



python™



MINDSTORMS
education EV3



Doing Things Differently

Written entirely in Python

Efficient vision with OpenCV

Choosing the Arduino route

XBee radio communication (no Bluetooth)



System flow

Pre-process

Vision - Find objects

Post-process

Planner - Plan

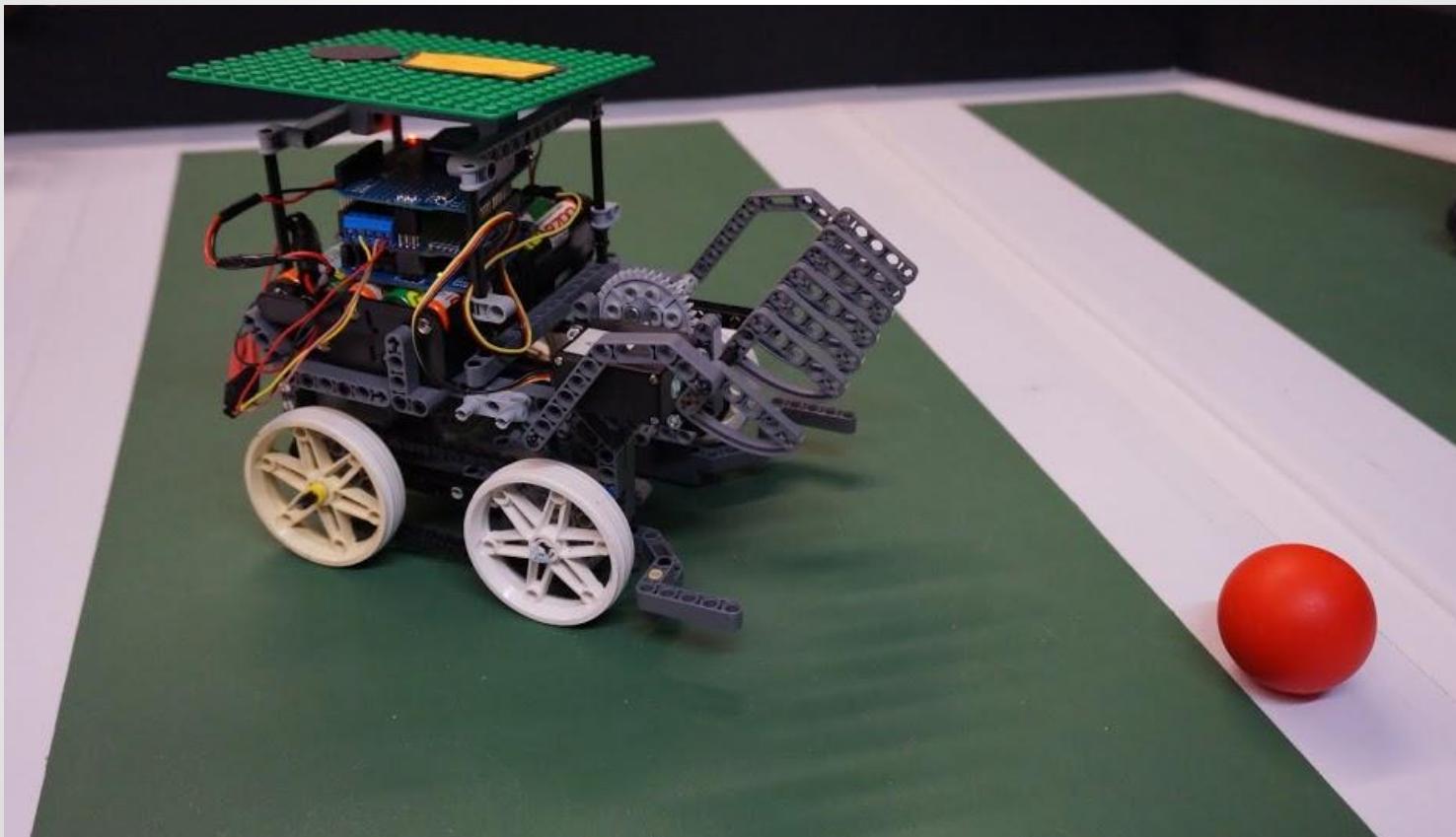
Send commands

Draw GUI

Main Loop



Robots





Design

Hardware

Driving

Kicker/Grabber

