata"

Figure 8.13: The aggregated results of those simulations of the "big series" for which the game noise was 10%.

Results for strategy set: "TFTs"

| Tournament Ranking | Evolutionary Ranking | Average Final Population |

Figure 8.14: The aggregated results of those simulations of the "big series" for which the game noise was 0%.

Results for strategy set: "TFTs"

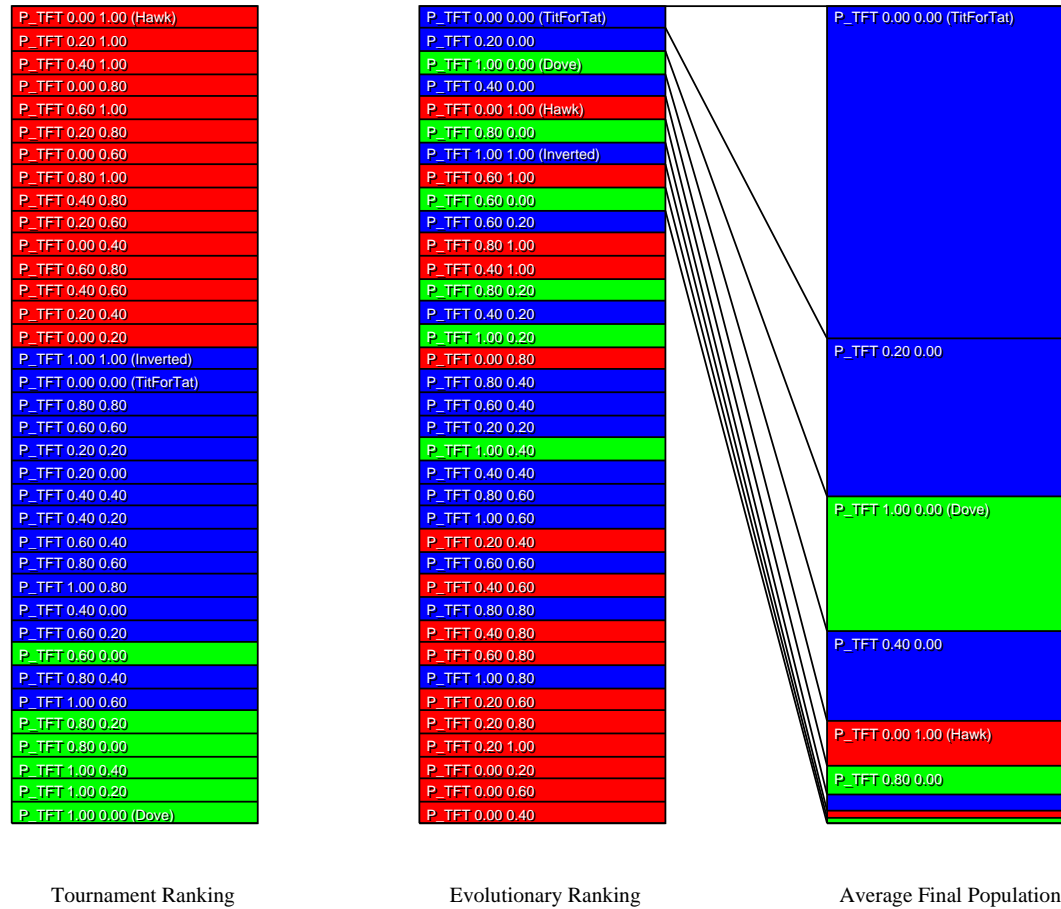| Tournament Ranking	Evolutionary Ranking	Average Final Population

Figure 8.15: The aggregated results of those simulations of the "big series" for which the game noise was 5%.

Results for strategy set: "TFTs"

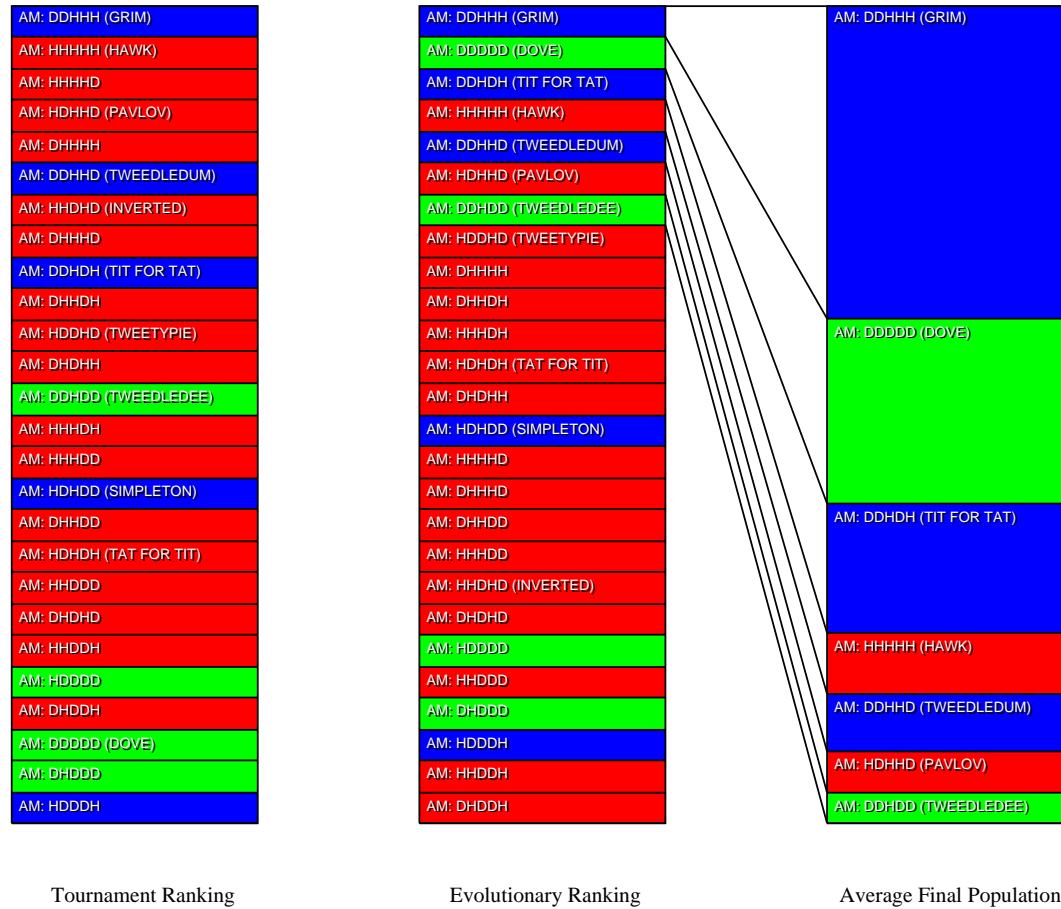| Tournament Ranking	Evolutionary Ranking	Average Final Population

Figure 8.16: The aggregated results of those simulations of the "big series" for which the game noise was 10%.
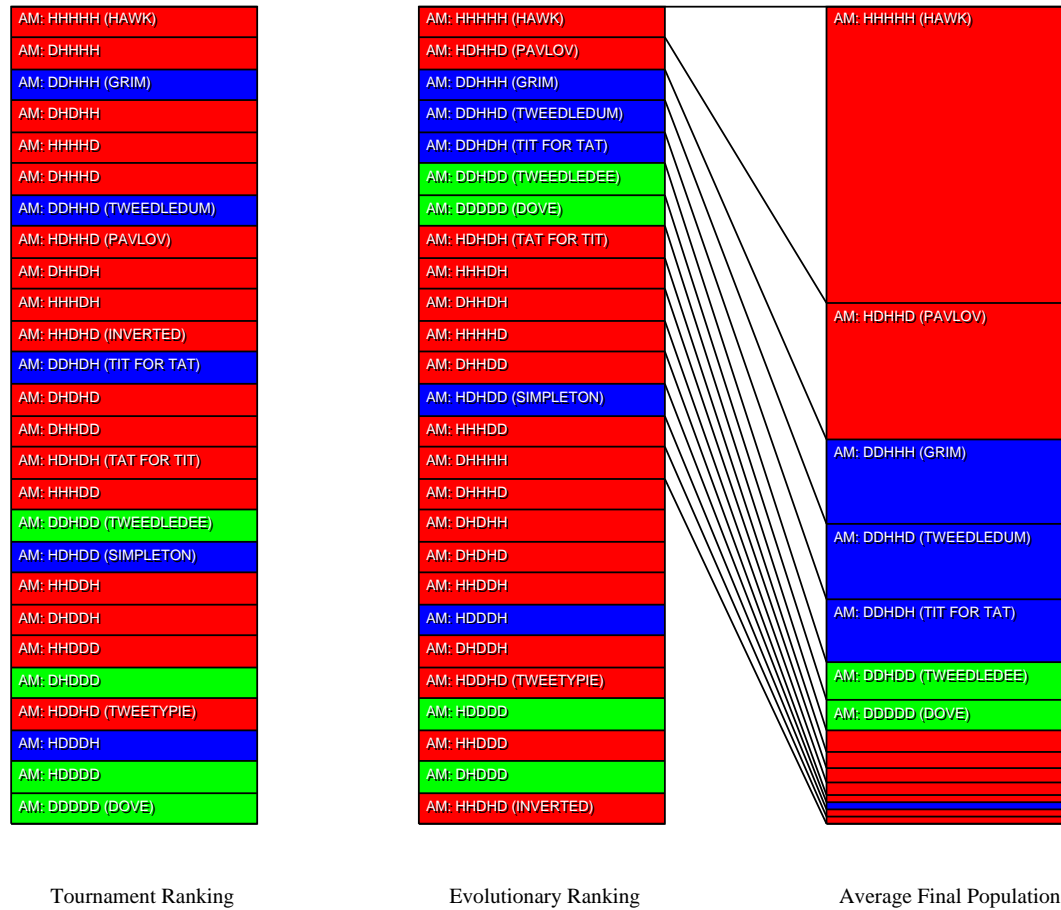
Results for strategy set: "Automata"
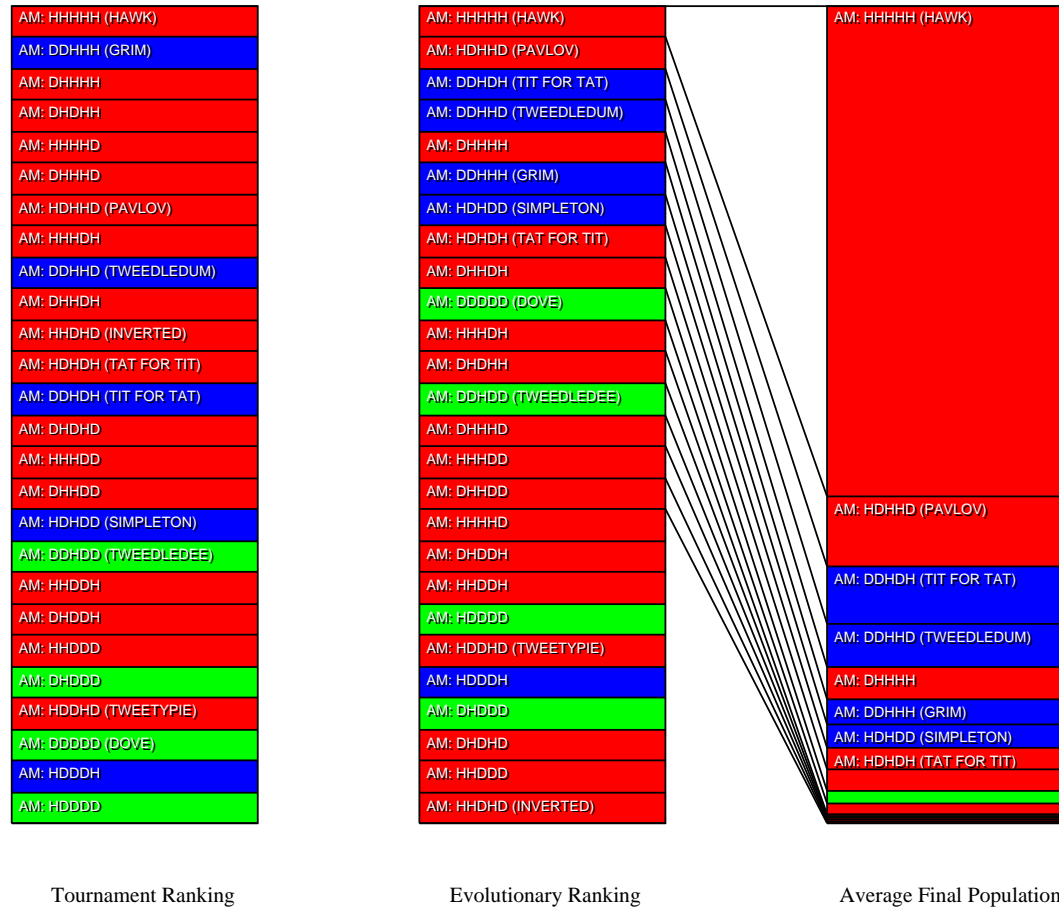

Figure 8.17: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 0%.

Figure 8.18: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 5%.

Results for strategy set: "Automata"

Tournament Ranking

- AM: DDHHH (GRIM)
- AM: HHHHH (HAWK)
- AM: DHHHH
- AM: HHHHD
- AM: HDHHD (PAVLOV)
- AM: DHDHH
- AM: DDHHD (TWEEDLEDUM)
- AM: DHHHD
- AM: HHDHD (INVERTED)
- AM: HHHDH
- AM: DHHDH
- AM: DDHDH (TIT FOR TAT)
- AM: HDDHD (TWEETYPIE)
- AM: HDHDH (TAT FOR TIT)
- AM: DDHDD (TWEEDLEDEE)
- AM: DHDHD
- AM: HHHDD
- AM: DHHDD
- AM: HDHDD (SIMPLETON)
- AM: HHDDH
- AM: DHDDH
- AM: HHDDD
- AM: HDDDD
- AM: DHDDD
- AM: DDDDD (DOVE)
- AM: HDDDH

Evolutionary Ranking

- AM: HHHHH (HAWK)
- AM: DDHHH (GRIM)
- AM: DDHHD (TWEEDLEDUM)
- AM: DDDDD (DOVE)
- AM: DDHDH (TIT FOR TAT)
- AM: HDHHD (PAVLOV)
- AM: DDHDD (TWEEDLEDEE)
- AM: HDHDH (TAT FOR TIT)
- AM: DHHDH
- AM: DHHHH
- AM: HDHDD (SIMPLETON)
- AM: HHHDH
- AM: HHHDD
- AM: DHHDD
- AM: DHHHD
- AM: DHDHH
- AM: HHHHD
- AM: HHDDH
- AM: DHDDH
- AM: DHDHD
- AM: HDDHD (TWEETYPIE)
- AM: HDDDD
- AM: HDDDH
- AM: DHDDD
- AM: HHDHD (INVERTED)
- AM: HHDDD

Average Final Population

- AM: HHHHH (HAWK)
- AM: DDHHH (GRIM)
- AM: DDHHD (TWEEDLEDUM)
- AM: DDDDD (DOVE)
- AM: DDHDH (TIT FOR TAT)
- AM: HDHHD (PAVLOV)

Figure 8.19: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 10%.

Figure 8.20: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 15%.

