POSITIONING IN SOCCER WITH AI

An automated approach to find heuristic-based solutions for defensive positioning of soccer players.

MPE – ProDEI – Tiago Mendes-Neves – up201406104@fe.up.pt

Motivation

Preparation of a soccer game has a very extensive checklist.

- Defensive positioning in certain game situations is one item.

Can AI (Optimization algorithms) help in this regard?

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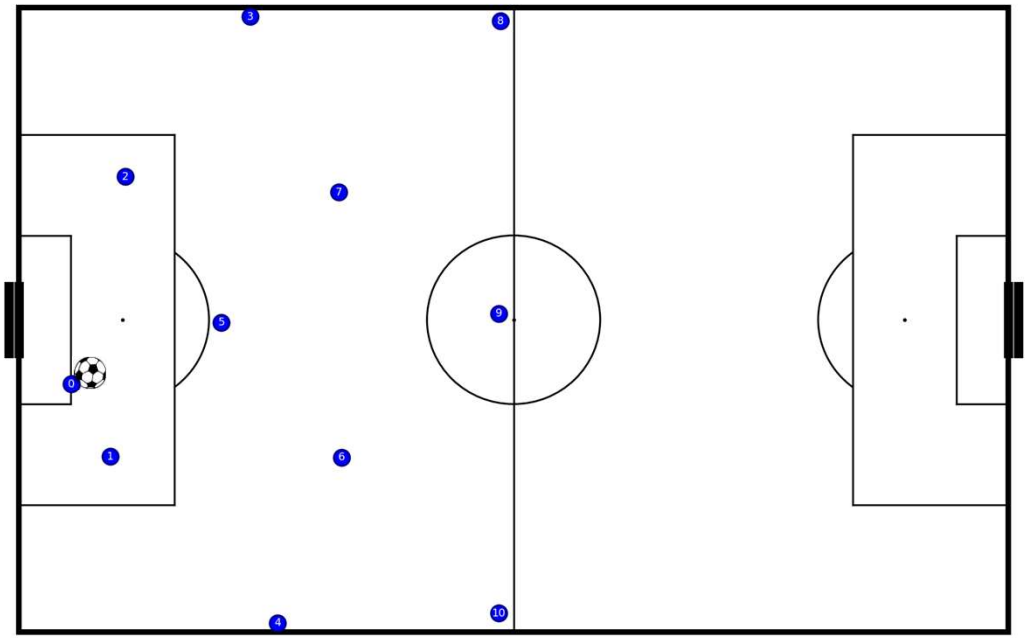
Problem definition



- 11 opposition players
  - Dependent on the use case
  - E.g., Goal kick
  - 10 (x,y) tupples

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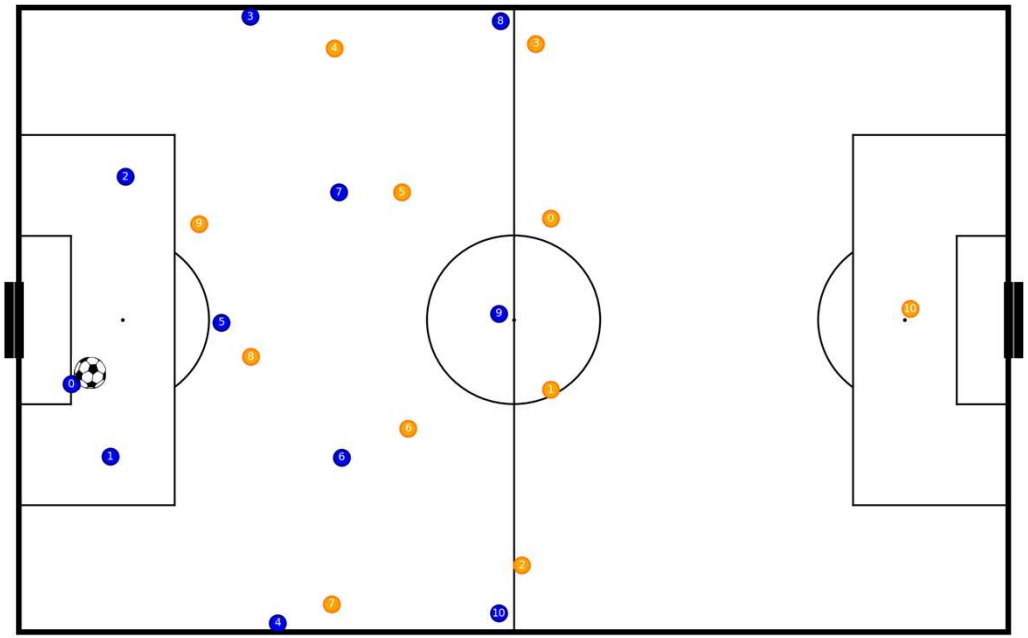

Problem definition

- 11 opposition players
  - Dependent on the use case
  - E.g., Goal kick
  - 10 (x,y) tupples
- We want to position 10 defensive players
  - 10 (x,y) tupples

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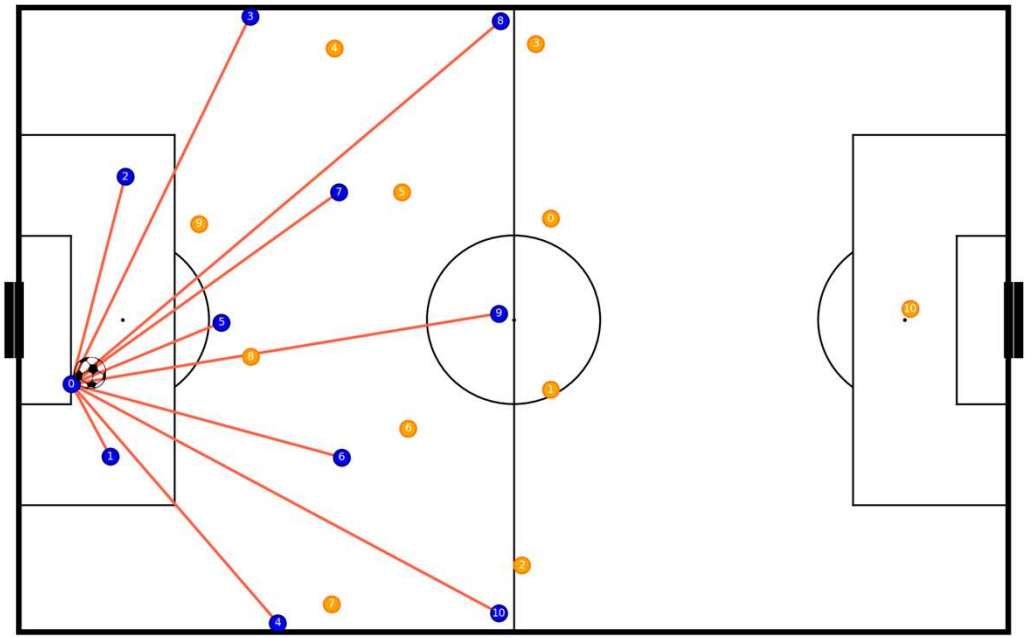

Criteria 1

- Maximize coverage of pass lines

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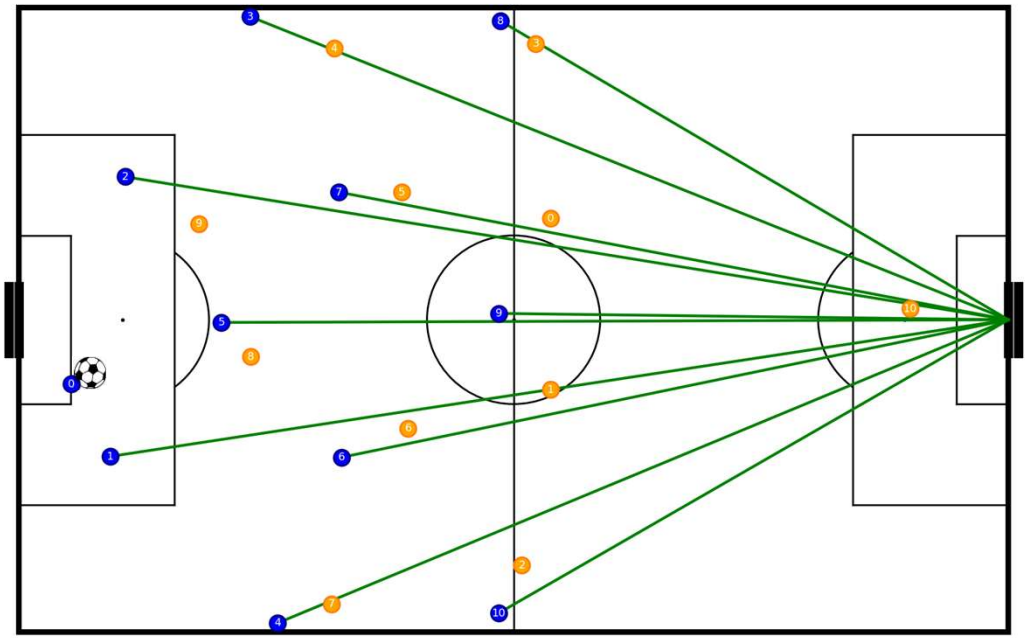