Hardware - Microcontroller

NXT



BrickPi



Arduino



Hardware - Motor Control

Adafruit Motor Shield v1



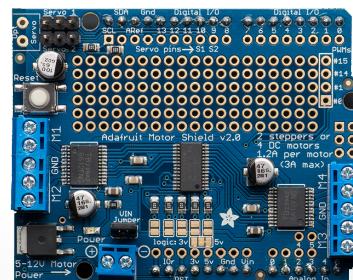
Servo



Stepper Motors



Adafruit Motor Shield v2



Hardware - Wireless

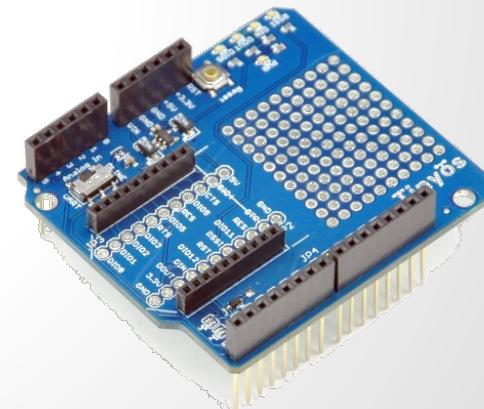
XBee Radio Module



No Pairing Delay

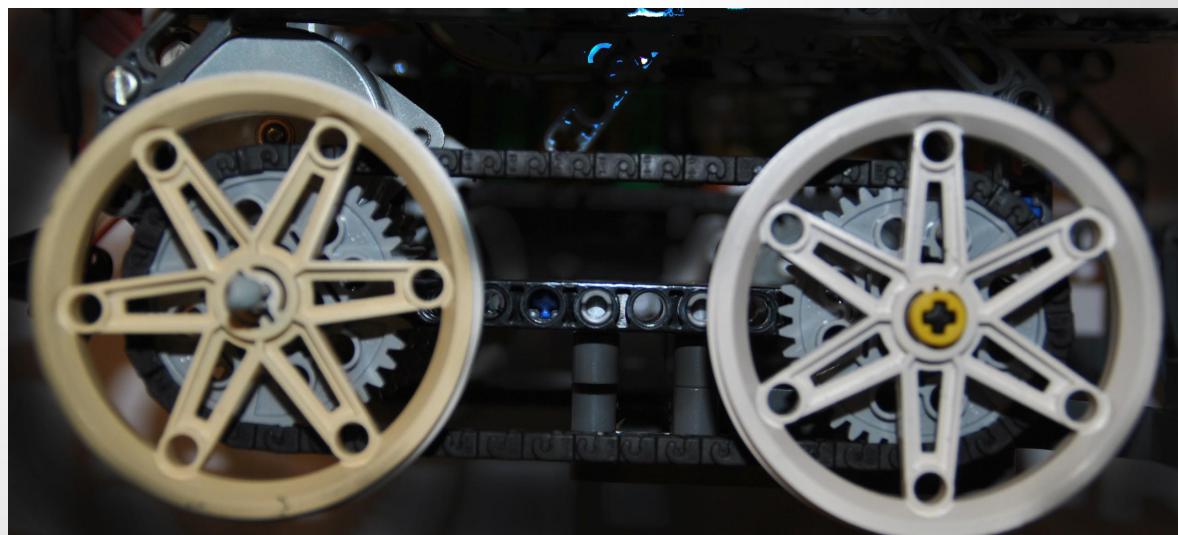
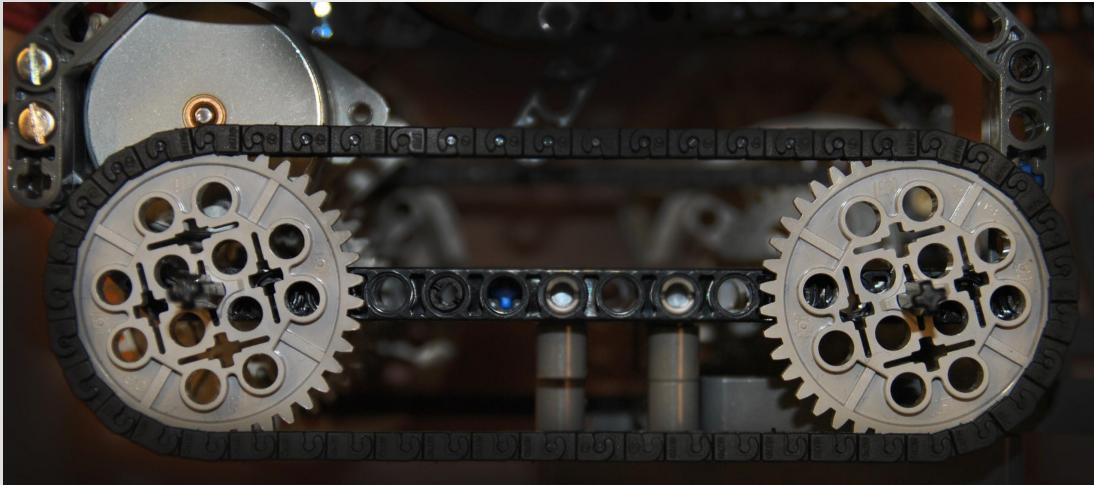
Faster Command Transmission

