PRISONER'S DILEMMA

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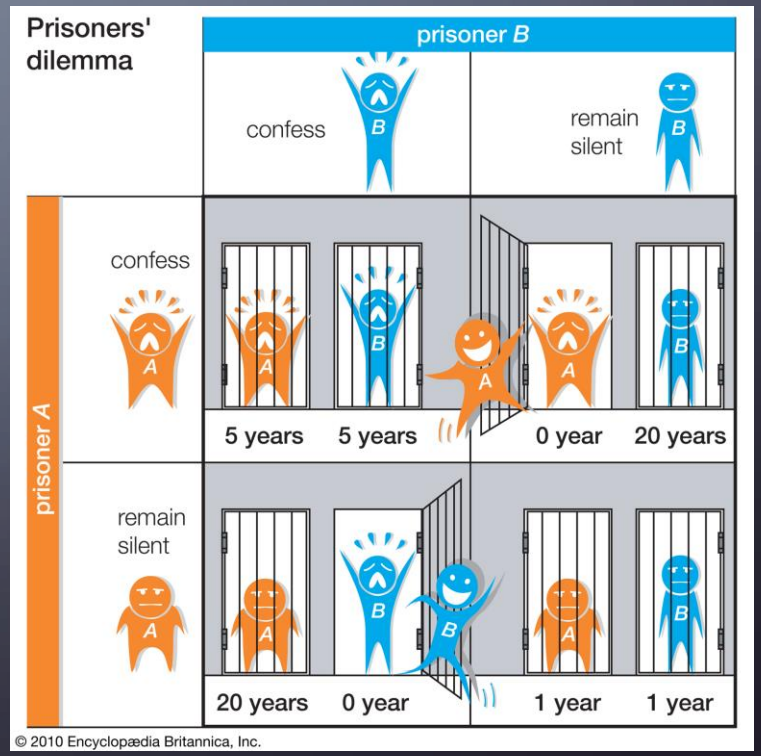
WHAT IS PRISONER'S DILEMMA?

Prisoner's dilemma is a problem of game theory. It is based on 2-person uncooperative game. In our case the problem is iterated prisoner's dilemma – playing the game multiple times.

RULES

The game must adhere to certain inequalities to be consiedered a dilemma. They are as follows: $T > R > P > S$ where:

- *T* –defnes the temptation to betray (payment for betrayal, when other cooperates),
- *R* – reward for mutual cooperation,
- *P* – punishment for mutual betrayal,
- *S* – reward for the betrayed.



PROBLEMATIC ASPECTS

The difficulty we have to face is choosing the optimal strategy based on the information one has. The greatest impact on our strategy have the oponent's moves, although we have to remember, that changing the values of rewards and punishments may turn the tables completely.

