Artificial Intelligence

Exercise Sheet 1

Exercise 1

a)

Condition	Action
sensor(l) and not-sensor(r)	move(r)
not-sensor(l) and sensor(r)	move(l)
not-sensor(l) and not-sensor(r)	move(f)
sensor(l) and sensor(r)	move(n)

b)
Limitation 1 - it doesn't use the most optimal route and consumes more fuel than is necessary to achieve the goal
Limitation 2 - the agent may not achieve its goal and get stuck in a loop or get into a dead end on a new road configuration, as the agent does not consider those cases

Exercise 2

a)

Condition	Action
sensor(l) and not-sensor(r)	move(r)
not-sensor(l) and sensor(r)	move(l)
not-sensor(l) and not-sensor(r) and in-area(C)	move(f)
sensor(l) and sensor(r)	move(n)
not-sensor(l) and not-sensor(r) and in-area(A, B)	move(r)

b)
This will address the first limitation by using the shorter route to the goal - turning right on the

first crossroad. However the second limitation is still not addressed, and given a different road configuration the car could still get stuck in a loop or get into a dead end

sheet01-programming

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Exercises for the course Artifical Intelligence Summer Semester 2024

G. Montavon Institute of Computer Science Department of Mathematics and Computer Science Freie Universität Berlin

Exercise Sheet 1 (programming part)

[2]:
```
%matplotlib inline
import utils
import numpy
```

0.1 Exercise 3: Implementing a simple reflex agent (20 P)

In this exercise, we would like to implement an simple reflex agent. Similar to the exercise in the theoretical part, the agent represents a car driving autonomously on some road. The goal is to reach the finish line and stop there. The car should remain on the road. If the car stops in the middle of the road or runs into a wall (we assume the road is surrounded with walls), we consider the agent has failed. The car is equiped with two sensors (`sensor_l` and `sensor_r`) that indicate whether there is a wall on the left, or a wall on the right of the car. Based on this sensory information, the car can take four actions (move forward straight ahead (`f`), move forward while turning left (`l`), move forward while turning right (`r`), and not move (`n`).

The simulation environment is given in the file `utils.py`. In particular, the function `run_sim` takes as input the agent and the number of steps of the simulation and produces some output describing the outcome of the simulation.

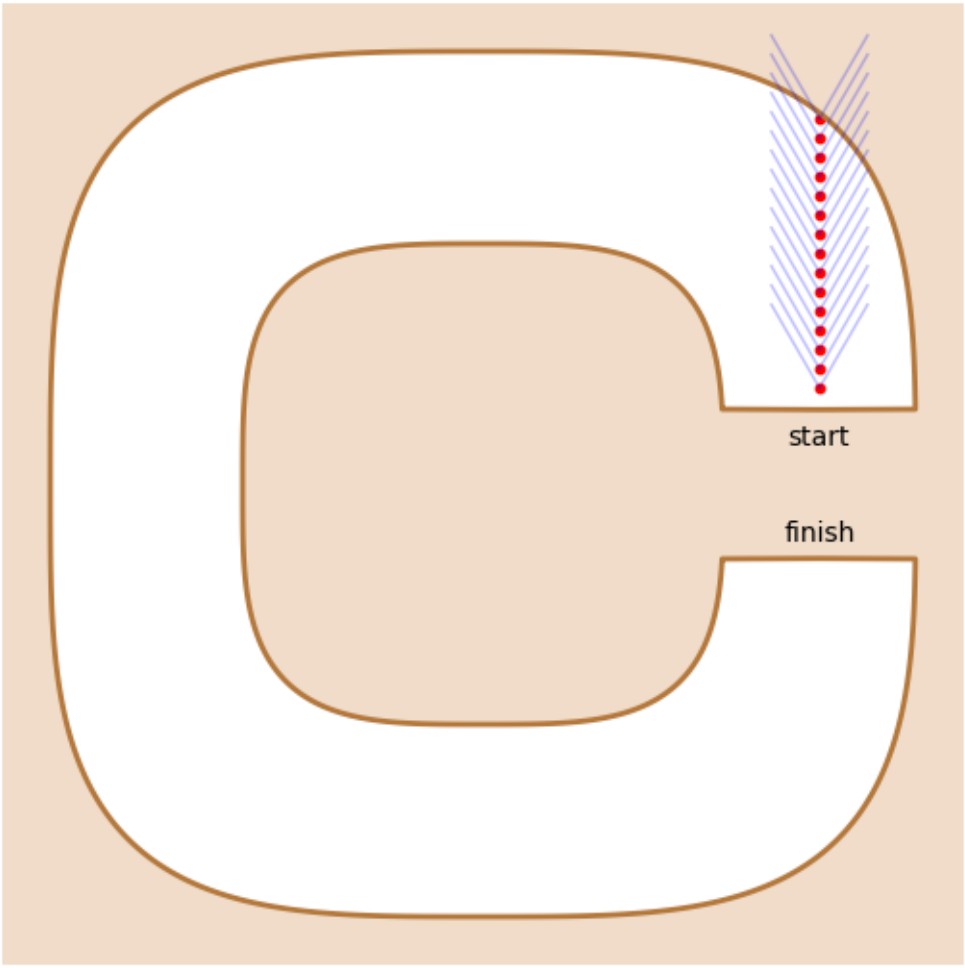
The code below implements a simple dummy agent whose policy is to always move forward straight ahead.

