Massachusetts Institute of Technology - Department of Urban Studies and Planning

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11.520: A Workshop on Geographic Information Systems

11.188: Urban Planning and Social Science Laboratory

In-Lab TEST - November 21, 2005

Test Instructions

- This test starts at the beginning of lab; You have 2 hours to finish.
- This is an open-book, open-note test. However, do not contact any "live" non-staff person via electronic or other means while you take this test.
- Please create your answers in electronic format - just as you have for lab assignments - and save your work, as usual, in your personal locker (i.e., the I:\ drive). For your convenience we have provided an answer sheet for your *textual* answers. (On this answer sheet, we've provided some extra space where you can explain how you obtained certain numbers and county names. These explanations don't earn extra points but *allow you to get partial credit* if some of your numerical answers and names are incorrect but your method had merit.)
- Turn in your test (both the text and the PDFs) *Remember to turn in your test before leaving the room. Please confirm with an instructor that your exam has been received. We strongly recommend that you retain the file containing your answers until we return the graded exams to you.*
- Make sure to include your name and Athena user ID near the beginning of each document that you turn in. Failure to include your name and user ID on both your text file and PDFs *can cost you* up to 5 points (in total)!
- *Finally, don't spend all your time on one or two questions.* Start by looking over all the questions to get a general sense of what, and how much, is being asked, and the grade points associated with each question--then start work on your answers. Move on to the next question if you've spent more than 5 minutes on any short answer question; mapping questions will likely take longer.

Good luck!

Datasets for the Test

For this test, we will use datasets, in the class data locker, from past homework and labs plus a new shapefile, a new data table, and a new grid coverage. All shapefiles and grids represent location using Massachusetts State Plane coordinates (NAD83) in meters. The old datasets are in the class data locker and the new datasets sets are in M:\test05data. Here's a summary of the datasets you will use

Full pathname	Description
M:\data\matown00.shp	Shapefile from MassGIS of political boundaries for the 351 Mass municipalities (year 2000 version). Attribute information includes a municipality ID (TOWN_ID), municipality name (TOWN), town population as of 1980 (POP80) and 1990 (POP90) and 1980-1990 population change (POP_CH).
M:\data\shopcntrs.shp	Shapefile originally obtained in the mid-1990s from SRI Research of shopping center locations in Eastern Mass. Attributes include type of shopping center (PROPERTYSU) and square footage (SQUAREFEET). Squarefeet = -1 implies a missing value.
M:\test05data\exits_pt.shp	Shapefile of points from MassGIS (http://www.mass.gov/mgis) that mark the location of all exits on limited-access highways (i.e., interstates and certain major State roads) in Mass. Attributes include the Route number.
M:\test05data\madoreqv.dbf	A dBase-formatted table containing data about the 351Mass cities and towns developed from the 'Comparison Criteria Report' published annually by the Mass Dept. of Revenue (DOR). These data are from the year 2004 report and include these fields: town name (Municipali), county code (county_cod), 2002 population (pop02), 1999 per capita income (inc99), assessed property value per capita (eqv2002), area in square miles (sqmi), road miles as of 2002 (roadmile02), fiscal year 2004 municipal budget (budget04), and number of parcels as of 2004 (parcel04).
M:\test05data\matowngd	An ArcGIS grid coverage that what developed by rasterizing the polygons in the **matown00** shapefile using 1 km grid cells. The attribute value for the grid is the TOWN_ID in the original **matown00** shapefile.

Before starting to use these datasets, you should copy the entire 'test05data' directory to your personal locker. The **exits_pt** shapefile, the DBF table, and **matowngd** in the 'test05data' locker are read-only, but you will want write access to them for some of your work on the test.

