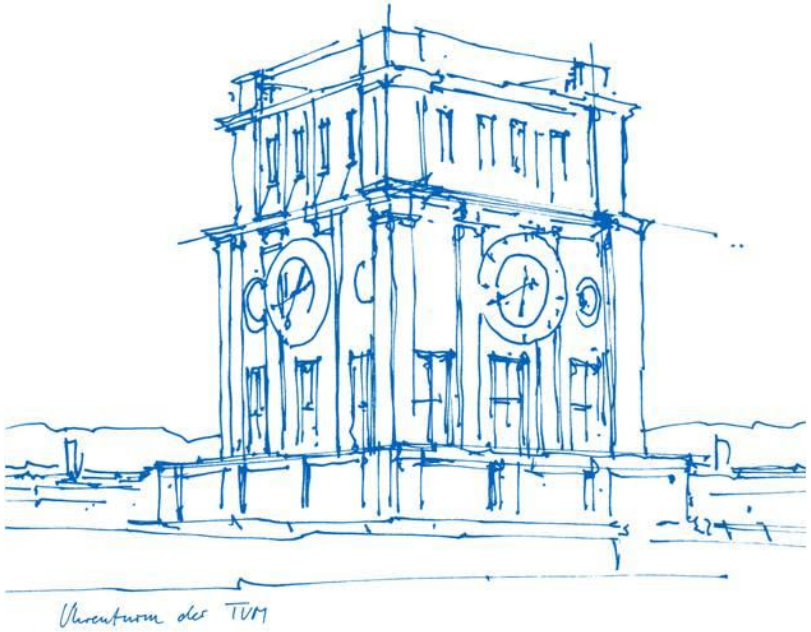
Practicum:
Scenario-Based Testing of Cyber-Physical Vehicles

Preliminary Meeting

17.07.2025

David Marson

Michael Wolf

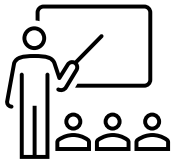


Agenda

- Schedule
- Overview
- Scenario-Based Testing
- Grading
- Open for Questions

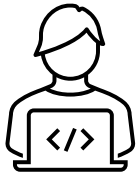
Schedule

Objective: build a test case generation tool based on scenario-based testing principles; generate challenging test cases efficiently



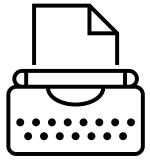
Kickoff
Class split into groups

Planning, Research, & Design



Implement

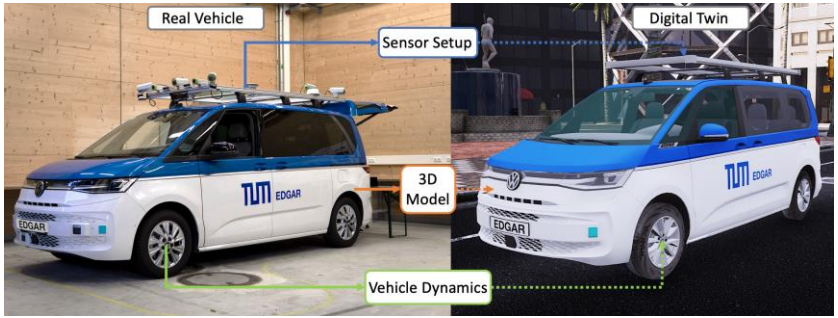
Evaluate



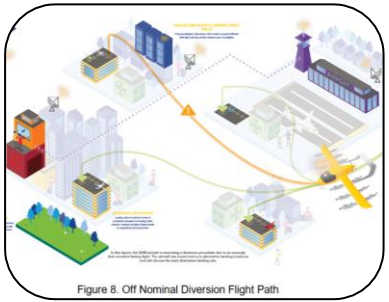
Write & Present

October 2025 — February 2026

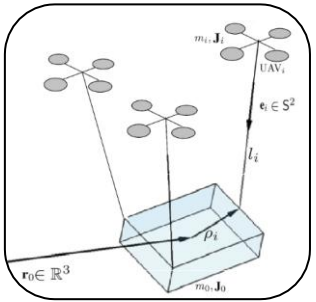
Overview: Motivation



- Autonomous vehicles promise a future with fewer accidents, reclaimed travel time, and increased mobility for many.
- AVs must safely navigate unpredictable real-world scenarios, from erratic drivers to severe weather.
- Rigorous testing in simulations and the real world is essential to ensure safety and build public trust.



