GEX1003 Seeing the World through Maps
AY25/26, Y3S1
Notes

Sim Ray En Ryan

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Contents

1 Topic 1: Introduction: Concepts

1.1 Definitions

1.1.1 Maps

- 2-dimensional, spatial representations of a 3-dimensional earth.
- A form of communicating & viewing of earth surface which involves a producer, medium, message & consumer.
- Graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes or events in the human world.
- Purpose:
  - **Inform:** education, wayfinding
  - **Delight:** art, decoration
  - **Inspire:** religious beliefs
  - **Project:** power & possession
- E.g. European imperial maps (1800s) display power, stake claim, identify resources, express government intentions.

1.1.2 Cartography

- Study & practice of making maps.
- Processes, procedures & protocols through which maps are created & used.

1.1.3 Epistemology

- 'Episteme' in Greek = knowledge or understanding.
- Study of how knowledge is derived; questioning the basis upon which any knowledge is derived.
- **Epistemology of Maps:** what is the basis upon which a map is produced?
- How can we know the knowledge base is accurate?
- Maps "do not represent unbiased depiction of 'reality'... convey subjective impressions of human will & intention."

1.2 Map Language: Concepts

1.2.1 Four Elements (Producer, Medium, Message, Consumer)

- **Mapmakers:** from specialists to laypersons sketching road directions (subjective knowledge?).
- **Medium:** how map information is presented e.g. cloth/napkin, stone, rock, silk, paper, computer form.
- **Message:** content & purpose of map e.g. give direction, plot journey, place description, locate phenomena, explain history, guide present & future action, claim territory, educate & decorate etc.
- **Men/Women (Consumers):** from general users/ readers to specific audiences.

1.2.2 Scale

- Relationship between distance on map (smaller surface) & corresponding distance on ground (larger surface).
- A measure of compression:
  - e.g. 1:100,000 [1cm map = 1km ground]
  - e.g. 1:30,000 [1cm map = 300m ground]
- **Large Scale Map:** lots of details, but less territory covered.
- **Small Scale Map:** less details.
- Note: Scale can be in ratio format or ruler format.

1.2.3 Projection

- Representation of a round/spherical world on a flat surface (different projections lead to different degrees of distortion).
- **(i) Mercator Projection (1569):** map to aid navigation but polar areas appear as large as equatorial zone.
- **(ii) James Gall Projection (1871):** focus on size of land mass but shape may be distorted.
- **(iii) Goode Projection (1923):** aka 'orange peel map', focuses on land area & sinuous meridians.

1.2.4 Orientation

- Directionality of map (What's on top & what's at the base? What is at the centre?).

- In a spherical (round) world, there is no reason why north needs to be on top, or Europe/North America need to be centre.
- 'Normal/expected' orientation = 'True North' (i.e. location of North Pole) at the top of map.
- **'Counter Mapping' (Alternatives):**
  - Early Islamic maps with South orientation.
  - Medieval maps (400-1400) orientated towards Jerusalem with an East orientation.
  - Contemporary Upside Down maps e.g. souvenir maps in Southern hemisphere (Australia, New Zealand).

1.2.5 Symbols

- Graphical representations of things in the world, as captured on maps (usually collated in a 'Legend').
- Expressed as dots, lines, circle, different-sized/ coloured/numbered objects or pictorial.
- **Plan View:**
  - Looks straight down onto surface.
  - Standard symbols, serious & professional-looking.
- **Panoramic or Bird's Eye View:**
  - Captures heights of features.
  - Whimsical pictorial symbols, informal & fun-looking.

1.2.6 Grid

- System of vertical & horizontal lines on maps that organise how we see & represent space: longitudes (V) & latitudes (H).
- **Function:** precise pin-pointing of location [Singapore at 1'18' N. latitude & 103'51'E. longitude].

1.2.7 LOSS Acronym

- **L**egend, **O**rientation, **S**cale, **S**ymbols.
- Are they always present in maps?
- Will you be lost if they are absent in maps?

2 Topic 2: The First Maps: History

2.1 Maps from the Rock Ages

- Oldest maps: 40,000 years old rock maps.
- Hunter & Gatherer maps: 30-40,000 years ago (Southern Africa).
- **Medium:** Rock surfaces (ground & caves), wooden boards, paddles, canoe seats, body & skin.
- **Types of Maps:**
  - **Topographical:** land surfaces & earth features.
  - **Celestial:** heavens & gods.
  - **Cosmological:** universe stars.
- **Needs:**
  - **Religious:** acts of supplication because the gods lived in hills, rivers, forests etc.
  - **Practical:** reveal location of food, hunting grounds, migrating animals – maps as "important sources of spatial knowledge".
- **Challenges in Interpreting Rock Maps:**
  - (a) Lack of legend, orientation, scale, symbols [LOSS].
  - (b) Lack of knowledge of religious meanings.
  - (c) Dates are only estimates.
  - (d) Are they even maps? (decorations, worship?).
  - (e) Not portable (how to carry a rock around?).

2.2 Indigenous Cartographies

- Native people's spatial knowledge expressed in the form of maps.
- **Examples:** Australia's Aborigines; Malaysia's Orang Asli; America's Native Indians; British Columbia's 'Beaver' people.
- Hunters & gatherers make use of maps to plan land use, chart travel routes, express creation beliefs & views of the universe.
- **E.g. 1 Aborigine (Australia):** Aboriginal maps serve as medium for 'Dreamtime' stories & histories of creation, evolution, how to survive, culture, universe etc.
- **Power of Indigenous Maps: Land Claims**

  - 1976: recognition of Aborigine land claims/rights.
  - 1991: Australia High Court ruled that "native titles" (land ownership titles & maps) are legitimate & can be used to assert claims on territory.

2.3 History of Mapping: 6 Phases (Kitchin et al. 2011)

2.3.1 Renaissance (1300-1600 Europe)

- Between Middle Ages & Modern Era.
- Application of enlightenment to cartography: rationality, objectivity, functionality.
- Universal system of measuring distance: comparable across peoples & places, and invention of compass, telescope etc.
- **E.g. Mercator's Projection (1569);** concept of 'Atlas' by Mercator (1595).

2.3.2 Cartography as Science (17th C)

- Established principles in surveying & map design e.g. triangulation / trigonometry to determine location & height of features.
- **Positivism principles:** knowledge system based on only that which can be scientifically proven.
- Emphasis on objectivism & calculability.
- **Danger 1:** Role of human elements & subjectivity in map-making obscured (human oversight, ignorance, biases).
- **Danger 2:** Role of 'society' & 'politics' hidden (Power, money, conquest, ego of leaders).

2.3.3 Communications Model Approach (1930s)

- Maps as "communication devices": readers must be able to intuitively interpret them.
- Research design techniques:
  - influence of Psychology & Information Theory.
  - how best to select information & symbolize.
  - how to combine different map elements, colours, distances etc.
- **'Cognitive Mapping' (Topic 5):** behavioural geographers & cognitive scientists researching on mental maps (1970s).

2.3.4 Semiology Approach (1960s)

- **Semiology:** study of signs & symbols (late 1960s France).
- **Carto-semiotics:** signs, symbols & design, but also circumstances of map design (contexts & mapmaker's character).
- Recognition of social & cultural aspects of mapping.

2.3.5 Social Construction Perspective (late 1980s)

- Maps as social constructions by humans & human agencies: subjective versions of reality (Brian Harley, 1989).
- Seeds of 'critical cartography'.
- **Persuasive cartography:** propaganda maps in economic & political development of nations (especially during wartimes).
- **Subjectivity in Map Making:**
  - Deliberate inclusion & exclusion.
  - Ideological framing e.g. Japanese forces as friends, Western forces as evil.
- Maps must not be seen as 'mirrors of world'.
- **'Epistemological deconstruction' of maps:**
  - Deconstruct knowledge source: who is map-maker & what is their hidden agenda?
  - Agenda: political & economic?

2.3.6 Post-Representational Approach (2000s)

- **'Representational' approach** = what maps represent & mean [surface study of maps].
- **'Post-representational' approach** = how maps work & their effects on people [deeper study].
- If a place is not-mapped ("bounding practice") not 'territory' not meaningful/useful to humans.
- Maps activate territories source of conflicts, battles, disagreements e.g. China vs SE Asia; Malaysia vs Singapore.

2.4 Mapping Early Singapore

- Historical maps tell us new things about a place we think we know so well.

- studying 1500s-1819 maps of Singapore alternative histories & names emerge.
- **16th Century:** Portuguese-explorer maps (Cantino Planishere, 1502) depicted Malaysia & Indonesia, based on local inputs, calling an island "Bargungapura" & "Garsyn Gapara".
- Arabic & Turkish sources: "Bar" = "Coast" & "Sin, Xin" = "China".
- "Bar-Xin" = Coast of China (or South China Sea).
- "Gapara" = "Gopara" (Sanskrit) & "Gapura" (Javanese) = "Gate".
- **Alternative Meanings to 'Singapore'**
  - (a) "Sin-Gapura" means "gateway to China" & not "Singa-Pura" (or "Lion City" in Sanskrit).
  - (b) Portuguese translation: "wrong, tricky, difficult place to interrupt one's voyage".
- **Dispelling of Myths**
  - (a) Singapore was never called 'Temasek'.
  - (b) 'Lion City' (from Malay Classic Literature) is just one name. More frequent is 'Xin-Gapura' (Gateway to China).

