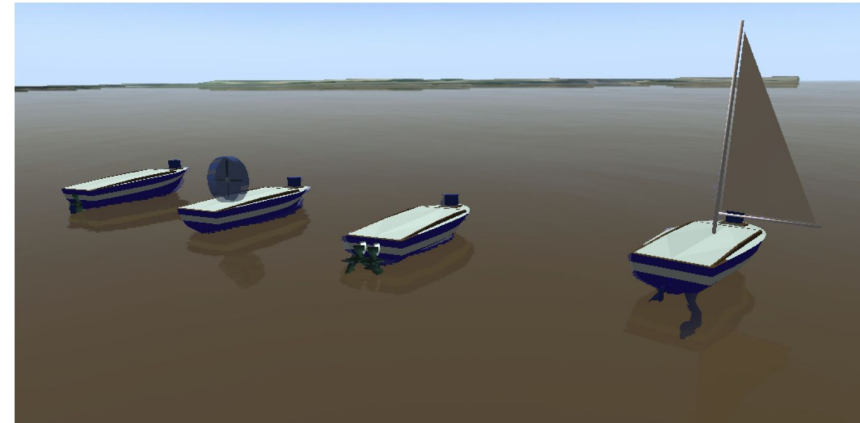
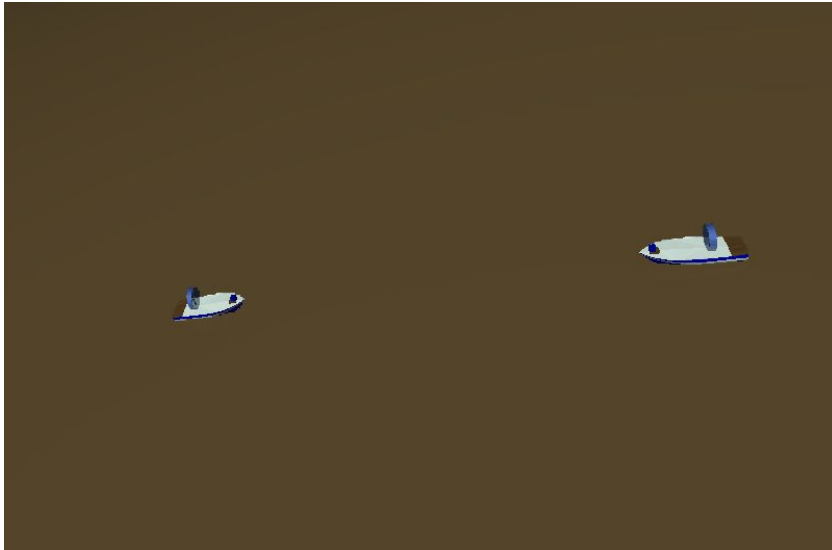


Integration of an Artificial Intelligence System with USV_SIM

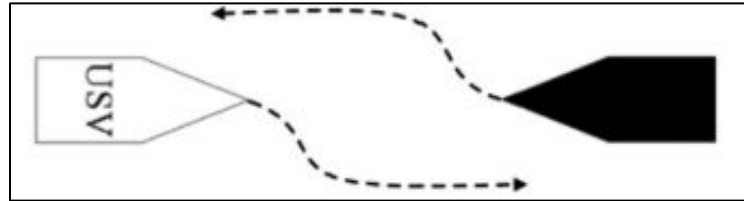
Unmanned Surface Vehicles (USVs)



USV_SIM (Simulated Environment for Unmanned Surface Vehicles)



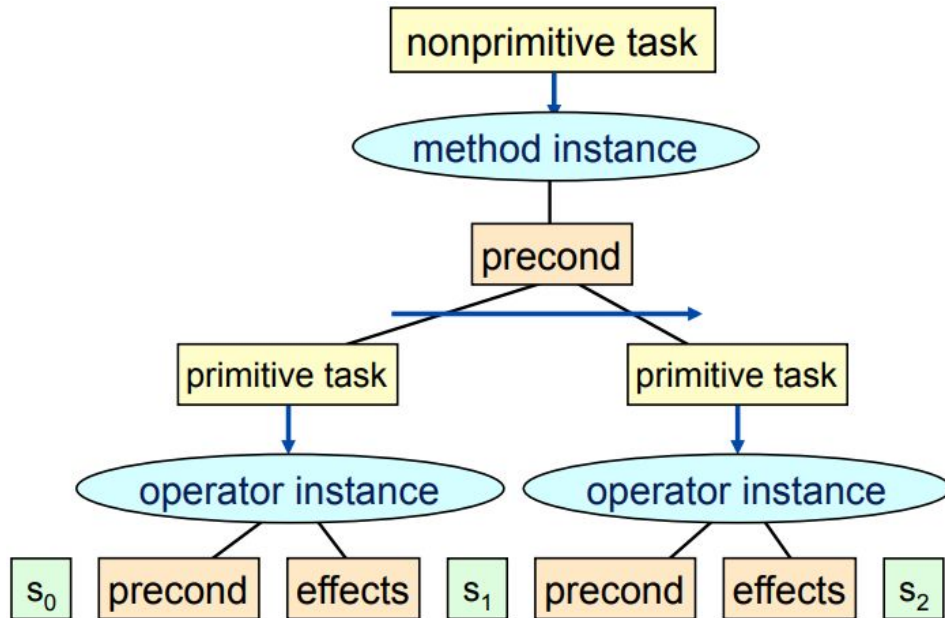
Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs)



