CS3001-CS3606: Autonomous vehicles

Please try to solve the following problems:

Problem 1

Calculate the value of f(x) for mean=10; variance=4 and x=8

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2}\frac{(x-\mu)^2}{\sigma^2}}$$

Response:

F(8) = 1/(sqrt(2*pi*variance)) * exp (-½ (8-mean)^2/variance

= 0.12

Problem 2

Calculate the value of f(x) for mean=0; variance=2 and x=4

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2}\frac{(x-\mu)^2}{\sigma^2}}$$

Response:

f(4) = 0.005

Problem 3

What is the maximum value of f(x), where mean=3 and variance=0.5?

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2}\frac{(x-\mu)^2}{\sigma^2}}$$

Response:

X = mean => f(3) = 0.56

Problem 4

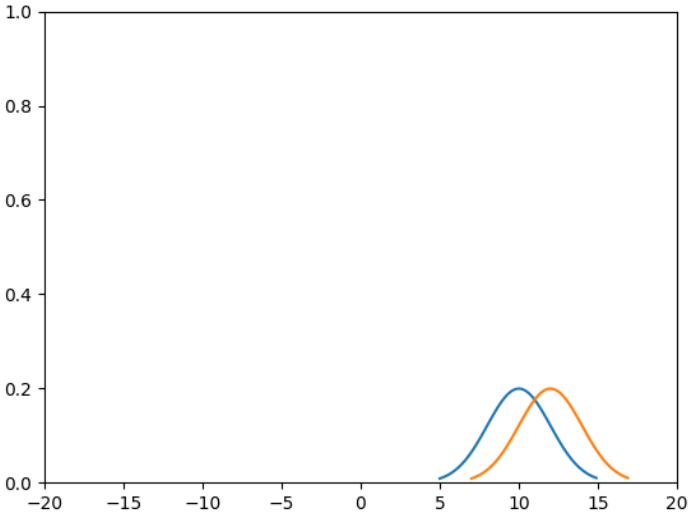
We have a prior position of a car with a mean 10 and a variance 4, and we read a measurement probability with a mean of 12 and a variance of 4. Compute the new mean and variance after the measurement update.

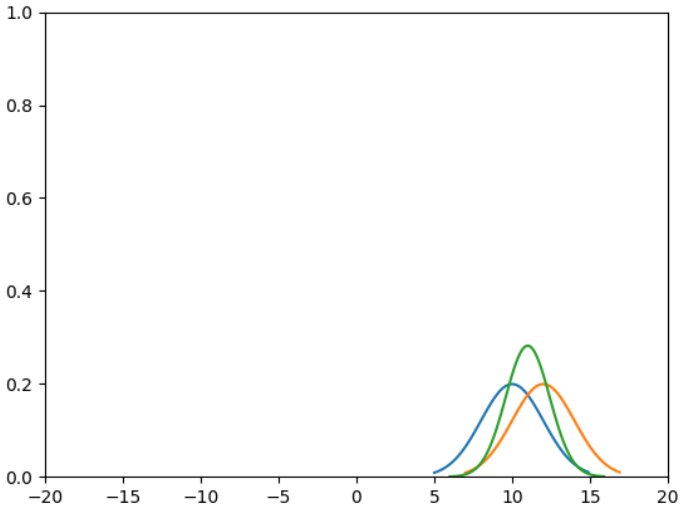
Response:

$$\mu_{new} = \frac{\sigma_2^2 * \mu_1 + \sigma_1^2 * \mu_2}{\sigma_1^2 + \sigma_2^2}$$