Criteria 2

- Maximize coverage of pass lines
- Maximize coverage of the goal line

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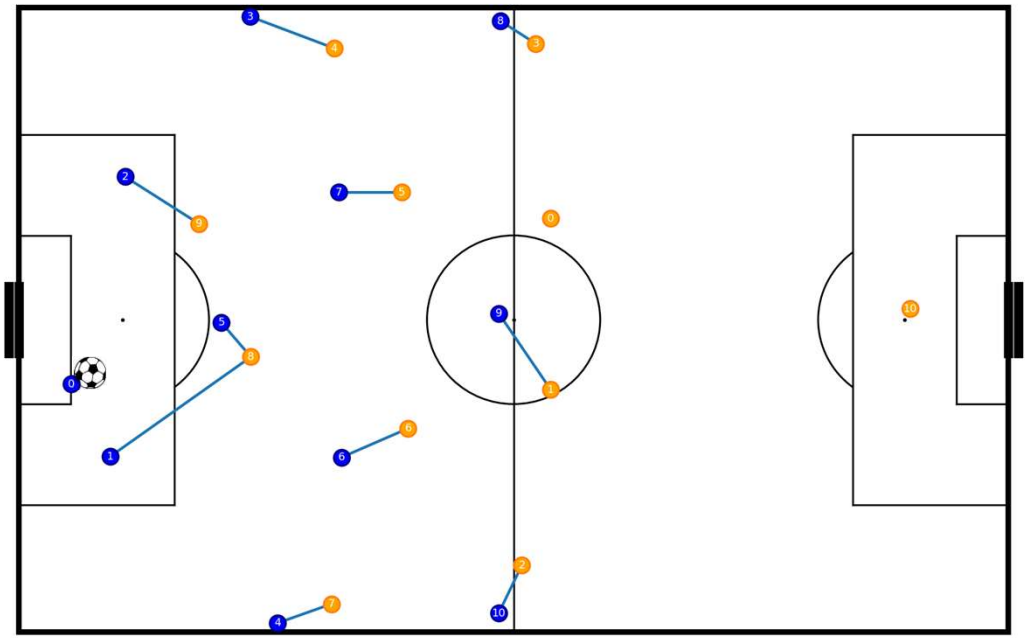

Criteria 3

- Maximize coverage of pass lines
- Maximize coverage of the goal line
- Minimize the distance to opponent players

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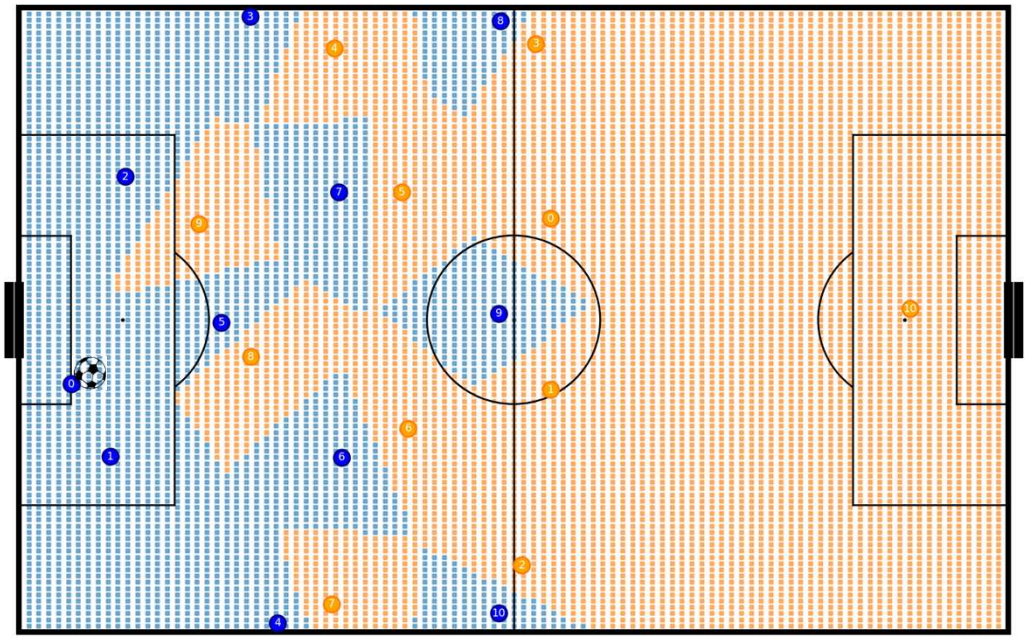

Criteria 4

- Maximize coverage of pass lines
- Maximize coverage of the goal line
- Minimize the distance to opponent players
- Maximize pitch control area

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From cafepress.com/+soccer-referee+wall-art

Criteria 5

- Maximize coverage of pass lines
- Maximize coverage of the goal line
- Minimize the distance to opponent players
- Maximize pitch control area
- Follow the rules

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Heuristic

- Each criterion Cx will have a quantified value (we will normalize them between [0, 1]).
- The user will define a weight Wx for each criterion [0,1].
- $H(x) = \sum^{x} Wx * Cx$

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Algorithms

Optuna (TPE/CMA-ES)

Hill Climbing, Simulated annealing

Genetic algorithms

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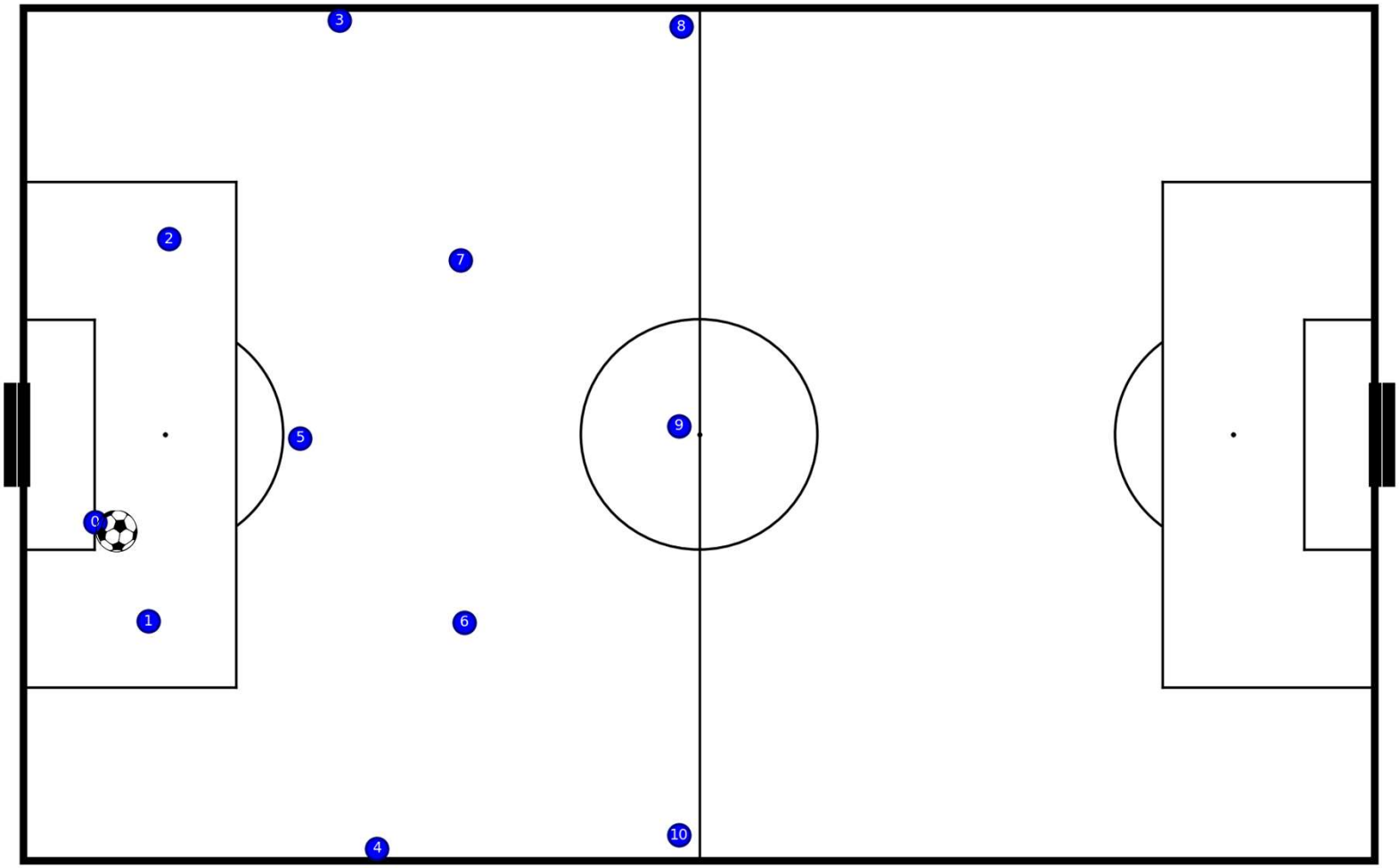

