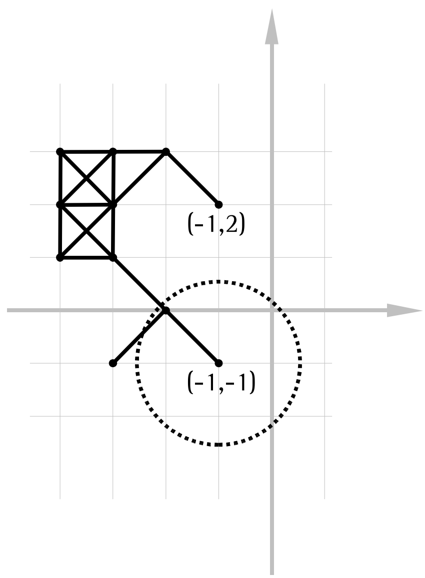
Exercise Sensor Networks

Lecture 8: Routing in sensor networks

Exercise 8.1: Geographic Hash Tables

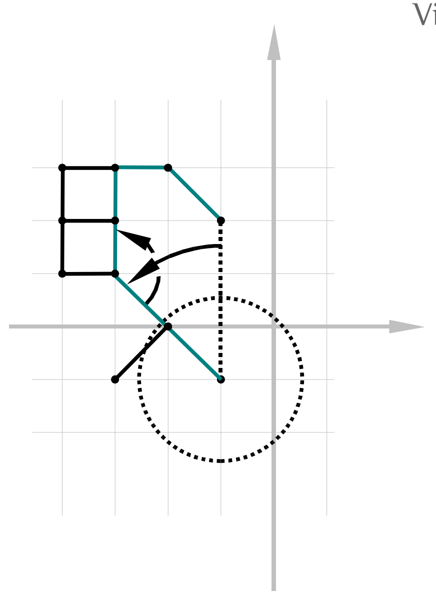
a) A number of nodes are shown in the right figure as small dots. Each node has a radio range of 1.5 units. The mutual connectivity is already included as connecting lines in the figure. Reduce the graph according to the Relative Neighborhood Graph (RNG) algorithm to a planar graph.

b) Route a packet according to the GPSR Algorithm from node (-1, -1) to node (-1, 2) and write down the visited nodes.



Solution to a) and b) :

Visited node: (-1,-1), (-3,1), (-3,2), (-3,3), (-2,3), (-1,2)



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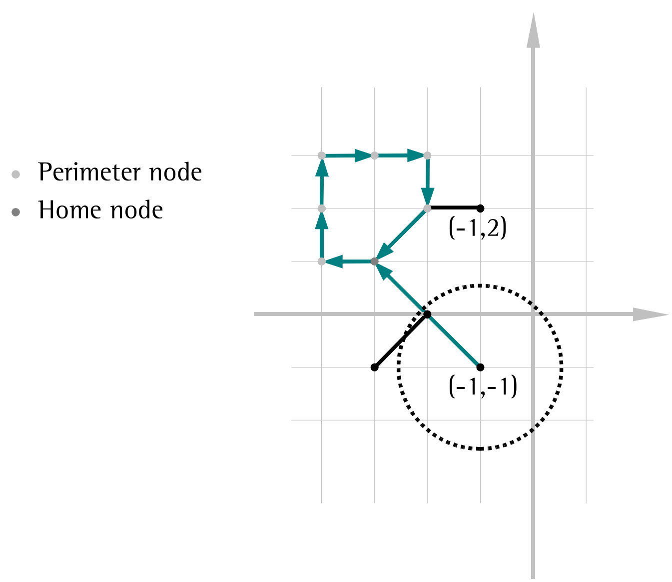
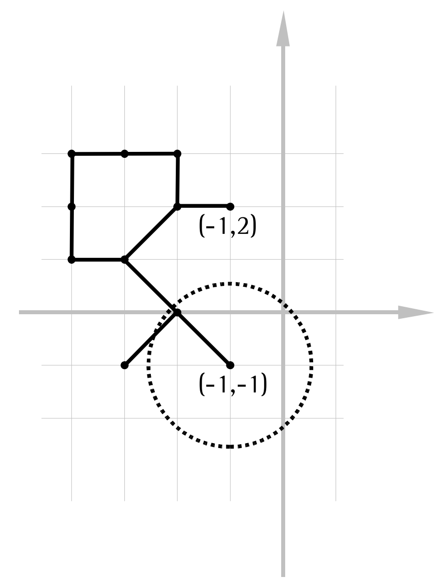
c) Node (-3, 2) moves to position (-2, 2). Shortly afterwards the sensor network has to associate some information with position (-3, 2). Which nodes become replica nodes according to Geographic Hash Tables and which one becomes the home node if we always rotate counter clockwise?