Results for strategy set: "TFTs"

Figure 8.21: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 0%.
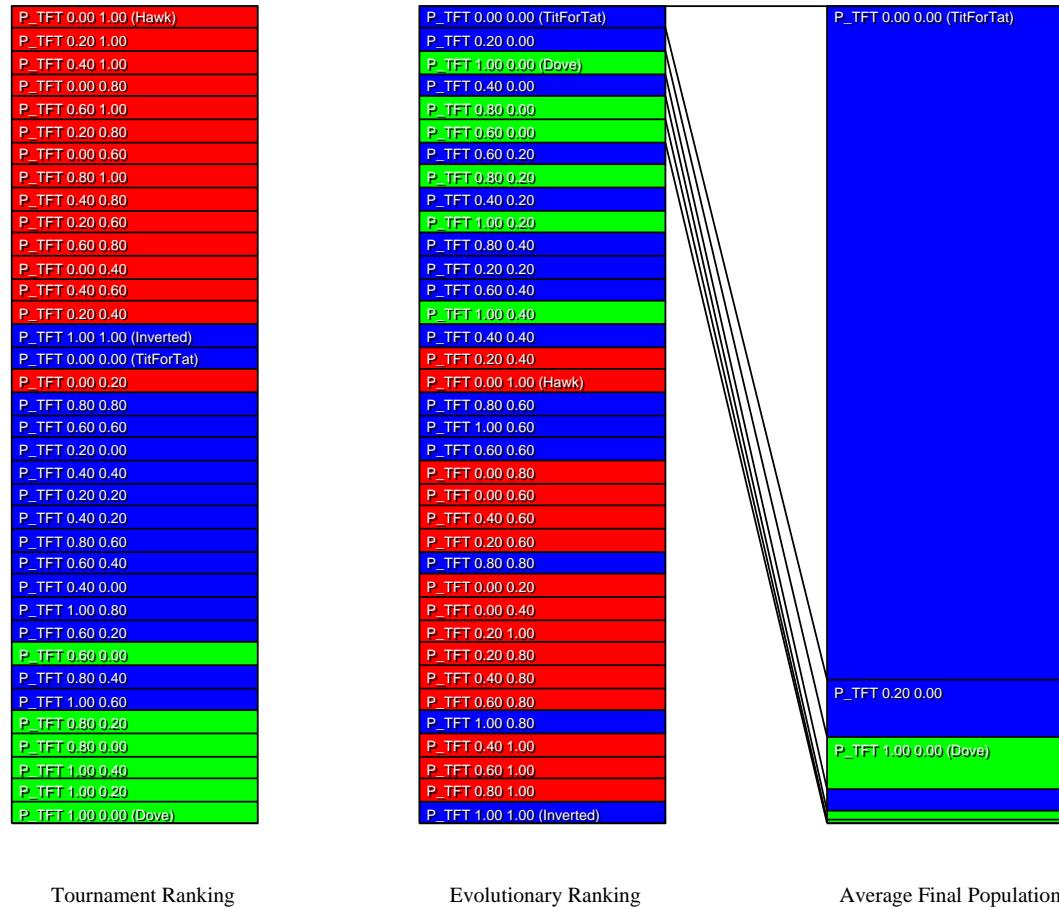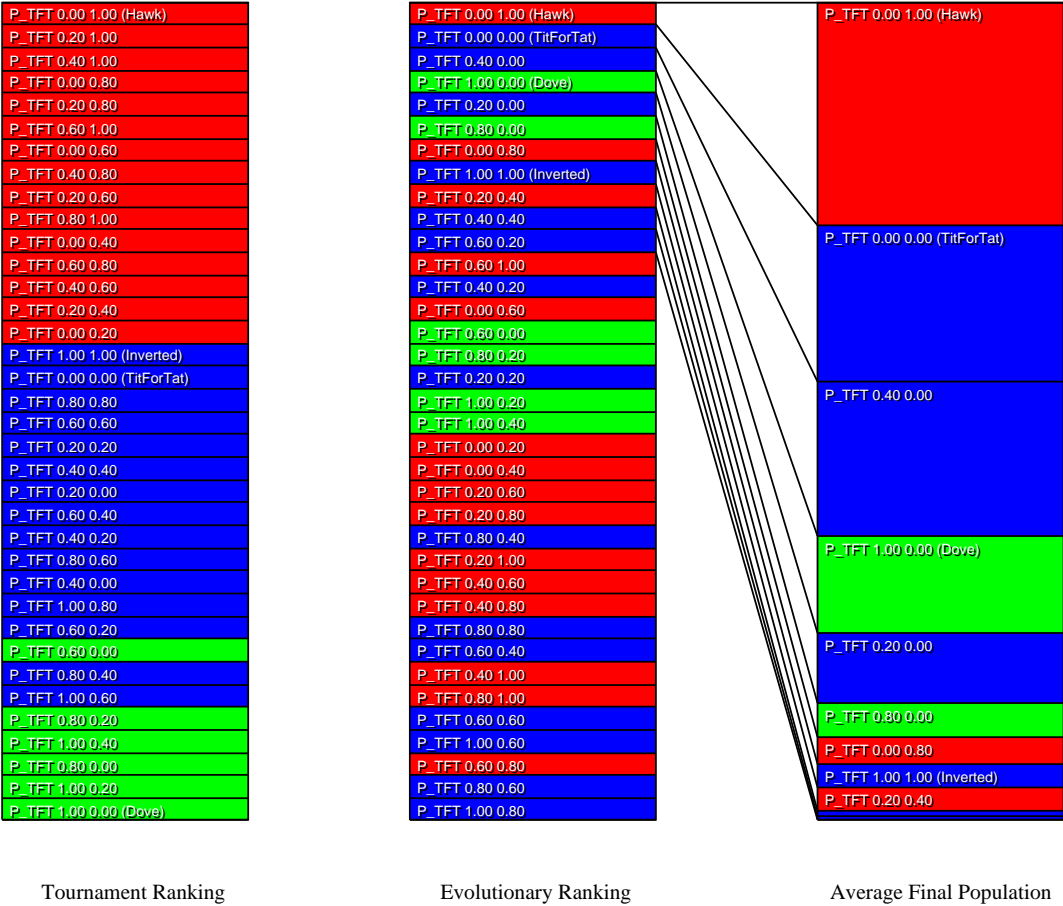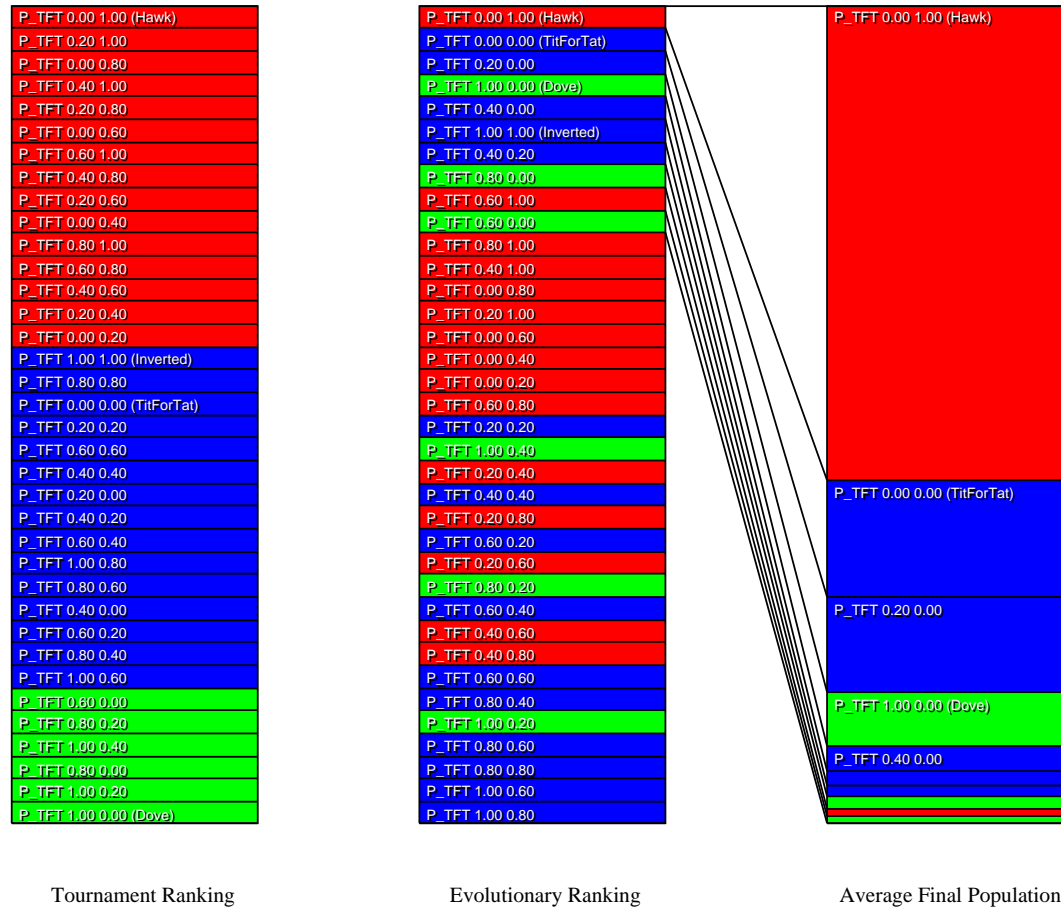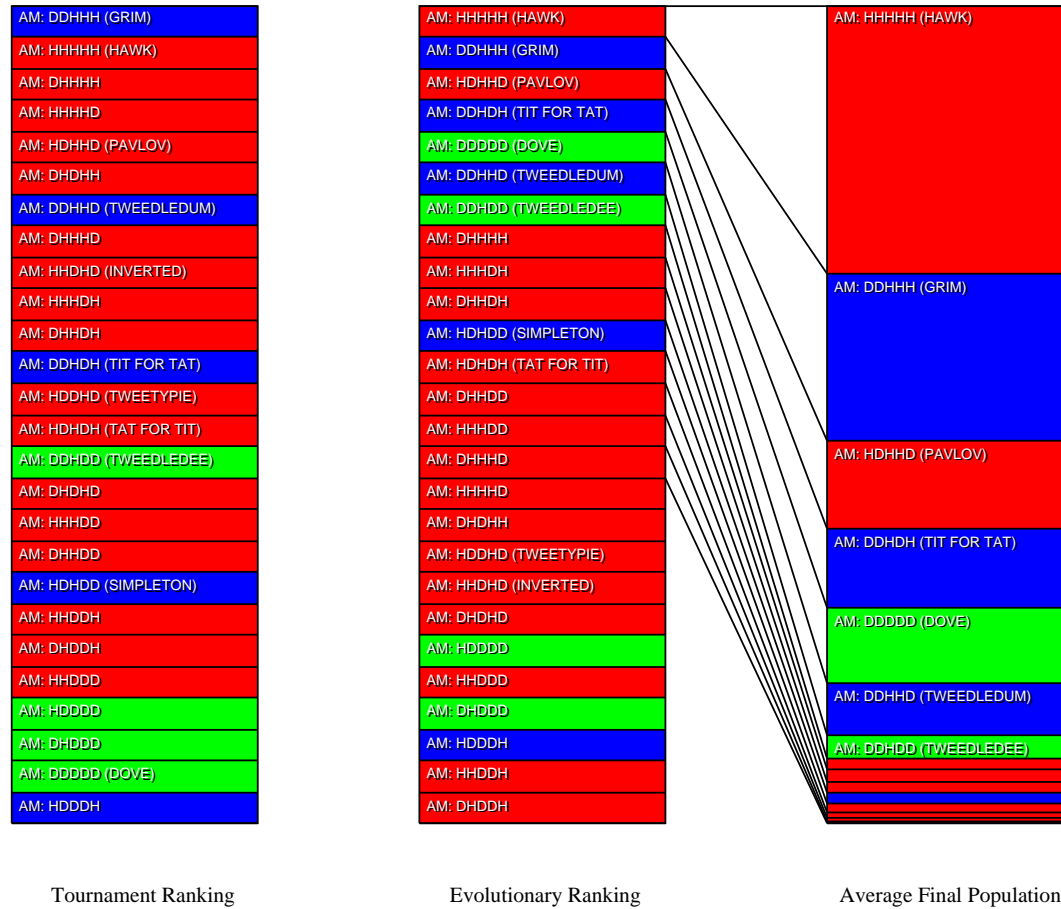
Results for strategy set: "TFTs"

Figure 8.22: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 5%.

Results for strategy set: "TFTs"

