

# URBAN COMPUTING

Image credit: The Linux Foundation

# AI6128 Urban Computing

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## Course Logistics

# Contents

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- Course Logistics
  - Instructors
  - Lectures
  - Quizzes
  - Literature review assignment
  - Course projects
  - Timeline

# Instructors

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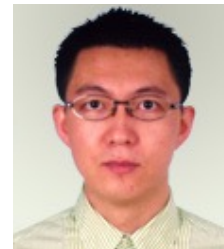
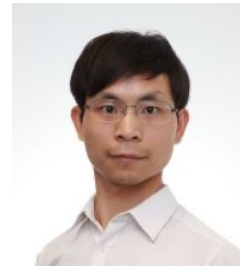
- Part 1

- Dr. TAN Rui  
[tanrui@ntu.edu.sg](mailto:tanrui@ntu.edu.sg)  
N4-02C-85



- Part 2

- Dr. LONG Cheng  
[c.long@ntu.edu.sg](mailto:c.long@ntu.edu.sg)  
N4-02C-117a
- Dr. CONG Gao  
guest lecturer (2 lectures)



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# Lecture-based Learning

# Lectures

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- Time/Location
  - Saturday, 2.30pm-5.30pm, live online at Zoom
  - 3 hours per week
    - 2.5 hours lecture, 0.5 hour consultation/discussion
- Two parts
  - Part 1 (Urban IoT): Week 1-6
  - E-learning (Advanced topics): Week 7
  - Part 2 (Urban data analytics): Week 8-13
- Course materials (enough for completing this course)
  - Lecture notes
  - Pre-selected research papers for literature review assignment
  - Course project manual

# References

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- For extended knowledge and scope
  - Wireless Sensor Networks: An Information Processing Approach, by Feng Zhao and Leonidas J. Guibas, Morgan Kaufmann Press  
Online e-book (NTU login required):  
<https://www.sciencedirect.com/remotexs.ntu.edu.sg/book/9781558609143/wireless-sensor-networks>
  - Urban Computing, by Yu Zheng, MIT Press  
(available at NTU library)

# Part 1: Urban IoT

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- **Introduction to urban IoT**
  - What is urban computing?
  - IoT applications
  - IoT architecture
- **Urban sensing**
  - Sensor and facility deployment
  - Data acquisition
  - Communication infrastructures
- **Localization and time acquisition**
  - GPS
  - Indoor localization
  - Indoor time acquisition
- **Cloud computing support**
  - Concepts, mechanisms, architecture
  - Virtualization, SaaS, PaaS, IaaS
  - Prevalent clouds



# Part 2: Urban Data Analytics

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- **Urban data management**
  - Spatial data indexing and querying
  - Spatio-temporal data indexing and querying
- **Urban data analytics**
  - Spatial data mining
  - Spatio-temporal data mining
  - Deep learning on spatial and spatio-temporal data

# Overall Assessment

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- Weightage
  - Two course projects: 50% (25% each)
  - Two quizzes: 20% (10% each)
  - Literature review: 30%
  - No final exam

# Quizzes

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- Quiz 1
  - Open book
  - Any 20 minutes during Week 5 lecture
  - Coverage: Contents in Week 1, 2, 3, 4
  - Make-up: Any 20 minutes during Week 6 lecture
- Quiz 2
  - Closed book
  - Any 20 minutes during Week 12 lecture
  - Coverage: Contents in Week 8, 9, 10, 11
  - Make-up: Exam Week 1
- Policy on make-up quizzes
  - For students who miss the quiz without a valid excuse, a penalty of 20% reduction will be applied to the make-up quiz score

# E-Learning: Advanced Topics

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- Edge computing
- Urban computing in industry

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# Group-based Self-learning and Hands-on Activities

# Student Groups

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- For both literature review assignment and course projects
- Group assignment will be generated on August 20<sup>th</sup> (i.e., after course add/drop period)
  - Based on index number in NTULearn
  - 2~4 students each group
  - Check your group assignment in NTULearn in Week 3
  - Liaise with your group mates in Week 3
  - Change of group assignment is not advisable, unless there are special reasons

