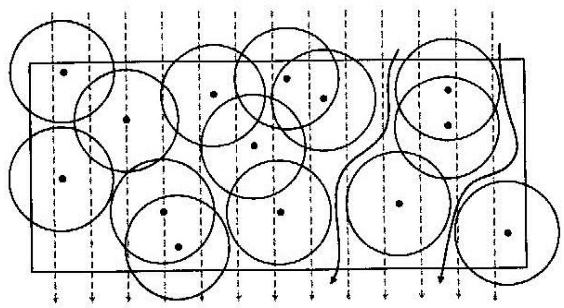
University of Delaware -- Computer and Information Science

CIS621 -- Homework 4

Handed out: October 25, 2011
Due date: November 8, 2011

10. [*Individual Problem*]

Consider a set of n sensors deployed in a "belt region" – that is, a rectangular region R that is aligned with the x-y axes, where typically the width along the x-axis is much larger than the height along the y-axis. Assume that each sensor has a **sensing range** of r. That is, the sensor can **detect** movement anywhere in or on the circle of radius r centered at the sensor. This set of sensors provides **k-weak barrier coverage** for R if an intruder moving across R on any path parallel to the y axis will be detected by at least k sensors. Here is an example where the sensors provide 1-weak barrier coverage:



An illustration of weak 1-barrier coverage: any orthogonal crossing path (dashed lines) is covered by at least one sensor. However, uncovered path(s) may exist, such as the ones shown in the solid curves.

Give an O(n log n) algorithm to determine if a set of n sensors provides k-weak barrier coverage for R.

11. [*Individual Problem*]

Consider a connected, undirected, edge weighted graph G with n vertices and e edges. For any spanning tree T of G, a **bottleneck edge of T** is an edge of largest weight in T. A **bottleneck spanning tree** for G is a spanning tree for G which, among all spanning trees for G, has the smallest weight bottleneck edge.

a. [3 pts] It follows easily from Kruskal's algorithm that any minimum spanning tree for G is also a bottleneck spanning tree for G. Give an example showing that the reverse however is not necessarily true. That is, show that a bottleneck spanning tree of G need not be a minimum spanning tree of G.

b. [7 pts] Give an O(e+n) algorithm for finding a bottleneck spanning tree of G.

12. [*Group Problem*]

A **scorpion** on n vertices is a graph that has a vertex of degree 1 (the tail), connected to a vertex of degree 2 (the body), connected to a vertex of degree n-2 (the head). The other n-3 vertices (the feet) can be arbitrarily interconnected.

Give an O(n) algorithm for deciding whether or not an arbitrary graph is a scorpion, assuming that the graph is represented by an adjacency matrix.