3 Topic 3: Maps of Power: Politics

3.1 Introduction: Maps as Political Tools

- Exertions of political might/power: military, artillery, conquests etc.
- **Maps as Political Weapons:** governments religiously map territories under their claim based on the belief that 'to map is to claim a territory'.
- **Knowledge is Power:** maps as knowledge about place & people (hence, power over places/people).
- **Examples:** South China Sea (contesting maps over space) & Indonesian UNESCO heritage sites (use of local language on maps).
- Mapping colonized territories:
  - to map/know space is to claim space.
  - to zone space is to control people.
  - to map is to contest others' claims of space (and their maps).

3.2 British Colonial Maps

3.2.1 America (1606 on)

- **Contesting colonial maps:**
- **French maps (1534 - early 1800s):**
  - maximized interior America as 'New France'.
  - minimized British presence east coast.
- **British maps (1606-1775):**
  - East coast titled 'New Britain' (Moll).
  - Atlantic Ocean labelled 'Sea of British Empire' (Moll).
  - British land claims extended to extreme west (Mitchell).
- **John Mitchell's map (1755):**
  - Used throughout 1800s & considered "most important map in US history".
  - Used to settle border disputes between Britain, France, Spain, America.
  - Establish boundaries for 13 colonies to form USA (4 July 1776) & final negotiations in Treaty of Paris (1782/83).

3.2.2 Australia (1779 on)

- Background: Captain Cook's arrival in Botany Bay & claimed it for Britain (1770).
- First official colony called 'New South Wales' (1788; a convict colony).
- **Map by convict F. Fowkes (c. 1788):**
  - map depicts a giant fish swallowing people – fearsome experience.
- **Maps as enticements** for citizens to migrate to 'unknown lands':
  - new lands for sheep & cattle farming.
  - opening new spaces to migrants.

3.2.3 India (1858 on)

- British colonial rule (1858-1947) & reliance on British East India Company (EIC) (1600-1874).
- EIC as funder of maps (from 1700s): need for accurate information on land, resources, people.
- Bengal Atlas (1779) with information on Ganges River & Bengal area.

- Central India mapped in a **Trigonometrical Survey (1837, by George Everest)**.
- Northern survey maps used trigonometry to identify height of **'Peak XV' (1852, named Mt. Everest in 1865)**.

3.3 Southeast Asian Maps

3.3.1 General

- Colonial companies produced maps to reflect land ownership, trade routes, company rule & for exploratory reasons (e.g. EIC).
- British governors created land use maps to plan cities, zone activities & control people (e.g. SG).
- **Ironical situation:** colonialists commissioned locals to create maps (locally-derived knowledge used to control/zone locals).

3.3.2 Singapore (1819 onwards)

- Politics of maps in Singapore: 2 Examples
- **(i) Jackson Plan (1822):**
  - Singapore post-1819: haphazard development under W. Farquhar.
  - Oct 1822: Raffles formed a town committee led by Lt. Peter Jackson (engineer & land surveyor) for orderly urban development.
  - Used to plan & zone the city.
- **(ii) Malaysia's Map of Pedra Branca (1979):**
  - 21 December 1979: Director of National Mapping of Malaysia published a map showing PB to be within its territorial waters.
  - 14 February 1980: Singapore rejected this claim.
  - 23 May 2008: ICJ (International Court of Justice) ruled that PB belongs to Singapore.
  - Reason: Although originally under Johor Sultanate, U.K. & Singapore had undertaken various acts of sovereignty (without Malaysia's protest).

3.3.3 Siam (or Thailand)

- Thongchai Winichakul (originally published in 1994; updated in 2011).
- Cartography (map making) helped to raise national consciousness of Thailand.

- Without maps, people cannot 'see' or 'imagine' the nation (unmapped land = 'empty space').
- Mapping raises spatial awareness & understanding, thereby increasing sense of identification with homeland (Geo-Body).
- **Siam Geo-body (Concept):**
  - Through territorializing acts (e.g. mapping) people can visualize Thai territory ("geo") belonging, personal identity & pride ("body").
  - The land as / is your body.
  - Maps give "Spatial Reality" to formless space.
- First full map of Siam (1897) produced with British & French help.
- **Ultimate Goal:** eradicate "ambiguity of margins" & clarify "boundary of the realm", thereby unifying people to the Siam nation.

