

**Geography 521
General Spatial Analysis
Final Exam
November 21, 2011**

**Time: 2 ½ hours
Total: 81 Marks**

Name: _____

Part A: Multiple Choice Answers (41 marks total). Circle the best answer. All questions are worth 1 mark.

1. What is a fractal? (1 mark)

- A. A complete series of distances between points, plotted against their differences in value
- B. A nested pattern that repeats at different scales
- C. A pattern that completely covers a surface
- D. A curve that describes the average difference in value between points at different distances from each other

Answer: B

2. How is the correction signal transmitted to a GPS receiver that uses the Wide Area Augmentation System (WAAS)? (1 mark)

- A. It is directly transmitted through radio link from a network of ground-based antennas
- B. It is transmitted through the cellular phone network
- C. It is relayed through the same satellites that provide trilateration on the L3 channel
- D. It is relayed through communications satellites in geosynchronous orbit

Answer: D

3. If you needed to determine whether spatial autocorrelation was present using ArcMap, prior to running Geographically Weighted Regression, which function would you use? (1 mark)

- A. Moran's I
- B. Kriging
- C. Pearson's R
- D. Kernel Density Estimation

Answer: A

4. If I had one thematic raster that showed municipalities in the Greater Vancouver Regional District, and a continuous raster which showed population density, which type of filter would I use to calculate mean population density for each municipality in the thematic raster? (1 mark)

- A. Global Filter
- B. Zonal Filter
- C. Local Filter
- D. Focal Filter

Answer: B

5. Which single command provides you with the mean centre and the standard deviation of distances from the mean centre to all other points? (1 mark)

- A. Standard Distance
- B. Circular Variance
- C. Directional Mean
- D. Directional Distribution

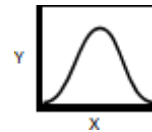
Answer: A

6. Two interrelated effects resulting from the Modifiable Area Unit Problem are: (1 mark)

- A. The Scale Effect and the Aggregation Effect
- B. The Population Effect and the Census Effect
- C. The Census Effect and the Scale Effect
- D. The Aggregation Effect and the Representation Effect

Answer: A

7. The following curve has a skew that is _____ (1 mark):



- A. Strongly Positive
- B. 1.0
- C. Strongly Negative
- D. Non-existent

Answer: D

8. What is the main purpose of an explanatory model? (1 mark)
- A. To predict the future state of a system
 - B. To show a future “ideal” situation
 - C. To describe the current state of a system without modelling its inner workings
 - D. To model the inner workings of a system, so that the system can be understood better

Answer: D

26. What is Kurtosis (1 mark)
- A. The number of peaks in a curve
 - B. The amount of "peakedness" of a curve
 - C. The length of the tail on the positive side
 - D. A measure of the number outliers in a data set
 - E. A nasty disease, in which you can't stop humming Nirvana songs.

Answer: B

9. Ratio data (1 mark)
- A. Allows you to know the exact difference between 2 values
 - B. Has an absolute zero
 - C. Is usually stored using a floating-point number in a computer
 - D. All of the above

Answer: D

10. An example of ordinal data is: (1 mark)
- A. Temperature, measured in degrees Celsius
 - B. Temperature, measured in degrees Kelvin
 - C. Length of a line
 - D. Room temperature, classified into Hot, Warm, Cool, and Cold.

Answer: D

11. What is a Global Filter? (1 mark)
- A. One that uses a raster that has a projection of the entire world (i.e. Mercator)
 - B. One that uses every value in a raster in its calculation
 - C. A way of erasing all points in a DEM
 - D. A way of converting all X, Y coordinates to a new location

Answer: B

12. A model of urban development whose goal is to minimize future expenditures for the provision of services is an example of this type of model: (1 mark)
- A. Descriptive
 - B. Normative
 - C. Predictive
 - D. Explanatory

Answer: B

13. Cost Allocation (1 mark)

- A. Identifies the nearest source to each cell in a grid, using Euclidean Distance
- B. Identifies the best place to put a new facility, using a cost surface
- C. Identifies the nearest source to each cell in a grid, using a cost surface
- D. Identifies the best place to put a new facility, using Euclidean Distance