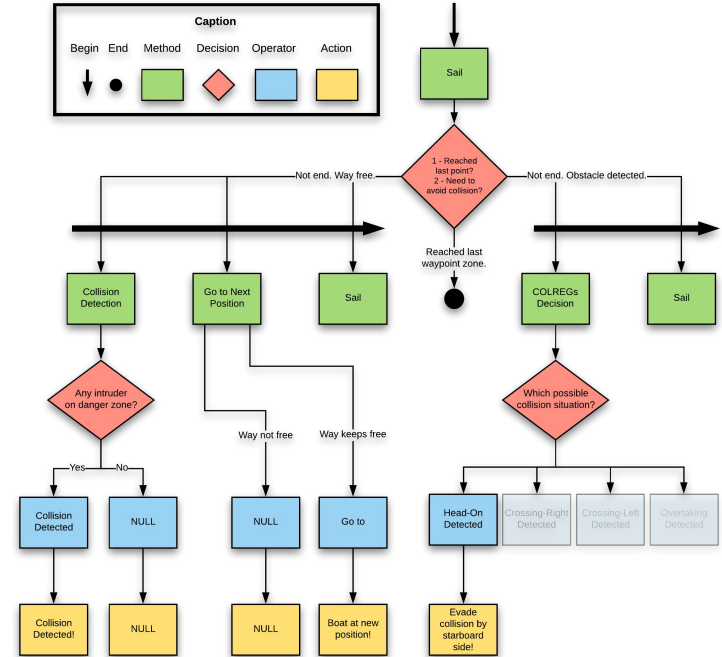
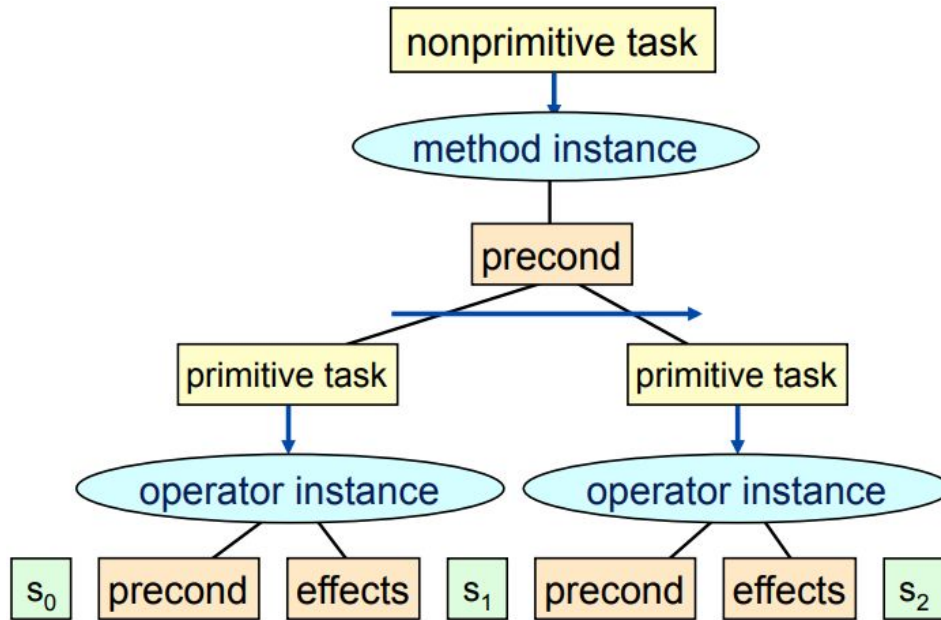
Rule 14 – Head-on Situation:

When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision, each shall alter her course to starboard so that each shall pass on the port side of the other.

Hierarchical Task Network (HTN) - AI



Hierarchical Task Network (HTN) - AI

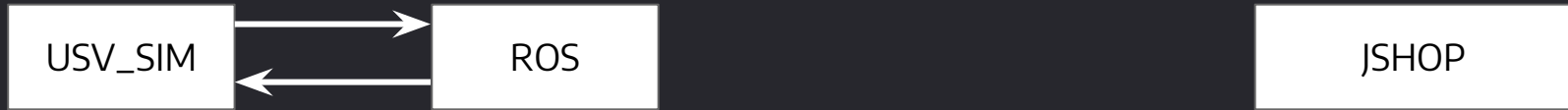


DEVELOPED WORK

1. Integrate HTN planning with USV_SIM

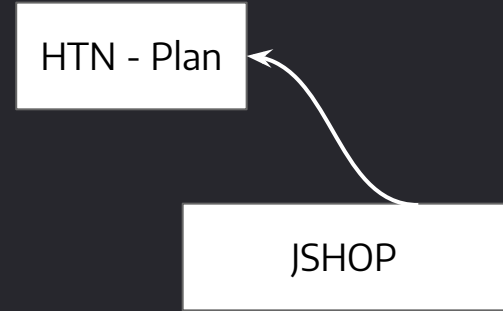
DEVELOPED WORK - Integrate HTN planning with USV_SIM

Step 0



DEVELOPED WORK - Integrate HTN planning with USV_SIM

Step 1



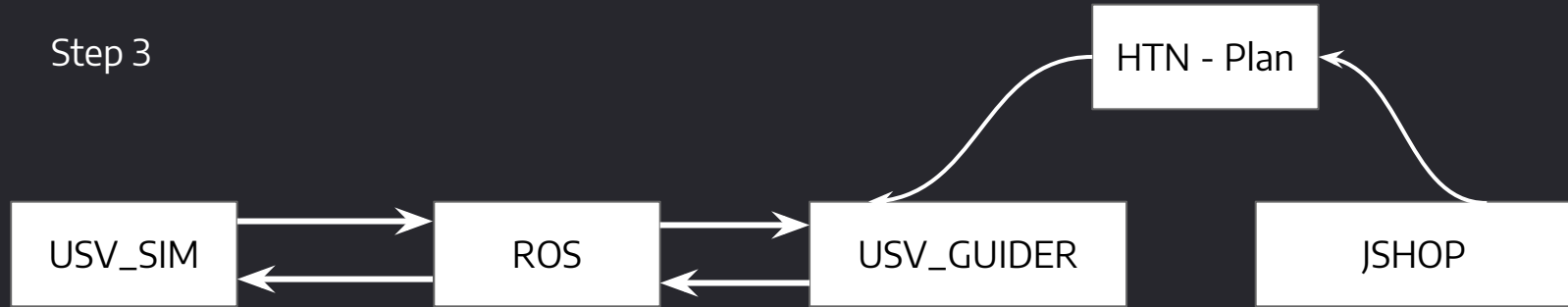
DEVELOPED WORK - Integrate HTN planning with USV_SIM