[4]:
```
class Dummy_Reflex_Agent:

    def callback(self, sensor_l, sensor_r):
        action = 'f'
        return action
```

We now simulate the agent in the provided environment. The code below runs the simulation with the given agent for a specified number of iterations.

[5]:
```
dra = Dummy_Reflex_Agent()
utils.run_sim(dra,150)
```

it	px	py	angle	sensors	action
0	0.70	0.20	90	- -	f
1	0.70	0.24	90	- -	f
2	0.70	0.28	90	- -	f
3	0.70	0.32	90	- -	f
4	0.70	0.36	90	- -	f
5	0.70	0.40	90	- -	f
6	0.70	0.44	90	- -	f
7	0.70	0.48	90	- -	f
8	0.70	0.52	90	- r	f
9	0.70	0.56	90	- r	f
10	0.70	0.60	90	- r	f
11	0.70	0.64	90	- r	f
12	0.70	0.68	90	l r	f
13	0.70	0.72	90	l r	f
14	0.70	0.76	90	l r	f



The red dots indicates the trajectory of the car, and the blue lines denote the angle an range of the left/right sensors. As expected, such simple agent which does not rely on its sensors, fails to negociate the first turn and drives into the wall.

We would now like to build a better reflex agent that makes use of the sensors available.

Task:

- **Build a reflex agent that achieves the desired goal. Specifically, implement appropriate condition/action rules in its callback function.**

[8]:
```
class Better_Reflex_Agent:

    def callback(self, sensor_l, sensor_r):

        if sensor_l and sensor_r:
            return 'n'
        if sensor_r:
            return 'l'
        if sensor_l:
            return 'r'

        return 'f'
```

We now test our refined reflex agent in the same environment as before and for the same number of iterations.

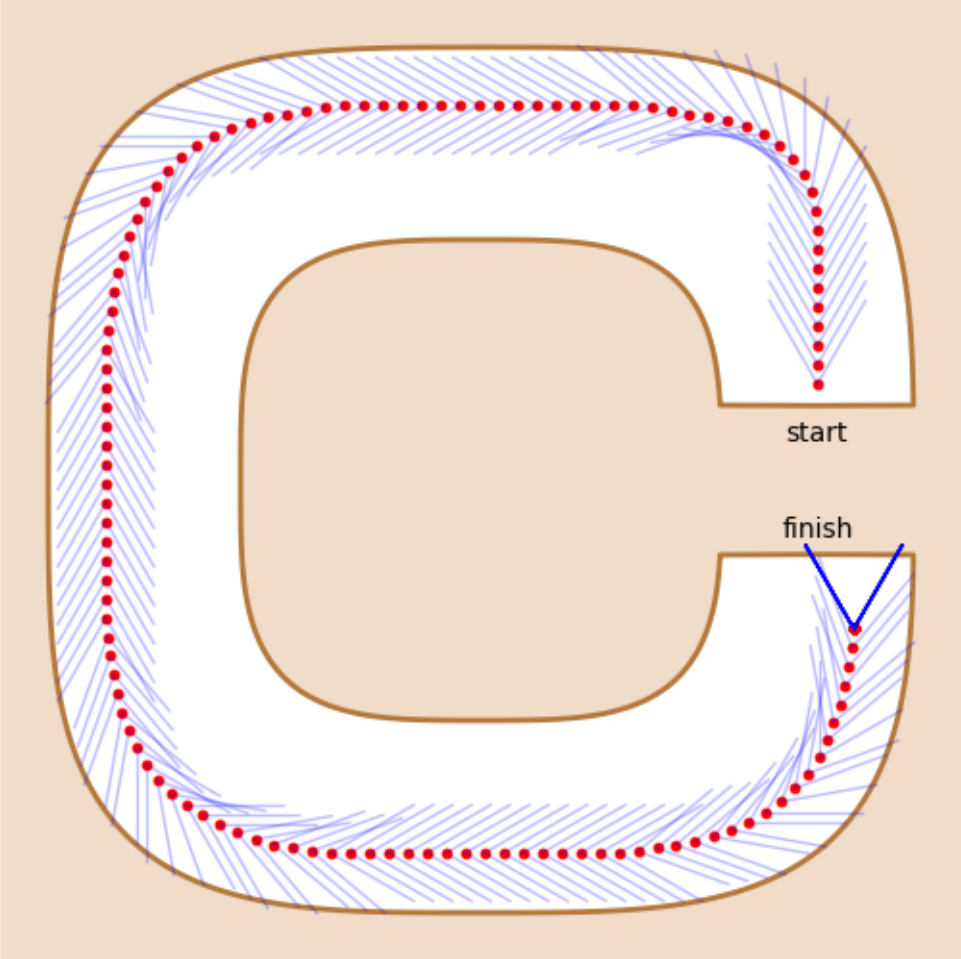
[9]:
```
numpy.random.seed(0)

bra = Better_Reflex_Agent()
utils.run_sim(bra,150)
```

```
it |    px    py angle | sensors | action
 0 |  0.70  0.20    90 |   -   - |      f
 1 |  0.70  0.24    90 |   -   - |      f
 2 |  0.70  0.28    90 |   -   - |      f
 3 |  0.70  0.32    90 |   -   - |      f
 4 |  0.70  0.36    90 |   -   - |      f
 5 |  0.70  0.40    90 |   -   - |      f
 6 |  0.70  0.44    90 |   -   - |      f
 7 |  0.70  0.48    90 |   -   - |      f
 8 |  0.70  0.52    90 |   -   r |      l
 9 |  0.70  0.56   100 |   -   r |      l
10 |  0.69  0.60   110 |   -   r |      l
11 |  0.67  0.63   120 |   -   r |      l
12 |  0.65  0.67   130 |   -   r |      l
13 |  0.62  0.70   140 |   -   r |      l
14 |  0.59  0.72   150 |   -   r |      l
15 |  0.55  0.74   160 |   -   r |      l
16 |  0.51  0.75   170 |   -   - |      f
```

