H. Choset Fall, 2000

ME 24-354: General Robotics
1 Exam

Date Handed Out: October 14, 1998
Time Allotted: 1 hour and 15 minutes

- Please show all work.
- You can use one crib sheet.
- You must attempt all *four* problems.
- GOOD LUCK!!!

P1. [***Motion Planning, 40pts***]

(a) Draw the Voronoi diagram for the ***configuration space*** in Figure 1.

(b) Draw the visibility graph for the ***configuration space*** in Figure 2. Hint: Draw the visibility lines from the corners of the outer obstacle first and look for symmertries. Dont get hung up on drawing all of the lines; it is not worth the time.

Figures 6, 7,8 and 9 contain extra configuration spaces.

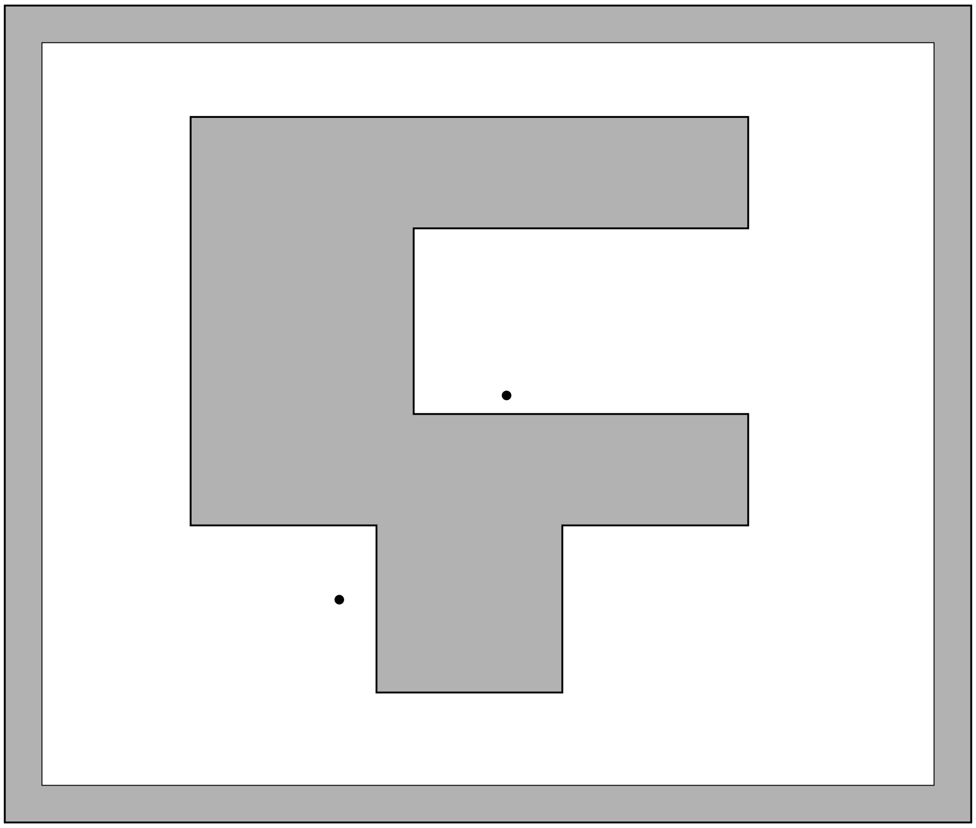

Figure 1. Draw Voronoi diagram of this Configuration Space.

