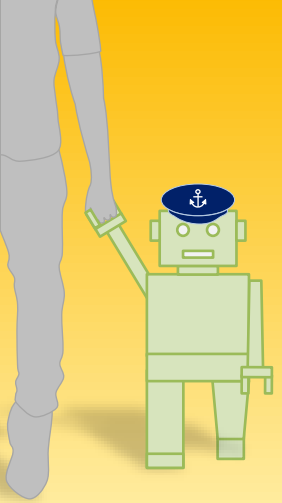
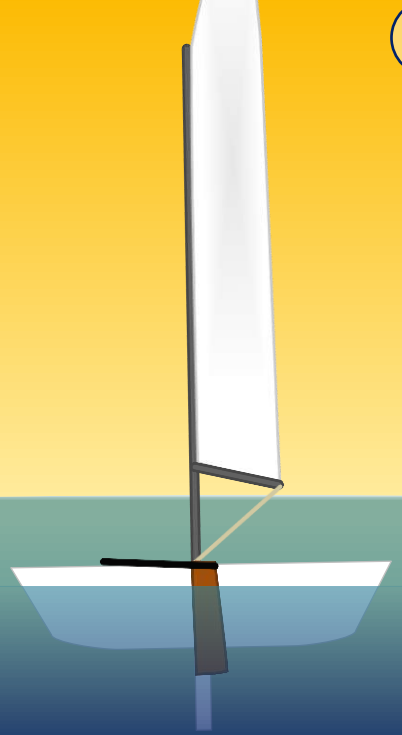
Workshop AI sail





MARIN

MARIN

BETTER SHIPS, BLUE OCEANS

Context

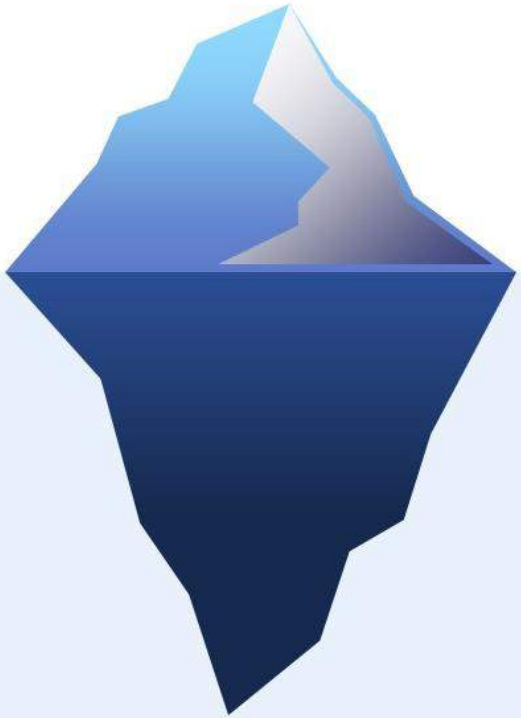
Intro to AI sail & RL

Sailing without knowing the details of physics

Why?

Explicit

Books
Equations

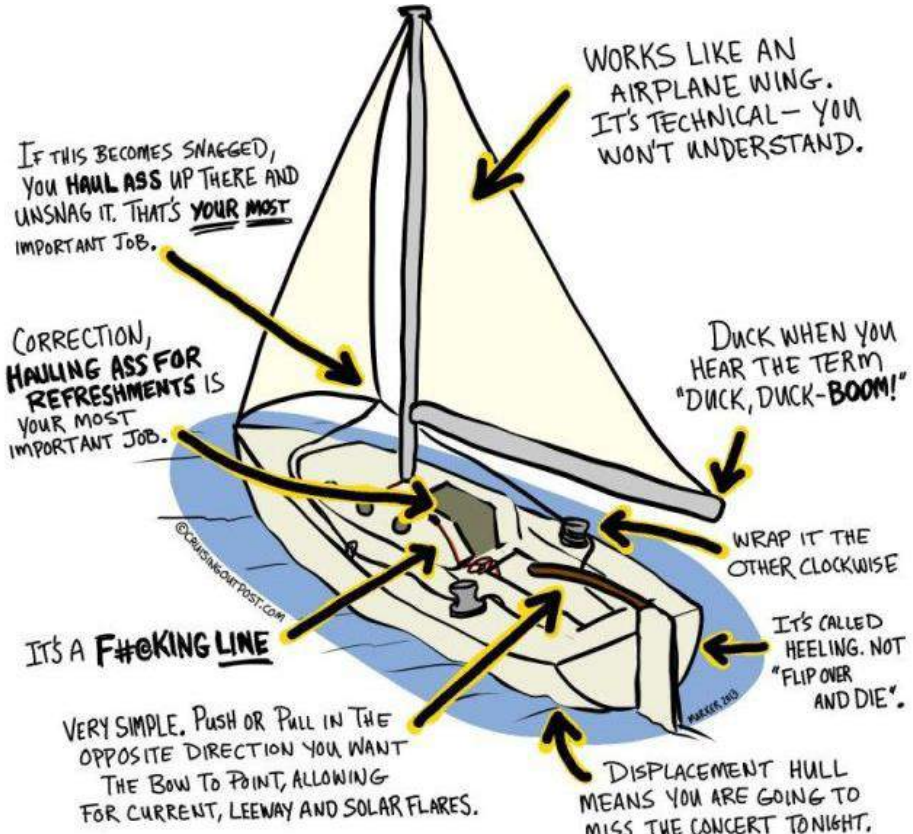


Implicit

Instinct
Feeling

Explaining implicit knowledge is not easy

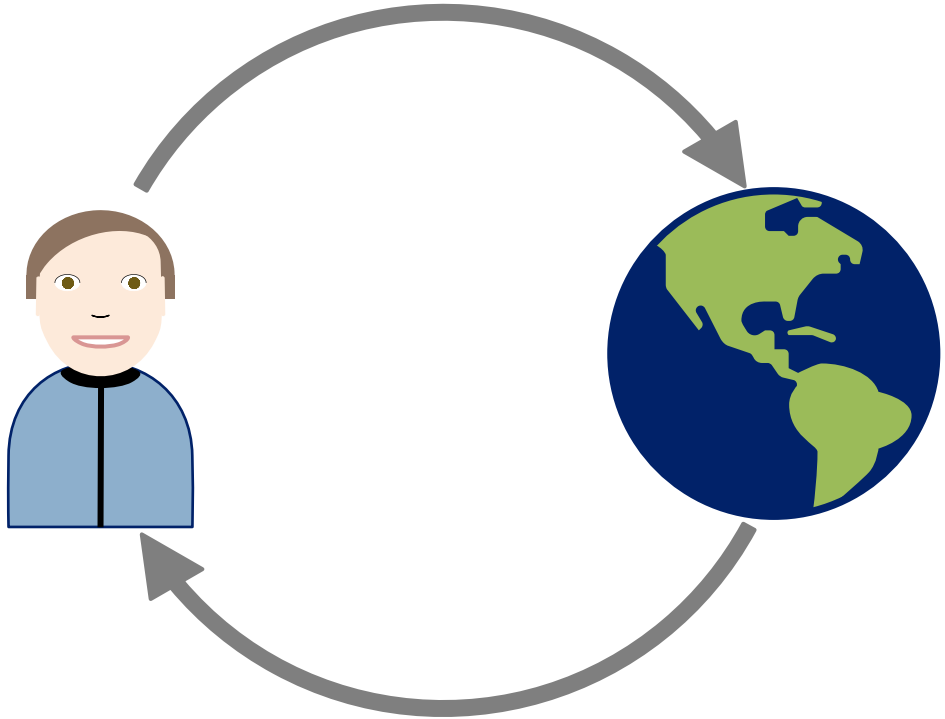
"How I explain sailing to my guests"



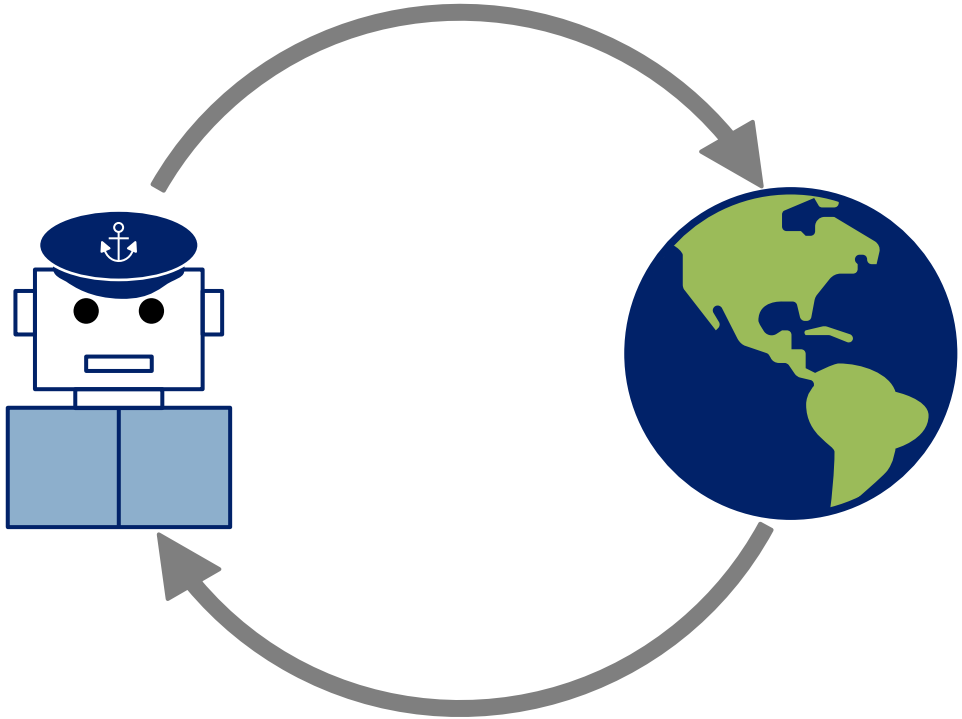
Latitudes & Attitudes magazine (2013) How I explain sailing to my guests, https://latsatts.com/2013/02/explain-sailing-graphic/explaining-sailing-to-guests/

How do kids learn?

