Exercise 1: Particle Filters
Consider the world shown below. A robot moves counter-clockwise (in a deterministic way) in a circular corridor containing 10 grid cells. In some grid cells are landmarks installed. If the robot is in a cell with a landmark it will detect it with a probability of 80%. If there is no landmark within the grid cell, the robot’s sensors will detect one with a probability of 40%. We want to apply a Particle Filter to estimate the position of the robot. We use 3 particles which are initialized at positions 1, 4 and 7 respectively, that is, $x_0^1 = 1$, $x_0^2 = 4$, $x_0^3 = 7$. The robot moves 3 grid cells forward and sees a landmark. Describe the first iteration of the Particle Filter Algorithm. Use the Systematic Resampling Algorithm (also called Low Variance Algorithm) for the resampling steps. Initialize the threshold of the resampling algorithm to 0.1. Which are the final states of the 3 particles after the first iteration?

Exercise 2: Occupancy Mapping
Proof that the occupancy value of a grid cell $P(m \mid x_{1:t}, z_{1:t})$ is independent of the order the measurements are integrated.