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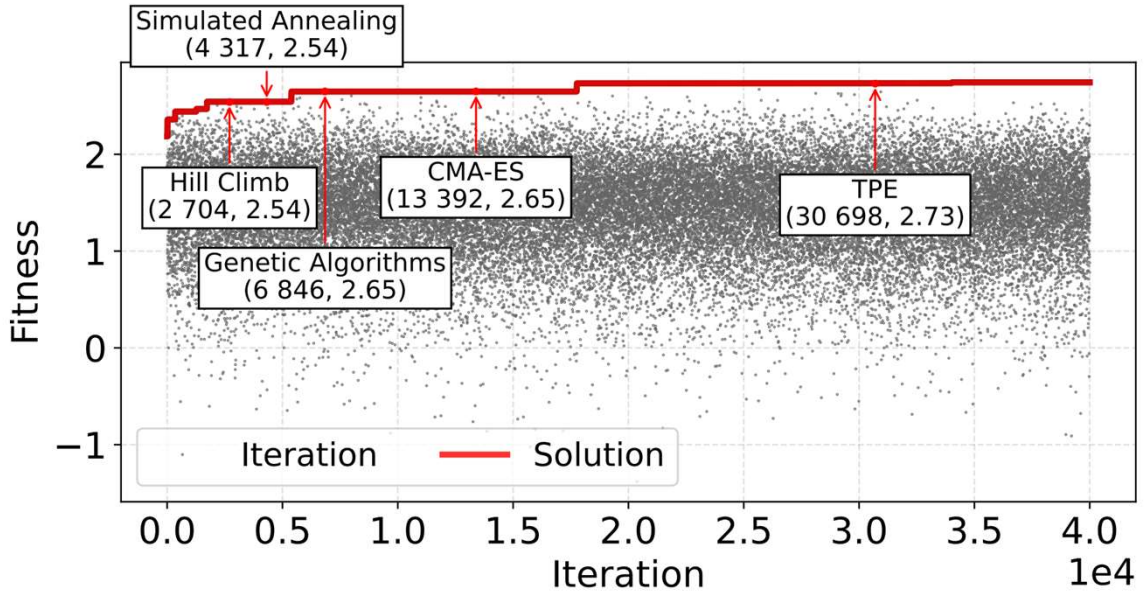
RANDOM SEARCH



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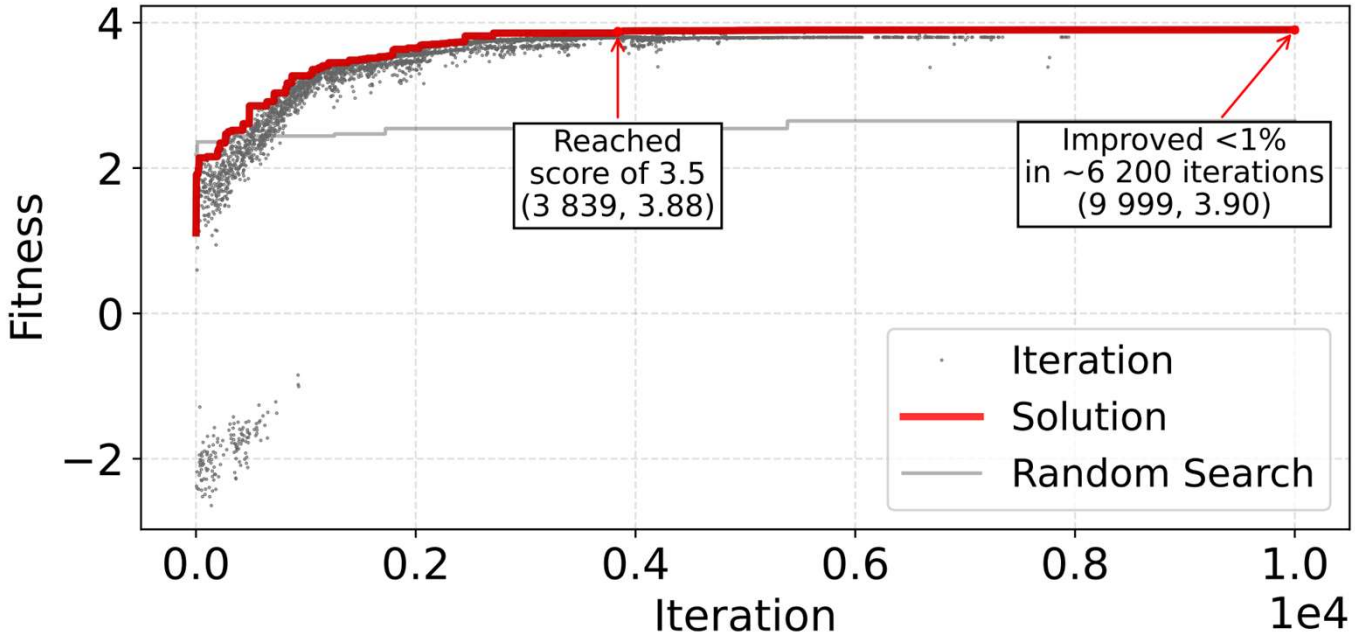
CMA-ES



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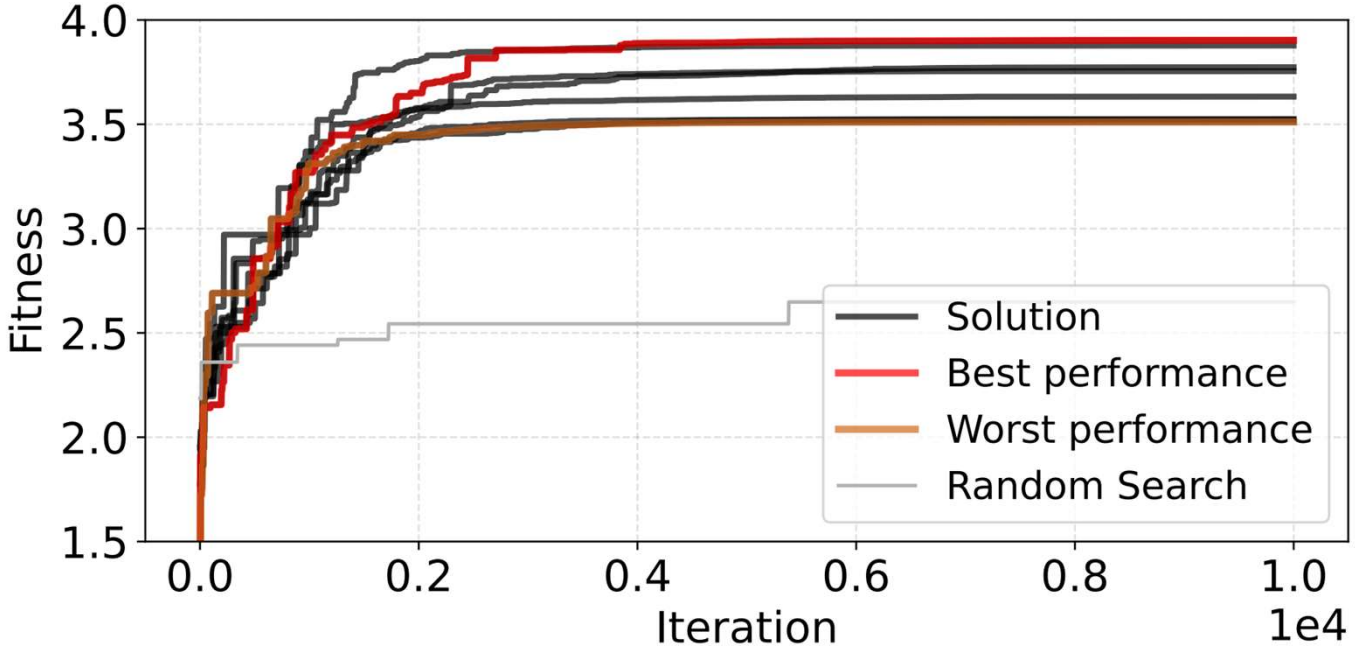

