VaMAI-Validator: Agent Validation Platform for Autonomous Maritime Navigation

Presenter: Christoph Baier
Researcher at Institute for Applied Systems Technology Bremen (ATB)
Website: https://www.atb-bremen.de

CHRISTOPH BAIER, JOEL ASCHMANN, FULYA HOROZAL, MARCEL DECHERT, SEBASTIAN SCHOLZE

Institut für angewandte Systemtechnik Bremen GmbH

IARIA

Funded by

Bundesministerium für Wirtschaft und Energie

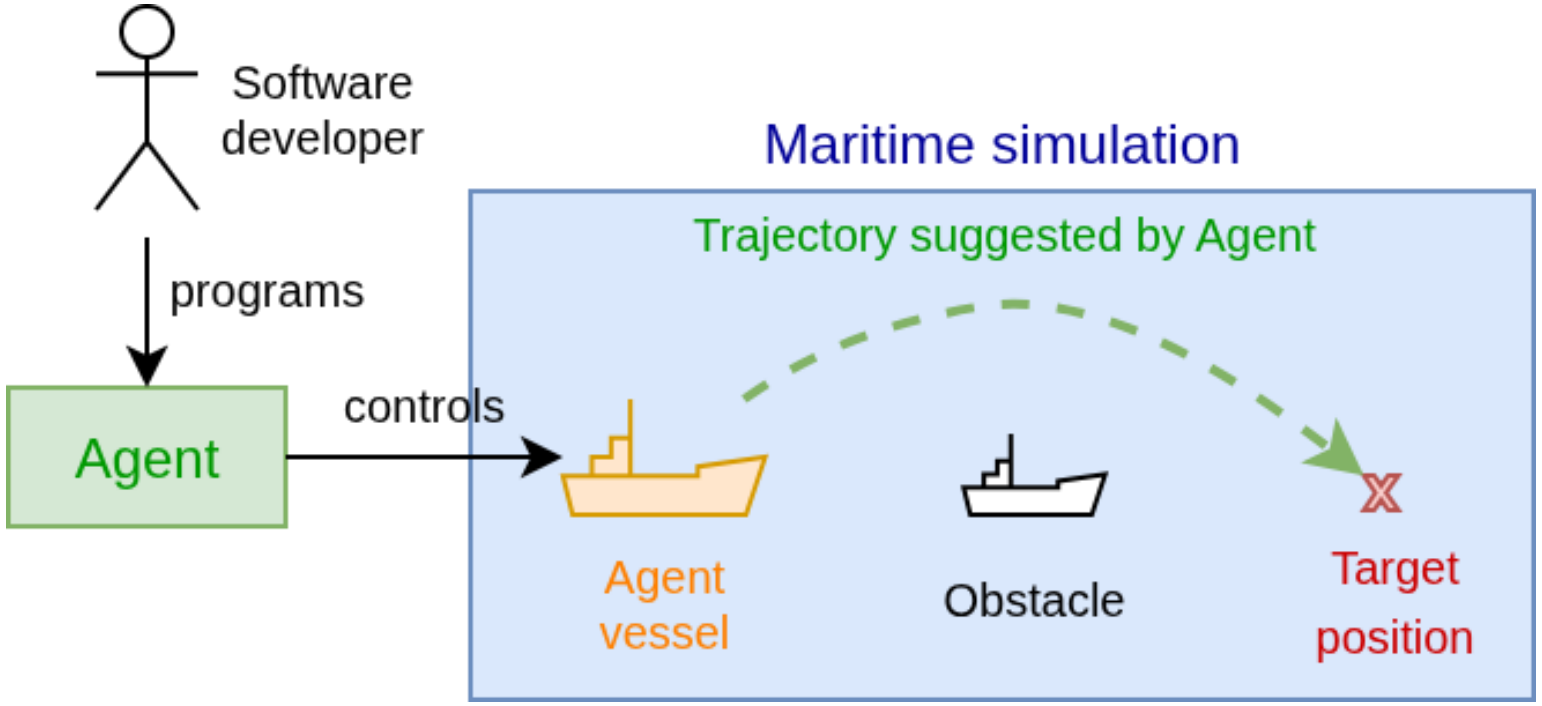
First Author

Christoph Baier received the master's degree in chemistry from the University of Rostock, Germany, in 2018. After completing his degree, he transitioned into applied IT science. He is currently a researcher at ATB, where he primarily works on EU-funded projects focused on developing technical solutions to societal challenges.