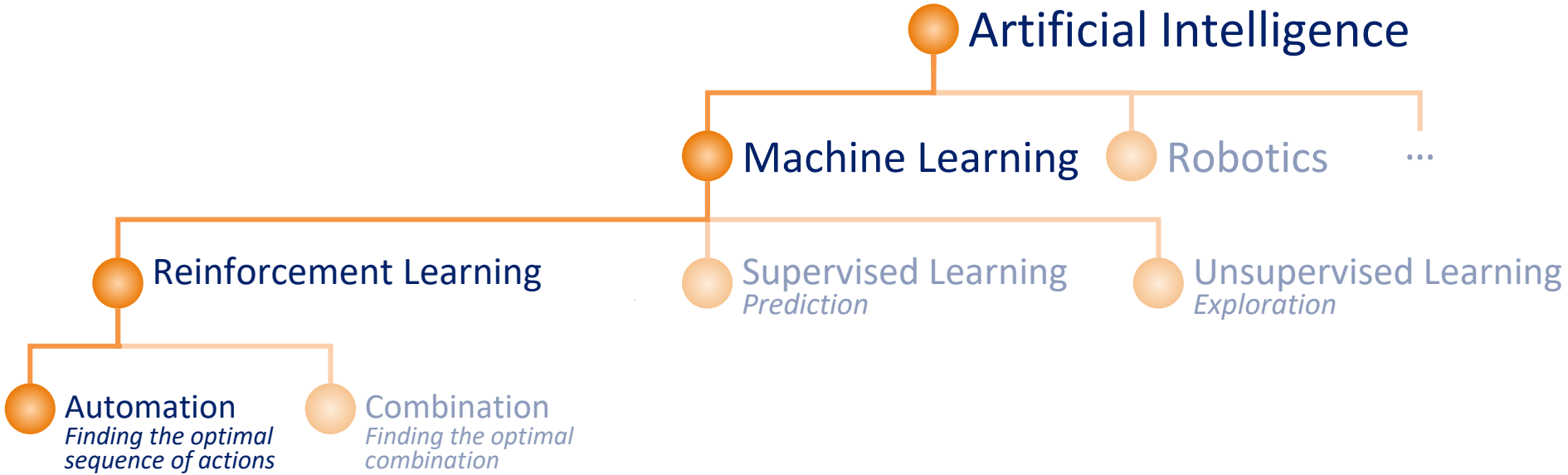
Reinforcement Learning



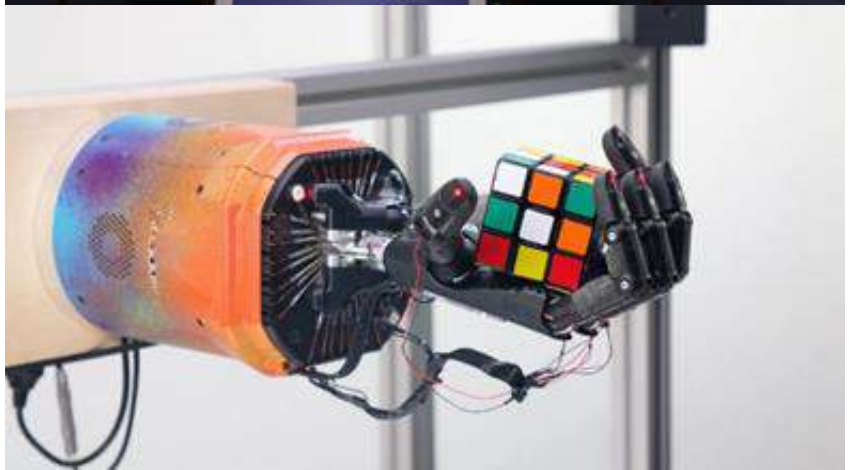
Reinforcement Learning



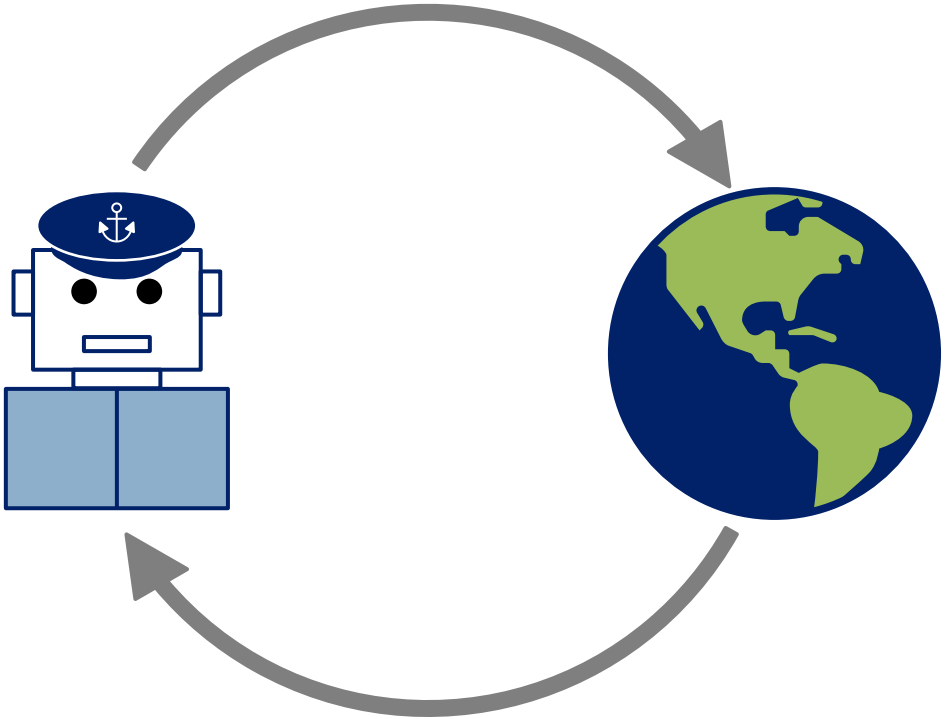
Reinforcement Learning



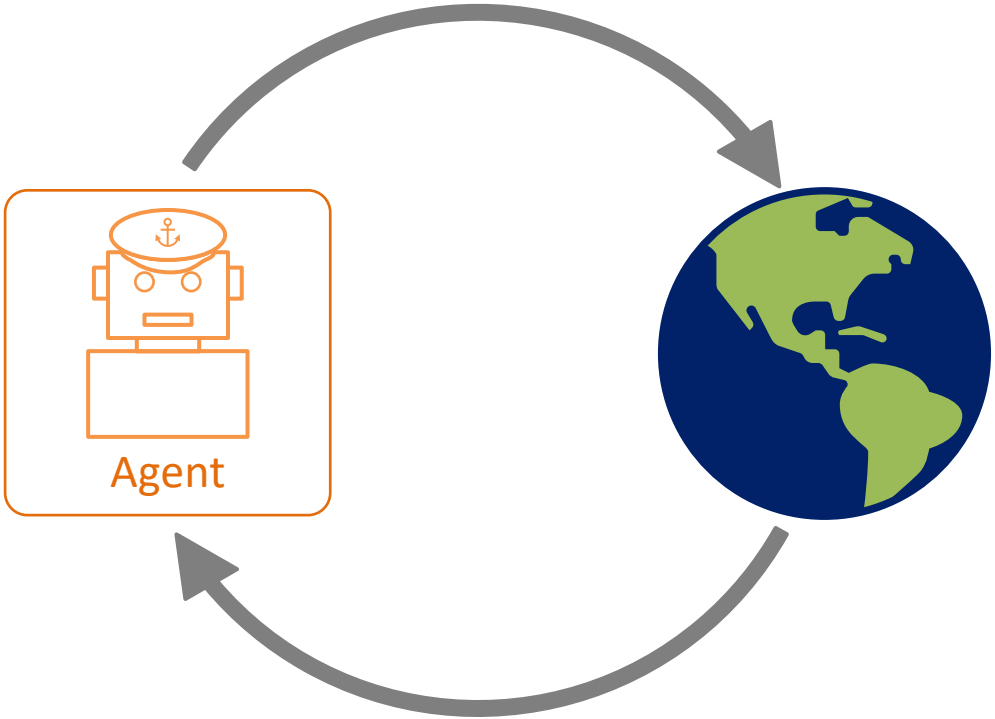
Success stories



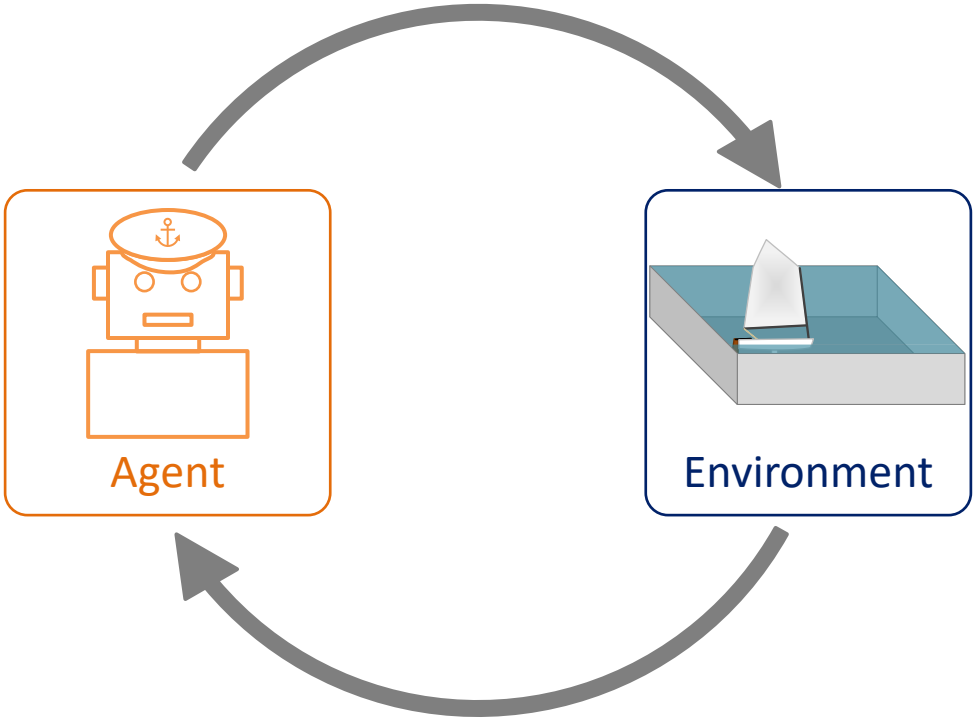
Interactions



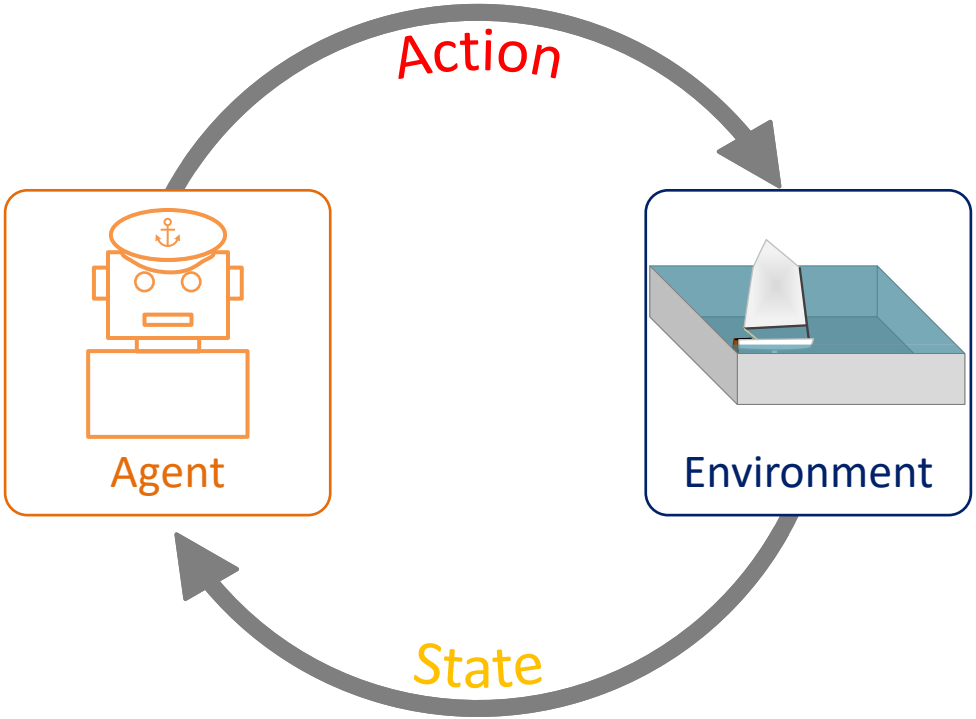
Interactions



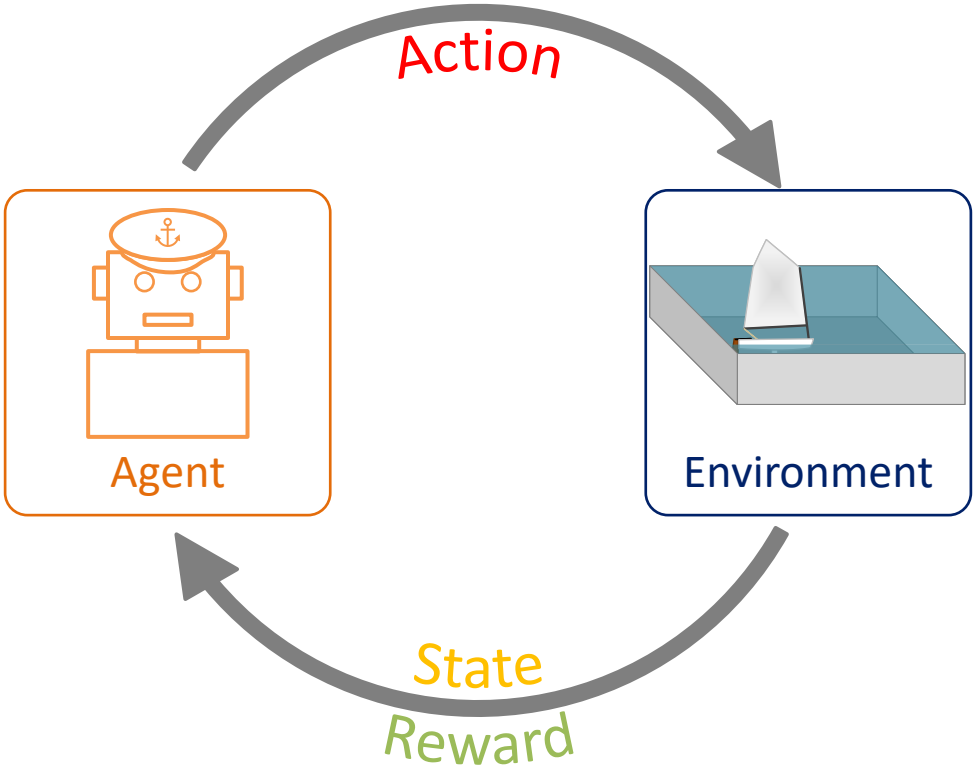
Interactions



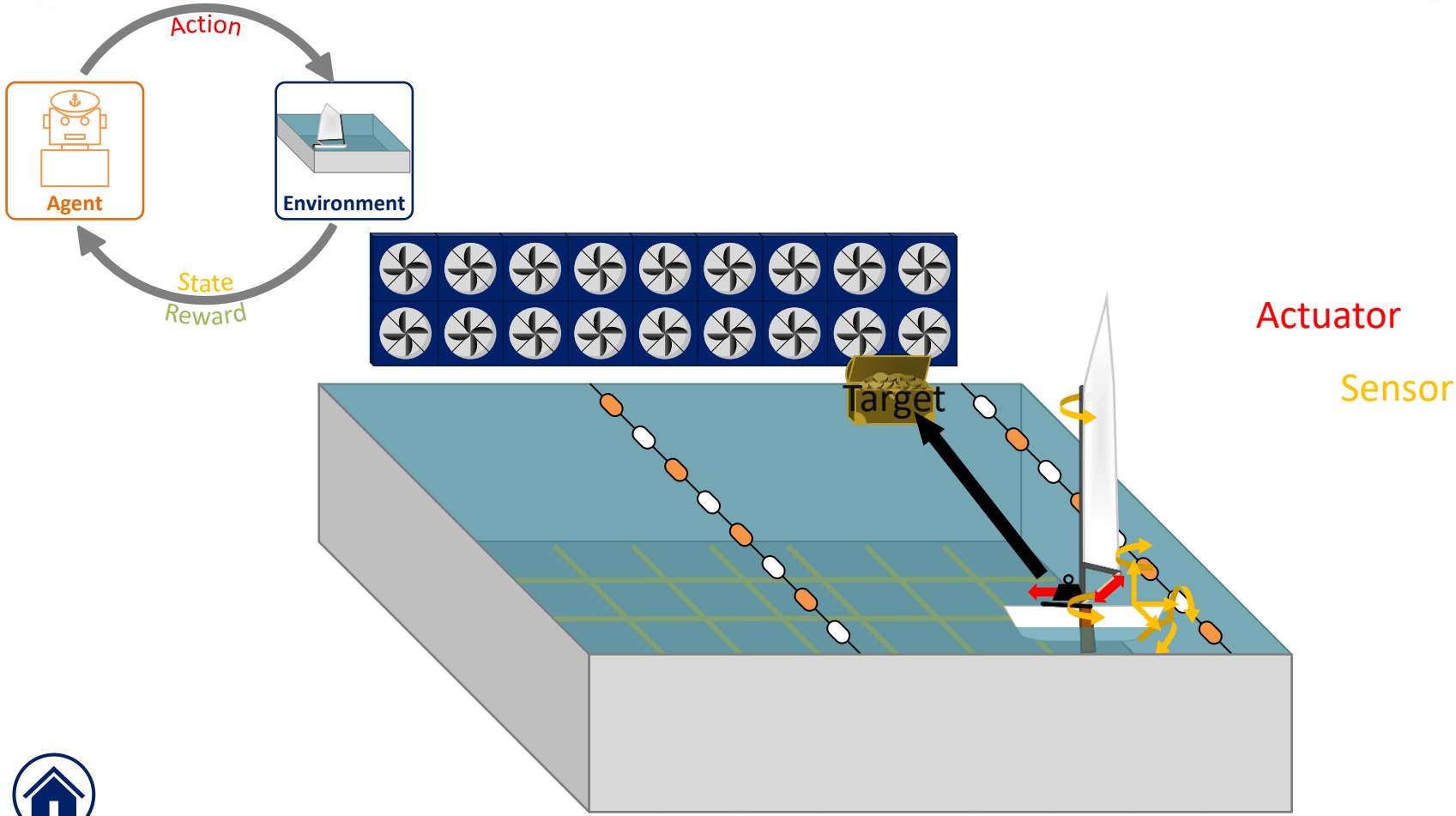
Interactions



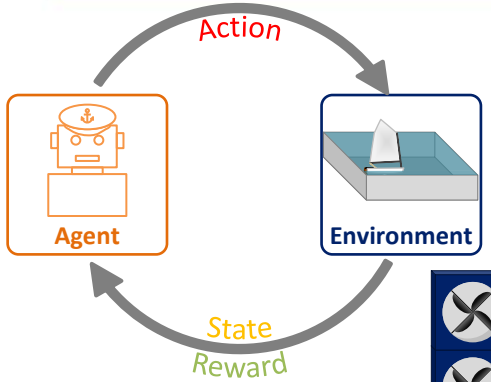
Interactions

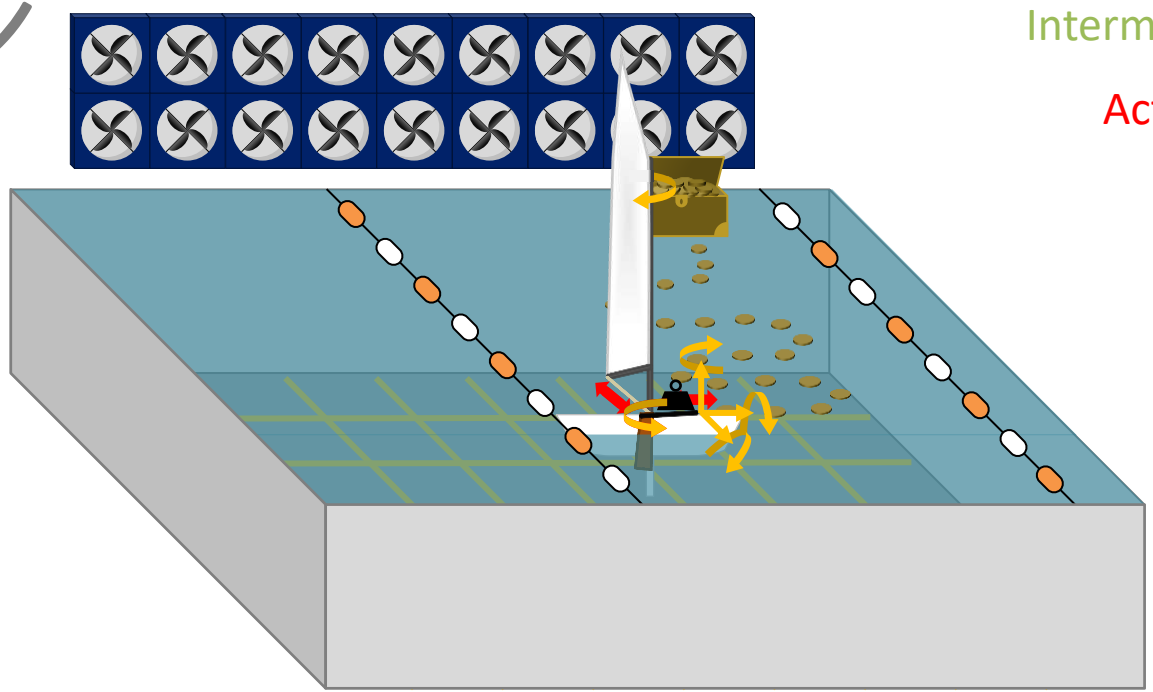


Interactions



Interactions



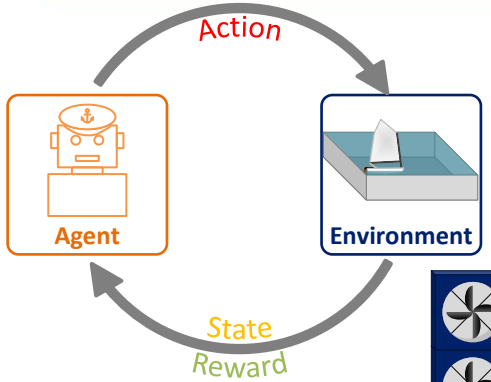


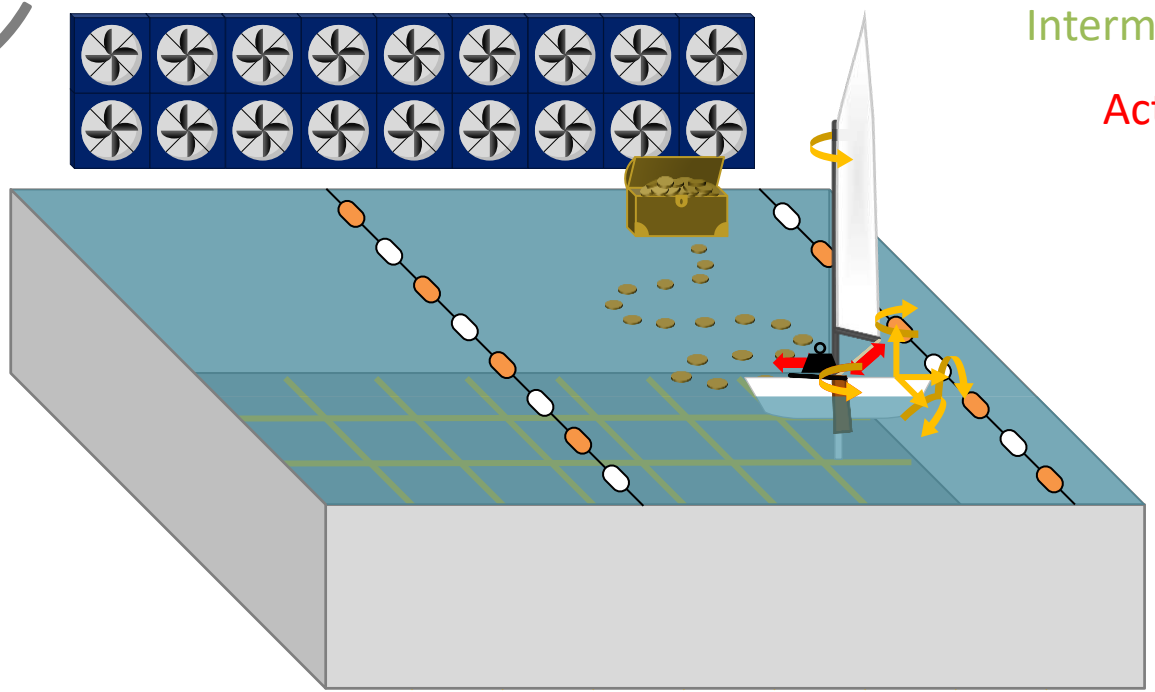
Intermediate reward

Actuator

Sensor

Interactions



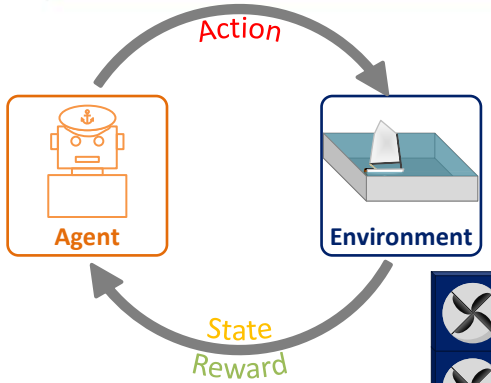


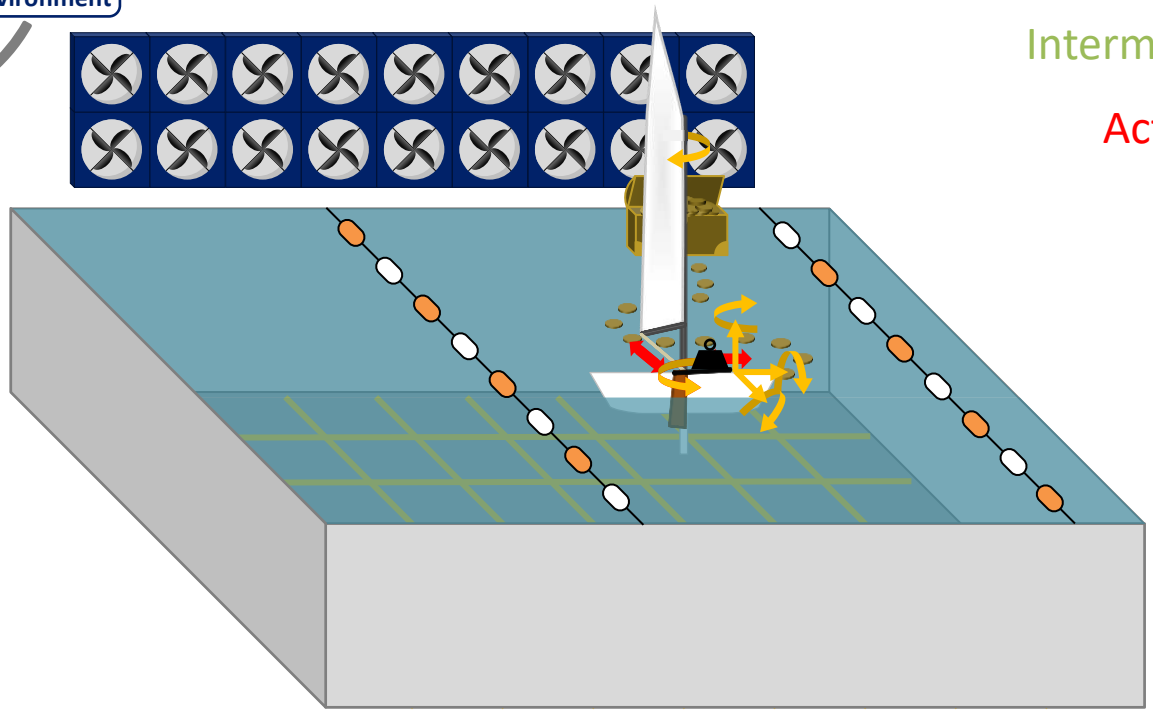