Solution:





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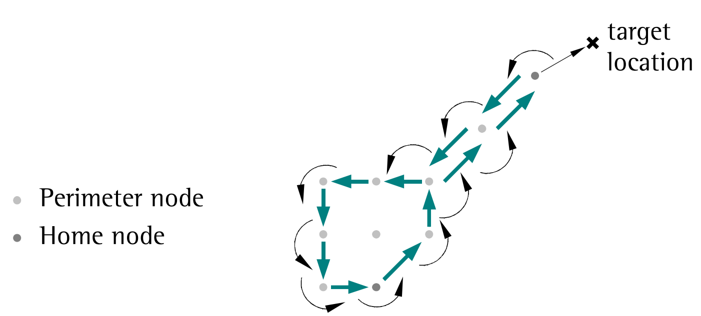
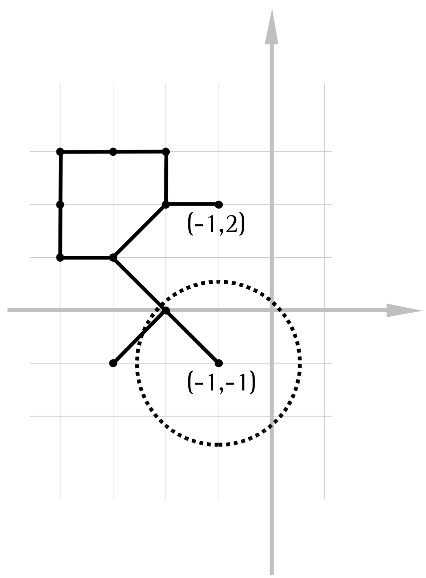
Exercise 8.1: Geographic Hash Tables

d) Some researchers claim that perimeter mode can cause a packet to traverse a network's entire outer boundary. Prove that this is false or show an example.

e) Again, information has to be associated with a specific location. A chain of sensors leads to that location however, in the fashion of a dead-end road. The last node before the considered location is only connected with the chain in one direction. How does perimeter mode behave here?

Solution for d) and e)





Exercise Sensor Networks

Lecture 8: Routing in sensor networks

Exercise 8.2: GeoCast

In order to route a packet a router has to intersect the target region contained in a packet with the region it is responsible for. Circles and arbitrary polygons are considered in the approach. In order to cut circles with polygons the authors suggest to decompose a circle into a number of line segments and cut the evolving polygon using a conventional polygon-polygon intersection.

a) Why is this solution not optimal?

Solution:

The circle is already defined precisely and simple by its midpoint and radius. Tessellating it into a number of line segments is demanding and not precise.

Exercise Sensor Networks

Lecture 8: Routing in sensor networks

Exercise 8.2: GeoCast

b) Design an approach which treats the circle as such. Think of the normal-based line equation to ease the task.

Solution:

$$dist = (\vec{P}_1 - \vec{M})\,\vec{n}_0$$

whereas n0 denotes the normal unit vector of length 1. If dist < the circle's radius then the circles cuts the straight line through P1 and P2. If the distance dist is larger no intersection is possible.

But we are not yet ready because the intersection (in case it exists) has to occur between P1 and P2 on the line and not beyond.

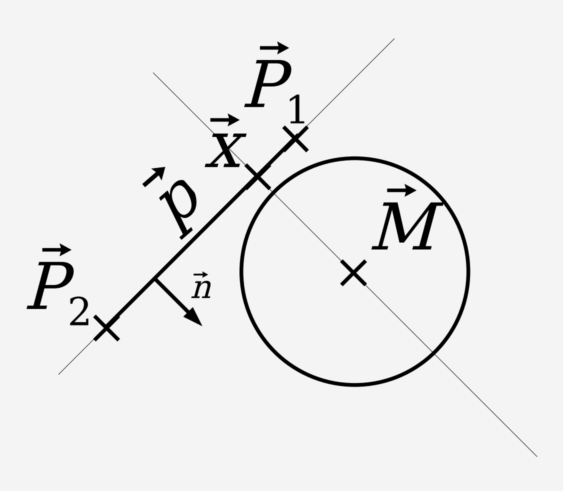
Therefore the perpendicular through M onto the line is constructed in order to obtain the intersection x. Ist is however, not necessary to calculate the coordinates of the intersection but only the parameter on the line through P1 and P2. If the parameter is in [0, 1] then the intersection is asserted.

$$\vec{X} = \vec{P}_1 + r\vec{p} \qquad \vec{p} = \vec{P}_2 - \vec{P}_1$$

Obtain the parameter r for which M-X is orthogonal to p:

$$(\vec{X} - \vec{M})\,\vec{p} = 0$$

$$(\vec{P}_1 + r\vec{p} - \vec{M})\,\vec{p} = 0 \Leftrightarrow \vec{P}_1\vec{p} + r\vec{p}\vec{p} - \vec{M}\vec{p} = 0 \Leftrightarrow r = \frac{\vec{M}\vec{p} - \vec{P}_1\vec{p}}{\vec{p}\vec{p}} = \frac{\vec{p}(\vec{M} - \vec{P}_1)}{\vec{p}^2}$$



Conclusion: It is a lot easier to calculate the intersection between the original circle and a line rather than to break the circle into a larger number of line segments as suggested in the paper.