Tournament Ranking

Evolutionary Ranking

Average Final Population
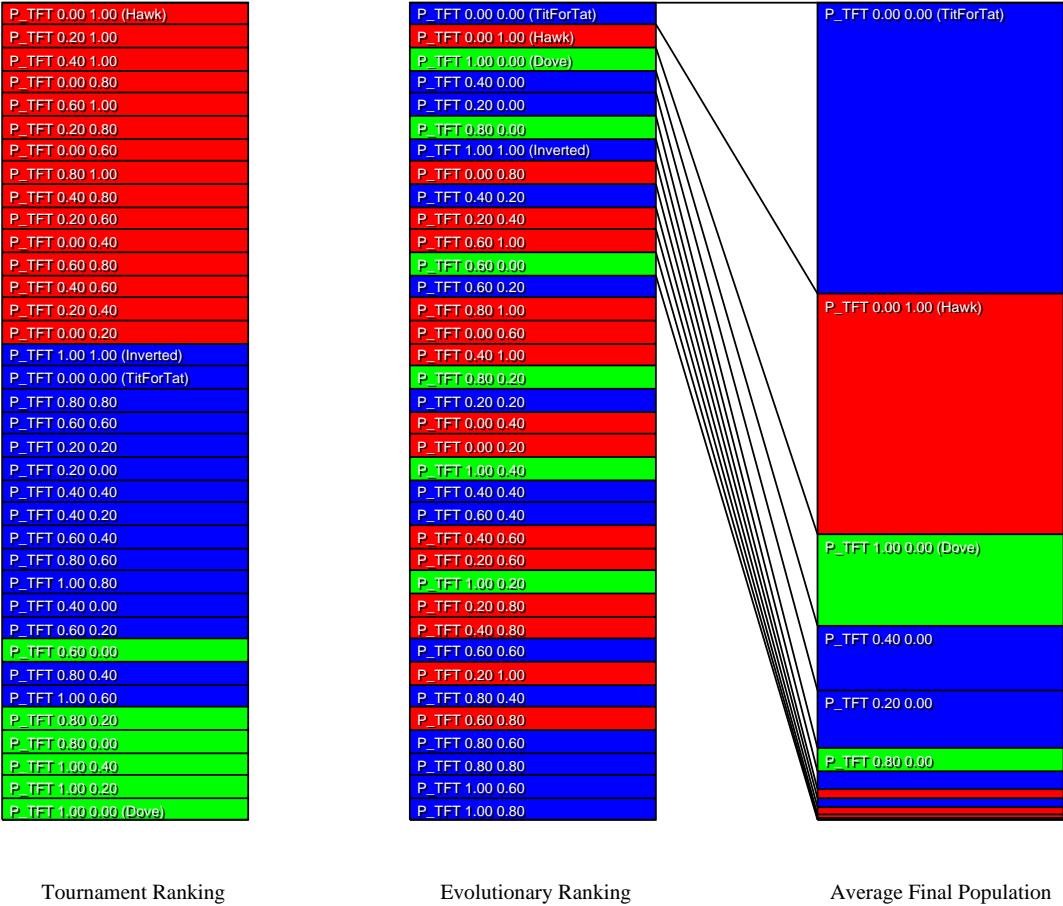
Figure 8.23: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 10%.
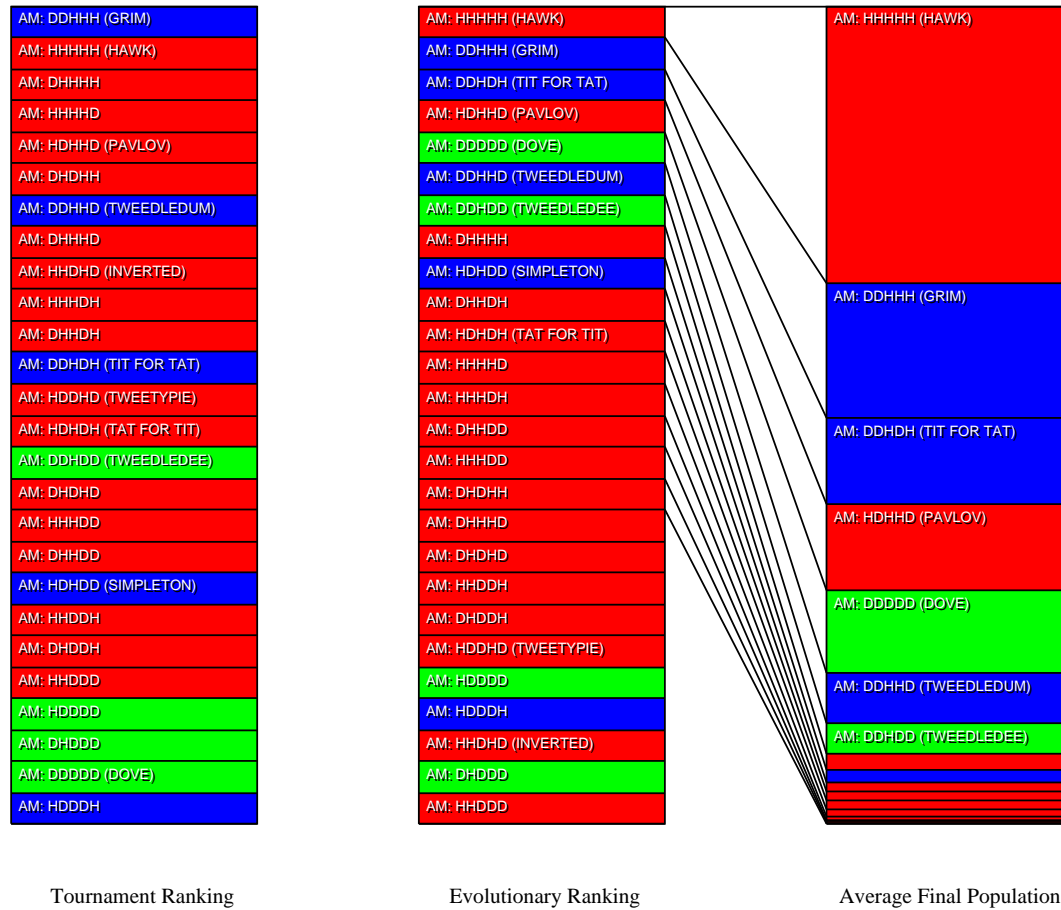
Results for strategy set: "TFTs"
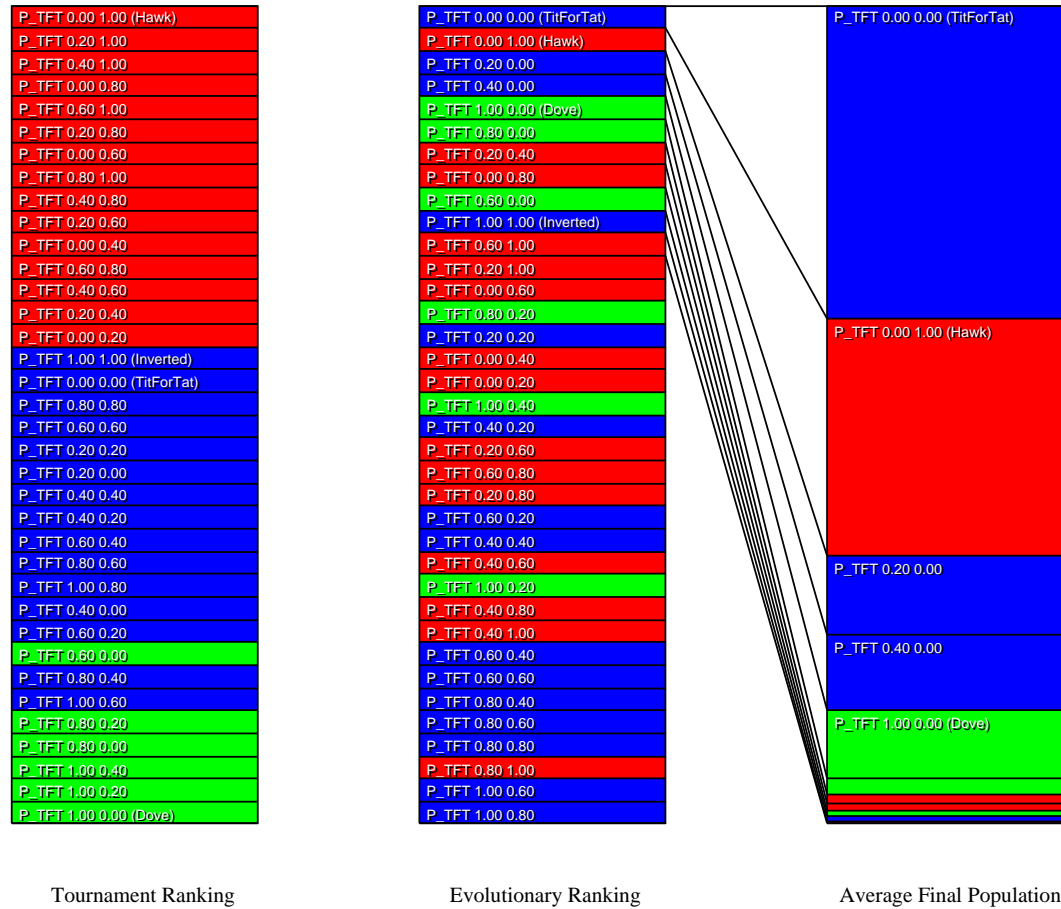
Figure 8.24: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 15%.
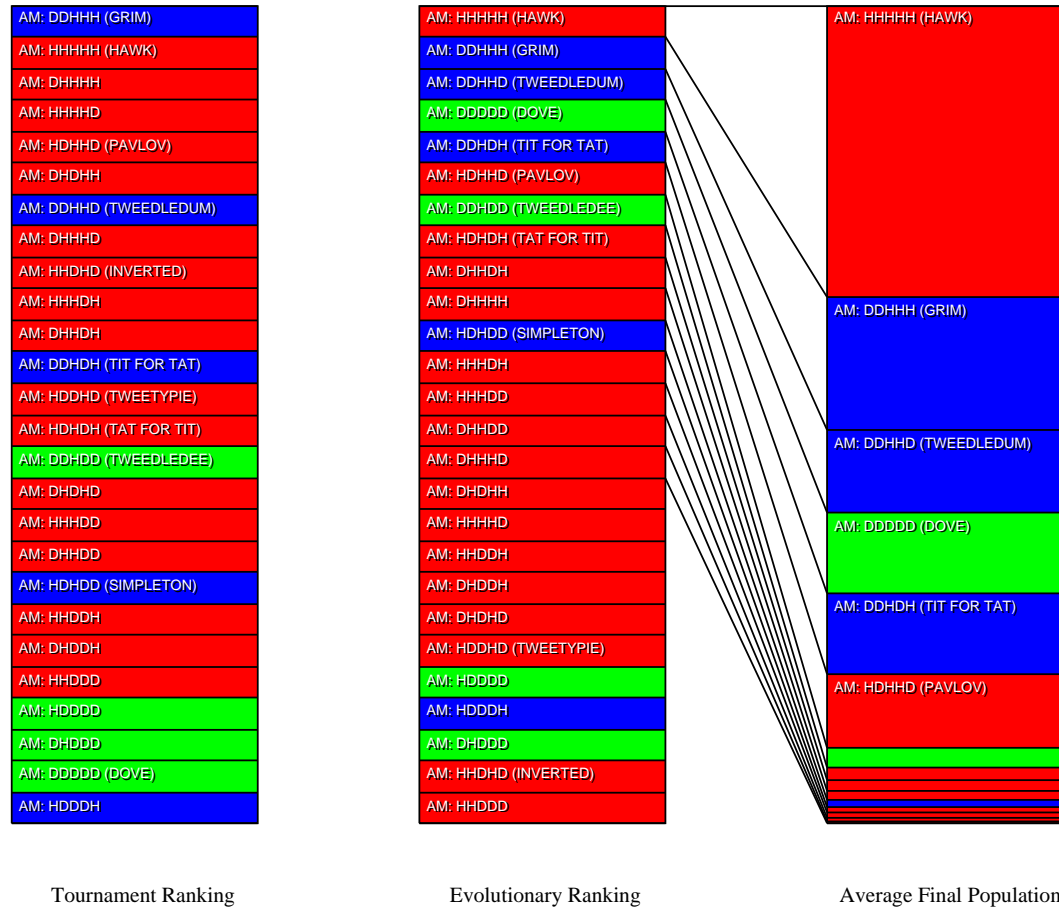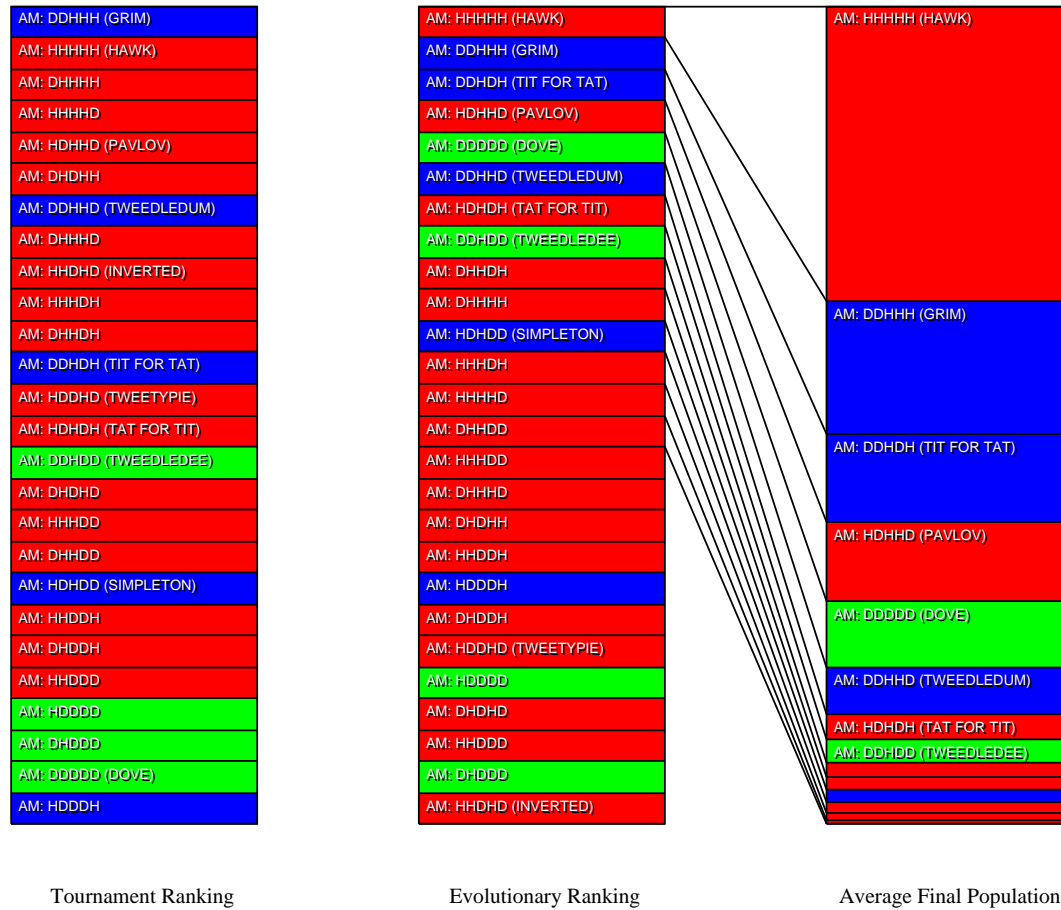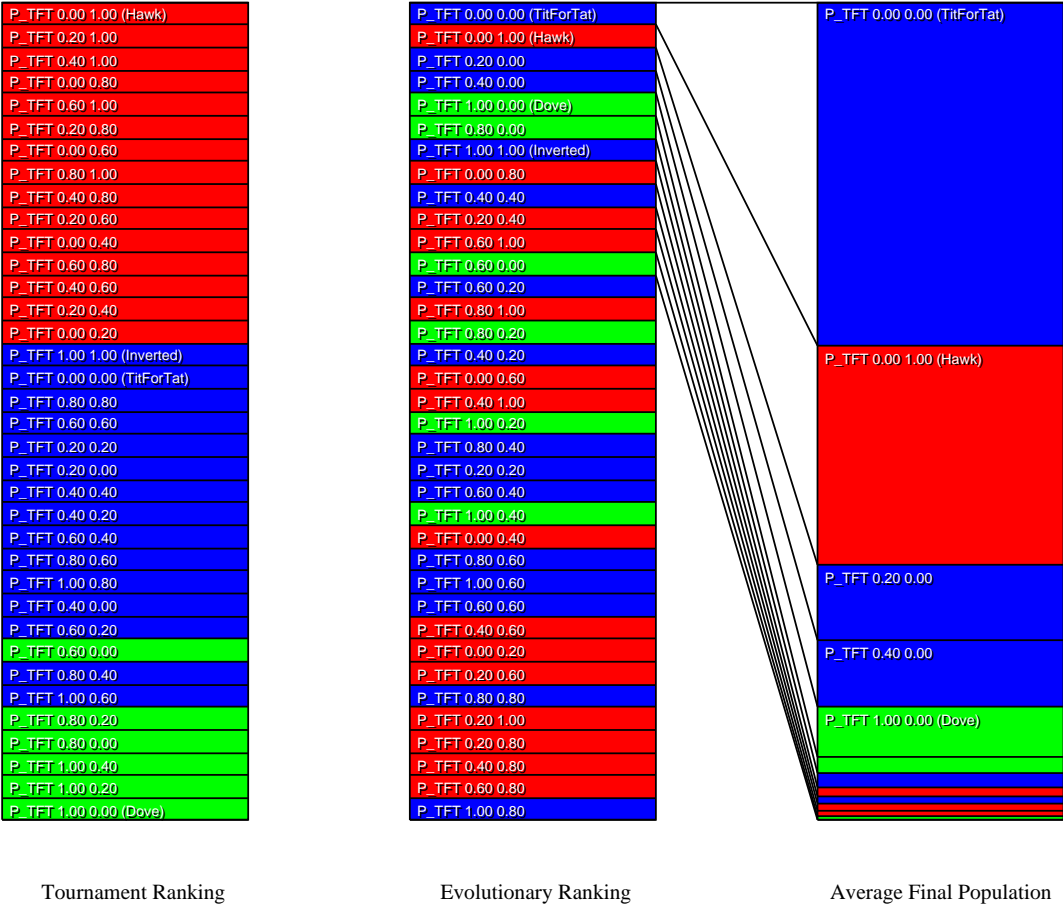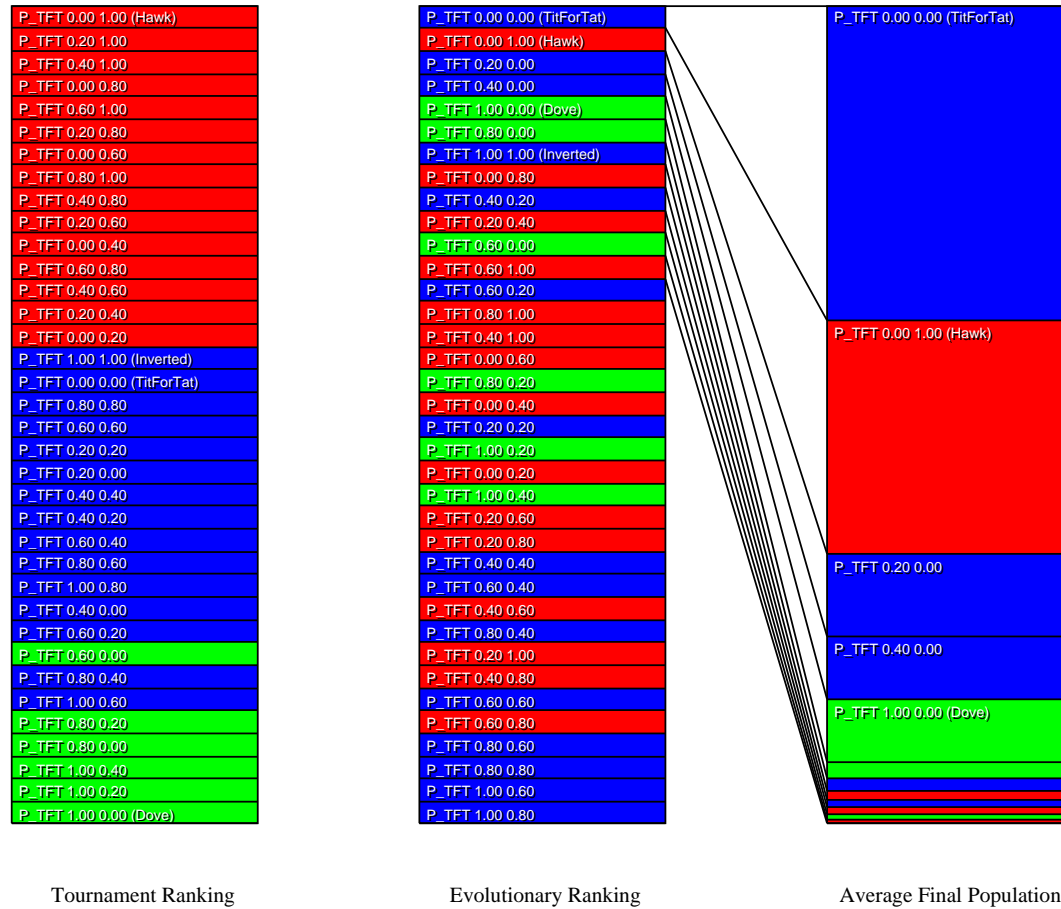
Results for strategy set: "Automata"