17	0.47	0.75	170	-	-	f
18	0.43	0.76	170	-	-	f
19	0.39	0.77	170	-	-	f
20	0.36	0.78	170	-	r	l
21	0.32	0.78	180	-	-	f
22	0.28	0.78	180	-	-	f
23	0.24	0.78	180	-	-	f
24	0.20	0.78	180	-	-	f
25	0.16	0.78	180	-	-	f
26	0.12	0.78	180	-	-	f
27	0.08	0.78	180	-	-	f
28	0.04	0.78	180	-	-	f
29	-0.00	0.78	180	-	-	f
30	-0.04	0.78	180	-	-	f
31	-0.08	0.78	180	-	-	f
32	-0.12	0.78	180	-	-	f
33	-0.16	0.78	180	-	-	f
34	-0.20	0.78	180	-	-	f
35	-0.24	0.78	180	-	-	f
36	-0.28	0.78	180	-	r	l
37	-0.32	0.78	190	-	-	f
38	-0.36	0.77	190	-	-	f
39	-0.40	0.76	190	-	-	f
40	-0.44	0.75	190	-	r	l
41	-0.48	0.74	200	-	-	f
42	-0.52	0.73	200	-	r	l
43	-0.56	0.71	210	-	-	f
44	-0.59	0.69	210	-	r	l
45	-0.62	0.67	220	-	r	l
46	-0.65	0.64	230	-	-	f
47	-0.68	0.61	230	-	r	l
48	-0.70	0.58	240	-	r	l
49	-0.72	0.54	250	-	-	f
50	-0.73	0.51	250	-	-	f
51	-0.74	0.47	250	-	r	l
52	-0.76	0.43	260	-	-	f
53	-0.76	0.39	260	-	-	f
54	-0.77	0.35	260	-	-	f
55	-0.78	0.31	260	-	r	l
56	-0.78	0.27	270	-	-	f
57	-0.78	0.23	270	-	-	f
58	-0.78	0.19	270	-	-	f
59	-0.78	0.15	270	-	-	f
60	-0.78	0.11	270	-	-	f
61	-0.78	0.07	270	-	-	f
62	-0.78	0.03	270	-	-	f
63	-0.78	-0.01	270	-	-	f
64	-0.78	-0.05	270	-	-	f

```
 65 | -0.78 -0.09   270 |   -   - |      f
 66 | -0.78 -0.13   270 |   -   - |      f
 67 | -0.78 -0.17   270 |   -   - |      f
 68 | -0.78 -0.21   270 |   -   - |      f
 69 | -0.78 -0.25   270 |   -   - |      f
 70 | -0.78 -0.29   270 |   -   r |      l
 71 | -0.78 -0.33   280 |   -   - |      f
 72 | -0.77 -0.37   280 |   -   - |      f
 73 | -0.76 -0.41   280 |   -   - |      f
 74 | -0.76 -0.44   280 |   -   r |      l
 75 | -0.75 -0.48   290 |   -   - |      f
 76 | -0.73 -0.52   290 |   -   r |      l
 77 | -0.72 -0.56   300 |   -   - |      f
 78 | -0.70 -0.59   300 |   -   r |      l
 79 | -0.67 -0.62   310 |   -   r |      l
 80 | -0.65 -0.65   320 |   -   r |      l
 81 | -0.61 -0.68   330 |   -   - |      f
 82 | -0.58 -0.70   330 |   -   - |      f
 83 | -0.54 -0.72   330 |   -   r |      l
 84 | -0.51 -0.73   340 |   -   - |      f
 85 | -0.47 -0.75   340 |   -   r |      l
 86 | -0.43 -0.76   350 |   -   - |      f
 87 | -0.39 -0.77   350 |   -   - |      f
 88 | -0.35 -0.77   350 |   -   r |      l
 89 | -0.31 -0.78   360 |   -   - |      f
 90 | -0.27 -0.78   360 |   -   - |      f
 91 | -0.23 -0.78   360 |   -   - |      f
 92 | -0.19 -0.78   360 |   -   - |      f
 93 | -0.15 -0.78   360 |   -   - |      f
 94 | -0.11 -0.78   360 |   -   - |      f
 95 | -0.07 -0.78   360 |   -   - |      f
 96 | -0.03 -0.78   360 |   -   - |      f
 97 |  0.01 -0.78   360 |   -   - |      f
 98 |  0.05 -0.78   360 |   -   - |      f
 99 |  0.09 -0.78   360 |   -   - |      f
100 |  0.13 -0.78   360 |   -   - |      f
101 |  0.17 -0.78   360 |   -   - |      f
102 |  0.21 -0.78   360 |   -   - |      f
103 |  0.25 -0.78   360 |   -   - |      f
104 |  0.29 -0.78   360 |   -   r |      l
105 |  0.33 -0.77    10 |   -   - |      f
106 |  0.37 -0.77    10 |   -   - |      f
107 |  0.41 -0.76    10 |   -   - |      f
108 |  0.45 -0.75    10 |   -   r |      l
109 |  0.48 -0.74    20 |   -   - |      f
110 |  0.52 -0.73    20 |   -   r |      l
111 |  0.56 -0.71    30 |   -   - |      f
112 |  0.59 -0.69    30 |   -   r |      l
```

