1	2	3	4	5	Total	Fraction	Grade

(Disclaimer: Some questions might be discarded / not graded, point values might be changed)

Architecture (50pts)

(3pt) Why is it preferred to start with an FSM and put BTs inside the states? _____

(3pt) What is the key purpose of a blackboard inside a BT? _____

(2pt) Smart objects are a programming architecture embodiment of what concept popularized by Don Norman? _____

(3pt) Why is Planning not used in most games? _____

(3pt) How is Utility better than a BT Selector node in terms of action selection? _____

(3pt) What aspect of Utility makes it possible to customize personality? _____

(3pt) In Utility, what method can be used to avoid always selecting the highest scoring? _____

(3pt) Compute Expected Utility for a sword that does 5 hit points damage with a 50% hit rate against a Slime with 50 hit points: ____

(3pt) Compute Expected Utility for a sword that does 5 hit points damage with a 80% hit rate against a Slime with 1 hit point: _____

(24pt) Draw the Utility curves (all except for Patrol) for an NPC with the following requirements:
- NPC that would like to Reload below 50% ammo. Always prefer Reload over Shoot at less than 25% ammo.
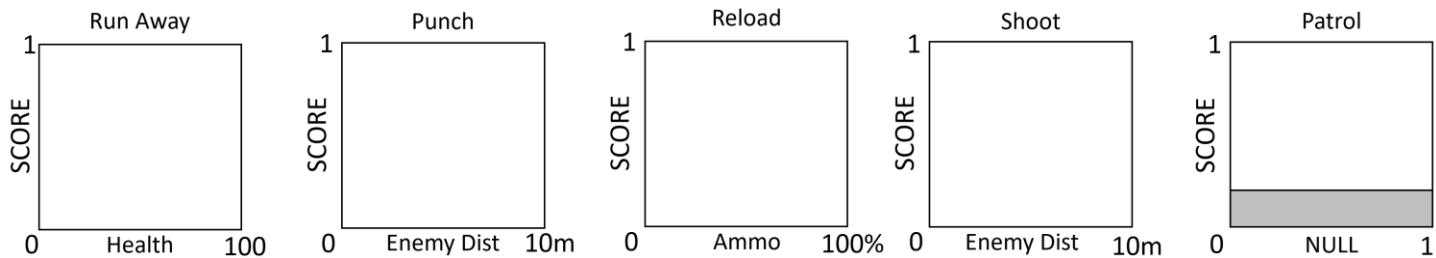- NPC that prefers Reload over Shoot if ammo 25% to 50% and enemy is more than 5m away.
- NPC wants to Shoot enemies up to 9m away.
- NPC will Punch enemies up to 1m away (always preferable to Shoot or Reload).
- If NPC has less than 10 health, NPC must always Run Away.
- Patrol if nothing else is desired.

Movement (18pts)
(3pt) Why is pathfinding not needed for flying NPCs? _____

(3pt) List the 3 flocking rules (one word each):   _____ _____ _____

(3pt) Name 3 other rules/steering behaviors to   _____ _____ _____
enhance flocking (randomness is not an answer). (<=2 words each).

(9pt) List the other 9 steering behaviors from Craig Reynolds:

_____ _____ _____ _____

_____ _____ _____ _____ _____

A* Pathfinding Problem (100pts)

(100pt) Given the following search space, start node (A), and goal node (G), calculate on this sheet of paper a path found using A*. Please show all work using the Open and Closed lists, **marking the order deleted using numbers starting at 1** when deleting a node **off of either list**. Please mark parent pointers and all cost terms. Use the indicated actual cost along each node-to-node connection and use the distance values in the table for the heuristic. (**NOTE: One mistake loses half points, two or more loses all points – don't make even one mistake – double check all math – double check the final path is optimal). The correct solution uses all blank rows. Don't forget to put the final path in the bottom right box.**
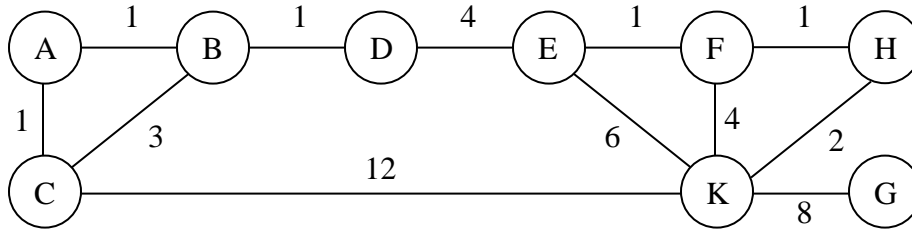
Heuristic estimate to Goal node (G) from any given node (heuristic is admissible, but not consistent):

