

Soccer robots by software engineers

Teade Punter

for

RIF Team

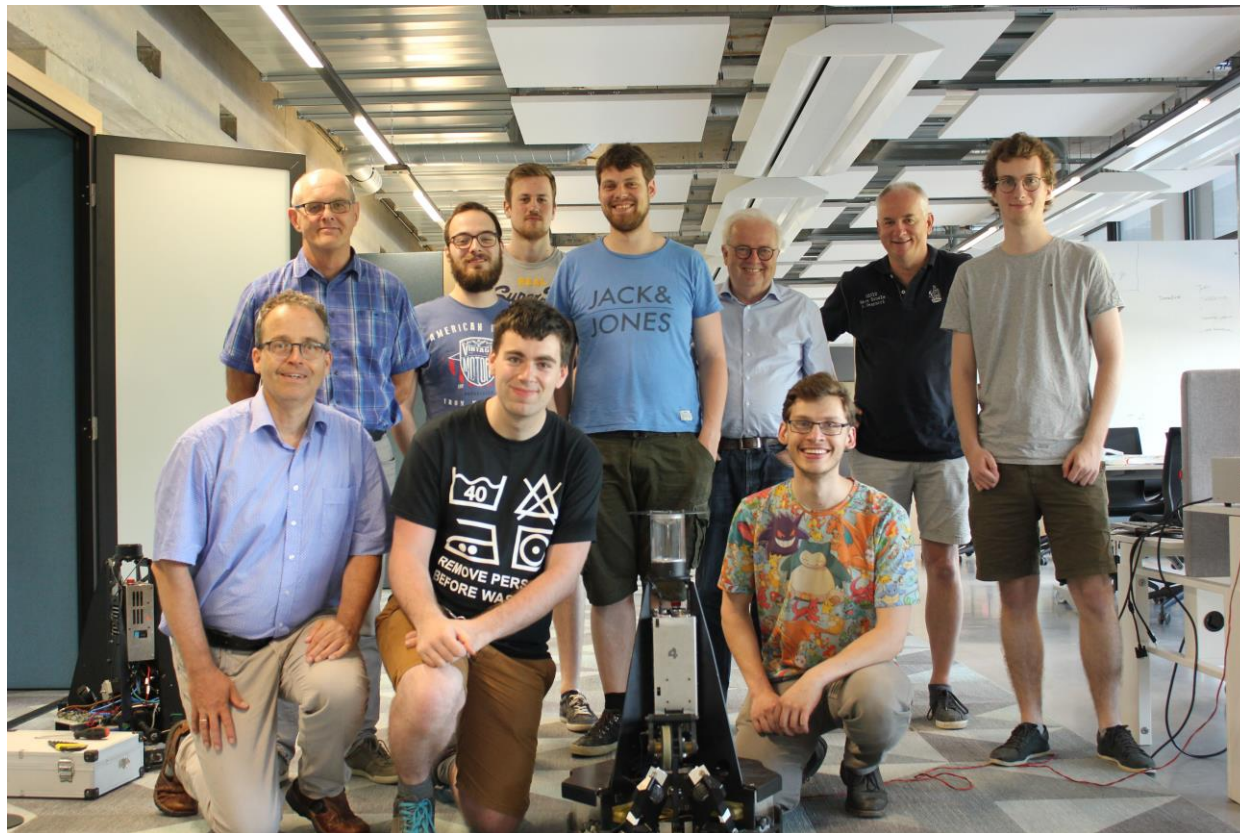
Robocup MSL International Workshop

Eindhoven, 22-24 November 2019

RIF Robocup team



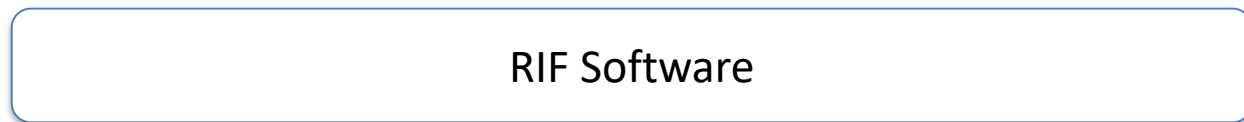
RIF Robocup team



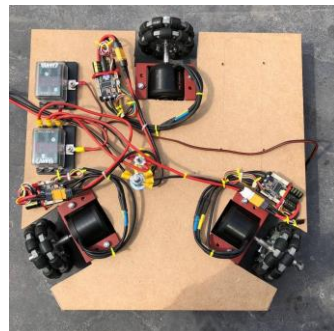
RIF team

- Applied research on autonomous mobile robotics
- Students and lecturers/researchers working together
- Student team
- Open challenge-based learning
- Software Engineering principles