4 Topic 4: Maps That Lie: Economics

4.1 Maps are Subjective: Seven Subjective Dimensions (Wright 1942)

- Because mapmakers are humans filled with personal biases & subjectivities.
- Maps are actually Compilations of: Existing maps, Surveyor's notes & observations, Statistics etc.
- Maps may appear precise scientific but are products of "human shortcomings":
  - **Unintended** (ignorance)
  - **Intended** (agendas: often political or economic)
- Every map is "a reflection partly of objective realities & partly of subjective elements.... No map can be wholly objective".

4.1.1 Scientific Integrity

- Devotion & commitment to accuracy (acknowledgement of ignorance).
- E.g. Contour lines: broken lines to suggest approximate slope?
- E.g. 'U/C' (under construction) or F/D (future development)?
- E.g. Symbols saying 'existence doubtful' or 'position doubtful'?

4.1.2 Judgement

- Critical acumen (decision) in selection of source materials, use of colours & symbols, lettering, consistency.
- Do we ever question the experience & skills of a surveyor / cartographer?

4.1.3 Taste & Aesthetics

- Mapmaker's sense of harmony in use of colour, shading & pictorial symbols.
- What is valued: aesthetics or scientific / mathematical precision?
- Market considerations: maps for popular use or specialized audience?
- 'Ugliness' or 'aesthetics' has no bearing on map's accuracy. But beauty can inspire confidence & purchase.

4.1.4 Simplification vs Amplification

- **SIMPLIFICATION**
  - When there is too much ground data.
  - Prevents over-crowding & public concerns etc.
  - E.g. removal of slope irregularities, rivers etc. (map smoothing).
- **AMPLIFICATION**
  - When there is too little ground data (or there is a need to highlight certain feature).
  - Suggests scientific authenticity & labour.
  - E.g. un-surveyed rivers drawn with sinuous lines ('naturalness') rather than with 'course unknown'.

4.1.5 Generalisation

- Maps featuring quantitative data...
- **E.g. Isopleths:** different numbered lines signifying different quantity e.g. altitudes, rainfall etc.
- **E.g. Point symbols:** different dots represent different quantities e.g. population size.
- **E.g. Chropleth (spatial shading):** different colours or patterns represent different intensities.

- Generalisation on 'class intervals' e.g. 10, 20, 30.... or 100, 200, 300.
- Generalisation can lead to over-crowding or too few details on maps.

4.1.6 Synthesisation

- Bringing together (compounding) different information into single map revealing relationship between 2 or more elements.
- E.g.1: rainfall, crops & population density.
- E.g.2: income level & educational level.
- **Usefulness:** creation of 'regions' & explanation of how/why regions differ from each other.
- **Subjective judgement:** who decides how to compound 2 or more unrelated elements? Co-relation vs causal? (fear of misrepresentation).

4.1.7 Progressiveness vs Conservatism

- **Conservatism** = adherence to conventions tested over time e.g. blue water; red/brown mountains; cross as religious place etc.
- **Progressiveness** = mapmakers' responsiveness to artistic trends, cultural sensitivity, technology.

4.2 Maps that Advertise (Monmonier 1996)

- Advertising & cartography share a "need to communicate a limited version of the truth".
- **Advertising Principle:** to Seduce & Appeal
  - (a) Suppress some details: i.e. simplification, omission, smoothing.
  - (b) Exaggerate other details: i.e. amplification, exaggeration, generalization.

4.2.1 Transport Map-Advertisement

- **Train Maps:** emphasis on accessibility, convenience, effective hubs.
  - (i) Straight rail lines: even if actual route is not.
  - (ii) Future developments: suggestive of improvement & potential for growth.
  - (iii) Omission: rival transport lines; hubs stations that are not connected.
- **Plane Maps (SIA):**
  - (i) Multiple destinations.

  - (ii) Shorten duration (omit transit stops).
  - (iii) Centralise key hub (Singapore).
  - (iv) Cheerful place symbols.

4.2.2 Place Map-Advertisement

- Single-place maps: featuring shop, resort, hotel, business, housing project etc.
- Emphasis on: access (getting to place), environment (neighbourhood), aesthetics (place features).
- (i) Distort distances (downplay it) e.g. condominiums.
- (ii) Suggested travel times (always close) e.g. condominiums.
- (iii) Leave out competitors (they don't exist) e.g. hotels.
- (iv) Place name-dropping (attractive neighbours) e.g. condos, shops.
- (v) Centralising place (we are central/top) e.g. condos, hotels, attractions.

