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Reliable Plan Selection with Quantified Risk-Sensitivity

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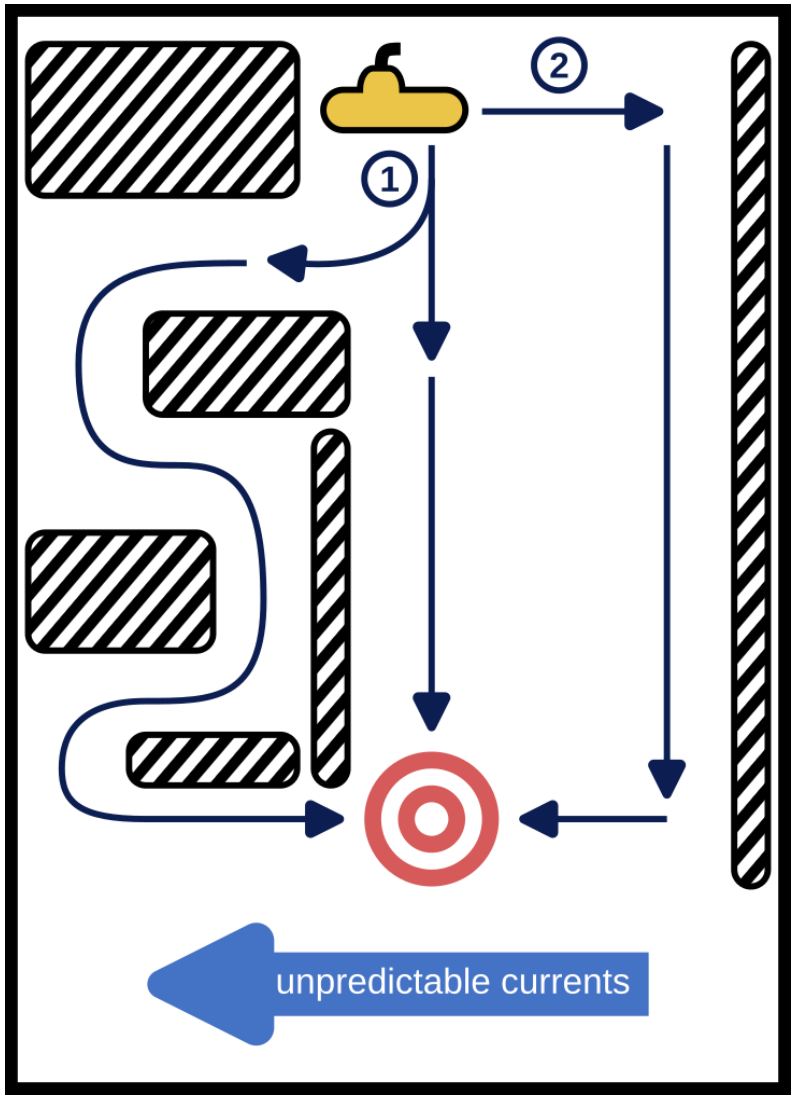
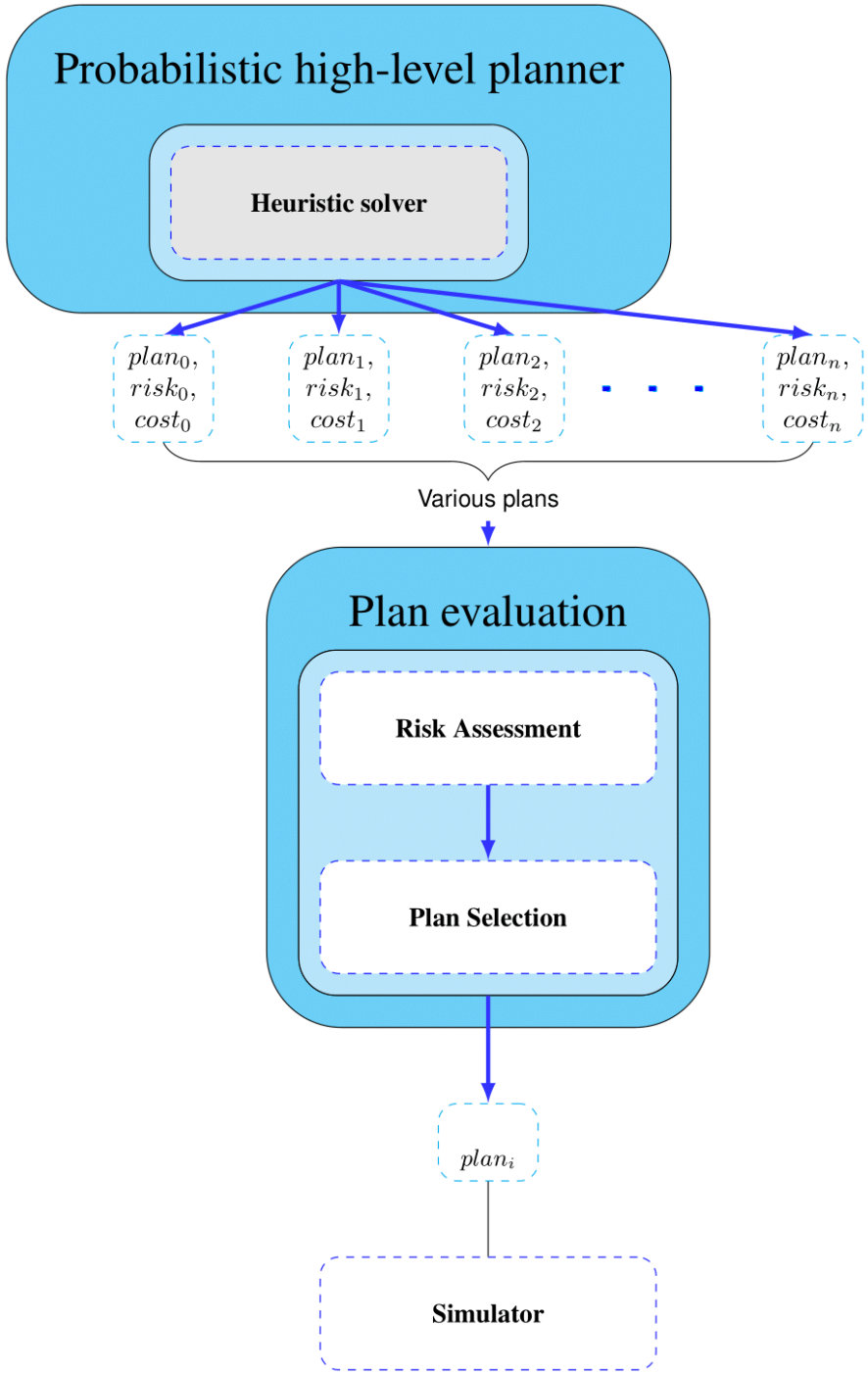
REMARO
RELIABLE AI FOR MARINE ROBOTICS