Step 2



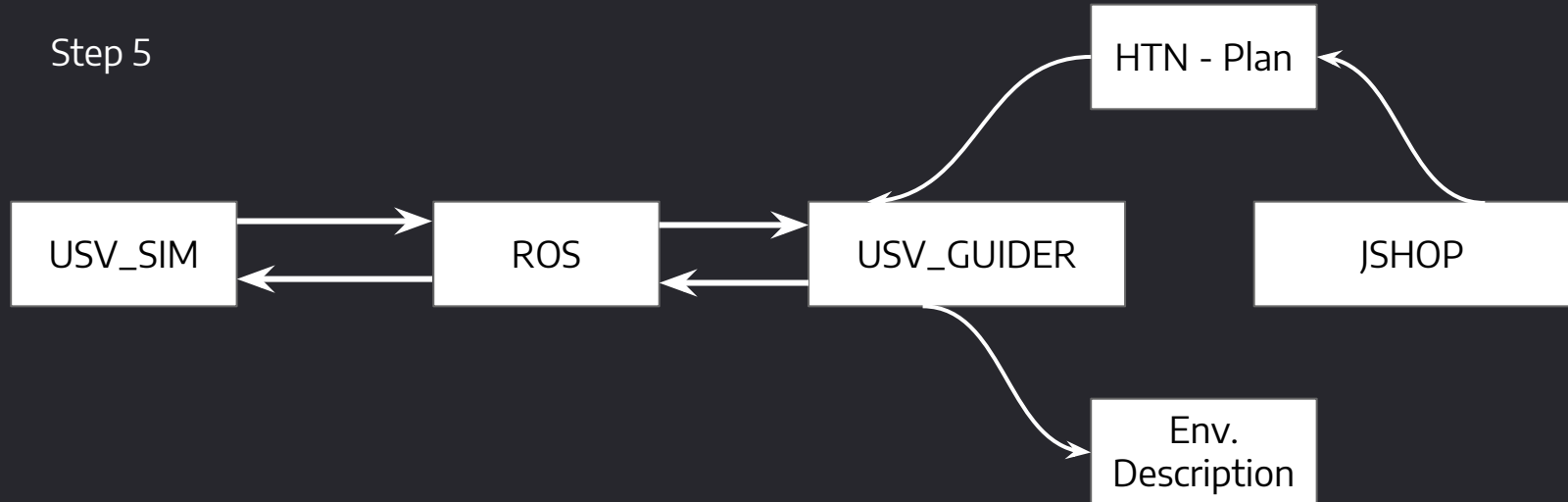
DEVELOPED WORK - Integrate HTN planning with USV_SIM

Step 3



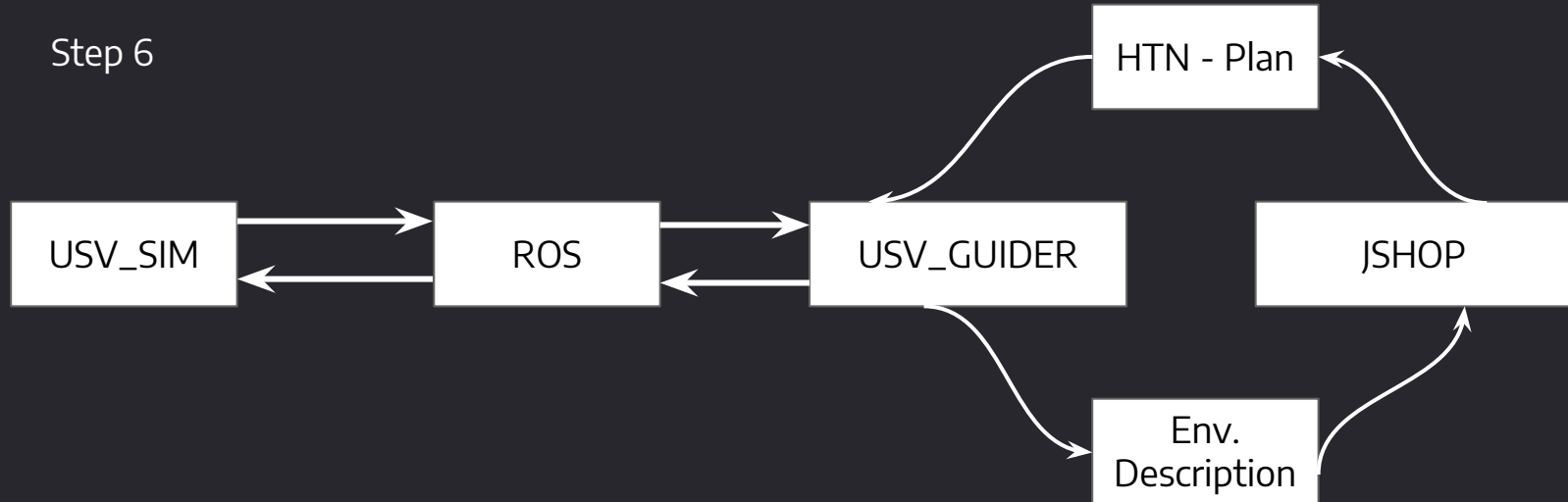
DEVELOPED WORK - Integrate HTN planning with USV_SIM