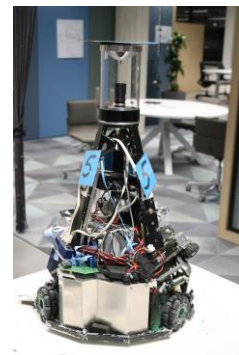
RIF Hardware platforms



Turtle5K



RIF RAF



VDL



RIF robot

- Electric Skateboard technology



ESP32 Microcontroller



Electronic Speed Controllers



Brushless DC motors

RIF robot



Camera –
5MP 160 Fish eye



PC –
Jetson TX2

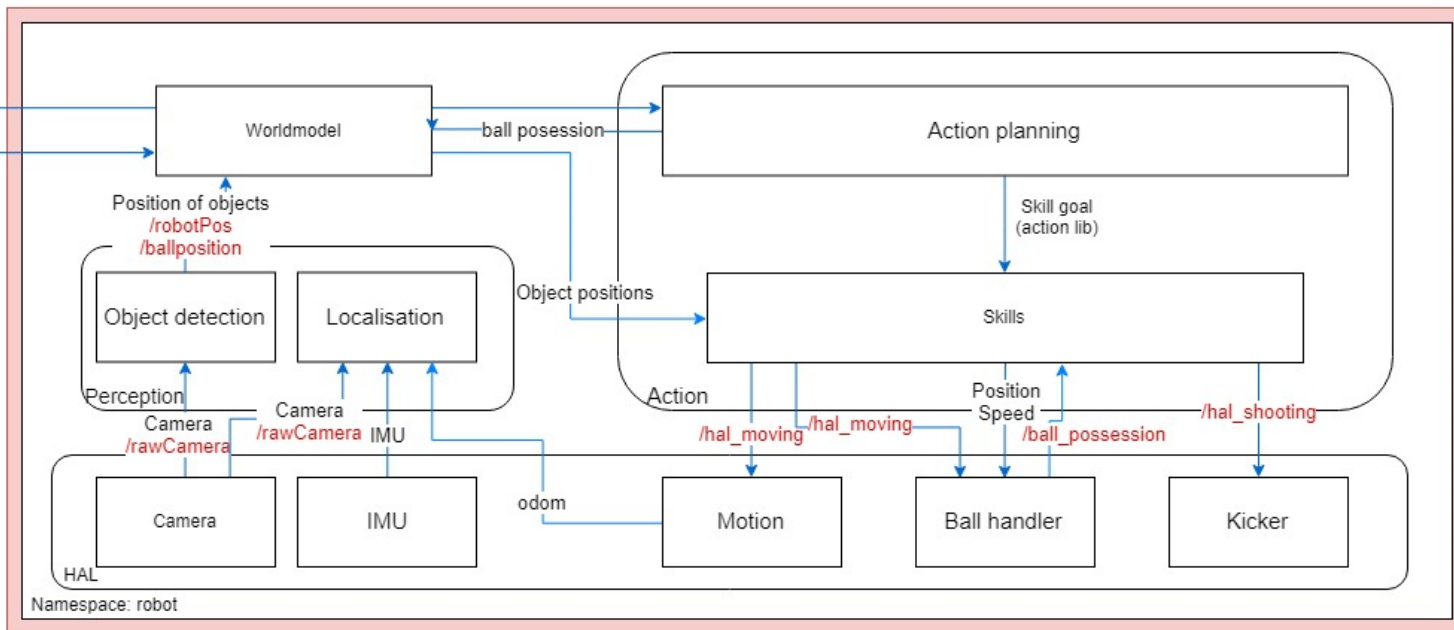
Robot architecture

Robot uses underlying positioning system. Called TF positioning. Every node can publish or subscribe to TF if needed.

