

GE2215 Introduction to GIS

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Week 1

Introduction to the Course and GIS

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Outline of this lecture

- Self Introduction
- Introduction to the Course
- Introduction to GIS



About Myself

- Lecturer & Director, Taught Graduate/Continuing Education and Training programmes in Applied GIS, Department of Geography, National University of Singapore
- Email: <u>yingwei.yan@nus.edu.sg</u>
- Research Interests:
 - Volunteered geographic information
 - Crowdsourcing
 - Data quality
 - Computational social science





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Outline of this lecture

- Self Introduction
- Introduction to the Course
- Introduction to GIS



Introduction to this Course

- Course Description
- Components
- Syllabus and Schedule
- Assessment
- Reading List
- Policies



Course Description

• This course covers the development and basic principles of Geographic Information Systems (GIS), and practical experience in the use of these systems



Course Description

• This course is designed as "learning through practicing", so a large emphasis is placed on practical GIS laboratory exercises.

• This course is designed for students throughout NUS with interests in GIS applications in environmental sciences, social sciences, regional planning, real estate, engineering, and business analysis.



Course Description

- This course aims to introduce students the fundamental concepts and components of Geographic Information Systems (GIS).
 - Fundamental concepts covered include spatial data models, data quality, cartographic principles, and spatial analysis (not limited to these aspects).



• It is one of the fundamental courses of the GIS Minor Programme.



Components: Lectures

• Lecture Sessions

Lecture 1: Introduction to GIS
Lecture 2: GIS Data Model – Vector Data Model
Lecture 3: GIS Data Model – Raster Data Model
Lecture 4: GIS Data Visualization and Spatial Representation
Lecture 5: Spatial Reference and Coordinate Systems
Lecture 6: Geometric Transformation

Syllabus is subject to changes. Please check Canvas for weekly activities and the latest updates



Components: Lectures

• Lecture Sessions

Lecture 7: Spatial Data Quality and Spatial Data Editing
Lecture 8: Spatial Database and Attribute Data Management
Lecture 9: Vector Data Analysis
Lecture 10: Raster Data Analysis
Lecture 11: Spatial Statistics
Lecture 12: TBA/Course Conclusion and Q&A

The lecture material will be uploaded to Canvas before each lecture session



Components: Lab

Lab exercises (starting from Week 3)
Lab 1: Introduction to ArcGIS Pro
Lab 2: Geo-visualization
Lab 3: Geometric Transformation
Lab 4: Geodatabase Development and Spatial Editing
Lab 5: Vector Analysis and Raster Analysis Functions



- Please contact Dr. Benny Chin Wei Chien wcchin@nus.edu.sg for ArcGIS Pro licenses (after week 1).
- GIS exercises (with an individual marked assignment) will be assigned for each lab.

The Lab material will be uploaded to Canvas before each lab session



• Multiple Choice Questions + Written questions (closed book)



Syllabus and Schedule

- Lecture Venue: LT10
- Lecture Time: Every week, Monday 10am-12n
- Lab Venue: GIS Lab (AS2 #03-13)
- Lab Time: Odd weeks (1 hour 35 mins for each group),
 - Monday: L1(4-6pm)
 - Tuesday: L2(10am-12n); L3(2-4pm); L4(4-6pm)



Syllabus and Schedule

Refer Canvas

Syllabus is subject to changes. Please check Canvas for weekly activities and the latest updates



- The Assessment includes "Participation", "Lab" and "Final Exam"
 - The "Participation" assessment task is worth 10% and will be based on the level of attendance
 - The "Lab" assessment tasks will comprise four lab exercises and assignments (60% in total)
 - The "Final Exam" assessment is worth 30%



• Chang, K.-T. (2018). *Introduction to Geographic Information Systems* (9th Edition). McGraw-Hill Education.





Introduction to geographic information systems by <u>Chang, Kang-tsung</u>

2016, Eighth edition.

Book AVAILABLE, G70.212 Cha 2016, Yale-NUS College Library Books +1 More ~



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• McHaffie, P., Hwang, S., & Follett, C. (2023). *GIS: an introduction to mapping technologies*. CRC Press.