Step 5



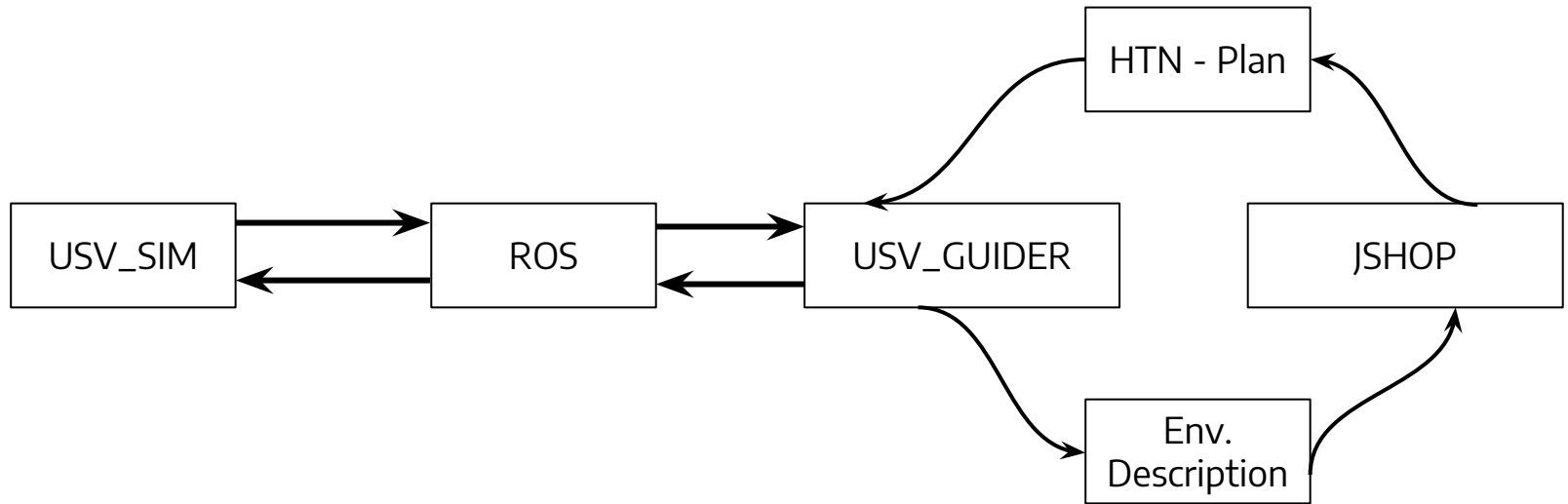
DEVELOPED WORK - Integrate HTN planning with USV_SIM

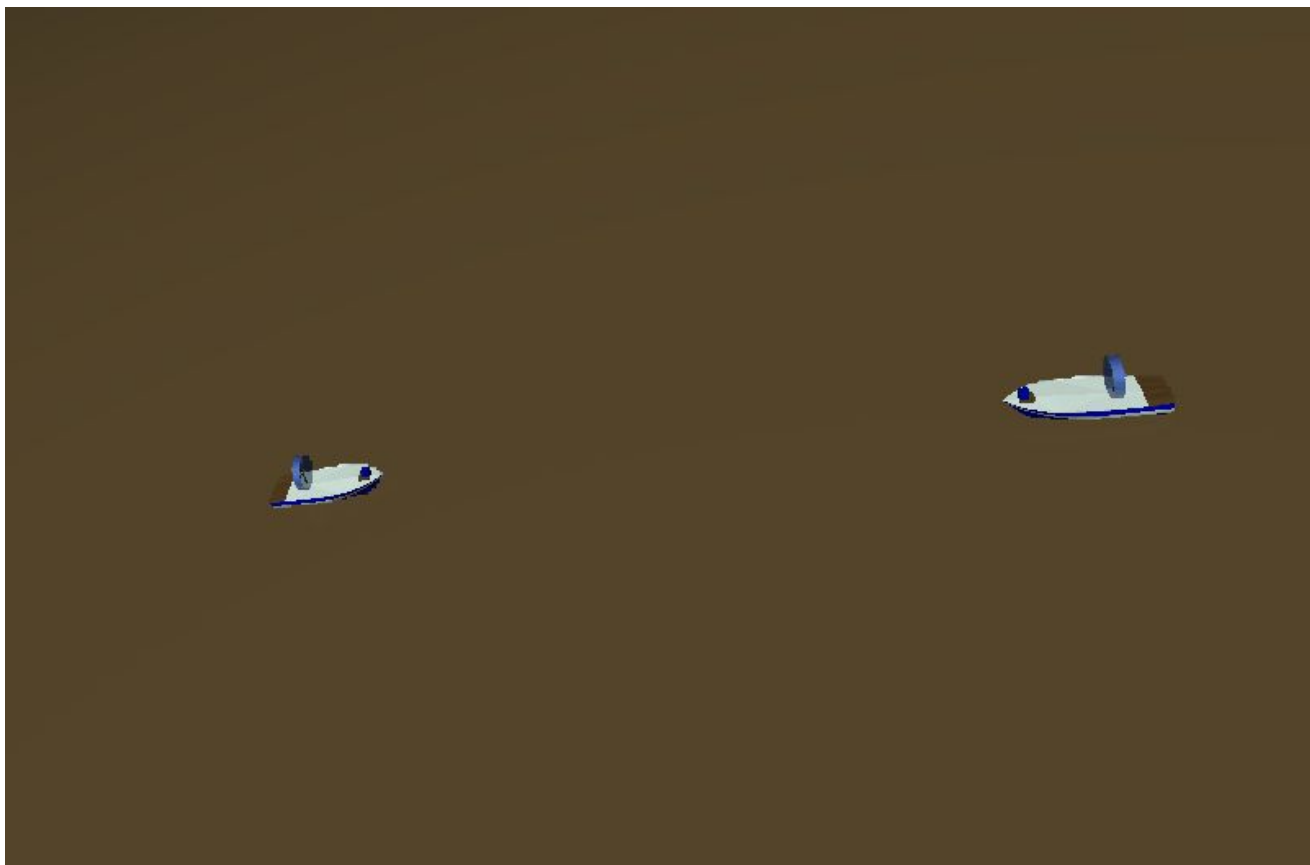
Step 6



DEVELOPED WORK

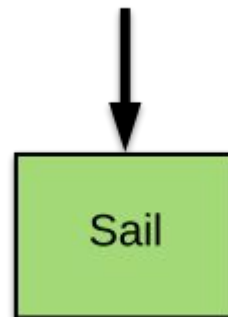
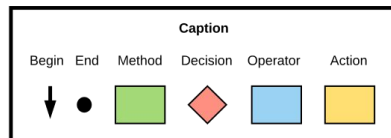
	1	2	3	4	5	6	7
A							
B							
C							





