# Generalizing Marine Traffic Rules for Multiple Vessel Types and Emergencies

## Background

Similar to autonomous driving, autonomous vessels would improve the safety of marine traffic and mitigate risks for the crew and environment. These autonomous vessels would have to obey the marine traffic rules which are currently not understandably specified for machines. Thus, to realize autonomous vessels marine traffic rules have to be formalized.

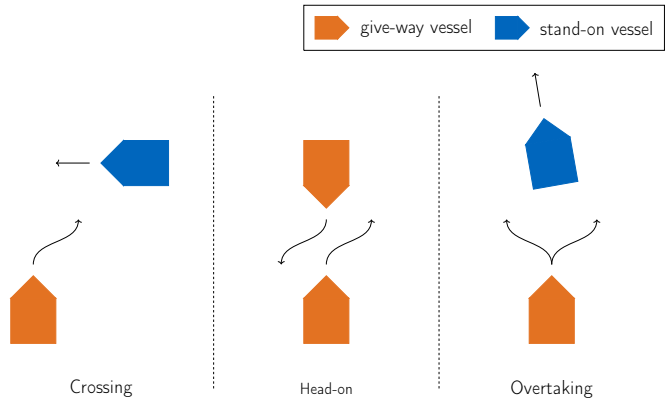


Fig. 1: Collision avoidance behavior for encounter situations of vessels

The fundamental marine traffic rules are defined in the COLREGS [1]. The convention defines different encounter situations as shown in Fig. 1. For power-driven vessels, which encounter each other at the open sea, the relevant COLREGS rules are formalized in a previous study [2]. However, if different types of vessels encounter each other different rule sets have to be applied. Next to the rule hierarchy introduced by different vessel types there is also a rule hierarchy dependent on the criticality of the situation.

## Description

The goal of this thesis is to extend the existing marine traffic rule monitor by including the rules that stem from different vessel types and emergency situations. This formalization should be evaluated on real marine traffic data to identify how accurately vessels follow the formalized rules. In addition, the current implementation uses the velocity obstacle concept [3] to determine if a collision between two vessels is possible. However, using velocity obstacles is less general than reachability analysis but more computationally efficient. Thus, the two concepts should be compared to identify differences more clearly. Optionally, a constraint mode can be implemented that creates constraints for a controlled vessel and, thus, can be evaluated with a existing motion planner.

## Tasks

- Perform a literature review on temporal logic and marine traffic rule specifications
- Familiarize with the existing implementation for marine traffic rules and vessel scenario representation
- Extend the existing formalization for multiple vessel types and the emergency maneuver
- Integrate and compare reachability analysis to the velocity obstacle concept
- Evaluate the implementation on real traffic data
- *Optional:* Implement constraint mode for rules and evaluate with motion planner

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ConVeY

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Formal methods, temporal logic

**Programming language:**
Python

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Good programming skills, interest in autonmous vessels

**Language:**
English

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## References


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[2] Hanna Krasowski and Matthias Althoff. Temporal logic formalization of marine traffic rules. In *IEEE Intelligent Vehicles Symposium*, 2021.

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