His primary expertise lies in software engineering, with a focus on clean code, agile methodologies, test-driven development, and DevOps practices, including Docker and continuous integration pipelines. He also conducts literature reviews and contributes to scientific publications as part of collaborative research projects.

Contact: baier@atb-bremen.de

The Use Case: Agent Development

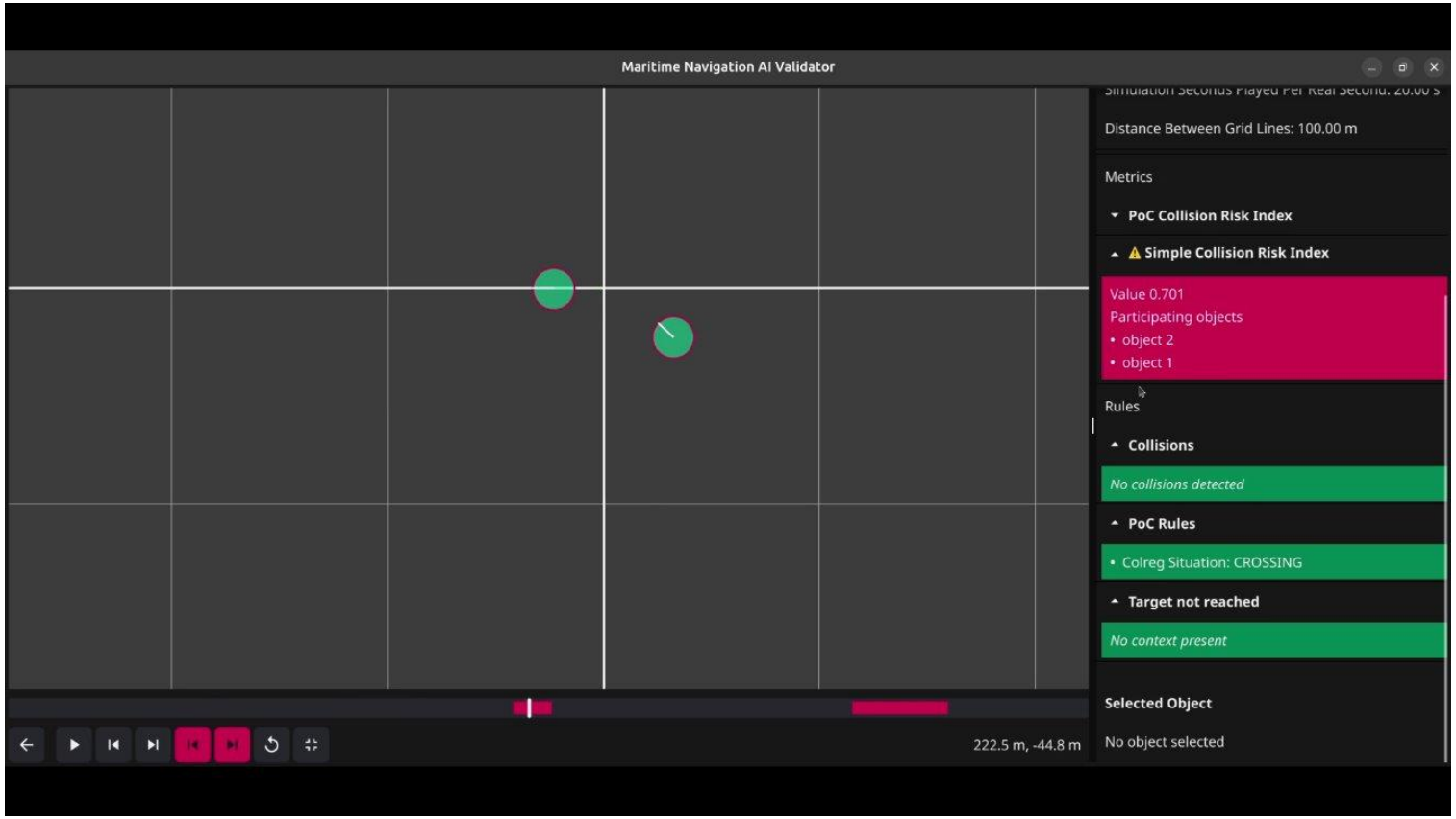


Main challenge: How to properly validate the agent?

Test-Driven Development: Demo

Derived Workflow:

1. Prepare scenarios, metrics, rules
2. Write agent code