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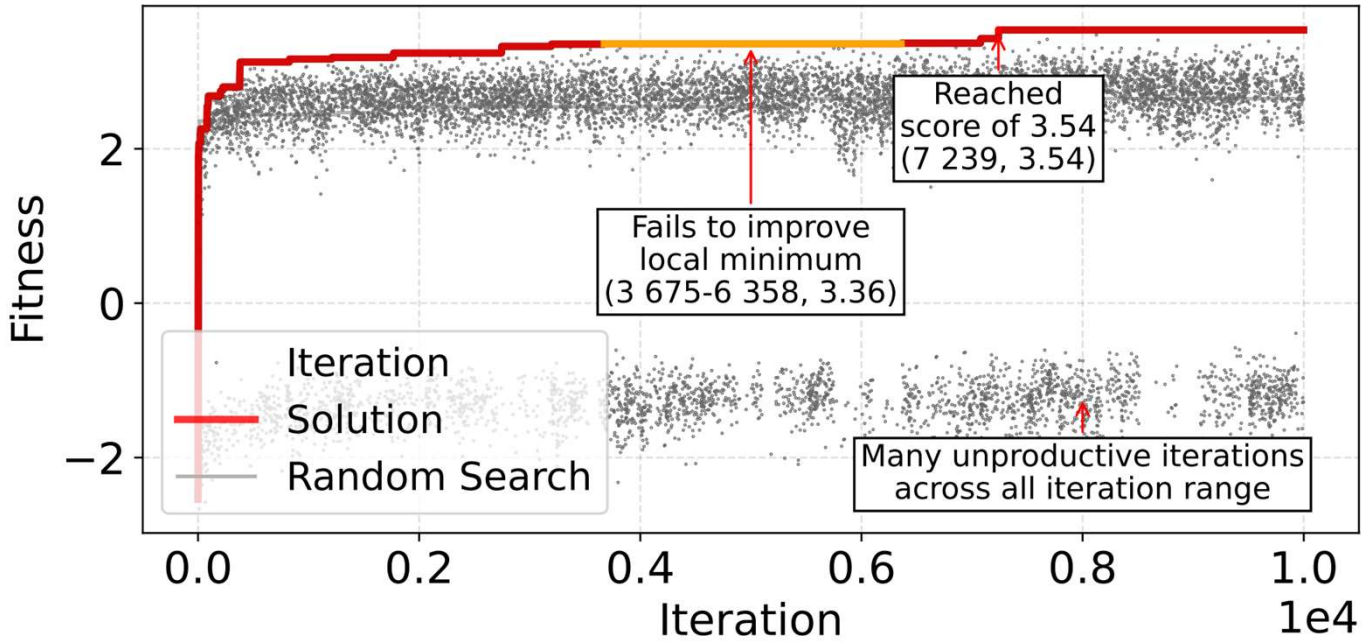
TPE



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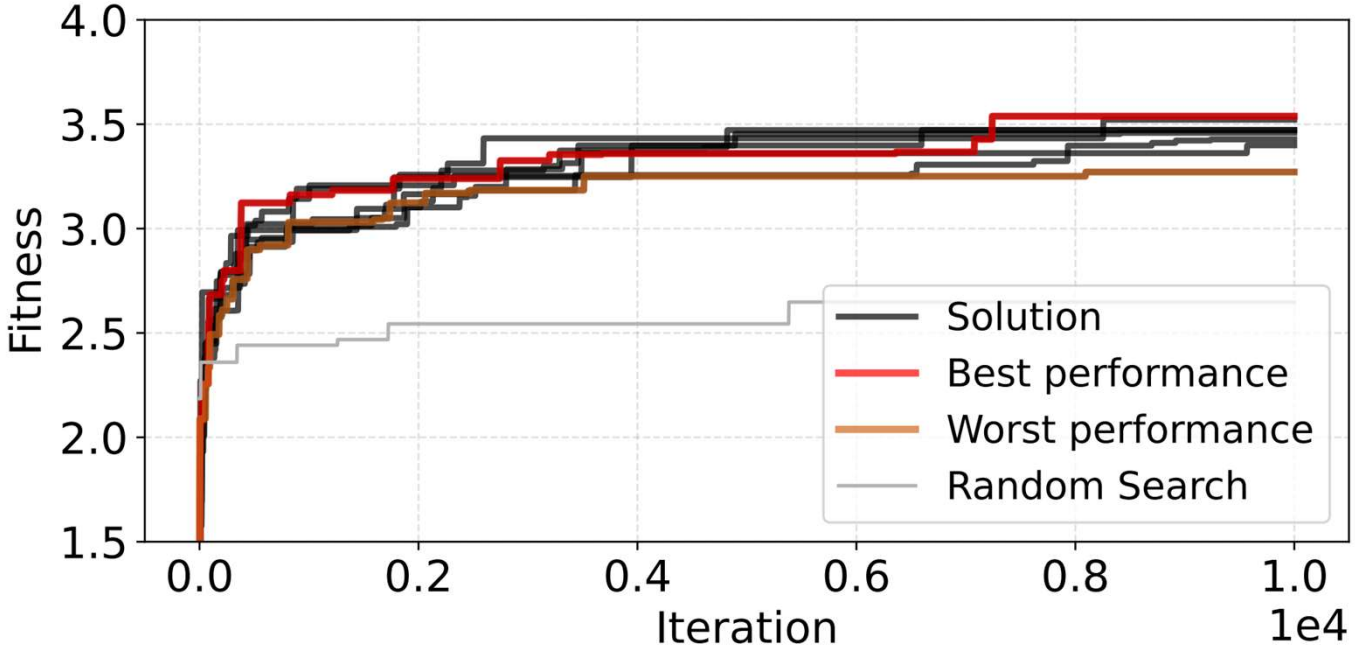
TPE



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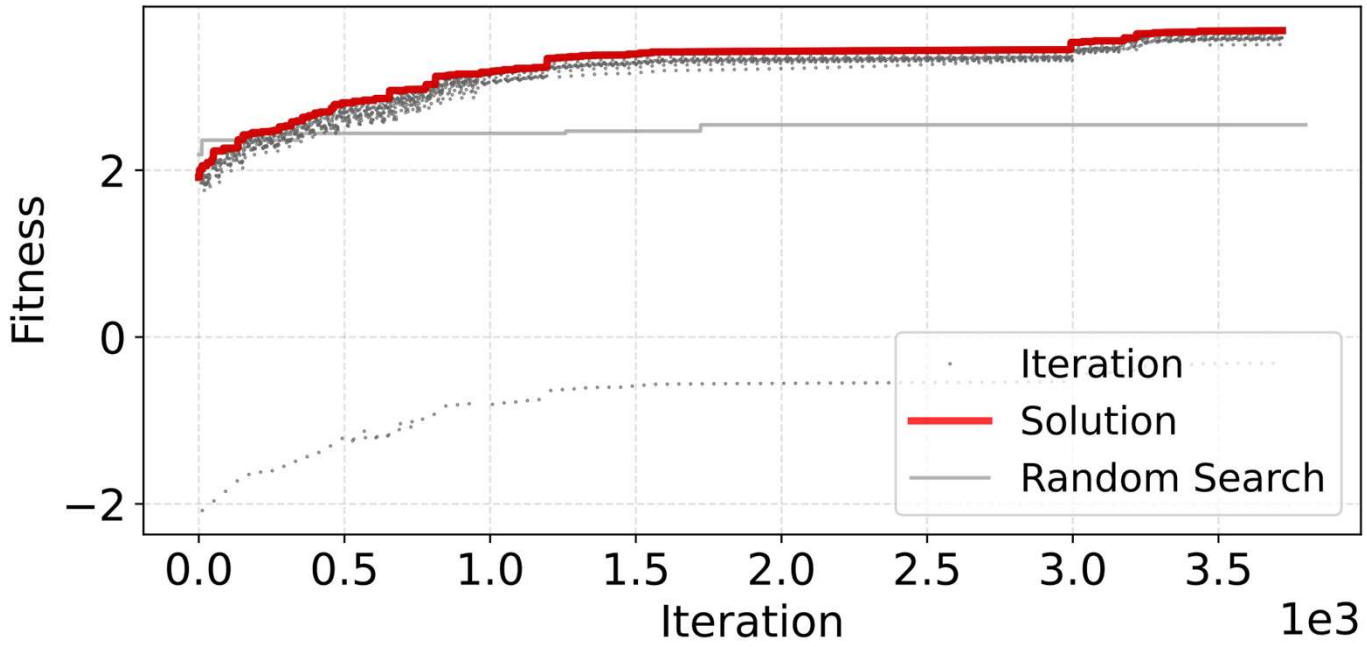
HILL CLIMBING



