GEOG 204

LECTURE 1

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GEOG 204
Introduction to GIS

Fall 2023

Lectures:
Tue: 10.30 - 11.20

Labs:
Room 8-125
Mon: 11:30 – 14:20
Tue:11:30 – 14:20
Thu: 15:00 – 17:50

Tutorials:
Mon: 8:30 – 10:20
Fri: 11:30 – 13:20

Outline and notes:
https://gis.unbc.ca

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Course Evaluation

- Technical / Lab-based course
  - Labs 35%
  - Midterm Exam (Oct 17th) 15%
  - Tutorials 10%
  - Projects (Dec 1st) 20%
  - Final Exam (Dec 5th) 20%

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Defining GIS

- A **geographic information system** (**GIS**)
  - is a system to store, manipulate, analyze, manage, and present geographic data
  - GI systems fall within the area of Geomatics. Geomatics is a broad field of study
    - methods and tools used from data acquisition to data distribution.

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GIS: a part of the 'Geomatics' field

The geomatics field

- Concerned with the gathering, storing, processing, and delivery of geospatial information
  - Geographic Information Systems
  - Cartography
  - Remote sensing
  - Land surveying
  - Photogrammetry
  - ….

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For the Geographer

- GIS technology has made it possible to efficiently integrate, manage, and analyze geographical information from maps, remote sensors, measuring tools, and text sources.

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GIS: a definition

- "A geographic information system (GIS) can be defined as a computer application capable of performing virtually any conceivable operation on geographic information, from acquisition and compilation through visualization, query, and analysis to modeling, sharing, and archiving (Longley et al., 1999, 2010)."

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GIS and GIScience

- "Geographic information systems (**GIS**) were originally conceived as digital toolboxes for handling maps; the principles underlying such systems, and framing their design and use, became known as geographic information science (GIScience)."

Goodchild, 2004

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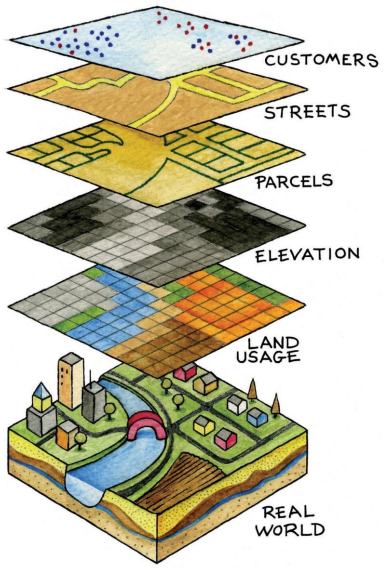
A GIS enables

Automated ….

- Acquisition (input)
- Management
- **Analysis**
- Display (output)
- … **of 'spatial' data**



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GIS and GIScience

- Phenomena on the Earth's surface have both geographic and temporal dimensions.
  - In reality we are dealing with spatial-temporal phenomena
    - The problems GIS deals with have different characteristics over space and time.
  - Modelling spatial-temporal phenomena has inherent challenges that we are continuously learning about
  - GIScience then is an important field of study in its own right.

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GIS and GIScience

- GIScience explores
  - Unique characteristics of geographic data
  - Methods of address geographic problems
  - Geographic information research as it relates to other disciplines
  - The impact of GIS technology on society
- It aims to provide coherence in the study of geographic information as it relates to geographic concepts and GIS tools

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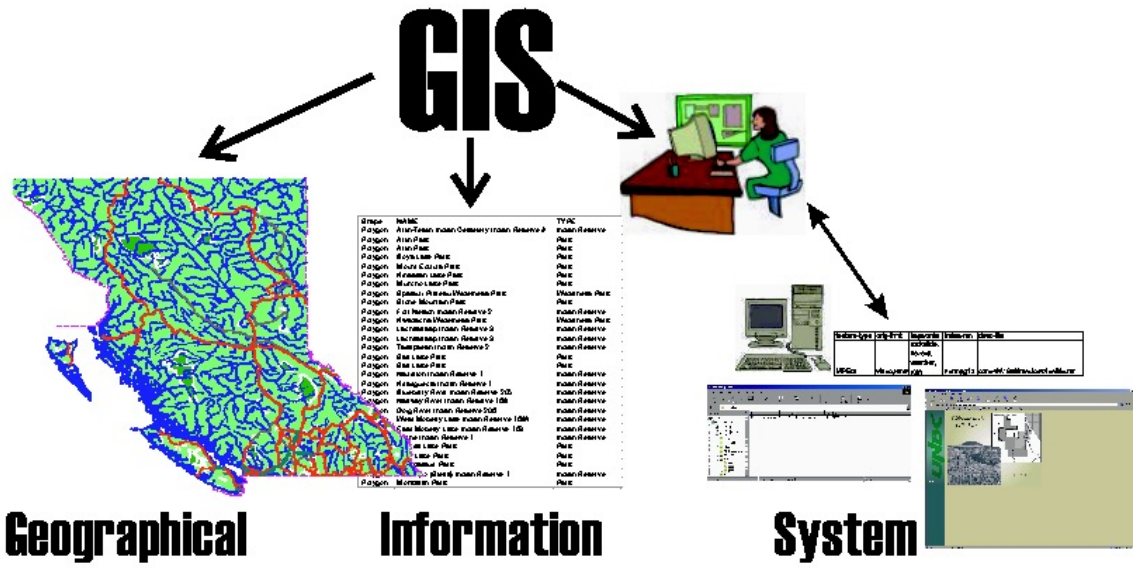