Risk-sensitive Planning



- Inspiration paper: Koenig, Sven, and Reid G. Simmons. "How to make reactive planners' risk-sensitive."
- Transformed MDP using an exponential utility function
- To have a safe plan, we need to consider risk-averse of above function

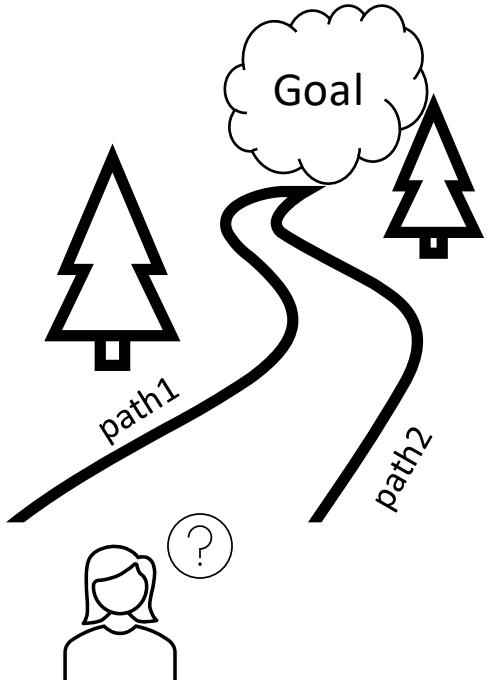
Proposed Framework



Probabilistic Planning

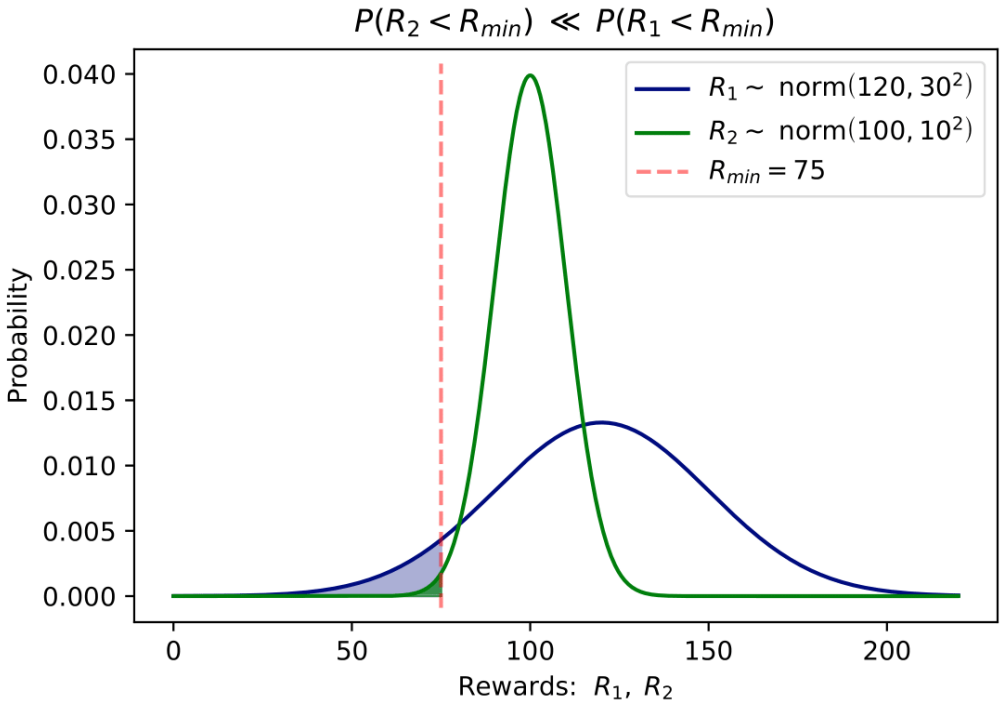
It’s great when a plan works …

… but world doesn’t work like that.



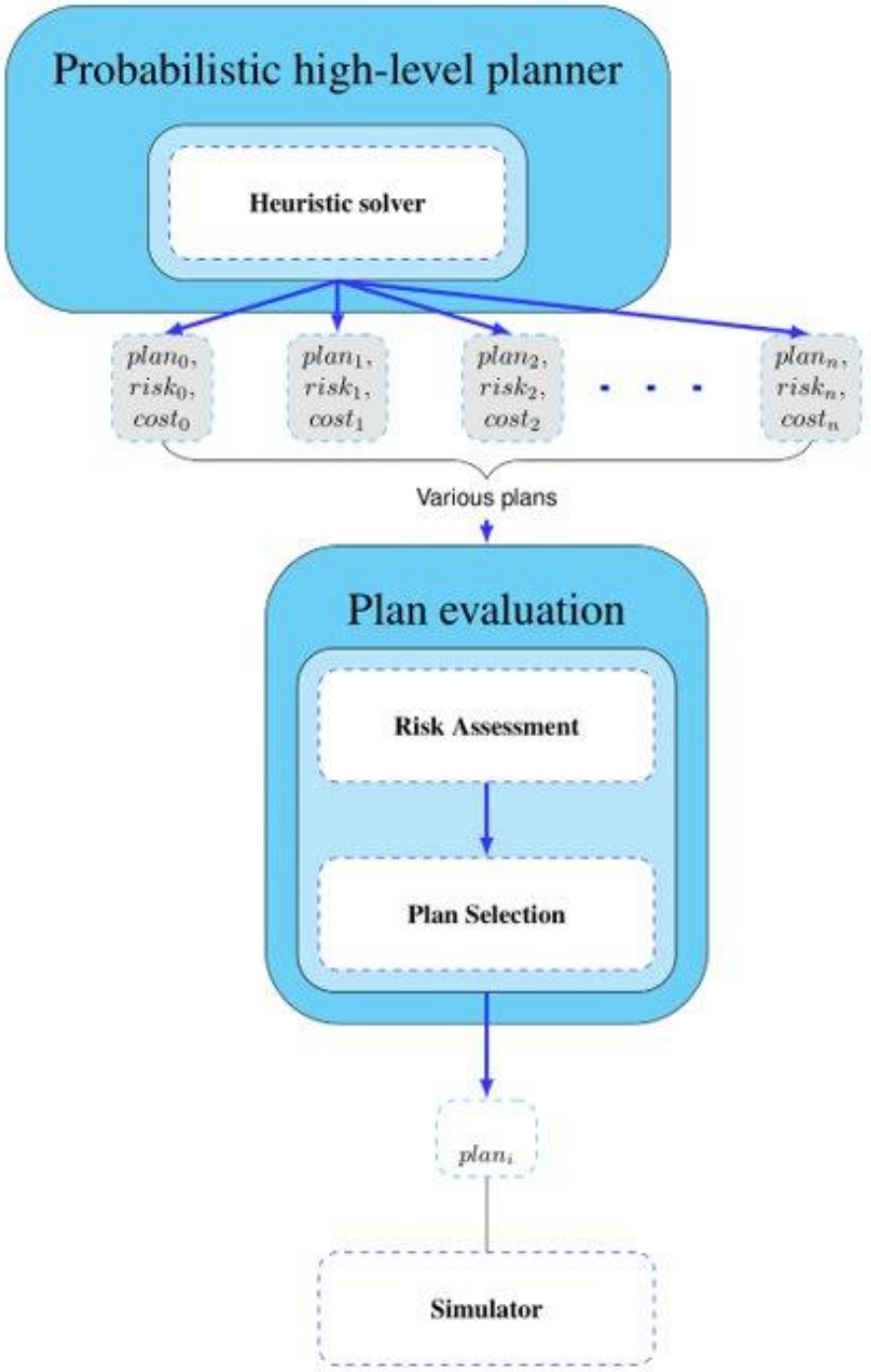
To plan effectively we need to take uncertainty seriously.

