Assignment 3

Due date: Thursday, November 9, 2017, by 6:00pm

Note: Late assignments will only be accepted with prior written permission of the instructor. You must explain all answers and show all work to get full marks! Please make sure your code is in a professional style: well-commented, properly structured, and appropriate symbol names. Marks will be very generously deducted if not!

Description

In this assignment you will explore dynamic pathfinding through an implementation within the Unity game development environment.
You must implement the pathfinding yourself; do not use any built-in or external asset tools for navigation mesh construction or pathfinding in Unity.

1. The overall context simulates a 2-story mall, with an upper level of 6 stores connected to a lower level of 6 stores by 4 stairways. Each store has an entranceway wide enough only for a single person to pass through at a time, and have an interior size such that it can hold 9 people. You do not need any decoration or obstacles in the stores. The area outside the stores, however, should have 4 plants (small obstacles), randomly placed (ie in a different location each time you run it).

   Shoppers may traverse stairs in either direction (up/down), although the stairways are not wide enough for two people to be side-by-side. The actual length of the stairs is measured in number of people who fit on the stairway. It is the same for each set of stairs in a given simulation, but needs to be a parameter in creating your simulation—you will need to generate multiple simulations with different stair lengths.

   This is a 3D design, but we will treat it as planar by ensuring that the levels do not overlap; see the layout sketch below (note that the stores do not have any ceilings). This will let you fully observe the simulation from a top-down camera, and simplify motion-planning.

   ![Layout Sketch](image)

   The layout is not necessarily to scale or in proper proportion; there should be ample space in front of the stores for shoppers to move around (3–5 deep), and width-wise there should be room for at least 5 shoppers between each shop entrance.

2. Populate the mall with shoppers (a geometric shape representation is fine, you do not need a nice model). The number of shoppers will also need to be changed, so make it a simulation parameter.

   Shoppers are initially randomly located, but never overlap.

   Shoppers move around the mall, shopping and doing idle behaviour. They must never overlap or pass through each other. They all move discretely, at the same speed, with movement based on a grid. You may use Manhattan or 8-way (octile or Chebyshev) motion.
Each shopper repeatedly attempts to perform a behaviour, selecting one with equal probability:

(a) **Move** Randomly choose a specific, currently unoccupied destination point outside of a shop, on either level, and go there.

(b) **Shop** Randomly choose one of the (12) shops as a goal, excluding the same shop as they are in if they are in one, and go enter the shop (any spot inside will do).

This will require actual motion-planning. Use a central, coordinated approach based on Silver’s *reservation-based* pathfinding for your shoppers. The size of the planning window (time-duration) should be a parameter you can easily vary.

There are various additional factors involved in this design that will impact the ability of your shoppers to shop effectively. Ensure that with a short, 2-step stairway length, and only a small number of shoppers (around 5–10) all shoppers are able to get to their destinations.

Your design should avoid head-to-head movement conflicts.

3. Test your simulation. Each time a shopper decides to go to a shop or move keep track of the number of time steps it takes to get there when they succeed, and the number of times a solution cannot be found. Compute the average of both measures over a couple of minutes of simulation. Find a baseline performance. Vary the mall population size to determine one that your system can support while still ensuring almost all shoppers usually reach their destinations.

In a *separate document* give data to back your choice, showing how the measures vary as the number of shoppers changes. Show data for at least 3 population sizes (your baseline, smaller, and larger).

4. Now, investigate the impact of the planning window size. Using your baseline settings from the previous question, vary the window size smaller or larger. What impact does it have? Find an optimal window size for your simulation. In a *separate document* give data to back your choice. Show data for at least 5 window sizes (your baseline, smaller, and larger).

5. Finally, increase the length of stairs. What impact does it have? Do window changes have any effect? Again, in a *separate document* give data to back your analysis. Show data for at least 3 stair lengths.

**What to hand in**

Assignments must be submitted on the due date **before 6pm**. Submit your assignment to *MyCourses*. Note that clock accuracy varies, and late assignments will not be accepted without a medical note: **do not wait until the last minute**.

For the Unity questions, hand in an exported project containing all files needed in order to reconstruct and run your simulations.

For non-Unity questions, submit either an ASCII text document or a .pdf file *with all fonts embedded*. Do not submit .doc or .docx files. Images (plots or scans) are acceptable in all common graphic file formats. You may submit a single document for such questions, as long as each answer is clearly delineated.

This assignment is worth 15% of your final grade.