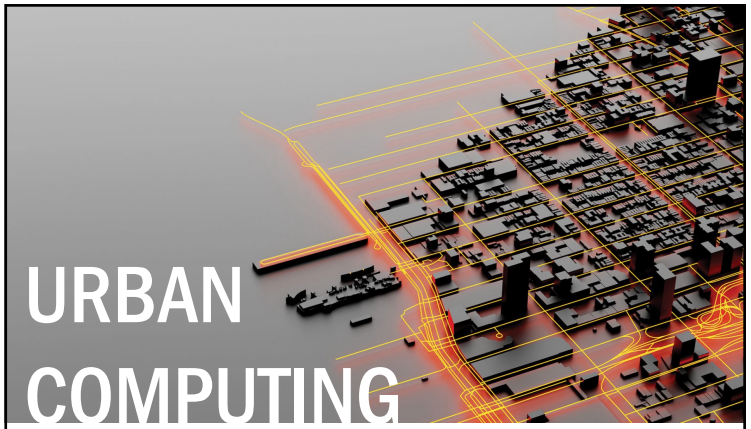

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

AI6128 Urban Computing

Course Project 1 Tutorial

A real-world case study: smartphone-based indoor localization

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Course Project 1

- Topic
  - Use a publicly available dataset to study indoor localization for smartphone
- Objective
  - Reinforce understanding on various sensors
  - Get familiar with spatio-temporal data
  - Able to pre-process and visualize spatio-temporal data
  - Understand challenges of indoor localization

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Overview of this tutorial

- 1. dataset
  - what we have?
- 2. tasks
  - what shall we do?
- 3. report
  - how to present the results?
- 4. sample code
  - How to run the sample code?

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Indoor localization Challenges

- Outdoor localization
  - ✓GPS
- Indoor localization
  - × GPS
  - ✓ Smartphone sensors

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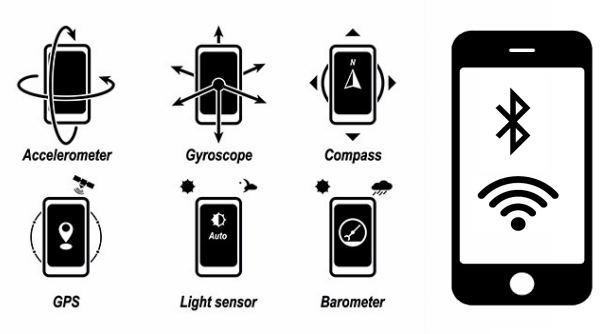
Smartphone Sensors



https://www.movisens.com/en/solutions/mobile-sensing/

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Indoor localization

raw data from one sensor or multiple sensors
(e.g., $x_{acc}(t, x_{acc}, y_{acc}, z_{acc}), x_{wifi}(t, \{ssid_1, RSSI_1\}, \{ssid_2, RSSI_2\}, \dots), \dots$)

↓

data preprocessing

↓ input data (e.g., $x(x_{acc}, y_{acc}, z_{acc}, \{ssid_2, RSSI_2\})$)

indoor localization model

↓ predict

location (x, y, z)

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Training process

raw data from multiple sensors
(e.g., $x_{acc}(t, x_{acc}, y_{acc}, z_{acc})$, $x_{wifi}(t, \{ssid_1, RSSI_1\}, \{ssid_2, RSSI_2\}, \dots)$, ...)

ground truth data recorded by volunteers
(t, x, y)

↓

data preprocessing

↓

training data
$x(x_{acc}, y_{acc}, z_{acc}, \{ssid_2, RSSI_2\}, \dots.), y(x_{gt}, y_{gt})$

↓ train

indoor localization model

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Dataset

- Sample data of Microsoft Indoor Location Competition 2.0 (https://github.com/location-competition/indoor-location-competition-20)
- Data collected by a smartphone in two multi-story commercial buildings

Site 1 has 5 floors

Site 2 has 9 floors.