Comparison between Two Plans



Reward comparison between two plans using risk metric, e.g. variance

Proposed Framework



Planning & Transformation Example

```
(:action waypoint-following
  :parameters (?from ?to)
  :precondition (position ?from)
  :effect (probabilistic 0.9 (and
     (position ?to)
     (not (position ?from))
     (increase (reward) 2)
  ))
)
```

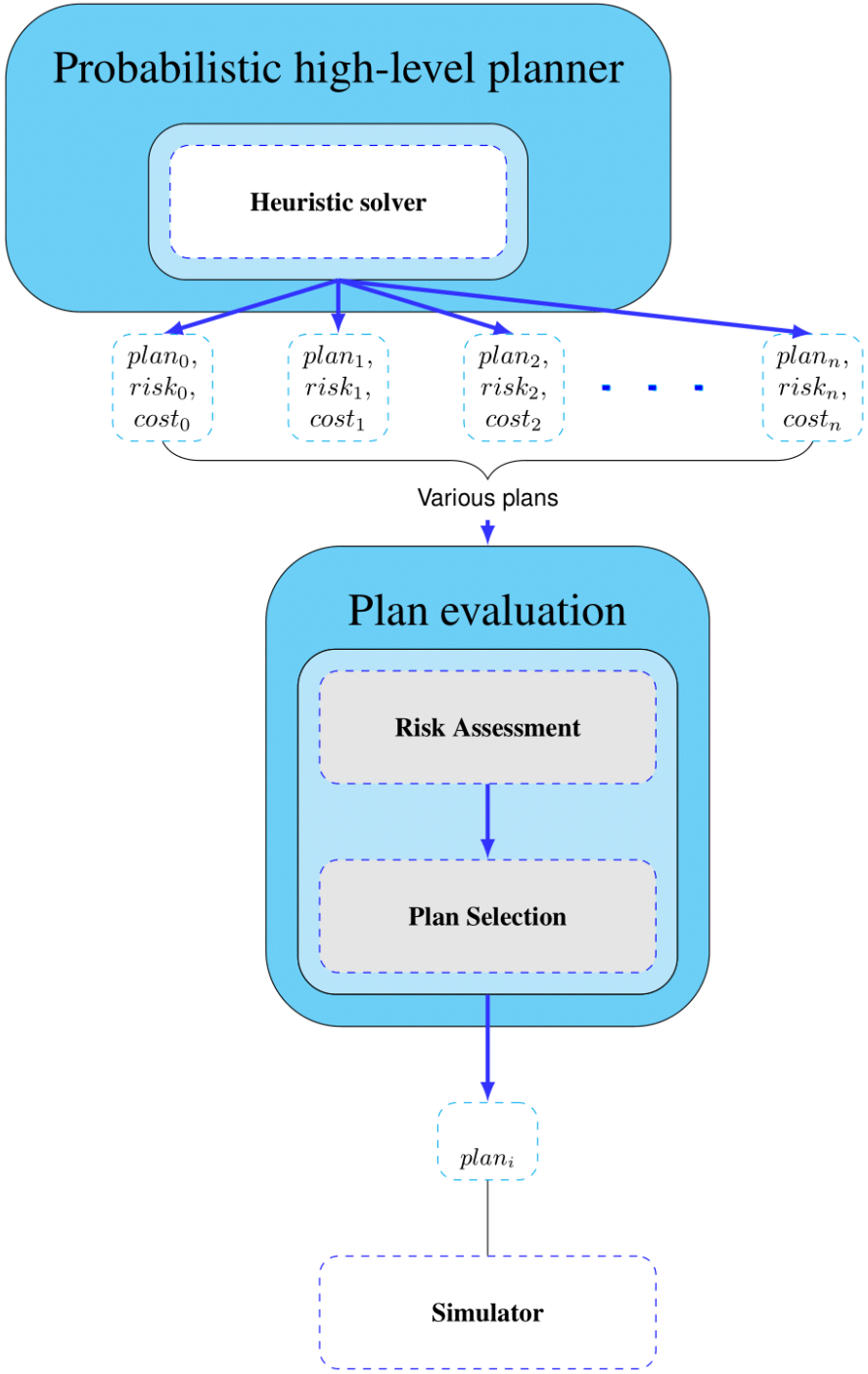
(a) before transformation

```
(:action waypoint-following
  :parameters (?from ?to)
  :precondition (position ?from)
  :effect (probabilistic -0.225 (and
     (position ?to)
     (not (position ?from))
  ))
)
```