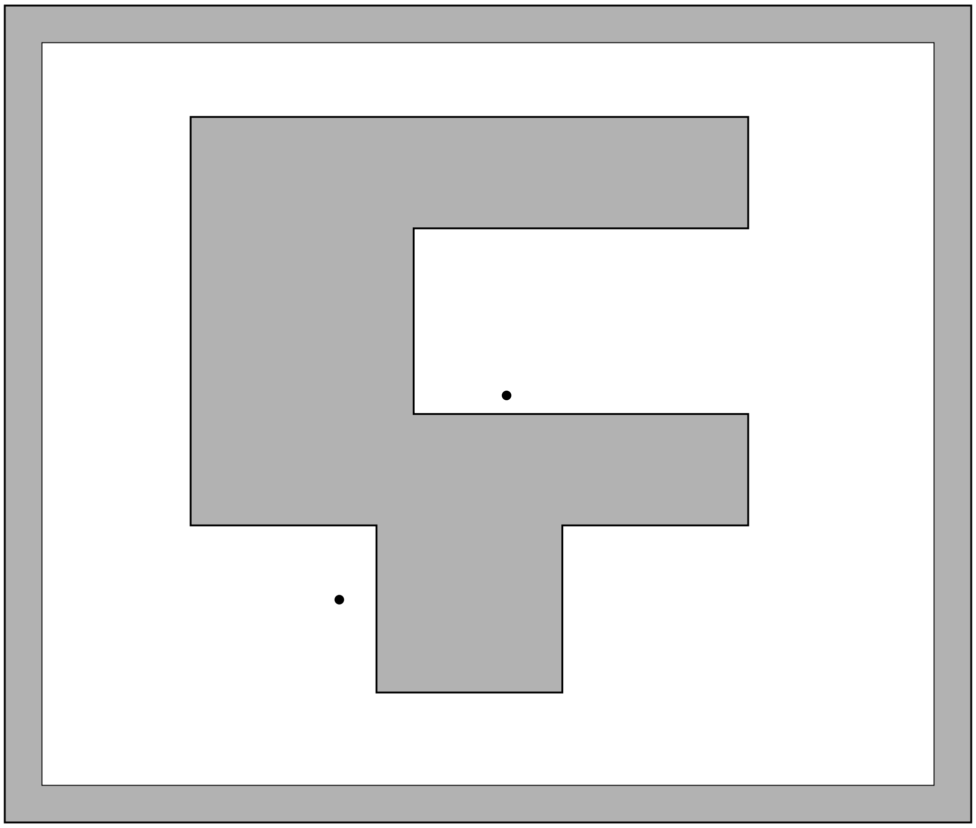

Figure 2. Draw Visibility Graph of this Configuration Space.

(c) Draw a resulting path from the Voronoi diagram and visibility graph (use a different color or draw the path real dark).

(d) List three metrics (e.g. fuel efficiency) for path planning and define each of them in one sentence.

(e) For each of the metrics listed above, explain how the metric applies to the Voronoi diagram and the visibility graph. For example, the visibility graph has good (or bad) fuel efficiency because ....

(f) Normally, the planner is given the work space, the shape of the robot and then it determines the configuration space where path planning takes place. In this problem, we gave you the configuration space, first. Figure 3 contains the workspace for this configuration space. Which robot was used to generate this configuration space (A,B,C,D). Write your answer in the test book in a full sentence. Robot X generated the configuration space.