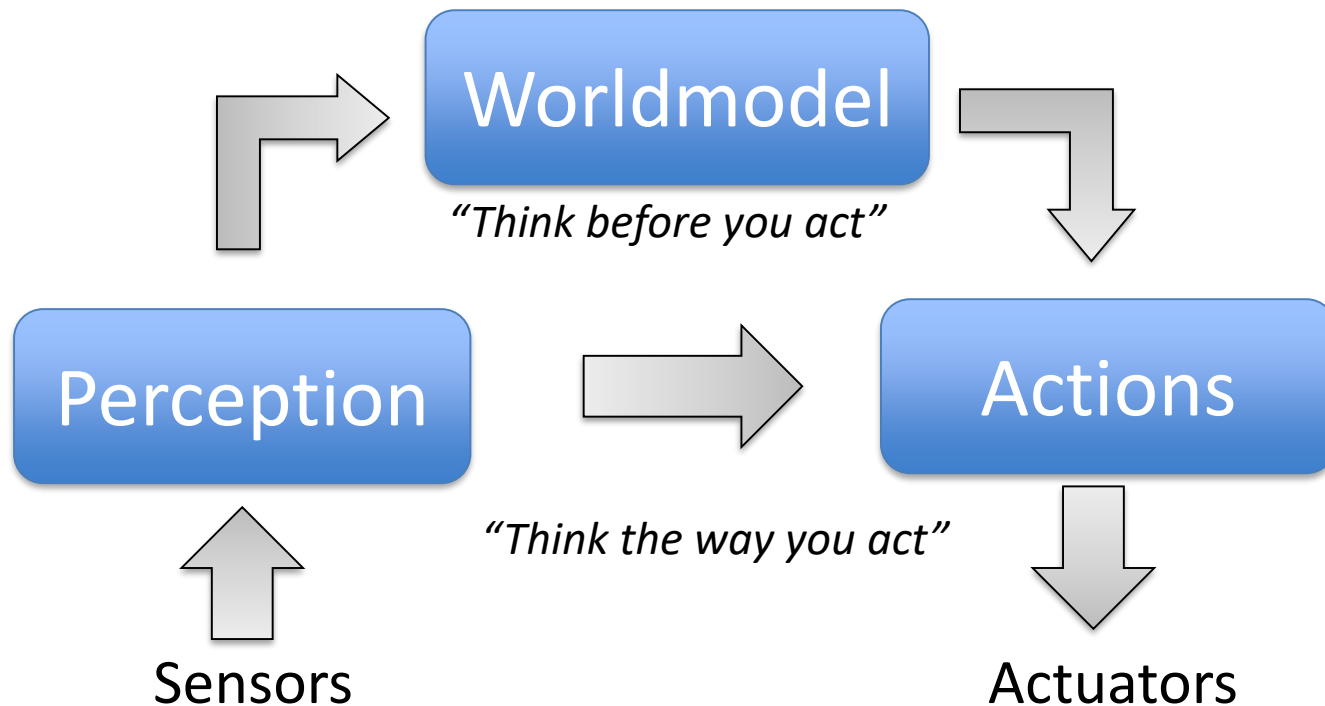
ROS

Open Source Robotics Foundation

Communicates with other robots by synchronizing the RTDB CAMBADA database



Robot architecture



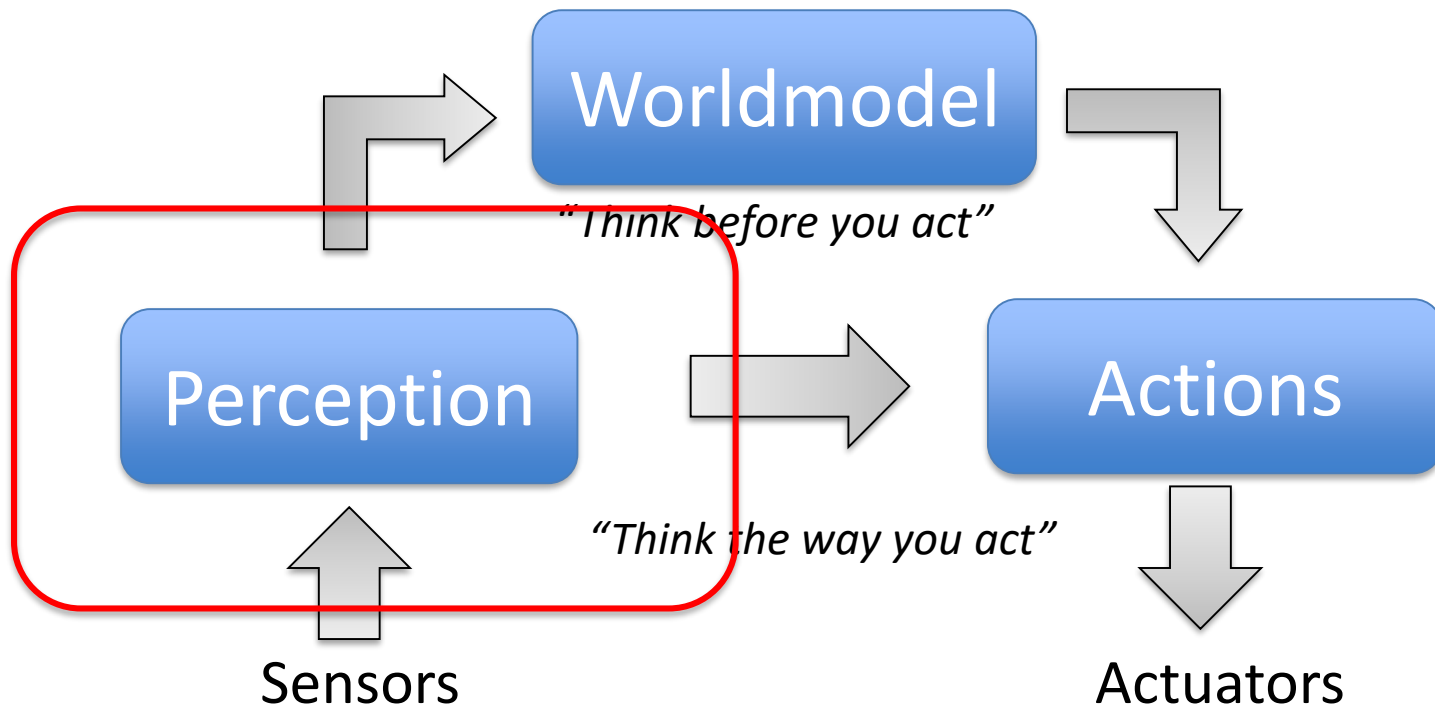
AI for Robotics

- Perception AI
 - Detect objects such as ball, obstacles, humans
 - Localisation using camera images of the soccer field
 - Human pose estimation & recognition of intentions
- Action AI
 - Navigation
 - Action selection

