Exercise 1

Return date: 28.1. before the exercise class.
One report per group.
Please use the Teams channel to ask your questions.
Total of 10 points.

1) (5points) Wheel odometry and dead reckoning (ROS1)

Provided Data: OneDrive link to ROS bag file with wheel positions of a differential drive robot.

Task:

- Create a ROS node to subscribe to the wheel rotational speeds in the bag file from the "/joint_states" topic and calculate the body frame twist (linear and angular speeds) and pose of the robot for each timestamp in the bag file. Use both forward **Euler** and **Euler midpoint** methods to estimate the pose trajectory.
- Create odometry [pose, velocity] message publisher for the calculated data.
- Publish ROS TF using the calculated pose data with "Odom" as parent frame and "robot_base" as child frame.

Data description: Given bag file is approximately 40 seconds long with 5 segments. The first and the last segments are 5 seconds long and the robot has no motion. The middle 3 segments are 10 seconds long, and the robot moves with constant linear and angular velocities which are different for each segment. Wheel radius **r = 0.1,** Distance between two wheels **d = 0.4**

Submission: Implemented ROS node and a short report with team members' info, description of your approach, **linear and angular velocities** of the robot in each segment, and **XY pose plots**.

2) (5 points) Discrete probability distributions

a) Study Matlab example in lecture slides page 16.
With the same parameters described in the example, now update the mean of the **Probability Density Function** to **0.5**, plot (x, p_x), and calculate the expectation of x and its covariance, that is, **Ex** and **COVx.** Report the observed changes caused by changing the mean of PDF.

b) Study Matlab example in lecture slides page 17. In the given example the sensor measures the distance from an imaginary wall at x = 0, and gets the value **z_sensor** = 2.6
   - Redo the shown plots with new wall location: **wall_loc = 8** and sensor measurement **z_sensor = 4.5**

c) Study Matlab example in lecture slides page 18. In the given example the robot takes only one step with **u = 0.5.**
   - **Repeat** the same control action **three times** and plot the belief distribution after each iteration.
   - After the third step, the robot receives a measurement, the distance to the wall described in b. **Apply** the **sensor measurement** step and plot the belief distribution.

Submission: Report the plots and briefly explain your observations.