Location Awareness 2016: 2st Exercises

November 11, 2016

All course participants are requested to submit their exercise solutions electronically to the instructors (ella.peltonen at cs.helsinki.fi and faghihib at cs.helsinki.fi), as well as, to the course lecturer (petteri.nurmi at cs.helsinki.fi) latest before the exercise session (Wednesday 4pm). We prefer PDF format for the reports.

In all the exercises, do not just give the answer, but also the derivation how you obtained it. Participants are encouraged to write computer programs to derive solutions to some of the given problems. You can include your code as a part of your solution (as separated files).

1 Coordinate Systems and Projections

a) What is the difference between a geoid and a reference ellipsoid? How are they used in practice?

b) Describe three different types of distortion in map projections and how they differ.

c) Describe the difference between the Mercator projection and the Transverse Mercator Projection.

2 KML Visualization

Write a program to generate KML[1] files which can be opened with Google Earth for visualization. Download the data from https://www.cs.helsinki.fi/u/peltoel/location_awareness/tokyo-lon-lat.csv. The columns of the file respectively represent longitude and latitude.

a) Generate a KML file that shows all the given location measurements present on Google Earth.

b) Show the chronological trajectory using KML by connecting successive locations with a line. The locations (rows) are in the order of appearance.

c) Preserve privacy by adding zero mean Gaussian noise to the location measurements provided and show the results using KML (experiment with the variance parameter and empirically and a good value for it).

3 Fingerprint-based positioning

Consider the radio map depicted in Table 3. Each row represents a point in the environment where some fingerprints have been recorded. Measuring the signal strength (SS) where you are standing now, you receive values $SS1 = -74dBm$, $SS2 = -80dBm$. Estimate your position using

a) **three** nearest neighbors (use Euclidean distance).

b) weighted **four** nearest neighbors (use Euclidean distance).

[1] https://developers.google.com/kml/documentation/kmlreference

Point	**SS1**	**SS2**	**X**	**Y**
1	-60	-62	36.41	211.4
2	-80	-90	84.21	99.1
3	-66	-71	35.99	179.99
4	-49	-66	55.21	223.78
5	-91	-93	55.98	109.11
6	-50	-81	85.61	223.98
7	-72	-55	22.57	197.91
8	-83	-79	53.33	141.12
9	-67	-61	22.51	226.1
10	-86	-91	82.11	128.97

Table 1: Radio map for Ex. 3.

4 Positioning implementation (2 pts)

Download the data given in a file https://www.cs.helsinki.fi/u/peltoel/location_awareness/training_set.csv that contains fingerprint measurements collected from an environment. Each row represents the signal strength measurements that have been recorded (39 first values) as well as the location, i.e. grid index, where they were recorded (last value).

Given this data, implement a positioning algorithm to find the most likely locations from which the fingerprints in https://www.cs.helsinki.fi/u/peltoel/location_awareness/testing_set.csv have been measured. You can assume the fingerprints are ordered the same in both files, i.e. that values in column 1 correspond to the same emitter or antenna, and so on. Note that you will have to do some preprocessing; both files contain zero values for missing measurements. Replace these values with a suitable value.

Return your code as well as a solution for the test set locations. You may choose any programming language you are familiar with, only include comments to make it easier to read.