5 Topic 5: Social and Political Impacts of Digital Maps

5.1 Digital Maps in Web 2.0

5.1.1 Locations and Digital Maps

- **Locations (Places):** Landmarks, Points of interest, and Places that can be located in the map. This is highly subjective.
- **Digital Maps:** Digital representations of geographical space that are interactive, dynamic, and real-time. They are platforms for social interaction.
- **Digital Maps in Web 2.0:** Interactive, user-generated, and participatory mapping.
- Featured by citizen science, crowdsourcing, and geo tagging.

5.1.2 Social Factors of Digital Maps

- Three key aspects: User-Generated Content (UGC), Gamification & Social Networking, and Community Building & Identity.
- **User-Generated Content (UGC)**
  - Created by users, not professional.
  - Shared publicly online on platforms.

  - Authentic and organic.
  - Examples: Google Map Review & Photos.
- **Community Building & Identity**
  - Mapping as a community, e.g., Mapathon.
  - Digital maps can strengthen a sense of belonging.
  - Mapping can be an act of advocacy, representing marginalized or overlooked communities.
  - Examples: Humanitarian OpenStreetMap Team (HOT).

5.2 Social Bias in Digital Maps

5.2.1 Digital Divides

- **Digital Divides:** refers to unequal and spatially varied access to and effective use of digital technology.

5.2.2 Inequality in Digital Maps

- Access to mapping technologies (internet, smartphones, GPS) is uneven.
- Communities with limited connectivity or technical resources are underrepresented in digital maps.
- Example: "Map deserts" in the Global North.
- **Cultural Bias:**
  - Maps are not neutral: maps encode cultural assumptions and bias about space, naming, and significance.
  - Often, cultural identities and histories are erased or misrepresented by Mapmakers.
  - Maps as tools of power rather than Inclusion.

5.3 Political Impacts in Digital Maps

- Digital maps may look like neutral tools, but they carry strong political impacts.
- Maps are not just representations of space.
- Map reflects power, authority, and governmental perspectives.

6 Topic 7: Digital Maps and Their Impacts

6.1 From Paper to Pixels: The Evolution of Maps

6.1.1 Map Making Technology

- **Early Mediums:**
  - Rock and Clay.
  - Animal skin and leather (e.g., The Ebstorf Map of World, c. 1234).
  - Paper (e.g., Ptolemy's world map, c. 150, first use of longitudinal/latitudinal lines).
- **"Age of Exploration" (around 1418 – 1620):**
  - Map mapping tools includes: Portolan chart (Sea chart), Astrolabe & compass, Navigational sextants.
- **17th to 19th century (Raise of Cartography):**
  - e.g., U.S. Geological Survey established to map government land.
- **20th century:**
  - Maps became more abundant due to advances in: Printing, Photogrammetry (Aerial Photography).

6.1.2 The "Digital Turn" of Map

- **1963:** The first geographic information system (GIS) developed by Roger Tomlinson.
- **1972:** The first Landsat satellite for Earth observation, the beginning of remote sensing.
- **May 2000:** The removal of Selective Availability in the Global Positioning System (GPS).
- **2004:** The invention of OpenStreetMap as an crowdsourcing project.
- **2005:** The launch of Google Earth.
- **Case Study: The 2010 Haiti Earthquake**
  - Showed the power of digital mapping for disaster response.
  - e.g., Humanitarian OpenStreetMap Team (HOT).

6.1.3 5 Historical Periods of Digital Map Evolution

- **Early Digital Cartography (1950s–1960s)**

  - Initially spurred by military and census need.
  - Waldo Tobler in "Automation and Cartography" (1959).
- **The Raise of GIS Era (1970s–1990s)**
  - "The father of GIS" - Roger Tomlinson and Canada GIS.
  - **1981:** Environmental Systems Research Institute (ESRI) released ARC/INFO - the world's first fully integrated, commercial GIS.
- **Web Mapping Emergence (Mid-1990s–2000s)**
  - Web 2.0 marks a shift from static websites to interactive, user-driven platforms.
  - **2005:** Google Map was launched, featuring:
    * Dynamic user interaction (drag-and-drop, zoom, and pan).
    * Enabled location-based service (place search and routing).
    * Democratized map development through Google Maps API.
- **Cloud & Mobile Mapping (2010s)**
  - **2007:** Apple releases the first iPhone.
  - Cloud-based spatial infrastructure (e.g., Google Cloud, Amazon Web Services) provides scalable backend.
  - Concept shift: From a software tool a real-time service in daily life.
- **Platform & AI-Powered Mapping (2010s–Present)**
  - Digital maps as Platforms (e.g., Google, Apple, Grab) with extensive APIs.
  - Integrated with everyday service like delivery, e-commerce, logistics.
  - When AI and GIS come together GeoAI.