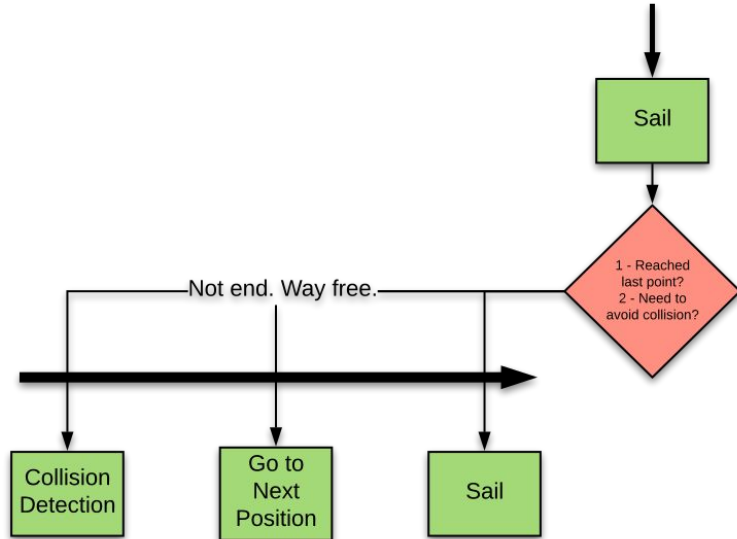
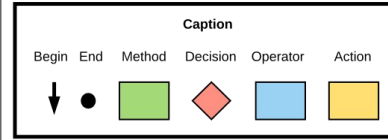
DEVELOPED WORK

1. LOCAL GUIDANCE SYSTEM
 - a. Avoid head-on collision situations
 - b. COLREGs-Compliant
 - c. Based on HTN
 - i. Developed using JSHOP2
2. SIMPLE MISSION
3. GRID
4. HIERARCHICAL TASK NETWORK
 - a. Sail



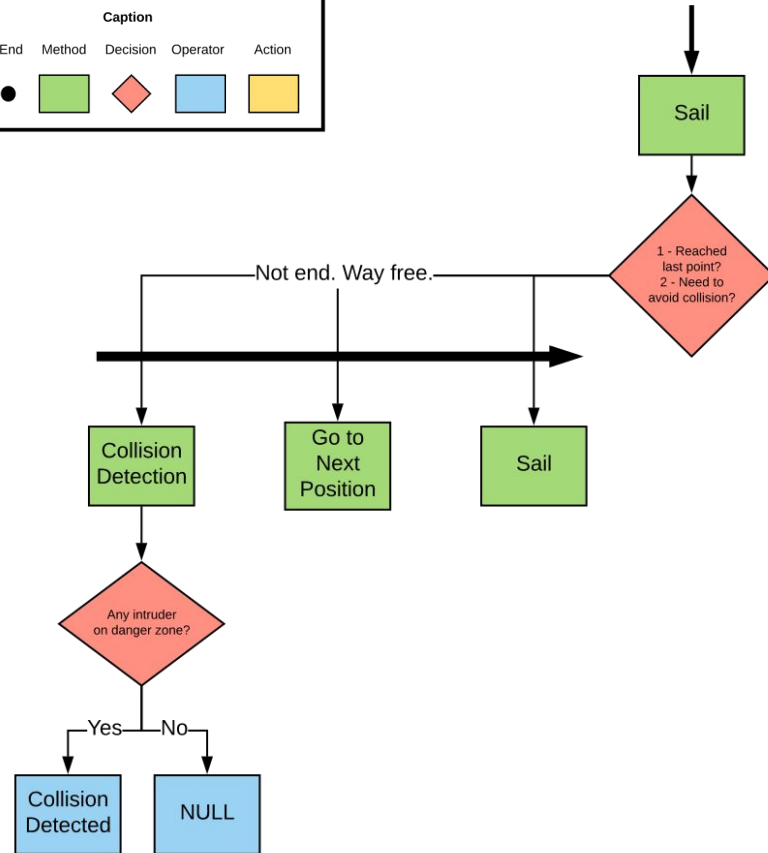
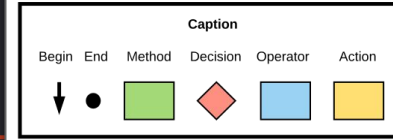
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 - a. Sail
 - b. Collision Detection
 - c. Go to the next position



