

Search-Based Testing and Automatic Reconfiguration of a Path Planner

Some members of group G3 of ERATO MMSD project (A. Calò, K. Liu, X. Zhang, P. Arcaini, F. Ishikawa)

(1) Path planner for autonomous driving

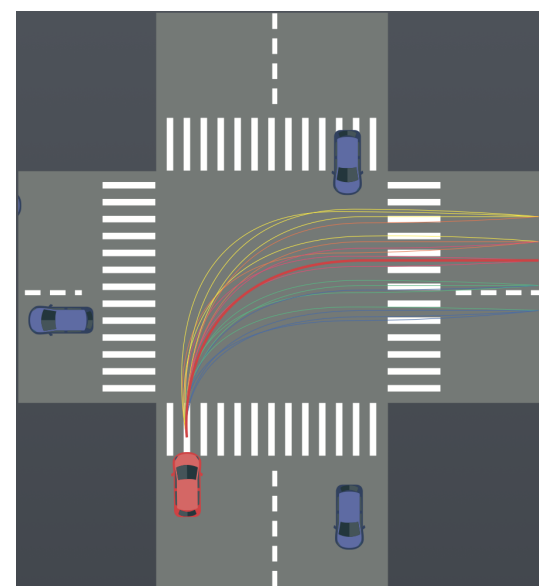
We consider an industrial path planner (PP)

The PP decides the path to follow by

- enumerating a set of possible paths
- scoring them with a *weighted* cost function
- selecting the least costly one (e.g., red path in the figure)

The PP behavior depends on the cost function *weights*

We consider *alternative* versions of PP (by changing the weights)