[1]

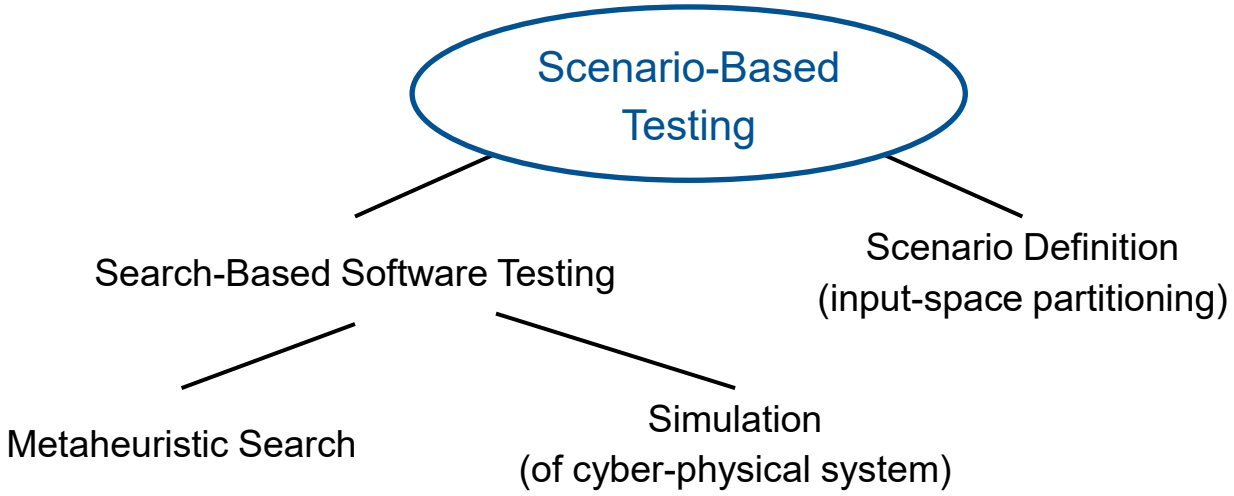


[2]

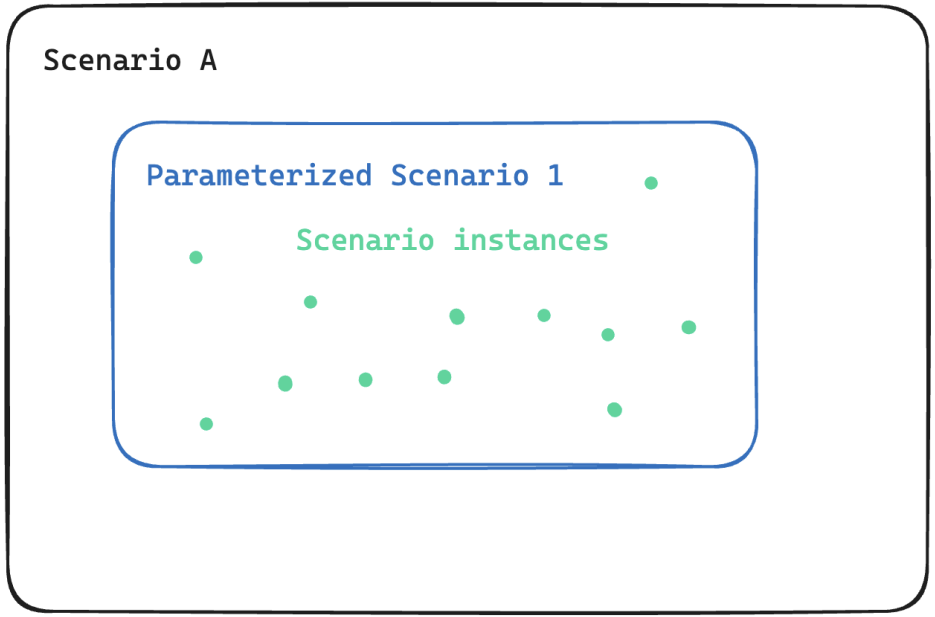
- Drones already widely used: transportation, surveillance, communications, military.
- Cooperating drones & drone swarms are being heavily researched.
- How can we make sure groups of autonomous, cooperating drones are behaving correctly?