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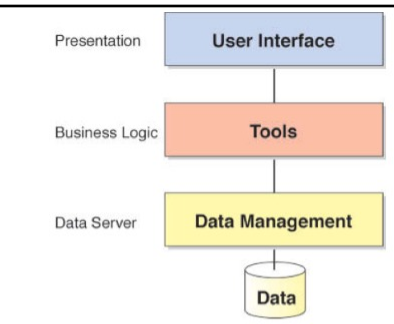
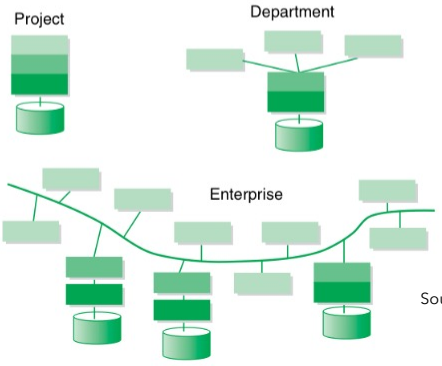
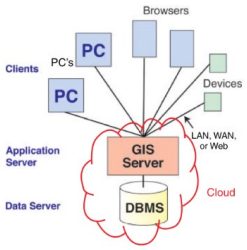
Typical Architecture of a GIS







Source: Longley et al 2015

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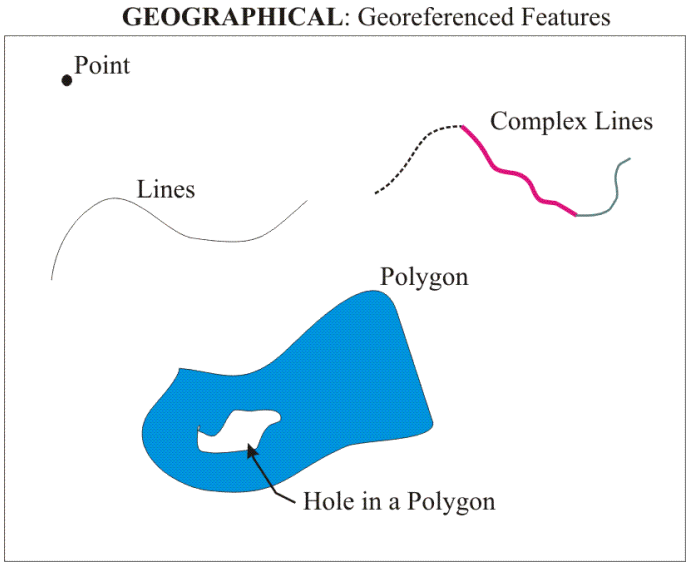
Spatial Features

- *Features* are the objects represented in a GIS – such as lakes, rivers, roads, buildings and points of interest



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Using GIS

- Examples
  - A community planner might want to assess the anthropogenic impact on lands that should otherwise be protected. She may also want to understand why these impacts are only in certain areas and not others.
  - A biologist might be interested in the impact of the wildfires on the on the populations of deer species to obtain a better understanding of long-term threats to those populations.

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Using GIS

- Examples
  - An analyst might like to identify areas at a high-risk for forest fires in BC by investigating rainfall patterns, terrain characteristics and fuel beds.
  - An analyst may be hired by a telecommunications company to determine the best sites for the company's relay stations, taking into account various cost factors such as land prices, population distribution, undulation of the terrain et cetera.

