* GIS: Geographic Information System are frameworks which gather, manage and analyze data
* GISystems: Focuses on tech and tools
* GIScience: Field of research which studies the theory and concepts which underpins GIS
* GIStudies: Study of use of Geographic info
* GISS: Geographic Info Science and Systems
* GIS&T: Geographic Ingo Science and Technology
* Can track objects via real-time maps, ensure security via monitoring can be used to navigate open areas to respond to an incident
* Is used to understand what has happened, what is happening and what will happen on an area
* GIS is made up of:
  + Hardware: Includes centralized computer servers, desktop computers and handhelds
  + Software: Store, analyze and display geographic data. Also provides tools needed to input, manipulate and query geographic data
  + Data: data which has location info. Integrates geographic info with data from other sources
  + People
  + Workflows: Composed of unique structured plans and business rules
* Geographic Information is made up of to 2 types of info:
  + Attribute: Describes non-location
  + Location: Describes where an object resides on the earth (x/y co-ordinates, latitude and longitude, others etc.)
* GIS Capabilities:
  + Spatial Analytics: Allows individuals to move beyond exploring the visual aspects of their data to using tools based on spatial algs to identify trends, patterns and relationships in data
  + Fields Operations: enable an organization’s office staff and fieldworkers to access the same authoritative data sources via mobile devices reducing the reliance on paper-based methods and increasing productivities and efficiency
  + Mapping and Visualizations: View data from multiple sources all at once
  + Real-time GIS: Real-time decision making via monitoring and displaying data from sensors or devices
  + 3D GIS: Transforms 2D data🡪3D Models, allowing real world context to maps
  + Imagery and remote sensing: Tools which allow people to extract info from imagery and remotely sensed data
  + Data management and collection: Use, access and integrate and store business data
* ArcGIS Online is a cloud-based Web GIS deployment for mapping and analysis which can be accessed anywhere and at anytime
* ArcGIS Pro is an application for which has the tools for data management, visualization and analysis of 2D and 3D data
  + Centered around projects
  + Stores multiple items, such as maps, layouts, tables and charts.
  + Key components of ArcGIS are: Ribbon Tab, group, Tool/button, view and Pane
* Is capable of consuming data from various systems which contain spatial information
* GIS allows us to map patterns and relationships such as:
  + Mapping locations
  + Map quantities onto a map
  + Map what is inside the map
  + Map densities such as population densities
  + What Is nearby
  + Changes
* You present it in either a static map or a dynamic map
  + Static = cant interact but view
  + Dynamic = view and interact
* GIS can be used in disaster management, urban planning, environmental planning and monitoring
* Imagery maps represent the area. Can be made by one or more images. Geological stuff as opposed to borders
* Reference maps are a representation of an area which tend to show borders and boundaries and other real life features
* Basemaps provide the background for features on a map
  + Imagery (satellite and aerial), Topographic, National Geographic, Street basemap
* WebGIS are interactive maps
  + Can be shared via Web GIS portal
  + Benefits:
    - Usable by broad audience
    - Accessible
    - Can be used my many users simultaneously
    - Access data from various sources
    - Appliable at any scale
* Scale is expressed as either:
  + Scale bar, akin to a ruler
  + A ratio
  + In two equivalent values
* Features = Display objects on a map using GIS
* Digital data is easy to transform, process and analyze
* Many standards allow various types of info to be expressed
* GIS relies on said standards for geographical data
* Benefits:
  + Easily copied and transmitted
  + Simple
  + Reliable
  + Economies of scale
* Issues:
  + Rarely perfect as either details are irrelevant, expensive or voluminous
  + Uncertainty: Important to know what’s missing
* Geographic world infinitely complex
* We use discrete objects and continuous fields
* Discrete objects:
  + World as empty space
  + Objects have well defined boundaries
* Continuous fields:
  + Continuous source
  + Represented by some variable/attribute which is measurable at any point
* Vector Data: Represents pints, lines and areas and all are represented using coordinates
  + One per point
  + Lines are polygons
  + Areas are also polygons
* Raster data:
  + Divides space into rectangular cells
  + Objects are collections of cells
  + Properties/attributes are assigned values to cells(single val)
* As cell size increases, raster becomes more voluminous
* Vector data is more favoured in admin data whereas raster is for remote sensing/elevation data
* GIS can suit either one
* 6 ways to represent fields:
  + Regularly spaced sample points
  + Irregularly spaced sample points
  + Rectangular cells
  + Irregularly shaped polygons
  + Irregular network of triangles
  + Polylines which represent contours
* All reduce variation of field to set of objects and attributes
* Look similar to phenomenon conceptualized as discrete objects
* Maps can help visualize where events happen, how far a character travels and what a country or landscape is like
* Maps give insight to why certain events happened, where they did
* GIS allows us to see the connection between features and their attributes via the attribute table
  + Row = Geographic feature
  + Colum = Field
  + Provides descriptive info about features
* Field data types:
  + Object identifiers. Unique id for each row in table, don’t query using these ones
  + Numbers: Can be short, long float or double. Usually queried via quantitative values
  + Text. Queried via textual values
  + Dates. Queried via time frame
* Attribute Query: When you query features based of attribute
  + Made up of attribute field, attribute value and operator.
  + Can be made up from multiple ones
* Able to use attributes to draw maps or style features in the map
  + Organized collection of predefined colours, symbols and their properties, and map elements
  + These control symbols used, colour, size etc.
* Thematic maps: Maps which convey information about a single topic/theme
  + Have 1+ layers which are symbolized
* All GIS datasets have a spatial component and this component allows one to perform tasks such as:
  + Visualize real life info
  + Implement analytical functions (proximity analysis, buffering and movement)
  + Select and filter geographically
  + Calculate different properties
* Data collection is a very expensive activity in GIS (up to 85% of cost). Has two broad types of data collection
  + Data capture/Direct
  + Data transfer
* Two capture methods:
  + Primary (directly measurement)
  + Secondary (indirect derivation)