More Responsive Action



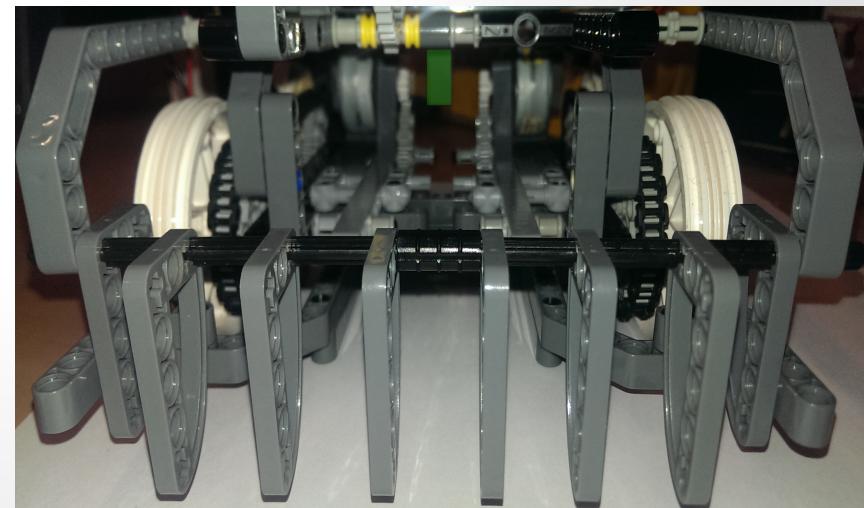


Driving





Kicker/Grabber





Vision - Tracking

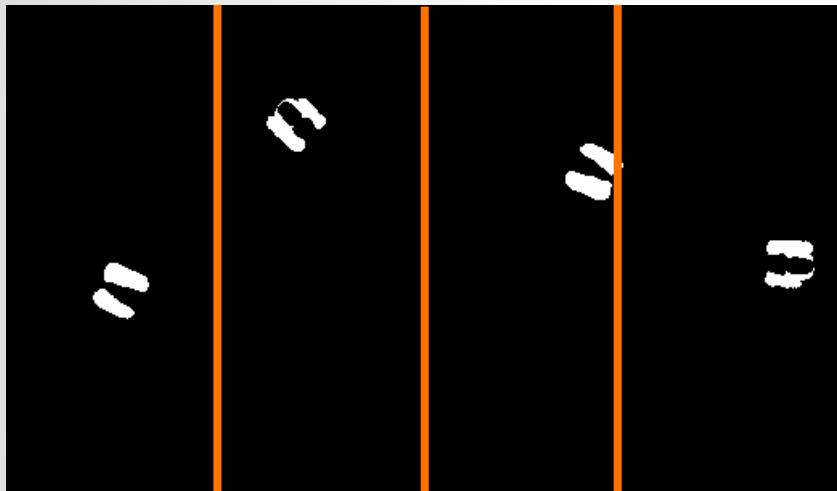
Python OpenCV

Masking & Contours

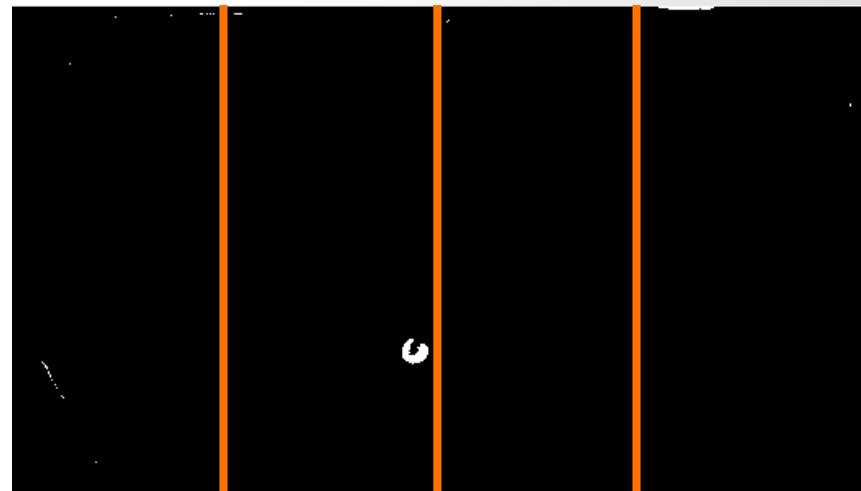
Multi Processed

Orientation

Masking objects



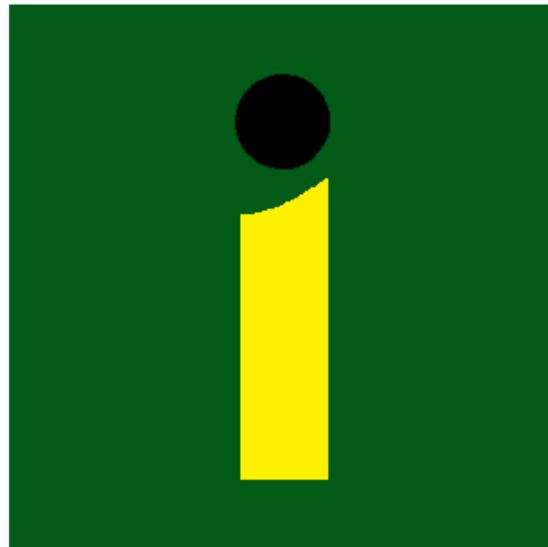
Robots



Ball



Plate Orientation



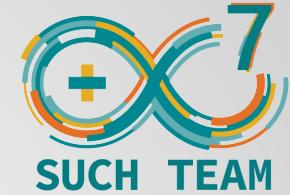


Plate Orientation

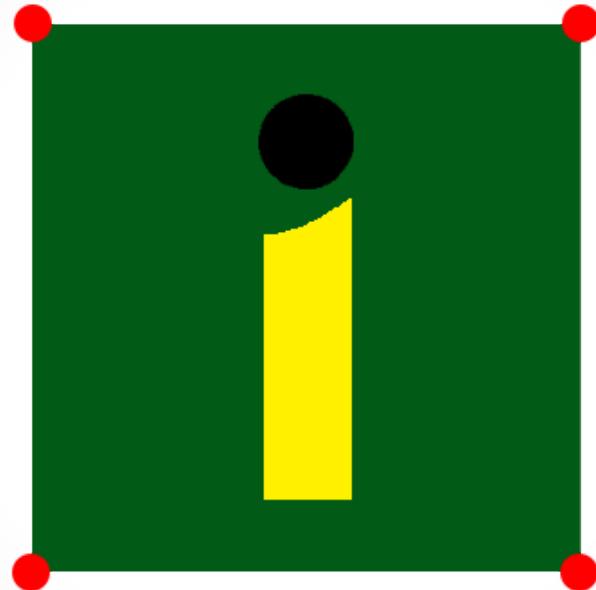
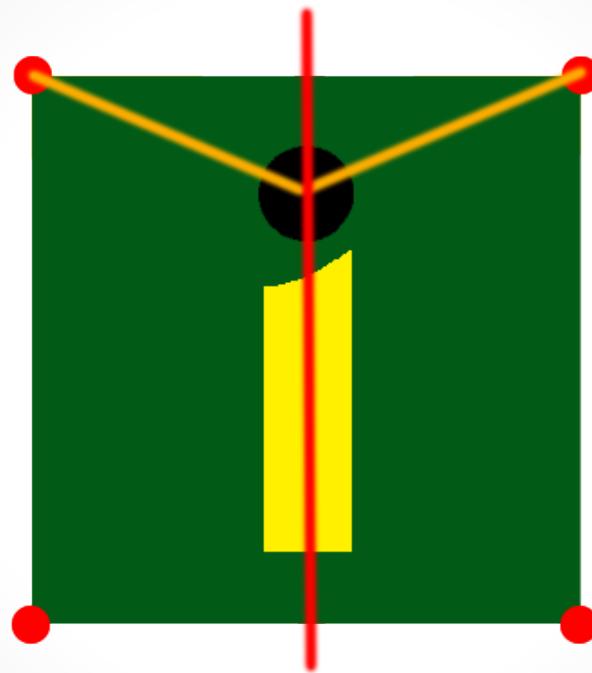