AI is non-deterministic

- Sensors are noisy
- Perception is uncertain
- Best possible is predict, estimate
 - Build belief – probability
- Learning with AI
 - Minimize loss (errors)
 - Maximize reward (utility)

Perception AI



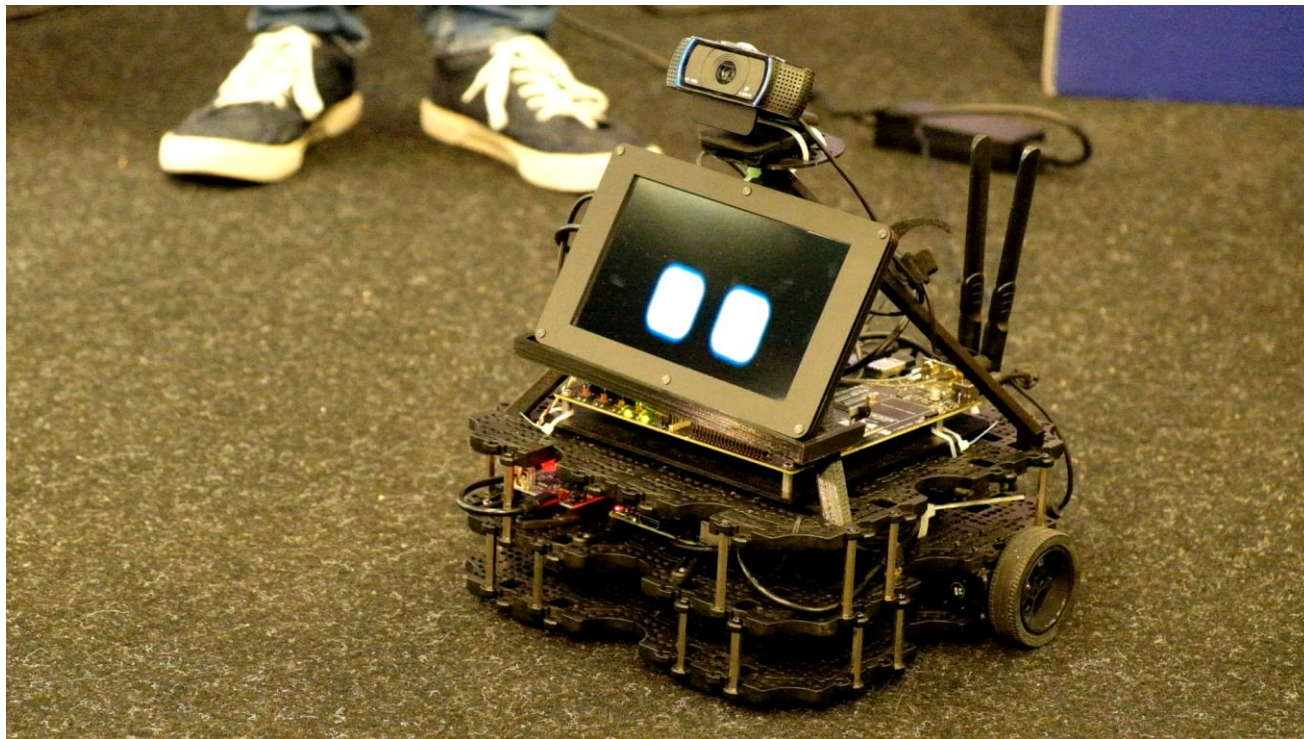
Perception AI

