Midterm #1 Study Guide
ENGR 180 Fall 2022
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Why? *"THE PURPOSE OF STUDY GUIDES is to organize lecture notes and text book material so that you can increase your comprehension and memory of large amounts of information. Preparing study guides that are visual is even more effective, as the visual organization helps you see related concepts and make meaningful connections with the material, thus acquiring the higher levels of learning expected by many of your professors." – Oregon State University*

Therefore – this study guide will provide topics and themes to help YOU organize YOUR material and understanding.

Things YOU can do to facilitate memorization and understanding:
- Timelines
- Write out short answers to questions BY HAND ("In through the hand, into the brain!")
- Doodle/diagram a process or connections between key concepts
- Compare and Contrast: Make a table for topics that are tricky to distinguish (e.g. Spatial Reference System components)
- Concept Cards: a small doodle + 3-4 key pieces of information on a specific topic, on a flashcard
- Review missed questions on previous quizzes
- Grandma method: How would you describe the content to your grandma/grandpa/little sibling/random stranger on the street who has never heard of Spatial Analysis and Modeling?

Key Terms and Acronyms: Be prepared to define the following key terms and acronyms. Key terms are underlined throughout. This is not an exhaustive list.

Chronological Topics

History and Philosophy
- Can you identify up to 5 key historical figures and their contributions to cartography and geodesy?
  Pythagoras - Created a theorem which calculates distance between points on a plane.
  Euclid - Created a type of geometry which can be used to calculate distance in 2D and 3D space
  Eratosthenes - calculated the first known measurements of the Earth
  Thales - brought key mathematical findings From Egypt and Babylon to Greece.
- Can you accurately describe *why* their contributions were important?
- How did the field of cartography and geodesy develop over time?
  Cartography is the art, science and practice of making Maps.
  Geodesy Is the branch of mathematics concerned with the shape and area of the Earth with the location of points on it.
- How do we know the earth is round (ish), and why do we need to know that?

Data and Models
- What is GIS? Why do we need it?

GIS(Geographic Integrated Systems) is a tool that allows us to map data about the world, data which is not limited to the simplifications that any map could produce, but also includes information regarding the key features of the geographic regions it mapped, it also allows for further analysis of the data collected about such geographic regions.

- What IS a model, and why do we need them?
  A model is used to represent real-world features and understand relationships between them.
- Can you provide two examples of a real world model of something?
  Architects usually build smaller models of bridges and buildings before building them.
- What makes a model good/effective?

- What are the four types of Models, and when would you use them?
- What are four types of common database models, and when would you use them?
  Relational, Hierarchical, Network and Flat-file database models.
- How can you manipulate/isolate the data in database models to answer questions? (e.g. Query)
  Restrict(query), Project, Product, Divide, Union, Intersect, Difference, Join(relate).

Spatial Primitives (Geoprimitives)

- Why do we need different geo primitives (raster/vector)?

- What are the most common data models, and what do they consist of? What are some examples?
  Data models, a conceptual model expressed in a data structure. Vector and raster are the most common data models, vector consists of point line or polygon feature types and raster consists of continuous coverage(square pixels, .png, .jpg).
- Can you differentiate between vector spaghetti and topology?
  Topology is the term describing the set of rules that define geographic features by their position in space and relationship to other features.
- Be able to identify and list topological components
  - Arc ID, Left Poly, Right Poly, From Node, To Node
  - Poly ID, No. of Arcs, List of Arcs
  - Fig. 1 at Right, Letter = Polygon, Number = Arc
  - Remember, we work clockwise in respect to given Polygon, so arcs moving counterclockwise will be negative when you list the arcs in Polygons
  - e.g. Polygon B: 3 arcs, -1, -5, -3

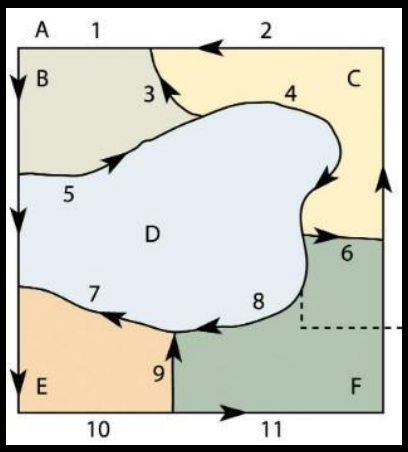
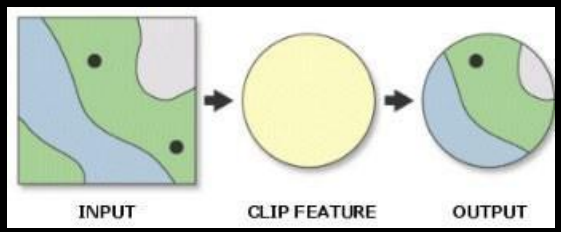


Figure 1- Topological Diagram

Basic Vector Operations

- Can you identify 5 basic vector operations (what are some geoprocessing tools you have done in labs?) in both *written* and visual format?
  point-in-polygon, polygon-on-point, line-on-line, line-in-polygon, polygon-on-line, and



polygon-on-polygon. Geoprocessing is geographic data processing. Five basic vector operations are Dissolve, Overlays for Merging Diverse Layers,