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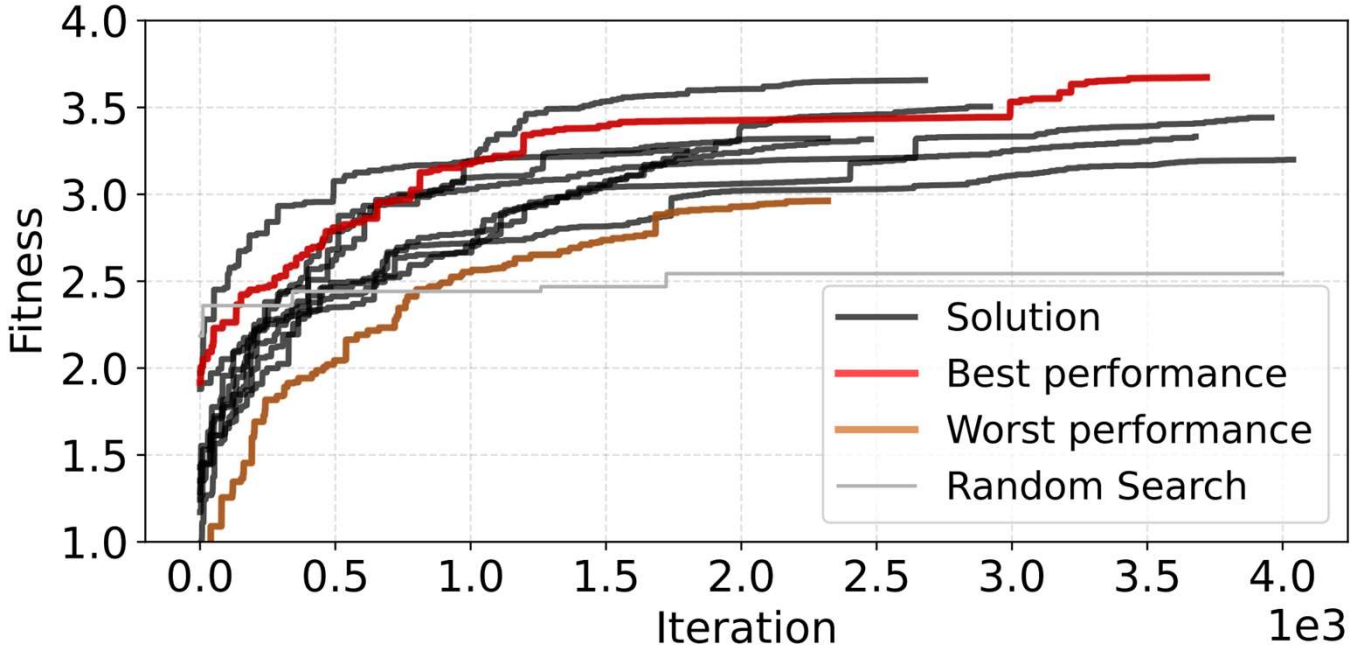

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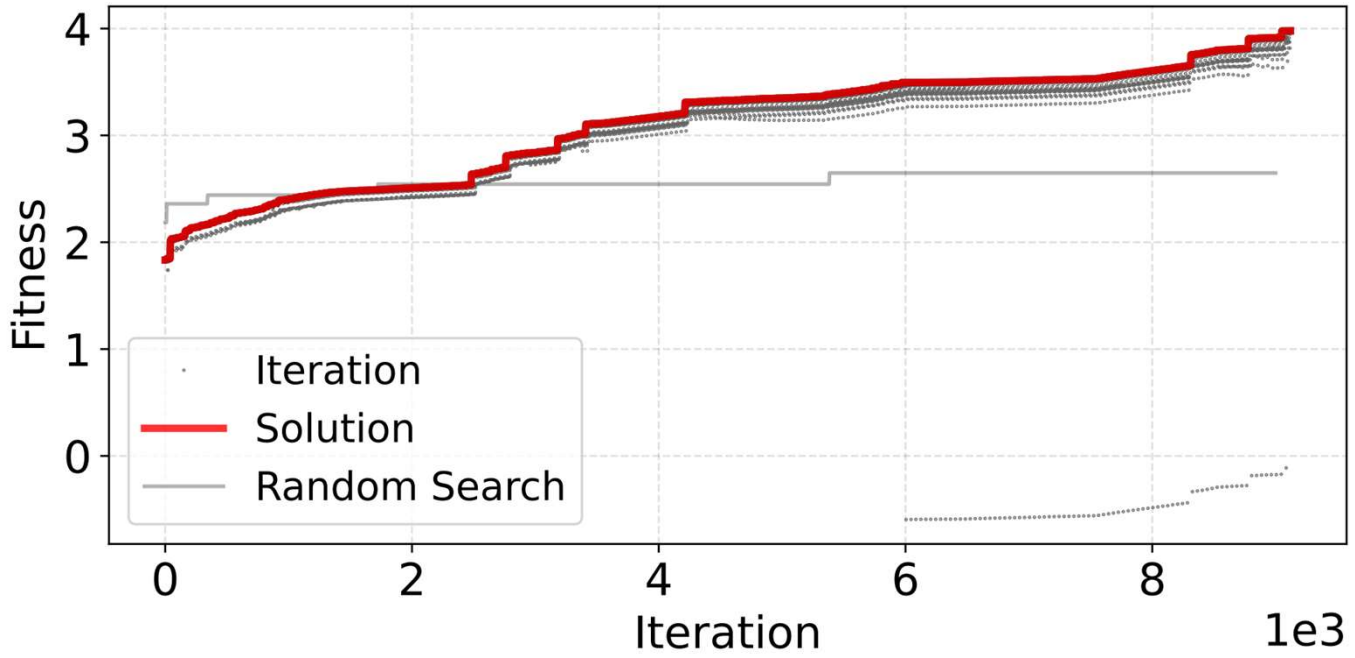
SIMULATED ANNEALING



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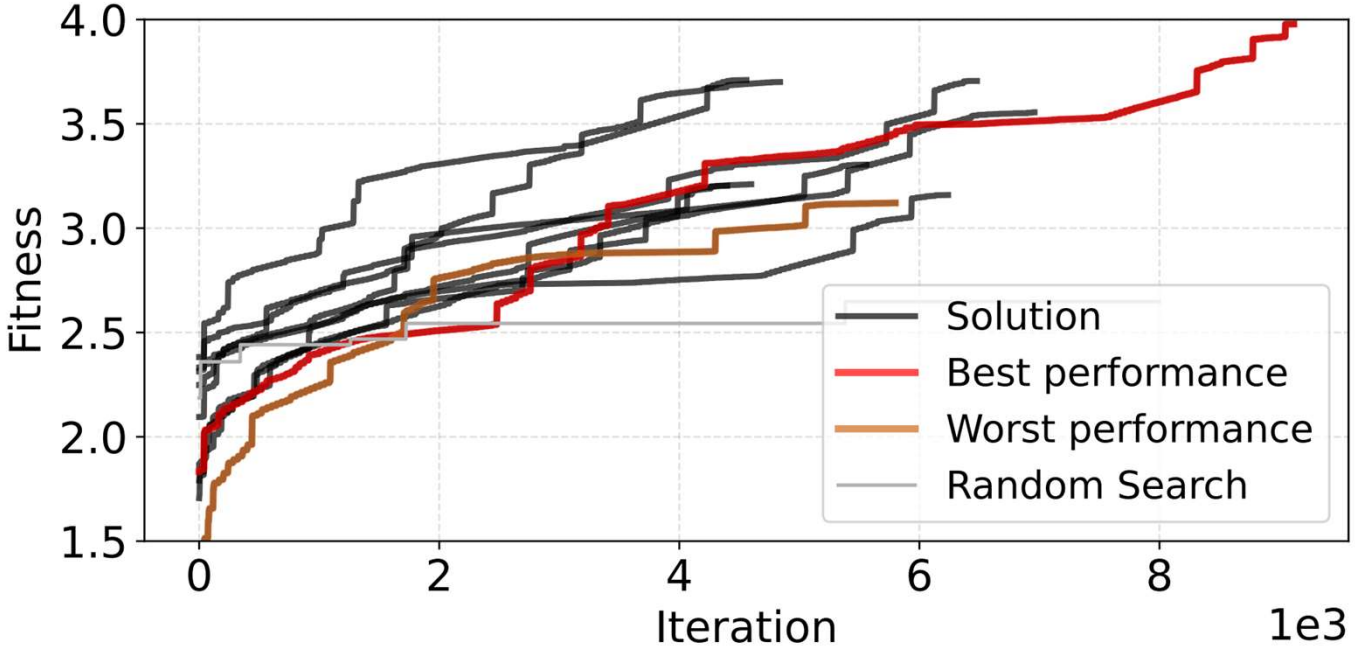