- OpenPose (CMU) - 17 keypoints



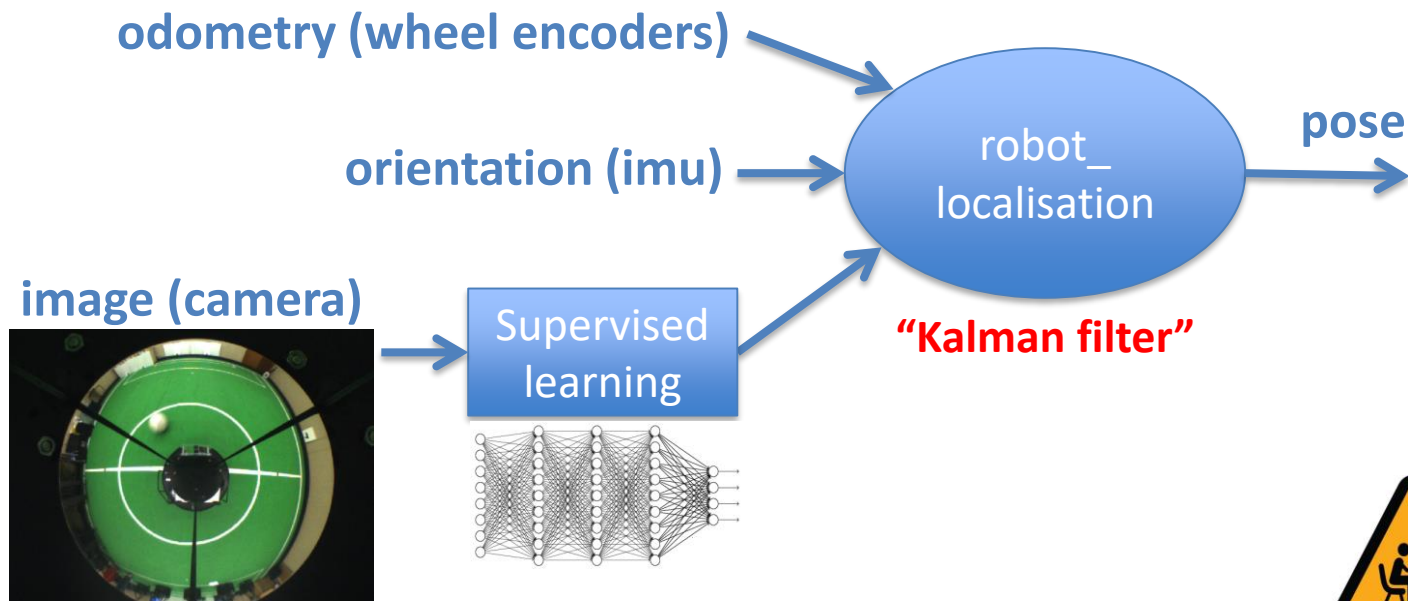
Perception AI

AGV with interaction module

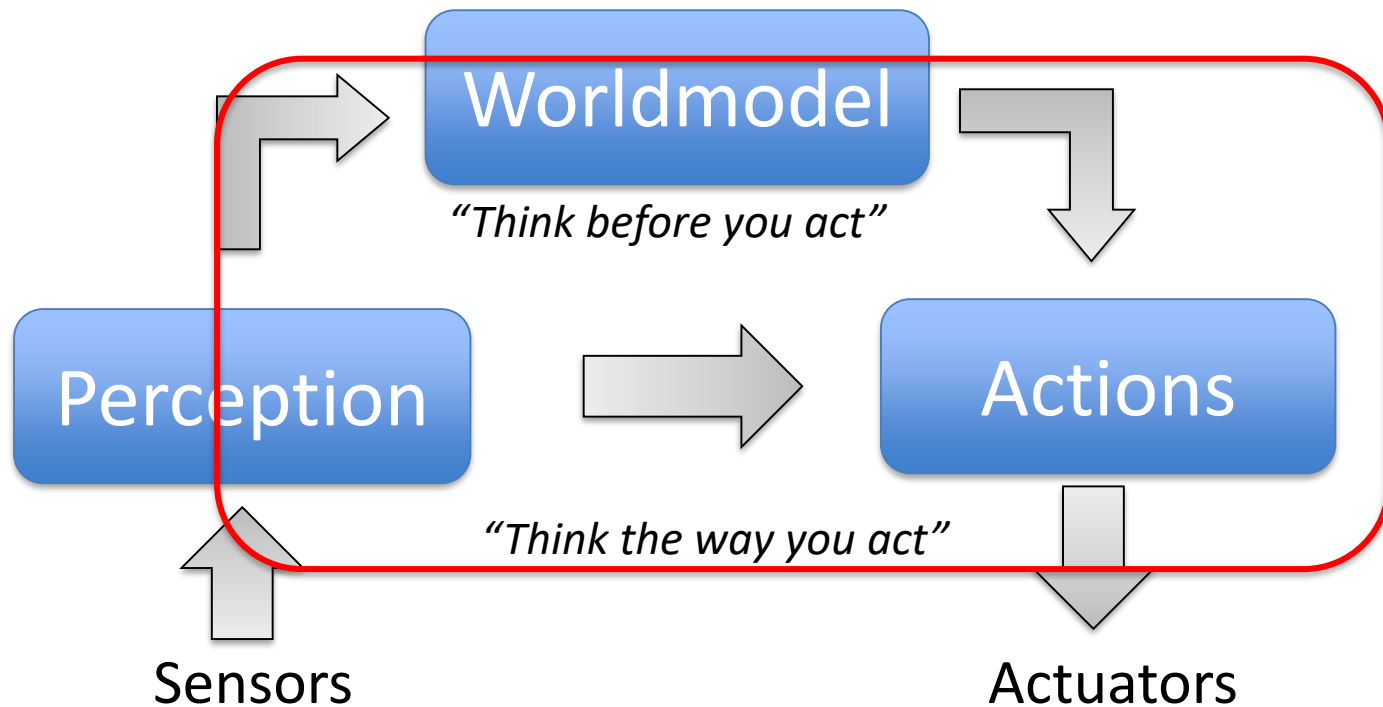


Localisation

- Convolutional Neural Network + Sensor Fusion



Action AI



Action Selection

- Model based

STATE
WorldModel →