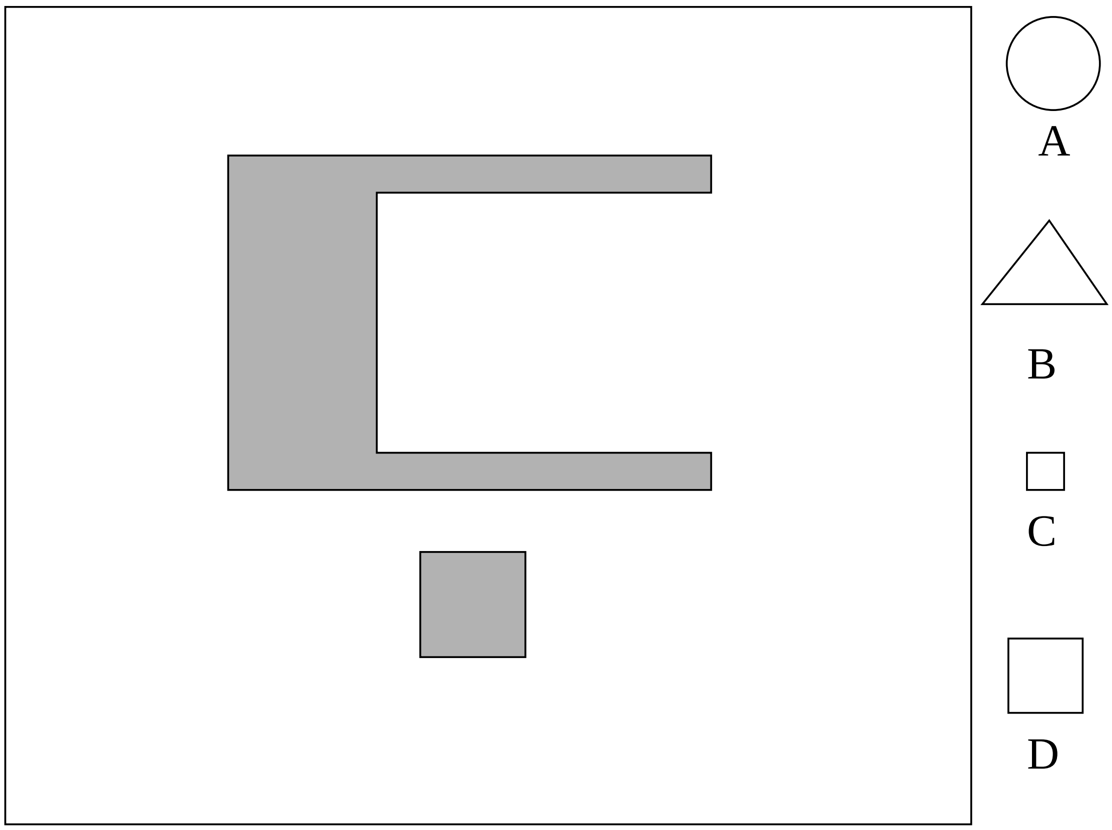

Figure 3. Workspace and choice of robots that generated it.

P2. [***Vision, 35 pts***]

Figure 4 contains a signal that has a rising edge and a falling edge when read from left to right. The rising edge goes up and the falling edge goes down, as labeled.

Figure 4. An example of a rising and falling edge.

(a) In class, we convolved a mask M with a one-dimesnional signal Σ to detect edges. What was this mask M?

(b) Once you have the convolved signal $(\Sigma \star M)$, how do you detect only the rising edges? I.e., what operation do you perform on the convolved signal $(\Sigma \star M)$ to determine the rising edges.

(c) In the signal given in Figure 5, how do you detect the indicated edge? (i.e., what operation do you perform on $\Sigma \star M$ to determine the indicated edge.