Part I: Short Answers (41 Points)

Question I-1 (21 points total, 3 points each)

Using the **matown00** shapefile, answer the following questions about Mass municipalities:

- Which municipality had the largest drop in population between 1980 and 1990: town name_____
- What is the population change for this municipality_____
- Which shopping center of type propertysu='Neighborhood Center' has the largest square footage? PropertyID=_____
- What is the square footage of that shopping center? SquareFeet=_____
- There are only 351 cities and towns (i.e., municipalities) in Mass, but there are 631 polygons in the matown00 shapefile because of islands, towns split by rivers, etc. How many municipalities are represented by a single polygon in the matown00 shapefile? _____
- Which municipality is represented by the largest number of distinct polygons in matown00? town name=_____
- How many polygons are used to represent that municipality? Number of polygons= _____

Question I-2 (20 points total, 4 points each)

Add the **exits_pt** shapefile to your ArcMap session and answer the following questions:

- Among those municipalities that contain at least one major highway exit, which one has the smallest 1990 population? town=_____
- What is the 1990 population of that municipality? pop90=_____
- Next, we would like to count the number of major highway exits in each municipality. One way to get started with this calculation is to tag each row of the **exits_pt** attribute table with the name of the municipality that it falls within. Explain briefly the steps that you would take to do this using ArcGIS.
- Carry out these steps in order to determine the number of highway exits within each municipality. Boston contains the *largest* number of exits (19). Determine the municipality with the *second* largest number of major highway exits? town_name =_____
- What is the number of major highway exits that fall within that municipality? number of exits =_____

Part II: Spatial Analysis and Mapping Using ArcGIS (59 Points)

Question II-1 (28 points total)

Part II-1A (4 points): How many municipalities have a population density (pop02/sqmi) of at least 500 people per square mile?(Hint: You may want to calculate the density in a new field that you add to one of the tables. There are two reasons to do this *before* you join the table to matown00. First, the matown00 shapefile is read only (unless you've copied into from the class locker into your own workspace), and second, the matown00 shapefile contains more than one row for some towns - you want the number of municipalities with high density and not the number of mapped polygons with high density.) **Number of towns with pop02 / sqmi > 500 _____**

Part II-1B (16 points): *Develop a thematic map* showing the population per square mile (using the *pop02* and *sqmi* fields from the *madoreqv.dbf* table). Turn in a PDF version of a properly annotated ArcMap layout of this thematic map using quantile classification with 5 categories. Display the major highway exits on top of the thematic map and show a *3 km buffer* around the highway exits. Use a 50% transparency factor for the 3-km buffer so that the town boundaries and thematic shading are partly visible through the buffer areas. Also, include in your layout a few rows of the *matown00* attribute table with the *pop02* and *sqmi* fields visible and at least one row each that does and does not have null values in the *pop02* and sqmi columns. (Hint: In case you aren't familiar with setting the transparency level for the buffer, you can set it from the display tab of the 'layer properties' window).

Part II-1C (5 points): **Do the towns containing major highway exits tend to be higher density towns? How many of the 428 major highway exits fall within municipalities that have a population density of at least 500 persons per square mile? Count=_____**

Part II-1D (3 points): Explain briefly the pluses and minuses of using equal interval vs. quantile classification to visualize the spatial distribution of population density across Massachusetts.

Question II-2 (11 points total)

The following chart uses *madoreqv.dbf* to plot linear road miles within each municipality vs. the area (in square miles) of each municipality. The chart shows this scattergram for the 346 (out of 351) municipalities with road mileage below 400.

