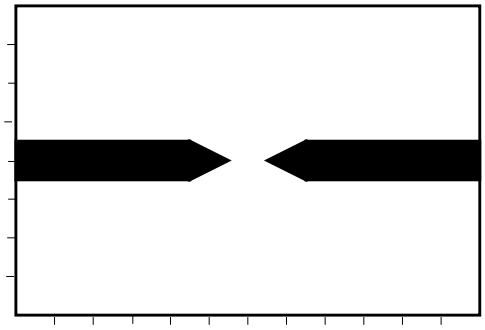
Assignment 3
CSCI-4965/6963: Robot Motion Planning

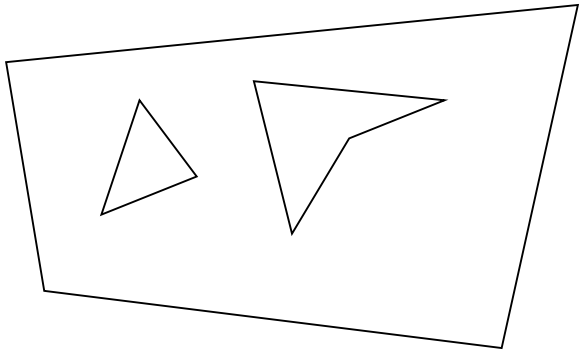
Due: Friday, October 14, 2005

Assignments are due at the beginning of class on October 14, and are to be done individually. Assignments will be graded on the basis of correctness, clarity, and legibility. See course syllabus for late submission policy.

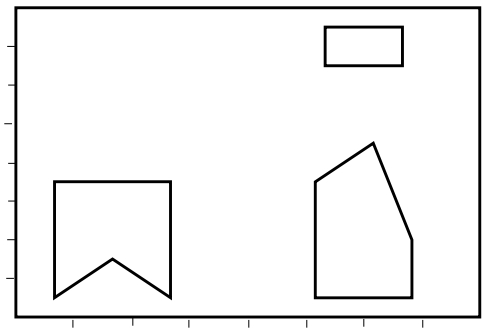
1. Draw the curves that make up the Voronoi roadmap for the environment shown below. Assume the bounding rectangle is part of the obstacle boundary. Label the curves so it is clear which features each segment is derived from, and whether it is linear or parabolic. A rough sketch that is clear is fine, your drawing does not need to be extremely precise. Assume the rectangular part of each "pencil" is 4.5 units by 1 unit, and the triangular part has a base of 1 unit and an altitude of 1 unit.



2. Consider the polygonal environment shown below. Show the progression of the sweep line algorithm in constructing a trapezoidal decomposition (give the events and status at each event). Draw the resulting trapezoidal decomposition and connectivity graph.

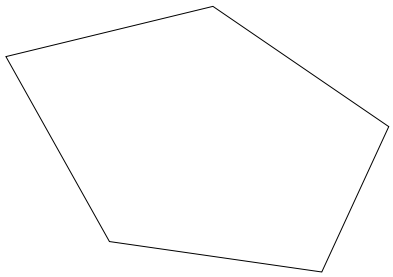


3. Generate the quadtree decomposition to depth 3 for the region shown in the figure below. Show both the quadtree decomposition and the resulting tree.



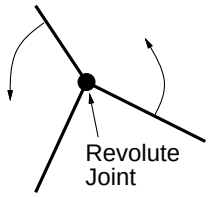
4. Consider two point obstacles O_1 and O_2 in the plane. O_1 is located at $(-a, 0)$ and O_2 is located at $(a, 0)$. Assume the scale factor η_1 for O_1 is 27 times η_2, the scale factor for O_2 and that the distance of influence ρ_0 for both obstacles is infinite. Find the point where the net repulsive force is zero. What is the repulsive potential at this point, expressed in terms of the above variables?

5. (a) Consider the convex polygonal obstacle shown below. Draw the Voronoi regions that are used for incremental distance computation.



   (b) Describe how to compute the closest point on an edge E, along the line $ax + by + c = 0$, to a point (x_p, y_p).

6. (a) Consider a rod that can translate and rotate in a 2D world, with two more rods attached to it at one end (figure below). Each of the additional two rods is free to rotate with respect to the first rod. What is the dimension of the configuration space of the system of rods? Express the configuration space of the system as a Cartesian product of simpler spaces.



   (b) Suppose there are five polyhedral bodies that can float freely in a 3D world. They are each capable of rotating and translating. If these are treated as "one" composite robot, describe the resulting configuration space of the system? What is its dimension? Assume the bodies are **not** attached to each other.