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Book

An Introduction to Mapping Technologies, Second Edition

By Patrick McHaffie, Sungsoon Hwang, Cassie Follett



| Edition | 2nd Edition |
|-----------------|--|
| First Published | 2023 |
| eBook Published | 29 May 2023 |
| Pub. Location | Boca Raton |
| Imprint | CRC Press |
| DOI | <u>https://doi- org.libproxy1.nus.edu.sg/10.1201/9781003307181</u> |
| Pages | 316 |
| eBook ISBN | 9781003307181 |
| Subjects | Built Environment, Earth Sciences, Engineering & Technology, Environment and Sustainability, Geography, Social Sciences, Urban Studies |

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- Longley, P. A., Goodchild, M. F., Maquire, D. J., & Rhind, D. W. (2015). *Geographic Information Science and Systems (4th Edition)*. John Wiley & Sons Inc.
- Others:
 - GIS Geography
 - **GIS Dictionary**
 - Esri Academy
 - Geography Realm
 - ArcGIS Pro quick-start tutorials
 - Introducing ArcGIS Pro
 - <u>History of GIS</u>
 - **QGIS** Tutorials
 - Refer to Canvas for more throughout the semester





- The lab assignments that you submit must be your OWN work. Copying others' files for submission is forbidden. See here for NUS Code of Student Conduct
 - (https://studentconduct.nus.edu.sg/administrative-policies/).



Rules on plagiarism



- The University takes a serious view of plagiarism.
- The URL here (<u>https://libguides.nus.edu.sg/new2nus/acadintegrity#s-lib-ctab-22144949</u>) includes (refer to the different tabs):
 - Guidelines to avoid plagiarism
 - Library E-Resources Usage
 - Copyright and Open Content
 - AI Tools: General Message to Students
 - AI Tools: Guidelines on Use in Academic Works
 - If you have general queries on any of these guidelines, please contact <u>askalib@nus.edu.sg</u>
 - If you have any doubts about how they may apply to your course, please seek clarification with your course instructor or supervisor



- Late submission of assignments will receive a mark deduction. No submission will be accepted seven days after the due day. You are responsible for submitting the final correct file Canvas. Submission of wrong files will NOT be accepted as an excuse for a late submission.
- If there is any question regarding the marks that you receive for your lab assignment, please speak to the lecturer in charge and your TAs. This must be done within one week after the assignment is returned to you.
- Please check your NUS email regularly for any update regarding the course.



- Please follow the GIS Lab usage rules. There is absolutely NO food and drinks in the GIS lab, except for bottled water. Violation will result in access suspension.
- We will consider requests for absence (before lab/lecture) or extensions (before due date) due to special circumstances on a case-by-case basis, but please do not count on such requests for granted.



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Introduction to GIS

- What is Geographic Information System (GIS)?
- Components of GIS
- Capabilities of GIS
- Applications and prospects of GIS

GIS Is Being Applied Around the World

Across Many Disciplines, Professions, and Organizations

Why study GIS?



Becoming an Instrument of Evolution

Source: Esri

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Information

What is Geographic Information System (GIS)?

GIS is focused on location-based information

Information is the expression of events, things and phenomenon by means of texts, numbers, symbols, languages and pictures. It is the reflection of features of things in the objective world.



Texts, numbers, symbols, languages, pictures...

Expression and reflection of events and phenomena.

Decision basis of production, construction, operation and

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Earth's rotation and

revolution

Characteristics of Information

• It reflects the status and mode of objects

• It can adjust to different application situations







Sharing



Apply to different situations

• Can be transmitted in various ways





Transmitted via network • Has the feature of spreading

Information sharing

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Geographic Information

Difference between General Info and Geographic Info: Geographic info contains location information (lat-long coord.)

Attribute features

Geographic Information is the general term that represents various elements of **geographic** system such as **quantity**, **quality**, **distribution features**, **interrelationships**, and **changing rules**, and is carried by **texts**, **numbers**, **images**

and graphs.