Overview: Scenario-Based Testing

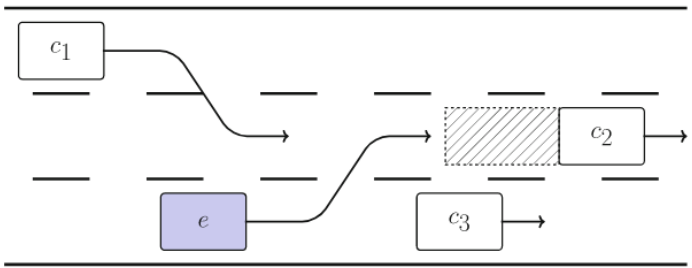
General challenge for testing CPS:
huge dimensionality of input parameter space



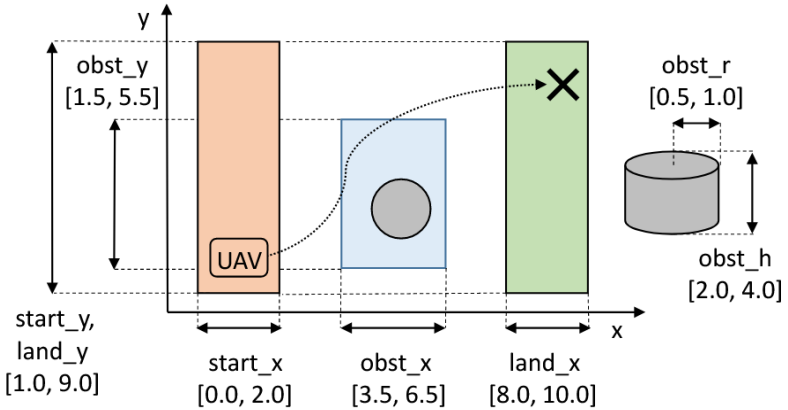
Overview: Scenario-Based Testing Layers



Scenario-Based Testing: Scenario Definition

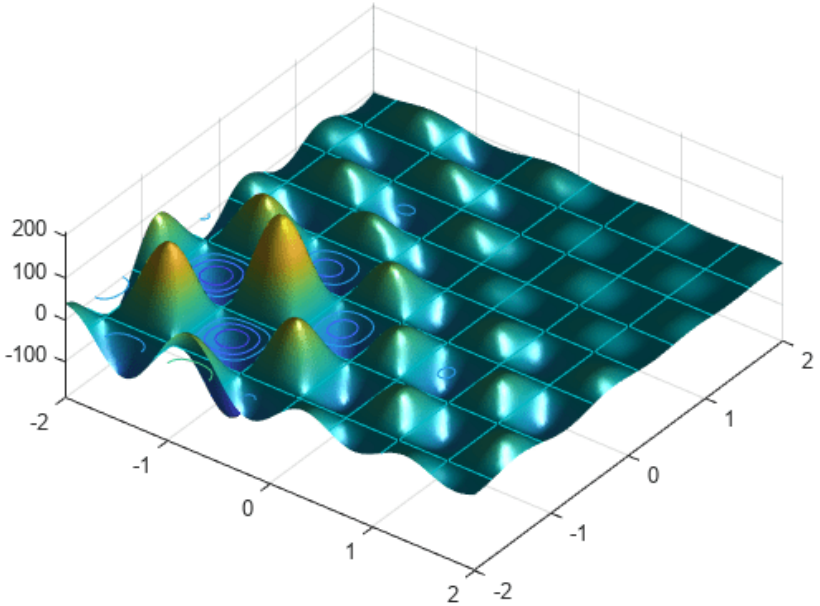


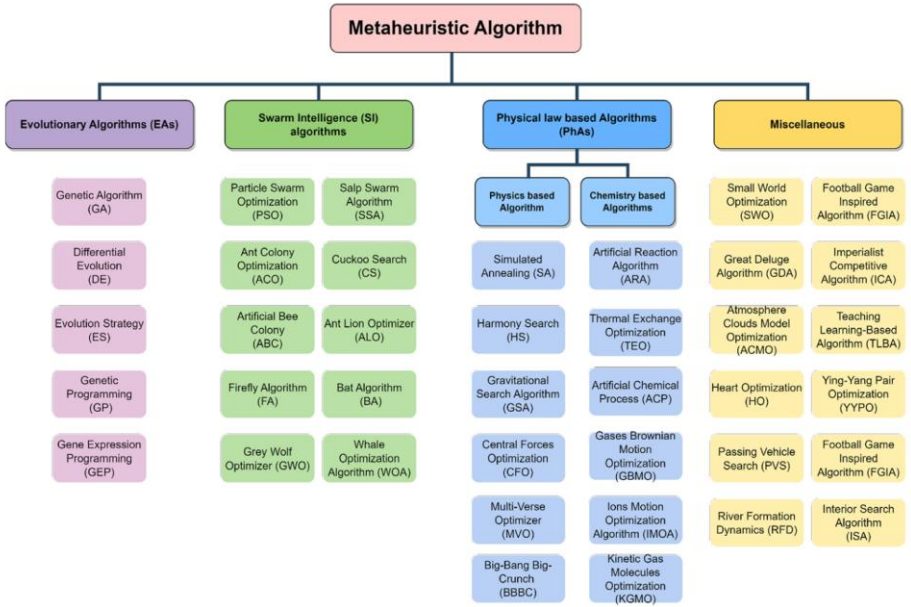
Scenario-based testing in the automotive domain [4]



Scenario-based testing in the UAV domain [5]

