> University of Michigan >Taubman College of Architecture
> ARCH 552, Perimeter @ Work Out [T]here, Fall 2009
>September 24, 2009

2G1/3G4 GIS TUTORIAL

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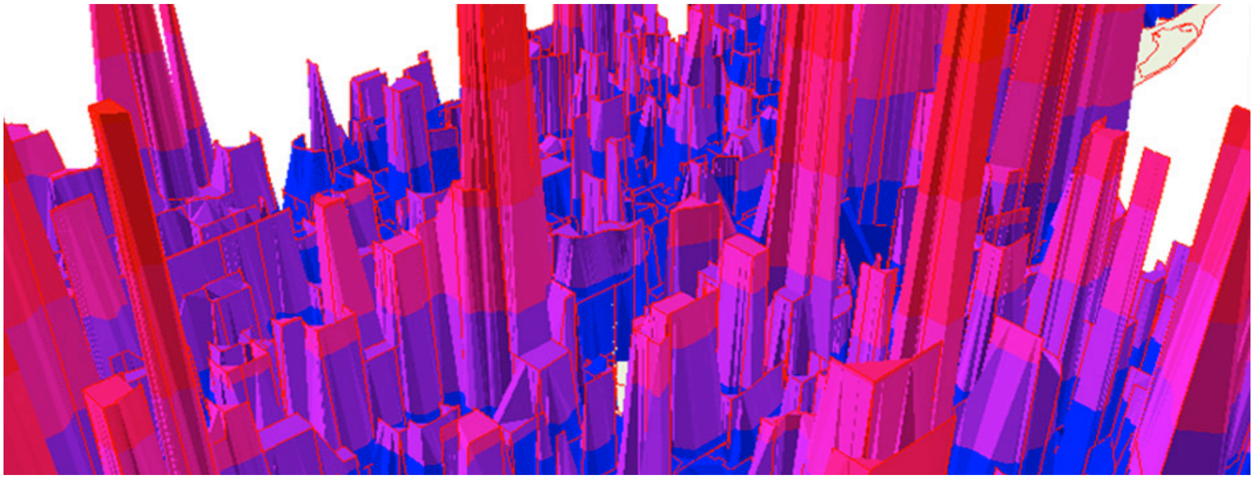

General informaion. What is GIS?

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The acronym GIS stands for *Geographic Information Systems.* GIS refers to one of the several software platforms for the capturing, storage, retrieval, analysis and display of geographic *spatial data*. GIS assigns abstract statistical information to physical geographic elements.

In GIS terminology, “spatial” has a different meaning than in architectural discourse. For GIS technicians, “spatial” means “locationally defined,” relative to other geographic features. Thus, “space” in GIS is fundamentally relational – it refers to the location of geographic features relative to other geographic features. In typical architectural language, “space” is fundamentally absolute – it is a measurable volume that can be defined, manipulated and discussed as if it were any object plastic object.

Most GIS maps are *geocoded.* Geocoded maps contain the appropriate 2-D coordinate information to allow them to align precisely with with other maps that are also geocoded.

Many GIS maps are also *projected*. A *projection* is a method of translating the earth’s 3-D surface into a flat map with a 2-D coordinate system. There are many methods of projection in geography, and each involves some sort of distortion. Different projections are used for different purposes, depending on the way they distort geographic information.

Common attributes of a GIS platform:

Allows multiple layers of data to be overlayed, read simultaneously.
Tranfers geographic data from spheroid to projected.
Geocodes data so multiple layers can stitch together larger maps.
Provides a platform for various forms of statistical and “spatial” analysis.
Provides a platform for data entry/management and creation/editing of 2-D and/or 3-D maps.

Some common GIS software platforms:

ArcMap, ArcCatalog, ArcScene (ESRI)
ArcView (ESRI)
Grass (Open source)
Saga GIS

ArcMap - ArcInfo Interface

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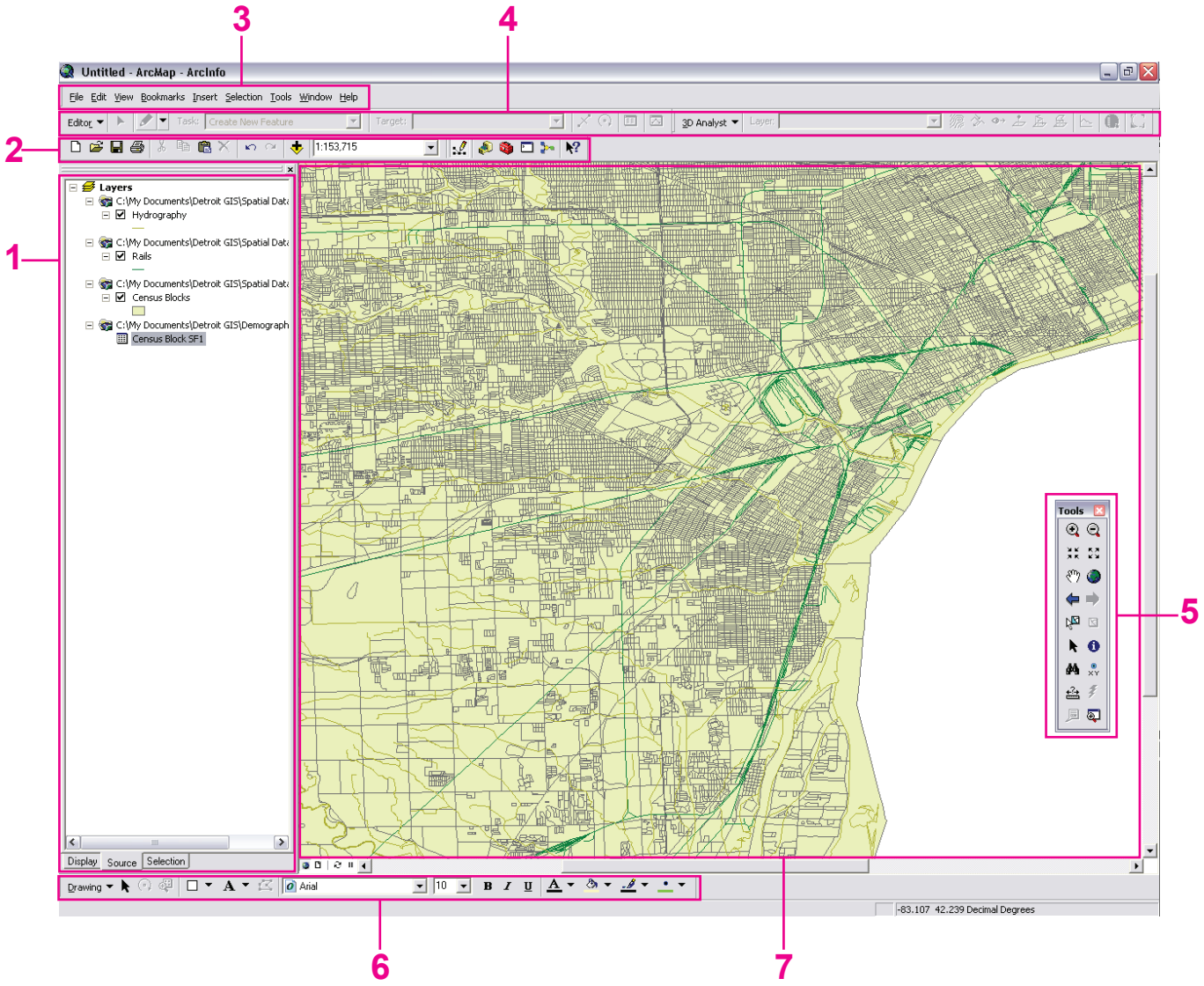

1. Map Layers Display. Right click on any layer to bring up a series of functional options, including opening the attribute table. Double click on any layer to bring up layer properties, including data source information and display options. Notice the three options at the bottom of the layer list (*Display/Source/ Selection*). If you click on *Display* you can change the layer order by clicking and dragging layers. If you click on *Source* layer names will appear with their file source specified.

2. Includes *Open, Save, Print* icons. The yellow diamond with the black arrow is for adding layers. The file cabinet icon opens *ArcCatalog*. The red toolbox opens the *ArcToolbox*.

3. Root toolbars. Special toolbars can be found under *View>Toolbars*. Editor is under *Tools>Editor.* Special extensions can be found under *Tools>Extensions.*

4. Controls for specially enabled Toolbars and Extensions. Note the icons at the far right for launching *ArcScene* and *ArcGlobe* (*3D Analyst* must be enabled under *Tools>Extensions*).

5. Tools for zooming, selecting, measuring, etc.

6. Drawing and text tools.

7. Map display window.

Getting Data
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Although GIS data comes in many formats, the most common types are *Shapefiles (.shp)* for spatial data, and *Database Files (.dbf)* for statistical data. These are the formats we will use.

Many city, state and national government agencies as well as research institutions provide GIS data free of charge via the internet. The internet is also full of GIS data "clearinghouses" that will provide data for a fee.

Some good data sources.
US Census: http://arcdata.esri.com/data/tiger2000/tiger_download.cfm
Simply Maps: http://www.simplymap.com.proxy.lib.umich.edu/main.php
Center for Geographic Information: http://www.mcgi.state.mi.us/mgdl/
Southeast Michigan Council of Governments: www.semcog.org
City of Detroit: http://www.ci.detroit.mi.us/Departments/PlanningDevelopmentDepartment/Planning/InformationServiceandMapping/CommunityInformationandMapping/AdvancedMaps/DownloadGISFiles/

NOTE: In order for discrete data sets to properly work together, they must share the same *projection*, and the data must be *geocoded*.

Tutorial
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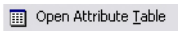
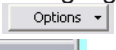
This tutorial is intended to introduce you to a few of the thousands of techniques for working with spatial and statistical data in ArcGIS software. The techniques you will be shown have been chosen for their potential relevance to collective 2G1/3G4 studio investigation. It is up to you to thoroughly conceptualize these techniques relative to your work and interests in studio.