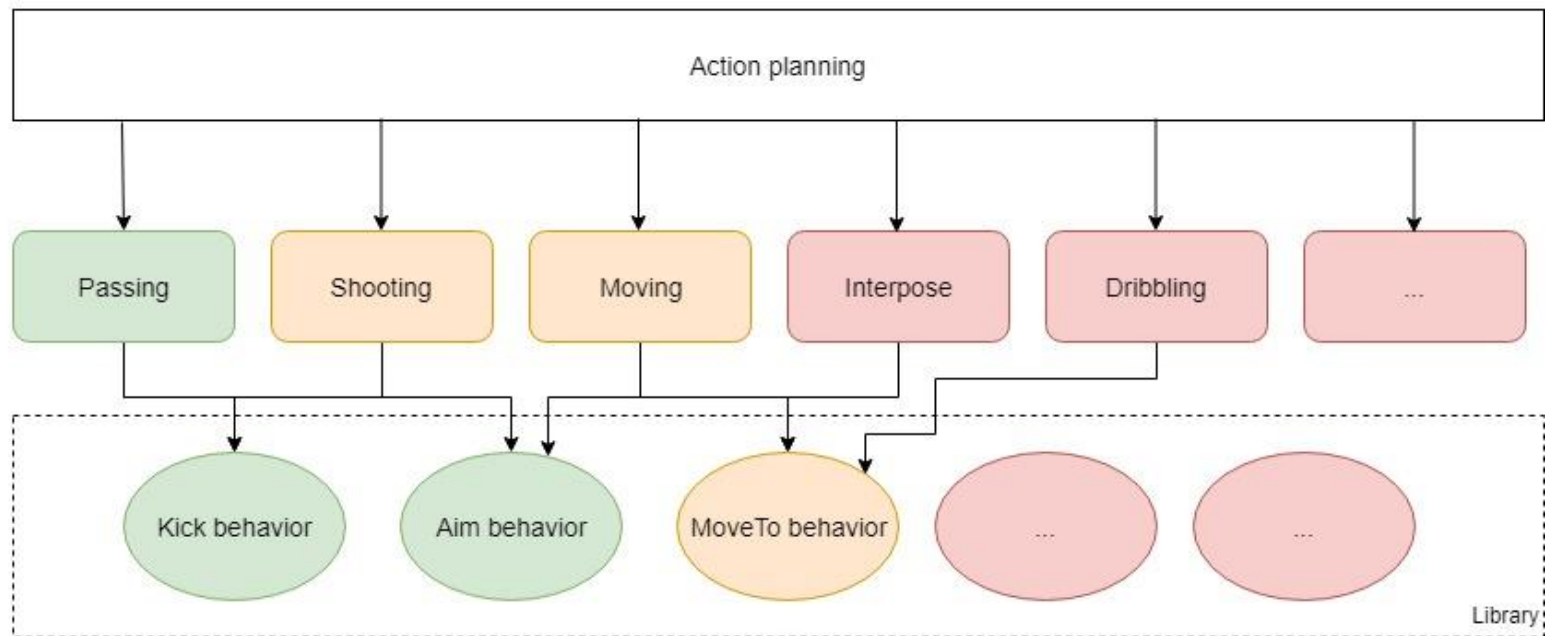
ACTION →

Skills
Move
Intercept
Dribble,
Pass,
Shoot
...

POLICY

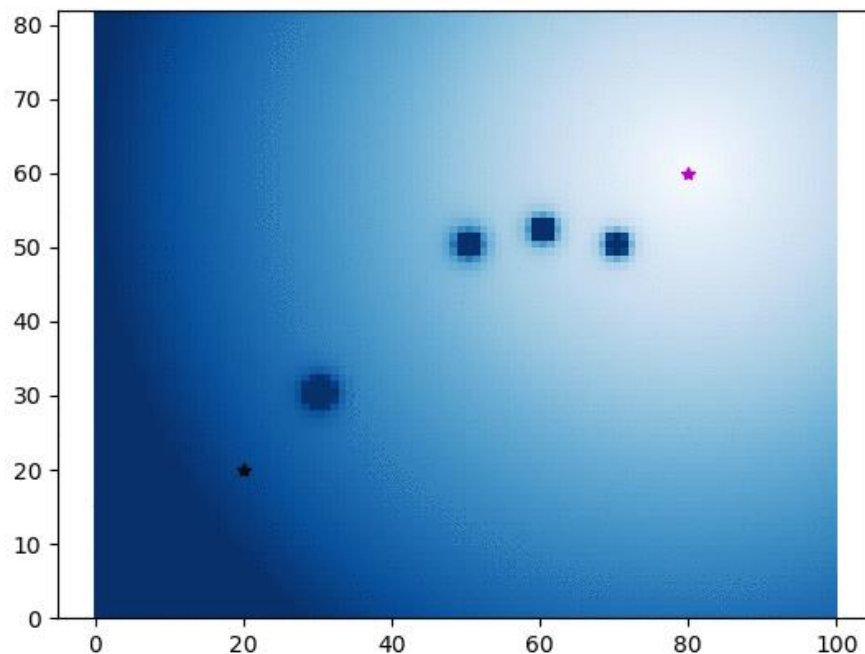
Legend

	Package
	Library
	Implemented node
	Node in progress
	Unimplemented node
	Implemented behavior
	Behavior in progress
	Unimplemented behavior

