Problem Statement 1 — April 9

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On-line search in polygons

An important problem in robotics is searching for a target point in an unknown polygonal region [5]. In this problem, a robot with vision is placed at a starting point s in a polygon and must traverse a path to some target point t in the polygon. The robot has no prior information about the geometry of the polygon or the location of the target, however, the robot will recognize the target when it sees it (a robot at x can see y if the segment xy is completely contained in the polygon P). In the worse case, a search performed by the robot can be arbitrarily inefficient compare to the shortest path from s, but strategies can be proposed depending on the type of polygon.

The robot, using its vision, makes decisions as it moves only using information of what it has seen so far [6]. The problem is online in nature [1] and the competitive ratio is used to measure the performance of a robot's strategy. In this particular problem, it is desired to minimize the ratio between the euclidean distance travelled by a robot to the distance of a path followed by an adversary who knows both the map of the polygon and the location of the target and can plan an optimal route. The competitive ratio is the worst case ratio achieved over all possible problem instances. An algorithm is called competitive if its competitive ratio is constant [6].

Since it is imposible to find a target in general polygons in a competitive manner [6], previous work has focused on restricting the classes of polygons for which constant competitive ratios can be achieved, results have been found for streets [5] and generalized streets [2].

More recently [7], another class of polygons, star-shaped polygons, has been considered. A polygon P is star-shaped if there is some point inside P that can see the entire boundary of P [3].

It might be possible that more general algorithms exists for a more general class of polygons than star-shaped polygons. One possible direction [4] could be define the illumination number of P to be the maximum number of point-source "light-bulbs" needed to provide direct illumination to the entire boundary of P from its interior (in the case of a star-shaped polygon the illumination number is one); within this framework, algorithms that can achieve constant ratio for searching polygons with a fixed illumination number can be proposed. Other restrictions over the class of polygons can be explored to expand the possible polygons for which a target can be found.

Bibliography

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