Tournament Ranking

- AM: DDHHH (GRIM)
- AM: HHHHH (HAWK)
- AM: DHHHH
- AM: HHHHD
- AM: HDHHD (PAVLOV)
- AM: DHDHH
- AM: DDHHD (TWEEDLEDUM)
- AM: DHHHD
- AM: HHDHD (INVERTED)
- AM: HHHDH
- AM: DHHDH
- AM: DDHDH (TIT FOR TAT)
- AM: HDDHD (TWEETYPIE)
- AM: HDHDH (TAT FOR TIT)
- AM: DDHDD (TWEEDLEDEE)
- AM: DHDHD
- AM: HHHDD
- AM: DHHDD
- AM: HDHDD (SIMPLETON)
- AM: HHDDH
- AM: DHDDH
- AM: HHDDD
- AM: HDDDD
- AM: DHDDD
- AM: DDDDD (DOVE)
- AM: HDDDH

Evolutionary Ranking

- AM: DDHHH (GRIM)
- AM: DDHHD (TWEEDLEDUM)
- AM: DDHDH (TIT FOR TAT)
- AM: HDHHD (PAVLOV)
- AM: HHHHH (HAWK)
- AM: DDHDD (TWEEDLEDEE)
- AM: DHHHH
- AM: DDDDD (DOVE)
- AM: HHHHD
- AM: HDHDD (SIMPLETON)
- AM: HDHDH (TAT FOR TIT)
- AM: HHHDH
- AM: DHHDH
- AM: DHHDD
- AM: DHDHH
- AM: HHHDD
- AM: DHHHD
- AM: HDDHD (TWEETYPIE)
- AM: HHDHD (INVERTED)
- AM: DHDHD
- AM: HDDDD
- AM: HHHDD
- AM: DHDDD
- AM: HDDDH
- AM: HHDDH
- AM: DHDDH

Average Final Population

- AM: DDHHH (GRIM)
- AM: DDHHD (TWEEDLEDUM)
- AM: DDHDH (TIT FOR TAT)
- AM: HDHHD (PAVLOV)
- AM: HHHHH (HAWK)
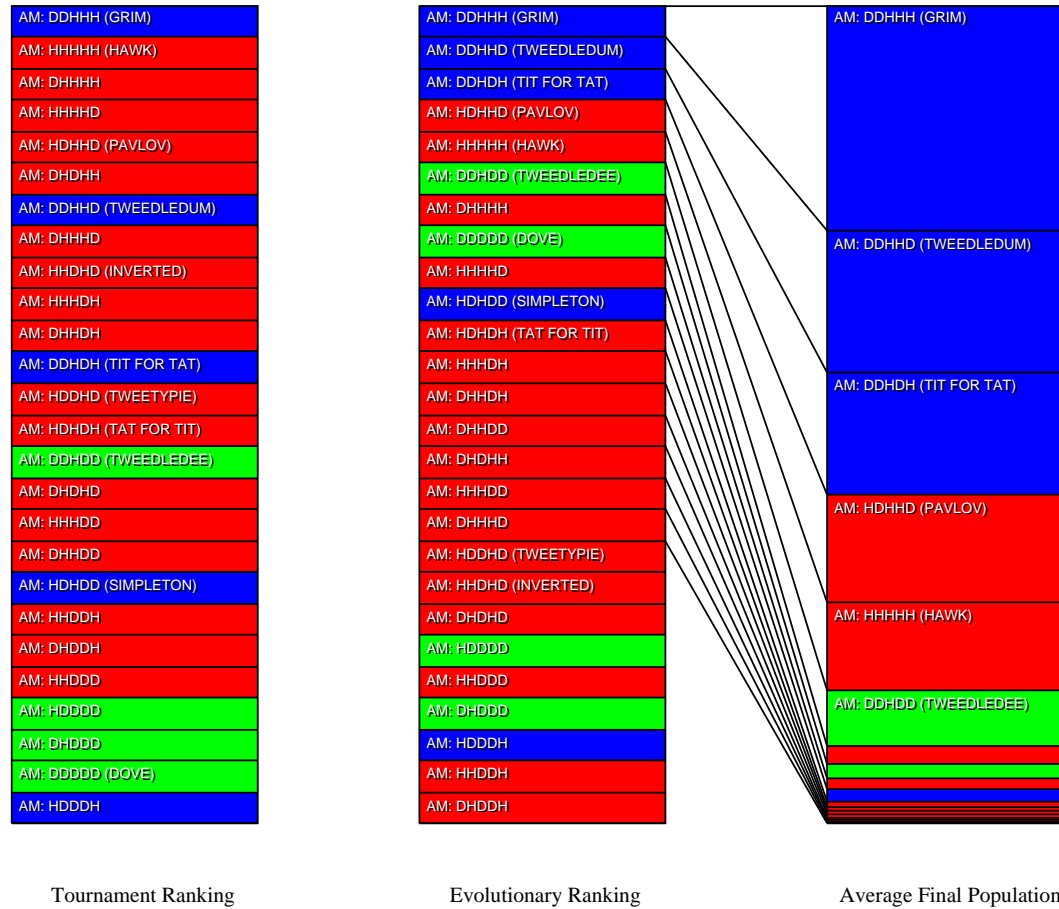- AM: DDHDD (TWEEDLEDEE)

Figure 8.25: The aggregated results of those simulations of the "big series" for which degenerative mutations were turned off.

Results for strategy set: "Automata"

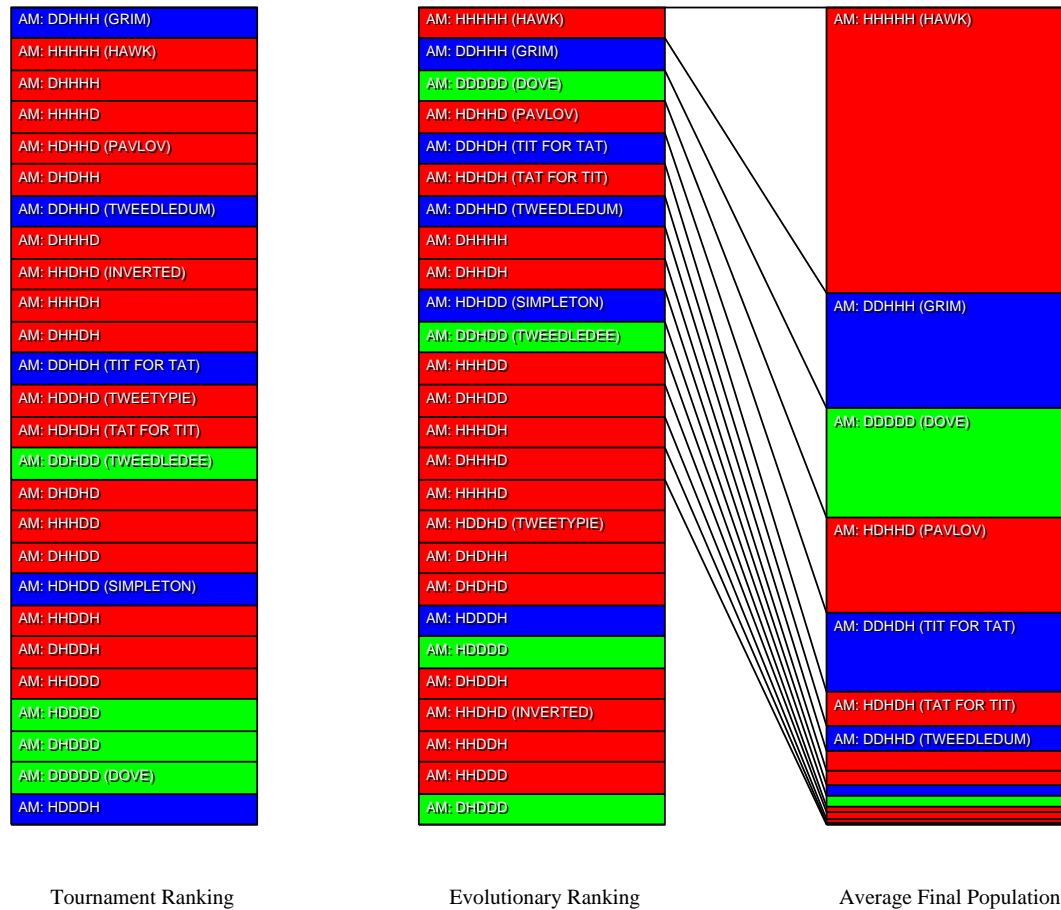| Tournament Ranking	Evolutionary Ranking	Average Final Population
AM: DDHHH (GRIM)	AM: HHHHH (HAWK)	AM: HHHHH (HAWK)
AM: HHHHH (HAWK)	AM: DDHHH (GRIM)	
AM: DHHHH	AM: DDDDD (DOVE)	
AM: HHHHD	AM: HDHHD (PAVLOV)	
AM: HDHHD (PAVLOV)	AM: DDHDH (TIT FOR TAT)	
AM: DHDHH	AM: HDHDH (TAT FOR TIT)	AM: DDHHH (GRIM)
AM: DDHHD (TWEEDLEDUM)	AM: DDHHD (TWEEDLEDUM)	
AM: DHHHD	AM: DHHHH	
AM: HHDHD (INVERTED)	AM: DHHDH	AM: DDDDD (DOVE)
AM: HHHDH	AM: HDHDD (SIMPLETON)	
AM: DHHDH	AM: DDHDD (TWEEDLEDEE)	
AM: DDHDH (TIT FOR TAT)	AM: HHHDD	AM: HDHHD (PAVLOV)
AM: HDDHD (TWEETYPIE)	AM: DHHDD	
AM: HDHDH (TAT FOR TIT)	AM: HHHDH	
AM: DDHDD (TWEEDLEDEE)	AM: DHHHD	
AM: DHDHD	AM: HHHHD	AM: DDHDH (TIT FOR TAT)
AM: HHHDD	AM: HDDHD (TWEETYPIE)	
AM: DHHDD	AM: DHDHH	
AM: HDHDD (SIMPLETON)	AM: DHDHD	AM: HDHDH (TAT FOR TIT)
AM: HHDDH	AM: HDDDH	AM: DDHHD (TWEEDLEDUM)
AM: DHDDH	AM: HDDDD	
AM: HHDDD	AM: DHDDH	
AM: HDDDD	AM: HHDHD (INVERTED)	
AM: DHDDD	AM: HHDDH	
AM: DDDDD (DOVE)	AM: HHDDD	
AM: HDDDH	AM: DHDDD	

Figure 8.26: The aggregated results of those simulations of the "big series" for which 1% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).
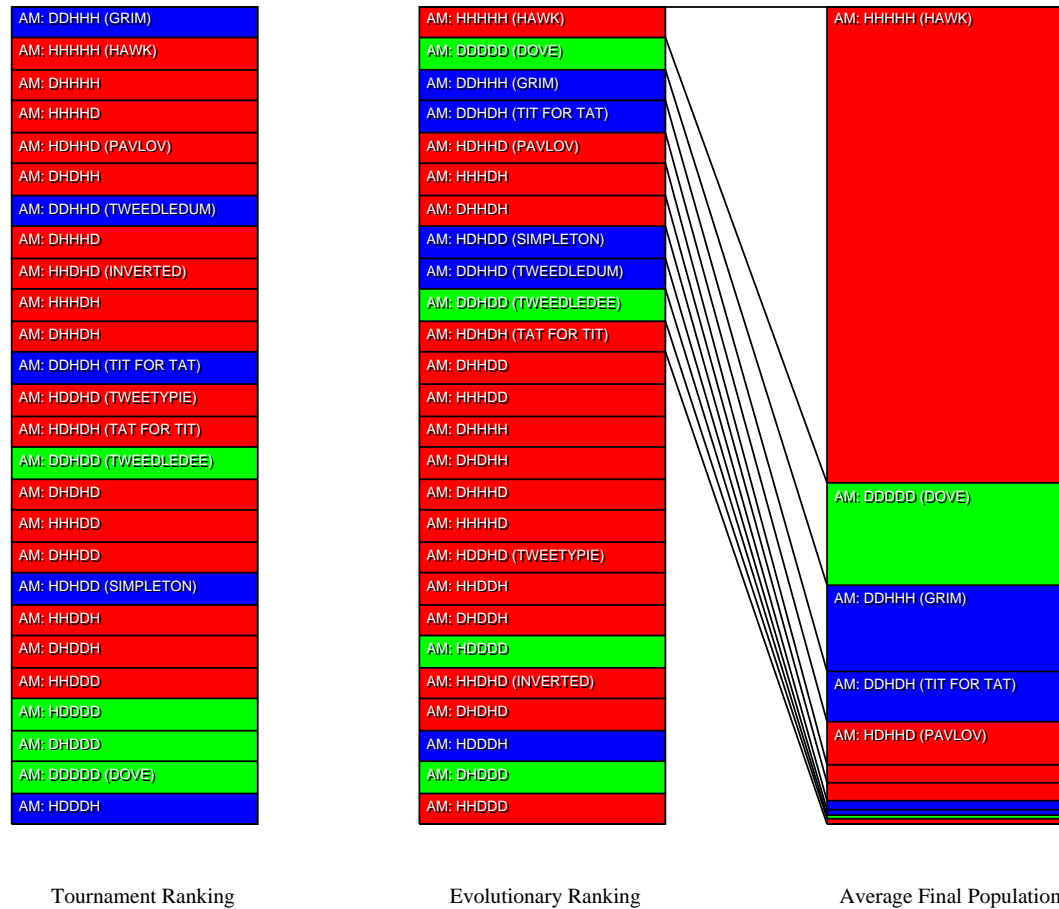
Results for strategy set: "Automata"