113	0.63 -0.67	40	-	r	l
114	0.65 -0.64	50	-	-	f
115	0.68 -0.61	50	-	r	l
116	0.70 -0.58	60	-	r	l
117	0.72 -0.54	70	-	-	f
118	0.73 -0.50	70	-	-	f
119	0.75 -0.47	70	-	r	l
120	0.76 -0.43	80	-	-	f
121	0.76 -0.39	80	-	-	f
122	0.77 -0.35	80	-	r	l
123	0.78 -0.31	90	l	r	n
124	0.78 -0.31	90	l	r	n
125	0.78 -0.31	90	l	r	n
126	0.78 -0.31	90	l	r	n
127	0.78 -0.31	90	l	r	n
128	0.78 -0.31	90	l	r	n
129	0.78 -0.31	90	l	r	n
130	0.78 -0.31	90	l	r	n
131	0.78 -0.31	90	l	r	n
132	0.78 -0.31	90	l	r	n
133	0.78 -0.31	90	l	r	n
134	0.78 -0.31	90	l	r	n
135	0.78 -0.31	90	l	r	n
136	0.78 -0.31	90	l	r	n
137	0.78 -0.31	90	l	r	n
138	0.78 -0.31	90	l	r	n
139	0.78 -0.31	90	l	r	n
140	0.78 -0.31	90	l	r	n
141	0.78 -0.31	90	l	r	n
142	0.78 -0.31	90	l	r	n
143	0.78 -0.31	90	l	r	n
144	0.78 -0.31	90	l	r	n
145	0.78 -0.31	90	l	r	n
146	0.78 -0.31	90	l	r	n
147	0.78 -0.31	90	l	r	n
148	0.78 -0.31	90	l	r	n
149	0.78 -0.31	90	l	r	n



As can be observed, the agent now properly negociates the first turn, and also does so for the following turns. Arriving at the finish line, the agent stops, thereby achieving its goal.