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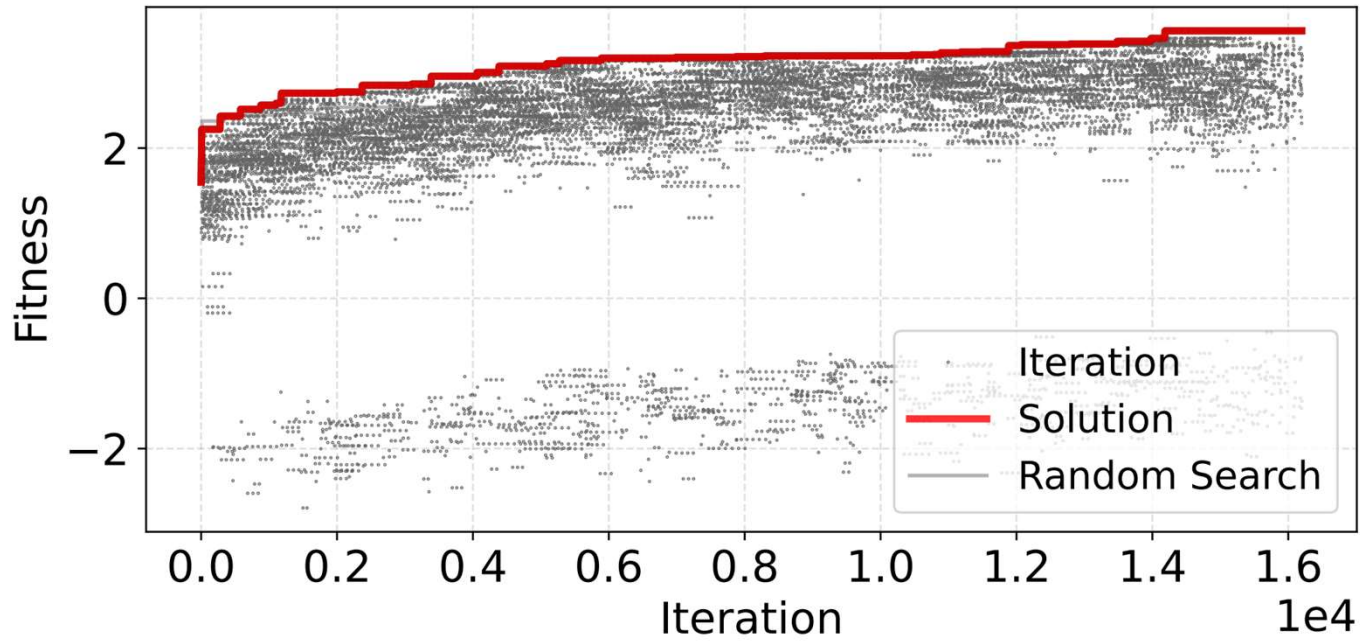
GENETIC ALGORITHM



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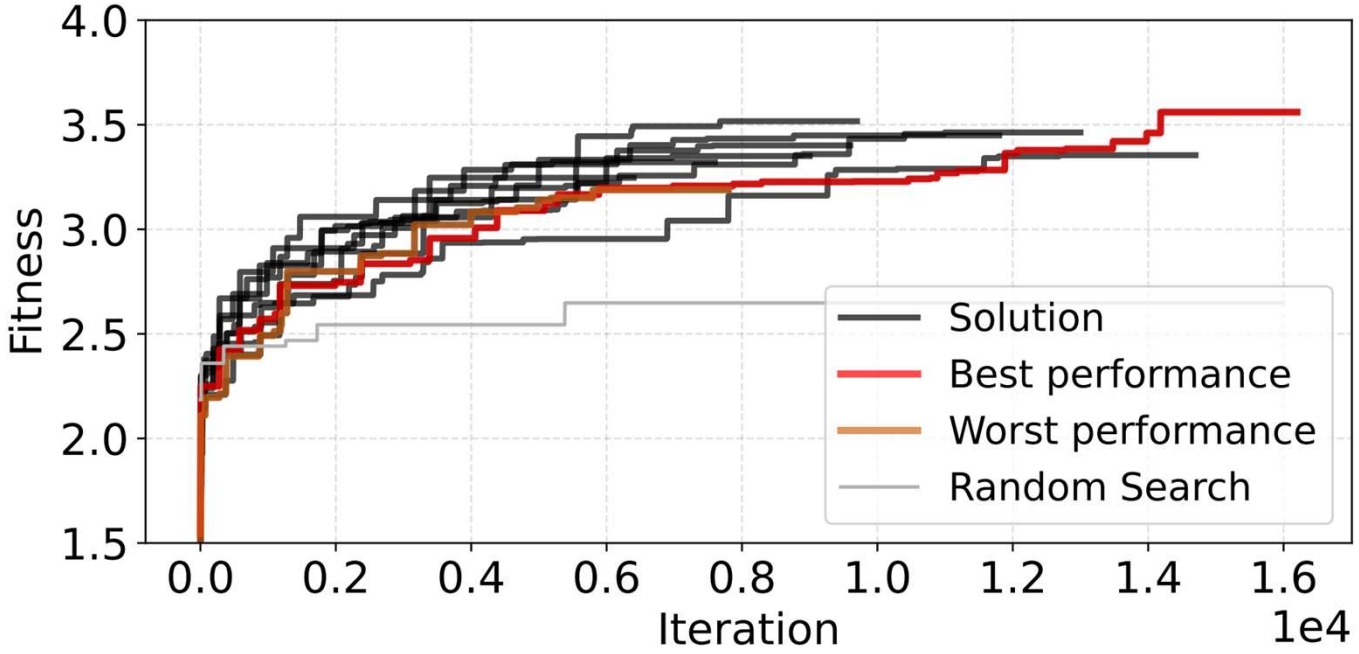

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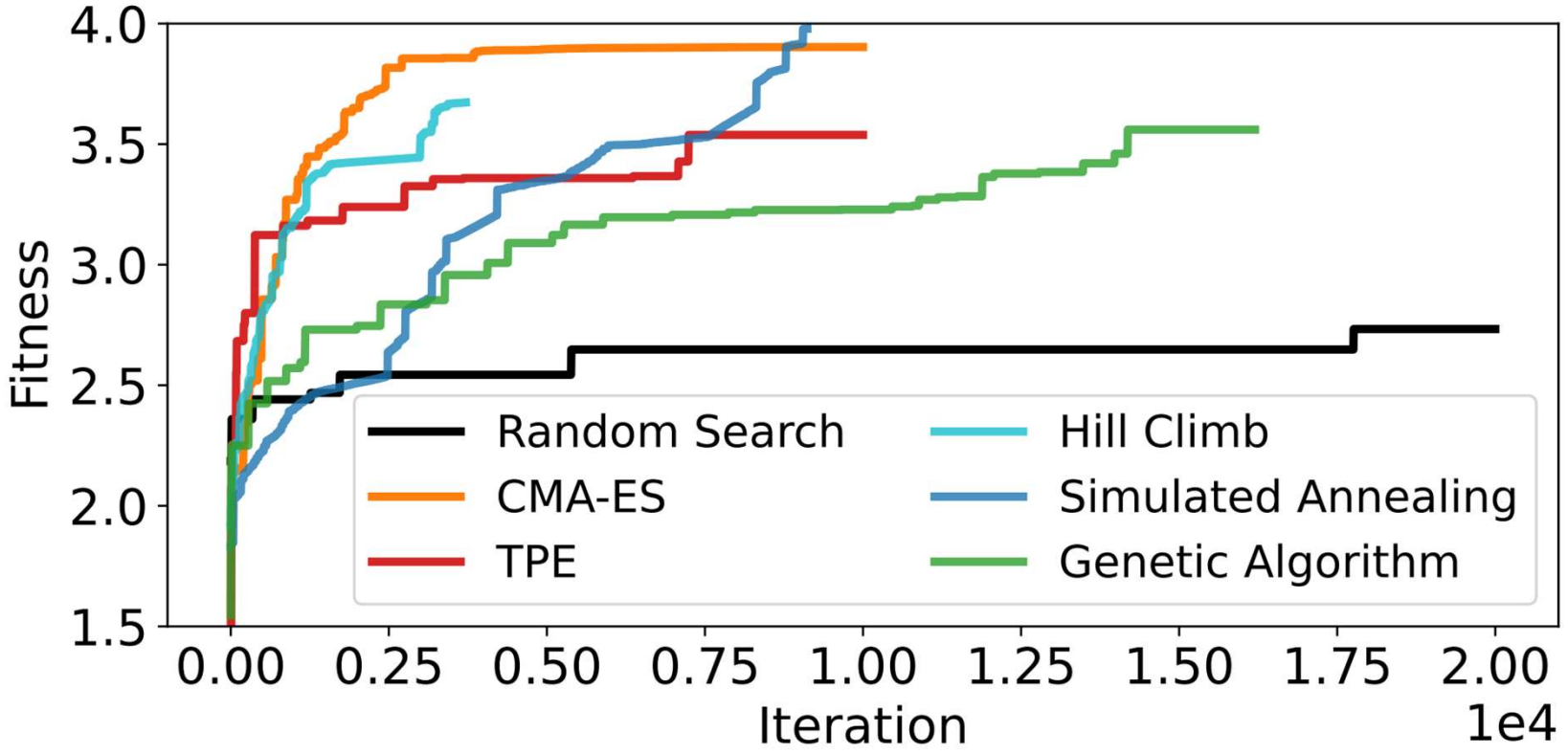
COMPARING ALL ALGORITHMS



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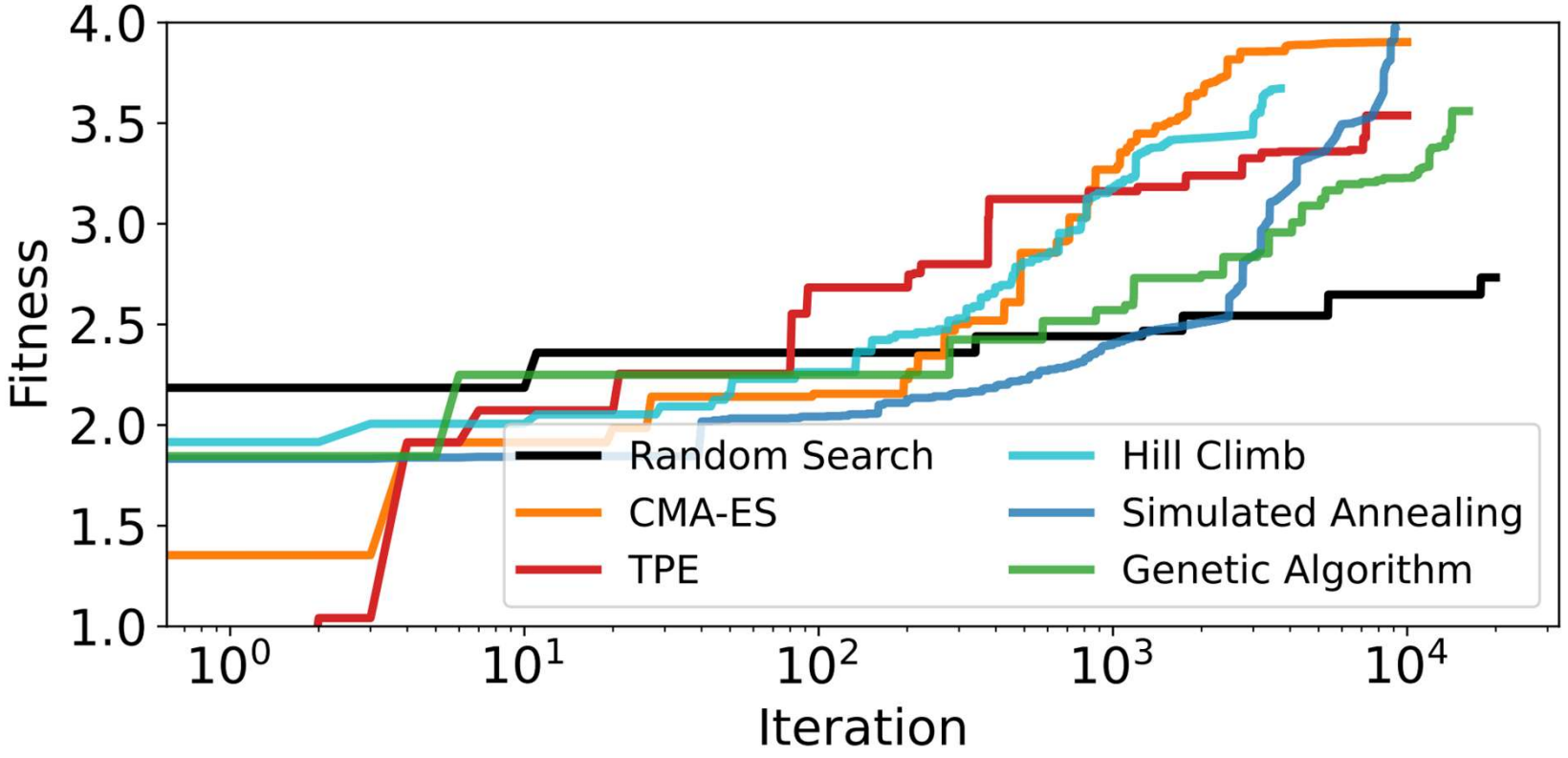

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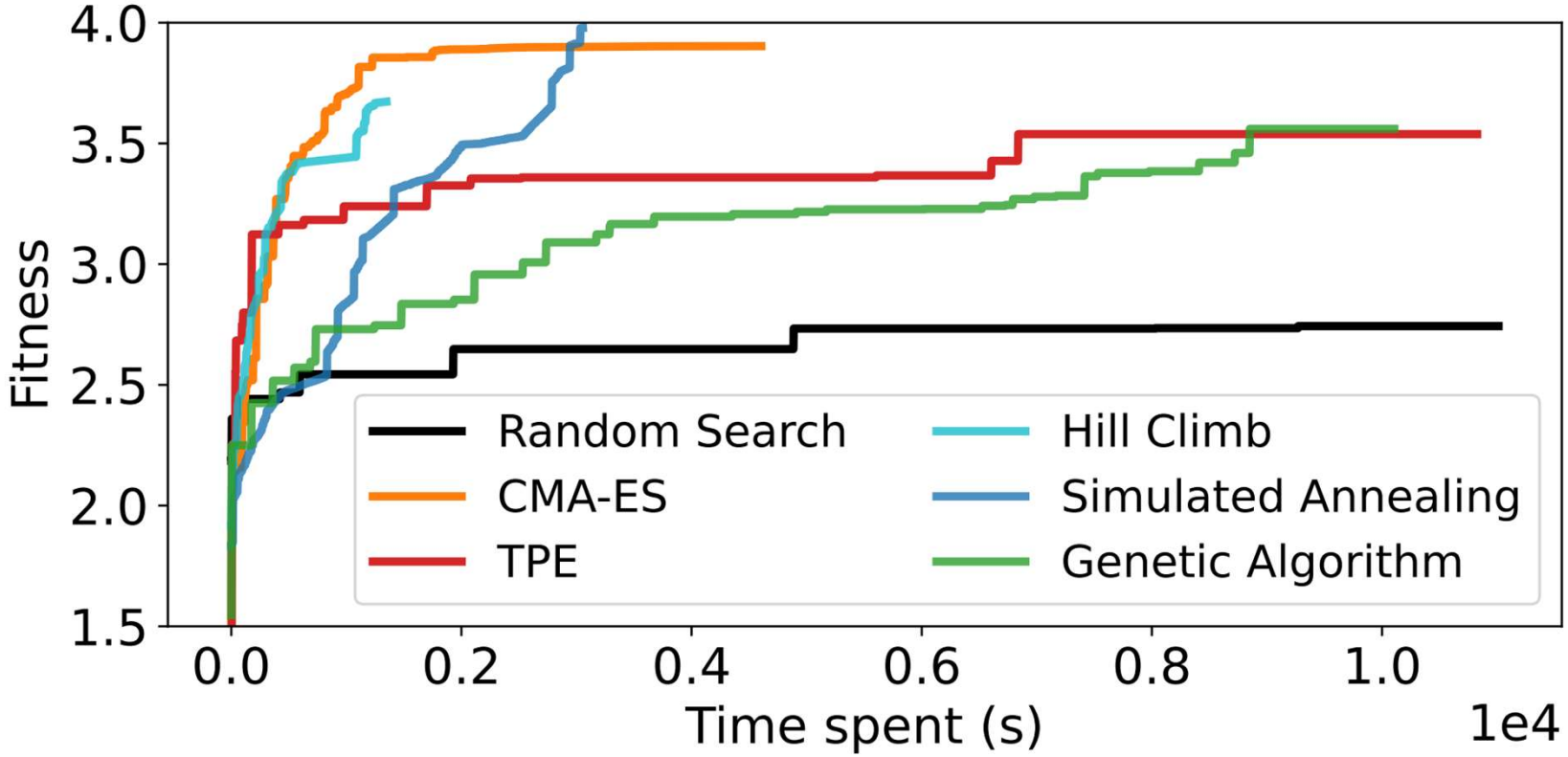

