CMSC425: Spring 2019

Midterm 2
Worth: 100

This exam is closed book and closed notes with the exception of one sheet of notes. Please turn in the notes with the exam. You may use any algorithms or results given in class or in the Mount lecture notes. We do not expect proofs, but do expect you to support answers when asked.

The boxes here are for Gradescope. Put your primary answer in each box. If you have supporting comments, scratch work, or other, put it on other blank sections and we will be able to see and take it into account. If a blank section is small is means the answer is short, but not the reverse.

Your Name

SOLUTION

I pledge on my honor that I have not given or received any unauthorized assistance on this examination.

Your Signature

Problem	Topic	Worth
1	**Short answer**	/20
2	**Navigation and obstacles**	/15
3	**L-System**	/20
4	**Flocking and crowd motion**	/15
5	**Winged edge mesh representation**	/15
6	**A***	/15

Problem 1. Short answer (20 pts, 3-4 each). Explanations are not needed, but may be given for partial credit, or to insure we understand your answer.

a) *Bump mapping.* Bump mapping is : (put your answer in the box).

C

a. Mapping street potholes

b. Mapping mountain ranges

c. Tweaking surface normals for texture

d. Making fractal mountains

b) *Perlin noise.* Why do values of persistence between 0 and 1 help smooth Perlin noise?

They reduce the amplitude of high frequency components by a power law: p^f. (Brown noise)

c) *Path quality.* Name two element other than distance might you use in weighing navigation path quality

ANY REASONABLE ELEMENTS OK

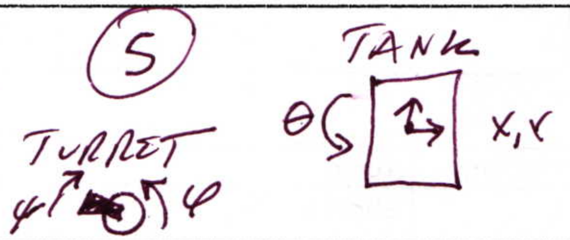
Slope, terrain elements, time to cross, energy cost, # turns, distance/sight from enemies.

d) *Configuration space.* How many degrees of freedom would the configuration space for tank that can move forward in any direction and has a turret that can rotate and lift the canon?

x, y, θ } motion

φ, ψ } turret

(5)



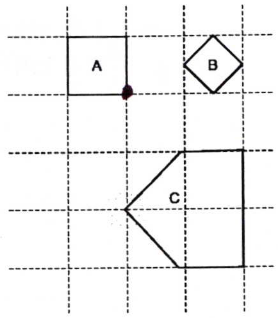
e) *Cubic curves.* If you have a cubic curve with the equation $p(t) = at^3 + bt^2 + ct + d$ and one point with position x0 and tangent dx0, what constraints on parameters a,b,c and d do you have?

$p(0) = d = x0$

$p'(0) = 3a(0) + 2b(0) + c = c = dx0$

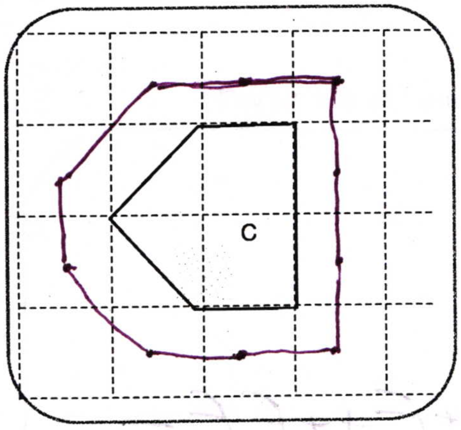
$p'(t) = 3at^2 + 2bt + c$

Problem 2. Navigation and obstacles (15 pts).
C-obstacles. Given the obstacle of the large diamond C in this diagram answer the following:

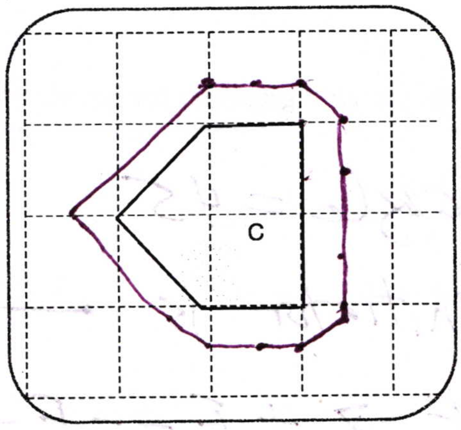


Sketch below the C-obstacles that result from the moving shapes A and B. Your sketches can be approximate. Use the centroid of each shape.

