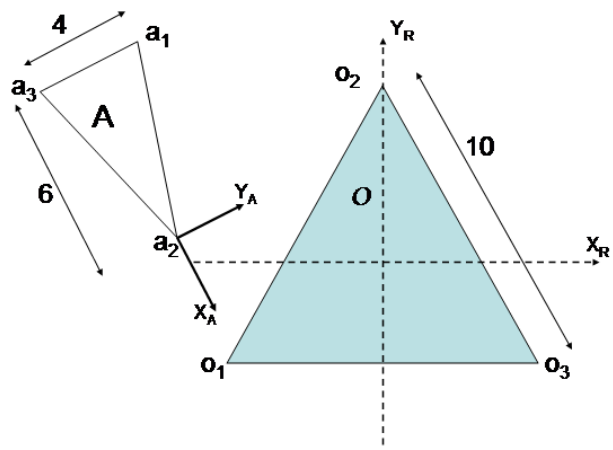
ME/CS 133(b): Homework #1

(Due Wednesday January 30, 2019)

Problem #1: (10 points) Consider the convex polygonal robot, $\mathcal{A}$, and obstacle, $\mathcal{B}$, shown in Figure . The obstacle is an equilaterial triangle with side dimension of 10 units, whose center is coincident with the origin of the workspace's reference frame. One triangle face is parallel to the x-axis of the workspace reference frame. The robot is an isoceles triangle whose base dimension is 4 and whose height is 6. Its body fixed reference frame is located so that its x-axis is aligned with the triangle's centerline, and its origin is located at the vertex bounded by the



Sketch the boundary of the fixed orientation configuration space obstacle associated with this configuration when the robot is oriented at: (a) $+45^o$, (b) 0^o, and (c) -45^o.

Problem #2: (20 points) Consider the case of a 2-dimensional configuration space populated by planar polygonal c-obstacles. In such c-spaces, the arcs of the Voronoi diagram are locally of three types, depending on the two local polygon features which are equidistance from the Voronoi arc:

1. the two closest polygon features are an edge and an edge
2. the two closest polygon features are a vertex and an edge
3. the two closest polygon features are a vertex and vertex.

Derive formulas for the Voronoi arcs for the three cases described above, and qualitatively describe the geometry of each type of arc.

Problems #3 (20 points)

Consider the "workspace" shown in Figure 1. One might think of this diagram as being related to the following problem. The interior walls of an apartment must be painted. To clear the bedroom for painting, a bed must be moved from the bedroom to the living room. The two rooms are connected by a short corridor. The bed is first flipped on its side so it looks like a rectangle. The rectangle is the moving robot $\mathcal{A}$. The outer wall is represented by the union of four rectangular obstacles $\mathcal{B}_{0_1}, \mathcal{B}_{0_2}, \mathcal{B}_{0_3}, \mathcal{B}_{0_4}$. The interior walls are rectangular obstacles $\mathcal{B}_1, ..., \mathcal{B}_5$.

Part (a): Sketch the Voronoi Diagram on a copy of this workspace, assuming that the robot is a point robot.

Part (b): Assume that we create a "grid," such as the one superimposed on Figure 1. Assume that for the purposes of the wavefront potential (or brushfire) method for constructing the voronoi graph, you have a matrix whose individual entries are an integer that indicates the status of each cell. The status of each cell will be one of the following: (1) a cell is occupied by an obstacle; (2) a cell is freespace and has not been visited; and (3) a cell is freespace, but has been visited and has been assigned an integer.

First, write a program that will "print" the contents of each cell in an array structure. If the cell is an obstacle, print an "X." If the cell is free space, then print a "blank" if it has not been visited, or print the assigned integer if it has been visited.

Second, assume that the robot is a point robot. Assume that the robot's initial configuration, q_I, is located in the cell that is 6 cells down and 5 cells to the right of the top left corner. Assume that the robot's goal configuration, q_F, is located 4 cells to the right and 4 cells up from the bottom left corner. Implement the part of the wave front potential method that fills all of the grid cells with integers, thereby approximating a Voronoi Diagram. Print out your result, and then hand-draw the path from start to goal (using the approximate Voronoi Diagram as a roadmap) using your results.

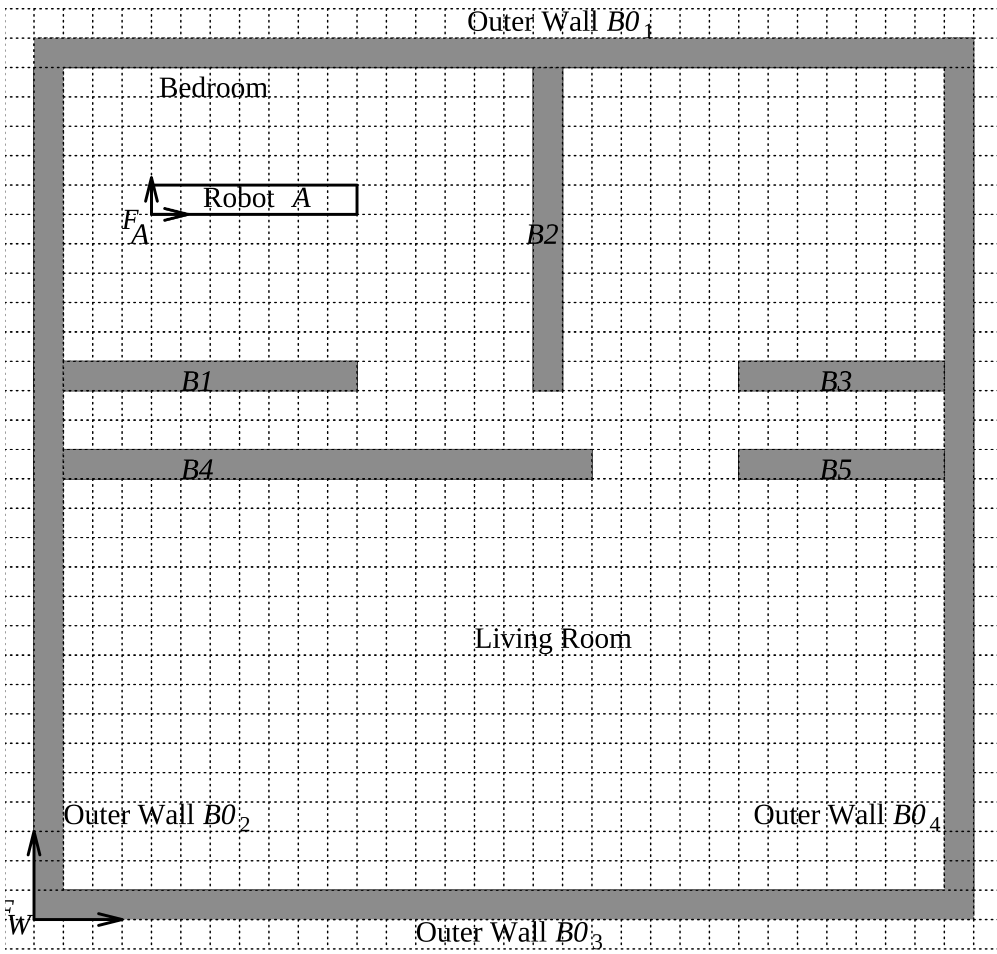


Figure 1: Schematic diagram of workspace