A	B	C	D	E	F	G	H	K
5.4	4.4	5.0	3.4	2.4	1.4	0.0	10.0	1.0

Open List:

Order Deleted	Node	Parent	g(x)	h(x)	f(x)

Closed List:

Order Deleted	Node	Parent	f(x)

Final waypoint path from start to goal:

Pathfinding (65pts)

(30pt) Carefully draw each search space representation (include **_ALL_** details required by a search algorithm):

Grid	Corner Graph	Nav Mesh
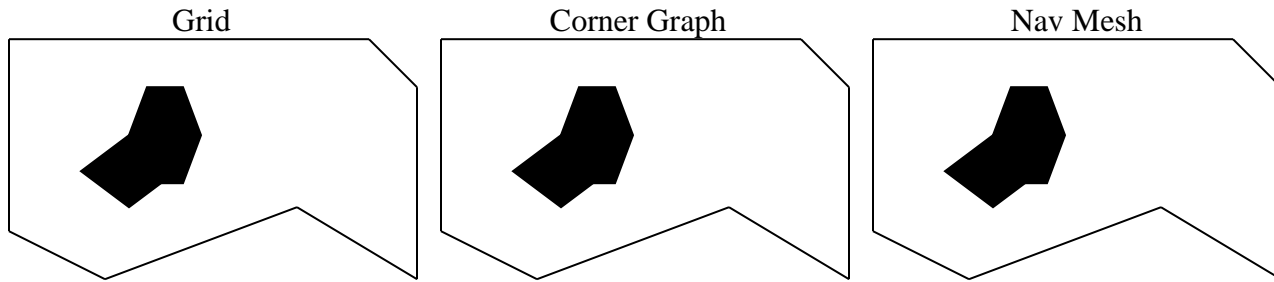
(2pt) Given all pathfinding search space(s), which ones do not represent the walkable surface area? _____

(2pt) Given all pathfinding search space(s), which ones can be used with the Roy-Floyd-Warshall algorithm? _____

(3pt) If the heuristic cost in A* is absolutely accurate,
what does it exactly represent? (<=6 words, be precise)   _____

(3pt) If a heuristic is admissible in A*, then it _____ the true cost.

(3pt) In a NavMesh, why can't the floor polygons of a level be directly used? _____

(3pt) Why would a Waypoint Graph be preferred over a Grid in an FPS like Call of Duty? _____

(3pt) What is the primary run-time CPU advantage of NavMesh over Waypoint Graph? _____

(3pt) What is the optimal A* heuristic in a grid-based environment that contains teleporters? _____

(3pt) If non-optimal paths are acceptable, when is it bad to over-estimate the heuristic with A*? _____

(4pt) Name 2 primary problems with Goal Bounding 1. _____ 2. _____

(3pt) A flow field could be generated using which search algorithm? _____

(3pt) In order to smooth a waypoint path on a NavMesh, you'll need this algorithm _____

Agent Awareness (20pts)

(6pt) Name 3 unique benefits of pathfinding sounds.   1. _____
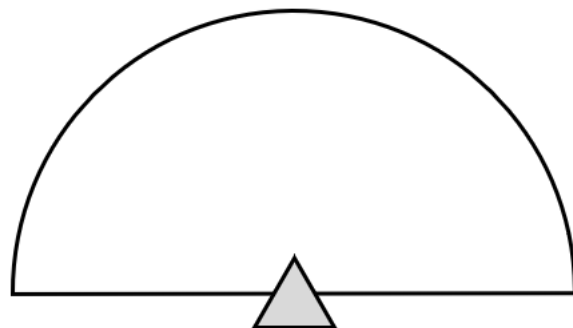
2. _____   3. _____

(10pt) Draw a complete vision model with percentage zones that a game like Splinter Cell would have had (make up reasonable %s):

(4pt) In the vision model, list 2 non-spatial aspects that
   can't be drawn in the previous question that would
   decrease the percentages.