- What is MAUP, and why does it matter?
  Modifiable areal unit problem, MAUP Refers to the representation of data whose values are affected, often significantly, by the geometry of the special units used. In other words if we change the special units by changing what we see in the map. Overlays for Trimming Diverse Layer Extents, Combining Similar Layers with Different Extents, Creating Proximity-Based Polygon.
  https://www.youtube.com/watch?v=CISjONu-5Qg
- What is the general 3 step workflow of spatial data analysis?
- Can you identify 3 basic spatial relationships, and examples of questions for each? What spatial queries would you use to address the questions?
  Spatial query refers to the process of retrieving a data subset from a map layer by working directly with the map features.

Spatial Projections

- What shape is the earth? How do we know?
  Oblong Spheroid
- What are the components of a Spatial Reference System?
  Coordinate system, Resolution, Tolerance.
- Can you explain the difference between the following?
  - Geoid:Ellipsoid - A measurement based model of the shape of the Earth. The geoid is used primarily as a basis for specifying terrain or other Heights.
  - Geographic Coordinate System: Projected Coordinate System
  - Projection: Projected Coordinate System
- Doodle the three projection developable surfaces (tangent AND secant), AND aspects?
  Cylindrical, conic, azimuth, tangent (once), secant (twice).
- What are the four types of distortions that occur with projections?
- What are you two favorite projections, and WHY would you use them?
- What are your two favorite Projected Coordinates Systems, and WHEN would you use them?
- **Calculate** the representative fraction of a bowling ball (68.58 cm circumference) to the earth (40,000,000 m circumference) and display in proper format.
  Representative fraction = 0.6858/40,000,000
- Why do scale and precision matter for mapping?
- **Calculate/Convert** between DMS – DD.

Rasters and Raster Math

- Identify components of a raster (like Quiz)
- When would we want to use rasters for analysis?
- What are the different origin points for different raster types (0,0) - When would you have NAN/Null in a raster?
- Compare/Contrast Low resolution and high resolution rasters and their traits
- What are the benefits/detriments of raster data?
- Can you visually identify different types of raster preprocessing? Why would you need to preprocess data?

Raster Operations

- At what scales can you perform the 6 types of raster operations? Provide examples of scenarios.
  - Logical operations
  - Arithmetic operations
  - Overlay operations
  - Geometric property operations
  - Geometric transformation operations
  - Geometric derivation operations

- What are orientation, origin, and resolution in relation to rasters, and why do they matter?
- If your orientation, origin, or resolution are off, what are the ways you can resolve this prior to raster analysis?
- What are different resampling techniques – what are their strengths?
- Compare/Contrast Georeferencing, Georectifying, and Orthorectifying
- What are three ways we can perform Spatial Aggregation?

1	1	3	2	2
2	2	3	3	2
1	1	1	1	2
1	2	2	1	2
2	2	2	2	2
2	3	1	1	1

- Can you calculate…
  - *Slope: arctan (vd/hd)*
  - *Area: number cells * cell area*
  - *Perimeter: number cells * cell width*

Terrain Analysis
- What is topography, and what are some common topographic features you might see if you visit Yosemite National Park; if you visit Zion National Park?
- What are some visual representation types that help us understand landscapes (or seascapes!) - What factors control hillshade effects?
- Can you define and differentiate between different terrain data structures?
- Can you calculate ○ *Aspect: atan[(dz/dx)/(dz/dy)]*
  - *Flow Direction: direction of steepest Slope: arctan (vd/hd)*
- Can you identify first and second derivatives of terrain, and when you would want to use them?
- Doodle the two main types of profile curvatures with each of their three potential values (-,+,0)
- What are two scenarios in which you'd like to know about a location's viewshed (aka visibility)

Hydrospatial Analysis
- PENDING

Remote Sensing Analysis

- PENDING

Rapid Fire

Know your abbreviations. Here are a few to consider:

- COGO - Coordinate geometry
- DBMS - Database Management system
- DEM -
- GIS
- GPS
- GNSS - Global navigation satellite system
- MMU
- NAD83
- PDOP
- RMSE - Root mean square error
- RTK
- SQL - Structured query language
- TIN - Triangulated irregular Network
- USGS
- UTM
- WAAS - Wide area augmentation system

Know your definitions and be able to describe concepts and provide examples. Here are a few to consider:

- Vector
- Raster
- Projections
- Geodesy, not limited to spheroid, geoid, ellipsoid and datum
- Geo-primitives
- Geo-processing
- Historical approaches to mapping, such as T-O maps
- Zonal Statistics and other raster processing techniques
- Terrain analysis

Know how to do some calculations. Here are a few to consider:

- Conversion between DMS and DD
  DMS to DD = D + M/60 + S/3600
- Inverse distance between two points
- Traverse a set of points given starting location, bearings, and distances
- Calculate geodetic distance between two points (i.e., “Great Circle”)
- Calculate slope in a 3 x 3 raster grid
- Calculate aspect in a 3 x 3 raster grid