Answer: C

14. Which GNSS works the best in the Arctic, because of the inclination of its orbital planes?

- A. NAVSTAR GPS
- B. GLONASS
- C. GALILEO
- D. COMPASS

Answer: B

15. Which of these is the "native" datum used by GPS receivers? (1 mark)

- A. NAD 27
- B. NAD 83
- C. WGS 84
- D. NAVD 88

Answer: C

16. Other than NAVSTAR GPS, which of these is the only other fully operational GNSS?: (1 mark)

- A. Galileo
- B. GLONASS
- C. COMPASS
- D. IRNSS

Answer: B

17. If I wanted to save the location of my car on a GPS receiver before I left on a hike, I would enter a: (1 mark)

- A. Track
- B. Route
- C. Waypoint
- D. Point of Interest (POI)

Answer: C

18. What does the corridor function create? (1 mark)

- A. A raster path from A to B, following the line of lowest elevation
- B. A raster path from A to B along the shortest Euclidean distance
- C. A raster area between A and B showing travel costs through every cell
- D. A polygon area between A and B within which all water flows into the centre

Answer: C

19. What is Dynamic Segmentation? (1 mark)

- A. A way to automatically create nodes in lines
- B. A way to record attribute information based on where that attribute begins and ends, relative to the start of the line.
- C. An artificial intelligence technique to calculate line lengths
- D. A technique to build faster computers with which to run GeoComputational Models

Answer: B

20. On which frequencies are the primary GPS navigational signals broadcast? (Circle all that apply) (1 mark)

- A. L1 (1575.42 MHz)
- B. L2 (1227.60 MHz)
- C. L3 (1381.60 MHz)
- D. L4 (1841.40 MHz)
- E. L5 (1176.45 MHz)

Answer: A and B

21. The raster operation that most closely matches an Intersection is: (1 mark)

- A. | (OR)
- B. ^ (XOR)
- C. & (AND)
- D. ~ (NOT)

Answer: C

22. Which of the following statements is not true? (1 mark)

- A. NoData is different from 0
- B. NoData is always invisible
- C. NoData / NoData = 1
- D. NoData allows rectangular rasters to appear irregular in shape

Answer: C

23. If I have a raster with 20m resolution and another with 10m resolution, when I combine them, ArcMap automatically: (1 mark)

- A. Reclassifies
- B. Rubbersheets
- C. Resamples
- D. Replaces

Answer: C

24. A model which predicts the climate of the World in 2050 is an example of this kind of model: (1 mark)

- A. Descriptive
- B. Normative
- C. Predictive
- D. Explanatory

Answer: C

25. What is the function of the Thin command? (1 mark)

- A. Convert a polygon into a line
- B. To create a test data set with a reduced number of features
- C. To reduce the complexity of a boundary between raster regions
- D. To remove pixels from the outside of a raster feature

Answer: D

26. Which polygon generalization function merges polygons that have the same values for a particular attribute? (1 mark)

- A. Dissolve
- B. Simplify
- C. Eliminate
- D. Smooth

Answer: A

27. Which concept in Spatial Statistics has two different definitions, one British and one American? (1 mark)

- A. Mean Centre
- B. Linear Directional Mean
- C. Median Centre
- D. Standard Distance

Answer: C

28. How can you change NoData values to zeroes? (1 mark)

- A. Add 1 to them
- B. Reclassify the raster
- C. AND it with a coverage containing all 1's
- D. Make a new raster equal to NOT the input raster

Answer: B

29. What are two inherent attributes of every polygon? (1 mark)

- A. Area and Width
- B. Length and Pixel Size
- C. Must Not Overlap With and Must Not Have Gaps
- D. Perimeter and Area

Answer: D

30. To be able to double-click on a model in ArcToolbox and change its settings, you must do the following when editing that model: (1 mark)

- A. Add Functions
- B. Add Connections
- C. Make Layer Visible
- D. Set Parameters

Answer: D

31. If you converted polygons with nominal data into a raster, what would you get? (1 mark)

- A. A thematic raster
- B. A continuous raster
- C. A field
- D. An image raster