   1. _____

   2. _____

Learning (50 points)

(5pt) List 5 problems with Neural Networks. 1. _____ 2. _____

3. _____ 4. _____ 5. _____

(3pt) Given the "Draw the Utility" exam question, what broad category of ML using labeled data could replace it? _____

(4pt) Given the "Draw the Utility" exam question, how many features would it have? ____ How many outputs would it have? _____

(5pt) In gesture recognition with K-Nearest Neighbors, if the player did the move [20, 20, 0, 40], circle the best matching gesture:

A. [0, 40, 40, 0]   B. [20, 20, 40, 20]   C. [20, 0, 20, 20]   D. [20, 20, 0, 0]   E. [-20, -20, 0, -40]

(12pt) Use this sequence to determine the **probability** of the next move being a **Kick** for Bi-Gram, Tri-Gram, and Quad-Gram:
Punch, Kick, Punch, Kick, Punch, Uppercut, Punch, Punch, Kick, Punch, Punch, Kick, Punch, Punch, Kick, Punch

        Bi-Gram: _____, Tri-Gram: _____, Quad-Gram: _____

(3pt) In player modeling, UsesSmokeGrenades is stored as what data type? _____

(3pt) In player modeling, AttacksOnTwoFronts, UsesSmokeGrenades, and CanDoTrickyJumps are examples of _____.

(5pt) In player modeling, when you make your Excel sheet to evaluate what to implement, what categories/columns should you score?

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

(5pt) Using the moving average equation w/ alpha=0.2, what is the final average: (newest to oldest) 40, 80, 70, 60, 50, 0: Avg = ____

(5pt) Using the moving average history window of length 5, what is the final average of the previous question's sequence: Avg = ____

Terrain Analysis (5 points)

(5pt) Combine the influence of three maps using the geometric mean (A: [0, 0.5, 0.2], B: [1, 1, 1], C: [0.5, 0.6, 0.5]) _____

Randomness (8 points)

(5pt) Write a **ONE LINE** equation to generate Gaussian randomness in the range [-3,3] with roughly a **NORMAL** distribution (which has a standard deviation of 1). Use the random function RandReal() that returns a uniform random number in the range [0,1]:

_____

(2pt) Explain how to calculate a natural random offset for bullets aimed at the center of a target:

_____

(1pt) What was my seemingly odd belief about randomness in games? Rand() is _____

PCG (11 points)

(5pt) Name the five PCG techniques described in class: 1. _____ 2. _____

3. _____ 4. _____ 5. _____

(2pt) What is the new name given to modern transformer-based techniques to create content, like images and text? _____

(4pt) What are the two primary problems stopping large game companies from using ChatGPT or Midjourney?

    1. _____ 2. _____

Draw Behavior Trees (60 points)

Directions: You can use any number of Selectors, Sequencers, or Parallel nodes. Parallel nodes Succeed if any children Succeed and Fail if any children Fail. You can use any number of Always Succeed, Always Fail, Rerun until Success, Rerun until Fail, or Invert decorator nodes. For all other nodes, you can only use the nodes given to you in the question.

(10pt) Draw a Behavior Tree that endlessly patrols between three points: A, B, and C. Use multiple "Move To _" Leaf nodes which will move toward the point you give it, will return InProgress if moving toward the point, and will return Success if it reaches the point (it will never Fail).

(50pt total) Draw a Behavior Tree that performs the previous endless patrolling behavior with "Move To _" nodes (10pt), but if it sees an enemy at any time during its movement, it immediately moves to point X (20pt) and stays there forever (20pt). Use the Leaf node "See Enemy?" that returns Success if it sees an enemy and returns Fail if it does not.