AS 2007                              Prof. Dr. Roger Wattenhofer, Nicolas Burri, Stefan Schmid,
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# Ad Hoc and Sensor Networks
# Exercise 2

Assigned: October 8, 2007
Due: October 15, 2007

## Wave Phenomena

a) Aline sits in her car and listens to the radio station AM Energy. She has to stop at a red light. Right at the stop, the quality of the music becomes very poor. When she pulls back 1 meter, the music is fine again. Give different explanations for this phenomenon.

b) Can these phenomena also happen with acoustic voices (around 1000 Hz)? Please explain.

## Connectivity Models

In the lecture you have learned that researchers have studied different models for wireless sensor networks. Such models are often simplifications of reality but allow to give formal proofs, e.g., on the correctness or performance of an algorithm.

a) You are asked to model the connectivity of two different sensor networks: The first sensor network is used by a farmer in the outback of Australia to monitor his cattle; the second network is located inside an office building in Zurich. Which model would you recommend and why?

b) Consider the following nodes in the 2-dimensional Euclidean plane:
$V = \{v_1 = (1,2), v_2 = (2,1), v_3 = (2,3), v_4 = (3,2), v_5 = (4,4), v_6 = (2,4), v_7 = (2,5)\}$.
The connectivity of the nodes be as follows: $E = \{\{v_1, v_2\}, \{v_1, v_3\}, \{v_1, v_4\}, \{v_2, v_3\}, \{v_2, v_4\}, \{v_3, v_4\}, \{v_2, v_5\}, \{v_4, v_5\}, \{v_5, v_6\}, \{v_5, v_7\}, \{v_6, v_7\}\}$. Is this graph $G$ a Unit Disk Graph?

c) If only the connectivity information of b) is considered but not the absolute positions, can the resulting graph be modeled as a Unit Disk Graph?

d) Can graph $G$ of task b) be modeled as a Quasi Unit Disk Graph? If yes, what is the maximal $\rho$?

e) Can the graph $G$ be modeled as a Bounded Independence Graph? Find the nodes for which the 1-hop neighborhood contains the largest set of independent nodes; what is the cardinality of this set? What is the solution for the case of the 2-hop neighborhood?

f) Can the situation be modeled as a Unit Ball Graph? Define a metric on the nodes of $G$ which maintains $G$'s connectivity and which has a minimal doubling dimension.

g) Prove that the Unit Disk Graph is a special case of a Bounded Independence Graph.

h) Formally show that there exist graphs which fulfill the metric space property but which do not have a constant doubling dimension.