(b) after transformation

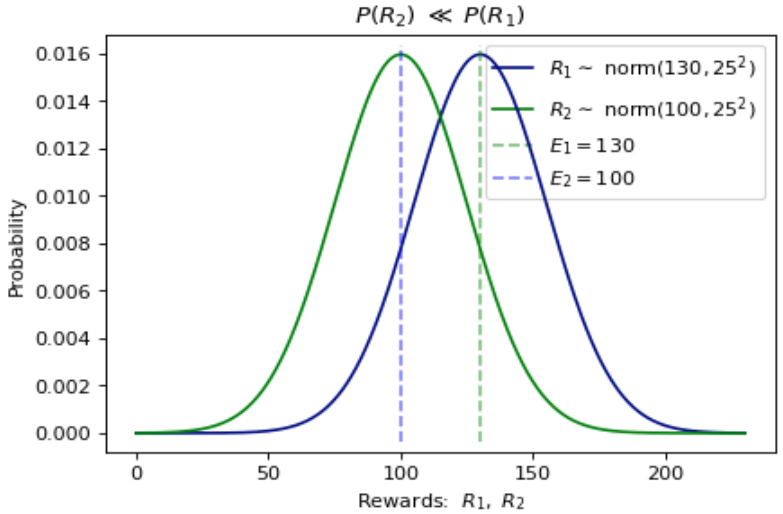
Let's consider $\delta = 0.5$,
1 action: waypoint-following
Rewards: {+2}