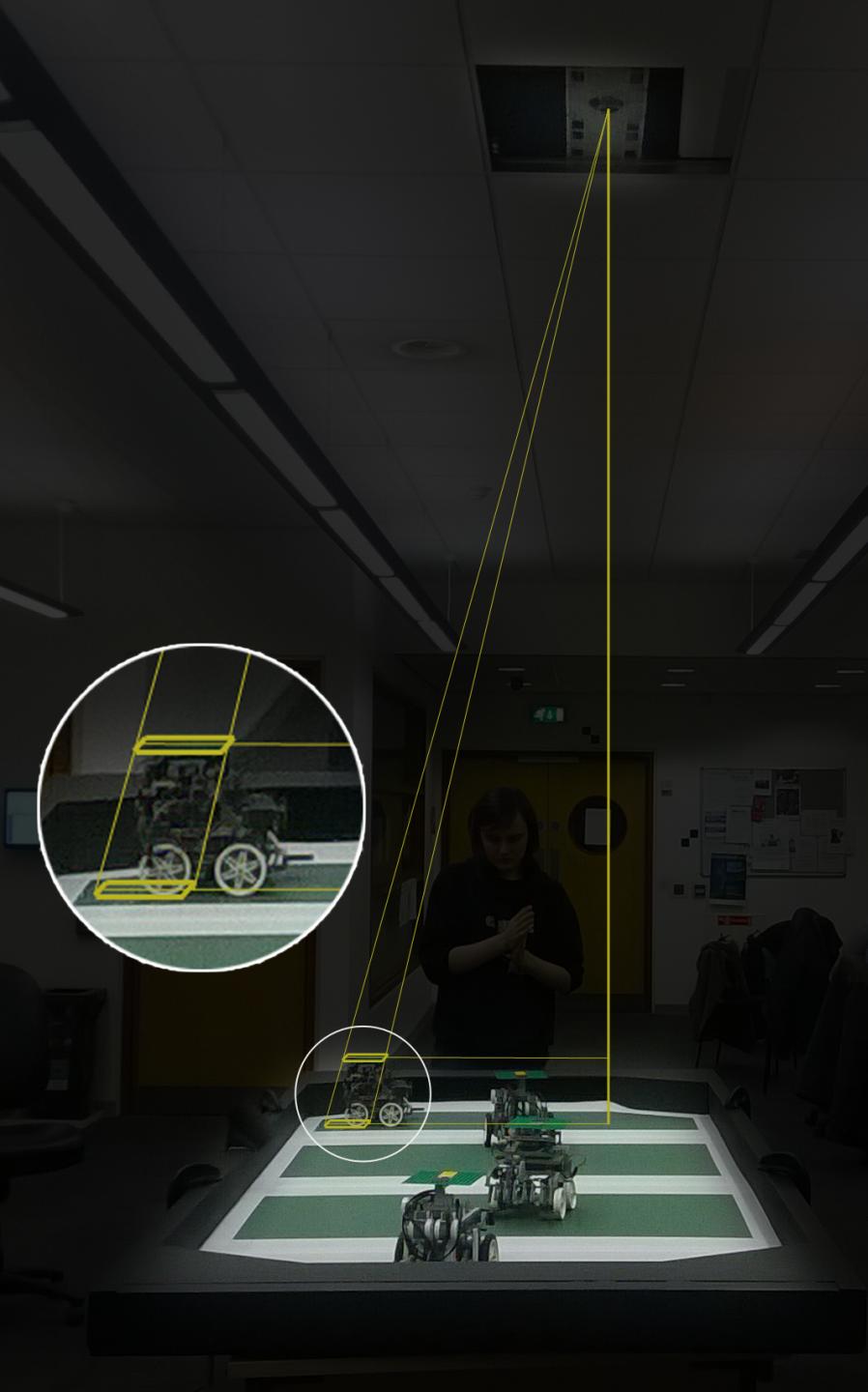
Plate Orientation



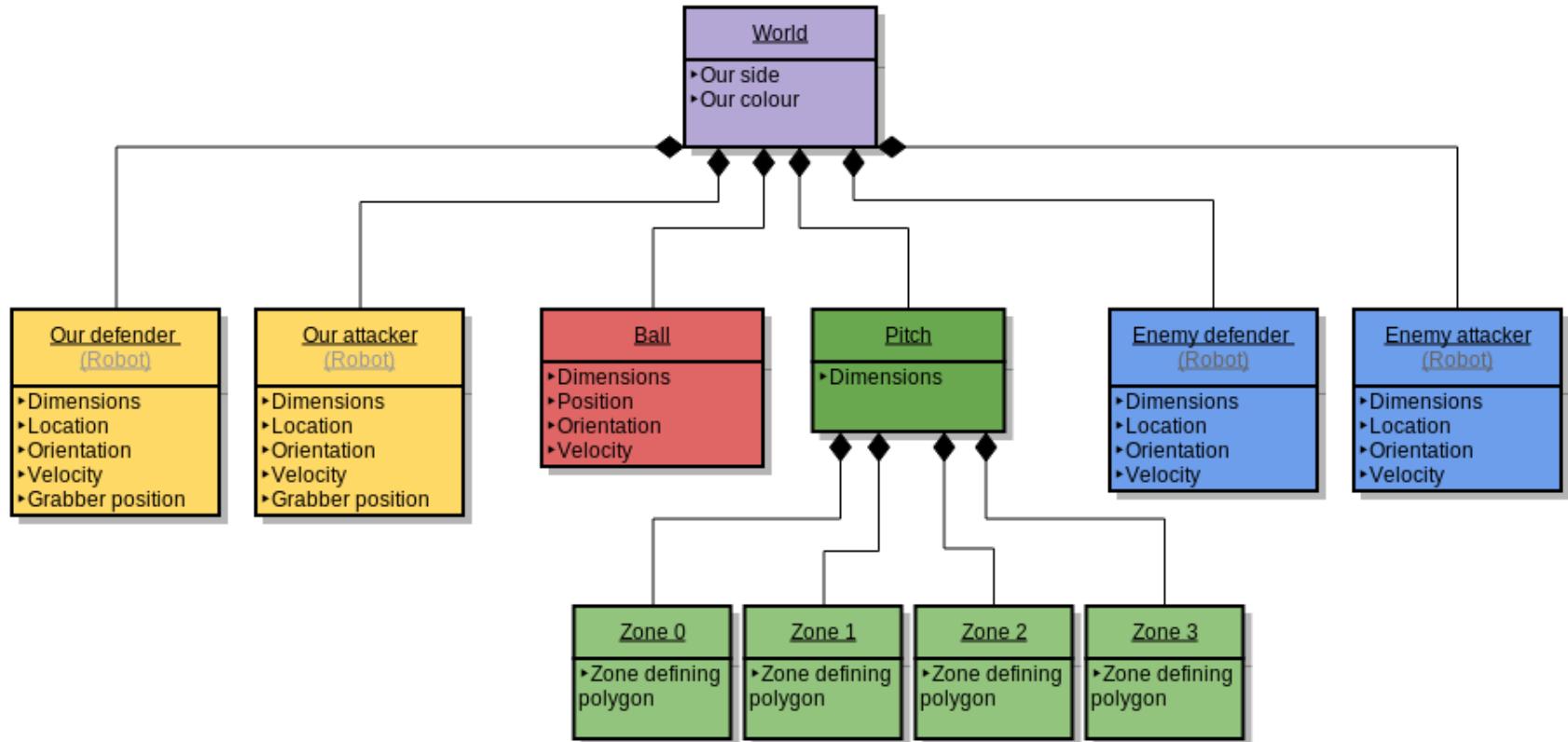
Distortion

Perspective distortion arises from projecting the 3D space onto a 2D plane.

Radial distortion is caused by the properties of the lens and camera.



Models