POSSIBLE APPROACHES

Check out every single possible strategy for the game

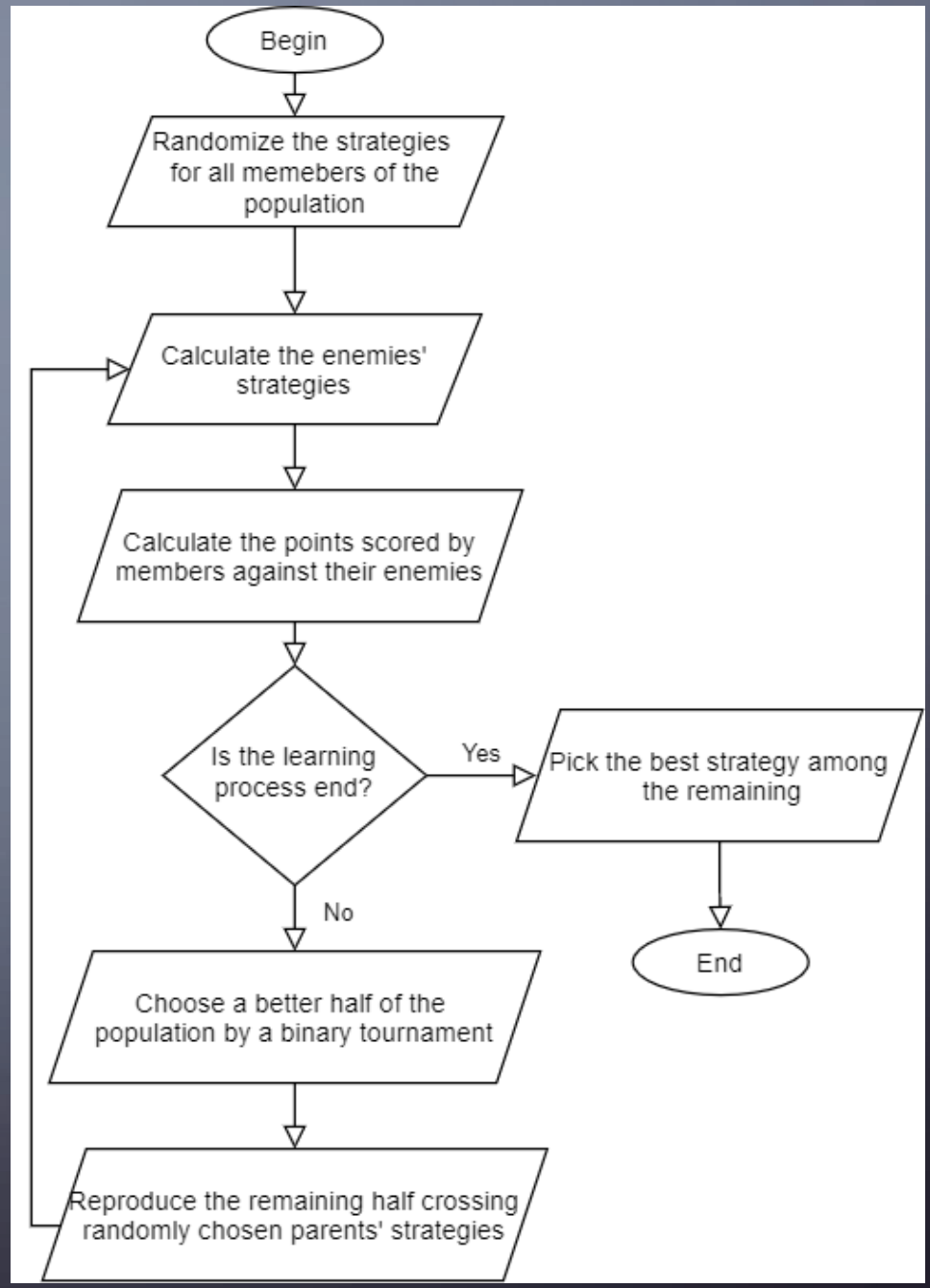
- Game consists of 10 turns – 1024 possible strategies
- Game consists of 30 turns – 1 073 741 824 possible strategies
- Game consists of 259 turns – 926 336 713 898 529 563 388 567 880 069 503 262 826 159 877 325 124 512 315 660 672 063 305 037 119 488 possible strategies (the amount of the atoms in the observable universe $\sim 10^{78}$)

POSSIBLE APPROACHES

NSGA – II (**N**on-dominated **S**orting **G**enetic **A**lgorithm **II**) – One of the most popular multi objective optimization algorithms with three special characteristics:

- Fast non-dominated sorting approach
- Fast crowded distance estimation procedure
- Simple crowded comparison operator