1. Opening and formatting the interface: Open *ArcMap*. Select *A new empty map* and click OK.Open the *ArcToolbox* by clicking on the toolbox icon above the main map window>  Browse to *Tools* > *Extensions* and enable everything except *Data Interoperability*. Browse to *View* > *Toolbars* and enable *3D Analyst.*

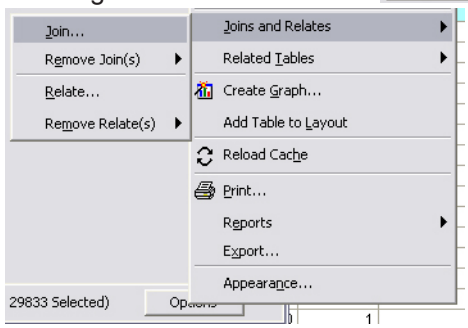
2. Adding data: Click on >  to add data to your project. Browse to C:/Documents and Settings/uniquename/Desktop/GIS Tutorial and add: *Census Block SF1.dbf*, *Census Blocks.shp*, *Landmarks.shp* and *Rails.shp.* You can hold the shift button and select all of the files at one time. The files should now appear in your map display window, and the layers should be listed in the *Map Layers Display*. These three layers represent the three geometric types of shapefiles. *Census Blocks* is a polygon file; *Rails* is a line file; *Landmarks* is a point file.

Practice clicking between the *Display/Source/Selection* tabs at the bottom of the *Layers Display* Practice moving the layer order by highlighting the *Display* tab and left-clicking + dragging layers up and down. Use the middle mouse button to zoom in and out. Press the middle mouse button to pan. Practice using the zooming and panning tools in the *Tools* menu. Right click on layers and look at the options that appear.

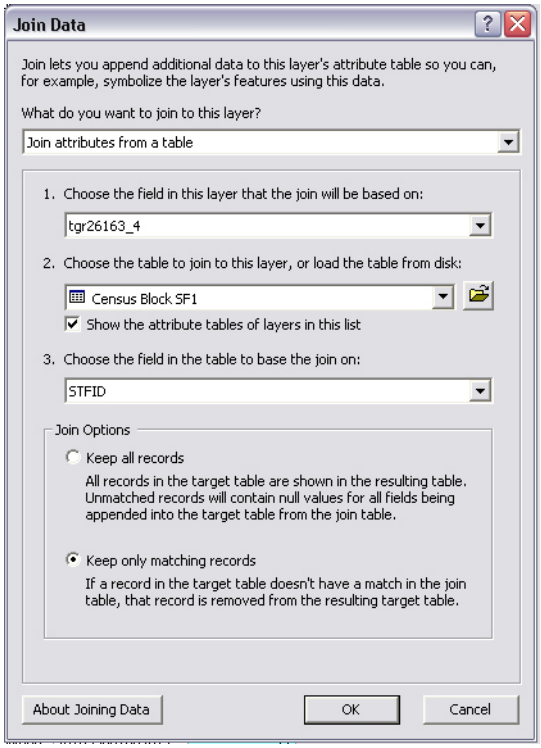
3.Joining attribute tables: Right click on *Census Blocks* and select *Open Attribute Table* > 

The table should appear. Do the same for *Census Blocks SF1*. *Census Blocks* is a polygon file describing the geometry of census blocks in Wayne County. *Census Blocks SF1* is a database file containing statistics that can be assigned to the block geometry. To do this, we must *Join* the tables. In order to Join two tables, the values in one field (a field is a vertical heading in a table) must be common in both tables. Notice that the values of STFID in Census Block SF1 and tgr26163_4 in Census Blocks are similar. We will join the tables based on these fields. Highlight the *Census Blocks* table and click on the *Options* tab at the lower right corner of the table > 

Browse the *Options* menu to *Joins and Relates* and then *Join...*



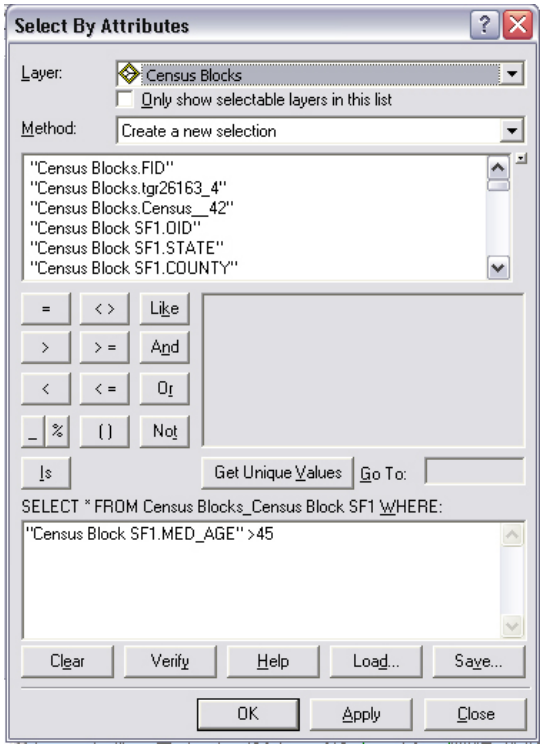
In the *Join Data* dialogue box, choose *Join attributes from a table* from the top scroll-down. The field in this layer that the join will be based on is *tgr26163_4*; the table you are joining to this layer is *Census Block SF1*; and the field in that table to base the join on is *STFID*. Select *Keep only matching records*, and click OK. The statistical fields from Census Blocks SF1 have now been joined to the attributes table of Census Blocks.