Planning

Given the current model of the world, the planner chooses a goal and a strategy for achieving that goal.

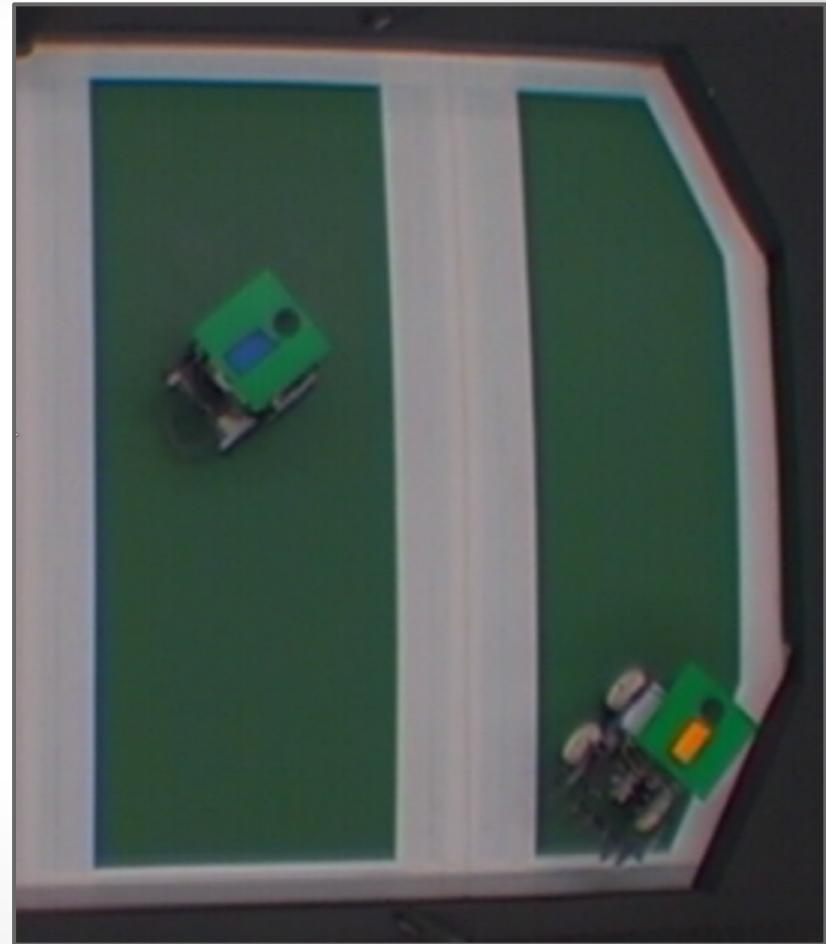
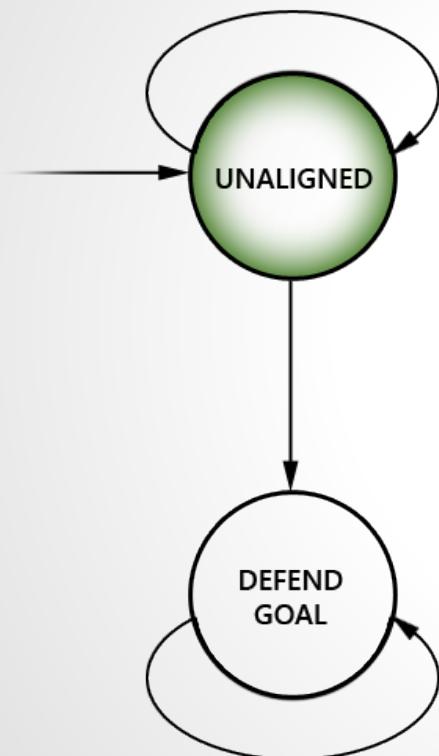
Various strategies for achieving each goal.

Able to choose between them.

