CS 638: Computer Game Technology

Final (Fall 2001)

Dec 19, 2001

Name: _____

ID: _____

Login: _____

- You have 1 hour 15 minutes to complete the exam.
- Before beginning, write your name, ID number and login on the front page, and your login on every page.
- On your desk you may have something to write with, a ruler, one double-sided piece of paper with anything on it, and nothing else.
- Do all your work on the pages provided, going to the back side if necessary. If you do use the back, indicate on the front side that there is something on the back.
- If you need to make assumptions in order to answer a question, say what they are. However, all the questions should be unambiguous.

Question 1: ____/10

Question 2: ____/4

Question 3: ____/4

Question 4: ____/8

Question 5: ____/6

Question 6: ____/4

Question 7: ____/6

Question 8: ____/2

Question 9: ____/10

Total: ____/54

Question 1: (10 points)

Design a finite state machine for a "hunting animal" AI. The animal should exhibit the following behaviors:

- The animal lies and relaxes by default.
- When it gets hungry, the animal seeks prey.
- When it sees prey, the animal attacks it.
- When it has prey, the animal eats it.
- If the animal loses sight of prey, it continues seeking prey.
- When the animal finishes eating, it goes back to relaxing.
- When it gets tired, the animal sleeps.
- The animal sleeps for 1 hour at a time.

Your state machine should label each state with an activity, and each edge with an event of some type. If it is not obvious, define what you mean by each activity and event.

Question 2: (4 points)

Consider the problem of resolving conflicting rules in a rule-based AI, and the **prioritized matching** strategy.

a. Does the order in which the rules appear make any difference in this strategy? Why or why not?

b. What happens when the rule-set contains multiple rules that match a given state? One example of such rules is "if see enemy then attack" and "if see enemy and low energy then retreat."

Question 3: (4 points)

Your game design allows for different types of terrain over which the player and AI characters must travel. There is a maximum speed associated with each terrain type that indicates how fast a character can travel over it. You are planning to use A* to find a path that minimizes the **time** taken to reach a goal.

a. What is a suitable heuristic for this situation?

b. Will A* be more efficient if your terrain types all have similar travel costs, or have a wide range of travel costs? Why?

Question 4: (8 points)

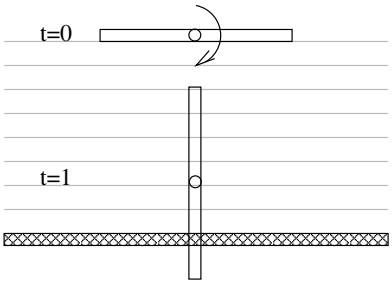
You are adding virtual school groups to a theme park game. School groups have specific rides that they wish to visit, as a group, in a fixed order. The theme park environment is cluttered with small dynamic obstacles, such as other patrons, but it is possible to define a waypoint graph with waypoints at rides and path intersections.

a. Describe a 2-level hierarchical planning strategy to move the group around the park. Your approach should use a different type of path planning for each level in the hierarchy. Be sure to describe what the goals would be for each stage.

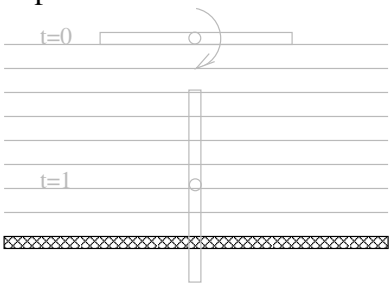
b. Explain why each of the planning algorithms you employ above would be inadequate if used alone for this problem.

Question 5: (6 points)

The state of a thin rod is shown at time $t = 0$, and again at time $t = 1$, when it is penetrating the plane. The center of the rod is moving downwards with constant velocity while the rod is also rotating clockwise with constant angular velocity. You are going to use interval halving to find the collision time.



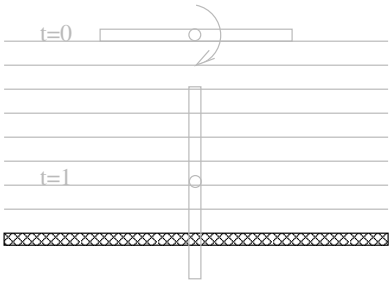
a. On the figure below, draw the position of the rod at the first midpt you test.



b. What are the upper and lower bounds on the collision time after the first midpoint is tested?

Lower bound: $t =$_____ Upper bound: $t =$_____

c. Perform the next iteration on the figure below. Show the location of the rod for the collision test you would use, and give the new bounds.



Lower bound: $t =$_____ Upper bound: $t =$_____

Question 6: (4 points)

Oriented tetrahedrons could be used as a simple bounding volume for certain objects. (Tetrahedrally are triangular pyramids with equilateral triangles for faces, while oriented means they could be rotated in any way to get a tight fit.)

a. How many potential separating axes do you have to test to determine if two such bounds overlap? Explain your answer.

b. What makes a bounding volume a good candidate for collision detection using separating axes tests?

Question 7: (6 points)

You have a broad-phase bounding volume scheme that costs 5 units per object-object bound overlap test. You also have a narrow-phase collision test that costs 50 units per object-object test.

The efficiency, e, of the bounding scheme is the percentage of object-object pairs that it **eliminates** from consideration. A 100% efficient bounding scheme eliminates all pairs from consideration, while a 50% efficient test eliminates half of the pairs.

a. Write an expression for the cost, C, in terms of the number and cost of broad-phase tests, N_b and C_b, and the number and cost of narrow-phase tests, N_n and C_n. (The equation that was given in class.)

b. Write an expression for N_n in terms of N_b and e.

c. Hence, re-write the expression for C in terms of N_b and the efficiency, e, using the costs given above.

d. At what efficiency does the broad-phase test become beneficial?

e. The cost equation given in class implicitly assumes that the cost of each broad-phase test, C_b is independent of the number of broad-phase tests, N_b. Is that a good assumption?

Question 8: (2 points)

You have decided to use UDP as the networking protocol for all the AI state communication in your multi-player game. Does this suggest a polling or event-driven AI system? Why?

Question 9: (10 points)

You decide to use **area of interest management** to control the distribution of game state in your multi-player game. Your game is designed as a client-server architecture, with the server having full knowledge of the game state and performing area of interest management to control which clients receive what state.

a. What impact does this scheme have on bandwidth requirements for the game? Explain your answer.

b. Which sources of latency are affected by this approach, why, and in what way?

c. How is game security impacted by this technique?