CSS 4200 Geographic Information Systems (GIS)
Practice problems for Prelim Exam #1 (16Oct08)

The following questions are compiled from various problem sets and exams, and represent the type of questions asked on prelim and final exams for this course. Some calculations below would need a calculator and are included for practice. Similar questions on CSS 4200 prelim exams will not require a calculator, but will include some fundamental calculations that can be done by hand. The Bolstad citations below refer to the 2nd edition.

If the distance between two points is 2,500 meters on the ground and 15 cm on the map, what is the map scale?

1/sf = 0.15m/2,500m
sf = 2,500m/0.15m
sf = 16,667
scale = 1/16,667 (or 1:16,667)

What is the surface area in hectares (1 ha = 10,000 m^2) of a feature on the ground if the dimensions of the feature as measured on a map at 1:50,000 scale are 1.5 cm by 2.5 cm?

1/sf = md/cgd
cgd = (md)(sf)
cgd_1 = (0.015m)(50,000)
cgd_1 = 750m
cgd_2 = (0.025m)(50,000)
cgd_2 = 1250m
area = 750m x 1250m
area = 937,500 m^2
area = 937,500 m^2/10,000 m^2/ha
area = 93.75 ha

The area of a square feature on the ground is 100 hectares and measures 4 cm by 4 cm on the planimetric map. What is the map scale?

100 ha = 1,000,000 m2
cgd = $[1{,}000{,}000]^{0.5}$ = 1,000m
1/sf = (0.04m)/(1,000m)
sf = 1,000m/0.04
sf = 25,000
map scale = 1/25,000 (or 1:25,000)

Geographic Coordinate System:

Convert the following geographic coordinate from degrees-minutes-seconds (DMS) to decimal degrees (DD): **11^{o} 35' 53"** (reference: Figure 2-7, p. 29, Bolstad)

11.
35/60 = 0.583333
53/3600 = 0.014722
DD = 11 + 0.583333 + 0.014722
DD = 11.598056

Convert the following geographic coordinate from DD to DMS: **37.388889^{o}**
(reference: Figure 2-7, p. 29, Bolstad)

37^{o}
0.388889 * 60 = 23.33334
0.333340 * 60 = 20.00040

37^{o} 23' 20.000"

Briefly define the following GIS terms:

Arc: a line defined by vertices and nodes, which usually represented by pairs of map coordinate points (x,y).

Boolean algebra: mathematical logic that expresses the relationship between objects or entities.

Buffer: a boundary condition implemented by a series of polygons or grid cells circumscribing a feature of interest

Geographic information system (GIS): a set of interacting processes that provides data and information on spatial and temporal relationships of the Earth.

Line: a directed segment defined by a beginning and ending nodes, or vertices.

Node: a point, or vertex of a line that represents beginning, ending, or intersection

Point: a set of x,y coordinates representing the position in space of a feature without length or area.

Polygon: a closed topological entity that represents area of a feature.

Raster: a square cell within a set or array of cells in rows and columns that represent features of interest (points, lines, or polygons).

Vertex: a point used to represent the individual position of a point, or shape of a linear feature or polygon.

What are the five major functions commonly provided by GIS software?
Data Entry, Editing, Data Management, Analysis, and Output

What are the two major types of data models used in GIS, how are features on the Earth's surface represented in each, and what are three advantages and disadvantages of each data model?

a) **data model types**:

vector, raster

b) **feature representation**:

vector: points, lines, polygons; raster: grid cells

c) **advantages/disadvantages**:

vector: small file sizes, simple coordinate conversions, map-like cartographic representation; complex data structure. Raster: simple data structure, large file sizes, coordinate conversions may require resampling; analysis easy; cartographic representation not map-like.

What is topology?

Topology expresses the spatial interrelationships between features.

What shape-invariant spatial properties does topology describe?

Contiguity, containment, connectivity.

List two topological entities that are used to define and encode map features using a vector data model.

Arc, node, or vertex

What is the fundamental difference between **union** and **intersect** overlay operations using vector (feature) data?

Union retains the map extent of both input features ("OR"), whereas intersect retains only what is common between both input features ("AND").

Give one example of a "local," "neighborhood," and "global," function when using map algebra with raster data (discrete or continuous rasters).

Local:

a function is applied to input cell that is used to encode value of output cell (e.g., the population density of a geo-political state replaces the existing value of the output cell)

Neighborhood:

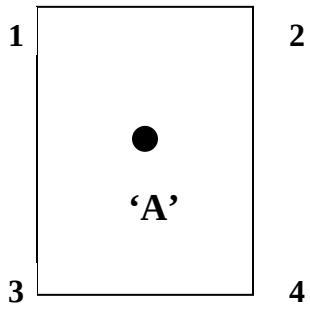
a function is applied to a set of cells in proximity to the output cell that is used to encode the value of the output cell (such as the number of geo-political "adjacent states" to a given state)

Global:

a function is applied to the entire set of input cells to compute a value for a individual output cell (e.g., population rank of cell based on population of all geo-political states in a set).

The graphic below represents a portion of a planimetric map for an area in Africa. Point 'A' is located at 12^{o} north latitude and 28^{o} east longitude. The four pairs of coordinates, using the Universal Transverse Mercator coordinate system, represent the location of the four corners of a project area. Answer the following questions using information provided by Point 'A' and the four coordinate pairs. (20 points)

1,400,000 650,000 = 3
1,404,000 653,000 = 2
1,400,000 653,000 = 4
1,404,000 650,000 = 1



(a) What are the UTM coordinates of each corner of the map?

Corner #	UTMe	UTMn
1	650,000	1,404,000
2	653,000	1,404,000
3	650,000	1,400,000
4	653,000	1,400,000

(b) In what UTM Zone is this map located?