$$\sigma_{new}^2 = \frac{1}{\frac{1}{\sigma_1^2} + \frac{1}{\sigma_2^2}}$$

Mean_new = 11; variance =2





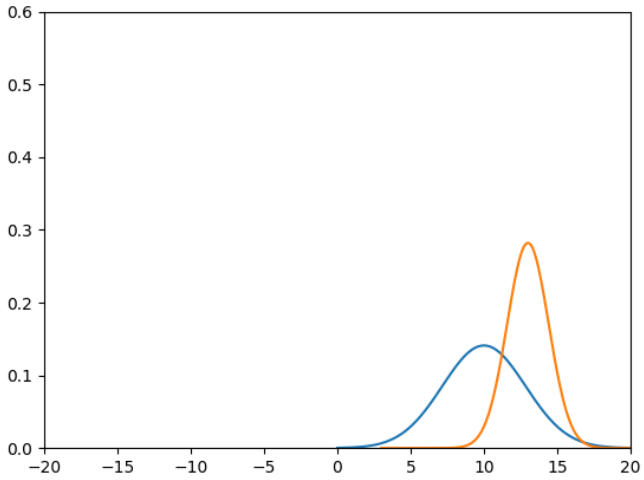
Problem 5

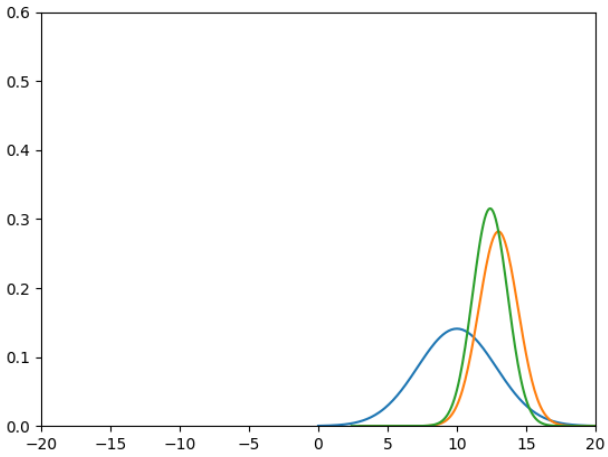
We have a prior position of a car with a mean 10 and a variance 8, and we read a measurement probability with a mean of 13 and a variance of 2. Compute the new mean and variance after the measurement update.

Response:

Mean_new = 12.4

Variance_new = 1.6





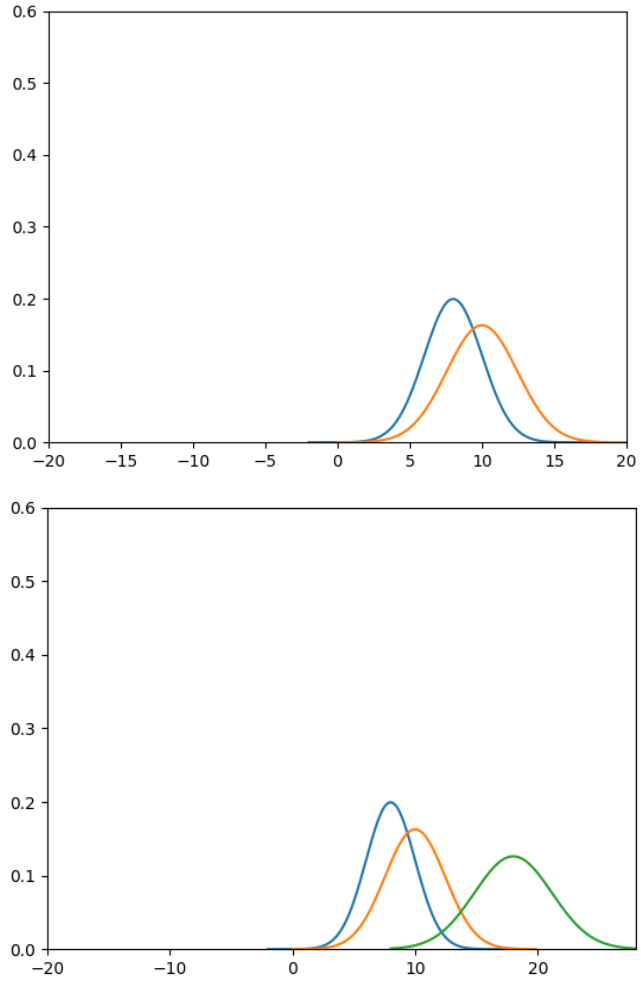
Problem 6

We have a prior position of a car at position 8m from the origin with an uncertainty of 4 . The car moves forward 10m, but the motion was its own uncertainty 6. What is the predicted position of the car?

Response:

Mean_new = 8 + 10 = 18

Variance_new = 4 + 6 = 10



Problem 7

A car is equipped with a radar sensor. We have a series of measurements [5, 6, 7, 9, 19] taken at five time steps. The uncertainty of the sensor (variance) is 4 for each measurement. The car also moves at each time step with the following distances [1, 1, 2, 1, 1]. The uncertainty of the movement (variance) is fixed at 2 for each movement. The initial position of the car is 0 with an uncertainty of 10.

Apply Kalman filter in order to predict the position of the car after the five time steps.

Hint: Apply iteratively the update and predict steps for the Kalman filter. There will be basically five iterations of update & predict.

Response:

Prior: mean = 0; variance = 10

Problem 7						
Kalman filter						
Step 1	Old mean	Old variance	mean	variance	New mean	New variance
Update	0	10	5	4	3.57142857	2.85714286
Prediction	3.57142857	2.85714286	1	2	4.57142857	4.85714286
Step 2						
Update	4.57142857	4.85714286	6	4	5.35483871	2.19354839
Prediction	5.35483871	2.19354839	1	2	6.35483871	4.19354839
Step 3						
Update	6.35483871	4.19354839	7	4	6.68503937	2.04724409
Prediction	6.68503937	2.04724409	2	2	8.68503937	4.04724409
Step 4						
Update	8.68503937	4.04724409	9	4	8.84344423	2.01174168
Prediction	8.84344423	2.01174168	1	2	9.84344423	4.01174168
Step 5						
Update	9.84344423	4.01174168	10	4	9.92183683	2.00293112
Prediction	9.92183683	2.00293112	1	2	10.9218368	4.00293112