Simulation Overview

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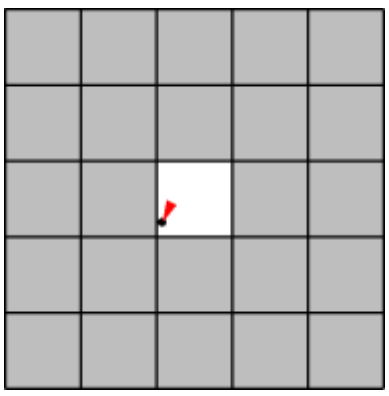
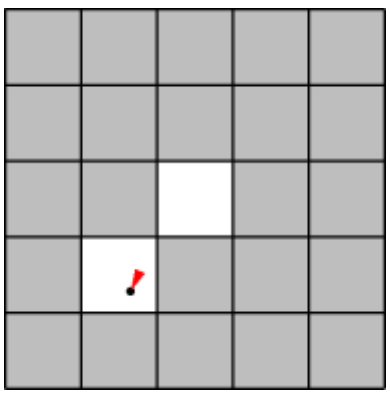
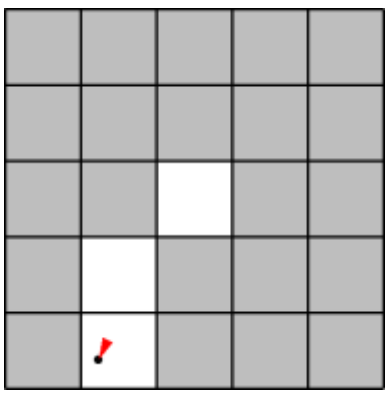
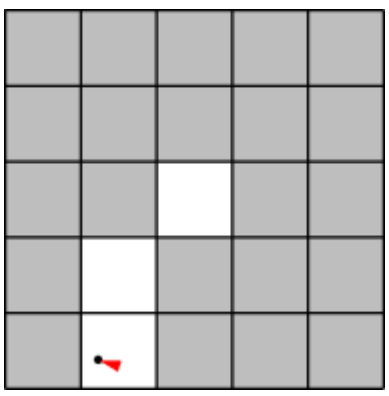
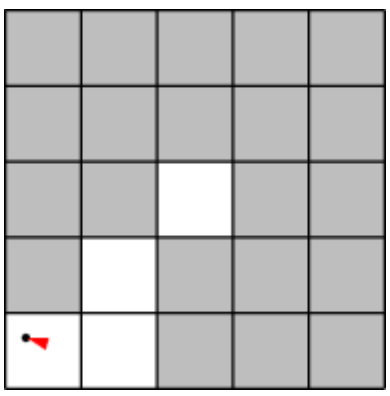
iRobot is a company (started by MIT alumni and faculty) that sells the Roomba vacuuming robot (watch one of the product videos to see these robots in action). Roomba robots move around the floor, cleaning the area they pass over.

In this problem set, you will code a simulation to compare how much time a group of Roomba-like robots will take to clean the floor of a room using two different strategies.

The following simplified model of a single robot moving in a square 5×5 room should give you some intuition about the system we are simulating.

The robot starts out at some random position in the room, and with a random direction of motion. The illustrations below show the robot's position (indicated by a black dot) as well as its direction (indicated by the direction of the red arrowhead).

 **Time *t* = 0** The robot starts at the position (2.1, 2.2) with an angle of 205 degrees (measured clockwise from "north"). The tile that it is on is now clean.	 ***t* = 1** The robot has moved 1 unit in the direction it was facing, to the position (1.7, 1.3), cleaning another tile.	 ***t* = 2** The robot has moved 1 unit in the same direction (205 degrees from north), to the position (1.2, 0.4), cleaning another tile.
 ***t* = 3** The robot could not have moved another unit in the same direction without hitting the wall, so instead it turns to face in a new, random direction, 287 degrees.	 ***t* = 4** The robot moves along its new direction to the position (0.3, 0.7), cleaning another tile.	

Simulation Details

Here are additional details about the simulation model. Read these carefully.

- **Multiple robots**
  In general, there are $N > 0$ robots in the room, where N is given. For simplicity, assume that robots are points and can pass through each other or occupy the same point without interfering.

- **The room**
  The room is rectangular with some integer width w and height h, which are given. Initially the entire floor is dirty. A robot cannot pass through the walls of the room. A robot may not move to a point outside the room.

- **Tiles**
  You will need to keep track of which parts of the floor have been cleaned by the rob le the area of the room into 1×1 tiles (there will be $w * h$ such tiles). When a robot's locatio tile, we

will consider [illegible] the tiles using ordered pairs of integers: (0, 0), (0, 1), ..., (0, *h* − 1), (1, 0), (1, 1), ..., (*w* − 1, *h* − 1).

- **Robot motion rules**
  - Each robot has a position inside the room. We'll represent the position using coordinates (*x*, *y*) which are floats satisfying 0 ≤ *x* < *w* and 0 ≤ *y* < *h*. In our program we'll use instances of the `Position` class to store