Intermediate reward

Actuator

Sensor

Interactions



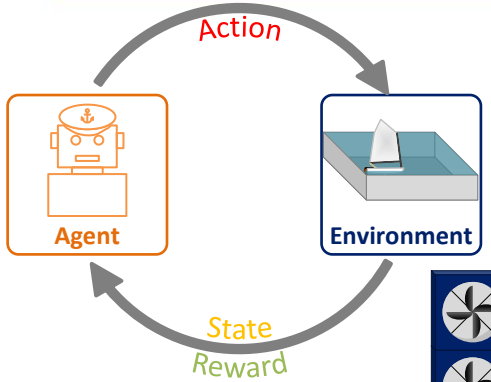


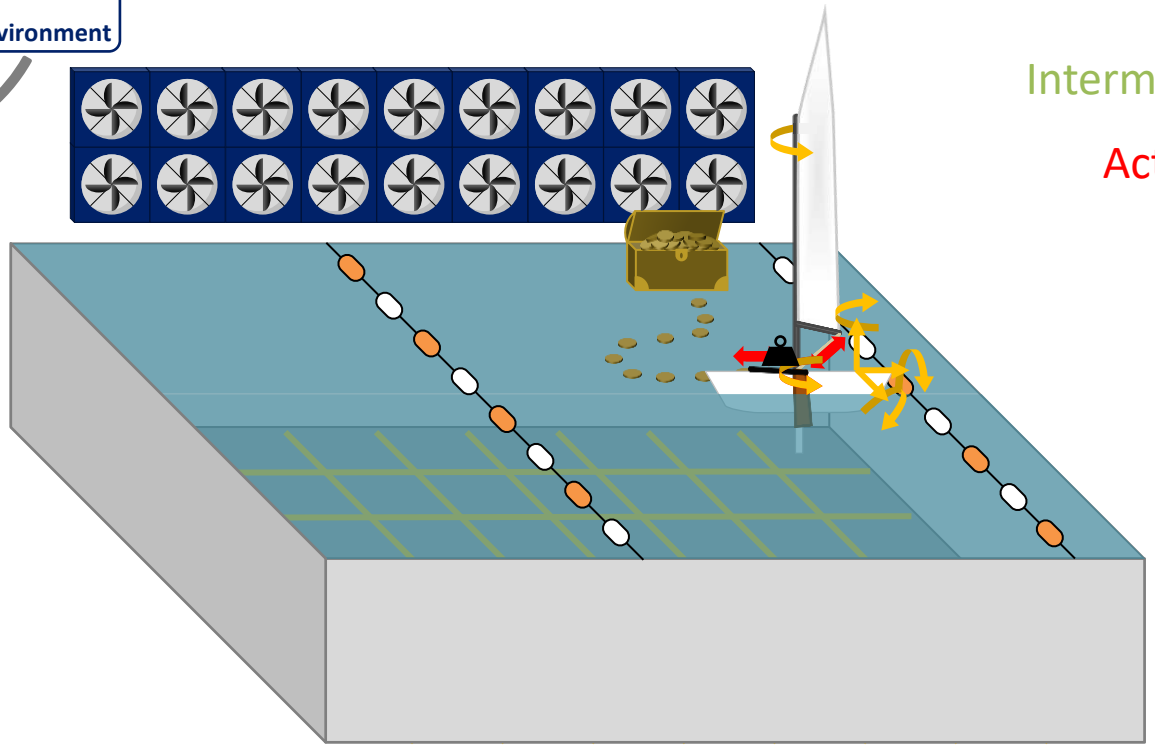
Intermediate reward

Actuator

Sensor

Interactions



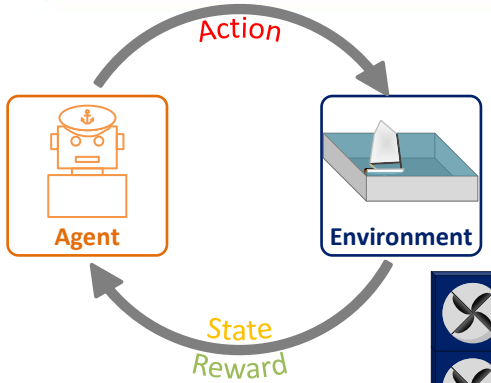


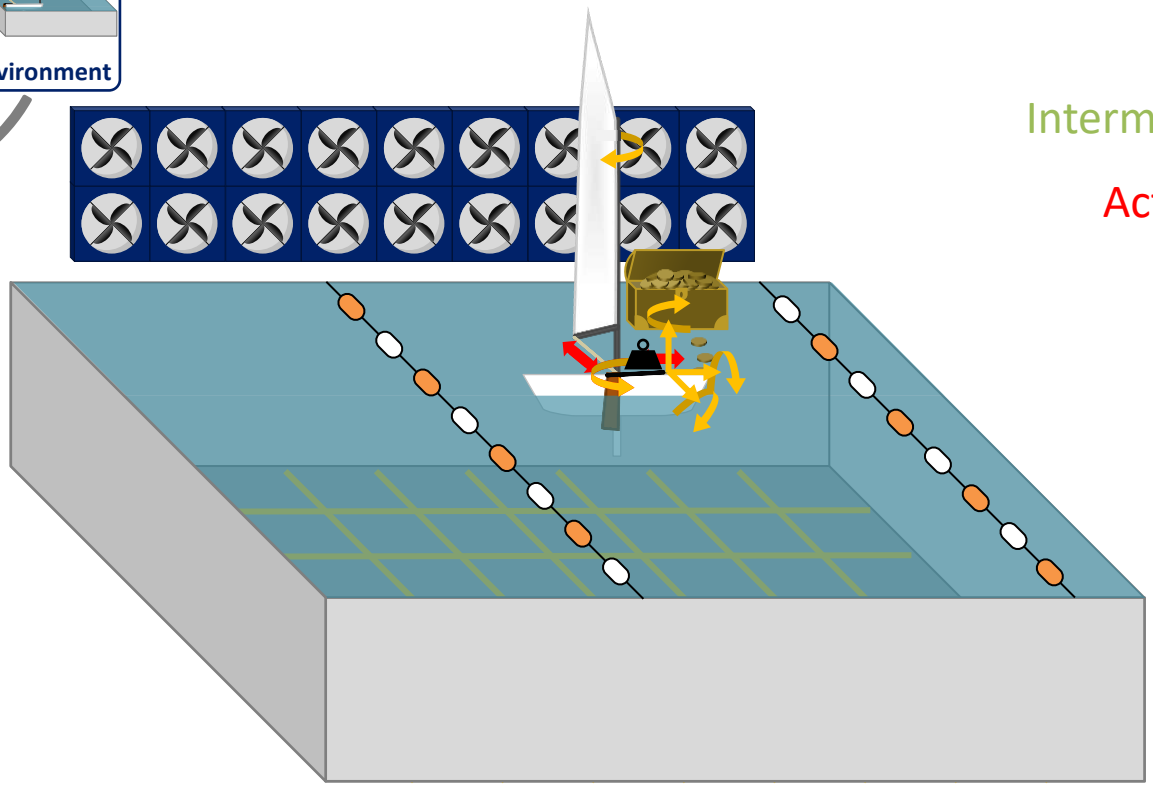
Intermediate reward

Actuator

Sensor

Interactions



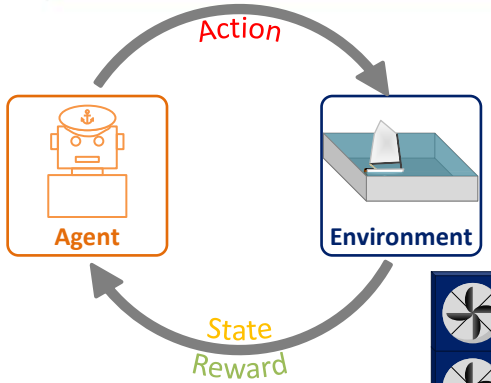


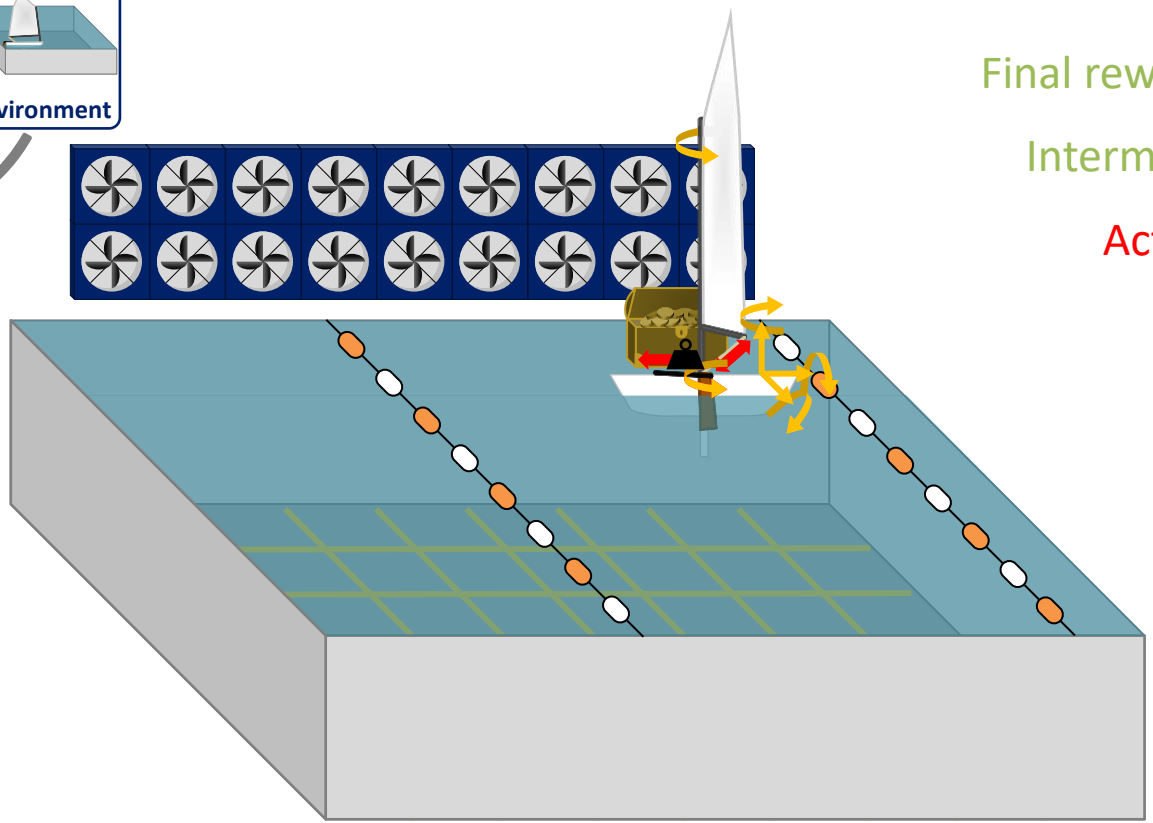
Intermediate reward

Actuator

Sensor

Interactions





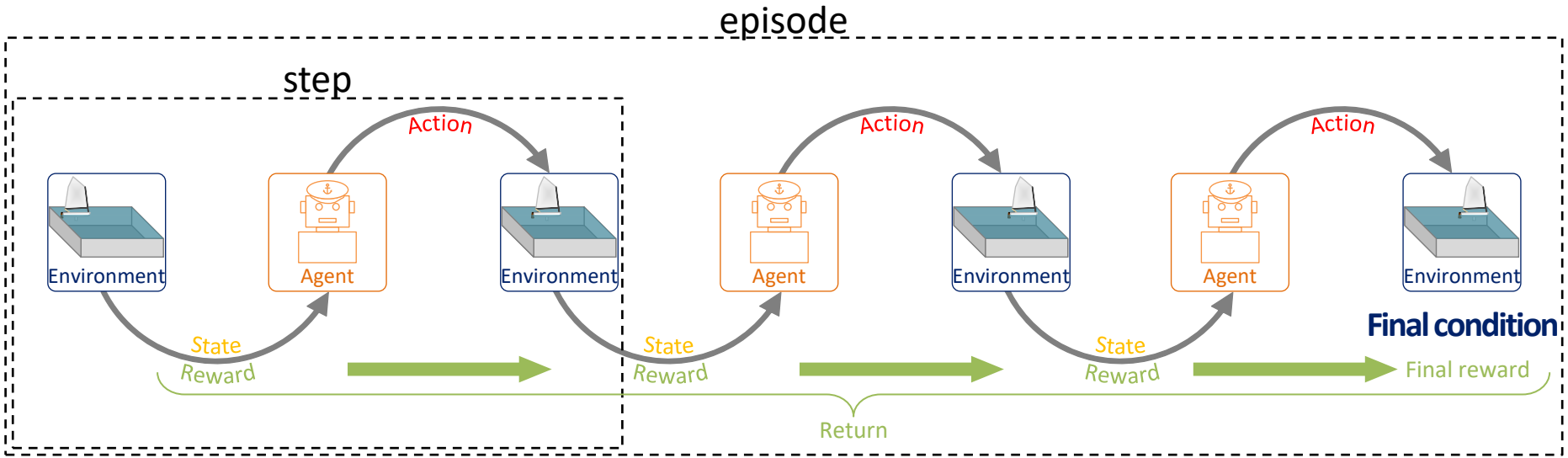
Final reward

Intermediate reward

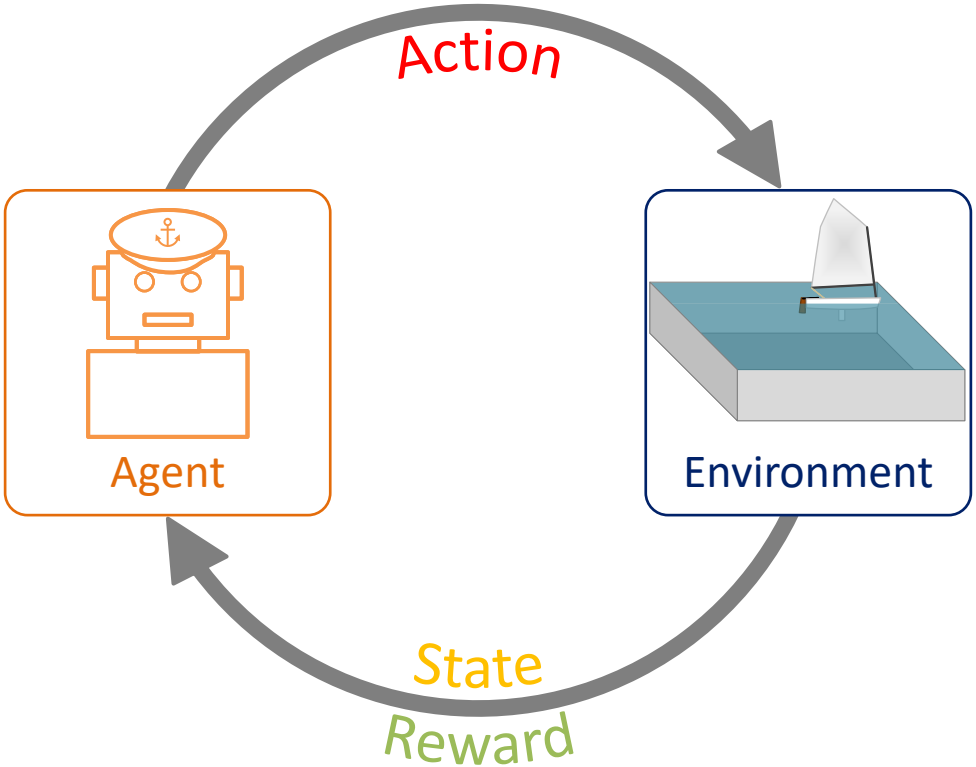
Actuator

Sensor

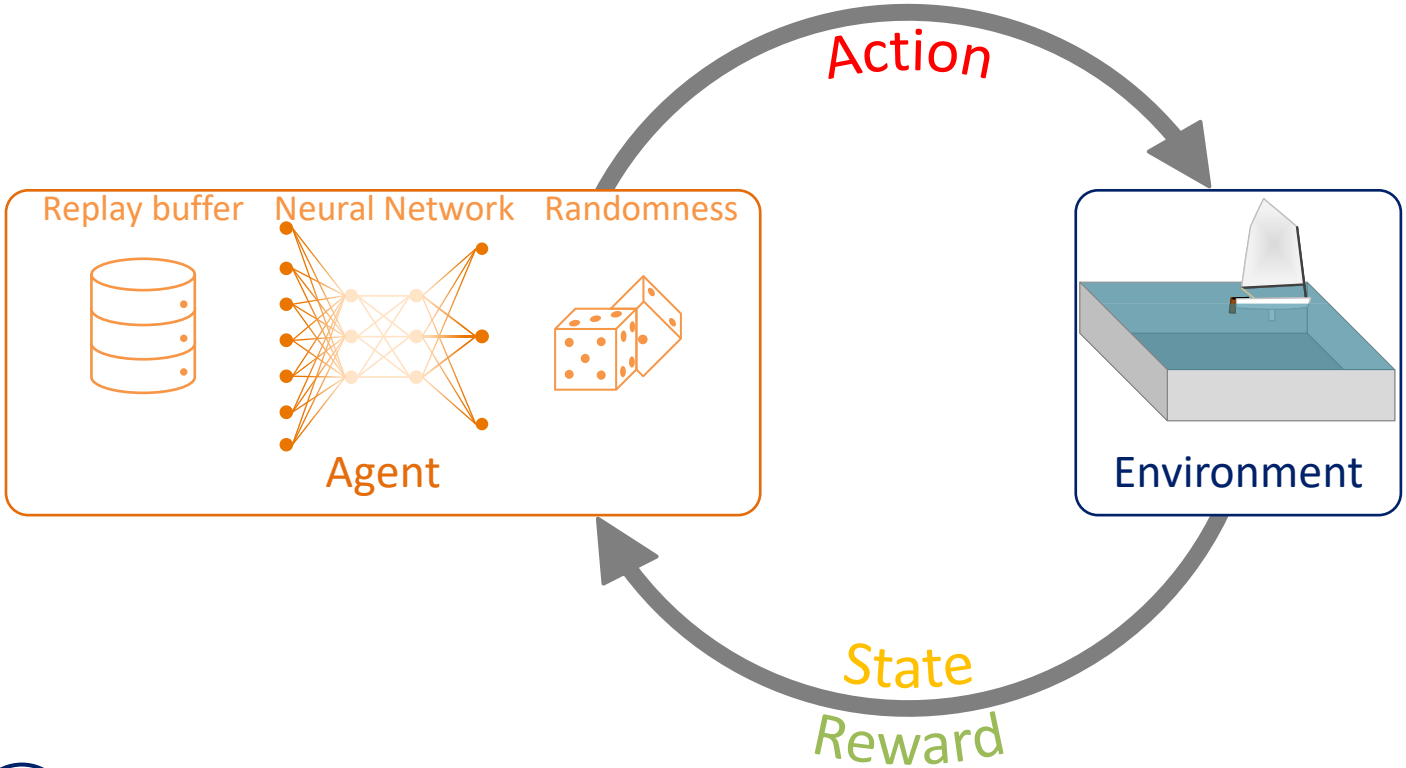
Interactions



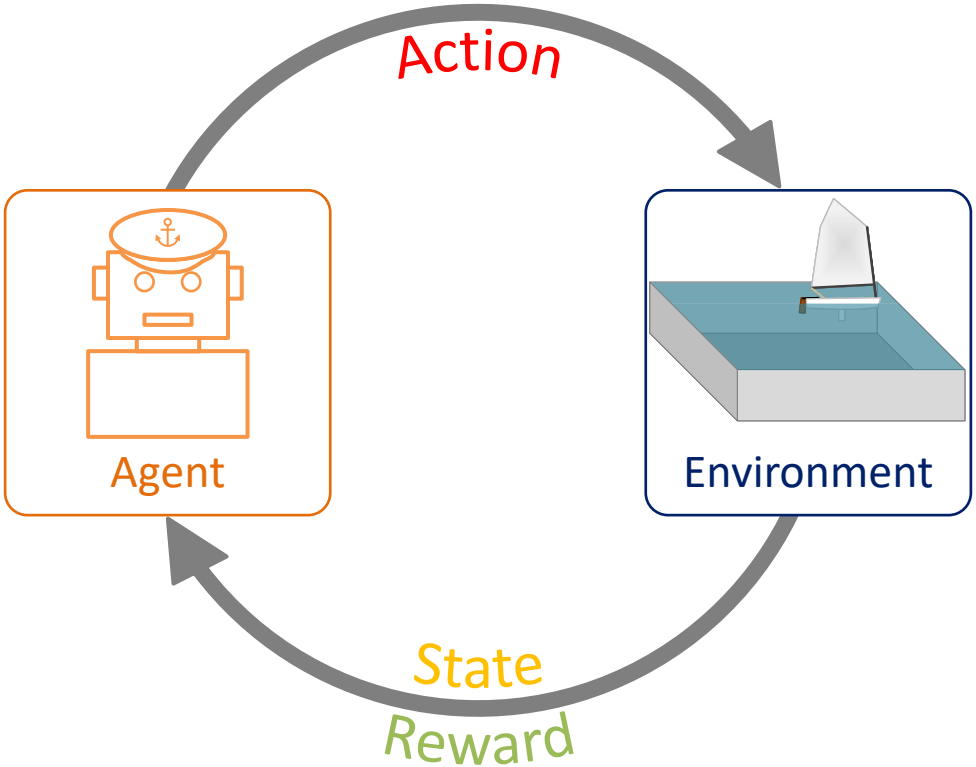
Agent



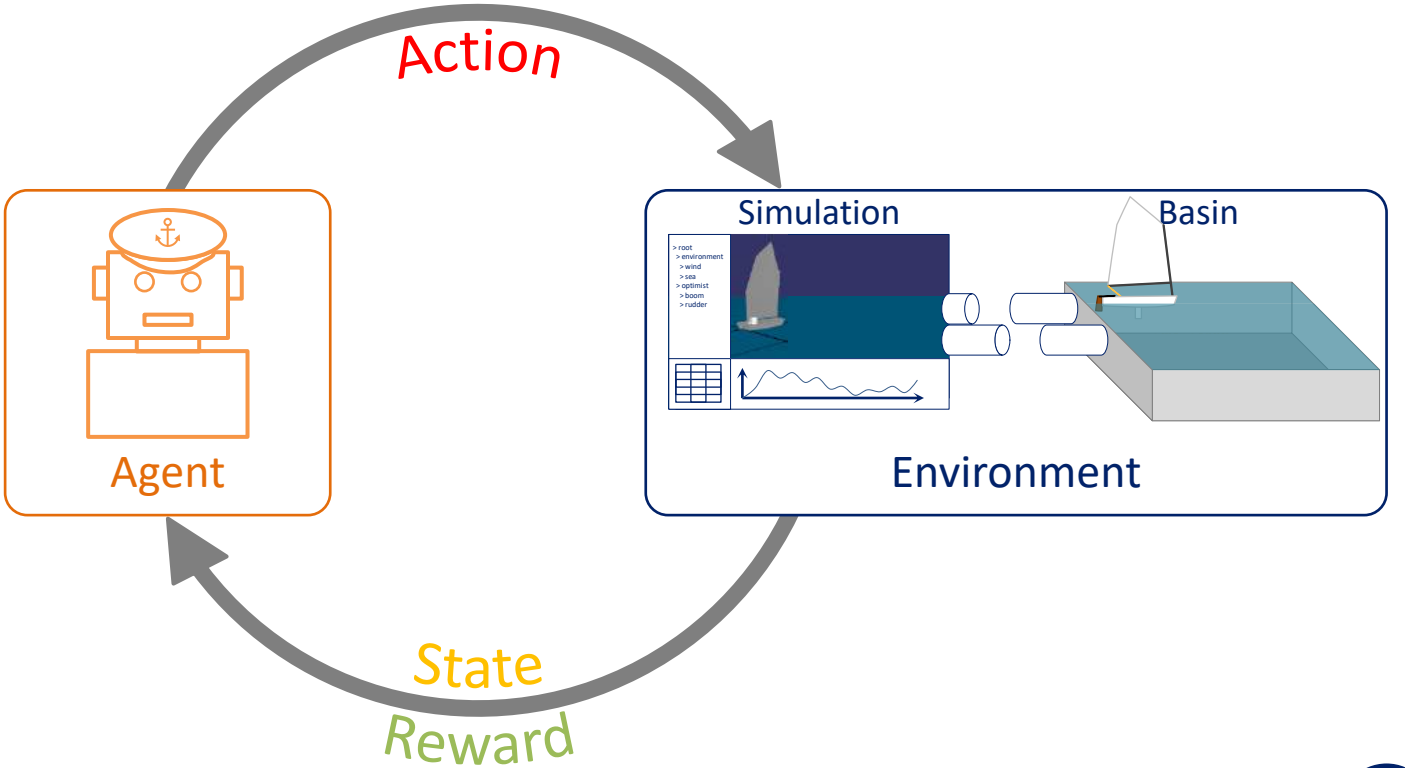
Agent


Action
Replay buffer
Neural Network
Randomness
Agent
Environment
State
Reward