Proposed Framework

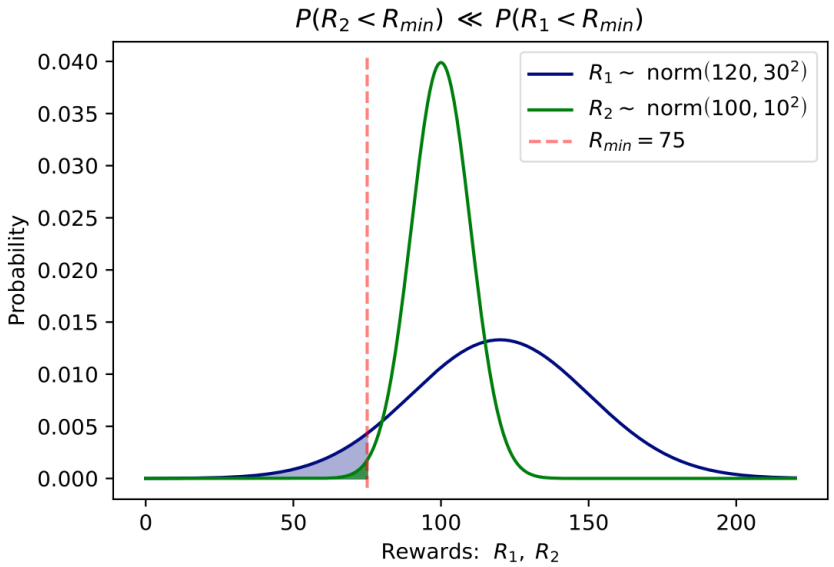


Plan Selection

- Expected reward

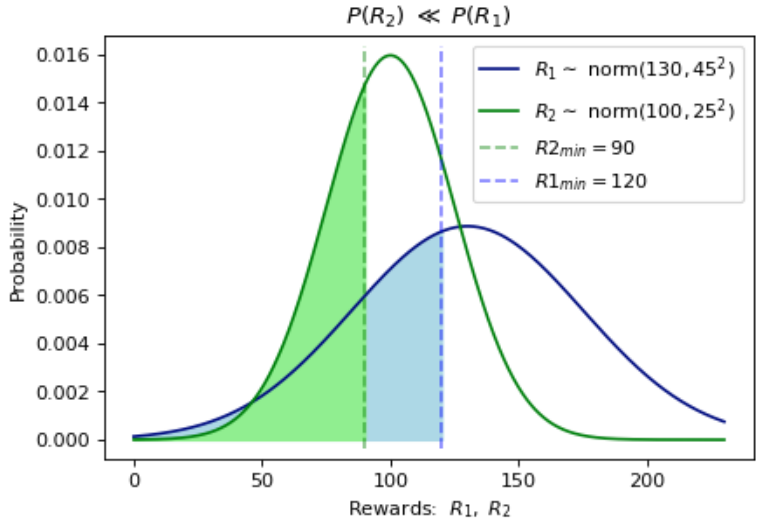


- Variance of the reward

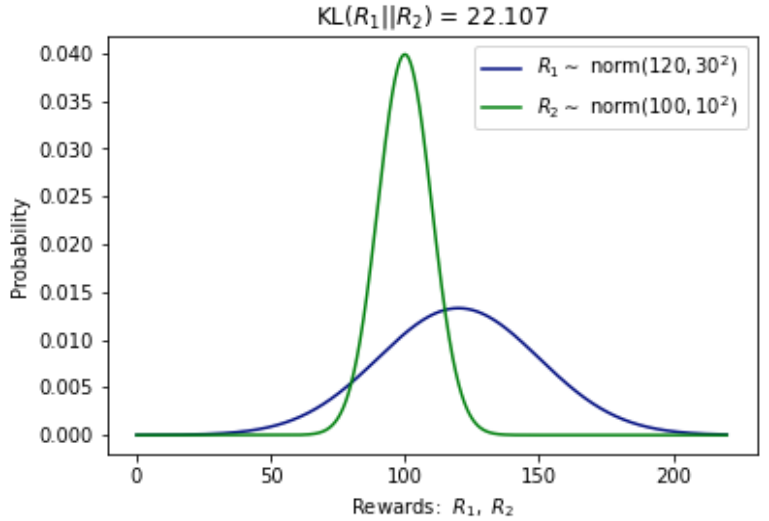


Plan Selection

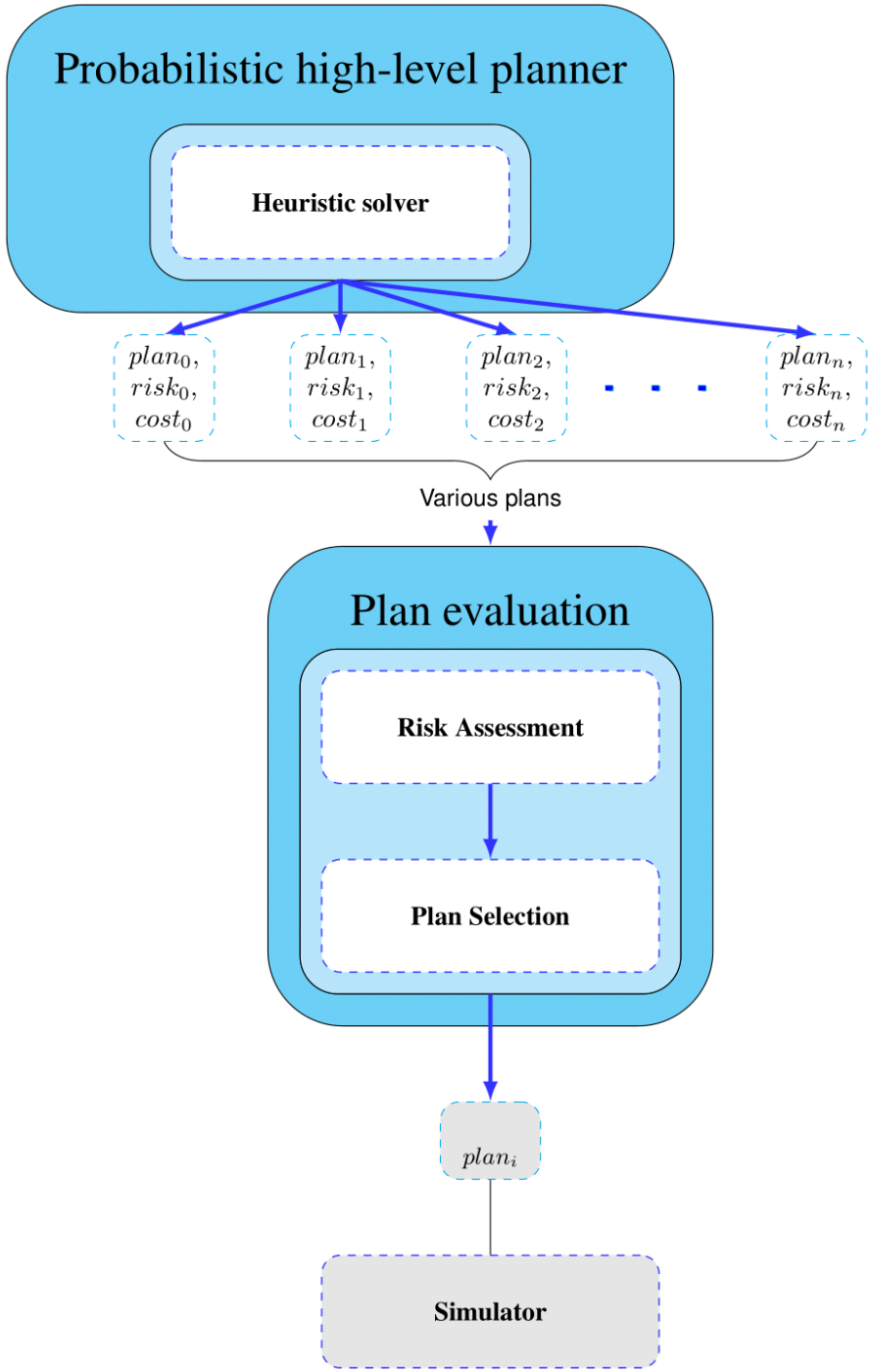