|  |  |  |
| --- | --- | --- |
|  | Raster | Vector |
| Primary. Process to collect data specifically for GIS use | Digital remote sensing images | GPS measurements |
| Digital aerial photographs | Survey Measurements |
| Secondary. Process of creating raster and vector and DBs from other files | Scanned maps | Topographic maps |
| DEM from maps | Toponymy (place name) data sets from atlases |

* Data collection workflow:
  + Planning: User requirements, gather resources, develop plan
  + Preparation: obtain data, clean data, scan map into digital format
  + Digitizing/transfer: Needed for secondary data capture to digitize the scanned maps or transfer other formats into GIS
  + Edit/improve: Validate data, correct errors, improve quality of data
  + Evaluate: Check if what we have is qualified to be used for other tasks
* For raster:
  + Remote Sensing: Measurement of physical, chemical and biological properties of objects without direct contact
  + Resolution is important. Spatial = pixel size, temporal is the repeat cycle and spectral is the EM spectrum to be measured
* For vector:
  + Surveying:
    - Measure distance and angles from known locations
    - Creating 3D models via LiDAR
      * Uses a scanning laser rangefinder to make topological surveys
      * Produces point cloud datasets
    - Principle: 3D locations of objects determined by angle and distance measurements from known location
  + GPS:
  + Digitalize/vector
* VGI: Volunteered Geographic Information
* Buy vs build is important when thinking about data transfer
* Data being encoded in many different formats is a huge problem with data from other sources
* Attribute data can be entered via:
  + Manually
  + Direct data logging
  + Text/voice recognition
  + Citizen Science
  + Questionnaires
* Can use Non-GIS data in GIS like spreadsheets as long as it contains some location info
* We need a clear plan, adequate resources, funding and time. Decide whether one wants incremental or very rapid collection of data
* Vectorization: Raster 🡪Vector data
  + Adjacent same valued raster cells with same attributes ae aggregates and then class boundaries are created at intersection between classes as vector lines
  + Undershoots/Overshoots can occur
* To minimize error in a vector data, we can do the following:
  + Use domains to constrain valid values for a particular field
  + Subtypes: These are a subset of features with same attributes
  + Topology: Connectedness, adjacency and proximity between features. Using this we can define spatial relationships which we want protected so not matter how much we edit feature datam they are adjacent to area they belong to
  + Archive data
* Uncertainty: Situations in which digital representation is simply incomplete.
  + Can occur when we are unable to describe real phenomena exactly
  + A diagram of uncertainty and measurement