6.2 Social and Political Impacts of Digital Maps

6.2.1 Digital Maps in Web 2.0

- Interactive, user-generated, and participatory mapping.
- Maps are no longer just representations of space, but platforms for social interaction.
- Featured by citizen science, crowdsourcing, and geo tagging.
- **User-Generated Content (UGC)**
  - Created by users, not professional.
  - Shared publicly online (e.g., Google Map Review & Photos).

  - Authentic and organic.
- **Community Building & Identity**
  - Mapping as a community, e.g., Mapathon.
  - Digital maps can strengthen a sense of belonging.
  - Mapping can be an act of advocacy, representing marginalized or overlooked communities (e.g., Humanitarian OpenStreetMap Team (HOT)).

6.2.2 Social Bias in Digital Maps

- **Digital Divides:** refers to unequal and spatially varied access to and effective use of digital technology.
- **Inequality in Digital Maps:**
  - Access to mapping technologies (internet, smartphones, GPS) is uneven.
  - Communities with limited connectivity or technical resources are underrepresented in digital maps.
  - Example: "Map deserts" in the Global North.
- **Cultural Bias:**
  - Maps are not neutral: maps encode cultural assumptions and bias about space, naming, and significance.
  - Often, cultural identities and histories are erased or misrepresented by Mapmakers.
- Maps as tools of power rather than Inclusion.

6.2.3 Political Impacts in Digital Maps

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- Maps are not just representations of space.
- Map reflects power, authority, and governmental perspectives.

7 Topic 8: Where am I: Digital Maps in Everyday Life

7.1 Digital Maps: Types and Components

7.1.1 Types of Digital Maps

- **Static Map:** fixed representation with geographical data, don't change or update with time.
- **Dynamic Map:** Interactive, real-time maps that can change depending on user interaction or live data feeds.
  - **Animated Map:** Maps that change over time automatically, like a video or slideshow.
  - **Interactive Map:** Maps that respond to user actions e.g., zooming, clicking, or filtering.

7.1.2 Key Components ("LLS")

- **Layers:**
  - different types of data & information put on top of the based map.
  - e.g., Roads, 3D Buildings, Street View, Traffic, Weather.
- **Locations (Places):**
  - Landmarks, Points of interest, and Places that can be located in the map.
  - Highly subjective.
- **Search & Route:**
  - to find places and generate directions for navigation.

7.2 Location Based Service (LBS)

- **What are LBS?**
  - LBS are mobile applications that provide information / service depending on the location of the users.
- LBS has become ubiquitous (means everyone and everywhere) in our daily life.
- **4 Key Components in LBS:**
  - Mobile device
  - Positioning

  - Communication network
  - Service and content provider

7.2.1 4 methods of locating devices

- **Cell ID:**
  - From the nearest cellular towers & their Coordinates.
  - Pros: mostly available, low cost.
  - Cons: low accuracy.
- **Global Positioning System (GPS):**
  - based on multiple satellite signals with Trilateration.
  - Pros: high accuracy, works globally.
  - Cons: high power, struggles indoors.
- **Wi-Fi:**
  - from signal strength and MAC addresses of nearby Wi-Fi access points.
  - Pros: works on GPS denies, high accuracy.
  - Cons: requires dense Wi-Fi networks.
- **Image-based Geolocalization:**
  - just like the Geoguessr game.
  - Pros: Useful when GPS and WiFi are weak.
  - Cons: Difficult to develope.

7.3 The Paradox of Geoprivacy

- In 2013, a MIT study showed that 4 spatio-temporal points (e.g., places and times) are enough to uniquely identify 95% of 1.5M people.
- **Examples:**
  - Strava data & US military base: fitness tracker data shared on social media revealed bases and patrol routes.
  - Visits to clinics & Tracking.
- **Location Privacy Threats:**
  - Location data is sensitive.

  - Location data is difficult to anonymize.
  - It can reveal unwanted information even in aggregated way.
- **How to protect our own geoprivacy?**
  - Anonymization & Aggregation
  - Obfuscation & Noise Injection
  - End-to-End Encryption & Block Chain

8 Topic 9: What Maps Say: Thematic Maps and Storytelling

8.1 Thematic Maps: Arts or Tools

8.1.1 Definitions

- **Base maps (or reference maps):** shows general geographic features, e.g., river, cities, and political boundaries.
- Like a base of the cake.
- **Thematic maps:** are designed to illustrate the spatial distribution of a specific phenomenon, e.g., Population, Culture, and Climate.
- Like a "decorated" cake.

8.1.2 Thematic Map Design (Key Thinkers)

- **Key question:** Are thematic maps objective tools or creative arts?
- **Arthur Robinson (1952, The Look of Maps)**
  - Map design as communication, not just decoration.
- **Jacques Bertin (1967, Semiology of Graphics)**
  - Map visual variables (size, shape, color, orientation, texture, value).
- **Denis Wood (1992, The Power of Maps)**
  - Maps as propositions, not mirrors of reality.
  - Artistic vs scientific, a dual nature of maps.