# Literature Review Assignment

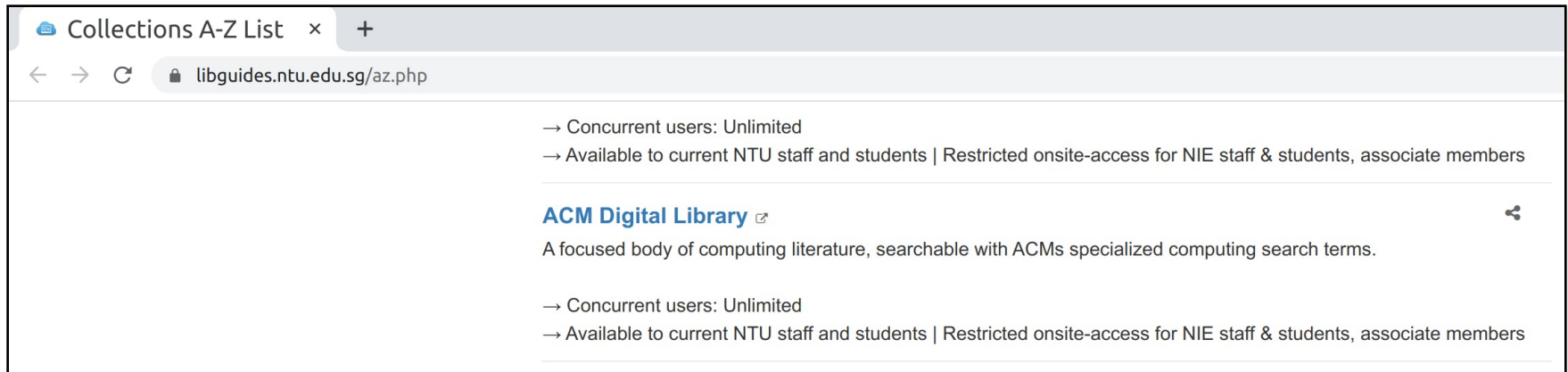
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- 18 topics
  - Each group will select a topic exclusively
  - Each topic has 4 pre-selected papers
- Use a Google Form to select your group's topic after knowing your group in Week 3
  - Each group designates one member to use the form to submit selection
  - Each group can only submit once!
  - Topics that have been selected by other groups are not shown on the form
  - Although selections are exclusive, no need to hurry because we have abundant topics
  - Google Form address announced in Week 3, submit the selection by end of **Week 4**
- Minimum reading requirement
  - Each student in a group should read **at least 2 papers** related to the selected topic, with at least 1 paper from the pre-selected papers
  - Students in a group should read different sets of papers

# How to Access a Research Paper?

- Most computer science/engineering papers can be found from three databases
  - ACM Digital Library, IEEE Xplore, ScienceDirect

Step 1: Visit <https://libguides.ntu.edu.sg/az.php> and find the database





# How to Access a Research Paper? (cont'd)

Step 2: Login using your NTU account and agree the terms of use.

**NTU Login to remotexs.ntu.edu.sg**

**Username**

**Password**

**Login**

**NTU Library**

**E-Resources: Terms of Use**

- E-Resources subscribed by the Library is governed by strict licence agreements between the Library and publishers / vendors.
- These licence agreements are legal binding contracts that allow staff, students and other authorised users to access the resources for noncommercial, educational, scholarly and research purposes.
- In general, the licence agreements prohibit:
  1. Large-scale or systematic downloading of single or multiple copies of abstracts, tables of contents or fulltext documents in print or electronic copies, for example, downloading the entire issue of an e-journal.
  2. Utilisation of software programmes or routines designed to continuously and automatically search and index the resources, such as spiders, web-crawlers and robots.
  3. Alter, amend, modify, abridge, translate or change in any manner the licenced materials.
  4. Sales and exploitation of licenced materials for any commercial purposes.
  5. Publication, distribution, mount on any electronic network, or retaining portions of licenced materials or combining them with any other material.
  6. Distribution to any unauthorised user.
- Please refer to individual licence agreement provided by publishers / vendors websites for full description on the conditions of use.
- You may send an [Online Enquiry Form](#) or call 6790 5776 for clarification or assistance.

☐ I agree and understand that any excessive downloading will lead to suspension of my access to e-resources. \*

Step 3: Use the database's search function to look for the paper. You can enter the title of the paper to do the search.

# Group-based Presentation

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- Week 13
  - Presentation time will be allocated proportional to group size
- Suggested format
  - Introduction by a lead presenter
    - Background of the topic
    - What the topic is about?
    - Significance (why it is important?)
  - Presentation of each reviewed paper
    - What problem addressed
    - Why the problem addressed is important
    - How the problem is addressed
    - How the experiments are conducted
    - What results are obtained
    - What limitations the paper has
    - How to address these limitations if you will do further research

# Literature Review Assessment

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- Purely based on the presentation
- Assessment criteria
  - Introduction (group's common score)
  - Each paper review (individual's score)
  - Extra paper review (individual's variable bonus)

# Course Projects

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- Two course projects
- A report is required for each project
  - Two reports to be submitted

