Robocar in python™

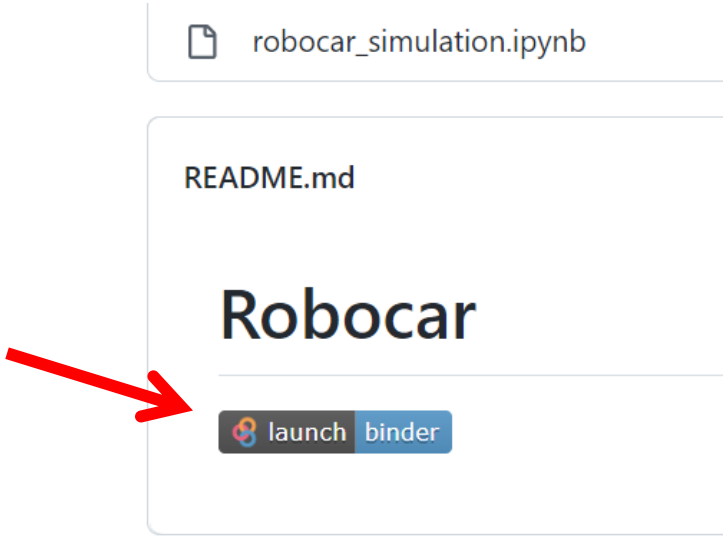
Today we are going to work on programming a robotic car, using a simulation written in Python. The simulated robocar has many of the same functions as the Arduino robot we worked with last week. We're going to work towards programming the car to perform tasks "*autonomously*", i.e. to do things without our input and react to a changing environment.

Getting Started

To start, visit the below website:

https://github.com/LSBU-IOP/Robocar

Click on the "launch binder" button



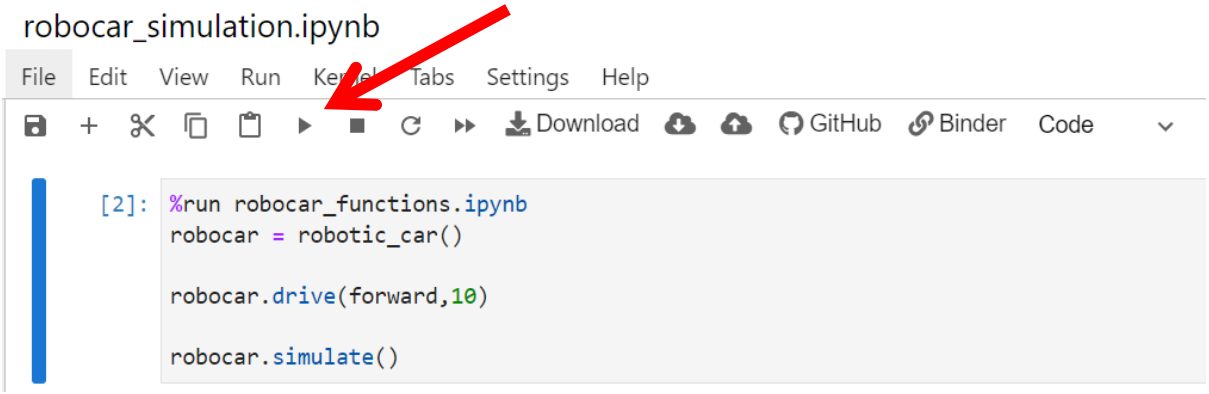
This will launch an interactive coding environment, called a "Jupyter notebook". This let's us write and run Python code through a web browser.

The first line of code imports all the functions and important things that are already written to create the simulation

As with the Arduino car, we have lots of useful functions we can use. The next line tells robocar to drive forward 10 units.

Finally, robocar.simulate() will execute all the commands and generate a video.

Run the code by pressing the play button, or clicking in the "cell" (the grey box with the code in it) and pressing *Ctrl+Enter* on your keyboard.



Functions

Here are the basic functions you can use, try them out.

`robocar.drive(direction, distance)`

direction = forward or back

distance = a number

`robocar.turn(direction, angle)`

direction = left or right

angle = a number (degrees)

`robocar.scan_ahead()`

tells you the distance to any obstacle in front of the car

`robocar.get_heading()`

tells the direction the car is pointing in

`robocar.get_position()`

tells you the position of the car

Loops and Conditions

We can use "conditional" statements to only run some code "if" a condition is met, or "while" something isn't true.

In Python, the syntax is:

```
if condition:
    do some code once...
```

Or

```
while condition:
    repeat some code until condition is false...
```

A "condition" is something which evaluates to True or False, some examples:

`1 < 2`	Always True
`1000 < 2`	Always False
`robocar.scan_ahead() < 5`	True if something is closer than 5

Example: turn right by 5 degrees if there is an obstacle less than 5 units in front of robocar

```
if robocar.scan_ahead() < 5:
    robocar.turn(right,5)
```

Example: drive forwards until robocar is near a wall

```
while robocar.scan_ahead() > 2:
    robocar.drive(forward,1)
```

Challenges

1. Draw a square

2. Drive to (5,10) and then (10,0)

2b) Drive to (5,10) and then (10,0) but only use robocar_drive() twice

3. Draw a circle

4. Complete the maze

Add the line **`robocar.create_maze()`** to the top of your code and then complete the maze by reaching the green square without crashing

```
%run robocar_functions.ipynb
robocar = robotic_car()
robocar.create_maze()
```

5. Automatically avoid obstacles

Add the line **`robocar.gen_walls(20)`** to the top of your code. This will create 20 walls and place them randomly in the area. Make robocar drive around continuously, while avoiding the walls.

```
%run robocar_functions.ipynb
robocar = robotic_car()
robocar.gen_walls(20)
```

Hint: use the scan_ahead function, what should robocar do if scan_ahead says it is close to a wall?

6. Automatically drive to a goal

Add the below line to the top of your code:

```
%run robocar_functions.ipynb
robocar = robotic_car()
robocar.set_goal(random.randint(-18,18),random.randint(-12,12))
```

This will create a goal in a random place on the map. You can get the heading of this goal (the direction robocar needs to travel to reach it), by using the function **`robocar.get_goal_heading()`**

Hint: compare the goal heading with robocars heading!

7. Search and rescue! *(Difficult!)*

Use the below setup, this will place a random goal in the map, and place random walls in the way. Can you program robocar to autonomously reach the goal without crashing, and **without using the get_goal_heading function.** This means that robocar doesn't know where the goal is, and needs to search the map without crashing.

```
%run robocar_functions.ipynb
robocar = robotic_car()
robocar.set_goal(random.randint(-18,18),random.randint(-12,12))
robocar.gen_walls(20)
```

The below loop will execute some code until the goal is reached. Note that if robocar doesn't reach the goal, this code will never stop!

```
while not robocar.goal_reached:
    robocar.drive(forward,1)
```

Add a timer so that the code will stop after a set time, even if robocar doesn't reach the goal

```
t = 0
while not robocar.goal_reached and t<100:
    robocar.drive(forward,1)
    t+=1
```

Hint: because the walls and goal are placed randomly, even a well programmed car might not reach the goal on every attempt.