Tournament Ranking

- AM: DDHHH (GRIM)
- AM: HHHHH (HAWK)
- AM: DHHHH
- AM: HHHHD
- AM: HDHHD (PAVLOV)
- AM: DHDHH
- AM: DDHHD (TWEEDLEDUM)
- AM: DHHHD
- AM: HHDHD (INVERTED)
- AM: HHHDH
- AM: DHHDH
- AM: DDHDH (TIT FOR TAT)
- AM: HDDHD (TWEETYPIE)
- AM: HDHDH (TAT FOR TIT)
- AM: DDHDD (TWEEDLEDEE)
- AM: DHDHD
- AM: HHHDD
- AM: DHHDD
- AM: HDHDD (SIMPLETON)
- AM: HHDDH
- AM: DHDDH
- AM: HHDDD
- AM: HDDDD
- AM: DHDDD
- AM: DDDDD (DOVE)
- AM: HDDDH

Evolutionary Ranking

- AM: HHHHH (HAWK)
- AM: DDDDD (DOVE)
- AM: DDHHH (GRIM)
- AM: DDHDH (TIT FOR TAT)
- AM: HDHHD (PAVLOV)
- AM: HHHDH
- AM: DHHDH
- AM: HDHDD (SIMPLETON)
- AM: DDHHD (TWEEDLEDUM)
- AM: DDHDD (TWEEDLEDEE)
- AM: HDHDH (TAT FOR TIT)
- AM: DHHDD
- AM: HHHDD
- AM: DHHHH
- AM: DHDHH
- AM: DHHHD
- AM: HHHHD
- AM: HDDHD (TWEETYPIE)
- AM: HHDDH
- AM: DHDDH
- AM: HDDDD
- AM: HHDHD (INVERTED)
- AM: DHDHD
- AM: HDDDH
- AM: DHDDD
- AM: HHDDD

Average Final Population

- AM: HHHHH (HAWK)
- AM: DDDDD (DOVE)
- AM: DDHHH (GRIM)
- AM: DDHDH (TIT FOR TAT)
- AM: HDHHD (PAVLOV)

Tournament Ranking   Evolutionary Ranking   Average Final Population

Figure 8.27: The aggregated results of those simulations of the "big series" for which 5% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).
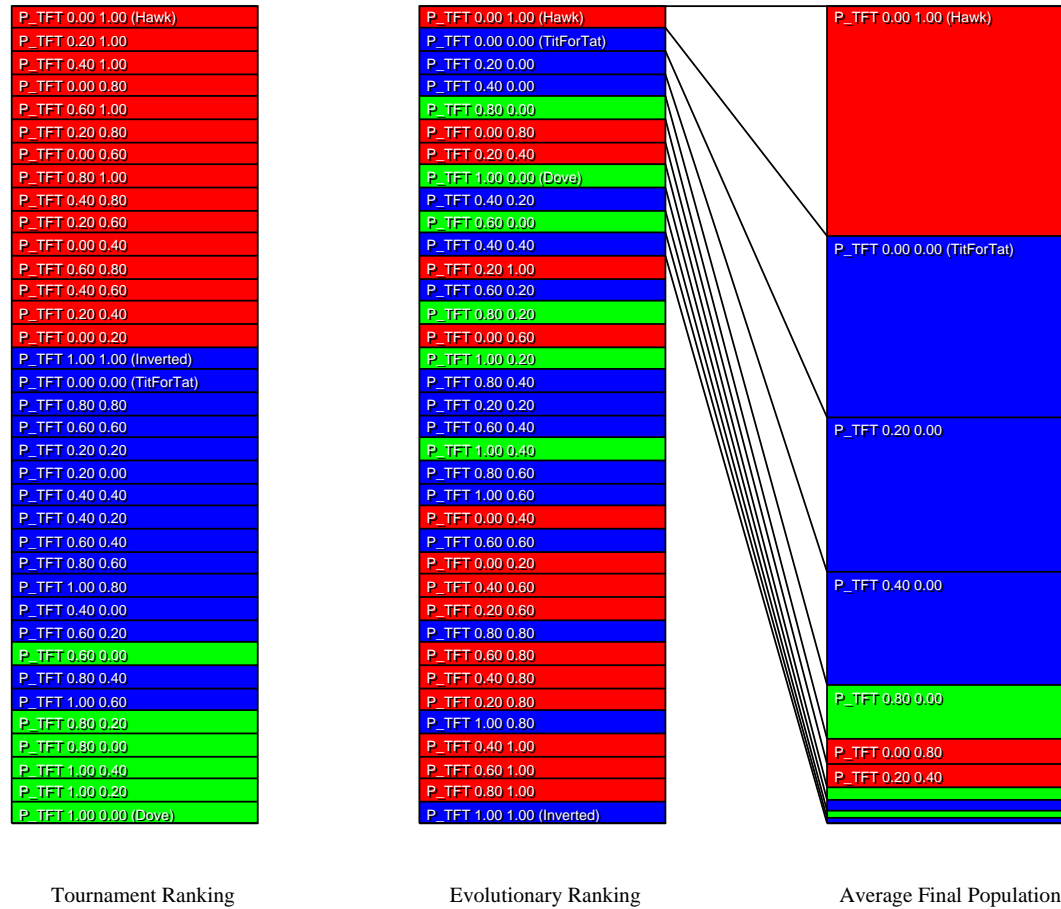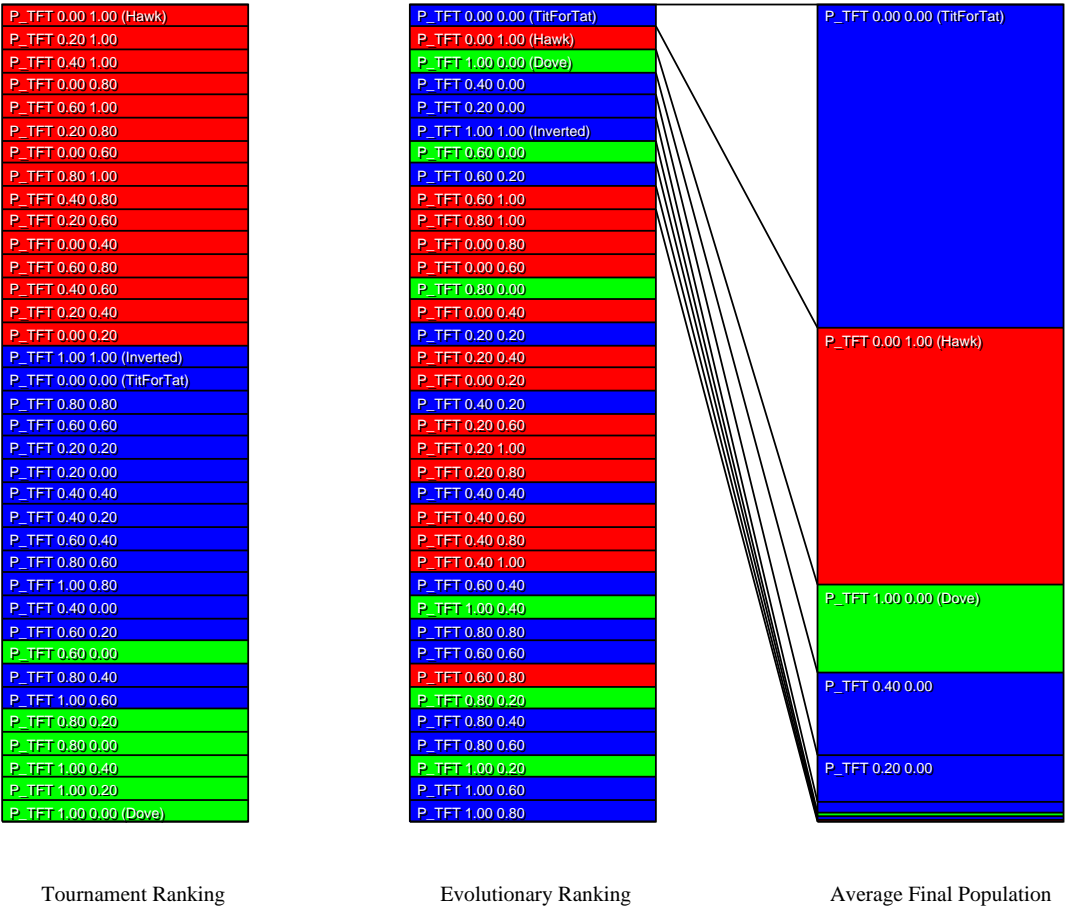
Results for strategy set: "TFTs"

Figure 8.28: The aggregated results of those simulations of the "big series" for which degenerative mutations were turned off.

Figure 8.29: The aggregated results of those simulations of the "big series" for which 1% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).

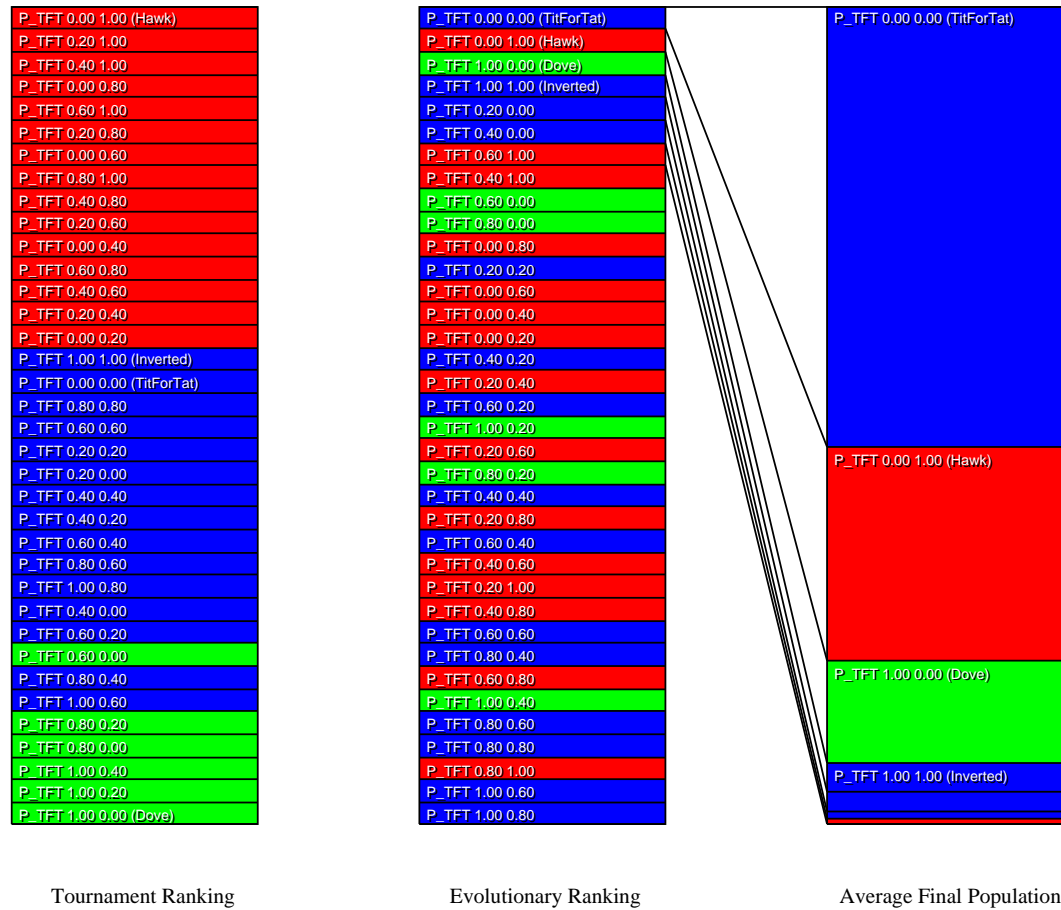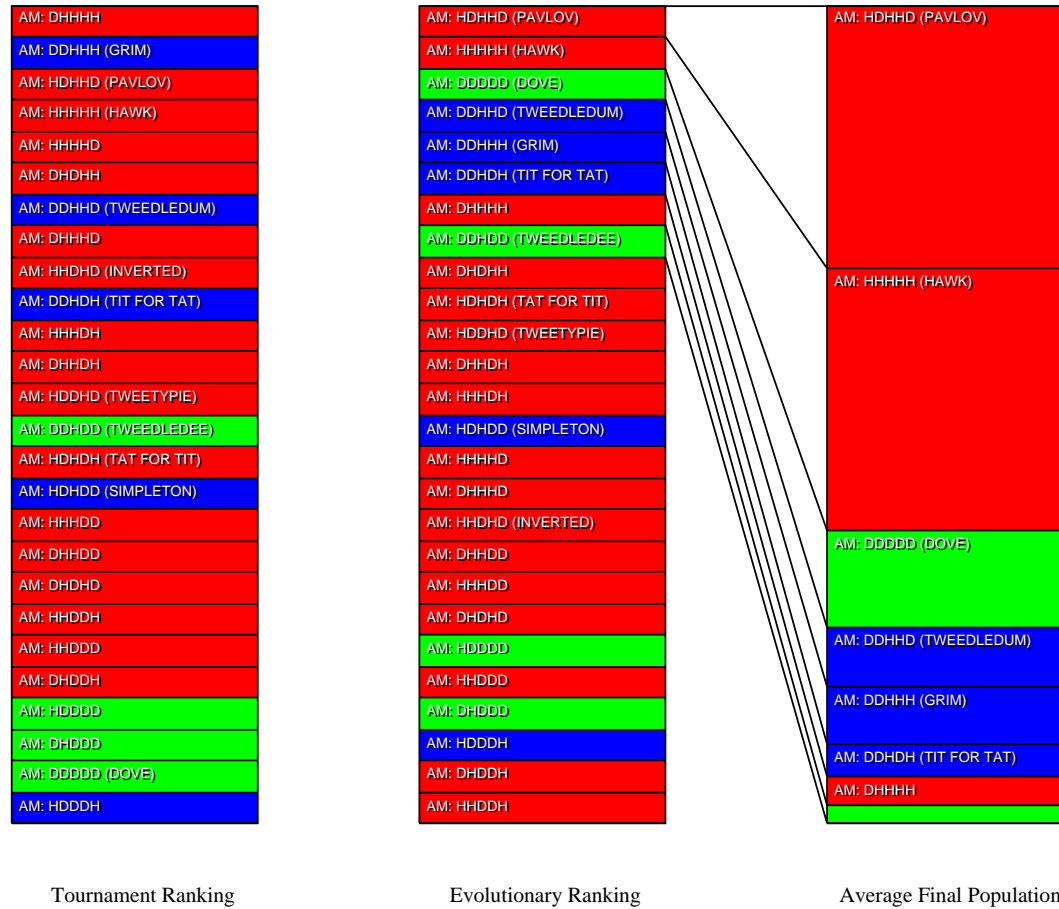# Results for strategy set: "TFTs"