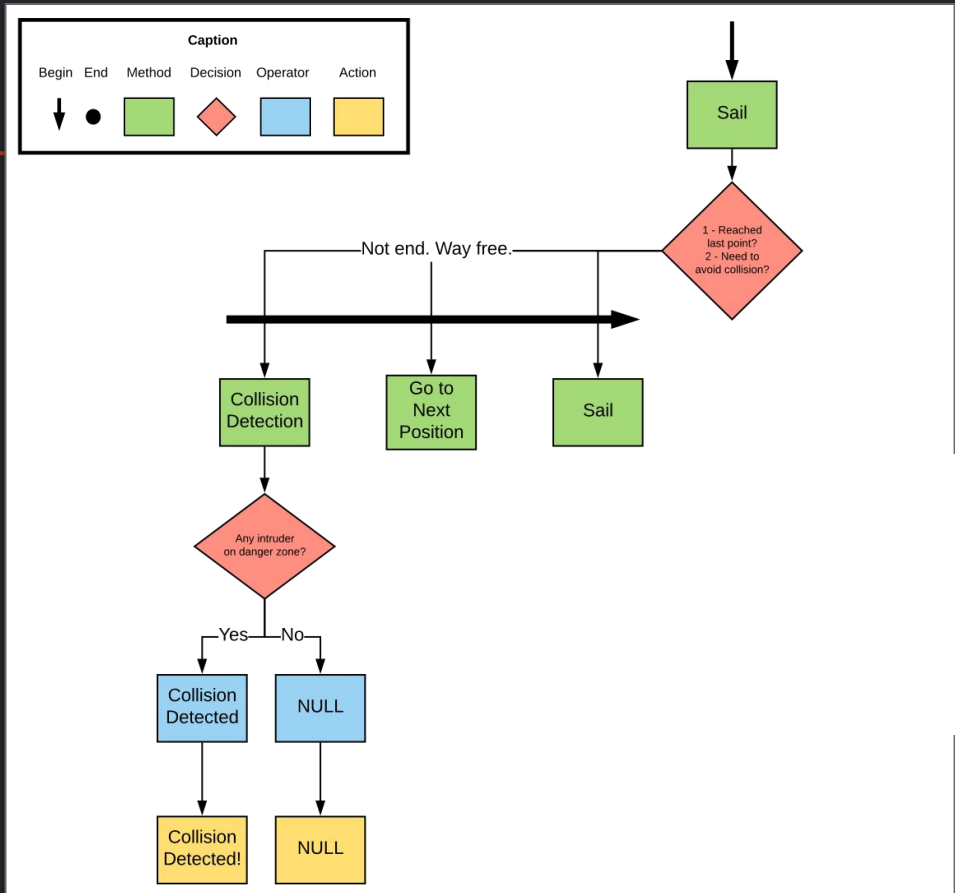
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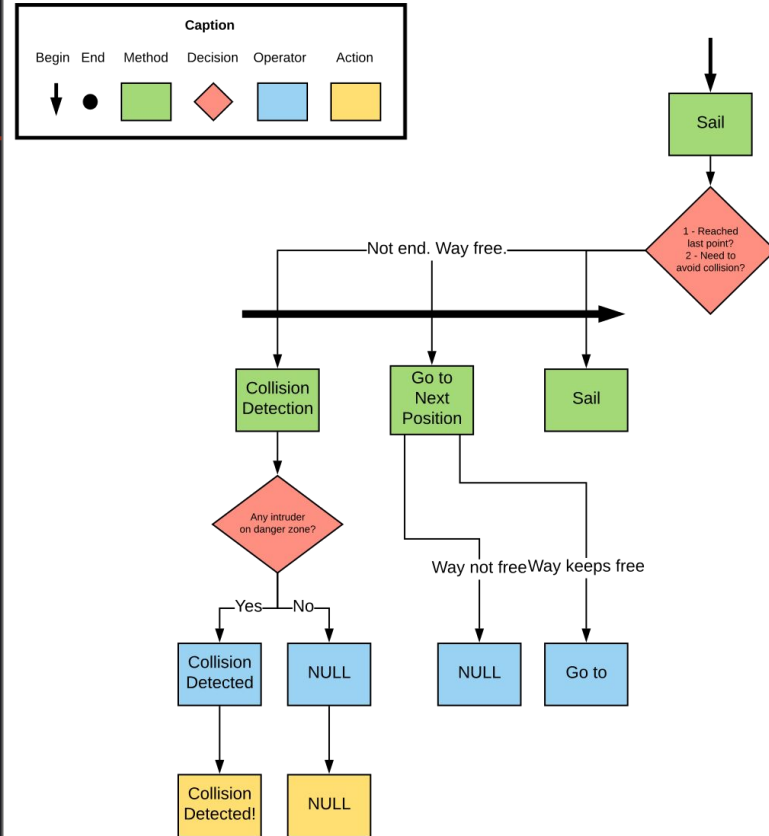
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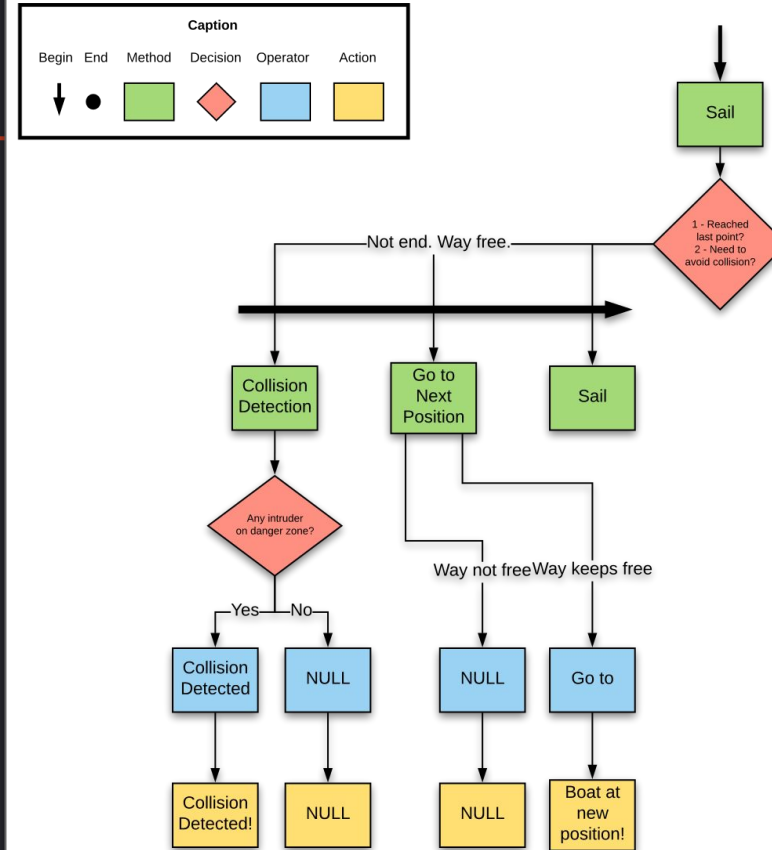
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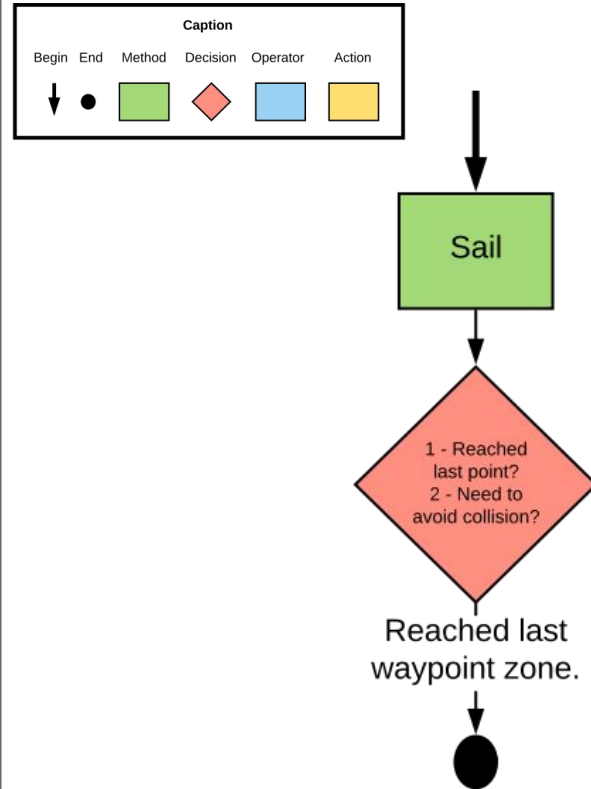
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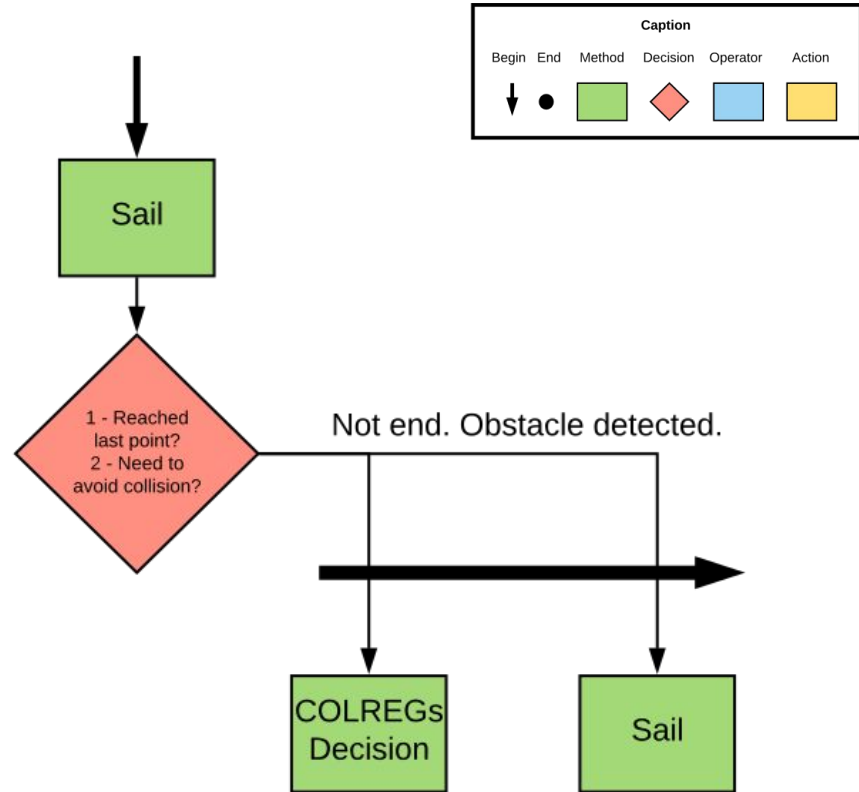