3. Run validation
4. Analyze feedback
5. If performance gets worse, then rollback, otherwise continue

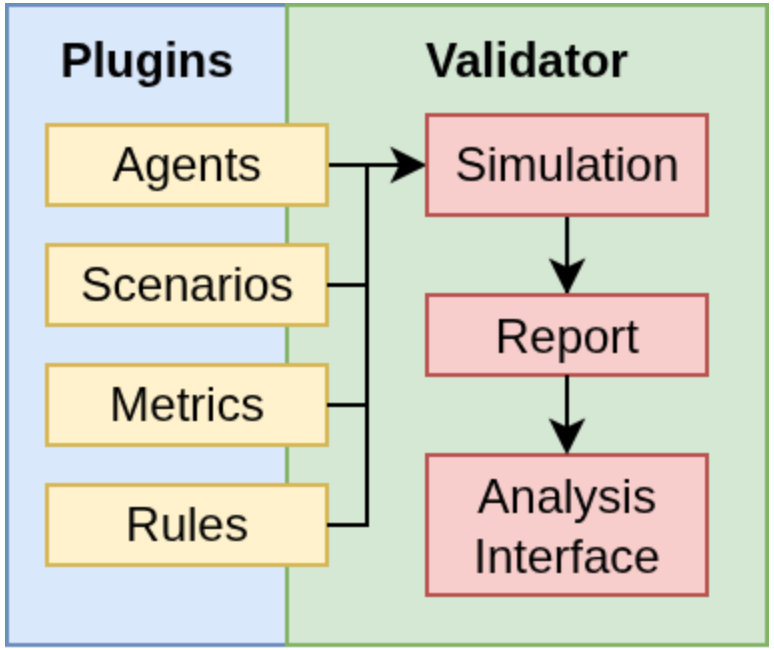


Addressed Issues

- Validation complexity in autonomous navigation
- High development effort for simulations
- Agent-specific tooling
- Missing automated validation
- Redundant implementations across agents

Architecture And Workflow

- **Agents** – algorithm controlling the autonomous vessel
- **Scenarios** – navigation task (vessels, targets, obstacles)
- **Metrics** – e.g. collision risk index
- **Rules** – e.g. COLREG, good seamanship