Geographic phenomenon







Distribution features

| 60 - 50 - 40 - 30 - | * | 1 | 4 | × | ~ | + | 1 | ^ | b - | 7 | \checkmark | / |
|------------------------------|------|------|------|------|------|------|------|------|------------|------|--------------|------|
| 20 - | | | | | | | | | | | | |
| 10 - | | | | | | | | | | | | |
| 0 - | | | | | | | | | | | , | |
| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2003 | 2000 |
| | | | | | | | | | | | | |

Temporal features



Spatial-temporal patterns

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Characteristics of Geographic Information

Large data volume Geographic information has spatial features, attribute features and versions at different times, thus resulting in large data volume

Uneven distribution

Densely distributed in some areas, while sparsely distributed in other areas.





Complexed topological relations • Some complexed spatial relations are needed to be represented, e.g., the representation of urban overpass



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Characteristics of Geographic Information

Multiattribute

• The same phenomenon could have multiple attribute features. Geographical phenomenon may overlap. There can be building data, human activity data, etc. (multiple layers of

Multi-scale

 Representations of geographical data may vary at multiple scales
 At street level scale vs country level scale (E.g. MRT station locations)

Multi-source

• Paper map, measured data, test data, remote sensing data...



data)



Reflected by shape, direction, color, texture

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Geographic Information System (GIS) is based on the spatial database, and adopts geographic analysis models to implement the collection, storage, retrieval, analysis, display, forecast, and update of **geographic information**




What is Geographic Information System (GIS)?





Introduction to GIS

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Hardware

Hardware includes computer systems (server, workstation, PC), GPS receiver, digitizer, scanner, printer, plotting instrument, etc.

Server

Workstation







- Computers that are used for managing resources and offering service to client terminals. They are expected to have high **stability**, **security** and **performance**
- High-class **microcomputers**. They are expected to have high performance in **graphic processing** and **parallel processing**
- Small portable personal computers, e.g., iPad, Surface



82.03648

Hardware

Input Devices

....

GPS receiver

Output Devices



Digitizer

Printer



Scanner



Plotting instrument



Software

GIS software includes source code and user interfaces



Source can be written by C++, Python, Java and other programming languages to implement various GIS functions.



User interfaces include menu, icons, command lines and scripts





Some popular GIS software





GIS workload ratio: Hardware: Software: Data = 1:2:7





The key function of GIS is to integrate **spatial data** with **other data** for comprehensive applications



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People

Academic researcher

- Focus on basic theories and methodologies of GIS

Project manager

- Need to coordinate on project developing procedures





Responsible for GIS
data processing

Software designer



• Need to work out solutions based on user requirements

System developer



Responsible for programing implementation



Which career path do you like most?



Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**



Infrastructure

It is the physical, organizational, administrative and cultural environment that is required for the maintenance of GIS system

Work environment



Enterprise culture





Relevant laws and regulations



Data standards



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Data collection

Data collection is to convert original geographic entities or materials into **digital forms that can be processed by computers**, and guarantee data in the GIS database being **complete** in contents and spatial forms and **consistent** in logic



Different kinds of data collections



Data processing



Modify the coordinate systems

Data transformation





Vector data

Raster data

Format transformation



Vector data











Raster data







Data storage

Point

Polyline



Geometric data storage

Polygon



Data management

| Add to formula-best | | | | | | | | | | | |
|---------------------------|---------------|-----------------|---|--------------|---|--|--|--|--|--|--|
| Attribute Auriction | Function name | Feature | Format | Return value | T | | | | | | |
| Edit function | AREA | Set bounding (| double Width, | nut | 2 | | | | | | |
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Organizing the structure of attribute data



GIS query Q \times \equiv NUS Japanese School of En Back to results veriny intro with this place Hours or services may differ due to COVID-19 Founded in 1905, an eminent Asian university with 3 campuses & 16 faculties. 21 Lower Kent Ridge Rd, Singapore 119077 NUS Scho S & Environ 7QWG+MH Singapore ... C D nus.edu.sa MYYOGA 6516 6666 Add a label Suggest an edit

Querying locations via attributes

Querying locations via spatial relations



Where are the restaurants near UTown?