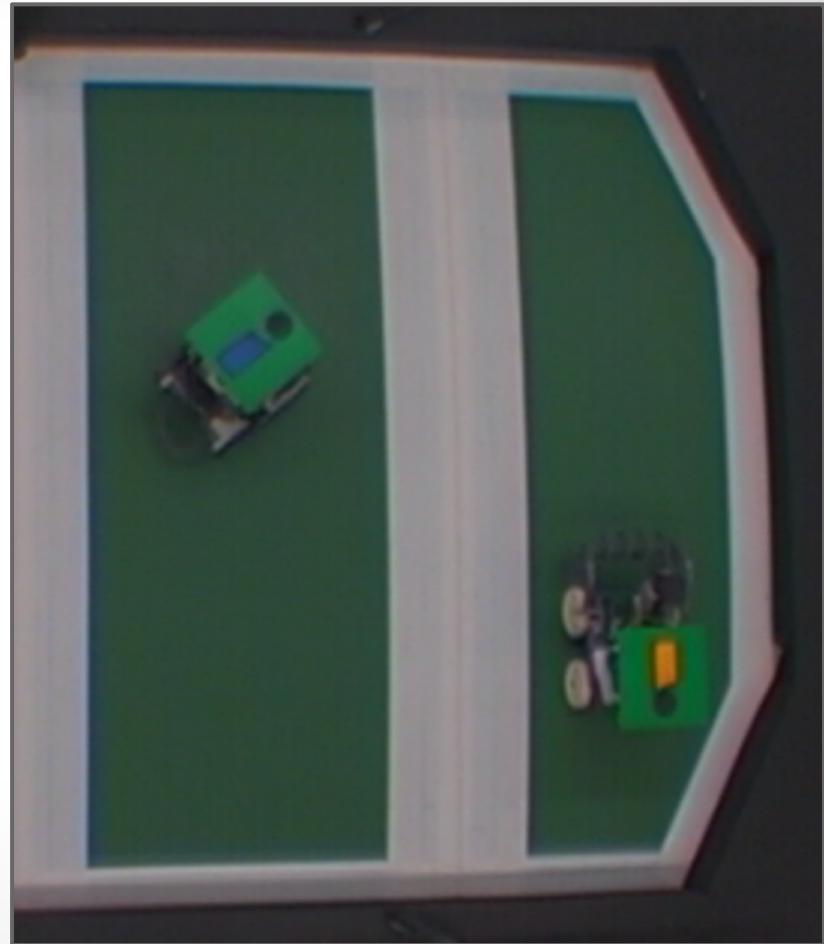
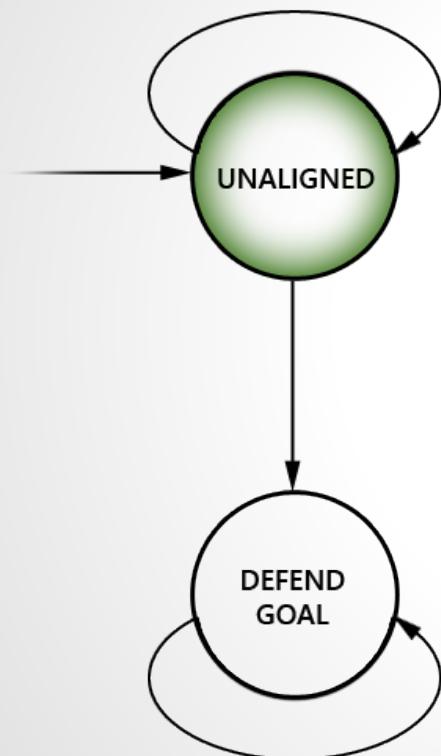
(Examine view of world → choose goal → select strategy → perform action → re-examine world)

Planning and strategies modelled as **FSMs**.

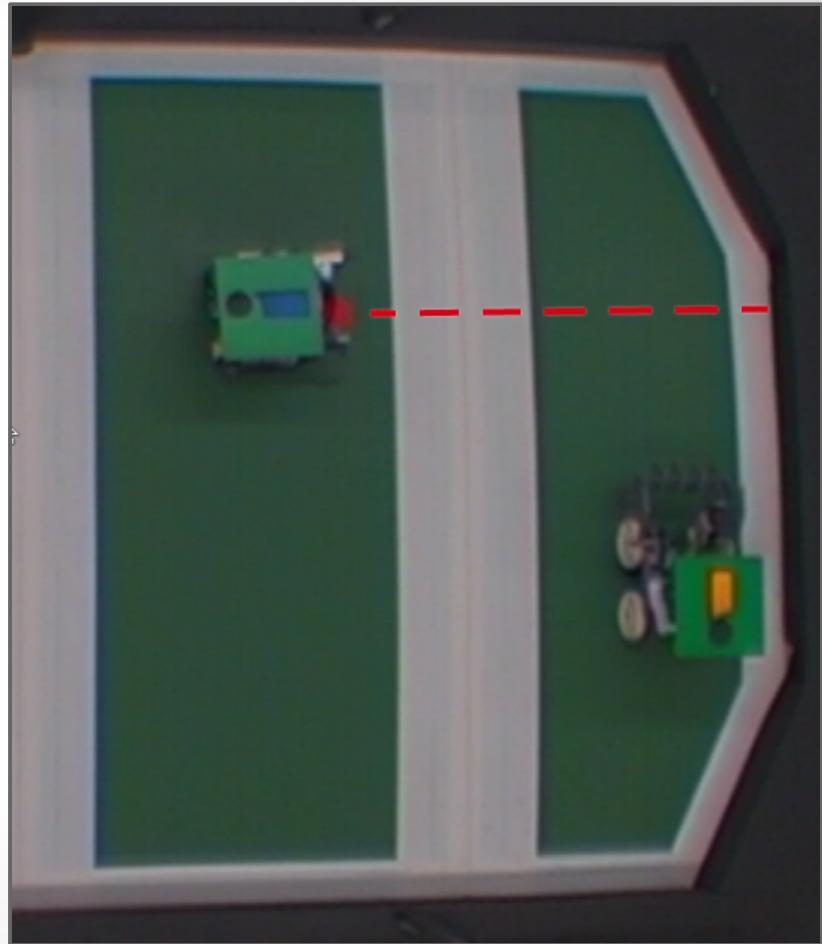
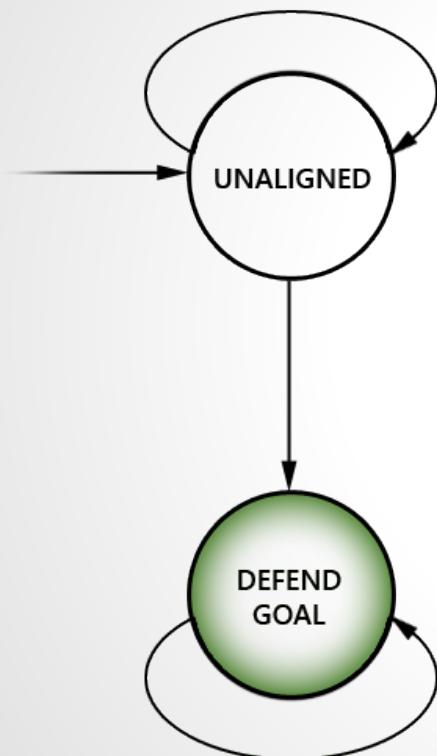
Strategy FSM