Answer: A

32. Which source of GPS error can be compensated for by employing a dual-frequency GPS receiver? (1 mark)

- A. Ionospheric Error
- B. Multipath Error
- C. Receiver Noise
- D. Dilution of Precision

Answer: A

33. A filter that uses a square of 9 cells, takes the mean, and assigns it to the centre pixel is a: (1 mark)

- A. Global Filter
- B. Zonal Filter
- C. Local Filter
- D. Focal Filter

Answer: D

34. If I wanted to return back along my original convoluted route using a GPS, I would create a: (1 mark)

- A. Waypoint
- B. Track
- C. Route
- D. Bearing

Answer: B

35. A raster needs an origin, the cell size, the number of rows and columns, the pixel values and: (1 mark)

- A. The orientation
- B. The centre of each pixel
- C. The edges of the raster
- D. A colour ramp

Answer: A

36. What is a cost surface? (1 mark)

- A. A raster that shows travel time in dollars
- B. A TIN
- C. A classified raster showing erosion potential
- D. A raster where each pixel contains a value indicating how much effort or time is required to cross that pixel

Answer: D

37. Through which sense does most information enter the human brain? (1 mark)

- A. Touch
- B. Smell
- C. Sight
- D. Taste

Answer: C

38. What is the main function of Spatial Analysis? (1 mark)

- A. Producing raster overlays
- B. Turning data into information
- C. Modelling the growth of fires etc. over a landscape
- D. Identifying clusters in data

Answer: B

39. There is a hierarchy in our way of understanding the world. The order of the hierarchy is: (1 mark)

- A. Information, Data, Wisdom, Knowledge
- B. Data, Information, Knowledge, Wisdom
- C. Data, Knowledge, Information, Wisdom
- D. Information, Wisdom, Knowledge, Data

Answer: B

40. The distance from A to B "as the crow flies" is an example of: (1 mark)

- A. Euclidean Distance
- B. Manhattan Distance
- C. Migratory Distance
- D. Mahalanobis Distance

Answer: A. Euclidean Distance

41. Waldo Tobler: (1 mark)

- A. Led the revival of Artificial Neural Networks in the 1980's
- B. Is the person who described spatial autocorrelation as the first law of Geography
- C. Devised the first Database Management System
- D. Invented the TIN, after being inspired by Toblerone

Answer: B

Part B: Short Answer Questions. Marks vary by question (24 marks total).

42. What are the six steps involved in developing a spatial model? (3 marks)

Answer: 1) state the problem 2) Break down the problem 3) Explore the datasets 4) (build the model and perform the analysis 5) Verify the model results 6) implement the result

43. How are Image, Continuous, and Thematic Rasters different from each other? (1 mark)

Answer: A continuous raster stores interval or ratio data in each pixel, which must be converted into colours using a classification scheme. A thematic raster stores nominal or ordinal data in each pixel. An image raster stores colour values directly in each pixel.

44. Fill in pixels in the following raster to represent *positive* autocorrelation. Assume only 2 classes. (1 mark)

Answer:

X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						
X	X	X	X						

45. Describe the columns that you would expect to see in the results of a spatial join (2 marks)

Answer: the attributes of the layer from which the join was made, plus a number of summary statistics that were chosen by the user from the attributes of the layer that was being joined.

46. Explain how the distance from one GPS satellite to a recreational-grade GPS receiver is determined (3 marks)

Answer: 1. Satellite Number is determined

2. Satellite Number is used to calculate a PRN

3. Offset between PRN generated by receiver and PRN received from satellite is determined to determine time differential

4. $D = VT$ ($D=299,734... \text{ km/s}$)

47. Given the following list of numbers:

8, 8, 1, 3, 1, 8, 4, 5, 8, 8, 3, 3, 2, 6, 7

Calculate the first quartile, median, third quartile, mean, mode, and range. Use the Mendenhall and Sinchich (1995) method to calculate the quartiles. (you should not need a calculator for this!) (3 marks)

Answer: $Q1 = 3$, $Q2 = 8$, $\text{mean} = 5$, $\text{median} = 5$, $\text{mode} = 8$, $\text{range} = 7$

48. Describe the significance and importance of a normal (Gaussian) curve in statistical analysis (1 mark)

Answer: Normal curves are formed by many natural processes that are the result of stochastic processes. Inferential statistics are based on normal curves

49. What is the directional mean of 315° and 345° (1 mark)

Answer: 330 degrees

50. What is the difference between data and information? (1 mark)

Answer: Data are raw symbols or numbers. Information is processed data that answers "who," "what," "where," and "when" questions.