FLOWCHART

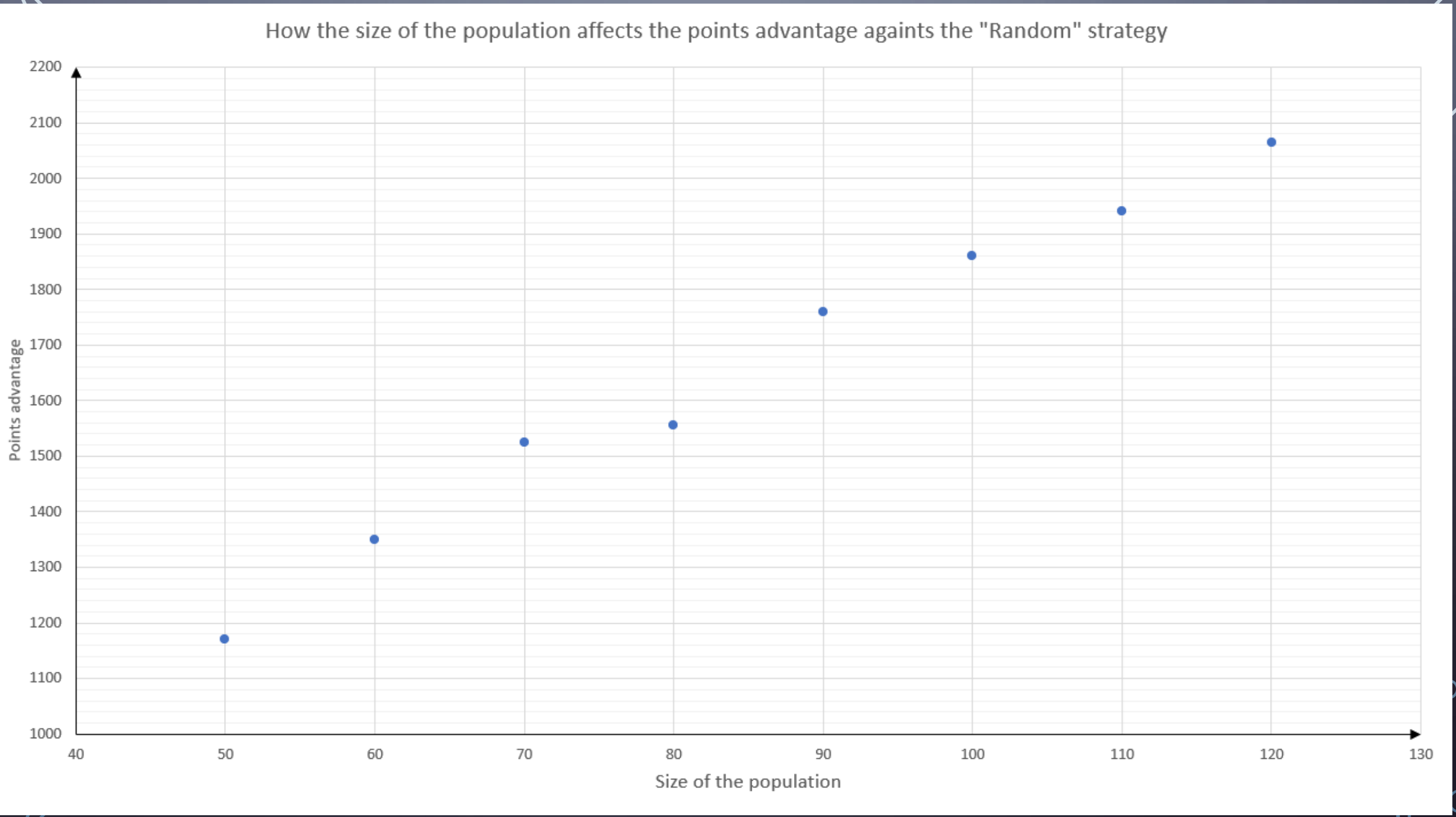

Begin
Randomize the strategies for all memebers of the population
Calculate the enemies' strategies
Calculate the points scored by members against their enemies
Is the learning process end?
Yes
Pick the best strategy among the remaining
End
No
Choose a better half of the population by a binary tournament
Reproduce the remaining half crossing randomly chosen parents' strategies