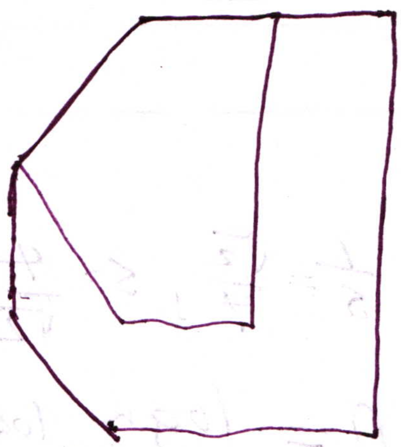
a) With A



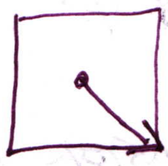
b) With B



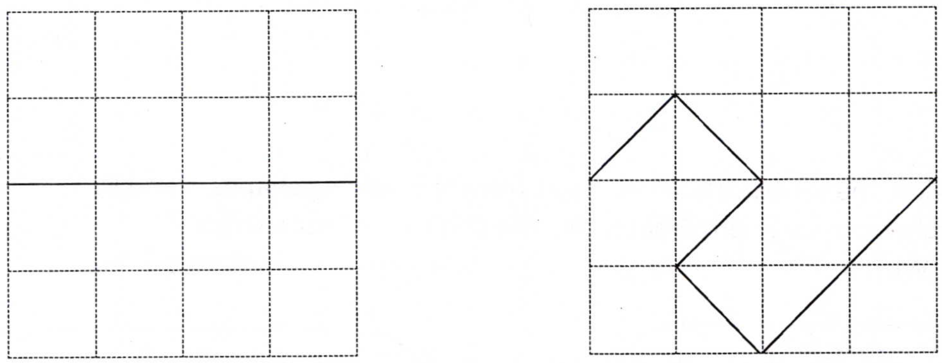
c) What difference would it make to shape and position of the C-obstacle if you use the right corner point on the square A instead of the centroid?



The shape is not different but moved by the vector from the centroid to the lower right point



Problem 3. L-System (20 points). Given this diagram of recursive step of a possible L-system curve, with the initiator on the left and the next step on the right, answer the questions below.



a) Give an L-system with grammar for drawing the shape defined by the curve?

angle = 45

Initiator is ——

F → +F--F--F++F++FF-

Oh if the first + and last - are missing. Should have F →

b) Give the fractal dimension of the curve.

# of pieces $n = 6$

Scale factor $\frac{1}{4}\sqrt{2}$ so $\frac{1}{s} = \frac{\sqrt{2}}{4}$, $s = \frac{4}{\sqrt{2}}$

fractal dimension is $D = \frac{\log n}{\log s} = \frac{\log 6}{\log 4/\sqrt{2}}$

Problem 4. Flocking and crowd motion (15 points). Let's assume you have game with a NPC wolf pack that chases the player, and the wolf pack exhibits flocking behavior. It stays together, but can separate to go around an obstacle.

a) Describe at least three forces you'd apply to each wolf.

Any of the four:

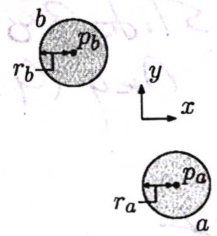
seperation - avoid collisions w/ boids

alignment - face same direction

avoidance - avoid collisions w/ obstacles

cohesion - stay together

b) One way to insure two wolves do not collide is to compute a forbidden region of velocities for each pair of wolves based on their current velocities. If you have two wolves a and b in 2d space like on the left, how do you compute a forbidden region of velocities for a if b is static?