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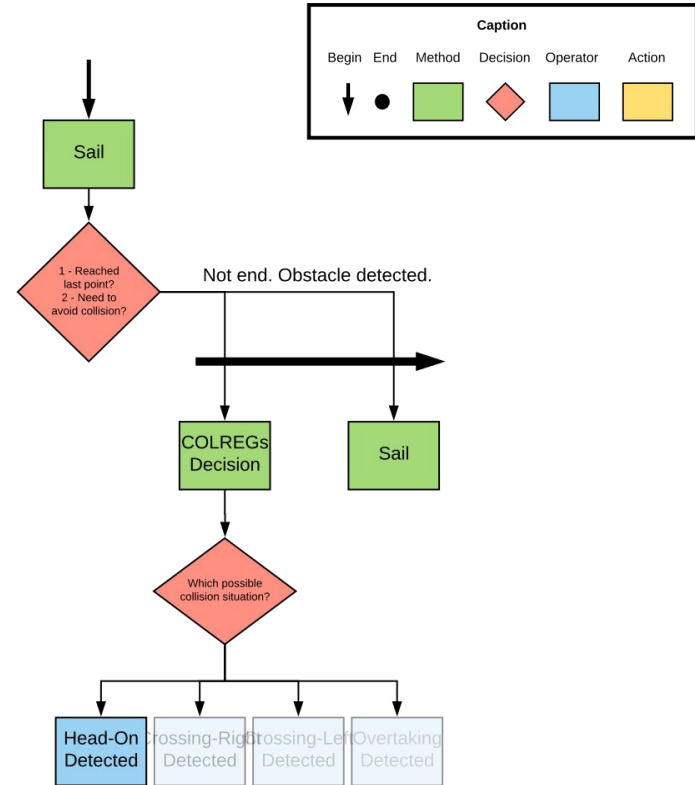
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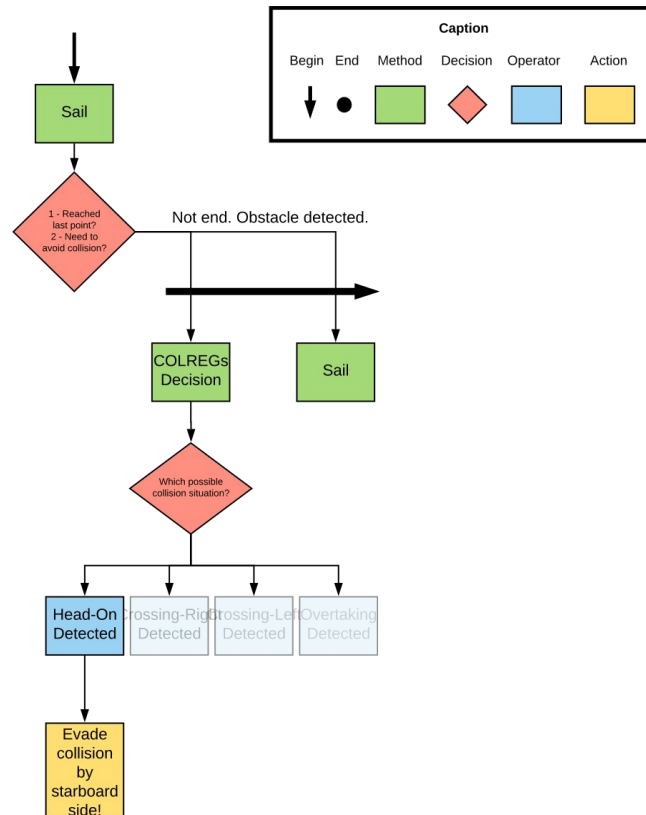
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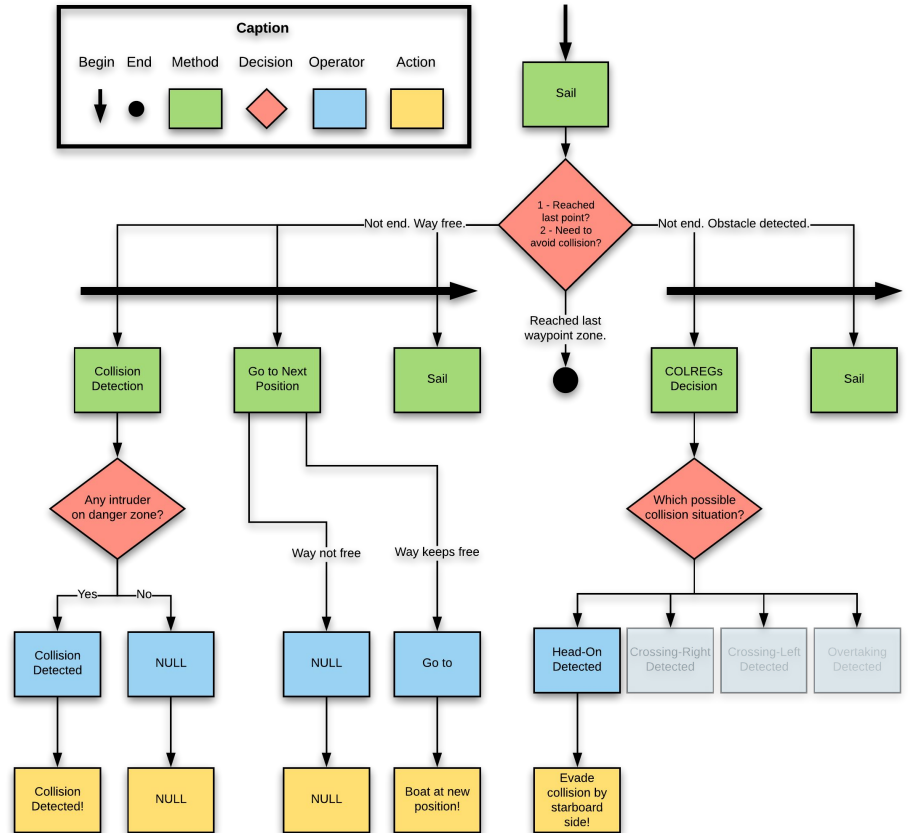
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DEVELOPED WORK