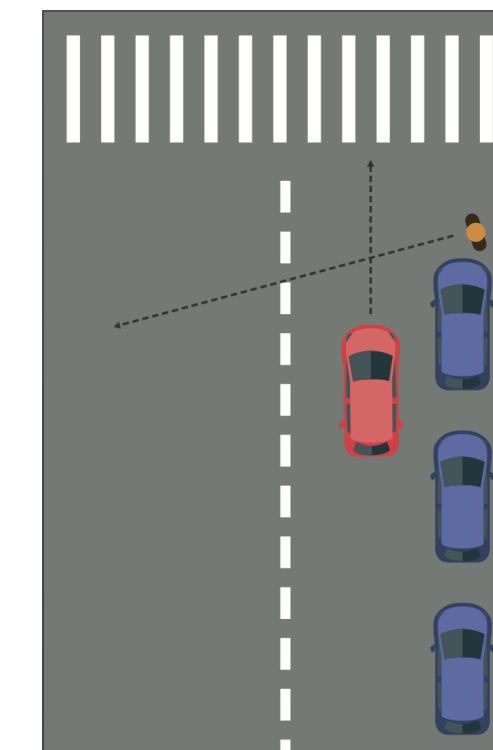


(2) Oracle problem in testing the PP

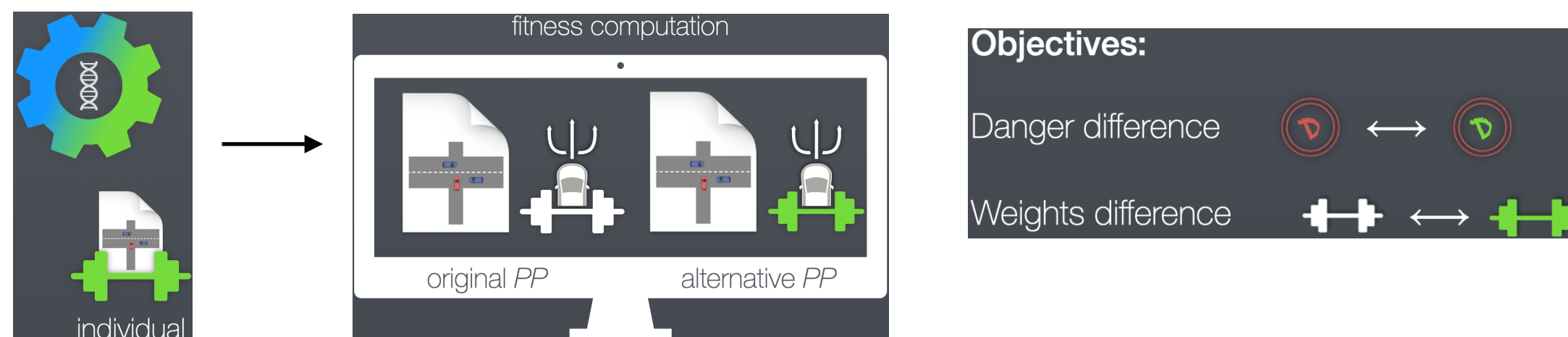
Testing the PP poses several challenges

- Huge search space
- *Oracle problem*
- A collision is sometimes *unavoidable* (see example)
- How to find collisions that are *avoidable*?

We deem a collision **avoidable** if the PP configured with different weights does not lead to a collision



(3) Searching for Avoidable Collisions [ICST'20]



We proposed an approach based on genetic algorithms to find avoidable collisions

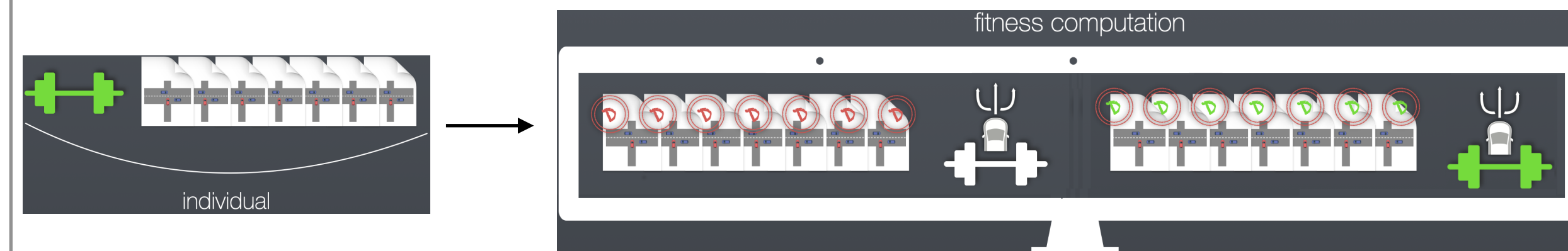
- A solution (individual) is a scenario and alternative weights
- Two objectives
 - Maximize the danger difference between the executions of the scenario in the original PP and in the alternative one
 - Minimize the difference between original and modified weights

The alternative weights for solving a collision may *overfit*, i.e., they do not solve other collisions (see solution in GECCO'20 work)

References

- A. Calò, P. Arcaini, S. Ali, F. Hauer, F. Ishikawa. Generating Avoidable Collision Scenarios for Testing Autonomous Driving Systems. In ICST 2020
- A. Calò, P. Arcaini, S. Ali, F. Hauer, F. Ishikawa. Simultaneously Searching and Solving Multiple Avoidable Collisions for Testing Autonomous Driving Systems. In GECCO 2020
- K. Liu, X. Zhang, P. Arcaini, F. Ishikawa, W. Jiao. Leveraging Test Logs for Building a Self-Adaptive Path Planner. In SEAMS 2020

(4) Avoiding overfitting of solutions [GECCO'20]



We proposed an approach for finding weights solving *multiple* collisions

- A solution (individual) is given by *multiple* scenarios and alternative weights
- Two objectives
 - Maximize the danger differences between the executions of the scenarios in the original PP and in the alternative one
 - Minimize the difference between original and modified weights

(5) Self-adaptive path planner [SEAMS'20]

- There is no *best* PP configuration
- We re-engineered the PP such that it modifies the weights at runtime (according to the observed environment)
- We follow the MAPE-K loop architecture