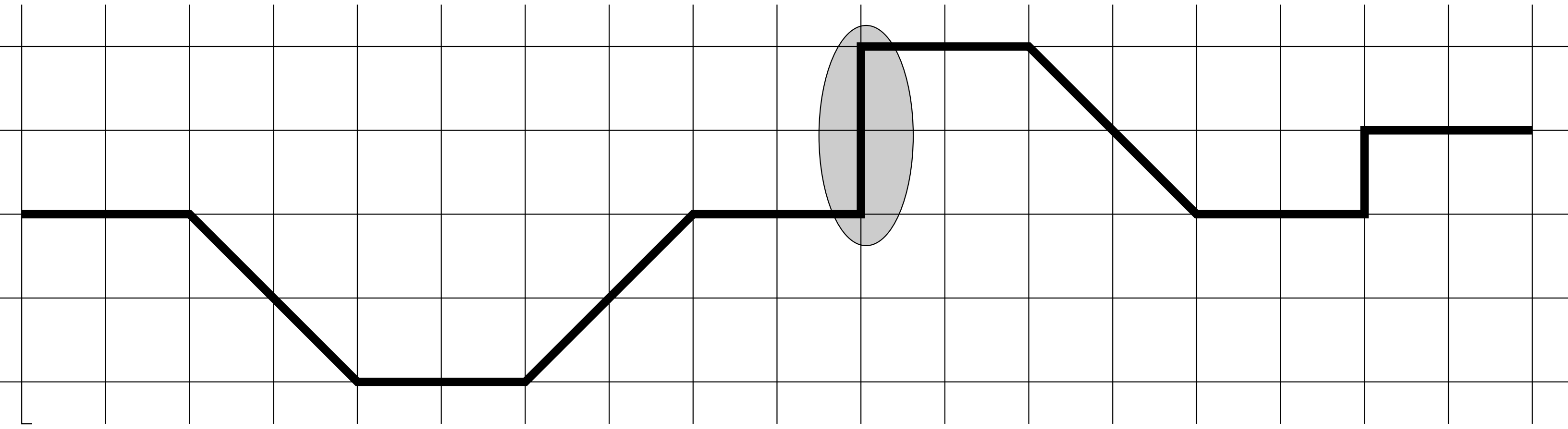

Figure 5. Signal with rising and falling edges.

P3. [***15pts***] In the motion planning lab, some groups used eight-point connectivity when growing their wavefront, i.e., their wave front expanded according to the generator

1	1	1
1	1	1
1	1	1

as opposed to four-point connectivity, i.e., a wavefront expanded according to the generator

	1	
1	1	1
	1	

(a) Which wavefront generator gives rise to the shortest path in the $L1$ metric and why?

(b) Why does the other *not* not give rise to the shortest path in the $L1$ metric?

(c) Does the other generator give rise to the shortest path with the $L2$ metric? Why?

P4. [***10pts***] Match (connect with lines) the researcher to the research performed.

Ben Brown	Mechanisms and System Integration
Howie Choset	Snake robots
Illah Nourkhabash	Artificial Intelligence

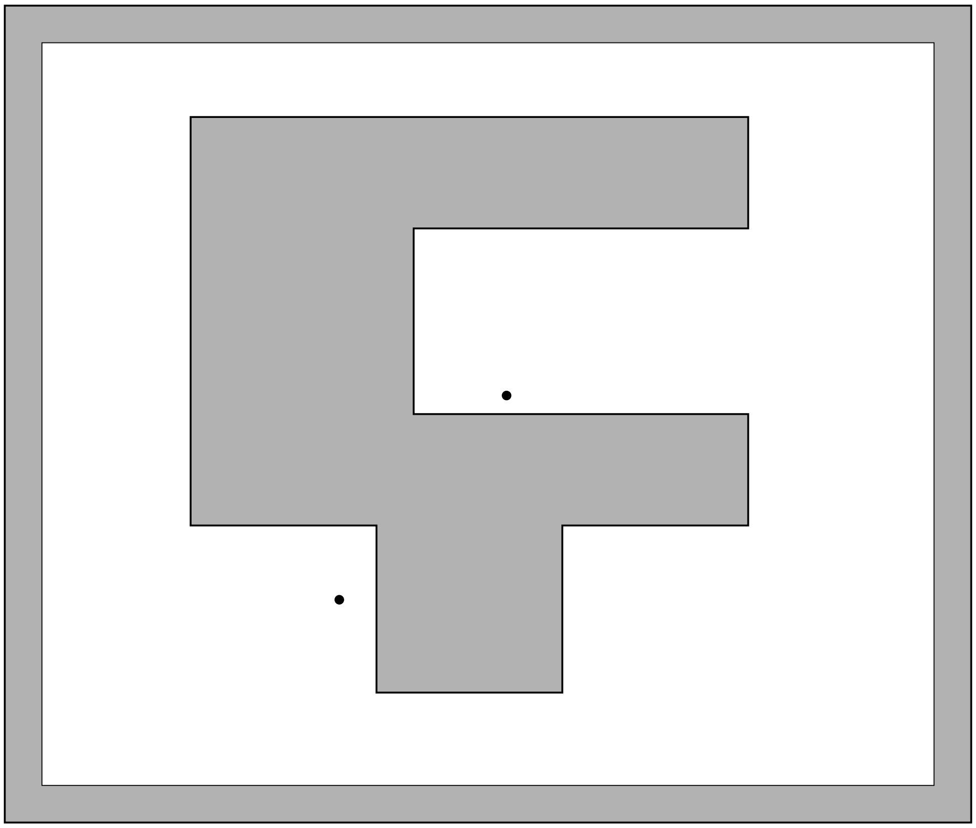

Figure 6. Configuration Space, extra c-spaces at end of test.