- Reward-bounded probability



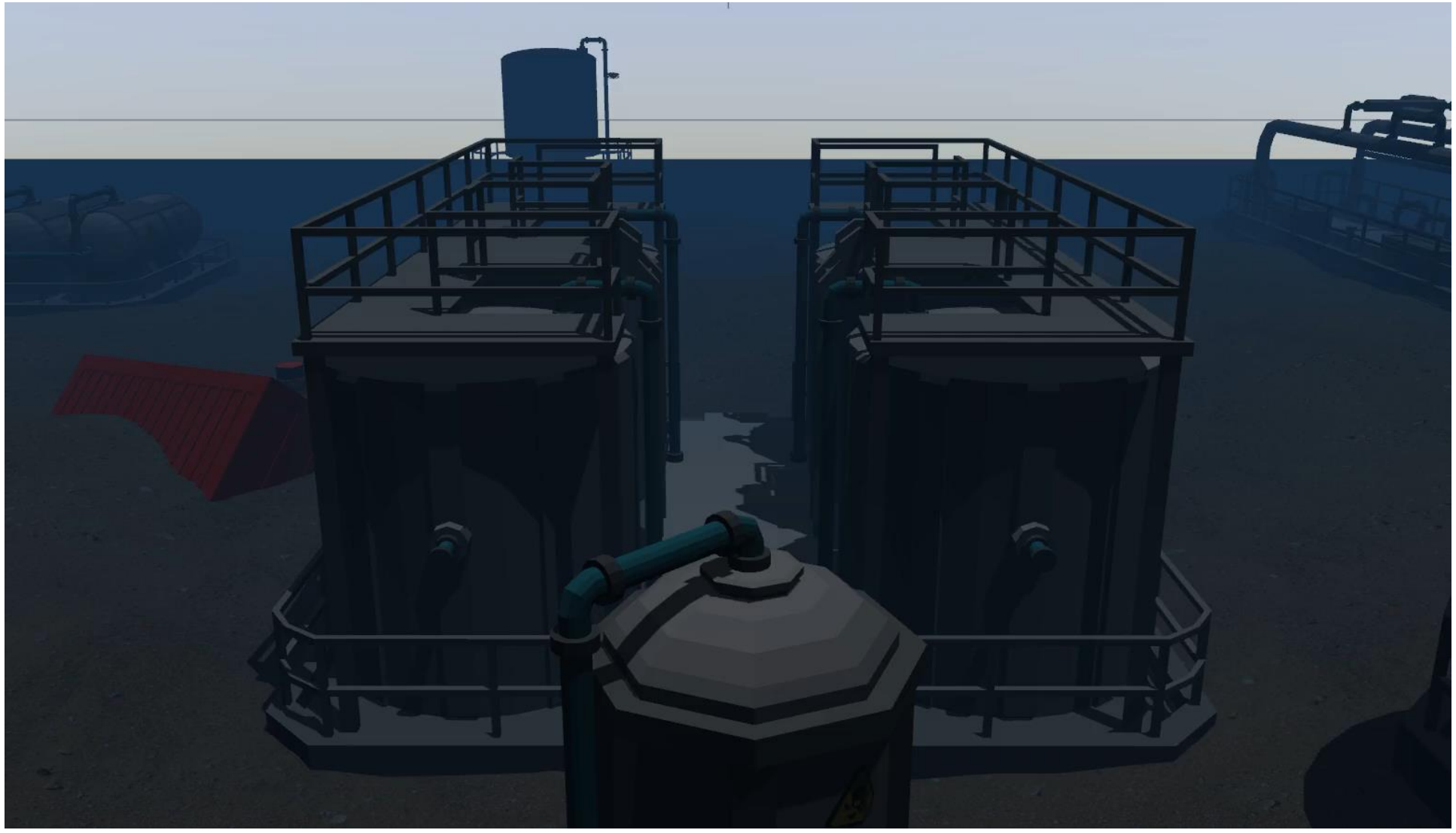
- Entropy of reward



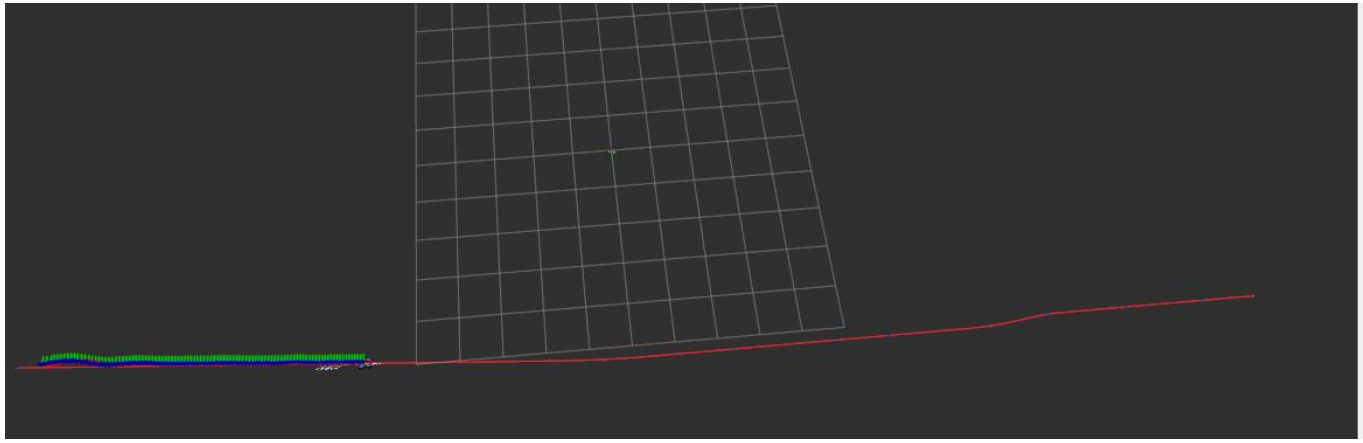
Proposed Framework

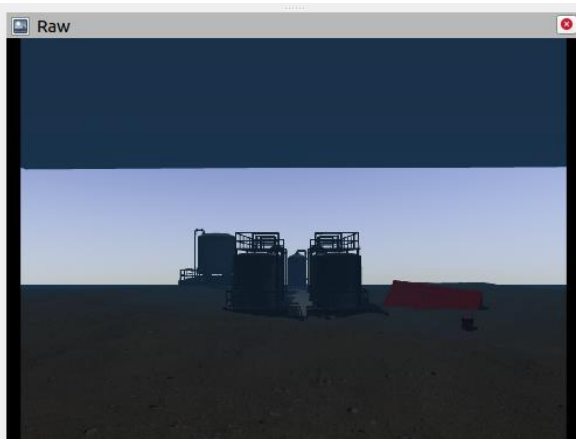


Subsea Infrastructure Inspection Scenario

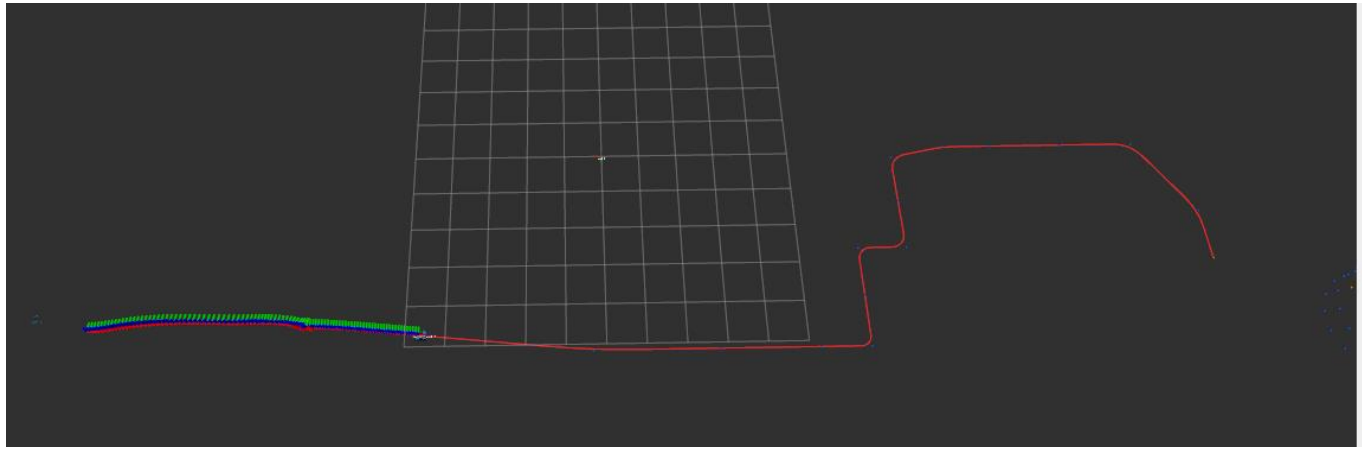