51. What is the difference between cost and path functions? (2 marks)

Answer: Cost functions only consider the difficulty in travelling through a cost surface. Path functions include vertical and horizontal cost factors in addition to the cost of travelling through a cost surface.

52. Describe the Ecological Fallacy (1 mark)

Answer: the statistics of a group do not apply to an individual member of that group or a smaller subgroup

53. What are Spatial Statistics? (1 mark)

Answer: Spatial statistics analyze spatial distribution or spatial and attribute distribution together

54. "The Modifiable Area Unit Problem is a result of the arbitrary division of space into districts, and does not happen on natural boundaries." Discuss. (3 marks)

Answer: With natural boundaries, the boundary reflects fundamental differences between polygons. With human boundaries, no such difference exists. Changing the boundaries, even within the same statistical population, results in the aggregation effect, which results in different statistics being generated.

55. Define Aspect (1 mark)

Answer: the bearing towards which a particular area of ground faces.

Part C: GIS Analysis Scenarios. Please answer concisely in point form, using diagrams as necessary to illustrate your thoughts. Answer on the attached paper (16 marks total)

56. Choose Either Option A or Option B, below (8 marks)

Option A:

A wildlife biologist has come to you with a problem. She has a series of coordinates that were reported by GPS tracking collars on the elk she is studying on Vancouver Island. The data are stored in an Excel spreadsheet with the date of observation, and separate columns for degrees, minutes, and decimal seconds for both Latitude and Longitude. She would like a shape file showing the summer and winter range of the elk in the BC Albers Projection, together with some estimates of elk density for every month.

You are Given:

- A list of observations, with Latitude (NAD 83), Longitude (NAD 83), date and time in an Excel spreadsheet
- A digital base map of the elk habitat in BC Albers Projection

Your task:

1. Create two separate polygons that describe the Summer (March 1 – October 31) and Winter (November 1 – February 28 or 29) range of the elk.
2. Create a series of 12 maps showing the density of elk expected per month over the entire year.

Answer:

1. Import Excel file into ArcMap
2. Create new columns for latdec and longdec.
3. Calculate latdec as $\text{latdeg} + \text{latmin}/60 + \text{latsec}/3600$, do the same for longdec.
4. Start a new edit session, and define the projection for the frame to be geographic, NAD83
5. Convert the X and Y coordinates into point features (we haven't discussed how)
6. Save the temporary features to a new shape file
7. Define the projection of the shape file
8. Project the shape file to BC Albers
9. Create a density surface for the point data
10. Determine a cut-off point
11. Use reclassify to convert all values $>$ threshold to 1 and outside to NoData

12. Run a raster to vector conversion to obtain a polygon for the range

Option B:

A large real estate development company has determined that there is sufficient demand on Vancouver Island to build a new destination downhill ski resort. The company has already ruled out purchasing an existing resort or reviving previous resorts such as Forbidden Plateau and Green Mountain, because climate change is forcing resorts to be located at higher elevations than ever before.

You are Given:

1. TRIM mass points, spot heights, and breaklines for all of Southern Vancouver Island
2. Complete weather records from all meteorological stations on Southern Vancouver Island, including solar radiation measurements for the more important stations. This is presented as a Comma Separated Value (.csv) file of data.
3. A file geodatabase containing layers showing wildlife ranges, avalanche zones, glaciers, existing roads

Your Tasks:

1. Find an appropriate location for a new ski resort which is within a 1½ hour drive of both Victoria and Nanaimo. The resort must have the following characteristics:
 - a. A large amount of skiable terrain above 1000 m elevation, preferably with a variety of terrain types.
 - b. Snowpack greater than 1 m depth 90% of the time between Dec. 1 and Mar. 1 of every ski season.
 - c. Low amounts of incident solar radiation for areas below 1200m to preserve snowpack into the spring.
 - d. No conflicts with wildlife habitat during the winter (Dec-Mar) and summer (June-Aug) seasons.
 - e. An area of 2 km² with slopes below 10% adjacent to the slopes to serve as a base area for the main ski lodge and on-mountain accommodation.
2. Plan a route between the base area and the nearest major highway, designing a road that has less than a 10% slope, and which avoids avalanche areas.