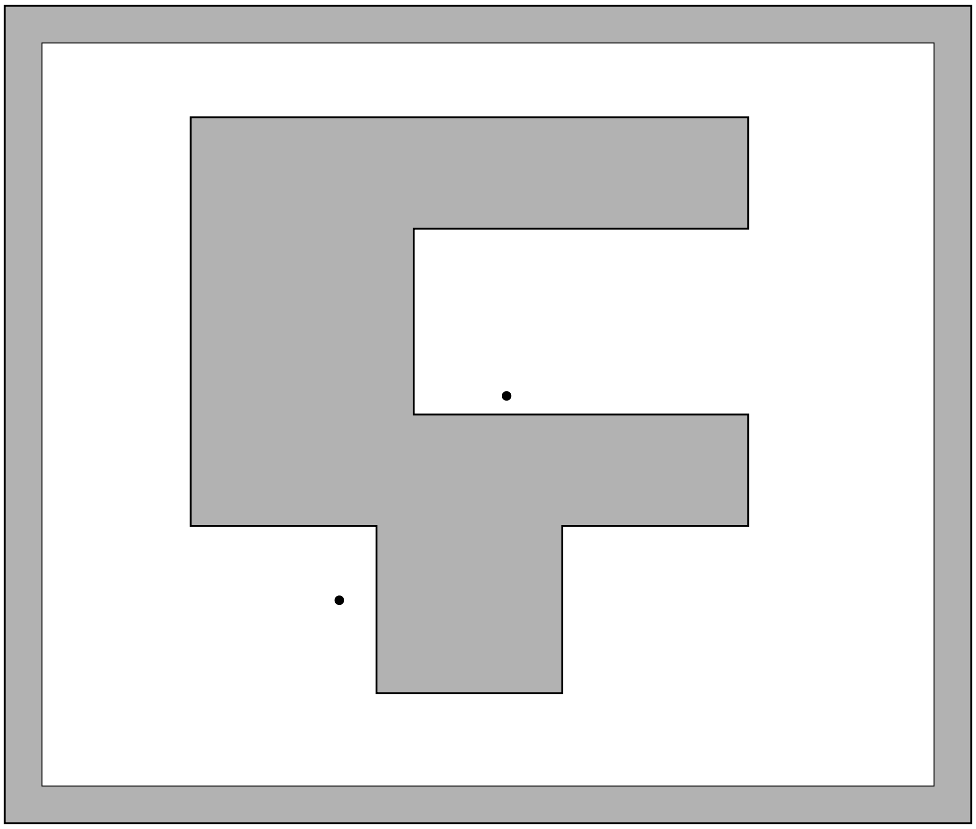

Figure 7. Configuration Space, extra c-spaces at end of test.