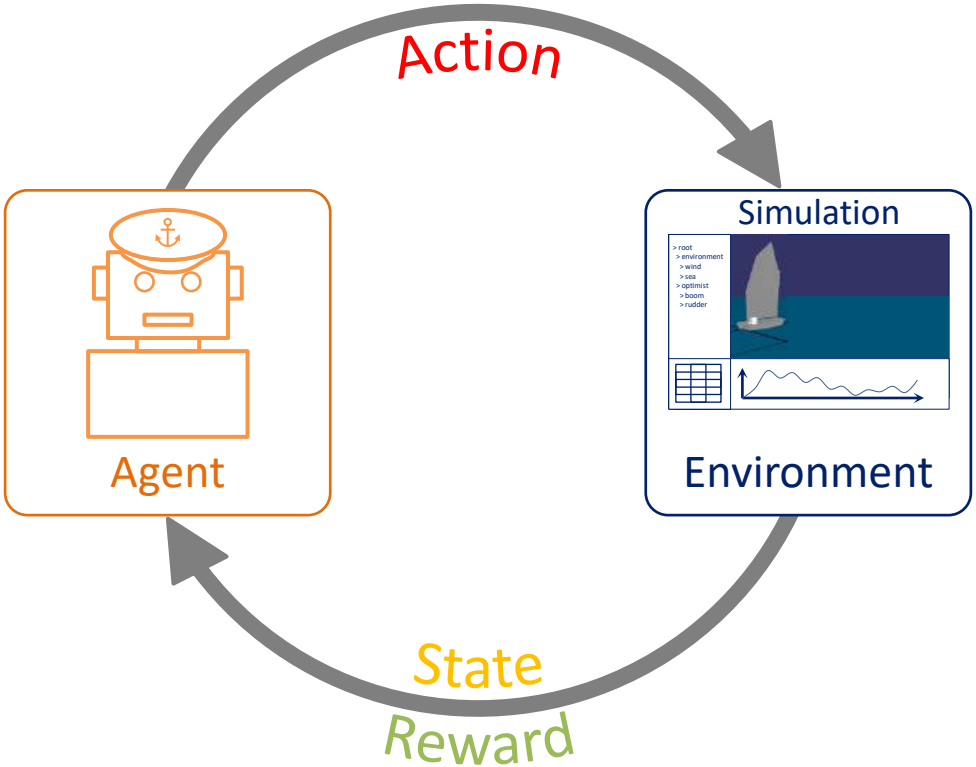
Agent



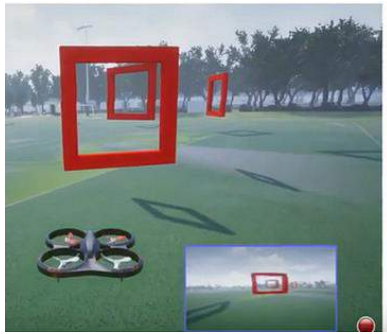
AI sail set-up



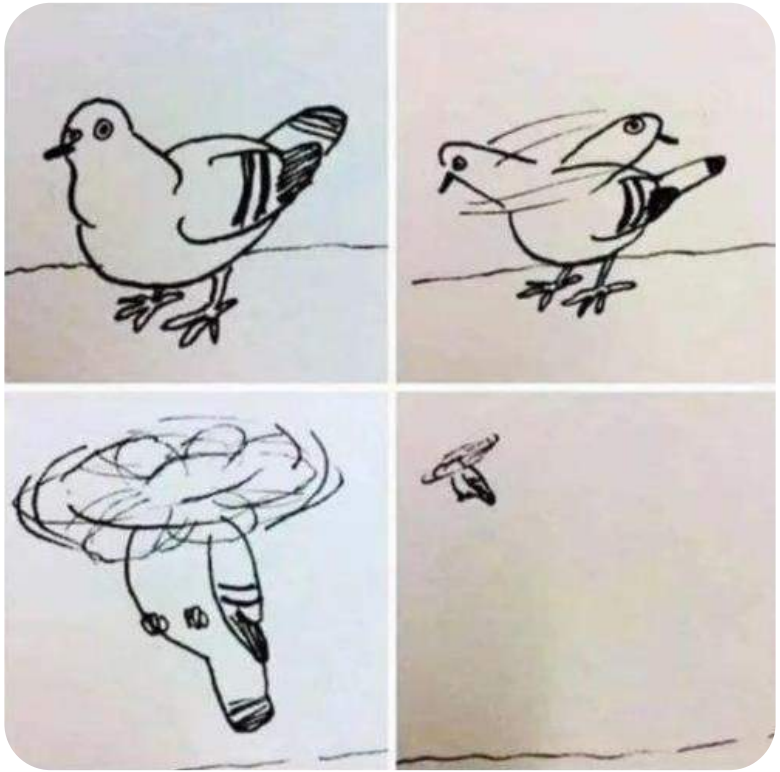
AI sail set-up



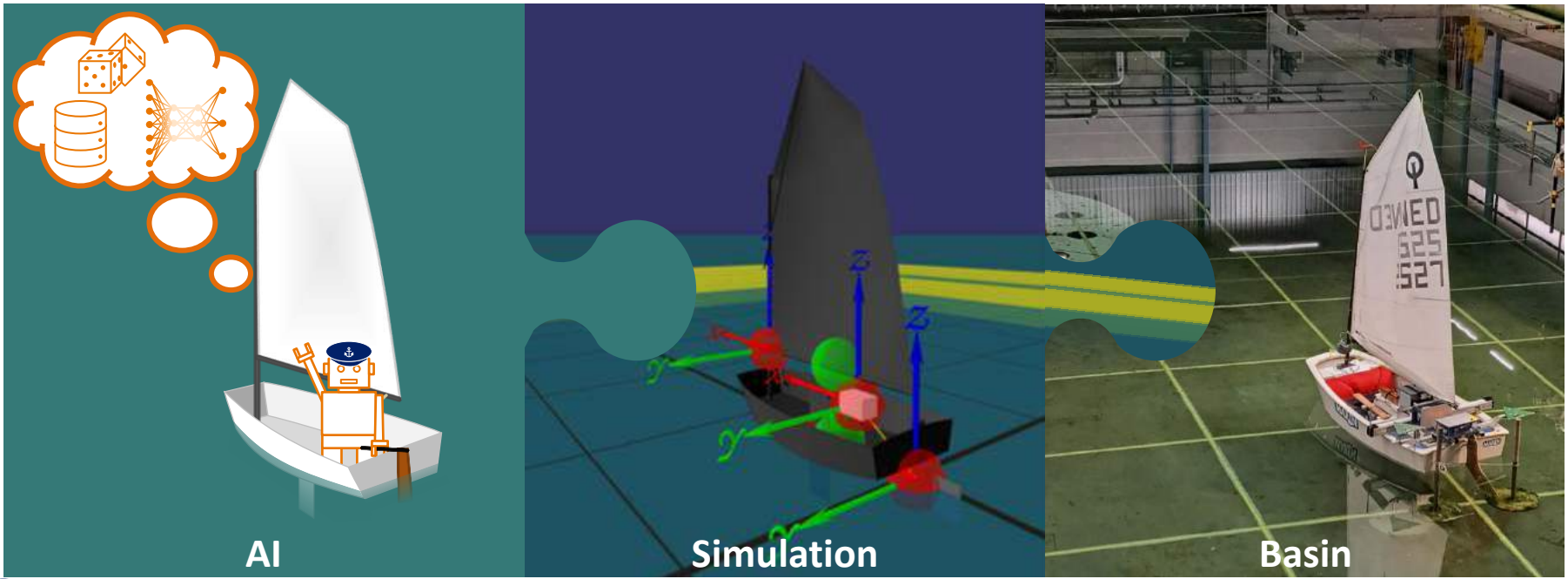
From simulation to reality



From simulation to reality



From simulation to reality



AI sail team

Project

Sailing advise

Media

marinRL

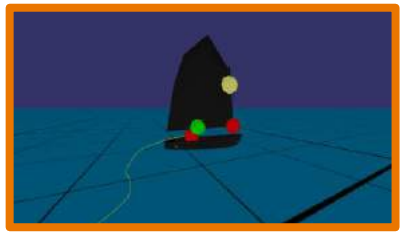
xsimulation

offshore basin

AI sail milestones

November 2022
Optimist instrumentation

December 2022
First simulation mockup



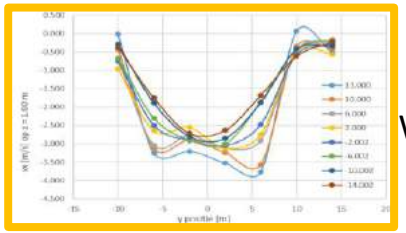
April 2023
Communication test

November 2023
First time AI sailed across the basin

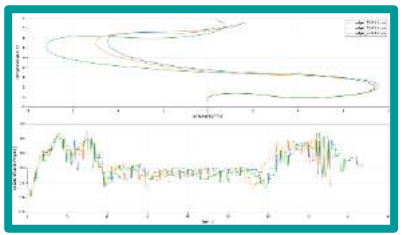
October 2022
Optimist acquisition

November 2023
AI sail demo

November 2022
First sailing test in OB

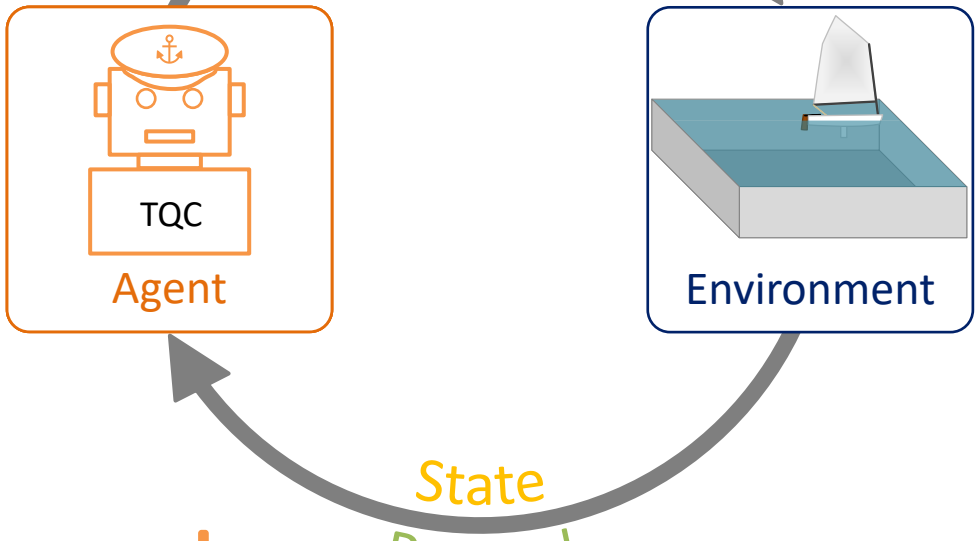


January 2023
Wind field measurement