Answer:

1. Identify mountains that have the correct height range, and calculate area above 1000m
2. Determine which of those have the most skiable terrain. Select the top 3
3. Interpolate snowpack based on weather station data; work out multiplier function based on altitude
4. Run solar radiation analysis on area above 1000m to determine energy input during fall, winter, and spring
5. Examine overlap between shortlisted mountains and animal habitat that are active in the winter
6. Perform slope analysis; reclass for areas < 10% slope; vectorize polygons and determine area
7. Determine distance to closest road, and plan route to avoid terrain with >= 10% slope.
8. Determine total distance to Victoria, Nanaimo with new road in place.

57. Choose Either Option A or Option B, below (8 marks)

Option A:

The VIU woodlot has been infested by the Douglas Fir beetle. In conjunction with the Ministry of Forests and Range, VIU wants to test a new method of biological control on the beetle. First, however, we need to know from where the infestation is originating. Last year, 170 pheromone-based beetle traps were set up throughout the woodlot in order to gauge the level of infestation. Ten thousand beetle predators will be dropped at each of the top 10 infested sites. Two months after the biological control method is used, the traps will be replaced to gauge the effectiveness of the technique.

You are Given:

1. A paper map of the woodlot, showing the primary, secondary, and tertiary tree species, plus the percentages for each. This map has UTM NAD 27 coordinates displayed in a graticule.
2. An Excel table show the X,Y coordinates of each trap, plus the number and size of male beetles collected from each (the traps only attract male beetles). These coordinates were collected using a GPS receiver, and the coordinates are in UTM, with a WGS 84 datum.
3. GPS receivers to locate the traps and the new release points.
4. A supply of beetle pheromone traps

Your task:

Determine the worst areas of infestation for targeting by biological control and describe how GIS can be used in an ongoing monitoring and control program. In following years, this program will be repeated, so you need to gauge the effectiveness of the process as well as propose 10 new infested sites to target on an ongoing basis, until the beetles are under control or eradicated.

Answer:

1. Import the Excel data
2. Convert the X, Y, data to points (Add XY data to map)
3. Run Point density, Kernel Density (Not mean nearest neighbour analysis – it doesn't create map output) (or for more sophisticated analyses, weighted point density, nearest neighbour distance, Getis-Ord General G, or Getis-Ord G_i^* function using beetle length to identify clusters)
4. Determine 10 highest peaks
5. Use GPS to locate the release sites
6. Reset the traps and recollect the data
7. Rerun the analysis next year, subtract next years' grid from this years to determine effectiveness of program
8. Retarget the 10 highest peaks for release, and repeat the process.

Option B:

Once again, the VIU campus has been overrun by rabbits. The rabbits have reached their carrying capacity on campus, and are now migrating to other places, and the neighbours are none too happy. As a result, VIU is developing a rabbit management strategy, and they want your help to develop a spatial model of rabbit habitat.

You are Given:

- A shapefile showing sources or pools of water where the rabbits can drink from
- A shapefile showing where remains of food “donations” have been found
- A Garmin GPS receiver, on which the locations of rabbit warren entrances have been stored as waypoints
- A geodatabase which contains a layer showing observed rabbit locations, each tagged by the time the rabbit was sighted

Your task:

Draw a conceptual model that describes how you could use a GIS to define rabbit habitat and the spatial distribution of rabbits on the VIU Nanaimo campus. The model will be used to make recommendations for physical changes to the campus design which will help to control the rabbit population. Make sure you consider the necessities of life, such as access to food, water, and shelter as well as other considerations such as the size of range, and competition for mates. Consider the role played by predators, the VIU cafeteria, and well-meaning students who feed the rabbits.

Answer:

