120.5 ≈ 121

CSE 162 Mobile Computing
Midterm Exam 2

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Part A: True / False (2 pts each)

Mark each statement as **True (T)** or **False (F)**.

1. A MEMS gyroscope measures acceleration along the X, Y, and Z axes. T
2. GPS determines a receiver's location using ~~three~~ four satellites only. F
3. An actuator takes an input → Electrical signal and produces motion or mechanical output. T
4. Ultrasonic sensors use electromagnetic waves. T
5. The LocationManager in Android requires ACCESS_FINE_LOCATION permission to use GPS. T
6. Fingerprinting-based localization requires prior site surveys. F
7. DBSCAN clustering requires the number of clusters (K) to be pre-specified. F
8. A proactive location-based service performs actions automatically when conditions are met. T
9. In Android, a Service always runs on a separate process. F
10. The main difference between participatory and opportunistic sensing is the user involvement level. T
11. Data anonymization guarantees that an individual's identity can never be inferred. F
12. In context-aware computing, dynamic context describes information that changes frequently. T

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Part B: Multiple Choice (3 pts each)

Circle the best answer for each question.

1. Which Android class connects your app to the phone's sensors? (a) SensorEventListener (b) SensorManager (c) SensorFramework (d) SensorEvent
2. The Coriolis force in a gyroscope is proportional to: (a) Velocity × Rotation (b) Mass + Gravity (c) Rotation / Friction (d) Magnetic field

3. Which type of localization algorithm uses time difference of arrival (TDOA)? (a) Range-free (b) Fingerprinting (c) Range-based (d) RSSI attenuation

4. The GPS receiver must solve for: (a) 3D position (x,y,z) only (b) 2D position and velocity (c) 3D position + clock bias (d) Altitude only

5. Fingerprinting-based localization requires: (a) Pre-collected RSSI map (b) Line-of-sight sensors (c) Triangulation geometry (d) Clock synchronization

6. Geofencing can be used to: (a) Control Wi-Fi frequency (b) Trigger actions when entering/exiting regions (c) Detect step count (d) Adjust magnetometer calibration

7. Which clustering algorithm requires radius (Eps) and minPoints? (a) K-Means (b) Hierarchical (c) DBSCAN (d) Fuzzy C-Means

8. Which API converts longitude and latitude into street addresses? (a) Google Maps API (b) LocationManager (c) Geocoder API (d) GPSProvider

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9. Reactive LBS differs from proactive LBS because it: (a) Requires constant background tracking (b) Is triggered by user request (c) Uses Bluetooth instead of GPS (d) Does not need location permission

10. The Reverse Auction Mechanism in crowd sensing is used for: (a) Data encryption (b) Privacy filtering (c) User incentive pricing (d) Battery saving

11. Data Perturbation in MCS is used for: (a) Noise reduction (b) Privacy preservation (c) Improving accuracy (d) Localization correction

12. SQLiteOpenHelper in Android: (a) Provides cloud synchronization (b) Creates and manages local databases (c) Performs clustering (d) Sends data to Firebase

13. Which of the following is an Active Context-Aware behavior? (a) Showing weather on request (b) Suggesting restaurants nearby (c) Automatically silencing phone when driving (d) Displaying a map when user asks

Part C: Short Answer (5 pts each)

Answer each question in 2–4 sentences. Use diagrams or equations if needed.

1. Explain how Time of Arrival (TOA) and Time Difference of Arrival (TDOA) differ in localization.

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Time of Arrival measures the time/latency between the sensor and node (sync required). Time Difference of Arrival measures the difference between the sensor and two seperate nodes

2. Describe the role of the `SensorEventListener` in Android's sensor framework.

Similar to a listener node that listens to data from a sensor. Receives all data sensor gets so app can use

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3. List three main types of GPS error sources and how can Differential GPS mitigate them?

1) bouncing from terrain like trees and building

2) GPS clock sync timings

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Differential GPS uses a nearby node and calculates the difference between the device and the GPS to get more precise locations.

4. List two major differences between range-based and range-free localization algorithms.

Range-based localization algorithms use algorithms such as fingerprinting to determine where a user is in a building by the connection to the wifi.

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Range-free uses algorithms such as centralized to get the range/center of 3 nodes to determine location

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5. Briefly describe how K-Means and DBSCAN clustering differ in detecting Points of Interest.

DBSCAN scans for nodes/radius to determine a location using signal strength

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6. What is semantic location, and how does it improve user experience compared to GPS coordinates?

Locating via connections, signal strength, and latency to be more precise than GPS.

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It improves a user experience because it can detect where a user is in their home.

7. Define the three levels of context-aware interaction (personalization, passive, active) with an example of each.

active: actions that happen based on context clues.
ex. do not disturb mode when driving

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passive: actions that happen based on user's approval
ex. do not disturb suggestion when driving

personalization: actions that happen by specified variables set by user
ex. do not disturb mode turns on when user is at a specified location at a specified time

8. Compare participatory and opportunistic mobile crowd sensing in terms of user effort, data quality, and scalability.

Participatory requires user effort while opportunistic doesn't.

Ex. Participatory is like telling Waze there's a cop car, while opportunistic is waze collecting your data like speed to get data for traffic.

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9. Explain why local databases (SQLite) are useful in mobile sensing apps such as fitness trackers.

To help store a user's data over time. Example: tracking a user's steps, movement, etc. in a database so the user can access their own data from any point in time.

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10. What privacy risks exist in mobile crowd sensing, and how does data perturbation help mitigate them?

The risk is we don't want people's exact work and home being exposed. Data perturbation helps because it adds noise to offset the exact locations, while still being able to provide accurate data.

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Part D: Long Answer / Application (15 pts each)

Provide detailed responses (1–2 paragraphs or diagrams).

1. **Context-Aware Travel App (15 pts)**
   You are designing a travel app that:
   - Tracks whether a user is walking, running, or driving.
   - Silently switches to "Do Not Disturb" while driving.
   - Stores travel routes locally for analysis.

   (a) Identify which sensors, APIs, and Android components you'll use.
   (b) Explain how to balance battery efficiency and accuracy.
   (c) Describe how to handle context transitions (e.g., walking → driving).

a) accelerometer, linear accel, magnometer, gyroscope (gets movement without orientation being an issue)

?

b) Make sure all services are bounded. Make sure all sensors are unbinded in on stop and on pause.

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c) If walking, use low-frequency pass filtering because high frequency is likely from random variance such as moving around in pocket.

If driving, use low-frequency pass filtering because we dont need high frequency, we are just checking to make sure user's location is moving but movement frequency is low. Turn BND on.

If running, use high-frequency pass filtering because we are measuring for just high frequency to measure step.

2. **Mobile Crowd Sensing for Air Quality (15 pts)**

Design a community air-quality app using MCS principles.

- (a) Describe sensors or external devices you'd use.
- (b) Decide if sensing should be participatory or opportunistic and justify.
- (c) Explain user incentive design and privacy protection.
- (d) Discuss local preprocessing and aggregation to save power/network use.

a) ~~air~~ -quality measuring sensor

b) opportunistic because it should collect and send data on its own

c) user's incentive is service (trading your data for a wide range of data to get most accurate results).

For privacy, making sure to add noise so people can't track anyone's specific locations (stats allows noise to still have accurate results)

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d) to save power and bandwidth, if app is open and service is available, sensor turns on and measures once and hours to ensure that battery and network bandwith are barely affected. we can also change frequency to every 30 min, 15 min, or any time that does not take too much bandwidth and battery life because the data is more accurate with more readings.