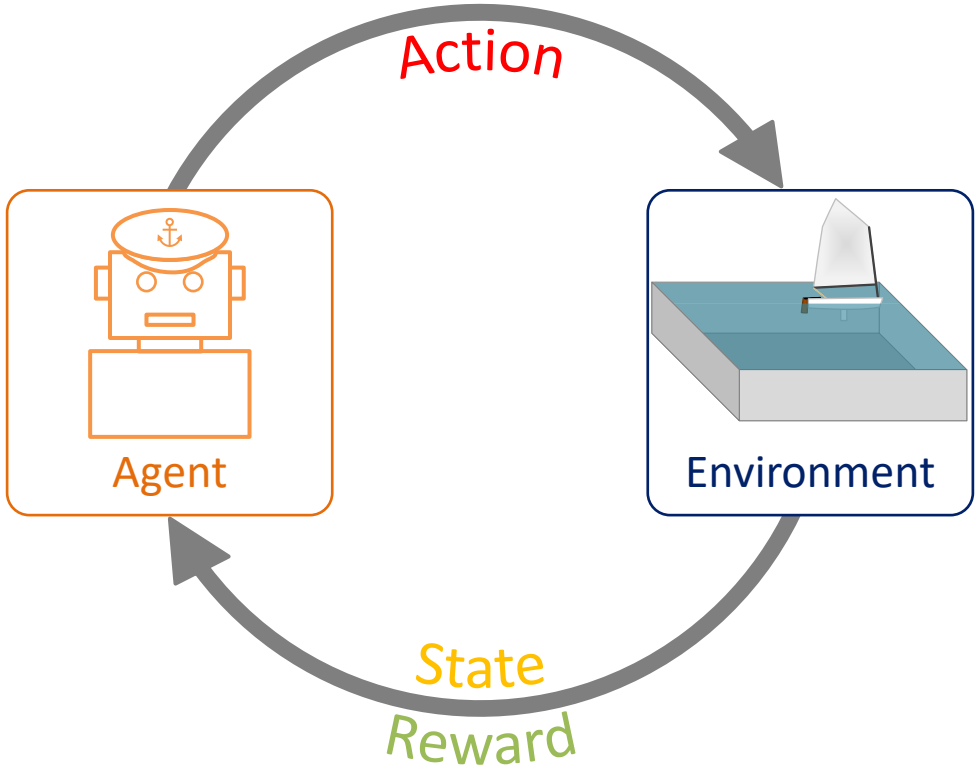


Mai 2023
First tack in the simulation

AI tuning

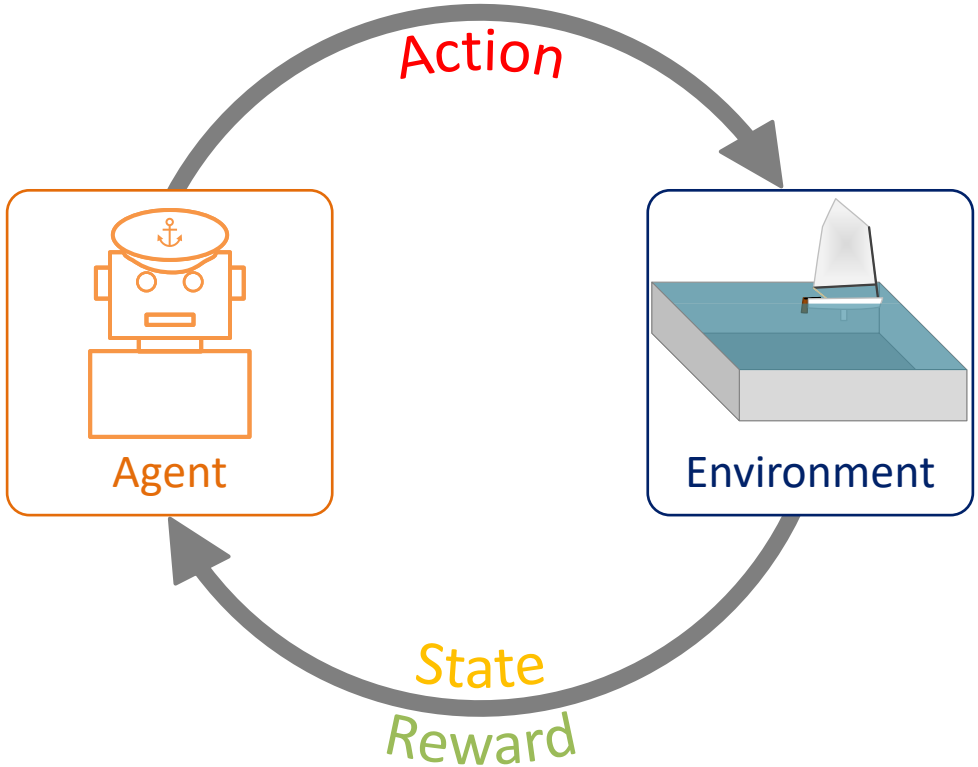


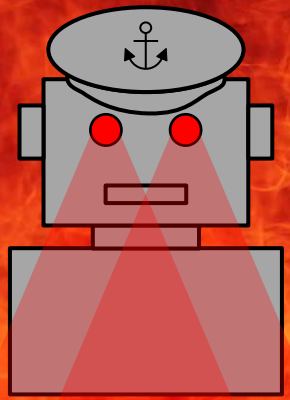
AI tuning



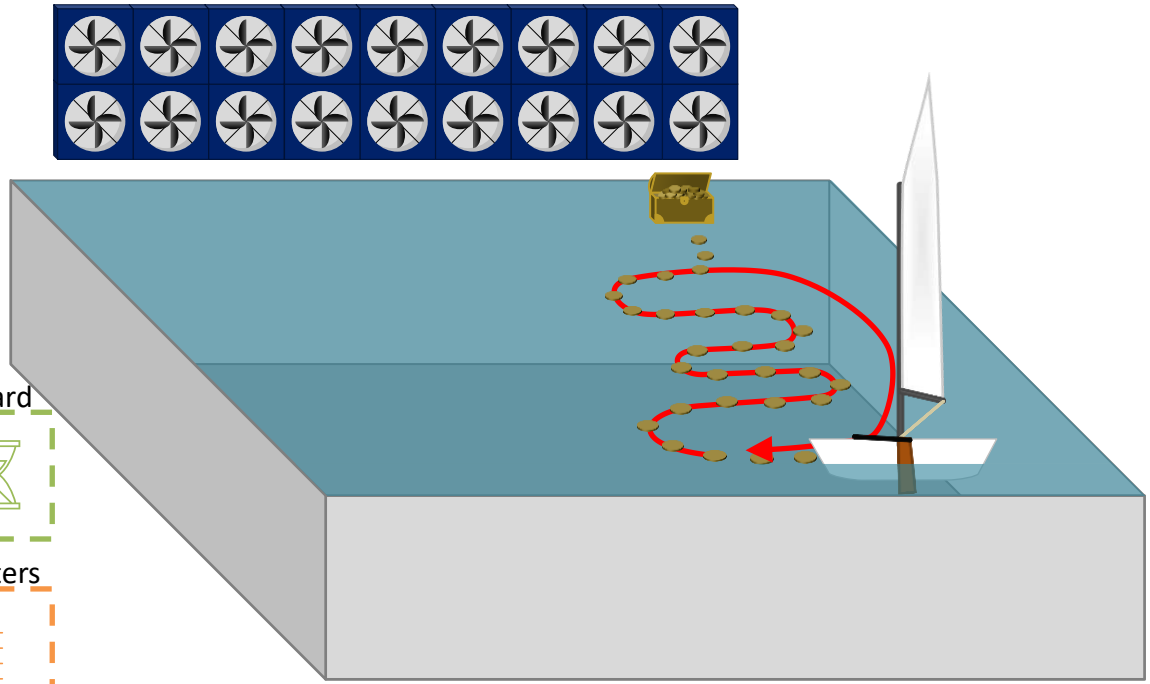
Agent & hyperparameters

AI tuning

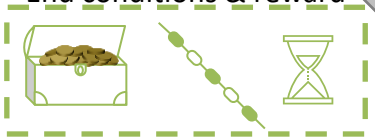

Action
Agent
Environment
State
Reward
End conditions & reward
Agent & hyperparameters



AI tuning

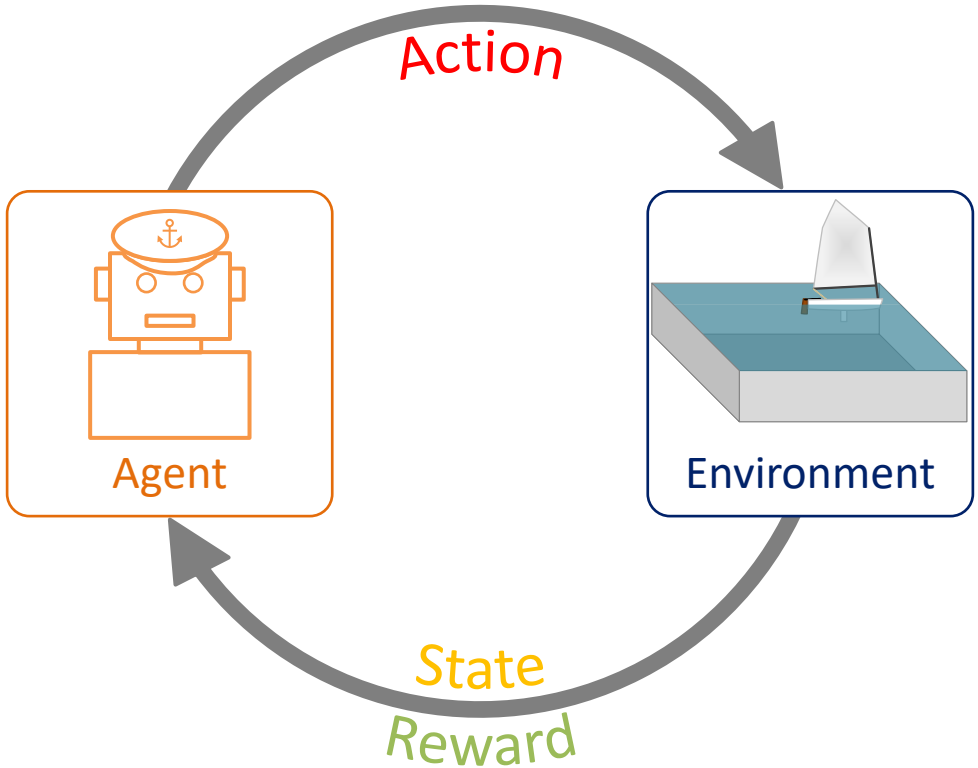


End conditions & reward

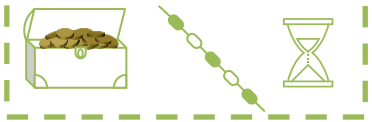


Agent & hyperparameters

AI tuning

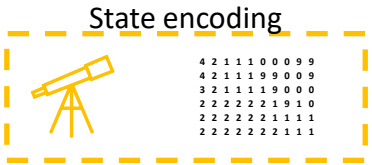


End conditions & reward



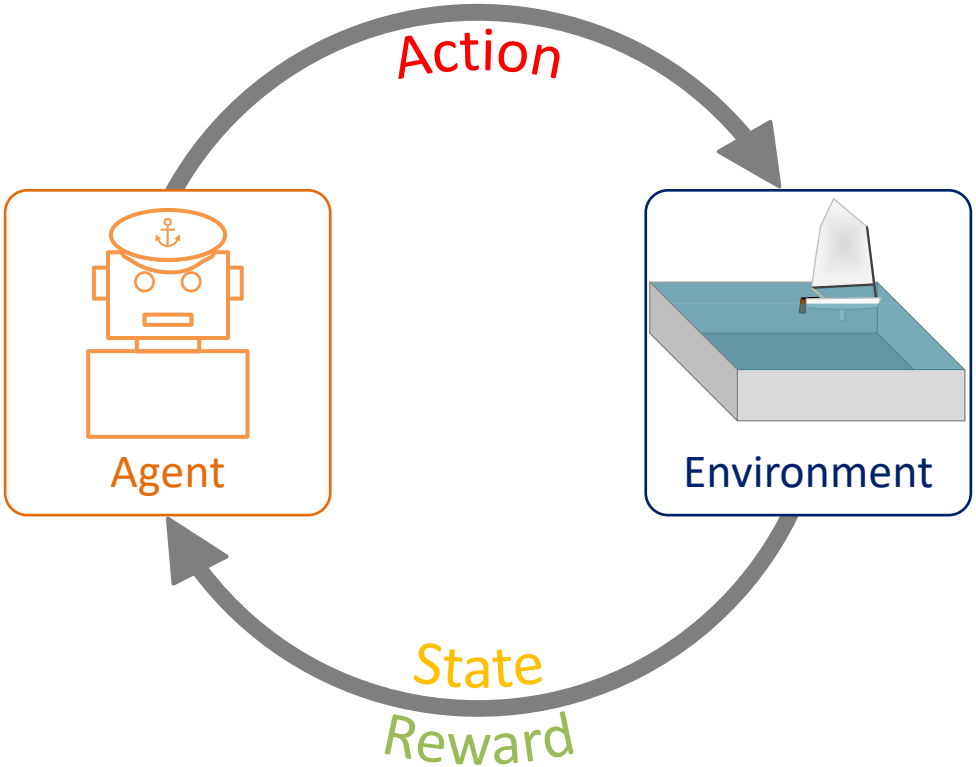
Agent & hyperparameters

AI tuning


State encoding
4 2 1 1 1 0 0 0 9 9
4 2 1 1 1 9 9 0 0 9
3 2 1 1 1 1 9 0 0 0
2 2 2 2 2 2 1 9 1 0
2 2 2 2 2 2 1 1 1 1
2 2 2 2 2 2 2 1 1 1