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Using GIS

- Examples
  - A forestry consultant might want to optimize timber production using data on soil and current tree stand distributions, in the presence of a number of operational constraints, such as the need to preserve species diversity in the area.
  - A fisheries researcher might want examine depth and water quality indices at different sites in a freshwater lake to understand how the distribution of an invasive species has changed from a decade ago.

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Using GIS

- Examples
  - A city planner will need to keep records of the cadastral parcel boundaries as well as the locations of all the city's infrastructure.
  - A developer must ensure that all construction in a new subdivision is least 100m from the highwater mark. Does she need a GIS?

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GIS Functions

- Examples:
  - Data Acquisition
    - Field Surveys, GPS sensors, aerial and satellite imagery, online databases, digitised from paper maps & paper records, IoT sensors…
    - Acquired data may need editing
      - to remove errors such as overlapping polygons, duplicate records
      - Geometric transformation
    - Most expensive part of a GIS project and thus a great barrier for many projects

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GIS Functions

- Examples
  - Data Attribute Management
    - Attribute data describe characteristics of spatial features
    - The data are usually arranged in a table. A relational database is the commonly used DB for management.
    - Metadata *sometimes* contains more descriptions on the properties
    - Do not underestimate the effort required to come up with sensible attribute names

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Flat file of land use data

PID	LU2000	LU2020	Area
11001	Residential	Commercial	6000
11002	Commercial	Commercial	9000
11003	Park	Open	5300
11004	Industrial	Industrial	11000
11005	Residential	Residential	8050

Relational tables of land use data

PID	LUC2000
11001	1
11002	2
11003	3
11004	4
11005	1

PID	LUC2020
11001	2
11002	2
11003	5
11004	4
11005	1

PID	Area
11001	6000
11002	9000
11003	5300
11004	11000
11005	8050

Land-use	LU-Code
Residential	1
Commercial	2
Park	3
Industrial	4
Open	5

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GIS Functions

- Examples
  - Data Display
    - Maps – very effective for spatial information
      - Not all maps are equal
      - Map elements: Title, legend, scale bar, data sources, author, North arrow, neatline, border, acknowledgement
      - Maps can be dynamic or static
      - A well designed map should enhance communication.
      - Poorly designed maps can confuse, distort, fail to communicate

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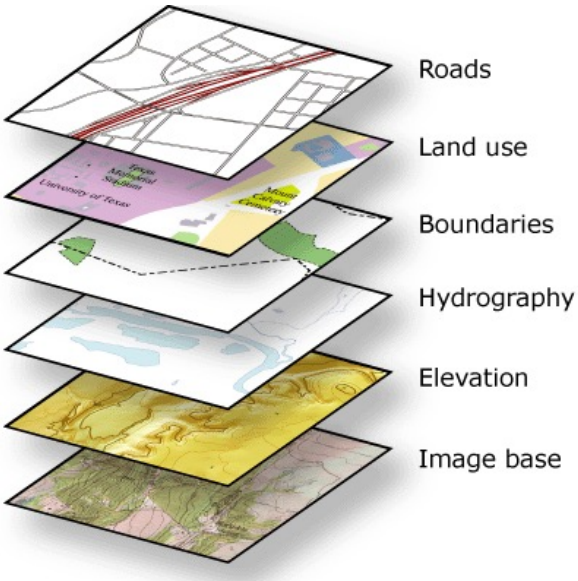
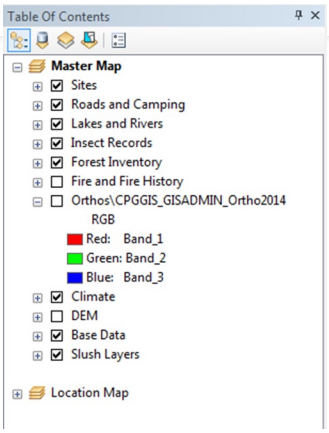
Layers for Cartography





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GIS Functions

- Examples
  - Data Exploration (exploratory spatial analysis)
    - Explore general trends in data
    - Explore relationships
      - Use graphs/matrices to assess correlations
      - Spatial distribution and clustering
      - Data classification, aggregation

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GIS Functions

- Examples
  - Data analysis and modeling
    - The use of analytical tools
      - Vector: Buffering, overlay, distance measuring…
      - Raster: Local, neighborhood zonal, and global operations
    - A model is simplified representation of a phenomenon or a system.
      - A model is extracted from multiple data layers
      - Data modelling is commonly conceptualised with entity relationship modelling

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GIS as a Tool

- Consider a scenario
  - A GIS specialist is given a problem to solve based on specifications described by other professionals
    - assembles the necessary data to complete the task
    - these data are modelled and analyzed
    - descriptive products that attempt to provide solutions for the problem are provided (such as maps, tabular information or statistics).