Demonstrations

1. Agent Setup

2. Plugin Creation

1/2 Validation of the VaMAI Method

Simulation Accuracy

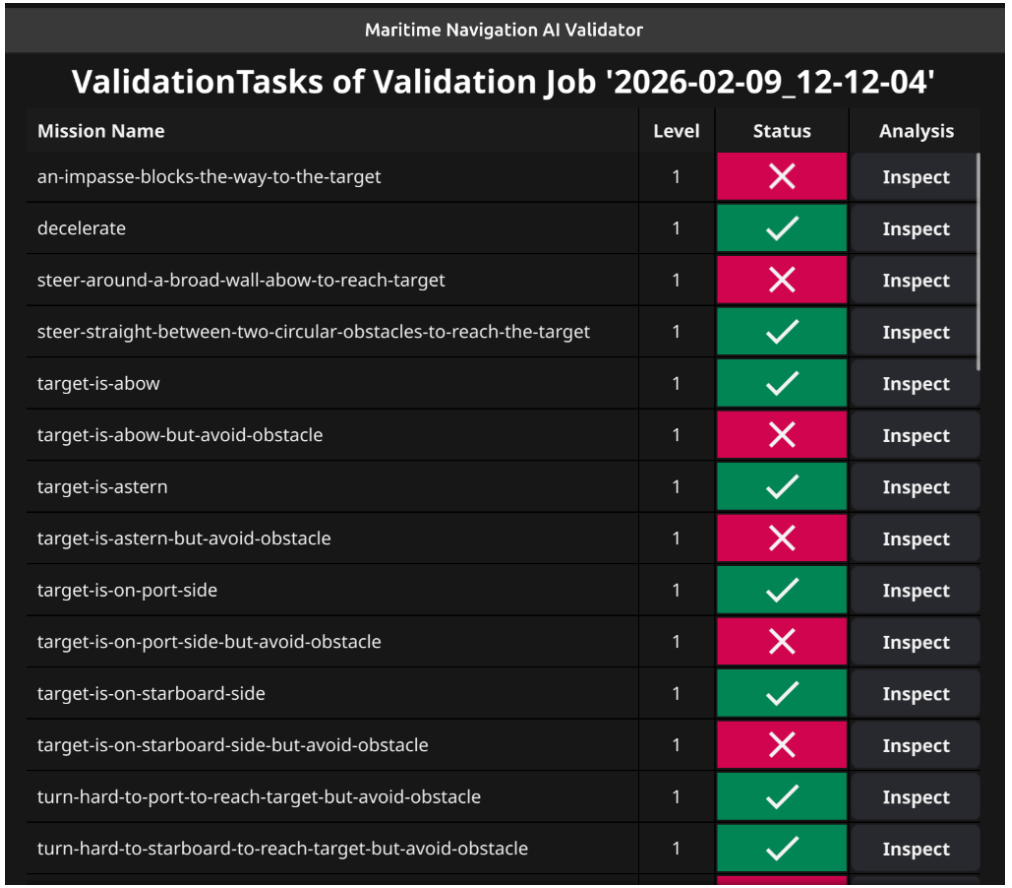
- Live trials for virtual simulation accuracy assessment
- Unmanned vessel under test and manned encounter vessel
- Realistic navigation scenarios
- Comparison result with virtual simulation: about 1.5 m average position deviation under calm weather conditions

Image source: Google Maps (edited)

2/2 Validation of the VaMAI Method

Case Study: Pathplanner

- Validator-based evaluation of the provided prototype navigation agent 'Pathplanner'
- Proof-of-concept plugins used:
  - Scenarios: mostly basic navigation and avoiding obstacles, and COLREG encounters with 2 vessels
  - Metrics: CRI based on DCPA/TCPA
  - Rules: simplified COLREG rules
- Result: Detection of behavioral flaws



Limitations and Future Work

- Simplified environment assumptions in validator
  - Missing environmental factors
  - Abstract vessel geometry
- Simple Plugins
- C++-only Validator client interface
- Limited number of agent integrations so far (n = 2)
- Generality claim requires further validation

Conclusion

- Simplified agent development workflow
- Reuse of scenarios, metrics, and rule checkers across agents
- Agent benchmarking
- Extensible plugin-based ecosystem
- Simulation-based validation of real-world scenarios
- Demonstration of capabilities to detect defects

Collaboration & Contact

- Open-source status undecided
- Direction depends on feedback
- Contact us for software access or cooperation
- Further details in the paper “VaMAI-Validator: Agent Validation Platform for Autonomous Maritime Navigation.”