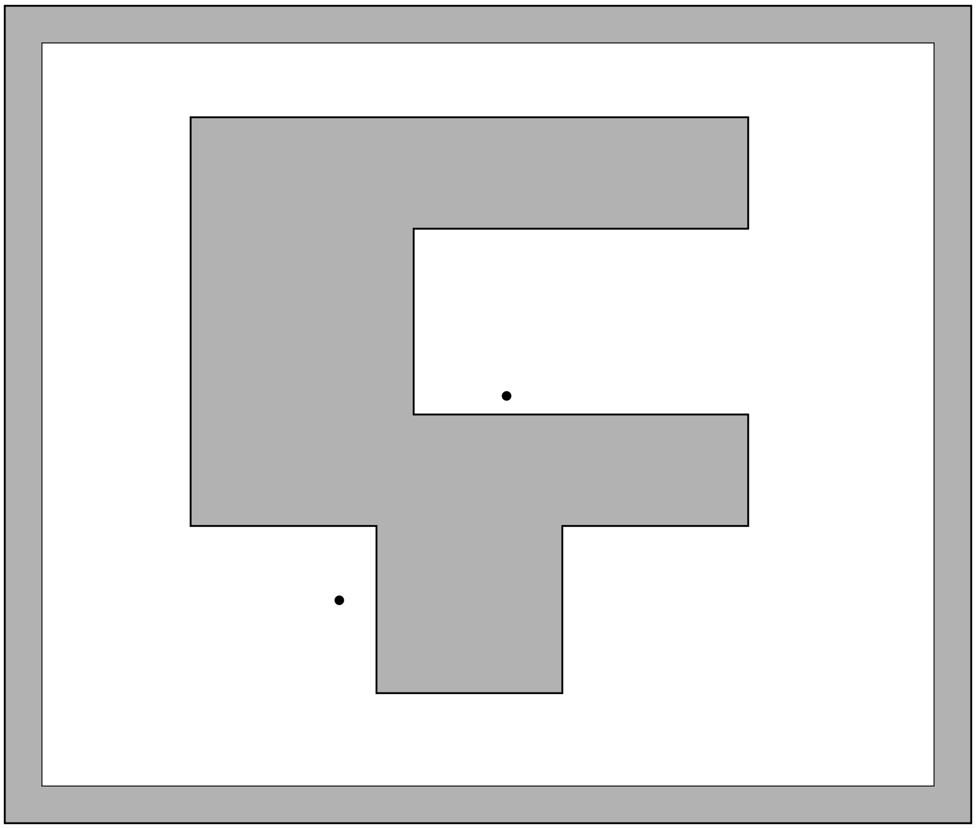

Figure 8. Configuration Space, extra c-spaces at end of test.

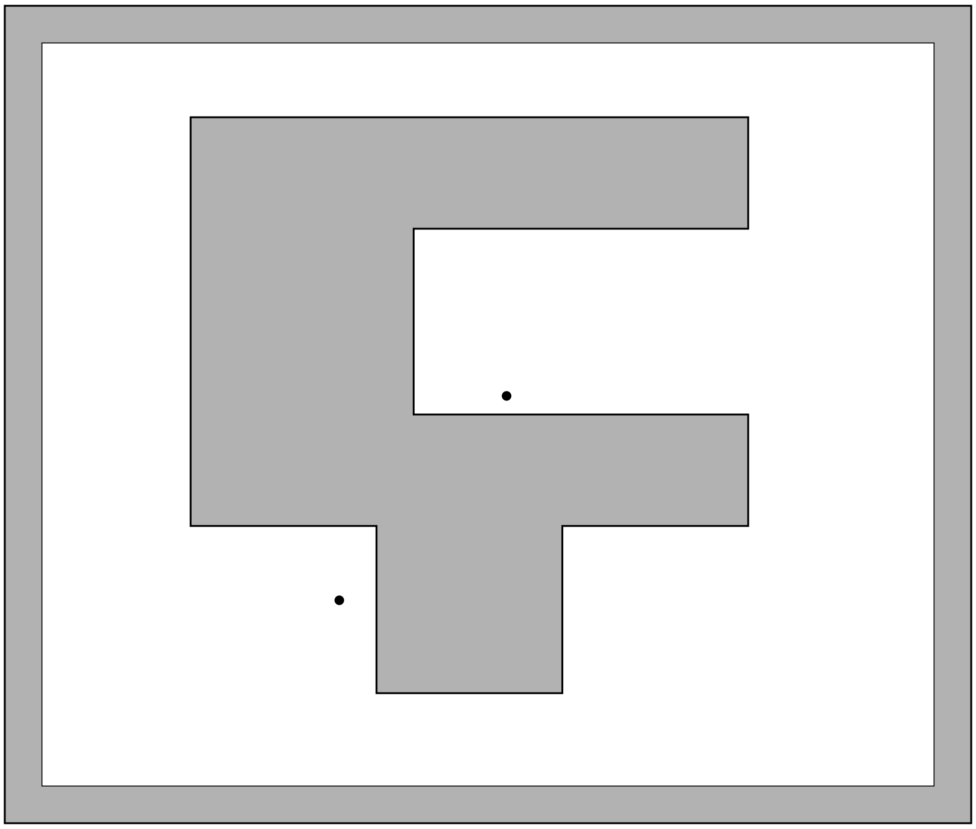

Figure 9. Configuration Space, extra c-spaces at end of test.