Longitude of 'A' is 28 ^{o} east longitude. The UTM grid starts at 180 ^{o} longitude and proceeds eastward with each Zone being 6^{o} longitude in extent. To the Prime Meridian (0 ^{o} longitude), there are 30 zones (180-0/6). To 28 ^{o} east, there 4 Zones plus 4 degrees (6 x 4 = 24 + 4 = 28 ^{o}). Therefore, 28 ^{o} east longitude is within UTM Zone 35. Since 'A' is north of the equator, we should specify that 'A' is in UTM *Zone 35N*.

(c) What is the central meridian of the Zone?

Zone 35 is delimited to the west by 24 ^{o} east longitude and to the east by 30 ^{o} east longitude. The central meridian = *27 ^{o} east longitude*

(d) Is Point 'A' located west or east of the central meridian?

Given that the central meridian is 27 ^{o} east longitude, point 'A' is east of the central meridian. You also know this because the UTM easting coordinate is greater than 500,000 m, which is the UTM easting coordinate of the central meridian of each UTM Zone, globally.

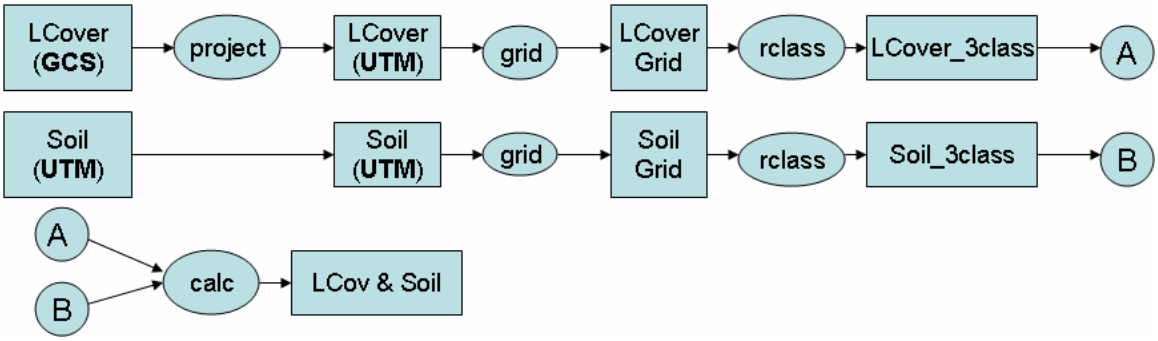
(e) What is the scale of the map if the map distance between corner point #1 and corner point #4 is 10 cm?

Using the distance formula and UTM coordinates provided or realizing our project area is constructed with two "3-4-5" triangles, the distance between the two opposite corners is 5,000 m. Using the map scale formula, we calculate that the map scale as 1:50,000.

1 / x = md / cgd
x = cgd / md
x = 5000m/0.01m
x = 50,000, or a map scale, using a representative fraction, is equal to *1/50,000*

Draw a spatial analysis flow diagram that describes the process to determine the distribution of soil type by land cover type for the two maps below. Assume the **land cover** map coordinates are geographic (latitude, longitude) and the **soil** map coordinates are UTM and datum WGS84, each map is a polygon shapefile, and the resulting **raster** map has a cell size of 50 m. (20 points)

Draw flow diagram here:



Complete the "raster calculation" below by filling in the output raster map with "1" for the true condition and "0" for the false condition for the occurrence of **SoilB** and **Agriculture** land cover types.

1 = SoilA, 2 = SoilB, 3 = SoilC

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

1 = Agriculture, 2 = Forest, 3 = Urban

1	1	1	1
1	1	2	2
2	2	1	1
2	1	1	2

Output =

0	0	1	1
0	0	0	0
0	0	1	1
0	1	0	0

What is the land area, in hectares (1 ha = 10,000 m^2), where **SoilB** and **Agriculture** land cover occur?

There are five (5) cells that have the combination of both SoilB *and* Agriculture land cover type. Your resulting raster map has a cell size of 50 meters square (or 2,500 square meters). Each cell represents 0.25 ha (2,500 m / 10,000 m^2 ha^{-1}). Therefore, the land area equals *1.25 hectares* (5 cells x 0.25 ha /cell).

Define the following geo-spatial processing and analysis terms:

Reclassification:
This process allows one to convert a continuous raster, or grid, to discrete values which are assigned to individual classes, the method for which and number of classes being defined by the user. One can also reclassify a discrete raster into an alternate set of classes, depending on one's geo-spatial processing and analysis objectives.

Geographic coordinate system:
These coordinates define x,y locations on the Earth's surface using units of arc-degrees, minutes and seconds as measured from the center of the Earth (1) northward from the equator to the north pole (north latitude) or southward from the equator to the south pole (south latitude), and (2) eastward from the Prime Meridian to the international dateline (east longitude) or westward from the Prime Meridian to the international dateline (west longitude).

Ellipsoidal distance:
One can measure distance on curved surfaces or planar surfaces. Using non-linear units of arc on the curved surface of a sphere (e.g., the Earth), we measure distance along the ellipsoid, or the mathematical definition of the shape of the Earth (Ellipsoidal distance). On flat surfaces, or planes, in which a units of distance in x and y are equal (e.g., maps which present 3-d surfaces as 2-d representations using 'projections'), we use Euclidean geometry to measure distance between objects of interest (Euclidean distance).

Small-scale map:
Maps are produced at different scales to represent the relationship between the size of an object (e.g., length, area) on a map to its true size on the Earth's surface. A small-scale map (small representative fraction) represents a large land area with general information about objects in that land area. A large-scale map (large representative fraction) represents a smaller land area with specific detail about those same objects.