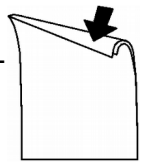
Spring 2017, Midterm 1
CSCE 4613, Artificial Intelligence



1. (4 points) I plan to return these tests face-down, so please write your name on the back, near the top.

2. (5 points) Which search algorithm assumes that all actions have uniform costs?
- Breadth-first search
- Uniform cost search
- A* search

3. (5 points) Choose the best one. Complete this statement: With A* search, the heuristic must
- underestimate the largest cost incurred so far.
- overestimate the smallest cost incurred so far.
- multiply by the fastest speed that can be traveled over any region of terrain.
- use Euclidean distance to estimate the remaining distance to the goal.
- underestimate the remaining cost to the reach the goal.
- overestimate the remaining cost to reach the goal.
- choose the action that minimizes utility.
- choose the action that marginalizes probability.

4. (5 points) Which one of these algorithms always finds the optimal goal in the least amount of time when implemented properly?
- Breadth-first search
- Uniform cost search
- A* search
- Genetic algorithm

5. (5 points) Which one of the following refinements would make the biggest difference in reducing the memory footprint of breadth-first search?
- Switch from using a priority queue to a “first-in first-out” queue.
- Use a smaller encoding of state.
- Implement a better heuristic.
- Increase the Java heap size.

6. (6 points) What would happen if you implemented a genetic algorithm with no selection operation (meaning no member of the population is ever killed) on a single computer? (Circle all that are true.)
- The computational cost would increase as the size of the population increased
- Mutations would have no effect.
- Randomly chosen parents would be more likely to produce good children.
- Diversity in the population would converge to zero.
- It would be more biologically plausible.
- Bacteria would overrun the population.

7. (6 points) Can A* search offer computational improvements over breadth-first search if all the actions have uniform cost?
- Yes
- No

8. (5 points) If some actions incur negative costs, does uniform cost search still guarantee to find the optimal solution?
- Yes
- No

9. (5 points) The purpose of the heuristic in A* search is
- to make it robust to negative costs by ensuring the costs increase monotonically as the frontier expands.
- to improve the quality of the solution.
- to reduce both computational cost and memory requirements.
- to promote diversity.
- to compute the Manhattan distance to the goal.
- to compute Euclidean distance to the goal.
- to re-parent states when a lower-cost path to them is found.

10. (6 points) Alice wants to make uniform cost search more efficient, but cannot find a useful heuristic. She plans to simultaneously search from the start to the goal, and from the goal to the start, then merge the two paths when the two frontiers meet. For each of the following pairs of statements, circle the one that is more correct in characterizing this proposed algorithm:

- If all actions were reversible (meaning each action has a corresponding one with the opposite effect), then this could be made to work.
- Merging the two paths that reach each other would not be possible because one of the linked lists would be backwards.

- This approach would find a path, but it would not be an optimal one.
- This approach would find an optimal path.

- This approach would incur lower computational cost than uniform cost search.
- This approach would incur higher computational cost than uniform cost search.

11. (5 points) If you want to make a vector that points in an unbiased random direction relative to the origin, you should fill the elements of this vector with values drawn from:

- a Uniform distribution
- a Normal (a.k.a. Gaussian) distribution
- the sum of two dice rolled together
- values derived from an audio recording of some natural phenomenon, such as dolphin communication.

12. (8 points) Match the problems below with the corresponding algorithm that is best for the job. (Use each algorithm exactly once):

(A) A* search
(B) Tabu search (a type of greedy search)
(C) Genetic algorithm
(D) Employ a team of 100 researchers to spend years working on this problem.

____ You want a path of actions that will cause a complex robot with 47 joints to bake a cake. The solution must be optimal.
____ You want to find path of actions that will cause a complex robot with 47 joints to bake a cake. The solution does not need to be optimal.
____ You want to find path of actions that will cause a video game character to travel from one point to another on a simple map. You need a solution quickly, but it does not need to be optimal.
____ You want a path of actions that will cause a video game character to travel from one point to another in a complex maze. Your solution must be optimal.

13. (10 points) Which operations are essential in an effective genetic algorithm? (Circle all that are needed.)

- Some way to evolve meta-parameters.
- Some way to ensure that the best member of the population never dies.
- Some way to select the more fit members of the population for survival.
- Some way to replenish the population.
- Some way to approximate the effects of continental separation.
- Some way to parallelize the simulation.
- A specific objective.
- Some way to promote diversity.
- Some way to identify which members of the population are well-suited as mates.
- Some way to simulate speciation.

14. (8 points) A well-designed implementation of uniform cost search would separate the implementation of the solution from the problem interface, so that other problems could be plugged in. Please indicate with the letter "S" which components would be part of the solution (uniform cost search itself), and indicate with the letter "P" which components would be part of an implementation to the problem interface:

___ Allocate a priority queue

___ A function that returns how many candidate actions are available, or an iterator that visits all candidate actions.
___ Code that performs the i^{th} candidate action.
___ The loop that continues the search until the goal is found.
___ Code to test whether a particular state is the goal.
___ Code that represents the state and implements comparators or tests for equality of states.
___ Code that maintains a set of previously visited states to ensure that they are not visited again.
___ When a lower-cost path is found to a previously visited state, update the cost associated with that state, and re-parent it.

15. (5 points) Suppose scientists estimate that each year there is a 1 in 8000 chance that an earthquake of sufficient magnitude to completely destroy the Union building will occur in Northwest Arkansas. Suppose a certain insurance company offers two earthquake insurance policies: Policy A covers up to $5,000,000 of damage for a cost of $1200/year. Policy B covers up to $20,000,000 of damage for $2000/year. (In the event of an earthquake, the insurance company will not pay you more than the cost of rebuilding the building.) Suppose the cost of rebuilding the Union building is $10,000,000. Which policy is a better deal for the University?

16. (12 points) Continuing with the previous problem, if the price of the other policy could be negotiated, at what price would it become the better deal?
(If you want to be considered for partial credit, show your work, write neatly, and label stuff.)