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GIS as a Tool

- The scenario above leads one to conclude that GIS is a tool
  - However, this is a narrow conceptualization of the GIS technology
    - Any thoughts on why this is so?

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GIS and Geospatial Reasoning

- GIS is a mature branch of Information Technology
- Uses logical thinking to infer spatial relationships and knowledge from given data
  - Less about knowing how to do this or that
    - and more about how to infer the spatial relationships in a given problem

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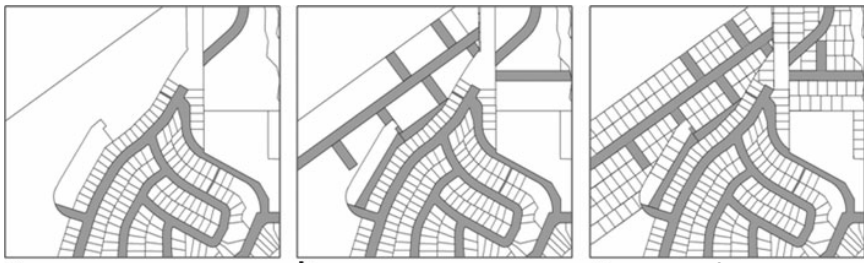
The nature of geographic phenomena

- Temporal Variation



Parcel subdivision

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The nature of geographic phenomena

- Spatial Variation
  - Tobler's First Law of Geography: "everything is related to everything else, but near things are more related than distant things."
  - Implications for appropriate representation:
    - Significance of spatial autocorrelation
    - Proximity effects
    - Geographic scale (level of detail)

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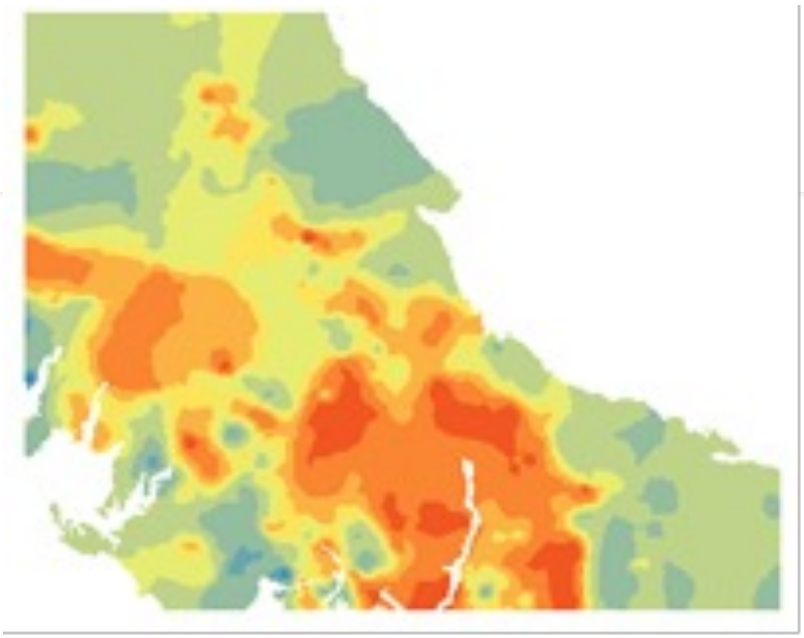

Soil pH Distribution

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Representing geographic space

- Two basic forms: Objects and Fields
  - Objects are discrete and definite, such highways, parks, municipalities…
  - Fields are distributed continuously over a large area for example temperature, rainfall, elevation…

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Representing geographic space

- The object view considers space to be populated by distinguishable, discrete, and bounded entities.
  - Objects have identity, boundaries or spatial extent and attributes
    - Points, lines, polygons
    - E.g. a representation of individual houses in a city suburb
  - Uses the Vector Data Model

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Representing geographic space

- A geographic field treats space as being populated by one or more continuous phenomena. For every point in the study area, a value can be determined.
  - E.g. River depth can be determined anywhere on a bathymetric map of the Netchako River
    - Uses the Raster Data Model