End conditions & reward

Agent & hyperparameters


Action
Agent
Environment
State
Reward

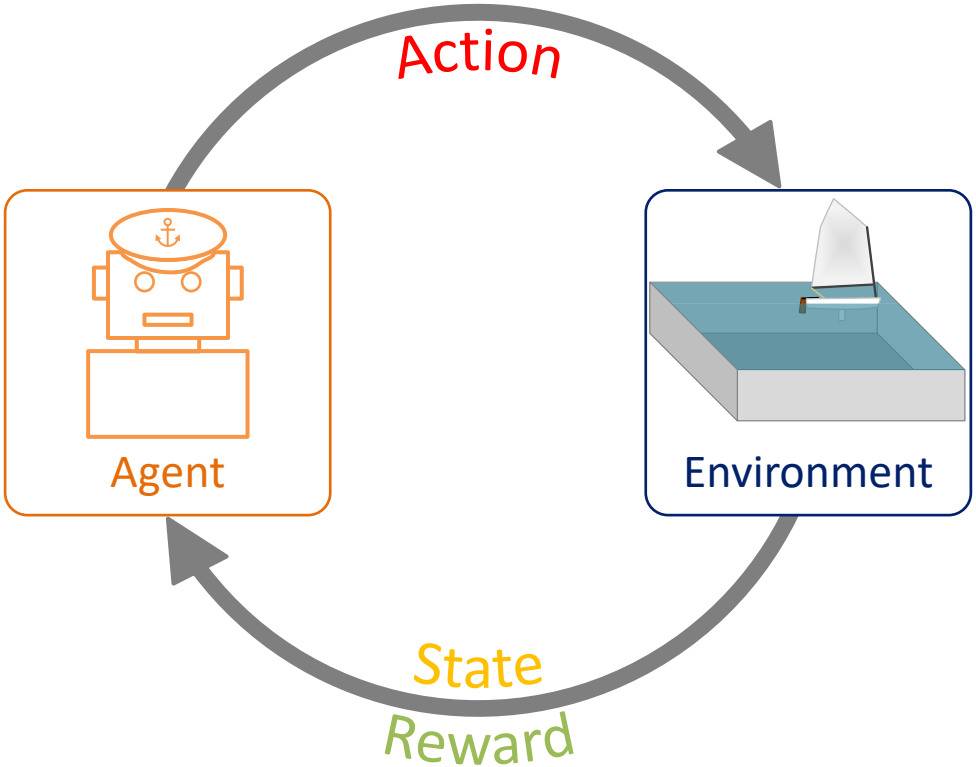
AI tuning

Environment settings

State encoding

End conditions & reward

Agent & hyperparameters



AI tuning

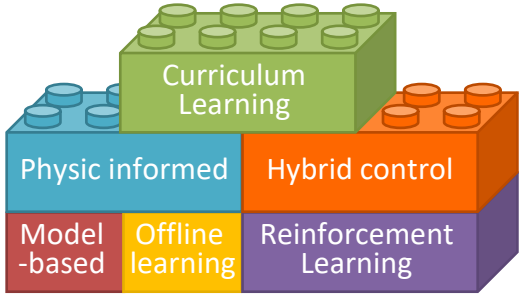
Infinite variants

+ Adaptability
+ Autonomy
+ Nonlinearity
+ Implicit knowledge

- Data efficiency
- Generalization
- Interpretability
- Complex to tune

Infinite variants

- Offline learning
  pretraining on other experiences (pilot, controller…)
- Model based
  ML model of the environment
- Hybrid control
  combination of RL and controller
- Physic informed
  providing knowledge to the agent (state encoding, reward prediction, constraint…)
- Curriculum learning
  task-by-task learning
- Evolutionary strategy
  training the actor with genetic algorithm



