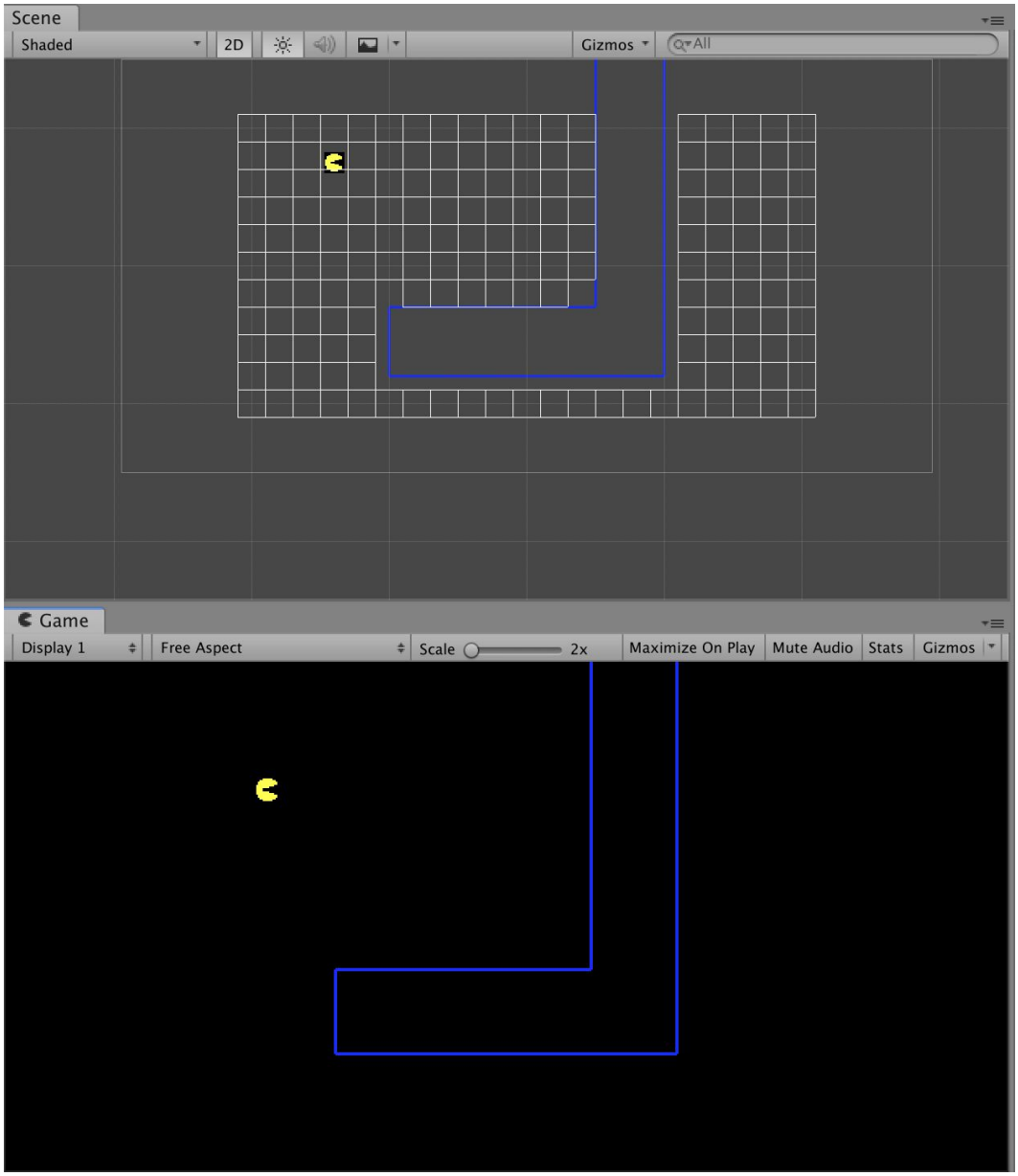
Assignment 2: A*

The purpose of this exercise is to have you implement the A* pathfinding algorithm, the most common pathfinding algorithm in games.

One of the main uses of artificial intelligence in games is to perform path planning, the search for a sequence of movements through the virtual environment that gets an agent from one location to another without running into any obstacles. Previously the Pacman agent didn't plan at all, but simply greedily attempted to get to a goal. In order to make the agent move more intelligently, you'll need to implement a more advanced pathfinding algorithm.



In this assignment, you will implement A* pathfinding on either a provided grid or on your own generated grid.

What you need to know

The primary script you will need to interact with for this assignment is **AStarPathFinder.cs**. This script makes heavy use of **AStarNode.cs** and **PriorityQueue.cs**. In addition you might find it helpful to look over **GraphNode.cs**.

This assignment also includes optional extra credit. If you pursue this extra credit it might be worth looking back over the information from the last assignment.