8.1.3 Visual Variables (VV)

- VV as the Language of Maps.

- Color
- Size
- Shape
- Orientation
- Pattern / Texture
- Value

8.2 Story Map and Visual Narrative

- **What is a Story map?**
  - To combines geographic maps with text, images, and multimedia to tell a narrative grounded in place.

8.2.1 Three Types of Story Map

- **Mapping Oral Stories**
  - Capturing spoken traditions, personal memories, and local narratives.
  - Examples: Historically used of stories from explorers; Map community or indigenous memories.
- **Mapping Literacy Stories**
  - Linking written narratives, literature, or textual records with geography.
  - Examples: Mapping Jane Austen's England; The "Authorial London" project.
- **Mapping Audio-visual Stories**
  - Combining sound, video, and imagery with spatial storytelling.
  - Examples: Global Soundscapes (participatory map); Sounds of New York City (SONYC).

8.2.2 Scale of Story Maps

- Story maps can be any geographic scales:
  - **Global** challenge (e.g., climate change)
  - **Regional** patterns (e.g., migration flows)
  - **Local** stories (e.g., neighborhood history)
- Similar in narrative scales:

  - **Micro-scale:** personal journeys
  - **Meso-scale:** city planning, cultural landscapes.
  - **Macro-scale:** global challenges, planetary change
- **Takeaway:** Scale in story maps is not only cartographic but narrative.

8.3 The Power & Responsibility of Story Map

- What makes story map powerful? Map reflects power, authority, and governmental perspectives.
- **Whose story get mapped?**
- **"Silences of the map" - Brian Harley (1992)**
  - What is left out is as important as what is shown.
  - Missing information is also information.
- **Example: How to minimize bomber losses?**
  - Data showed bullet holes (red dots) on planes that *returned*.
  - The "silence" (missing data) was from planes that did not return.
  - **Conclusion:** Armor should be placed where there were *no* bullet holes (e.g., engines, cockpit), as hits there were fatal.
- **Takeaways:** Think Twice Whose Stories Should be Mapped?

9 Topic 10: Who is Mapping: Crowdsourcing and Social Sensing

9.1 Introduction: Open Data and Mapmakers

- **Open Data** is freely accessible to everyone and can be used freely due to open and non-discriminatory licenses.
- In 2009, the United States launched data.gov.
- Since 2011, Singapore Launch of Data.gov.sg.
- Tim Berners-Lee, founder of the W3C, suggested a 5-star deployment scheme for Open Data.
- **Democratization of map-making:** everyone can map.
- Mapping as both a technical and social practice.

9.2 Citizen Science and Crowdsourcing

9.2.1 Citizen Science

- **Key definition:** Citizen Science is the active involvement of the public in scientific research through data collection, analysis, or collaboration with scientists.
- **Example:** Wikipedia, iNaturalist.
- **Participatory GIS (PGIS)** refers to the use of GIS technology to support and empower public participation in areas such as planning.
- **Goals of PGIS:**
  - empower less privileged groups in society;
  - influence policy-making;
  - support a more collaborative planning process.

9.2.2 Crowdsourcing Platforms

- **Crowdsourcing** is the idea of using the power of a crowd to collect data that is too vast, heterogeneous, or expensive to be collected by other types of sensors.
- **Web 2.0** (participatory/social web) refers to websites that emphasize user-generated content, ease of use, participatory culture.
- **Volunteered geographic information (VGI)**
  - Term first coined by Prof. Michael F. Goodchild in 2007.
  - The harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals.
  - "Citizens as sensors: the world of volunteered geography".
- **VGI Example:**
  - OpenStreetMap for Humanitarian mapping.
  - Mapiliary and Street View Image for urban environment mapping.
  - MyENV App for Singapore Climate and Weather Update.

9.3 Social Sensing and Human Behavior

9.3.1 Social Sensing

- **Social Sensing** is the process of collecting and interpreting data generated by people through digital platforms, sensors, or social media to understand real-world events, behaviors, and societal trends.

- **Advantages of Social Sensing:**
  - Human-Centered Data Collection.
  - Real-Time Insights of People's mobility.
  - Collective Intelligence to reveal social patterns.

9.3.2 Urban Human Mobility

- Human mobility here refers to when/why/how people move and travel.
- Collected via LBS, Social media, and VGI data.
- **Examples:**
  - Human mobility patterns during Covid-19.
  - Social media and human dynamics in Disaster.
- **Key Findings from Brockmann et.al. (Nature 2006):**
  - Human trips tend to be of mostly short distances with a few long distance ones.
  - Humans tend to visit some locations more often than what would have happened under a random scenario.