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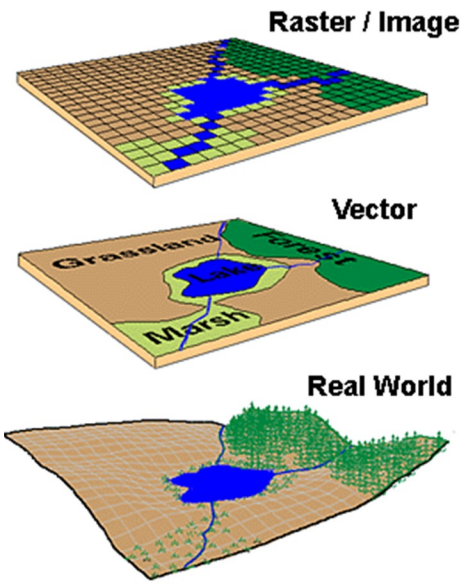
- Continuous field
  - A value can be determined for every point on the surface
- Discrete object
  - The space between them is potentially 'empty' or undetermined



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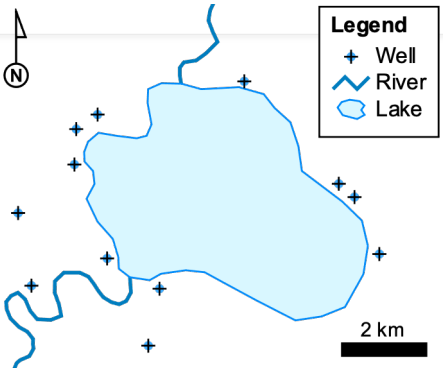
Vector data model

Three types of geometry

- Points:
  - dimensionless (no width, length, or height)
  - A pair of coordinates
- Lines:
  - One dimension
  - have length
  - At least two coordinate pairs (vertices)
  - Terms: Line, polyline, linestring
- Polygons:
  - Two dimension
  - closed vertices
  - Minimum vertices for a triangle?
  - Terms: polygon, multipolygon



Source: Wikimedia

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Vector data model

Formats

- Shapefile
  - Developed by ESRI as a data interchange format
  - Open specification, regulated by ESRI
  - A collection of multiple files
    - shp, .shx, .dbf, .prj, …
  - A shapefile can represent one geometry type

Other formats?

- GeoJSON

```
{
 "type": "Feature",
 "geometry": {
  "type": "Point",
  "coordinates": [-122.8155, 53.8922]
 },
 "properties": {
  "name": "UNBC"
 }
}
```

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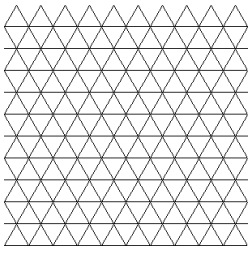
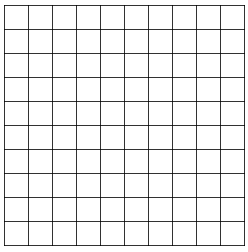
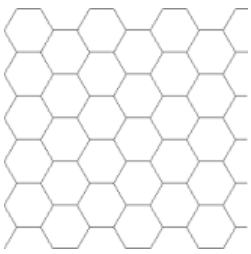
Raster data model

- Phenomena is continuous over a large area
- Regular tessellation of space
  - Triangles, squares, hexagons







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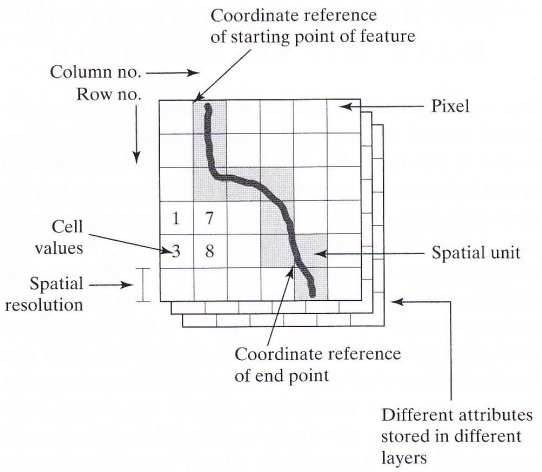
Raster data model



Characteristics of raster data

Source: Lo and Yeung 2007. Concepts and technics of Geographic information Systems. Pearson Prentice Hall

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Raster data model

- Formats
  - GeoTIFF
  - ESRI Grid
  - Pix

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Objects or Fields?

It is not a debate

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Communication

- Office Hours
  - Monday 10:30 - 11:30 || Tuesday 11:30 - 12:30
  - Email me
- Extenuating Circumstances
  - Email me ASAP
  - Email your TA regarding extensions for lab work
  - Much better to know before hand

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