Scenario-Based Testing: Metaheuristic Search





The MathWorks, Inc.

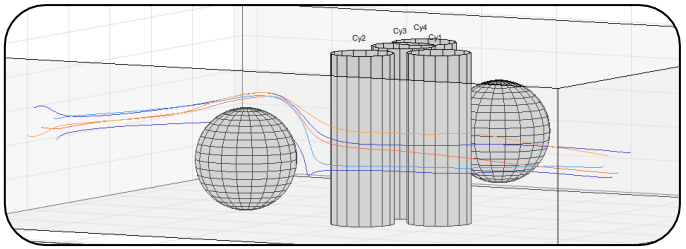
[6]

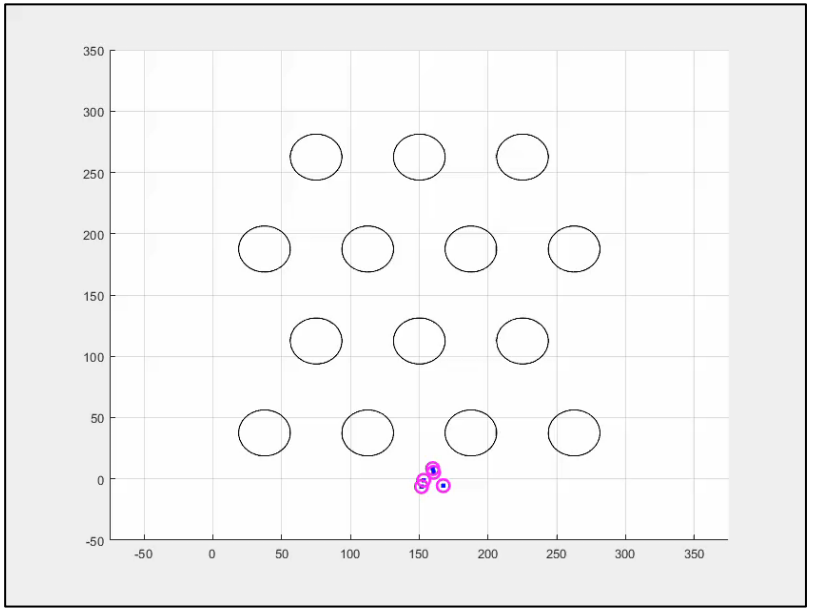
Scenario-Based Testing: Autonomous Car Simulation

Scenario-Based Testing: UAV Swarm Simulation

- “SwarmLab” developed by Soria et al. at the Laboratory of Intelligent Systems at EPFL [7]
- MATLAB-based simulator for designing, modeling, and analyzing drone swarm control algorithms