Tournament Ranking

P_TFT 0.00 1.00 (Hawk)
P_TFT 0.20 1.00
P_TFT 0.40 1.00
P_TFT 0.00 0.80
P_TFT 0.60 1.00
P_TFT 0.20 0.80
P_TFT 0.00 0.60
P_TFT 0.80 1.00
P_TFT 0.40 0.80
P_TFT 0.20 0.60
P_TFT 0.00 0.40
P_TFT 0.60 0.80
P_TFT 0.40 0.60
P_TFT 0.20 0.40
P_TFT 0.00 0.20
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.80 0.80
P_TFT 0.60 0.60
P_TFT 0.20 0.20
P_TFT 0.20 0.00
P_TFT 0.40 0.40
P_TFT 0.40 0.20
P_TFT 0.60 0.40
P_TFT 0.80 0.60
P_TFT 1.00 0.80
P_TFT 0.40 0.00
P_TFT 0.60 0.20
P_TFT 0.60 0.00
P_TFT 0.80 0.40
P_TFT 1.00 0.60
P_TFT 0.80 0.20
P_TFT 0.80 0.00
P_TFT 1.00 0.40
P_TFT 1.00 0.20
P_TFT 1.00 0.00 (Dove)

Evolutionary Ranking

P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.00 1.00 (Hawk)
P_TFT 1.00 0.00 (Dove)
P_TFT 1.00 1.00 (Inverted)
P_TFT 0.20 0.00
P_TFT 0.40 0.00
P_TFT 0.60 1.00
P_TFT 0.40 1.00
P_TFT 0.60 0.00
P_TFT 0.80 0.00
P_TFT 0.00 0.80
P_TFT 0.20 0.20
P_TFT 0.00 0.60
P_TFT 0.00 0.40
P_TFT 0.00 0.20
P_TFT 0.40 0.20
P_TFT 0.20 0.40
P_TFT 0.60 0.20
P_TFT 1.00 0.20
P_TFT 0.20 0.60
P_TFT 0.80 0.20
P_TFT 0.40 0.40
P_TFT 0.20 0.80
P_TFT 0.60 0.40
P_TFT 0.40 0.60
P_TFT 0.20 1.00
P_TFT 0.40 0.80
P_TFT 0.60 0.60
P_TFT 0.80 0.40
P_TFT 0.60 0.80
P_TFT 1.00 0.40
P_TFT 0.80 0.60
P_TFT 0.80 0.80
P_TFT 0.80 1.00
P_TFT 1.00 0.60
P_TFT 1.00 0.80

Average Final Population

P_TFT 0.00 0.00 (TitForTat)
P_TFT 0.00 1.00 (Hawk)
P_TFT 1.00 0.00 (Dove)
P_TFT 1.00 1.00 (Inverted)

Figure 8.30: The aggregated results of those simulations of the "big series" for which 5% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).

Results for strategy set: "Automata"

Figure 8.31: The aggregated results of the simulations of the "big series" with the payoff parameters T=3.5, R=3, P=1, S=0.

Figure 8.32: The aggregated results of the simulations of the "big series" with the payoff parameters T=5, R=3, P=1, S=0.
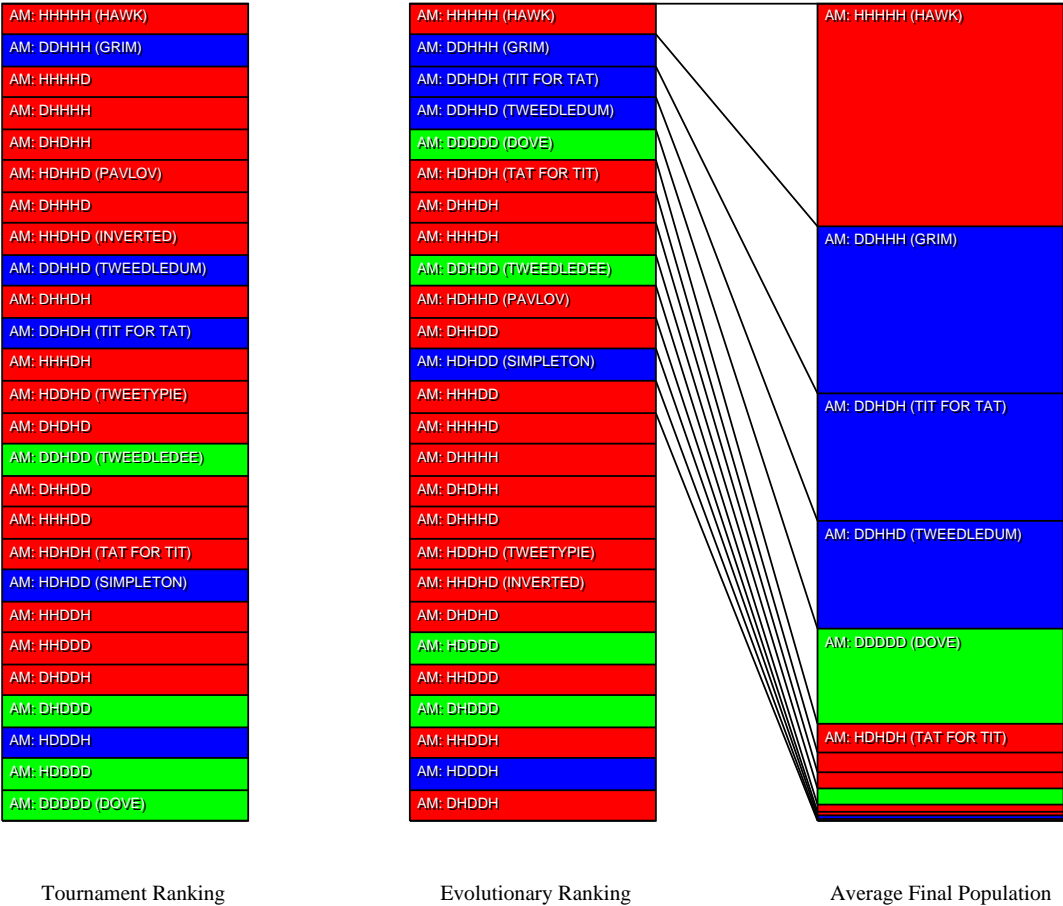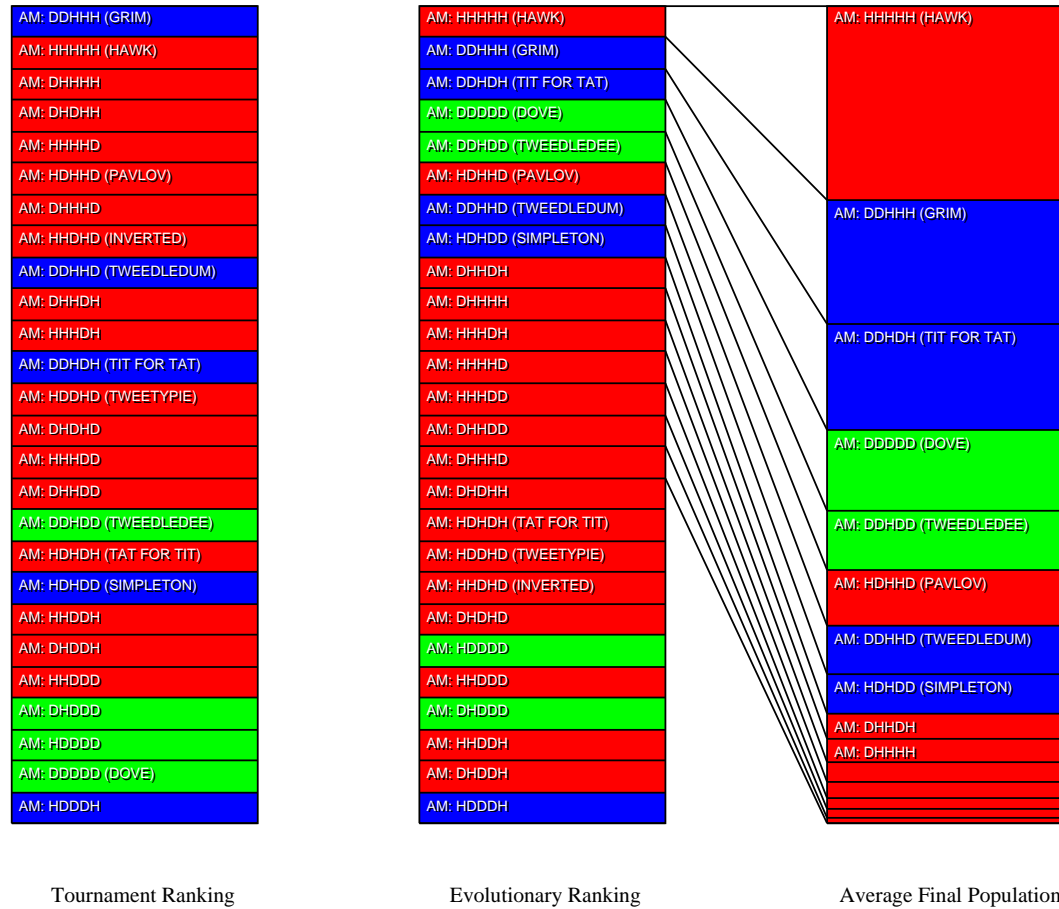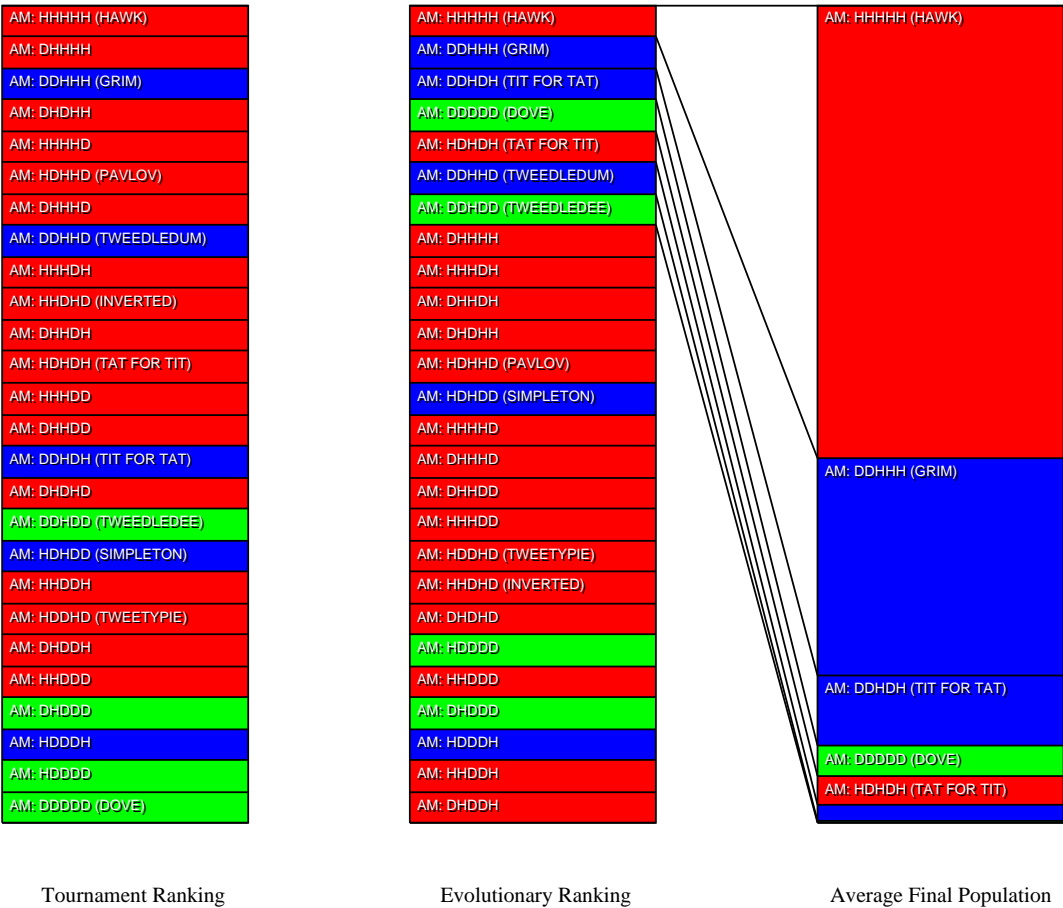
Results for strategy set: "Automata"
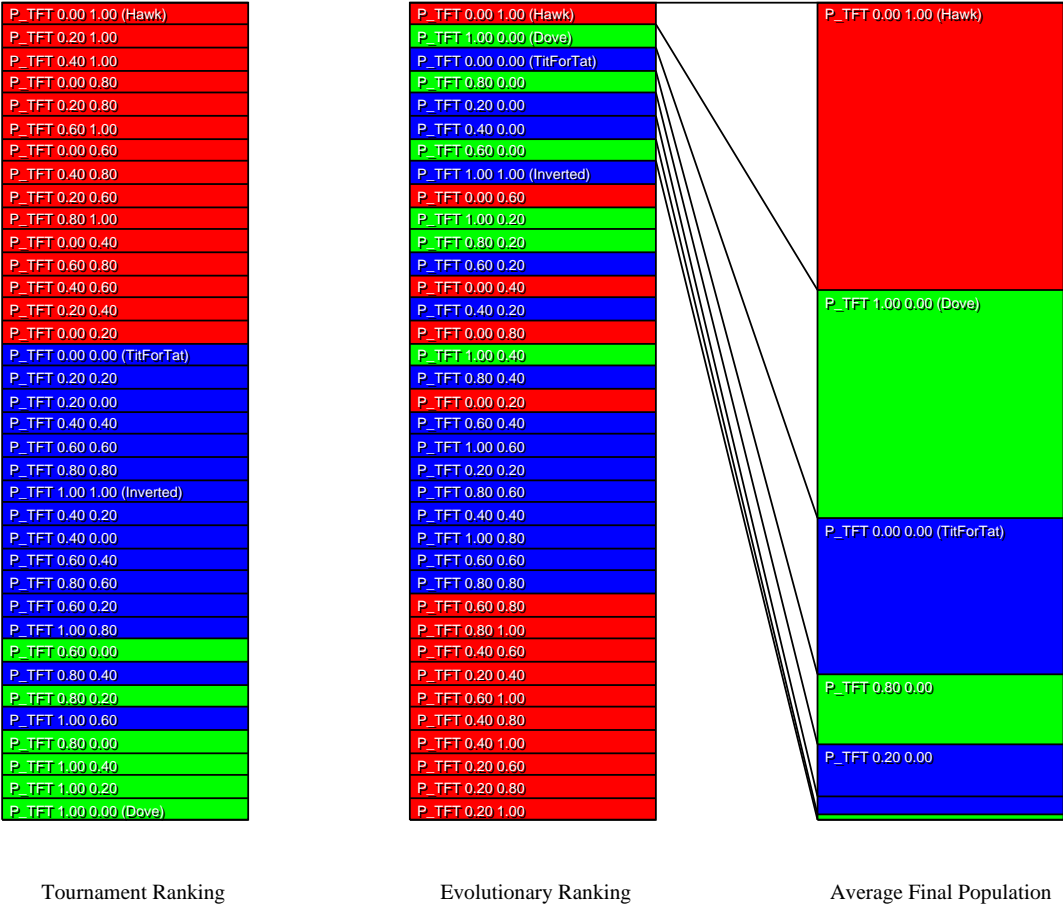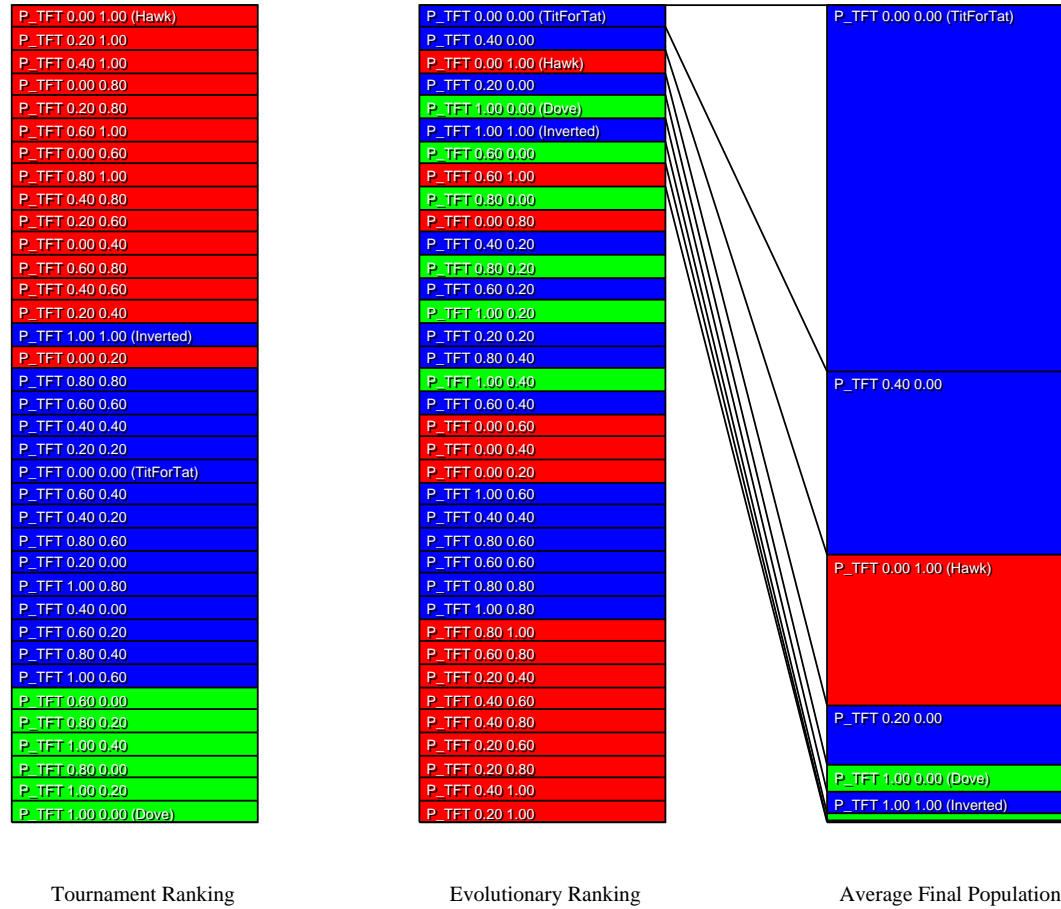