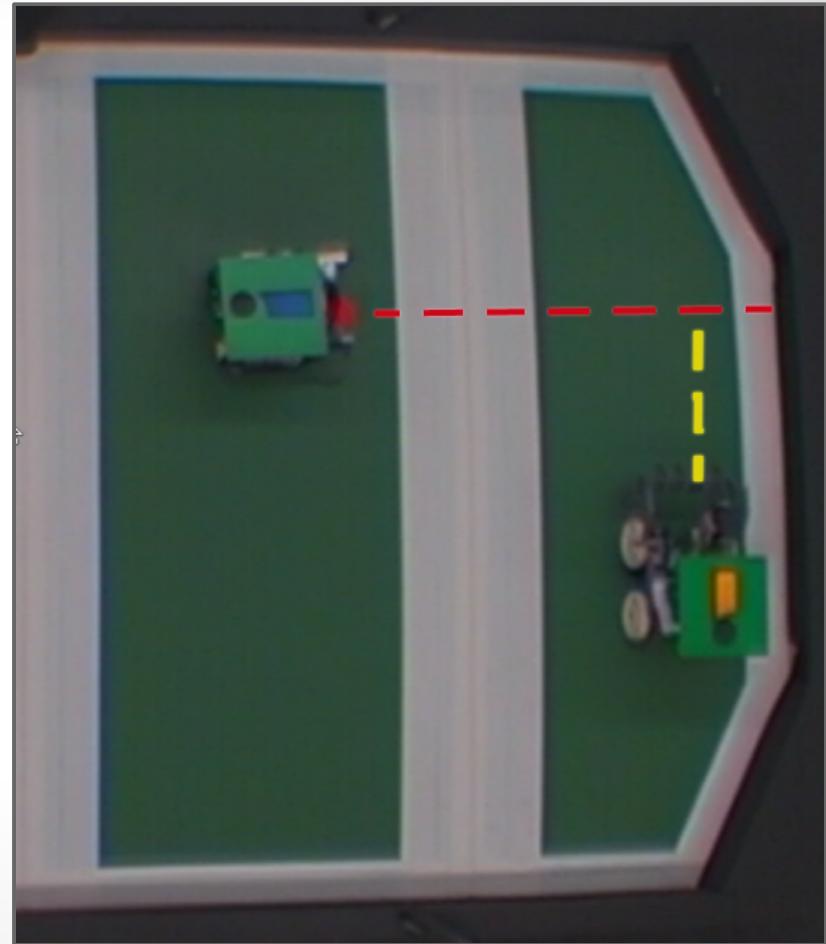
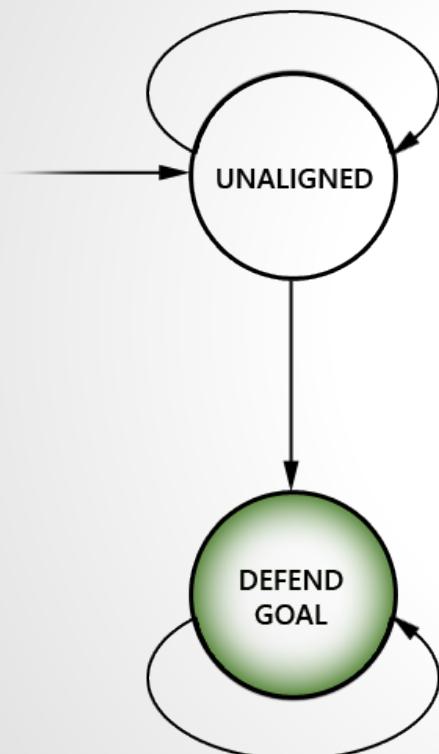
Strategy FSM



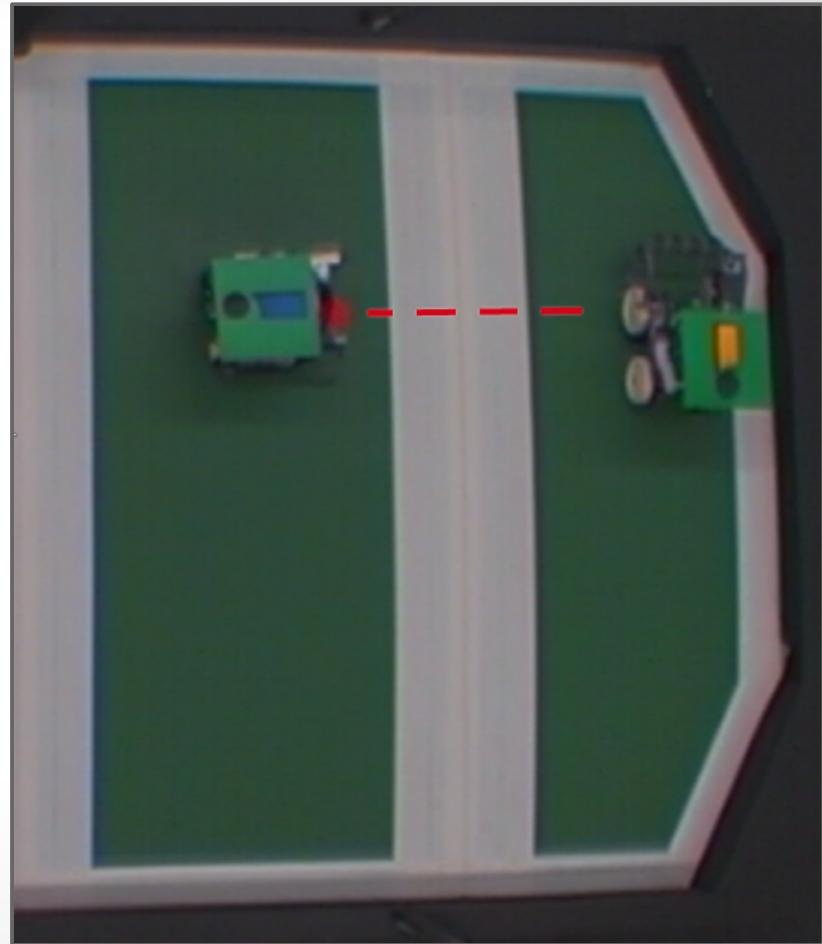
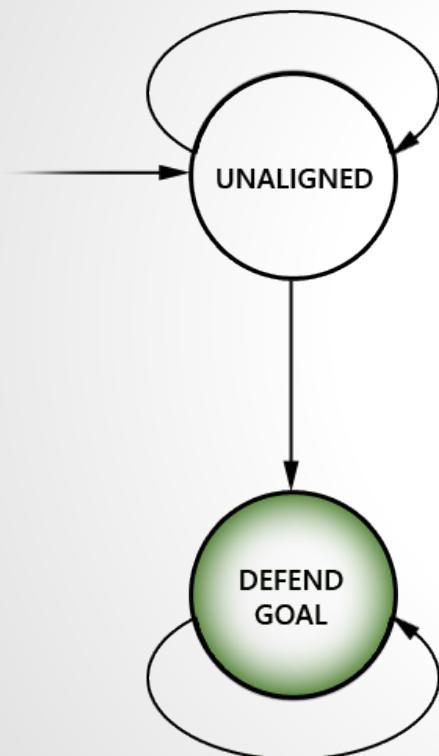
Strategy FSM