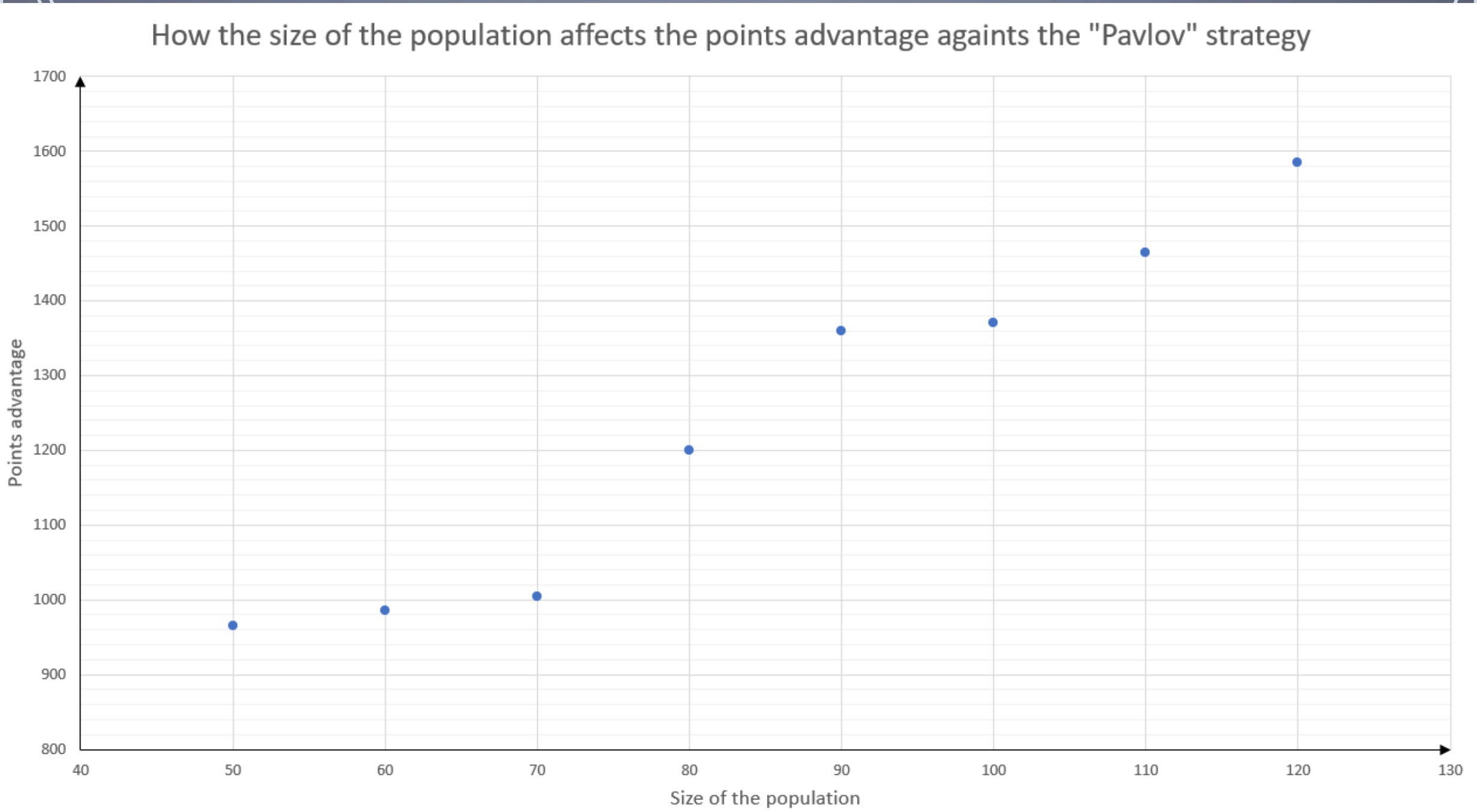
THE EFFICIENCY OF THE FOUND STRATEGY DEPENDS ON THE FOLLOWING PARAMETERS:

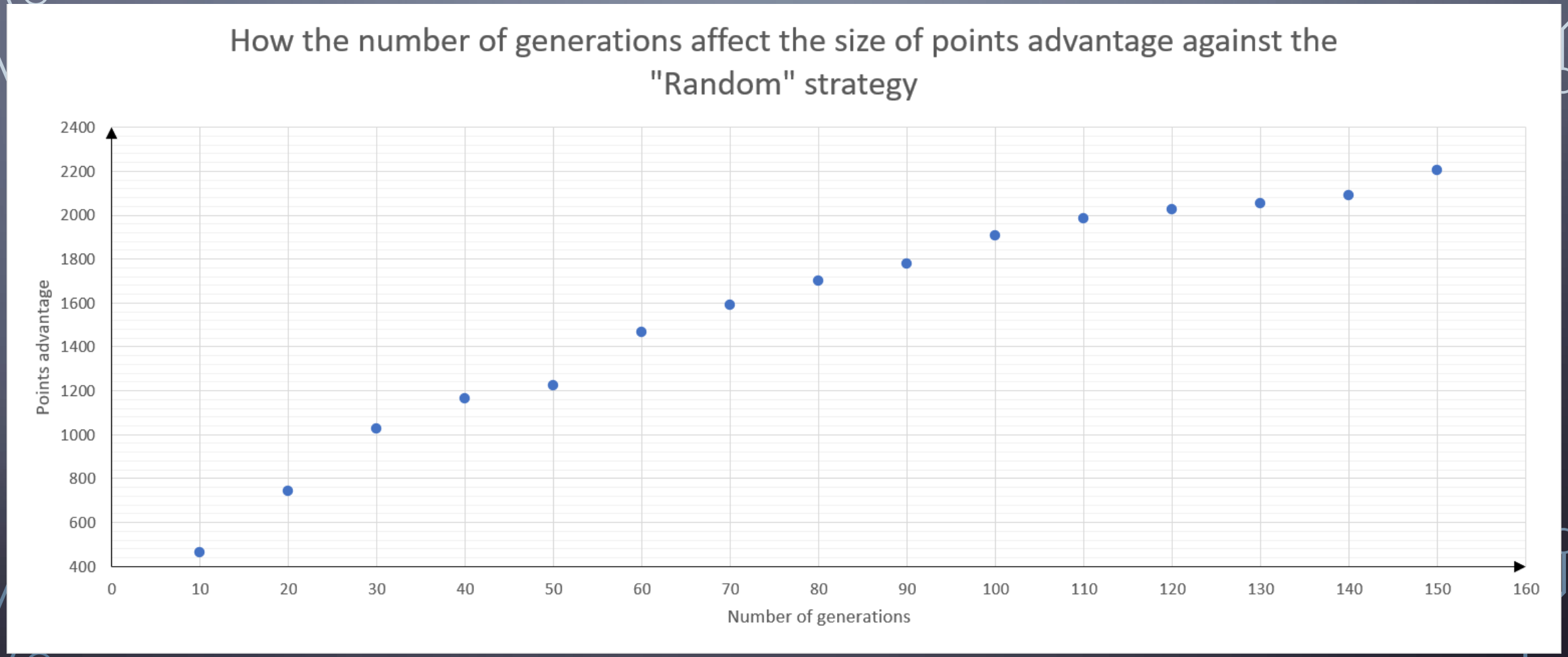
- Size of the population
- Number of turns in one game
- Number of generations (how long can the algorithm work)
- Enemy's strategy

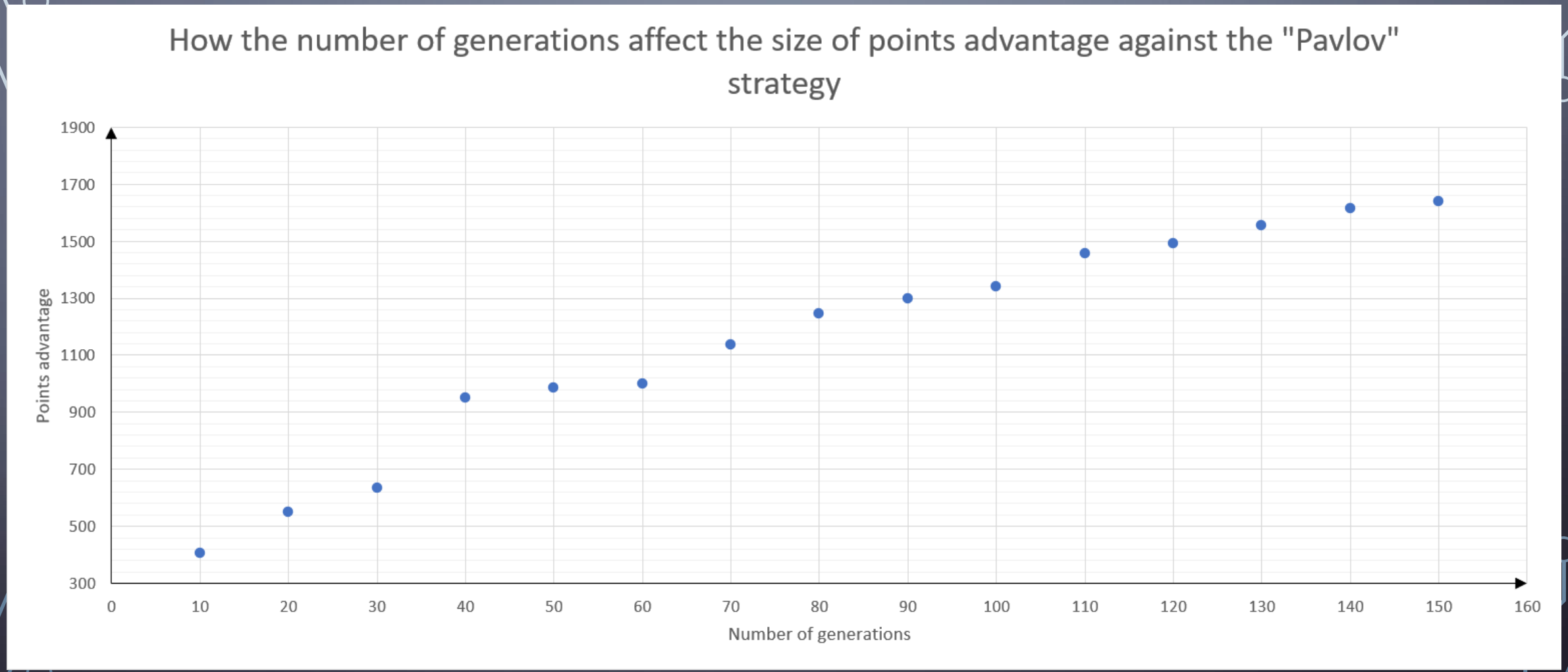
IMPLEMENTED ENEMY'S STRATEGIES

- Random – Enemy's strategy is chosen randomly for each turn
- Always Cooperate – The enemy always cooperates
- Always Defect – The enemy always defects
- Tit for Tat – The enemy cooperates in the first turn and then repeats what the player did in the previous turn
- Suspicious Tit for Tat – The enemy defects in the first turn and then repeats what the player did in the previous turn
- Imperfect Tit for Tat – The enemy cooperates in the first turn and then there is a given propability that they repeat what the player did in the previous turn
- Pavlov – The enemy cooperates in the first turn and then
  - Cooperates if both players did the same move in the previous turn
  - Defects if players did something different in the previous turn


How the size of the population affects the points advantage againts the "Random" strategy
Points advantage
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
40
50
60
70
80
90
100
110
120
130
Size of the population


How the size of the population affects the points advantage againts the "Pavlov" strategy
Points advantage
1700
1600
1500
1400
1300
1200
1100
1000
900
800
40
50
60
70
80
90
100
110
120
130
Size of the population


How the number of generations affect the size of points advantage against the "Random" strategy
Points advantage
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Number of generations


How the number of generations affect the size of points advantage against the "Pavlov" strategy
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Number of generations

THANK YOU FOR ATTENTION