Figure 8.33: The aggregated results of the simulations of the "big series" with the payoff parameters T=5.5, R=3, P=1, S=0.

Results for strategy set: "Automata"

**Tournament Ranking**

- AM: HHHHH (HAWK)
- AM: DHHHH
- AM: DDHHH (GRIM)
- AM: DHDHH
- AM: HHHHD
- AM: HDHHD (PAVLOV)
- AM: DHHHD
- AM: DDHHD (TWEEDLEDUM)
- AM: HHHDH
- AM: HHDHD (INVERTED)
- AM: DHHDH
- AM: HDHDH (TAT FOR TIT)
- AM: HHHDD
- AM: DHHDD
- AM: DDHDH (TIT FOR TAT)
- AM: DHDHD
- AM: DDHDD (TWEEDLEDEE)
- AM: HDHDD (SIMPLETON)
- AM: HHDDH
- AM: HDDHD (TWEETYPIE)
- AM: DHDDH
- AM: HHDDD
- AM: DHDDD
- AM: HDDDH
- AM: HDDDD
- AM: DDDDD (DOVE)

Evolutionary Ranking

- AM: HHHHH (HAWK)
- AM: DDHHH (GRIM)
- AM: DDHDH (TIT FOR TAT)
- AM: DDDDD (DOVE)
- AM: HDHDH (TAT FOR TIT)
- AM: DDHHD (TWEEDLEDUM)
- AM: DDHDD (TWEEDLEDEE)
- AM: DHHHH
- AM: HHHDH
- AM: DHHDH
- AM: DHDHH
- AM: HDHHD (PAVLOV)
- AM: HDHDD (SIMPLETON)
- AM: HHHHD
- AM: DHHHD
- AM: DHHDD
- AM: HHHDD
- AM: HDDHD (TWEETYPIE)
- AM: HHDHD (INVERTED)
- AM: DHDHD
- AM: HDDDD
- AM: HHDDD
- AM: DHDDD
- AM: HDDDH
- AM: HHDDH
- AM: DHDDH

Average Final Population

- AM: HHHHH (HAWK)
- AM: DDHHH (GRIM)
- AM: DDHDH (TIT FOR TAT)
- AM: DDDDD (DOVE)
- AM: HDHDH (TAT FOR TIT)
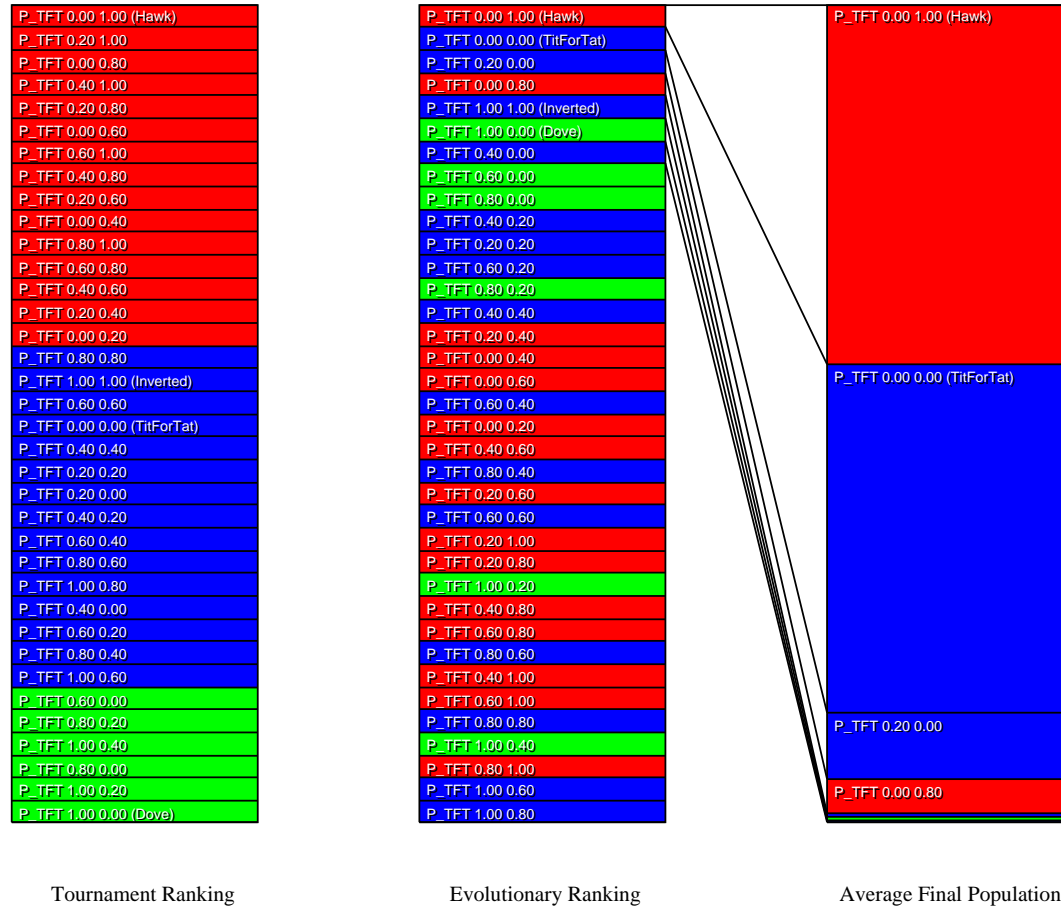
Figure 8.34: The aggregated results of the simulations of the "big series" with the payoff parameters T=5, R=3, P=2, S=0.

Results for strategy set: "TFTs"

Tournament Ranking	Evolutionary Ranking	Average Final Population

Figure 8.35: The aggregated results of the simulations of the "big series" with the payoff parameters T=3.5, R=3, P=1, S=0.
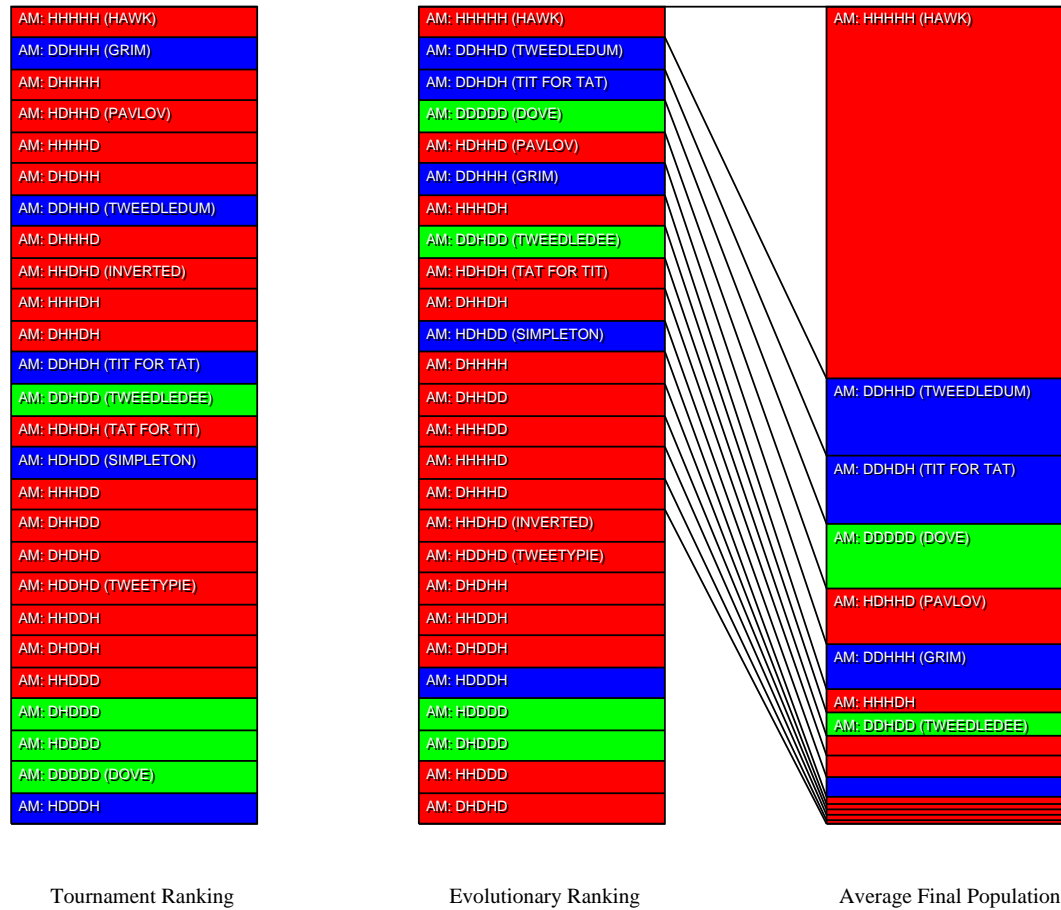
Results for strategy set: "TFTs"

Figure 8.36: The aggregated results of the simulations of the "big series" with the payoff parameters T=5, R=3, P=1, S=0.

Results for strategy set: "TFTs"
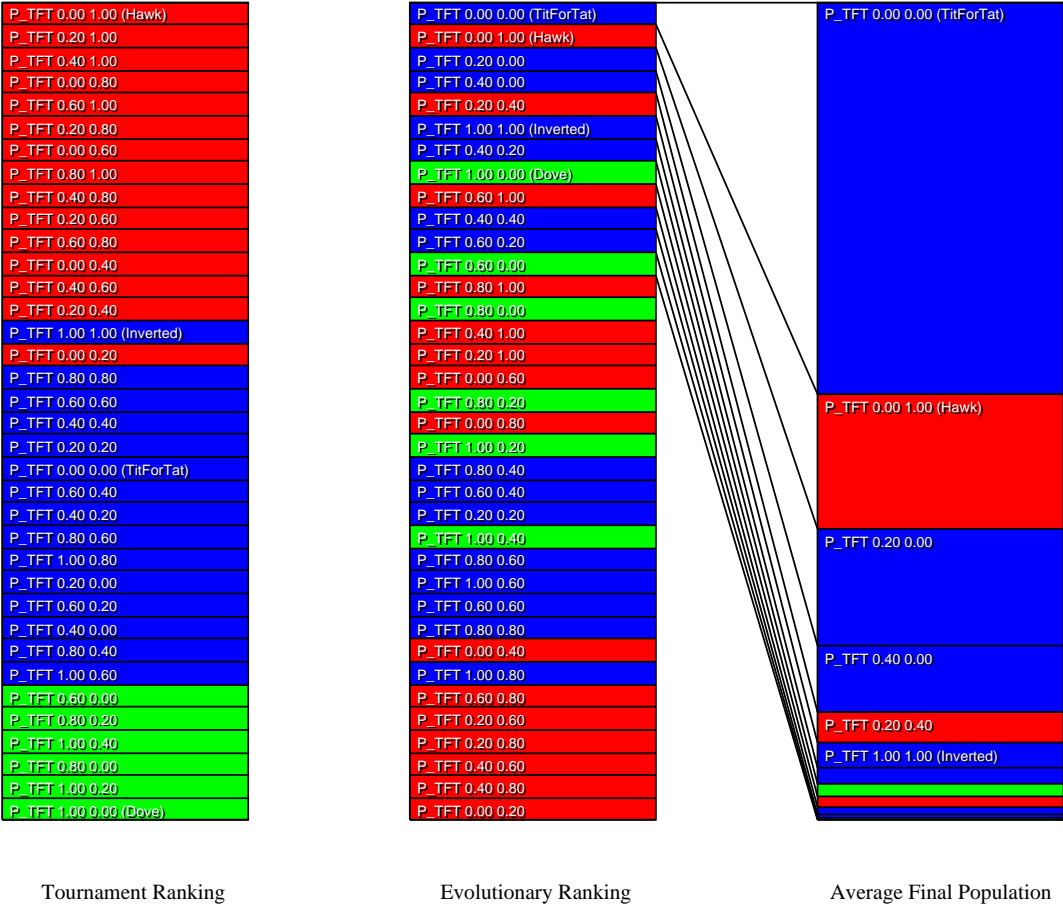
Figure 8.37: The aggregated results of the simulations of the "big series" with the payoff parameters T=5.5, R=3, P=1, S=0.