GraphNode

Member public variables:

- Location: a Vector3 representing this node's location
- Neighbors: An array of GraphNodes referencing the neighbors of this node (in this case, the grid cells to the north, east, south, and west.).

Member functions:

- GraphNode(Vector3 _location): this function instantiates a new GraphNode
- AddNeighbor(): Adds a new neighbor to the internal list of neighbors kept by the GraphNode (you will not need this).
- GetHashCode(): returns a unique hash for this GraphNode

AStarNode

Member public variables:

- Parent: Returns the AStarNode parent of this node.
- GraphNode: Internal representation of a GraphNode for this AStarNode, stores location and neighbor data.
- Location: Vector3, allows for reference to the location of the GraphNode more easily.
- GScore: The cost of the path up to this AStarNode.
- HScore: The heuristic cost to the goal from this AStarNode.
- FScore: The combined G and H score.

Member functions:

- AStarNode(AStarNode _parent, GraphNode _graphNode, float _hScore): constructor for a new AStarNode.

- GetFScore(): Alternative way to access the FScore.
- CompareTo(AStarNode other): compares two AStarNodes in terms of their FScores.
- Equals(object obj): checks to see if two AStarNodes are equal.
- GetHashCode(): returns a unique hash for this AStarNode.

PriorityQueue.cs

Member public variables:

- Data: a read-only (you cannot make changes to it) List<T> that reflects PriorityQueue's internal list.

Member functions:

- Enqueue(T item): Adds an item to the priority queue.
- Dequeue(): Equivalent to "pop", removes and returns the minimum cost item from the queue.
- Peek(): Returns the minimum cost item (front of the queue), but does not remove it.
- Count(): Returns the size of the queue as a integer.
- Remove(T item): Removes the specified item from the queue.
- ToString(): Returns a string representation of the queue (unlikely to be useful)
- IsConsistent(): Checks whether the queue is consistent (unlikely to be useful)

Instructions

When you click on the screen, you indicate the goal for the path planning algorithm. By correctly implementing A*, your agent will take the most optimal path, if one exists.

Step 1: Download the Assignment2.zip file from eclass, unzip it, and open it via Unity. You can open it by either selecting the unzipped folder from Unity or double clicking Scene1-5.

Step 2: Open Scene1-5 located inside Assets/Hw2. Hit the play button. Click inside the game window to see the pacman agent traverse the game world. By default it will only path correctly over very small distances.

Step 2b (optional): If you wish you can replace the GridHandler.cs file provided with your GridHandler.cs file from assignment 1.

Step 3: Modify AStarPathFinder.cs to complete the CalculatePath() function (see the commented lines of where to edit).

Step 3b (optional): Modify AStarPathFinder.cs to complete the Heuristic() function (see the commented lines of where to edit).

Step 4: Test your implementation across the five given scenes (Scene1-5)

Additional testing can be done by changing the maps by modifying the ObstacleTestPoints scripts.

Grading

This homework assignment is worth 10 points. Your solution will be graded by an autograder. The autograder will attempt to have Pacman navigate from various points across each map. For every map that your solution is tested on, 1 point will be deducted if your implementation expands more nodes than is necessary (if you did not implement A* correctly). The autograder will test your solution on 10 maps, the five provided maps and five withheld test maps.

For the given five scenes/maps, going from the top left to the bottom right corner should lead to the following (or fewer) nodes being created:

Scene 1: 140
Scene 2: 175
Scene 3: 175
Scene 4: 115 (more central top left and top right options, inside the obstacles)
Scene 5: 220

In addition, you may receive up to 1 point of extra credit for implementing a better heuristic than the one currently implemented in Heuristic (the Manhattan Distance). The best student implementation (in terms of fewest nodes explored with the instructor A* implementation) will receive 1 extra credit point, if your heuristic does no better than the given Manhattan Distance you will receive 0 extra credit points. All other implementations will receive a fractional percentage based upon where they fall between these two extremes.

Hints

Debugging within the game engine can be hard. Print statements (Debug.Log(“”) will be one possible way of figuring out what is going on.

For the extra credit Heuristic you might find it helpful to reference ObstacleHandler with ObstacleHandler.Instance.X where X is a function or public variable.

It is good to test your techniques on new maps. If you want to make new maps, modify one of the provided ObstacleTestPoints (e.g. ObstacleTest1Points.cs). This will alter the obstacles in

the same numbered scene. Note that you will need to use your own GridHandler.cs file to use this option.

Remove takes as input an AStarNode, which must exactly match the node you wish to remove. However, you don't want to instantiate additional AStarNodes for this assignment. Thus it might be helpful to keep track of your AStarNodes in an additional data structure.

You will need to make your own data structures for this assignment so reviewing Lists and Dictionaries might be a good idea, if you didn't for Assignment 1.

Submission

To submit your solution, upload your modified AStarPathFinder.cs. All work should be done within this file.

You should not modify any other files in the game engine.

DO NOT upload the entire game engine.