# Course Project 1

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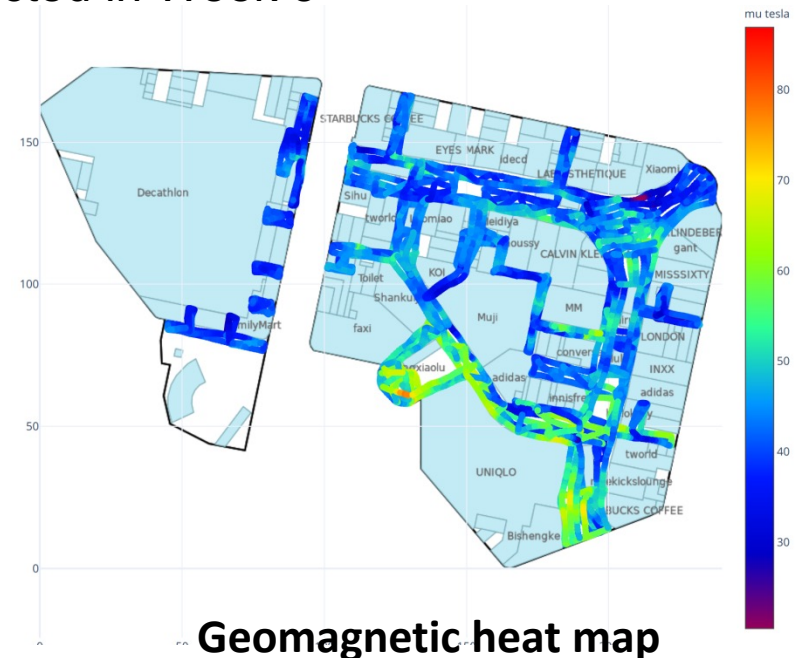
- Topic
  - Use a publicly available dataset to study indoor localization for smartphone
- Objective
  - Reinforce understanding on various sensors
  - Get familiar with spatio-temporal data
  - Able to pre-process and visualize spatio-temporal data
  - Understand challenges of indoor localization

# Course Project 1 (cont'd)

- 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 multistorey commercial buildings
  - A 1-hour tutorial class will be conducted in Week 5



Footsteps detected based on inertial sensors



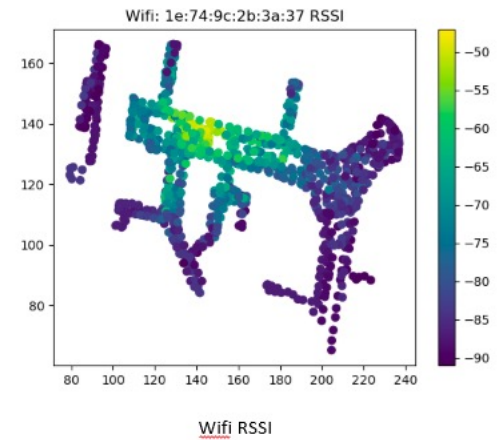
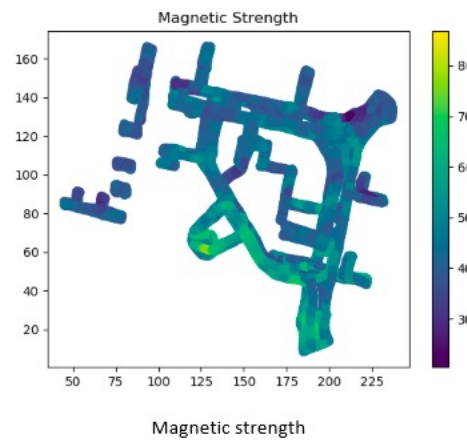
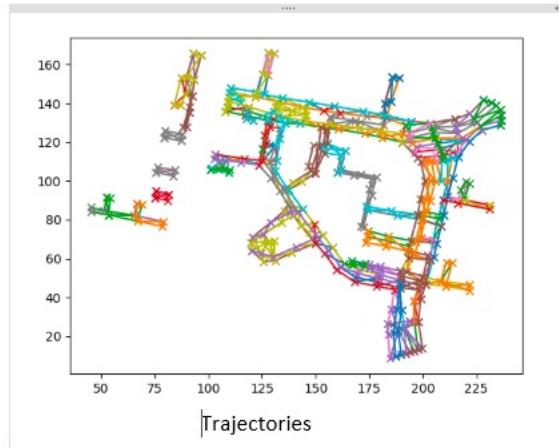
Geomagnetic heat map

# Course Project 1 (cont'd)

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- 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

# Sample Completion





# Course Project 1 (cont'd)

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- 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

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- 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](mailto:tanrui@ntu.edu.sg) by the end of **Week 9 (Oct 17th)**
  - 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

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- 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

# Project 1 Assessment

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- 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

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

# Course Project 2

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- To be announced by Part 2 instructor shortly

# Timeline

Week	Lecture Progress		Assessment and related activities
Week 1	Part 1: Urban IoT	Introduction	
Week 2		Introduction, sensing	
Week 3		Sensing	Check group assignment, liaise with group mates
Week 4		Localization	Literature review topic selection due
Week 5		Localization + tutorial	<b>Quiz 1 (10%)</b>
Week 6		Cloud computing	Quiz 1 make-up
Week 7 (E-learning)	Offline: Advanced topics		
Recess week	No lecture		
Week 8	Part 2: Urban data analytics		
Week 9			<b>Submission of Project 1 report (25%)</b>
Week 10			
Week 11			
Week 12			<b>Quiz 2 (10%)</b>
Week 13	<b>Literature review presentation (30%)</b>		
Exam Week 1	No lecture		<b>Submission of Project 2 report (25%);</b> Quiz 2 make-up;

# Clicker

- A few questions at the end of each week
- Questions are not scored
- They are used for you (and me also) to check your level of understanding
- Wooclap: Web-based response system
  - Scan a QR code to participate
  - No authentication

The Wooclap logo consists of the word "wooclap" in a white, lowercase, sans-serif font, centered within a solid blue rectangular background.