Results for strategy set: "TFTs"

Figure 8.38: The aggregated results of the simulations of the "big series" with the payoff parameters T=5, R=3, P=2, S=0.

Results for strategy set: "Automata"

Tournament Ranking	Evolutionary Ranking	Average Final Population

Figure 8.39: The aggregated results of all simulations of the "Monte Carlo series" using *Automata* strategies.

Results for strategy set: "TFTs"

| Tournament Ranking | Evolutionary Ranking | Average Final Population |
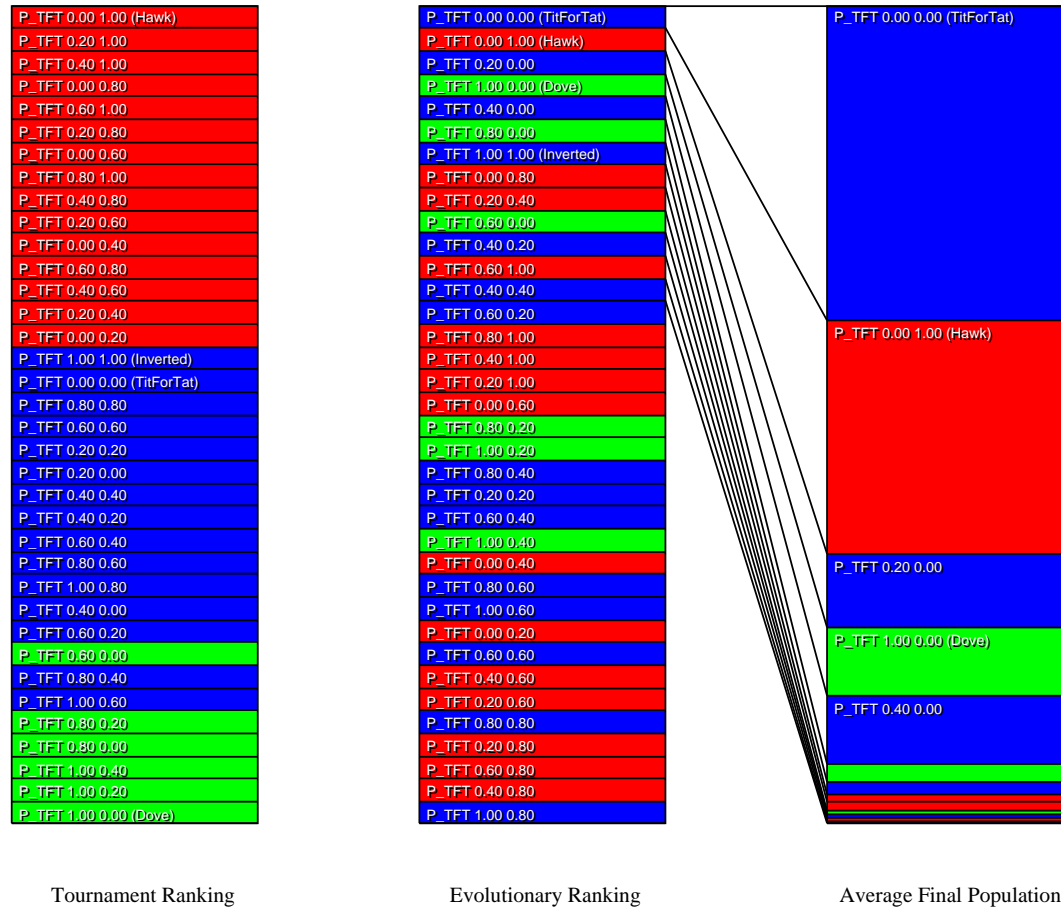
Figure 8.40: The aggregated results of all simulations of the "Monte Carlo series" using *Parameterized Tit for Tat* strategies.
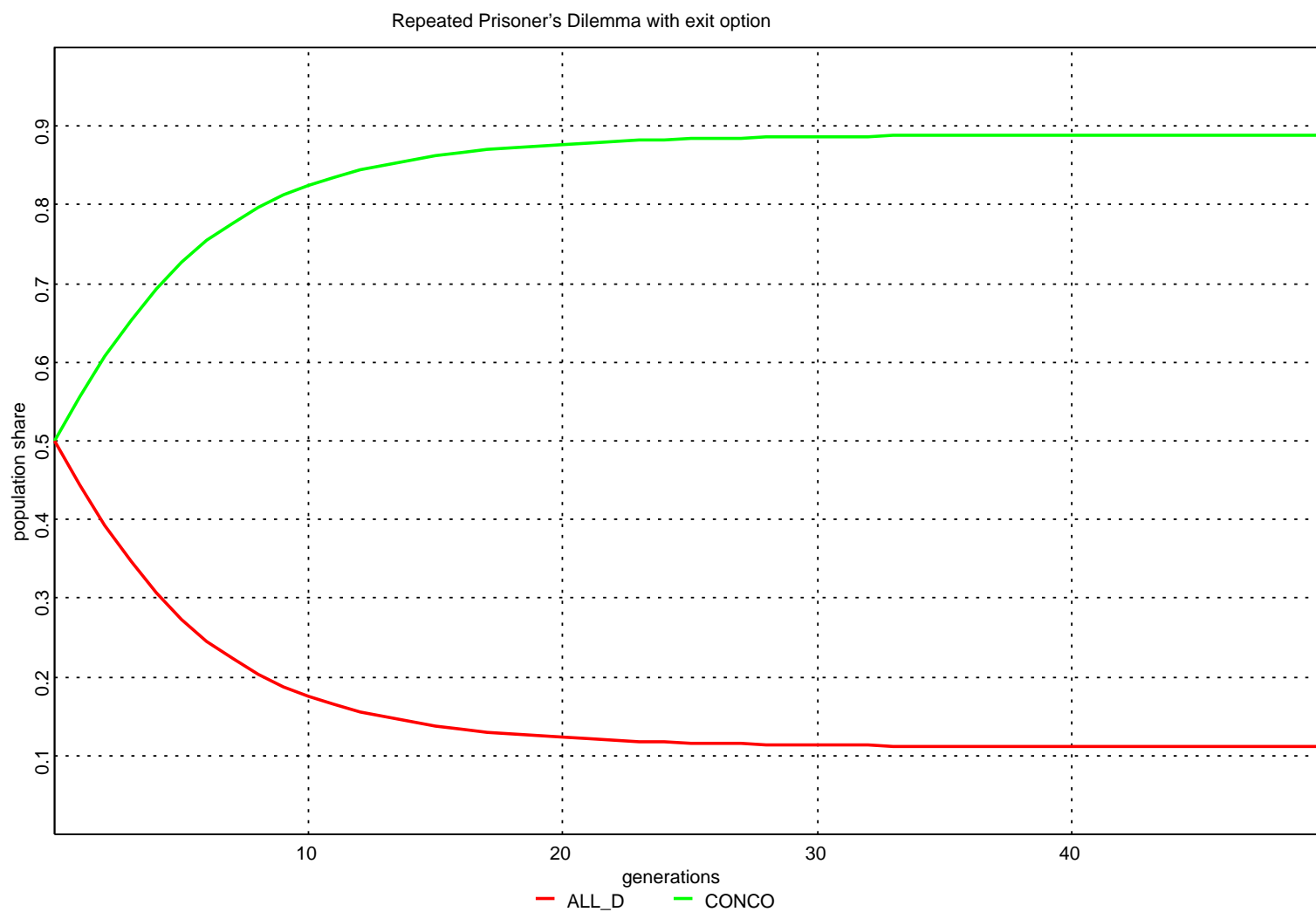
Figure 8.41: As this simulation following Schüßler (Schüßler, 1990) shows, cooperation may even evolve an "anonymous markets".
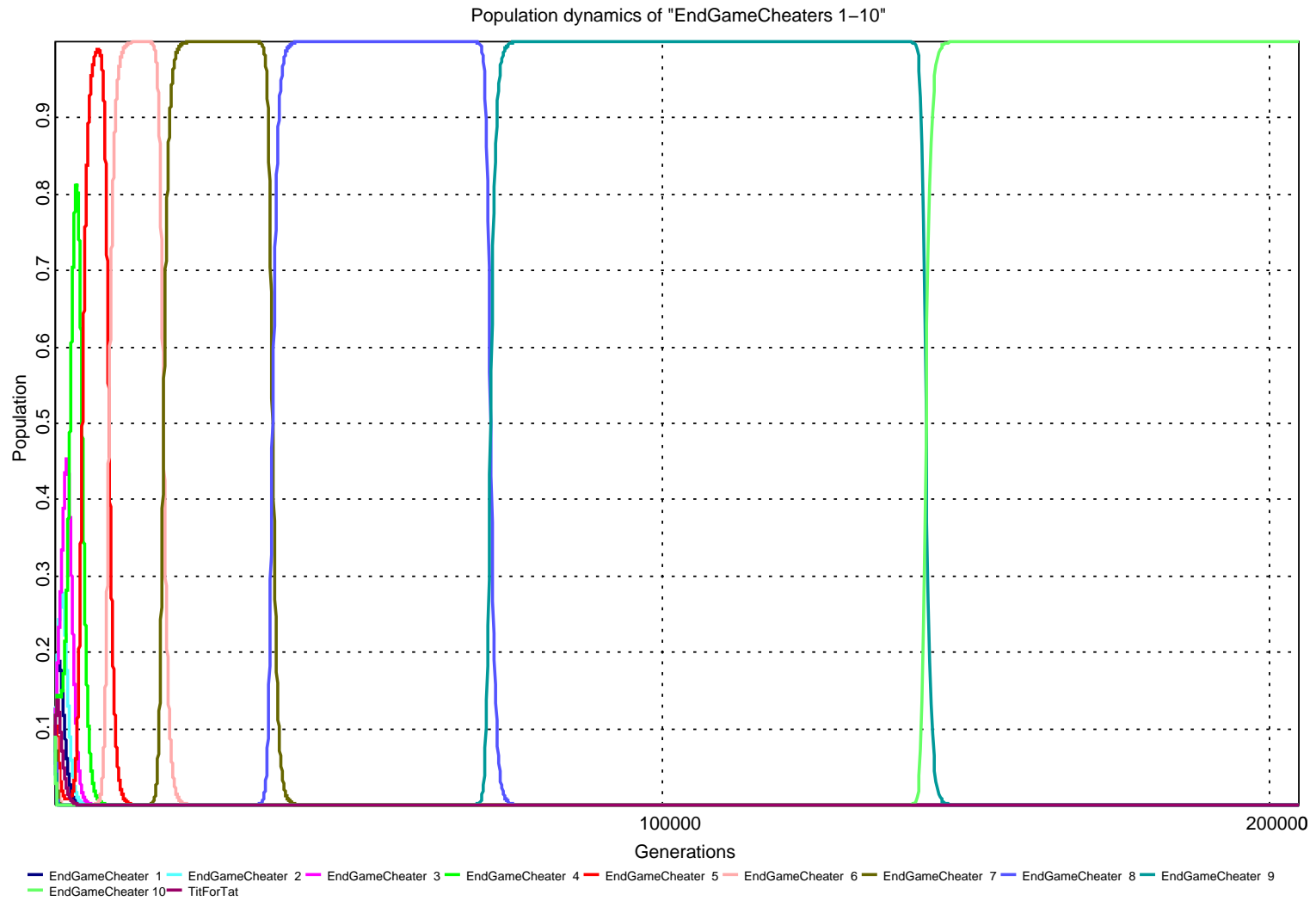
Figure 8.42: End game cheating as an evolutionary process: It takes more than 100,000 generations until it pays to cheat in the last ten rounds of a 200 round reiterated Prisoner's Dilemma.
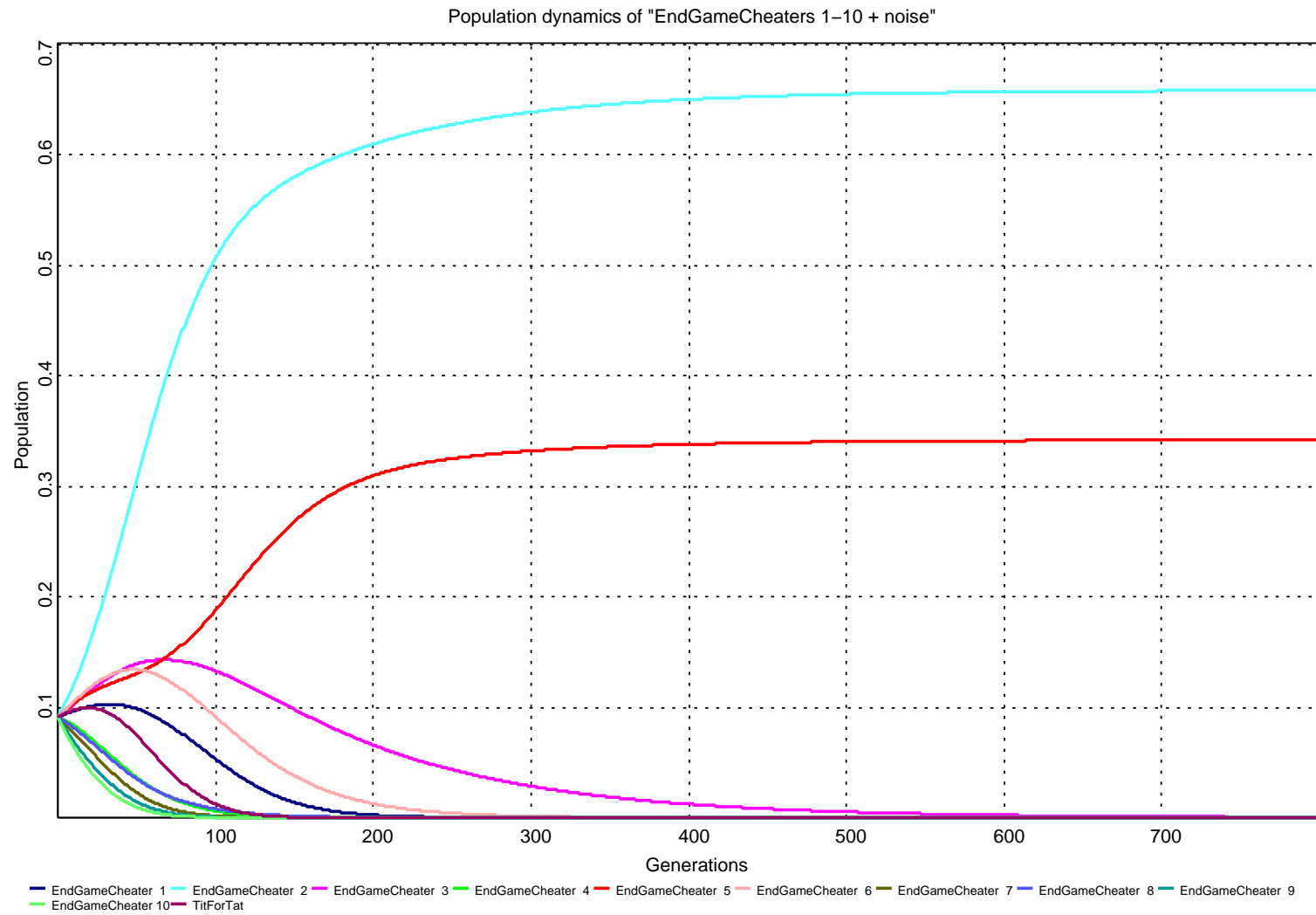
Figure 8.43: End game cheating is already stopped short when there is a slight amount of game noise (1%).