9.3.3 Human Perception

- **Key Question:** How can we understand how people perceive the urban environment via social sensing?
- **Examples:**
  - Urban Green Space
  - Air quality
  - Street Safety

9.4 Mapping with Communities: Power, Representation, and Ethics

- **Representation and Bias**
  - Unequal participation: rich vs. poor regions, gender imbalance.
  - What's mapped reflects what contributors find important.
- **Power and Ethics**
  - Platforms' influence: OSM Foundation, Google, Meta.

  - "Epistemic power" in mapping — whose knowledge is credible.
- **Toward Responsible Mapping with Community**
  - Inclusive mapping initiatives (e.g., YouthMappers, MissingMaps, UN Mappers).
  - Ethics frameworks: FAIR & CARE principles.
  - Responsibility — mapping *with* communities, not *for* them.

10 Topic 11: Environmental Impacts of Digital Maps

10.1 One Earth and Digital Mapping

10.1.1 Concept of One Earth

- **Origin:** Spaceship Earth thinking (Buckminster Fuller, 1960s) and the Earthrise photograph (Apollo 8, 1968).
- **Key message:** We all live on one interconnected planet with shared responsibilities.
- Link to the UN "One Health–One Planet–One Future" framework connecting environment, health, and sustainability.

10.1.2 Digital Mapping as a Global Lens

- Digital Mapping as a Global Lens for environment sustainability, climate justice, and the UN Sustainable Development Goals (SDGs).
- Environmental and human-wellbeing monitoring is central to achieving the "One Earth" vision.
- Digital mapping tools and platforms combine Earth Observation (EO), Citizen Science, and GIS to enable global-scale monitoring in real time.
- **Example platforms:**
  - Google Earth Engine
  - Copernicus Sentinel satellites
  - OpenStreetMap
- **Key domains and mapping examples:**
  - Land Use Change and Deforestation
  - Water Resources
  - Urban Heat Island

  - Air Quality
  - Disaster Monitoring

10.1.3 Climate and Health Applications

- Two key application domains:
  - Mapping Climate Change
  - Mapping Planetary Health
- Climate change is a global and interconnected challenge mapping reveals dynamics and vulnerabilities.
- Environmental change directly affects public health and human well-being air pollution, heat stress, vector-borne diseases.

10.2 The World in a Changing Climate

10.2.1 Global Challenge and Solution

- **Key global facts from IPCC AR6:**
  - Global warming (1.1 degree above pre-industrial levels).
  - Rising sea levels (3.3 mm/year).
  - More frequent extreme weather (floods, droughts, heatwaves, wildfires intensifying globally).
- **Mapping Global Climate Challenges:**
  - Heatwave and Temperature Extremes
  - Water and Cryosphere Disturbance
  - Extreme Events and Disasters
  - Food and Energy Shortage
- **Global initiatives:**
  - From Paris Agreement (2015) to COP29 "Just Transition." (2024).
  - Digital map tools and satellite monitoring (e.g., Climate TRACE,).

10.2.2 Regional Challenge and Solution (Southeast Asia)

- Southeast Asia as one of the most climate-vulnerable regions due to geography, economy, and population density.

- Region contributes 8% of global emissions but faces disproportionate impacts.
- **SEA Regional Climate Challenges:**
  - Sea-Level Rise and Coastal Threats
  - Urban Heat and Extreme Weather
  - Food and Water Security

10.2.3 Local Challenge and Solution (Singapore)

- **Climate projections for Singapore:**
  - Hot days and warm nights will be the new normal by end-century.
  - Rising threat of heat stress.
  - Extreme rainfall to intensify and dry periods to get drier.
  - Sea level rise will continue to accelerate.
- **Singapore's solution:**
  - Coastal protection: Tuas Seawall, East Coast masterplan.
  - Cooling Singapore 2.0: urban digital twin for heat mitigation.
  - Singapore Green Plan 2030: Net Zero by 2050 target.
  - Climate-resilient urban design: green infrastructure, biodiversity corridors.

10.3 Sustainability in the AI Era

- **AI Training and Inference & Energy Consumption**
  - Training costs for large language models.
  - ChatGPT uses 10 times as much energy as a Google search.
  - Hardware and Lifecycle Impact (e.g., AI chips of GPUs/TPUs).
- **Toward "Green AI"**
  - Efficiency over performance, like smaller, optimized LLMs.
  - Transparency via energy report and carbon metrics.
  - Renewable-powered data centers and hardware.