4. Selecting: You can select items in your map either graphically, by using the *Select Features* tool in the *Tools Menu*; or based on statistical boolean operations. To select items graphically, click on the *Select Features* tool > and left-click on the features you wish to select in the map. To see tabular information about the features you have selected, open the attribute table of the layer the features belong to (see 5) and click *Show: Selected* at the bottom of the table > Show: All Selected

To select features based on a statistical boolean, pull down the *Selection* menu at the top of the screen, and browse to *Select by Attributes*. At the Layer pull-down menu, select *Census Blocks*. All of the field headings for *Census Blocks* will appear in the white box in the middle. Experiment with making a boolean selection by double clicking on a field, a symbol and then specifying a value (click *Get Unique Values* to see the range of values for the field selected). Click OK to make the selection.

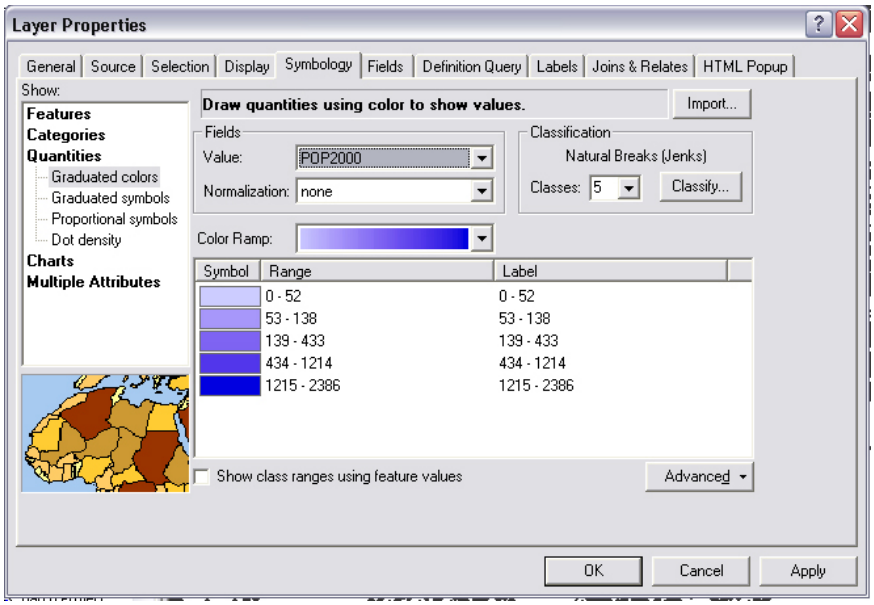
Now create the boolean: *Census Block SF1.MED_AGE>45* This will select all census blocks with a population of more than 45 people older than 45. Click OK.



Now right-click on *Census Blocks*. Browse to *Selection* > *Create Layer From Selected Features*. A new layer will be created based on the selection you just made. You can make several layers from several selections in order to simultaneously visualize spatial relationships between discrete constituencies.

5. Symbology: You can change colors and lineweights of map features by double-clicking a layer name to bring up the *Layer Properties*, and then clicking the *Symbology* tab. Bring up the *Layer Properties* of *Census Blocks selection*. With *Features* > *Single Symbol* highlighted on the left, click on the colored box in the center of the dialogue to change the line weight/color and fill.

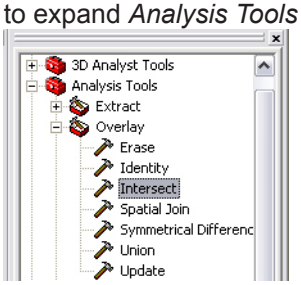
You can also use the *Symbology* dialogue to graphically differentiate the map based on statistical fields. Double click on *Census Blocks*. Navigate to the *Symbology* tab, click on *Quantities* at the left of the dialogue box, and then highlight *Graduated Colors*. Under the *Value* pull-down, you will see all the field headings for *Census Blocks*. In this menu, choose *POP2000*. Leave the normalization pull down at *none*, and select a *Color Ramp*. Click OK.



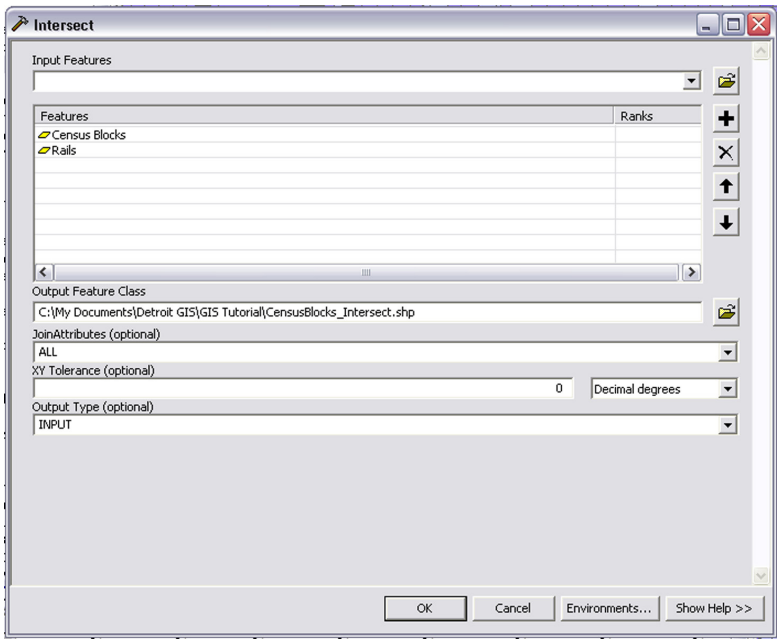
The map's colors should now be differentiated based on total Census Block Population in 2000. You can modify the numeric intervals by clicking on the numbers under *Range* and manually changing them. The intervals can also be modified graphically by clicking on *Classify* and dragging the value breaks on the graph. Using different *Value* fields, experiment with other methods of graphically differentiating your the map in the *Symbology* tab (*Graduated Symbol, Proportional Symbols, Dot Density*, etc). Different ways of classifying the data reveal varying dispositions towards urban organization, stratification, and distributions of intensity; and may reveal otherwise invisible similarities or connections across the land parcels.

