Introduction to Robotics
Wise 2021/22

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Exercise 11

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Submission online until **Tuesday, 01.02.2022, 11:55 a.m.**

Assignment 11-1: Autonomous navigation (4 Points)

For this task you need to use the provided `Map` class and controller node from the previous tasks or use the provided example solution.

Use the ground truth position published at `/simulation/odom_ground_truth`. The provided `Map` class consists of two lanes. The `Lane` class provides functions for calculating the lookahead point at a certain position:

```
import numpy as np
from map import Map

map = Map()
pos = np.array([x, y])
lane_index = 0
lookahead_distance = 0.7
p, _ = map.lanes[lane_index].lookahead_point(pos, lookahead_distance)
print(p)
```

You can also look at the `MapVisualization` class inside `map.py` for an example how to work with the `Map` class.

Using the position from the topic above find the lookahead point on a lane using the `Map` class. Calculate the desired yaw angle from the lookahead point and publish that angle to your controller.

You can display the map in `rviz` using the topic `/sensors/map`.

Record a video from your `rviz` showing how your car drives the oval (mp4, max 5mb).

Assignment 11-2: Lane Change (4 Points)

Subscribe to a topic which takes the lane number as an input. Make the car swap lanes whenever a lane change is published.

Record a video showing how your car changes lanes (mp4, max 5mb).

Assignment 11-3: Covariance Matrix (1 Point)

Calculate the mean and the covariance matrix for the vector set of $(-1,1)^T, (2,0)^T (2,2)^T (5,1)^T$ (use the maximum likelihood estimator, not the unbiased estimator).

	x	y	xy	x^2	y^2
	-1	1	-1	1	1
	2	0	0	4	0
	2	2	4	4	4
	5	1	5	25	1
M(Mean)	2	1	2	8,5	1,5

$var(x) = 8{,}5 - 2^2 = 4{,}5$

$cov(x,y) = 2 - 2 \cdot 1 = 0$

$Var(y) = 1{,}5 - 1^2 = 0{,}5$

$$\begin{pmatrix} 4{,}5 & 0 \\ 0 & 0{,}5 \end{pmatrix}$$

$$\sigma_x = \sqrt{\tfrac{1}{4}\left((-1-2{,}5)^2+(2-2{,}5)^2+(2-2{,}5)^2+(5-2{,}5)^2\right)}$$

$$\sqrt{\tfrac{1}{4}\left((-3{,}5)^2+(-0{,}5)^2+(-0{,}5)^2+(2{,}5)^2\right)}$$

$$=$$

Assignment 11-4: Bayesian Law (1 Point)

The probability of perceiving a traffic light in the city is for a given autonomous car 20 percent. The probability for perceiving a traffic light outside of a city is 5 percent. In 70 percent of the time the car drives in a city.

What is the probability of being in a city when perceiving a traffic light?

Hint: It might help to use the law of total probability.

Bayes Theorem

likelihood prior

posterior

$$p(x|Z) = \frac{p(Z|x)p(x)}{p(Z)}$$

whr dass x ist wobei z vorliegt

whr einen Turm zu sehen wenn man in Berlin ist

normalizing constant

A in City

C traffic light sehen

geg: $P(C/A) = 20\%$
$p(C/\bar{A}) = 5\%$
$P(A) = 70\%$

ges: $$P(A/C) = \frac{p(C/A)\,p(A)}{p(C)}$$

Totale whr $$p(C) = P(C/A) \cdot P(A) + P(C/\bar{A}) \cdot P(\bar{A}) = 0{,}155$$

$$P(A/C) = \frac{0{,}2 \cdot 0{,}7}{0{,}155} \approx 0{,}90$$