Road Mileage vs. Area for Mass Towns
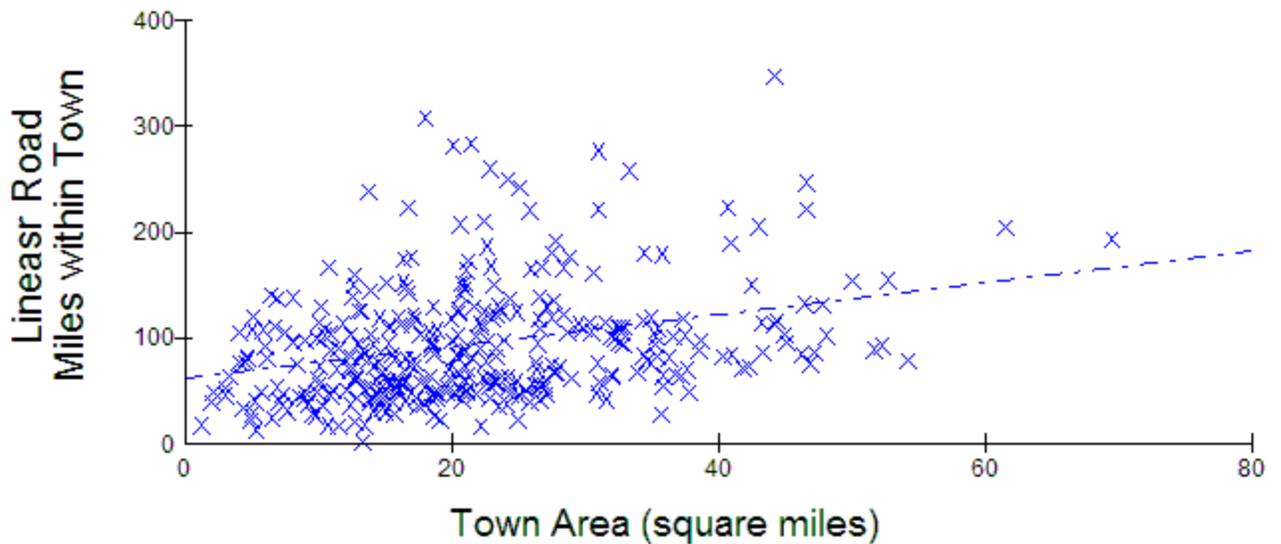
Part II-2A (3 points): Comment briefly on any pattern that is suggested by this scatterplot. **Do large municipalities tend to have high road mileage? What other factors may be at work?**

Part II-2C (8 points): *Prepare and turn in a new chart* showing a scattergram that compares road mileage with population density (as measured by pop02/sqmi). **Comment briefly** on any pattern that is suggested by this scaterplot.

Question II-3 (12 points total)

For this question, you will want to add the *shopcntrs* shapefile from your copy of the test05data directory.

Part II-3A (8 points): Determine the distance from each of the shopping centers in the *shopcntrs* shapefile to the closest highway exit. For this question, you'll want to use the 'Near' tool within the Proximity portion of the Analysis Tools in ArcToolbox. Summarize the results by generating a table that has one row for each type of shopping center (*propertysu*) along with the count of the number of shopping centers in each category and the average distance-to-the-nearest-exit for the shopping centers in each category. *Turn in a printout of this table.*

Part II-3B (4 points each): What is the furthest distance from a highway exit for any of the 'Neighborhood Center' shopping centers? **Distance =** _____ **Explain briefly** which types of shopping centers tend to be closer to (or further from) the major highway exits?

Question II-4 (8 points total)

For this question, you will want to use the grid coverage ***matowngd*** that rasterizes the matown00 polygons using 1 km grid cells.

Part II-3A (6 points): Find the grid cell that is furthest from any major highway exit. **What is the distance from that grid cell to the closest exit? Distance = _____.** **(Hint: Use the Spatial-Analyst/Distance/Straight-line function to compute a new raster layer whose cell value is the straight-line distance (of the center of the grid cell) to the nearest Exit).**

Part II-3B (2 points each): What town contains this grid cell? Town Name = _____

Please note:

- Before creating the PDFs, be sure to include your name and Athena ID somewhere on the text file and the map layouts
- You should test your PDF files with Adobe Acrobat Reader before emailing them to us in order to be sure they are readable.
- You should keep a copy of your text output and PDFs file in your 11.520 user directory until your test is graded
- You should confirm with an instructor that your test files were received?
- You should turn in one text file with written answers to the questions plus three PDF files containing maps and charts or tables for Questions II-1B, II-2C, and II-3A. For your convenience we have provided an answer sheet for your use in writing the textual answers.