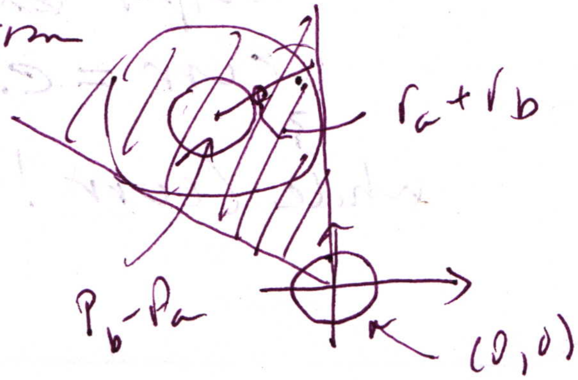


a has velocity v_a

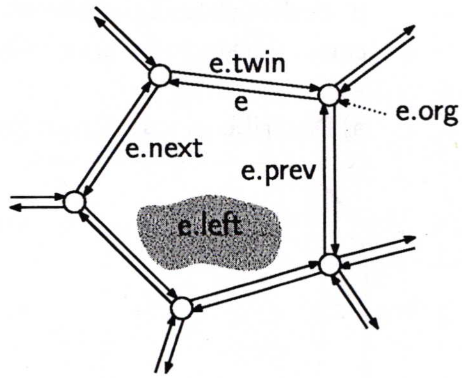
we have that

$$||p_a + t v_a - p_b|| < r_a + r_b$$

as a diagram



Problem 5. Winged edge mesh representation (20 points).
The DECL representation is given on the right. Given this, answer the questions below.
First: give short expressions to give:



a) e.right: the face on e's right side

e.twin.left

b) e.onext: the next half-edge that shares e's origin that comes after e in ccw order

e.prev.twin

c) Give an algorithm to give the *right* face of e in ccw order.

```
curr = e.twin
do {
    output curr
    curr = curr.next
while ( curr != e.twin )
```

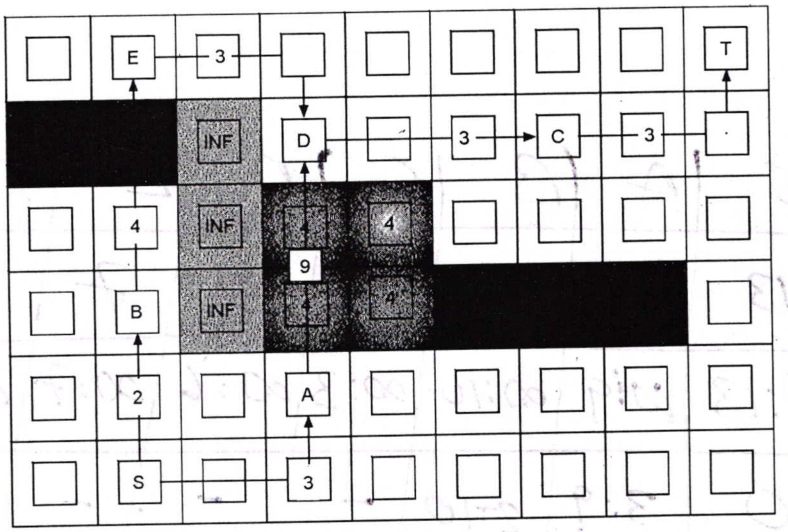
Faces must have #edges ≥ 3

d) Give an algorithm to give all the vertices adjacent to e.org in any order.

See Slide 38 Day 19

```
curr = e
do {
    output curr.dest
    curr = curr.twin.next
    }
while (curr != e)
```

Problem 6. A* (15 points). Assume a Manhattan-like arena with all the obstacles square blocks in a regular pattern, strictly bounded on the outside, like the diagram below. Most blocks have unit cost, but some have INF cost (full obstacles) and some have other costs (like water or forest) which are given in the diagram below.



a) Would the Euclidean distances sqrt((x1-x2)^2+(y1-y2)^2) between two blocks be an admissible heuristic? Why?

Yes.
The Euclidean distance is less than the Mahattan distance, and that is less than paths using the terrain costs.

b) Would the Manhattan distance abs(x1-x2)+abs(y1-y2) between two blocks be an admissible heuristic? Why?

Yes.
The Manhattan distance ignores the terrain costs so is less than paths using those costs.

Problem 6. continued

Given the data in the diagram above, show the result of A* from S to T using the Mahattan distance heuristic.

	S	A	B	C	D	E	T
h(v)	13	9	10	3	6	7	0
init	0:13	∞:9	∞:10	∞:3	∞:6	∞:7	∞:0
1. S	0	3:9 12	2:10 12	—	—	—	—
2: A	↓	3	~~2~~	—	12:6 18	—	—
3. B		↓	2	—	—	6:7 13	—
4. E			↓	—	9:6	6	—
5. D				12:3	9	↓	—
6. C				12	↓		15:0
7. T				↓			15

Scratch paper

If you want us to check anything here please make a note at the original question.