**UNIVERSITY OF MALTA**

**FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY**

**Department of Artificial Intelligence**

**Study-Unit:** ARI2202 (Robotics 1)

**Task 1:** Robot Localization

**Submission Deadline:** 13th May 2021 23:59

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- This task contributes towards 50% of your final project mark.
- You may submit your work multiple times. Only your final submission will be assessed.
- Please submit a **jupyter notebook** with your complete solution.
- The submission deadline is 13th May 2021 23:59.
- Late submissions will not be accepted.

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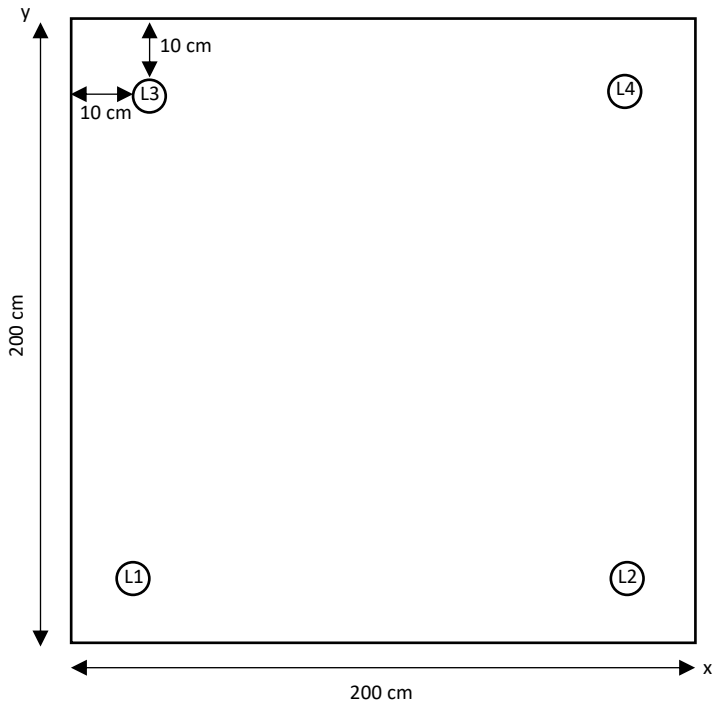
Your task is to implement in Python a particle filter that localizes a robotic car of **length 10cm** randomly positioned within a **2m by 2m** environment with landmarks located **10cm** away from the environment's border as follows:




You are to assume:

- The robot's maximum steering angle is pi/4
- The bearing noise has variance 0.1 rad
- The steering noise has variance 0.1 rad
- The distance noise has variance 5 cm

Your solution should include:

a. (i) A function **sense** which returns a vector Z of 4 bearings.

**[6 marks]**

(ii) The vector **Z** should simulate a bearing noise described by a Gaussian distribution centred at 0 and with a variance of 0.1 rad.

**[2 marks]**

b. A function **move** which returns the robot's updated state.

(i) The program should return an error if the robot's steering angle exceeds the maximum possible angle or if the robot attempts to move backwards

**[2 marks]**

(ii) The actual steering angle should be chosen from a Gaussian distribution of steering angles that is centred at the intended steering angle with variance of 0.1 rad. Likewise, the distance moved should also be chosen from a Gaussian distribution centred at the intended distance with variance of *5cm*.

**[4 marks]**

(iii) Calculate the robot's turn angle.

**[2 marks]**

(iv) If the turn angle is less than 0.001 rad, update the robot's state by approximating the robot's motion to straight line motion.

**[6 marks]**

(v) If the turn angle exceeds 0.001 rad, update the robot's state by approximating the robot's motion using the bicycle model

**[12 marks]**

**c.** (i) Create a particle filter with 500 random particles to localize the robot. Remember to include the bearing noise, steering noise and distance noise.

**[2 marks]**

(ii) The particle filter must include motion updates and measurement updates.

**[3+3 = 6 marks]**

(iii) Resampling should be carried out according to importance weights.

**[3 marks]**

(iv) Which parameter in your solution would you consider changing to get a better approximation of the robot's exact location? Explain why. What would be the disadvantages of changing this parameter?

**[1+3+1 = 5 marks]**