GIS spatial analysis



Network analysis

- Where is the nearest restaurant from AS2? [Closest facility]
- What is the shortest path to Clementi Mall? [Best route]
- What is the response coverage for emergency vehicles in NUH? [Service area]







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Capabilities of GIS

GIS spatial analysis

Overlay analysis

Land use change from 1987 to 2007







Data visualization







Choropleth mapping

Heat map visualization

3D visualization

GIS has many different visualization methods including 3D visualization



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GIS is widely applied in many fields including land management, urban planning, transportation, environment, public health, humanity studies



Transportation Planning (Where to build a new railway?)



Fisheries and Ocean Industries



Forestry Mapping



Public Health



Meteorology

CISION AGRICCUI

SITE INFO



Disaster Management



Urban planning Sindes for education purposes only





The geographic inquiry process (from the book *Mapping Our World*, ESRI Press)



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Applications and prospects of GIS









Source: https://www.onemap.gov.sg/main/v2/



Property Boundary & **Ownership**

Property ownership, registration of land titles and deeds. Approval of property boundary survey.

> Source: https://www.sla.gov.sg/ Slides for education purposes only





Source: https://www.ura.gov.sg/maps/?service=MP















Identifying the service







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Applications and prospects of GIS













Source: <u>https://covidsitrep.moh.gov.sg/</u> (closed)

Dengue Clusters



Source: <u>https://www.nea.gov.sg/dengue-</u> zika/dengue/dengue-clusters)



Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (... Ξ Total Deaths Total Recovered **Total Confirmed** 4,368 66,216 3.046 deaths Hubei China Hubei China **Confirmed Cases by** 631 deaths Iran (Islamic Republic of) Country/Region 354 deaths China NORTH **Guangdong** China AMERICA Italy 54 deaths Republic of Korea Henan China Iran (Islamic Republic of) 47 deaths Spain **Zhejiang** China **Republic of Korea** 33 deaths **Spain** AFRICA France Hunan China 23 deaths France Washington US Anhui China Germany À M E RIC A 9 US Others Switzerland Japan Esri, FAO, NOAA Norway **Cumulative Confirmed Cases** Active Cases Mainland China Other Locations Country/Region St/Prov Lancet Inf Dis Article: Here. Mobile Version: Here. Visualization: JHU CSSE. Automation Support: Esri Living Total Recovered 118 Last Updated at (M/D/YYYY) Data sources: WHO, CDC, ECDC, NHC and DXY and local media reports. Read more in this Daily Cases 3/11/2020 8:13:05 下午 Actua Logarithmic

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Humanity study

SINGAPORE HISTORICAL GIS



Spatial Distribution of Singapore Chinese Culture/新加坡华人文化空间分布



http://shgis.nus.edu.sg/



Meteorology





Source: http://www.weather.gov.sg/climate-historical-daily/

Historical Daily Records

Records will be updated by the 10th of the month

Daily Records

Location: Changi Jan 2023

Download as:CSV PDF

| Date | Daily Rainfall Total (mm) | Highest 30-min Rainfall (mm) | Highest 60-min Rainfall (mm) | Highest 120-min Rainfall (mm) | Mean Temperature (°C) | Maximum Temperature (°C) | Minimum Temperature (°C) | Mean Wind Speed (km/h) | Max Wind Speed (km/h) |
|-------|---------------------------------|---------------------------------------|---------------------------------------|--|-----------------------------|--------------------------------|--------------------------------|------------------------------|-----------------------------|
| 1 Jan | 0.0 | 0.0 | 0.0 | 0.0 | 27.2 | 30.6 | 25.3 | 9.8 | 31.5 |
| 2 Jan | 0.0 | 0.0 | 0.0 | 0.0 | 27.4 | 31.6 | 25.1 | 11.6 | 38.9 |
| 3 Jan | 6.0 | 6.0 | 6.0 | 6.0 | 27.4 | 31.8 | 24.4 | 9.3 | 37.0 |



Disaster management





Damage assessment






What else do you think GIS can do?



- What is GIS?
 - What is information and geographic information? What are their characteristics?
- What are the basic components of GIS?
 - Five parts: hardware, software, data, people and infrastructure
- What are the capabilities of GIS?
 - Five aspects: data collection, processing and transformation, storage and management, query and spatial analysis, and visualization
- What are the applications and prospects of GIS?



THANK YOU