In *Layer Properties*, click the *Display* tab. Experiment with the transparency levels. Turn several layers on and modify their transparency in order to read several levels of information at once.

6. Intersection: In the *ArcToolbox* window, click to expand *Analysis Tools* and then *Overlay.* A series of options will appear. Double click on *Intersect* >

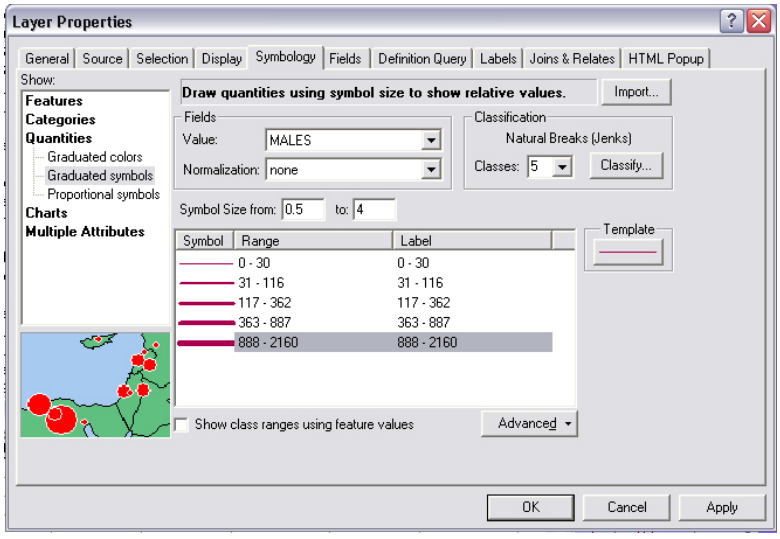


In the *Input Features* pull-down menu you will see the names of the layers in the project. Select *Census Blocks*, then pull down the menu again and select *Rails*. Make sure the *Output Feature Class* is displaying the directory where you are storing the data for your project. Keel the *JoinAttributes* menu at *ALL*. In the *XY Tolerance* menu, type in 0. Set the *Output Type* to *INPUT*. Click *OK*.



A status window will appear as the intersection is processed. This may take several minutes. When the intersection is complete, you will have a layer with the line geometry of the *Rails* layer that has been saturated with the statistical data in the *Census Blocks* layer. Open your *CensusBlocks_Intersect* attribute table to see the results of the intersection.

The line geometry of the *Rails* can now be differentiated based on the data fields from *Census Blocks* using the *Symbology* dialogue (see 5). Double click on *Census Blocks_Intersect*. Click on the *Symbology* tab. At the left of the window, click on *Quantities*, and then *Graduated symbols*. Choose a field in the *Value* pull-down, and keep the *Normalization* pull-down at none. A range of colored line weights will appear in the symbol box. You can change the line weights and colors by double clicking on them. You can change the numeric intervals by manually inputting numbers under *Range*. Click OK.



The *CensusBlocks_Intersection* layer will now display the line geometry of *Rails* with thicker and thinner line weights based on the value field you selected. This process is useful for visualizing the way abstract statistical categories register on tangible elements of the material environment.

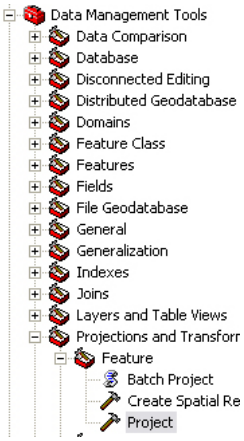
Experiment with other options in the *Symbology* tab for visualizing this intersection. Notice that pieces of the intersection can still be selected based on *Attributes* (see 6). Other tools in the *Analysis Tools* box work in a similar way. Experiment with the tools and speculate upon their theoretical significance.

7. 3D Analyst: Browse to *Tools* > *Extensions*. In the *Extensions* dialogue box, click the box to enable *3D Analyst*. Click Close. The *3D Analyst* toolbar should now appear at the top of your screen.