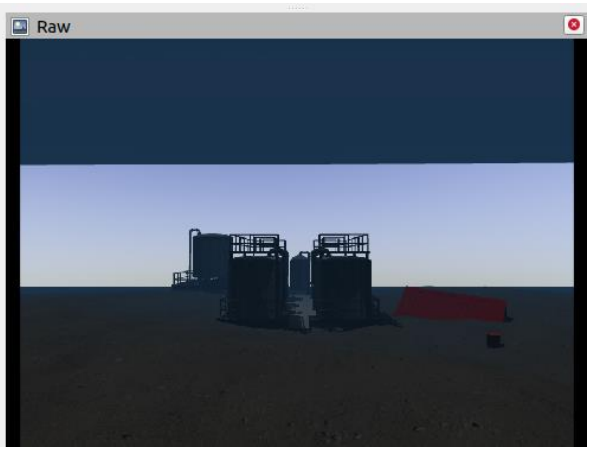
Dangerous Path vs Safe Path





Shortest but dangerous one





Safer but longer path

Conclusion

- Common risk-neutral planners' issue is those optimize planning problem w.r.t. time step
- Modeling transformed MDP with risk-sensitive utility
- Utilizing new model in PPDDL programming language format

Future work:

- Developing and leveraging an integrated risk-sensitive plan selection in risk-neutral probabilistic planner
- Evaluating generated plans using introduced metrics