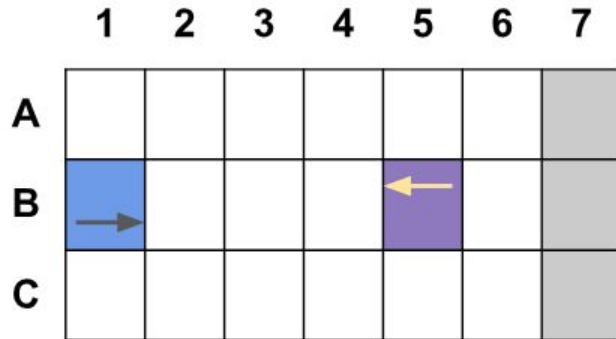
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EXPERIMENT

SIMPLE MISSION

Go ahead and stops when reached predefined end points.



EXPERIMENT

JSHOP 2 Output

Defined plan.

```
1 ] (!goto boat1 gc_b1 gc_b2)
2 ] (!goto boat1 gc_b2 gc_b3)
3 ] (!collision-detected boat1)
4 ] (!head-on-detected boat1 e)
5 ] (!goto boat1 gc_c4 gc_c5)
6 ] (!goto boat1 gc_c5 gc_c6)
7 ] (!goto boat1 gc_c6 gc_c7)
```

Conclusion and Future Work

CONCLUSION

- Integration done

FUTURE WORK

- More realistic environment description based on
 - LiDAR
 - Roger's work
- Implementation of other danger situation such as
 - Overtaking
 - Crossing
 - Encounter between different types of ships
 - Coastal proximity
 - Narrow Channels
- Waypoints
- ROSPlan

Thanks!

Q&A