Sensor data from Android

- TYPE_ACCELEROMETER
- TYPE_GYROSCOPE
- TYPE_ROTATION_VECTOR
- TYPE_MAGNETIC_FIELD
- TYPE_MAGNETIC_FIELD_UNCALIBRATED
- TYPE_GYROSCOPE_UNCALIBRATED
- TYPE_ACCELEROMETER_UNCALIBRATED
- TYPE_WIFI
- TYPE_BEACON
- TYPE_WAYPOINT: ground truth location labeled by the surveyor
- **Details can be found in https://developer.android.com/reference/android/hardware/Sensor**

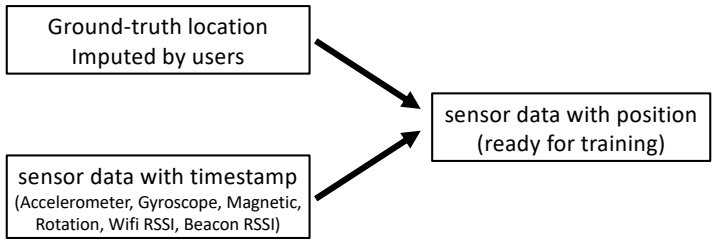
Sensor data from Android

- Raw data explanation

Essential tasks (100%)

- Visualize way points (ground-truth locations)
- Visualize geomagnetic heat map
- Visualize RSS heat maps of 3 Wi-Fi APs
- Requirements
  - You can choose any programming language
  - While you can refer to the sample code in Python, write your own code to pre-process the data and use a basic plotting tool (e.g., matplotlib) to visualize data
  - No need to superimpose your visualization onto map
  - 2-person group to cover 2 essential tasks
  - 3-person group to cover 3 essential tasks

Data preprocessing



Visualization

- Various plotting packages
  - E.g., Matplotlib for Python codes

Bonus tasks

- Build a deep learning-based location fingerprint model
- Study the performance improvement brought by multi-modal machine learning
- Study the performance improvement brought by integrating temporal relationship via SLAM
- Any other you can claim

Project 1 Report

- Format
  - Use IEEE A4-size two-column conference templates https://www.ieee.org/conferences/publishing/templates.html
  - Don't change page margins and font sizes
- Submit the writeup in PDF format
  - To tanrui@ntu.edu.sg by the end of **Week 9 (Oct 18th)**
  - If no acknowledgement is received within 3 days, resend and contact Dr. Rui Tan via Microsoft Teams
- One-week grace period for late submissions
  - No penalty if a valid excuse provided; otherwise, a penalty of 20% reduction will be applied to the mark of the late submission
  - Zero mark for submissions after the grace period
- Policy on plagiarism
  - Write by yourselves based on your own understanding
  - We will use a tool to check submissions against databases
  - Obvious plagiarism cases will have zero scores

Suggested Project 1 Report Content

- Section 1: Introduction (0.5 page)
- Section 2: Dataset (0.5 page)
- Section 3: Essential tasks (1 page each)
  - Subsection 3.1: Visualization of waypoints
  - …
- Section 4 (optional): Bonus tasks (1 page each)
- Section 5: Group member contributions (within 1 page)
- Appendix: source code

Introduction:

- Essential parts to be covered:
  - What topic is this report about?
  - What are the challenges/problems to be solved?
  - A brief introduction of used approaches
  - A short presentation of the results.
- Things to be noted:
  - An overview of the whole report.
  - The text shall be super concise and contain no technical details.
  - Can be understood by a non-technical reader.

For each task

- Approach description:
  - Contain enough details so that others can reproduce.
- Result presentation:
  - Each figure/result shall be:
    - a) described *(what do the points/lines mean?);*
    - b) explained *(why does it look like this? Possible reasons?)*

Project 1 Assessment

- Purely based on report
- Overall achievement and quality (70%)
  - Coverage of essential tasks
  - Pre-processing result quality
  - Depth of discussion on the results (e.g., what challenges experienced, **how they are addressed or why they cannot be addressed, etc**)
- Individual contribution (30%)

Extracurricular Activity

- Very successful groups may consider to participate in Microsoft's Indoor Location Competition 2.0 on Kaggle https://www.kaggle.com/c/xyz10test/overview

Sample code

- Prerequisites:
  - Python 3
  - Required python packages: numpy, scipy, dataclasses, plotly, pillow.
- Run sample code on your own computer:

  pip3 install wheel
  pip3 install numpy scipy dataclasses plotly pillow
- Run sample code on Google Colab (cloud):

  https://colab.research.google.com/drive/1BlBKe_CL7FRG7eWVcySoFsDuNct93yTU?usp=sharing