Location Awareness 2016: 1st Exercises

November 4, 2016

All course participants are requested to submit their exercise solutions electronically to the instructors (ella.peltonen at cs.helsinki.fi and farbod.faghihi 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 Location-based Services

Give examples of four location-based services and describe briefly what they do. For obtaining the full points describe examples not covered during the lectures. For each example, describe how they use location awareness, and how they address key challenges (including, but not limited to those mentioned at slide 20 of the first lecture).

2 Privacy

2.1 K-anonymity and anonymity region

Given the locations of the users in Table 2.1, determine the number of users k covered by anonymity region when user u_1's position allows a 42 unit error. Assume a cartesian coordinate system and a circular anonymity region. You may include a picture to your report. Can you get any benefit of increasing or decreasing the location error?

user	x	y
u_1	28	79
u_2	23	90
u_3	15	82
u_4	55	102
u_5	9	43
u_6	11	97
u_7	0	76
u_8	80	87
u_9	9	41
u_{10}	45	9
u_{11}	43	92

Table 1: Users and their locations for Ex 2.1

2.2 Pseudonymes

Given a smartphone, define a mathod to get a pseydonyme for the device that:

1. Does not include any plain text information about the device
2. Cannot be the same for two devices
3. Does not require communication between devices, network, or any database

The stronger the better. The method does not need to work for multiple platforms or manufacturers, e.g., Android is enough. Motivate your solution and describe how you end up to it. Hint: for unique identifiers in Android, see https://developer.android.com/training/articles/user-data-ids.html - note that these identify the phone, but the pseydonyme is supposed to also blind it.

3 Energy-efficiency

3.1 Duty Cycle

a.) The GPS receiver of user u last returned a location $(latitude, lognitude)$ and is put on sleep for saving energy. Given the user's velocity $v = 3.5m/sec$ (constant) and tracking error threshold $e = 50m$, determine when the GPS should be turned on for getting the next location. You may not assume any error in the last position update. Moreover, calculate the duty cycle for GPS if the tracking is performed for 10 minutes (assume one GPS reading takes 70 milliseconds).

b.) Same as above, but use $e = 150m$ as threshold.

All necessary formulas are in the first lecture slides.

3.2 Android Location API

Android Location Manager (https://developer.android.com/reference/android/location/LocationManager.html) provides basic location services for the Android devices. By using that API, implement the duty cycle presented in the first lecture. You can use pseudo style "fake" coding instead of actual implementation (but you are free to do so if you are already familiar with Android).

Project Work

Please select the topic for your project work. The project work consists of implementation of an algorithm or system for analysing location data, and a report of the algorithm's / system's performance. The project can be done individually, or in groups of 2-3 people. The scale of the project work needs to reflect the size of the group implementing it. Examples of project topics will be available from the course webpage.