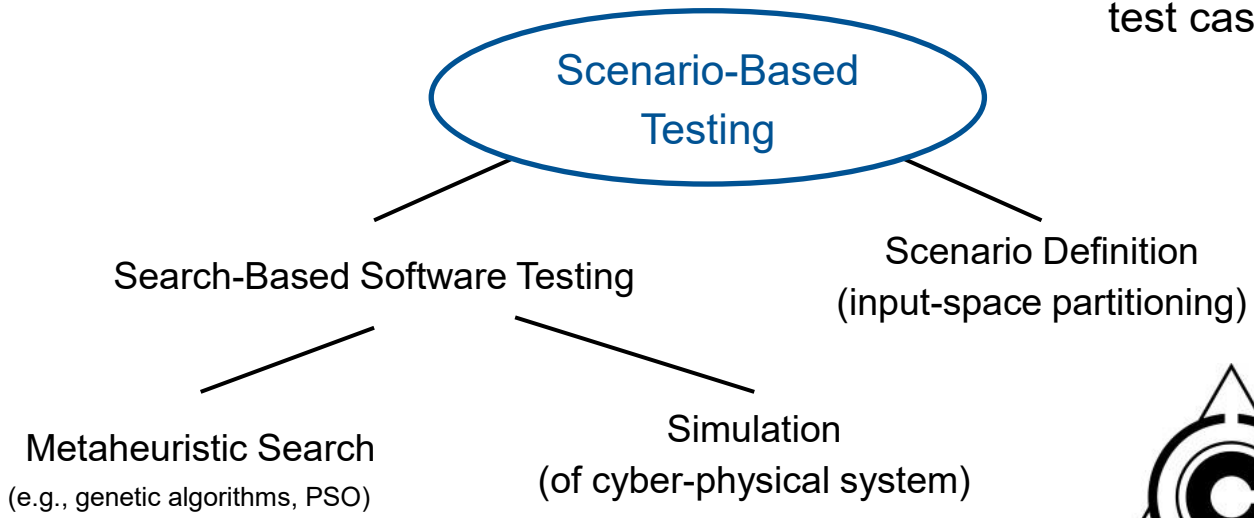
SwarmLab





Scenario-Based Testing: Implementation Overview

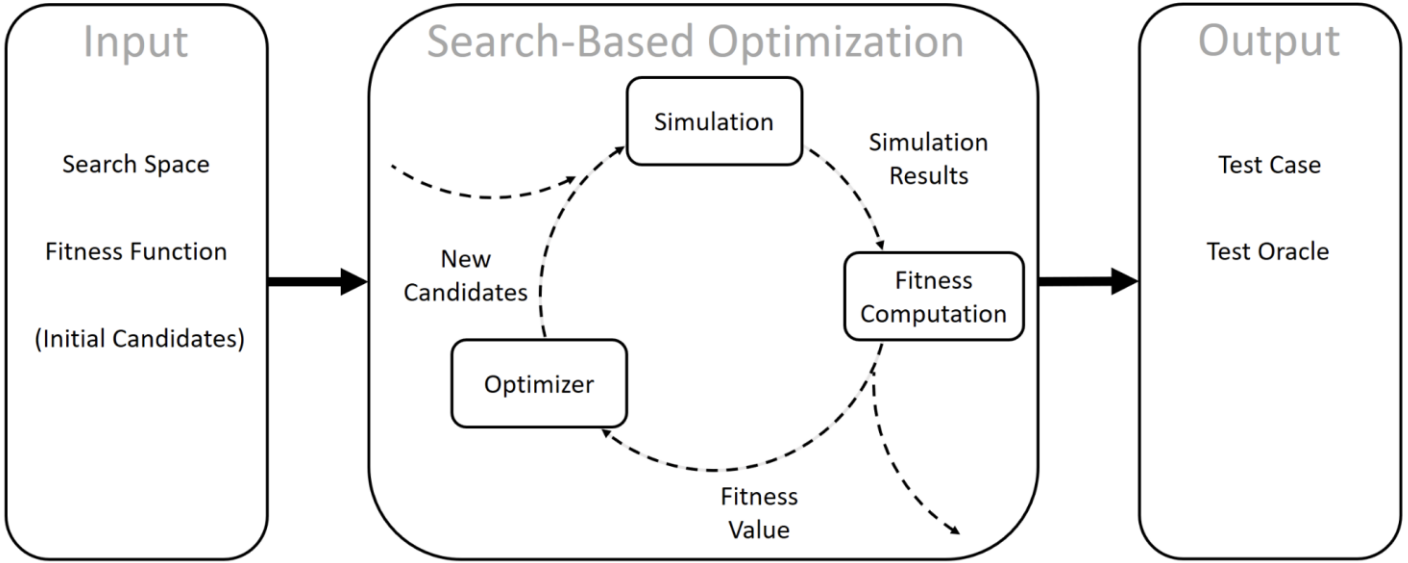
Goal: Develop automated test case generation tool