    Description automatically generated
  + Inevitable in GIS
  + Data obtained from others never the truth thus use multiple sources
* Accuracy: How close a measurement is to the true/accepted value
* Precision: Consistency of repeated measurement
* Ecological fallacy: mistaken conclusion drawn about individuals based on findings from groups they belong
* Logical Error: When individuals mistakenly infer info about individuals from aggregate data
* Modifiable Areal Unit Problem is when results change depending on size, shape and delineation of spatial units.
* Scale affect: Inconsistencies in analyses conducted across different scales or spatial resolutions
* Zoning effect: Inconsistencies in analyses based on different zonal systems
* Metadata includes info to make it easier to search for and discover appropriate data such as data quality, distribution (who holds that data, so data rights) and identification
  + Complete meta data🡪 high quality
* In geographic coordinate systems, Earth shape uses three things:
  + Datum
  + Prime Meridian
  + Unit of measure
* Datum: Frame or Reference for finding locations on the Earth
  + Based on spheroid
* Shape of Earth is more like an ellipsoid
* Both are interchangeable
* Spheroid: Ellipsoid which approximates shape of a sphere or an ellipsoid created by rotating an ellipse about its major or minor axis
* Surface not perfectly spheroid nor symmetrical
  + Semimajor and semiminor axes that fit one geographical regions don’t necessarily fit another
* Spheroid deviates slightly for different regions of Earth
  + Ignoring these deviations leads to large errors
* Authalic: Theoretical sphere which has the same surface area as the Earth
  + Used to simplify calculations and models
* Latitude: Parallel east and west running lines around surface of the Earth. Used to measure distances to the north and south of Equator
* Longitude: North and South running lines around surface of the Earth. Used to measure distances to the East and West of Prime Meridian. They intersect at the poles
* When the above to intersect, they are called the garticule
* To list, we first include latitude then longitude i.e. 0oN , 78oW
  + 0 Degrees north of equator and 78 Degrees west of Prime meridian
  + North and West are +, South and East are -
  + Here we use degrees/minutes/seconds referred to as DMS
  + Decimal Degrees (DD) = DMS but minutes/seconds are expressed as decimals
    - Used as storage/computations are faster
  + DMS🡪DD:
    - Treat 1 degree as 1 Hour. Using this to convert seconds🡪degree, div by 3600 and for a minute, divide by 60. Afterwards add up all degree values to get values in DD
  + DD🡪DMS
    - Multiply Decimal by 60 to get minutes part, then split the output into numbers pre and post decimal. The pre decimal is minutes. Multiply the numbers post decimal by 60 to get second
* Projection: Systematic transformation of a curved surface to flat surface
  + Different projection method, different datum
  + Any projection distorts Earth in some way
  + Need to preserve direction, shape, are and distance
  + Conformal: Shapes and angles preserved
  + Equal Area: Areas are preserved but shapes are distorted
* Developable surface: Surface which can be unfolded or unrolled into a plane/sheet without stretching, tearing or shirking
* Cylindrical Projection:
  + Wrapping a cylinder of paper around the Earth
  + UTM (Universal Traverse Mercator) is conformal
    - Zones start at -180o and are each 6 degrees of longitude
    - UTM is calculated as int( where int takes the integer part
* Conic Projections:
  + Wrapping a cone of paper around the earth
  + Used for midlatiude zones which have an east-west orientation
* Planar Projection:
  + Sheet of paper touching the earth
  + Azimuthal projection or zenithal projection
* Projection Coordinate system tells data how to draw on a flat surface while a Geographic coordinate system is unprojected
* Georeferencing: mechanism which allows you to use geographic information to identify locations on a map
* Types of georeferencing include:
  + Using XY coordinates
  + Place names
  + Postal codes/addresses
  + Street address
  + Grid system
* Spatial Analysis: Process of looking at and analysing a map by identifying patterns, trends or making decisions
  + How people understand the world by turning data into info
* 6 Spatial analysis categories:
  + Understand where you are or what is around you
  + Measure size shape and distribution like area, length, perimeter, height or volume
  + Determine how places are related: what is near, within or how something overlaps in space and time
  + Find the best locations and paths:
  + Detect and quantify patterns looks for patterns, hotspots or outliers and how they change over time
  + Make predictions
* Spatial analysis workflow: Ask questions🡪Explore and prepare data🡪Analyze and model🡪Interpret Results🡪Repeat and Modify🡪Present results🡪Make decisions
* Spatial analysis requires both attributes and locations of objects
* Types of vector spatial analysis are:
  + Queries (Location and attribute)
  + Measurements
    - Great circle is a circle which describes the intersections of the surface of a sphere with a plane passing through the center of the sphere. Divides the sphere into two equal parts where a segment of such a circle represents the shortest distance between two terrestrial points
  + Transformations
    - Clip
    - Cut
    - Buffering
    - Intersect
    - Union
  + Descriptive summaries such as Sum. Min Max etc
  + Optimization
* Raster Analysis: Process of analyzing data in grid datasets
  + We look at pixel value
  + We used a grid to model geographic data
* Types of Raster Analysis:
  + Reclassification:
    - Binary masking: Assign 0 or 1 to each cell in input using lookup table
    - classification reduction: Assign new values to classes/ranges to reduce no of classes
    - Classification ranking: Assign ranks to unique categories/values
    - Changing measurement scale: Assign vals to a qualitative scale layer to generate quantitative layer
  + Overlay: Creating a new layer by assigning each cell value which is a function of the independent values of the cells at the same location on 2+ input layers
    - New = Layer1 OP Layer 2 where OP is either a logical or arithmetic operation
  + Zonal Statistics: Summarize info about 1+ features within a zone
    - Dataset MUST be raster
  + Cost Path Analysis
    - Least Cost Path(LCP): Most cost effective path finding methofd
    - Practice in linear infrastructure and route finding apps
  + Terrain Analysis
    - Using digital elevation data(DEM) to analyze landscape topography
  + Interpolation
    - Estimate unknown values on existing sample points
* Geography Inquiry Process (can apply anywhere with geographic components):
  + Ask Geographic questions
  + Acquire geographic resources
  + Examine geographic data
  + Analyze geographic data
  + Act on geographic knowledge
* Geoprocessing: Process which software tools use geographic data to create new data
* A geoprocessing tool usually send an input layer through an analysis toll which outputs a result layer

Single Choice MCQ 25 Questions

Multiple Answer MCQ (Any mistake= 0) 10 Questions

Short Written (5 Questions Simple, 30 points total)