MARIN

BETTER SHIPS, BLUE OCEANS

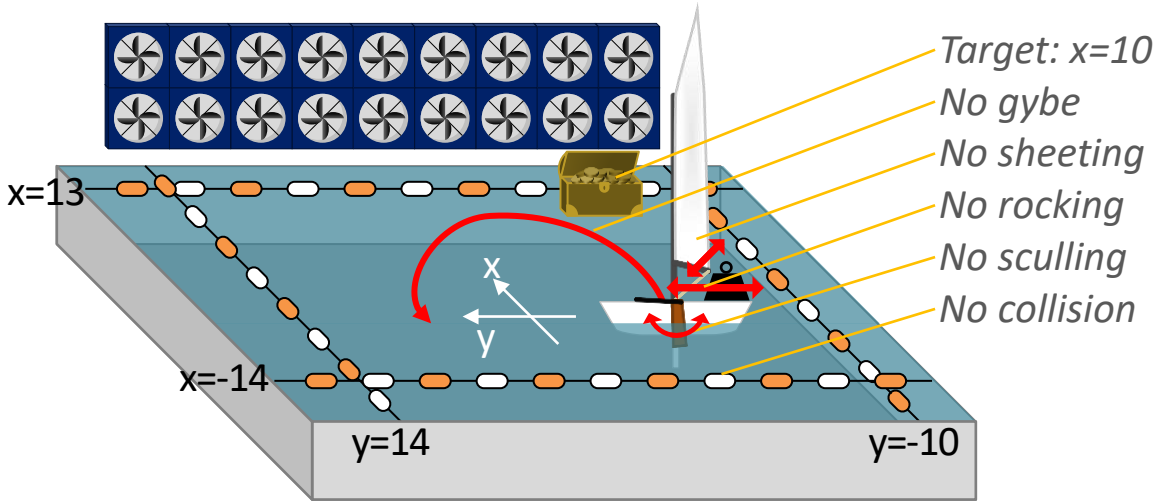
Results

Training analysis and agent behavior

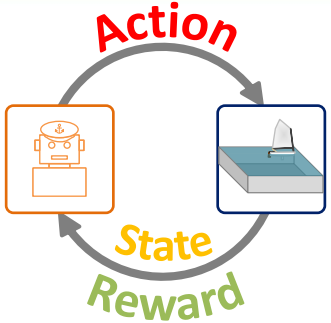
AI sail goal

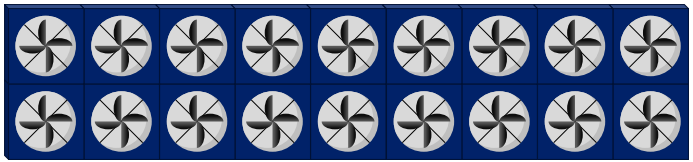
Safety

Racing rules of sailing

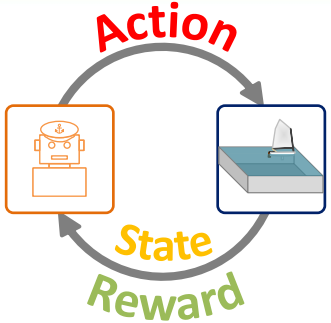


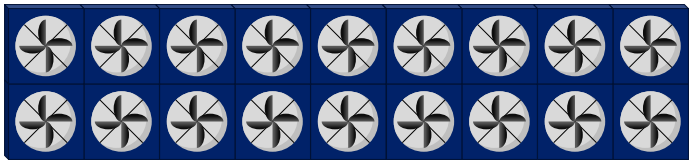
Environment

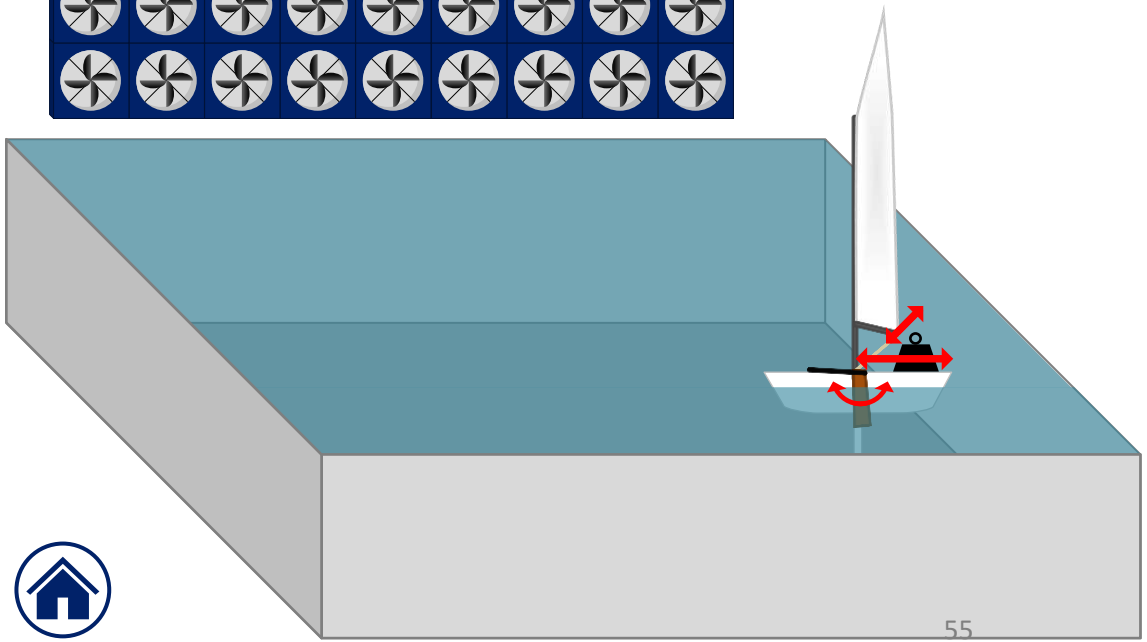




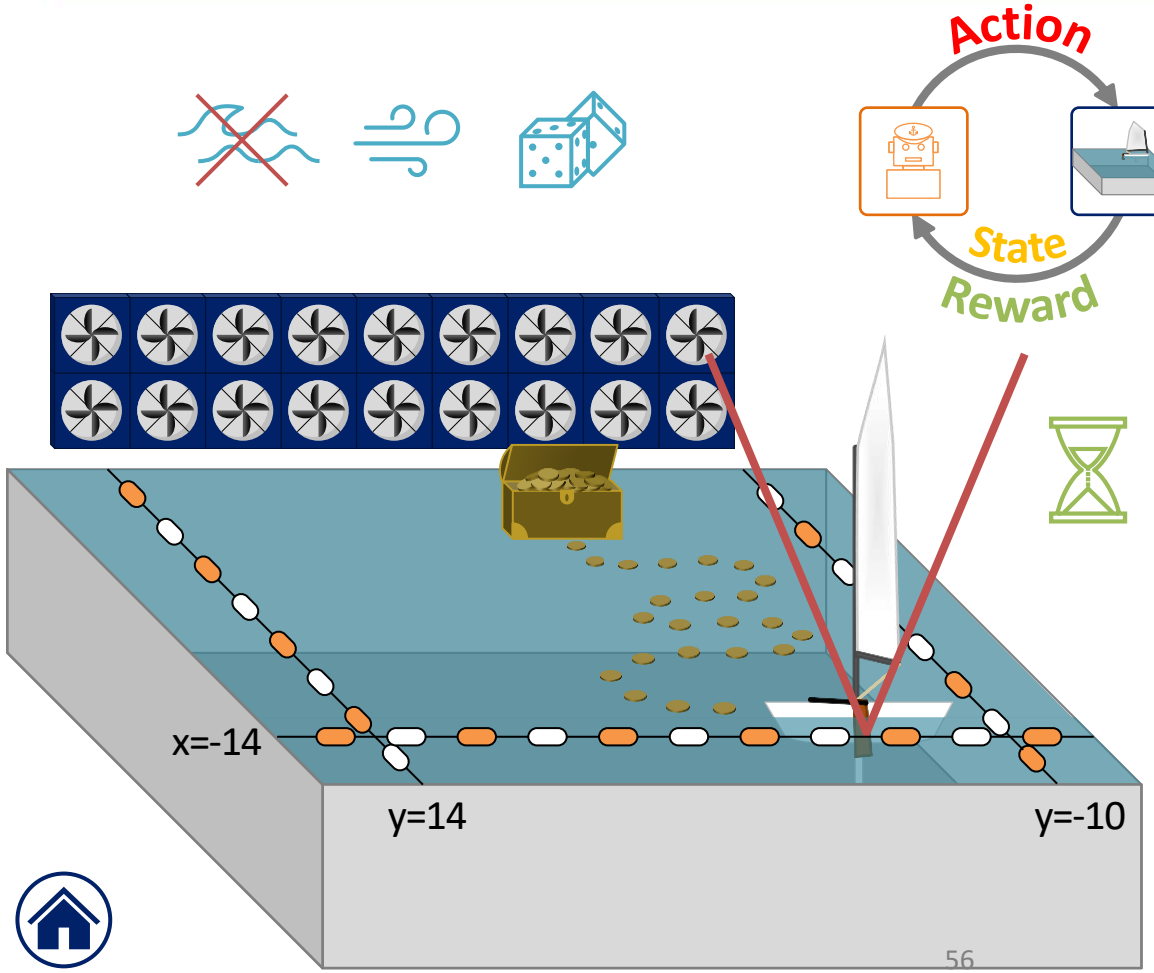
Actions

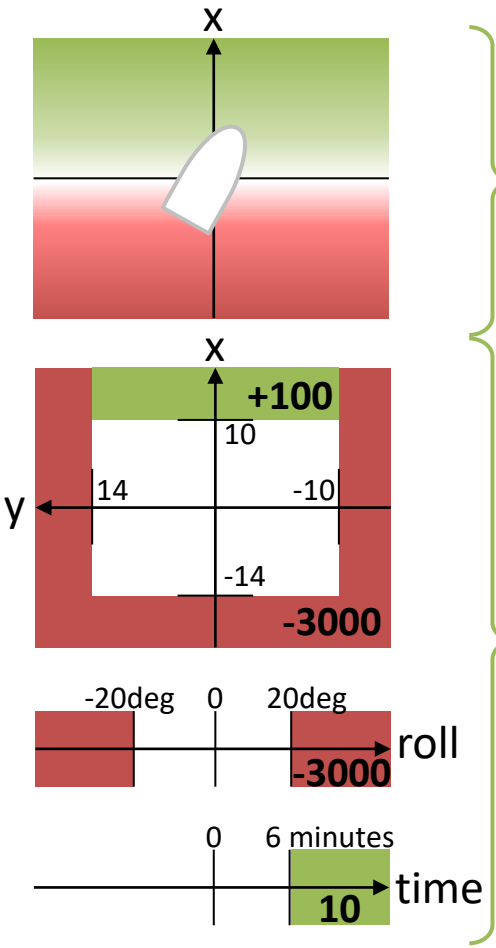




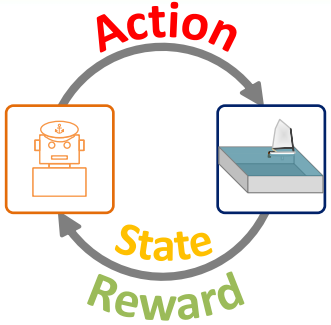


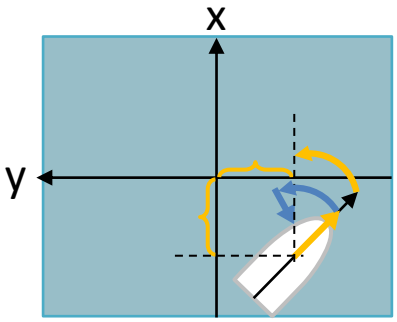
Reward design

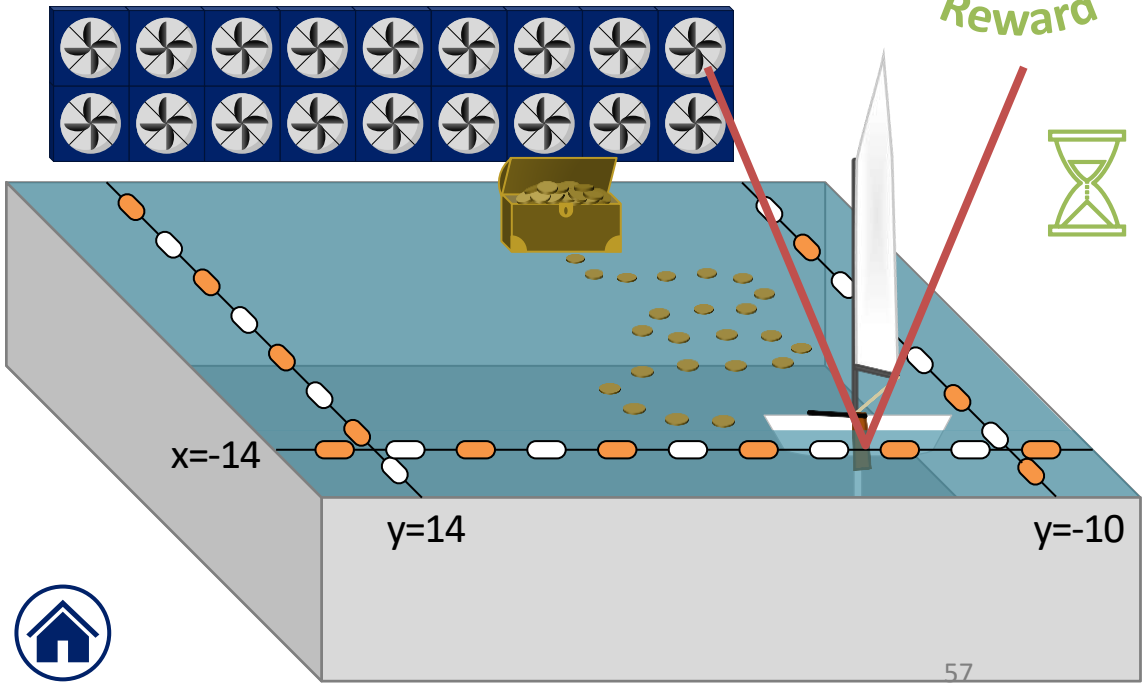




State design

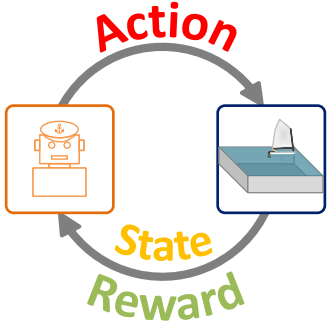


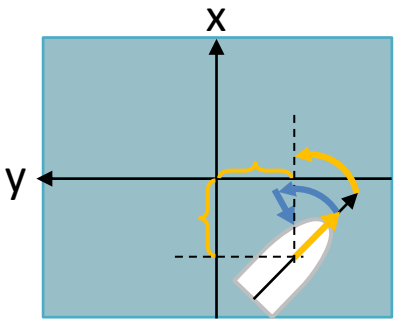


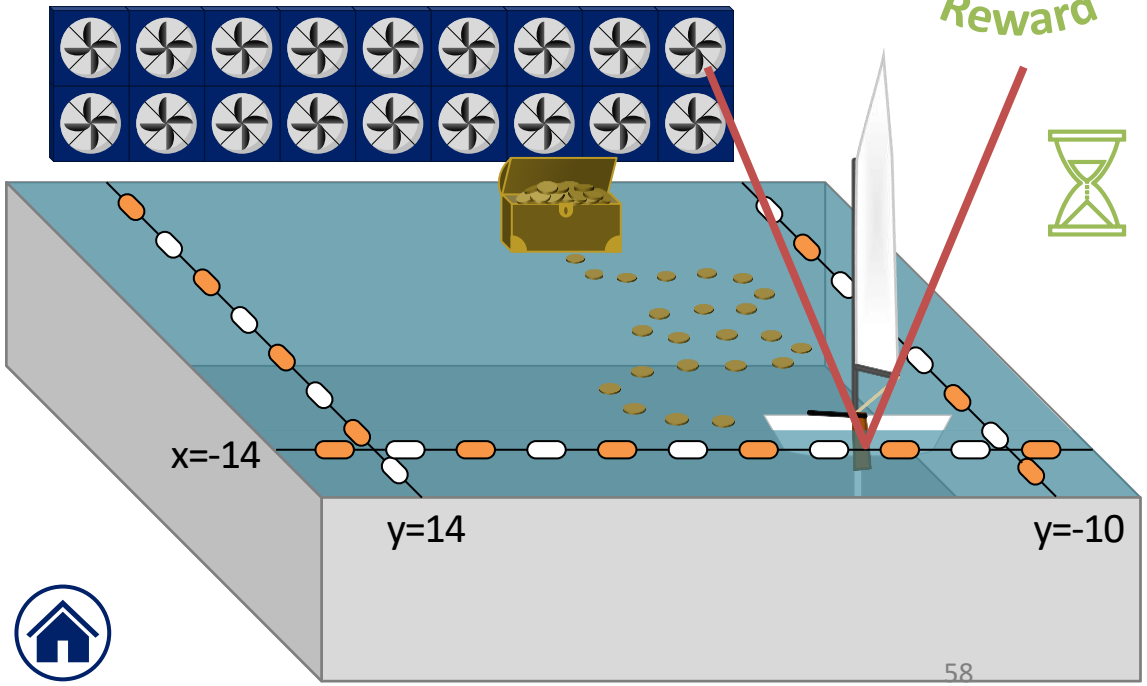


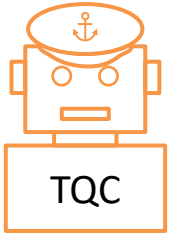
- x
- y
- yaw
- forward speed
- acceleration
- roll
- relative wind speed
- relative wind heading