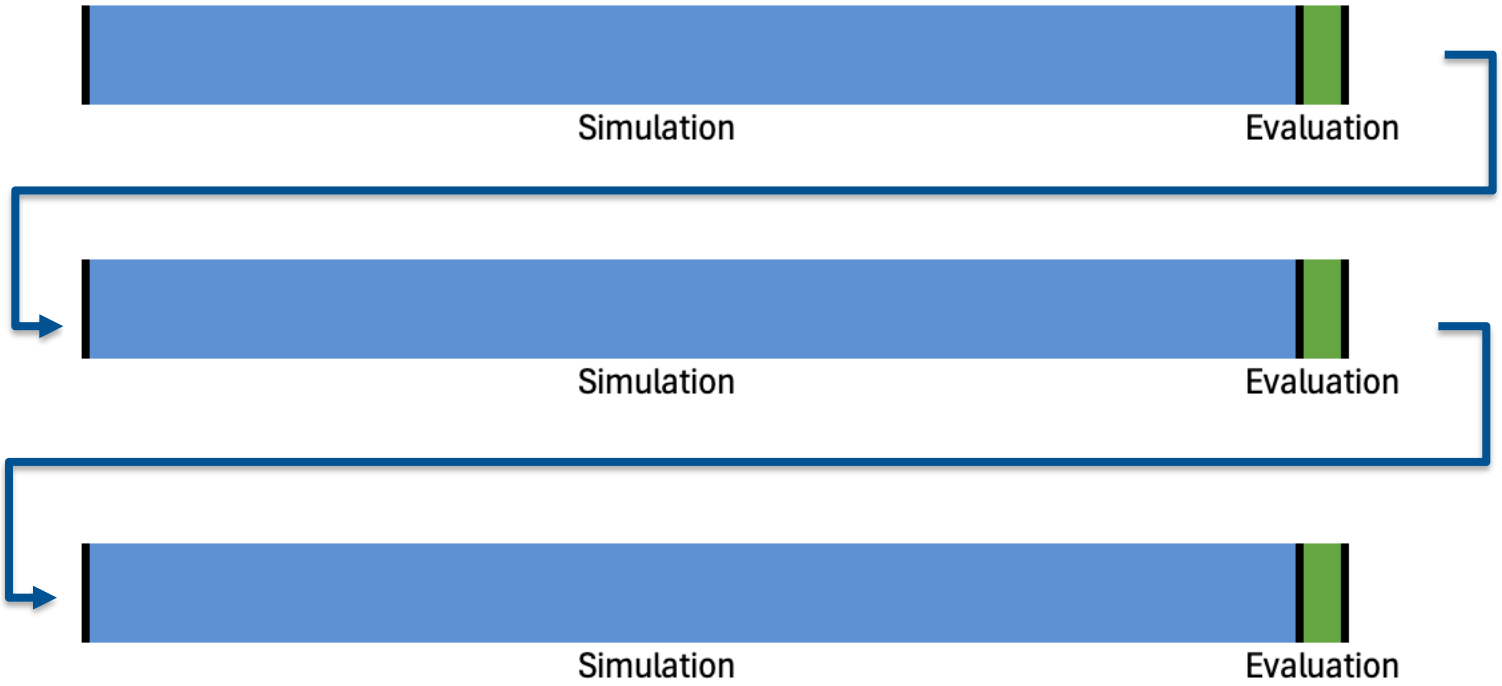


CARLA

SwarmLab

Scenario-Based Testing: Implementation Overview




Simulation
Evaluation
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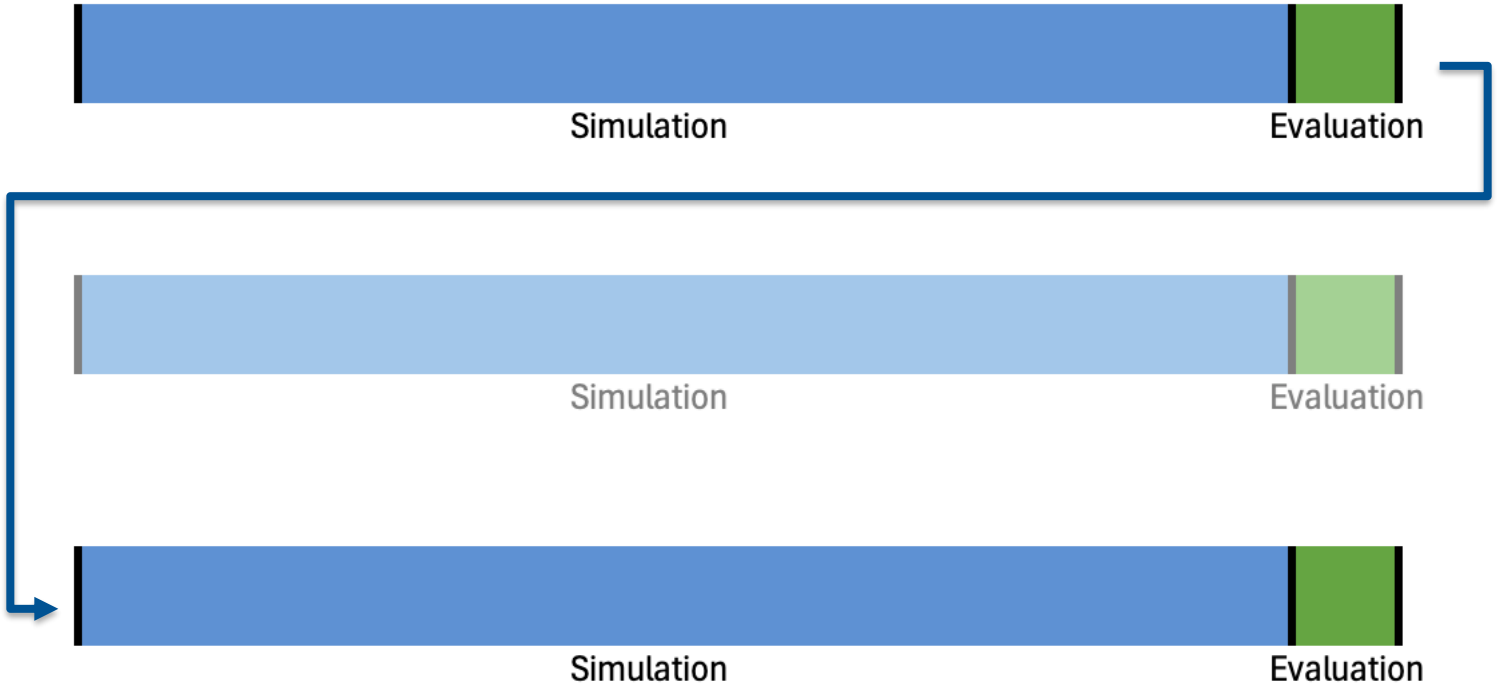
Evaluation


Simulation
Evaluation
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Evaluation

Grading

Final Deliverables	**Final Group Report**	**Presentation**
Process Deliverables	**Progress Reports**	**Implementation**

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Relevant schedule and links can be found here:
https://docmatching.in.tum.de/index.php/schedule

Questions?

References

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2. M. Abdelkader, S. Güler, H. Jaleel, and J. S. Shamma, “Aerial Swarms: Recent Applications and Challenges,” Curr Robot Rep, vol. 2, no. 3, pp. 309–320, Sep. 2021, doi: 10.1007/s43154-021-00063-4.
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