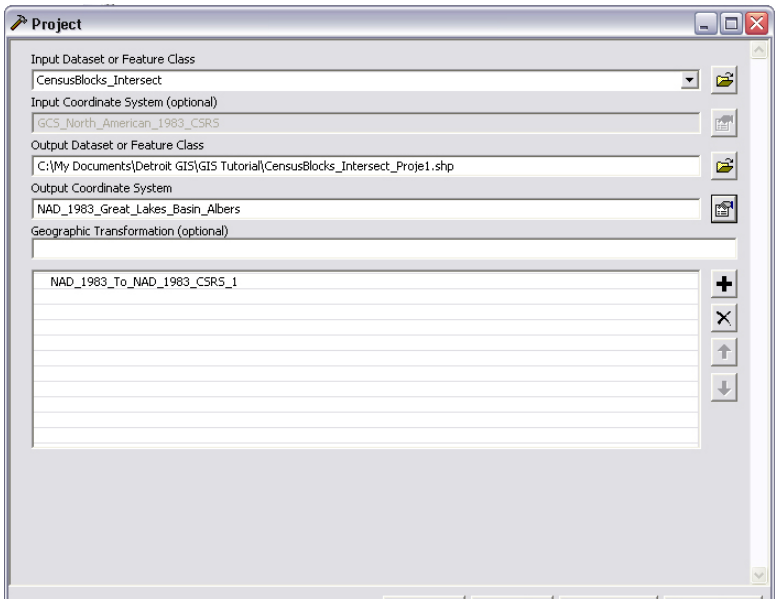
Next we're going to make a kind of 3D model called a TIN, or a Triangular Interpolated Network. This tool makes 3D network models that interpolate locationally defined data across space. The tool is typically used in GIS to make topographic models, but we can use it to visualize or project spatio-statistical networks.

In order to make a TIN, our source data must have a projection. We're going to make a TIN using the layer *CenusBlocks_Intersect*, so right click on *CenusBlocks_Intersect* and select *Properties*. Click on the *Source* tab. In the *Data Source* window, look on the left to see if "Projection" is listed. If it is not, then the file needs to be projected before we can do *3D Analysis*.

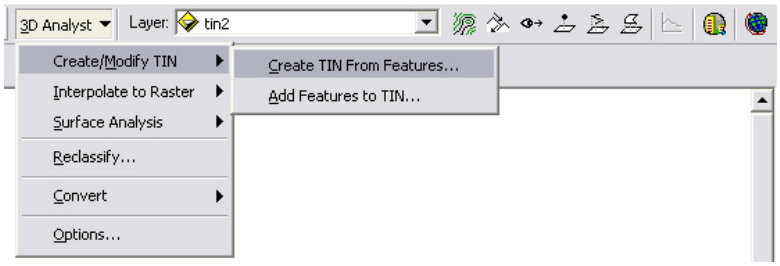
In the *ArcToolbox* window, expand the *Data Management Tools*, and then expand *Projections and Transformations*. Double click on *Project* >



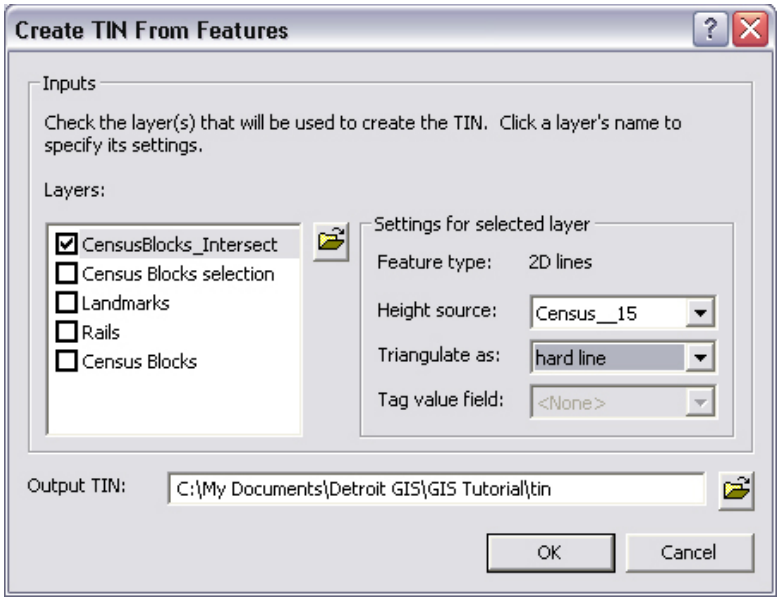
The *Project* dialogue box will appear. First select the layer you want to project (*CenusBlocks_Intersect*). The *Input Coordinate System* will appear automatically. Make sure the *Output Dataset or Feature Class* bar displays the directory where you are keeping your project files. Click on the icon to the right of the *Output Coordinate System* bar > The *Spatial Reference Properties* dialogue box will appear. Click on the *XY Coordinate System* tab, then *Select*. Browse to *Projected Coordinate System/Continental/ North America/NAD 1983 Great Lakes Basin Albers.prj*. Click *Add*. Click *Apply*. Now, back in the *Project* dialogue box, click OK. A projection progress window will appear and then a layer named *CensusBlocks_Intersect_Project* will appear.



Click on the *3D Analyst* drop-down menu, browse to *Create/Modify TIN* > *Create TIN From Features*.



In the TIN dialogue box that appears, select *CenusBlocks_Intersect_project* under *Layers.* In the *Height Source* pull-down, choose a value field to base the model heights on. Under *Triangulate as*, choose hard line. Make sure the *Output TIN* directory lists the directory in which you are storing your data. Click OK.