Strategy FSM



Strategy FSM





Possible Improvements

Lighter Structural Design

Increase Power of Kicker/Grabber

Strategies that Plan Ahead

Differential Driving



Production Costs (Per Robot)

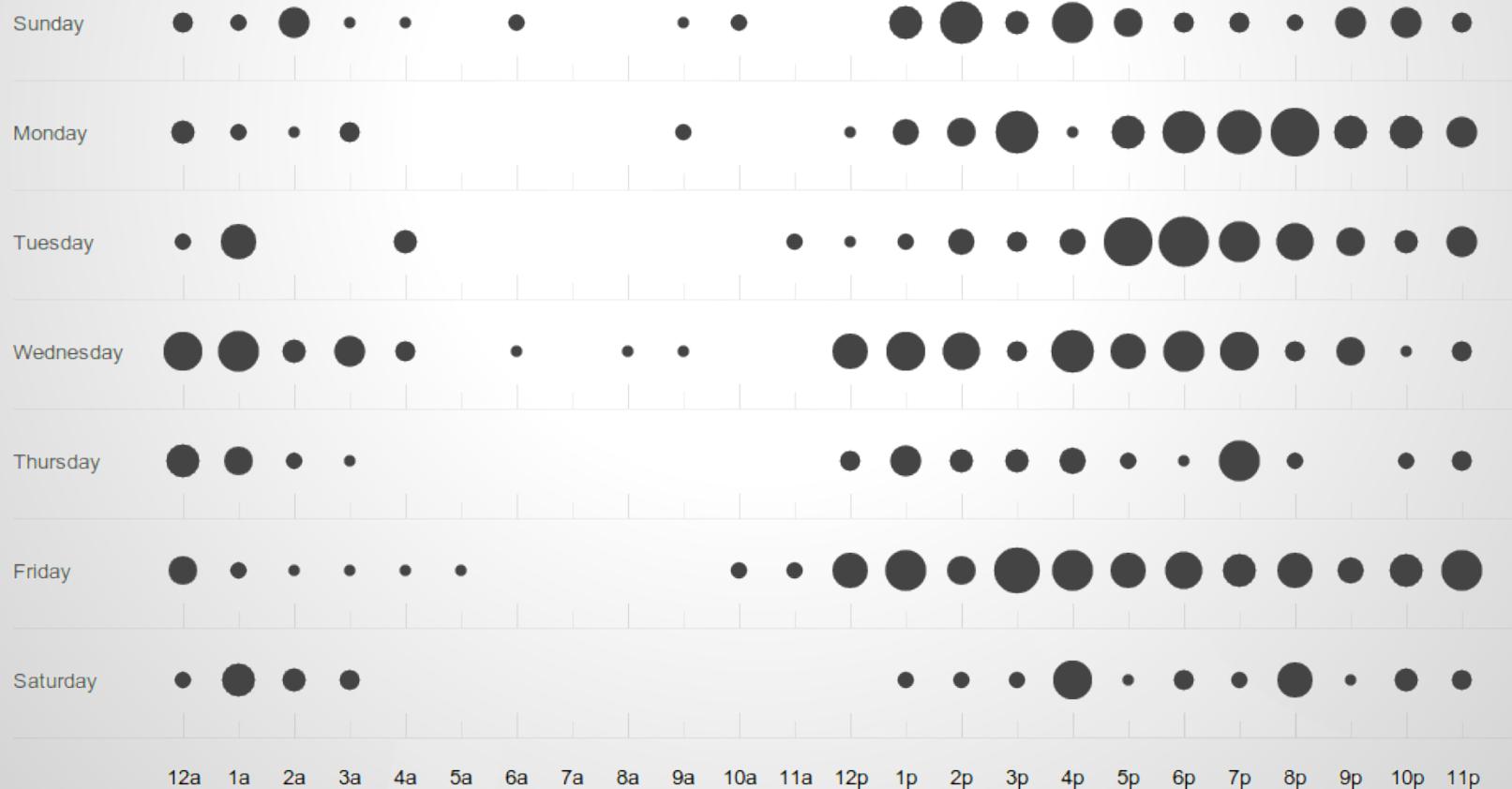
<i>Arduino Uno R3</i>	~ £6
<i>Adafruit Motor Shield v2</i>	~ £11
<i>XBee Shield</i>	~ £5
<i>XBee Series 1</i>	~ £9
<i>HS-322 HD Servo</i>	~ £9
<i>Small Stepper Motor x 2</i>	~ £10
Total:	~ £50



Project Stats

4674 Lines of *Python* Code

856 commits





Q & A