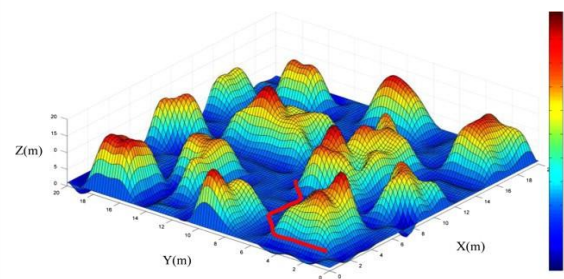


Navigation

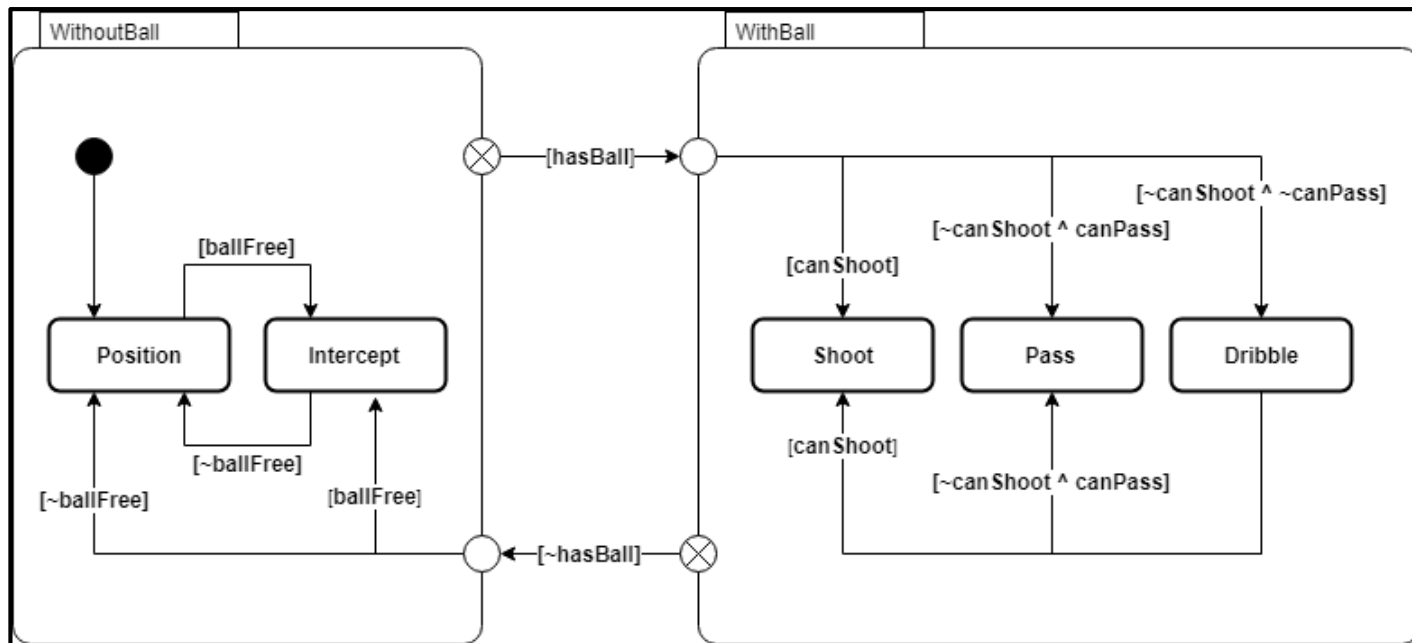
- Artificial Potential Field



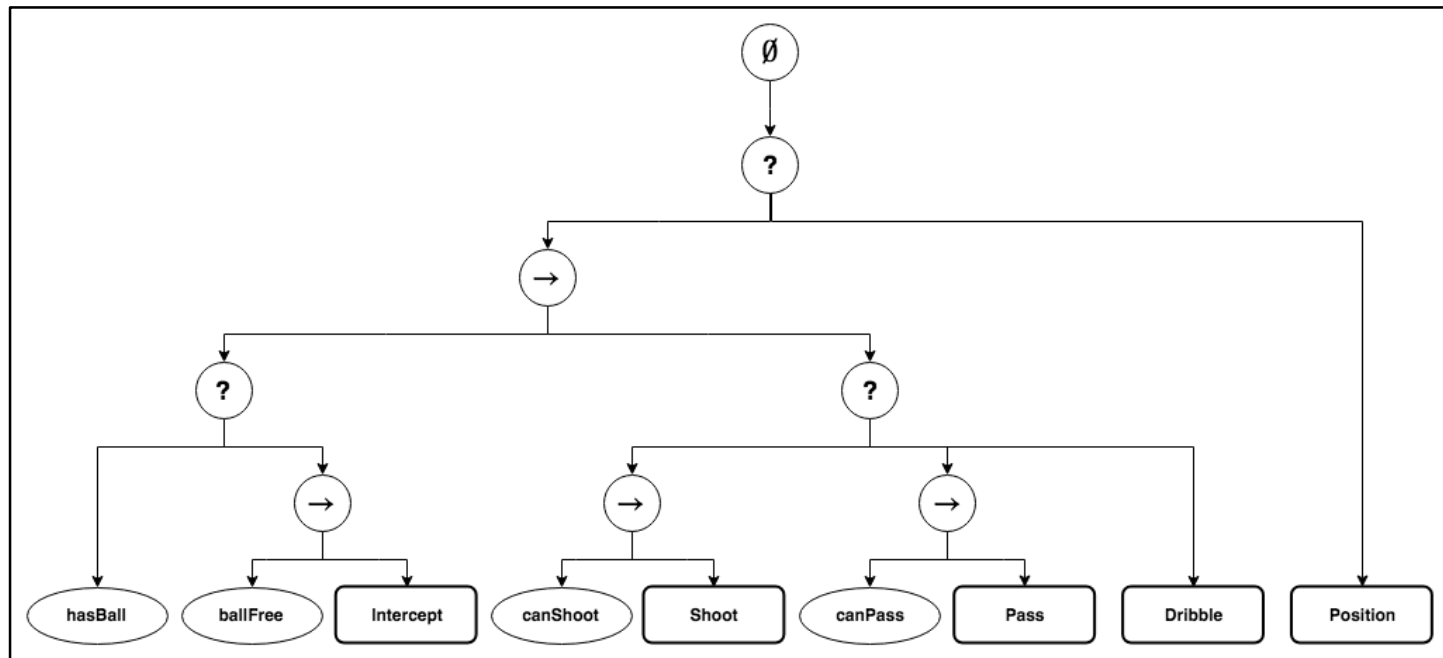
Attraction
+
Repulsion



State machine



Behavior tree



Action selection models

- Hierarchical State Machine
 - Verifiable
- Behavior Tree
 - Maintainable
- Neural Network
 - Trainable

	HSM	BT	NN
Maintainable	-	+	--
Explainable	+	+	-
Verifiable	+	-	-
Trainable	-	-	++

(Andova, Dortmans, Punter, 2019)

Next steps

Degree of difficulty

Ball detection and basic skills

Localisation and navigation

Engineering own robot behavior

Reverse engineering opponent
robot behavior

Continuous Integration

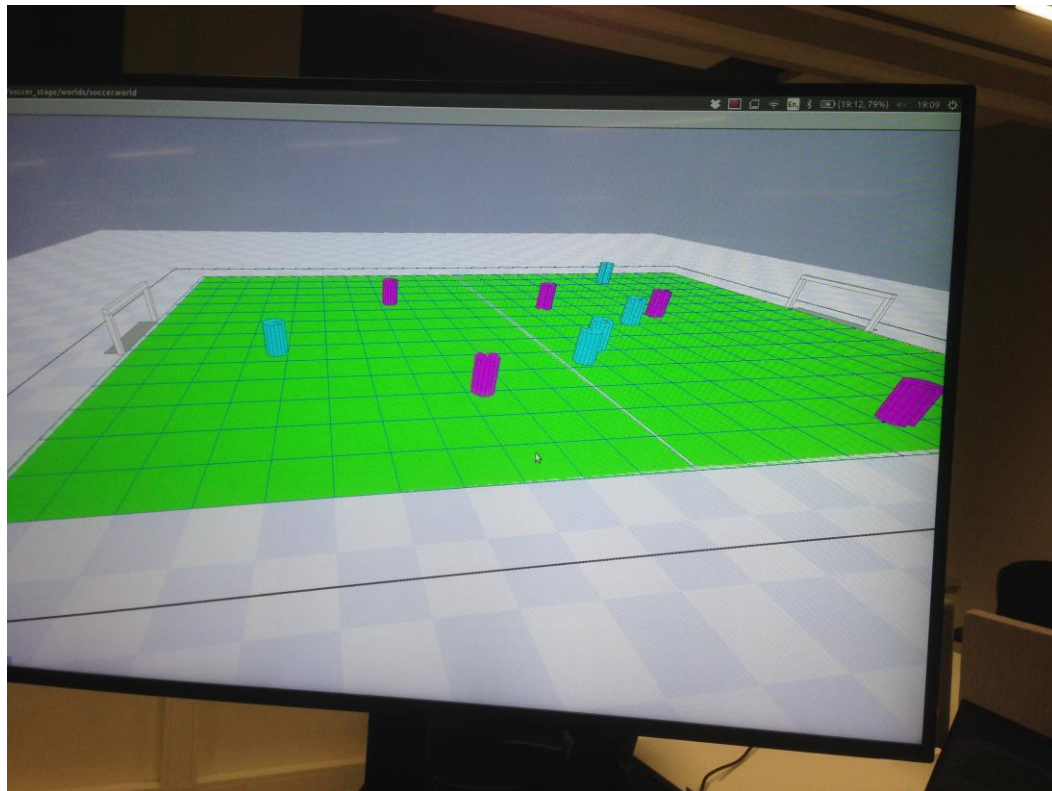
- GitLab repository
- CI/CD Pipeline



Simulator

2D – Stage

3D - Gazebo



Thank you

- Questions or remarks?