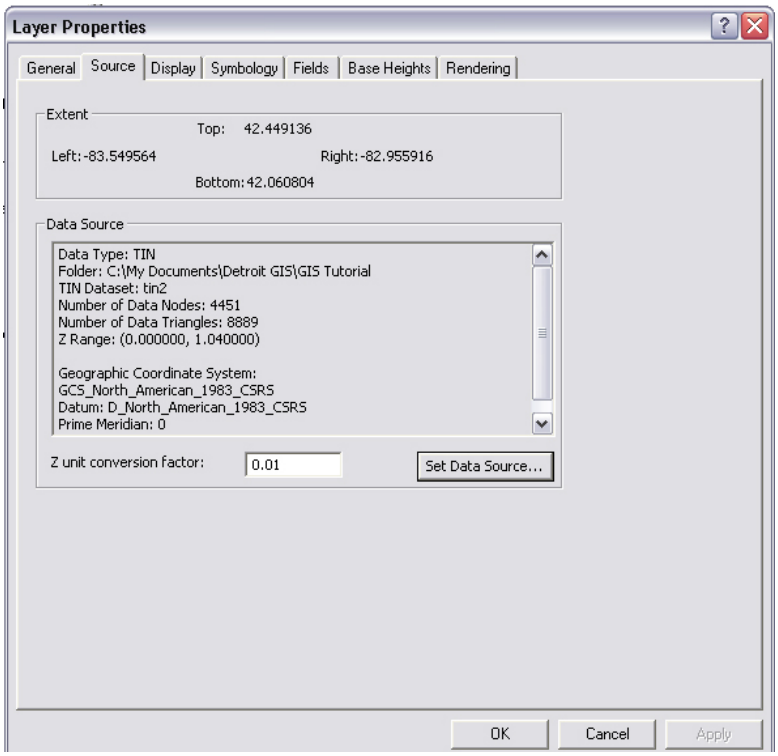
A TIN model should appear in your map display window and a TIN layer should appear in the *Map Layers Display*. The TIN model has interpolated the locationally-defined value field you selected across the space described by the geographic features in the source layer. This modeling technique can be valuable to visualize the way statistical values can register on tangible geographic features to produce a geographic system or network. TINs made in this way are not inclusive of all statistical variation in the regions they display – they are selective and potentially projective abstractions of the existing.

You can access options to modify the colors and numeric intervals of data in TINs by double clicking on the TIN layer and navigating the the *Symbology* tab. Notice that the TIN has appeared in the *Layer* pull-down in the *3D Analyst* toolbar, and the tools that were previously inactive are now available. Experiment with these 3D tools to see how TINs can be manipulated.

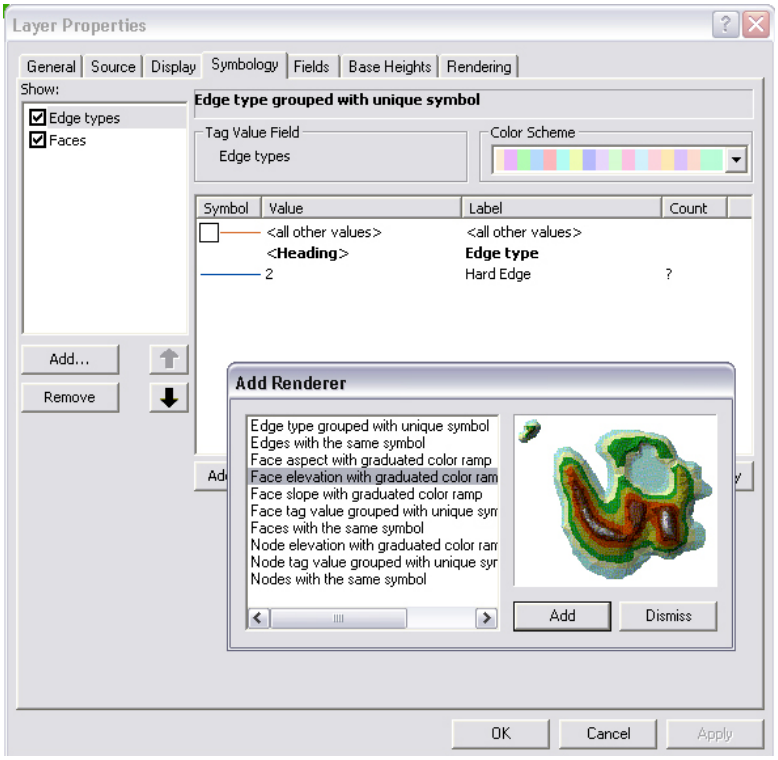
8. ArcScene: In *ArcMap - ArcInfo*, 3D map layers can only be shown in plan view. To see 3D layers in a model view, we must use an extension called *ArcScene*. To launch *ArcScene*, click on this icon in the *3D Analyst* toolbar > *ArcScene* will launch. This may take several minutes. You will notice that the *ArcScene* interface is very similar to the *ArcMap* interface. Click the *Add Data* icon > Browse to the directory where you are storing your data, and add the TIN layer you created in *ArcMap*.

Often, TIN's will come into *ArcScene* with a Z-dimension that is far too large to display properly. Since the Z-dimension of TINs are not spatially relative to the X-Y dimension, we can fix this problem by simply scaling down the Z-dimension of the TIN.

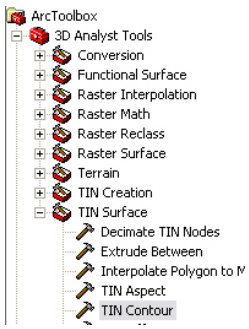
Double click on the TIN layer. In the *Source* tab, type in .01 for the Z unit conversion factor. Click OK.



Click on the zoom to *Full Extent* icon > Experiment with rotating the model, zooming and panning using your mouse. You can change the way the TIN displays data by double clicking on the layer, navigating to the *Symbology* tab and clicking on *Add* under the *Show* window. A series of renderer options will appear. Click through the different options to preview their effect.