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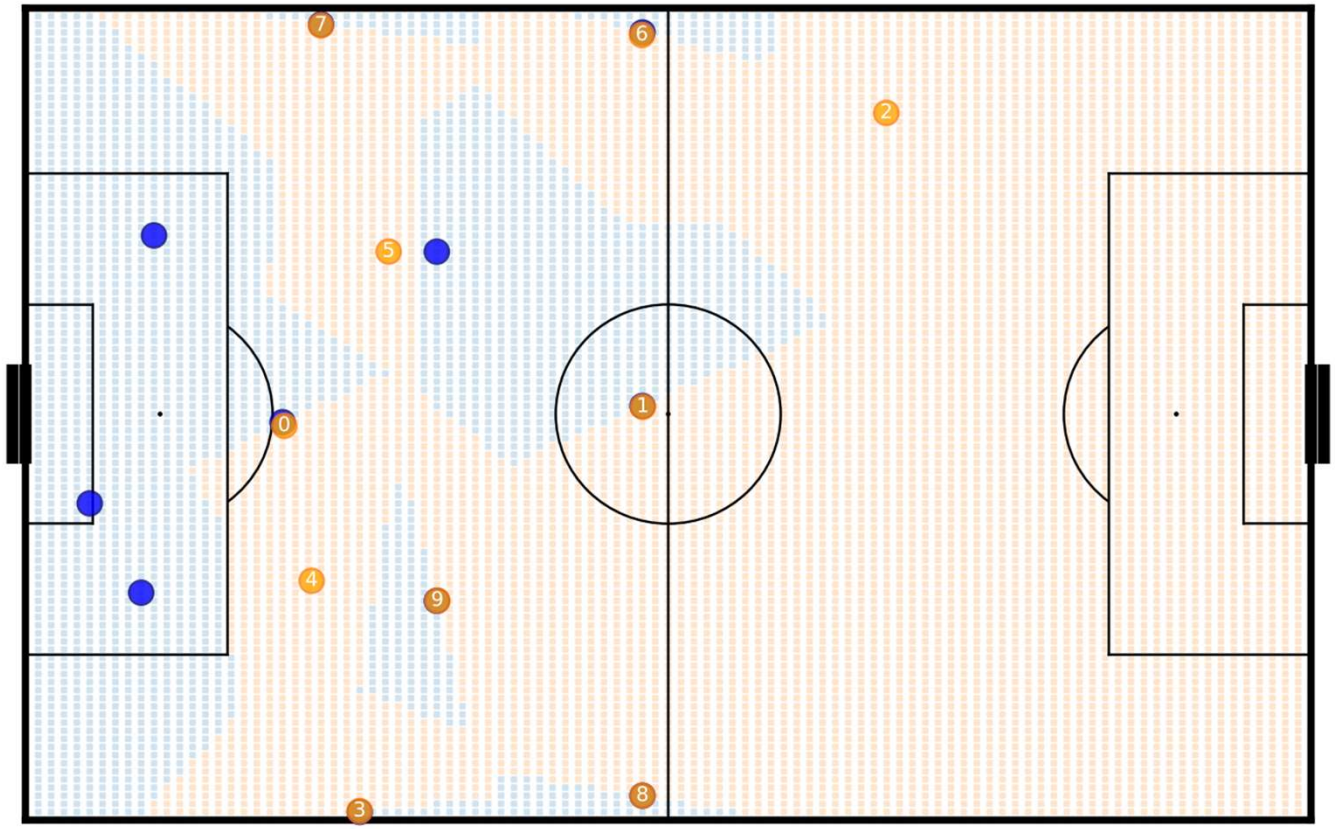
SOLUTION CMA-ES



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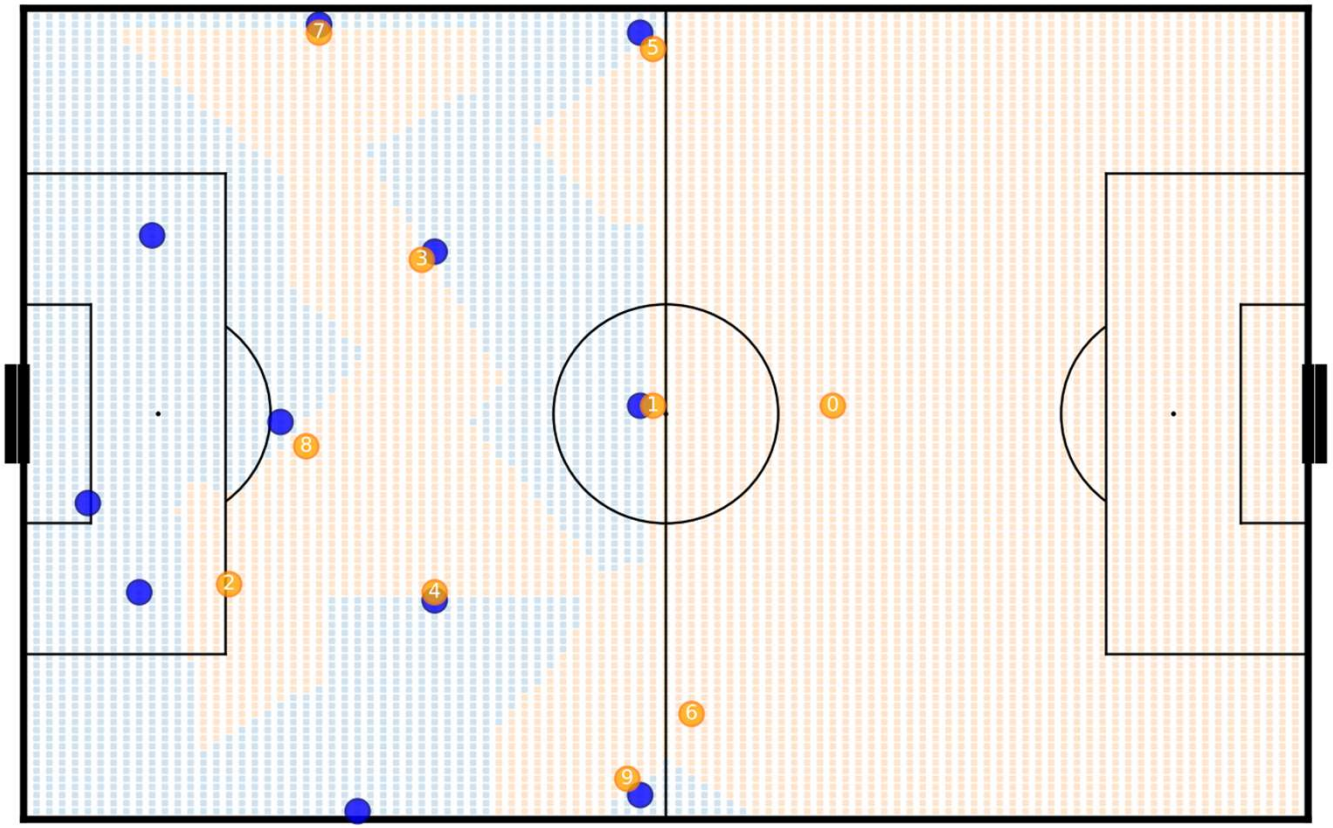
SOLUTION SIMULATED ANNEALING



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Conclusions

- CMA-ES & Simulated annealing are the best approaches for our problem.
  - CMA-ES wins in consistency and under restrict time constraints.
  - Simulated annealing wins otherwise (except against Grid Search if time available -> ∞).
- Local methods make a lot of sense:
  - Teams usually have predefined formations which will serve as a good starting point.
- Fitness function is the most important factor -> knowing what to optimize is the hardest thing to solve.

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Future Work

- Test more scenarios to check if the algorithms generalize properly.

- Test on real-time scenarios.

Q&A

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github.com/nvsclub/MarkingWithAI