Selected agent

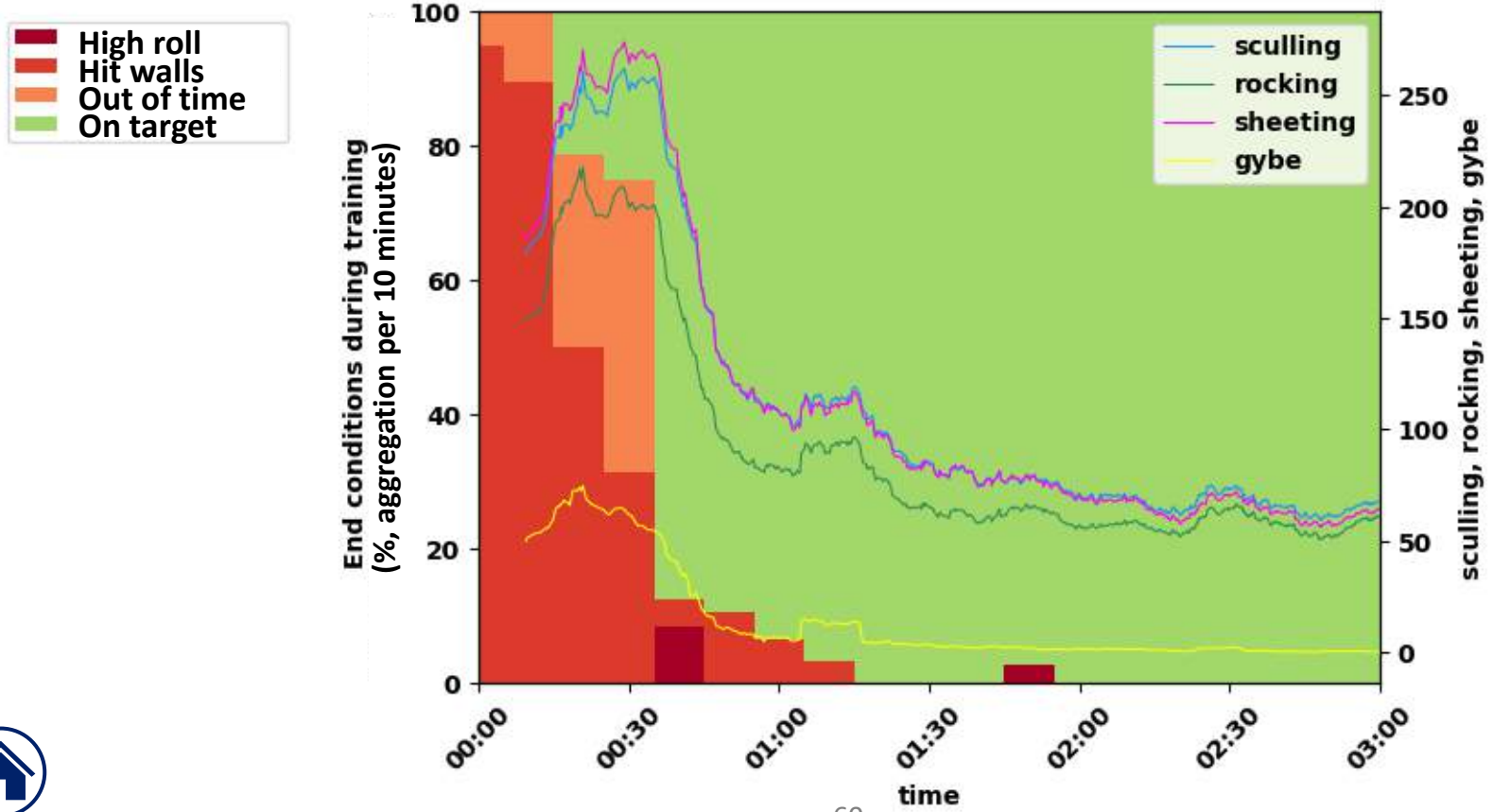




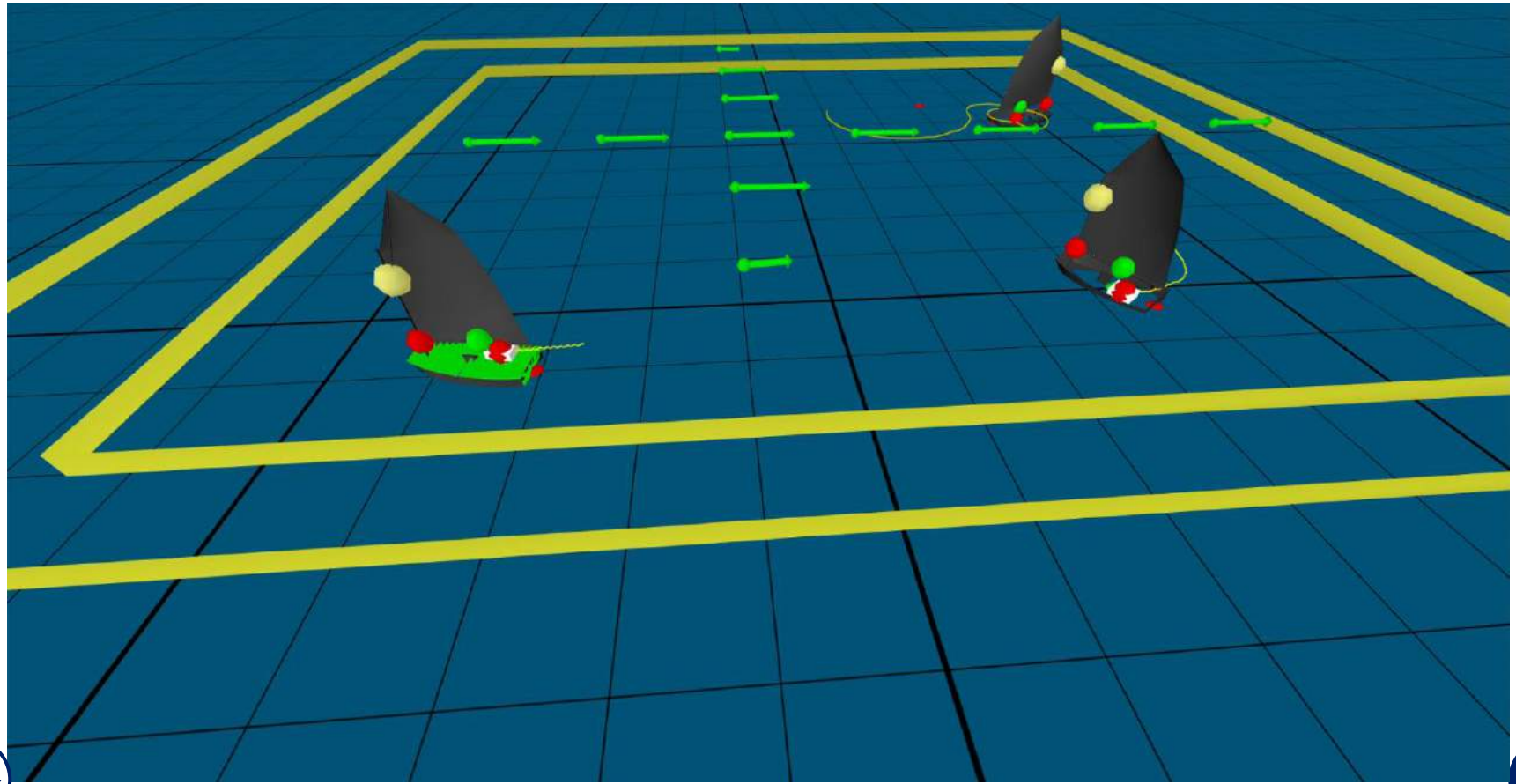




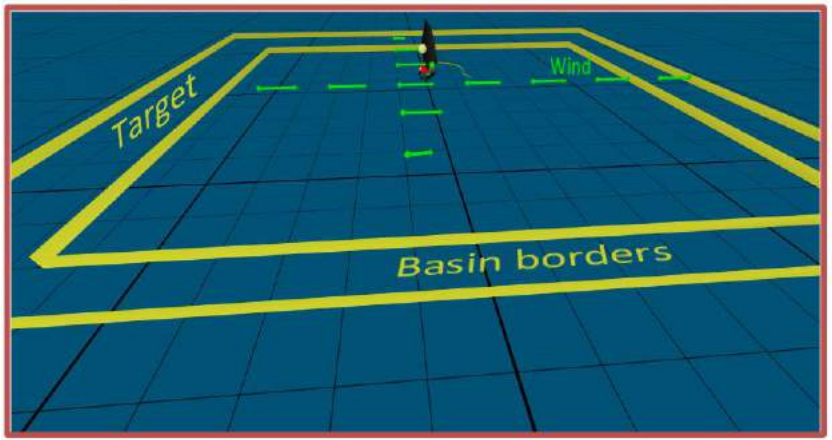
Results – Learning curve

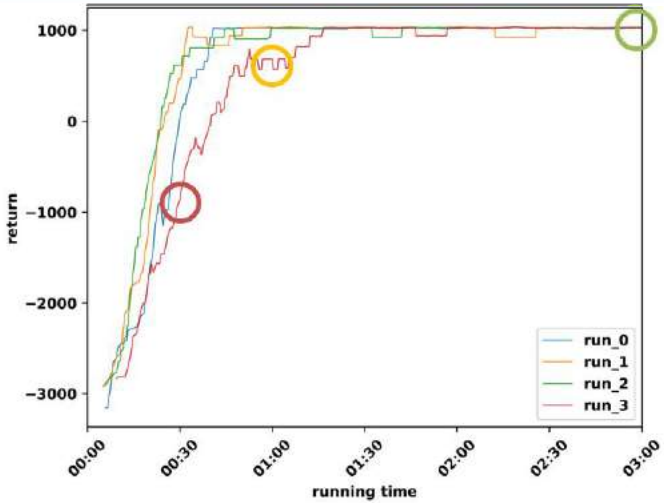


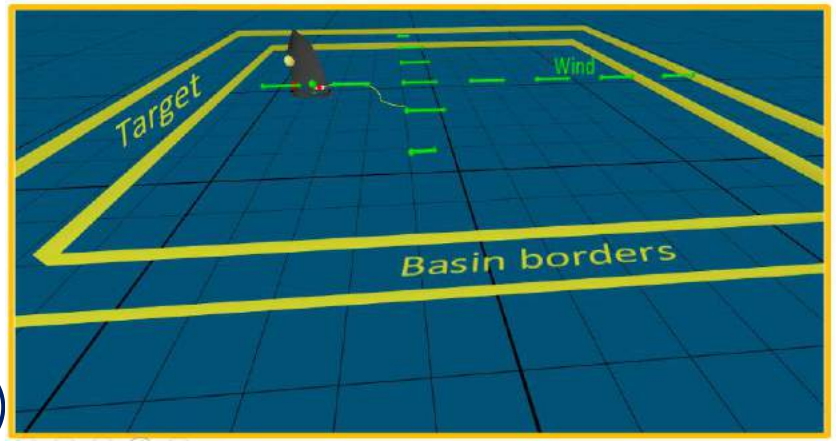
Results – Intermediate attempts

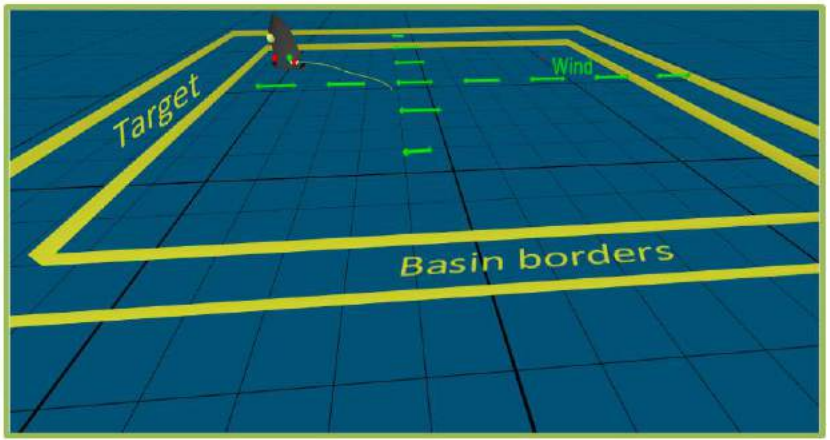


Results – Intermediate attempts





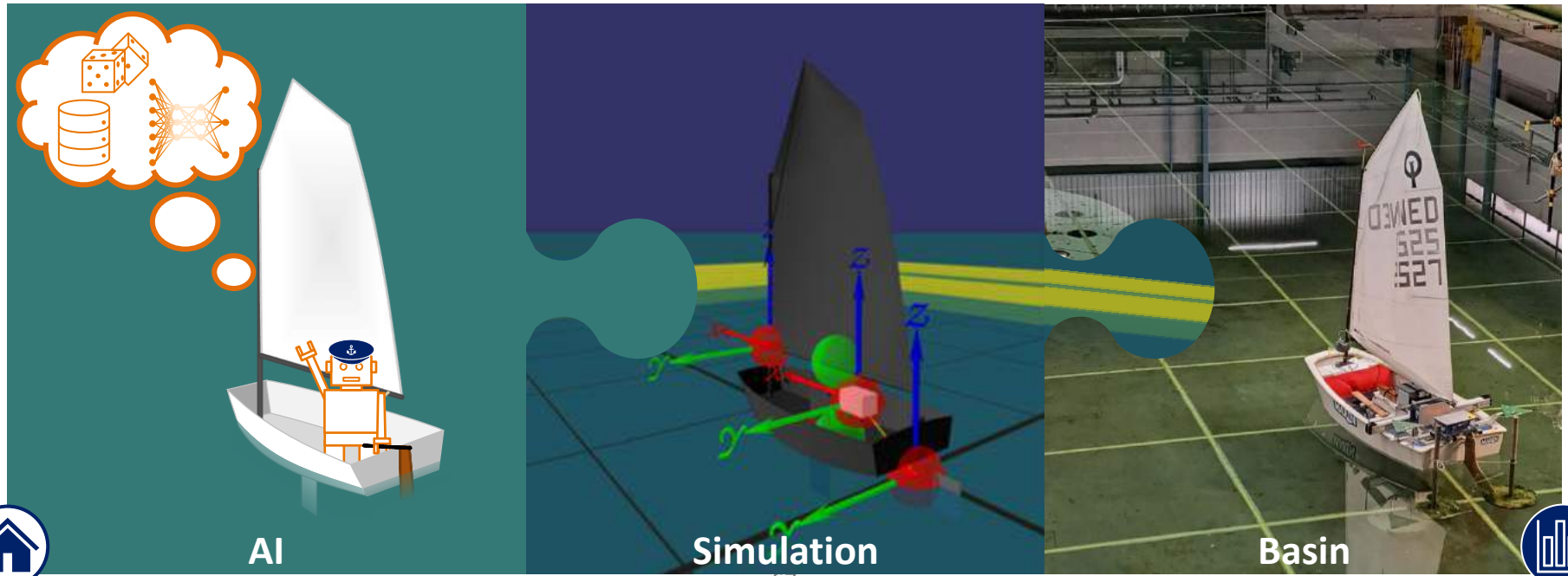




Optimist actuators

Agent sailing the real optimist

Conclusion

Challenges:

- From academic methods to maritime applications
- From simulation to reality