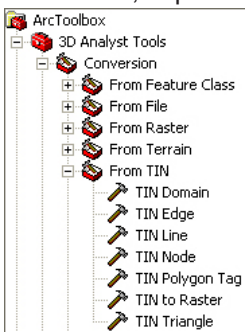


Since TIN's are typically used in GIS to make topographic models, we can use them to make contour lines. In the *ArcToolbox*, expand *3D Analyst Tools* and then *TIN Surface*. Double click on *TIN Contour*.

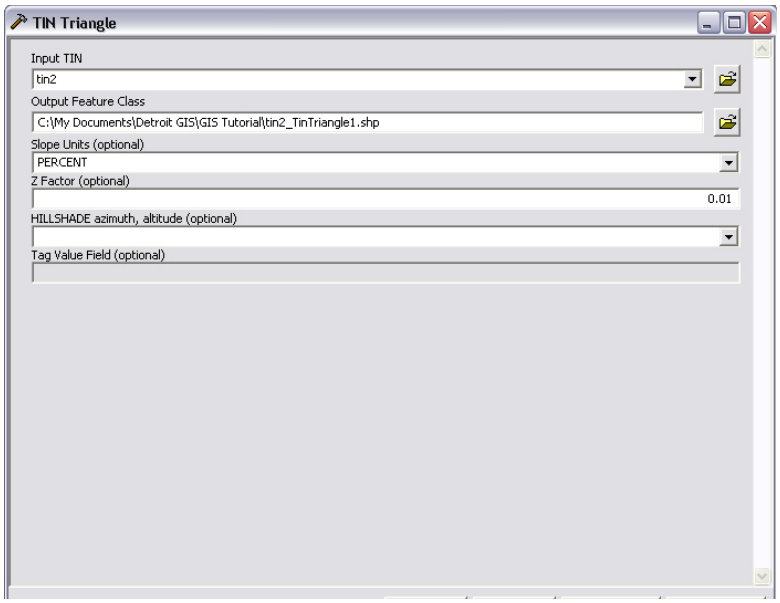


In the dialogue box that appears, choose the TIN in your map display as the *Input TIN*, and input .01 as the *Contour Interval*. A series of contours will appear in your map display. You can adjust the contour interval to change the density of the contour lines. These contour lines can be intersected with data in order to be used for further queries or analysis (see 6). They can also be individually selected and queried just like any other line-based shapefile.

There are limited ways that a TIN can be used as a base for analysis, as opposed to a final product of analysis. Converting TINs to contours is one way to work around this issue. Another method is to turn the TIN into a set of polygons. In the *ArcToolbox*, expand *3D Analyst Tools*, then *Conversion*, then *From TIN*, and double click on *TIN Triangle*.



In the *TIN Triangle* dialogue that appears, select the TIN in your map display as the Input TIN. You shouldn't need to input anything into the other menus. Click OK.



A new version of the TIN should appear in your map display. Unlike the original TIN, triangular polygons in this TIN can be manually selected or selected by attribute. This polygon TIN can also be intersected or unioned with statistical data for further analysis.

9. From *ArcGIS* to other work environments: Sometimes you will create a layer in *ArcScene* and you will want to use an analytic tool on that layer that is only available in *ArcMap*. In this event, you will need to move the layers you have created in *ArcScene* back into *ArcMap*. There are two methods to do this. One method is to simply right click on a layer in *ArcScene* and navigate to *Copy* in the menu that appears. Then return to *ArcMap*, and browse to *Edit* > *Paste*. The file from *ArcScene* should paste into the map window in *ArcMap*.

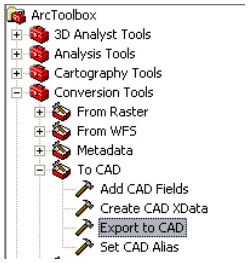
Another method is to add the layer created in *ArcScene* to *ArcMap* manually. Right click on the layer in *ArcScene* and browse to *Properties*. In the *Properties* dialogue, click on the *Source* tab. In the *Data Source* window, after *Shapefile:* the directory for the layer should be listed. You can use the *Add Data* function in *ArcMap* to browse to the layer's directory and add it to the map.

Other conversions:

From *ArcScene* to an architectural modeler like Rhino: Browse to *File* > *Export Scene* > *3D* and save the file as a VMRL (.wrl). This file type will open in most 3D surface modelers.

From *ArcScene* or *ArcMap* to a image file: Browse to *File* > *Export* > *(2D in ArcScene)* and choose an image file format, resolution. You can also export into an editable vector Illustrator file using this method (choose file types .ai or .eps)

From *ArcScene* or *ArcMap* to autocad: In the *ArcToobox*, expand *Conversion Tools*, then *To CAD*, and double click on *Export to CAD*.



In the dialogue that appears, choose the layers you wish to export, choose a CAD version, and then directory to which you want to write the file.

Fin
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This tutorial should give you enough information to begin working in ArcGIS and familiarizing yourself with the software. The techniques you have be show were chosen because they are potentially relevant to the understanding of geographic and spatial systems that operate discursively between the social and the material. There are thousands of other modeling and mapping techniques in this software platform left for you to discover and conceptualize relative to your work in studio. Have fun.