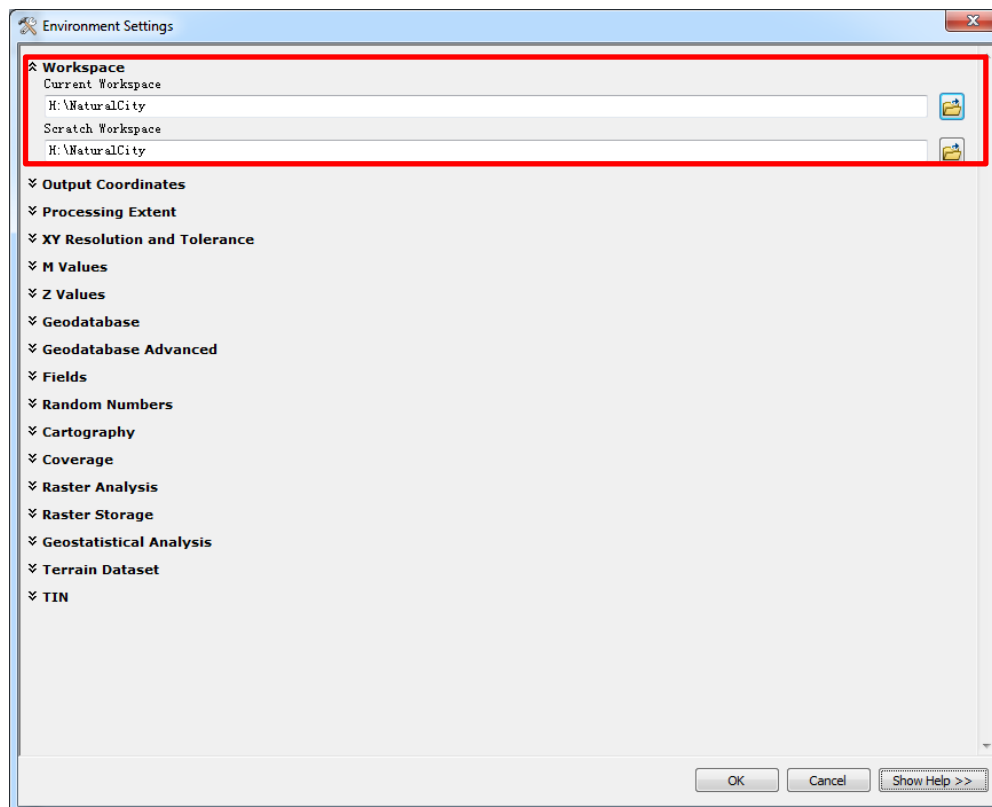


Visualizing the Evolution of Natural Cities from the Perspective of Location-Based Social Media Based on ArcGIS

Natural cities (Jiang and Miao 2015), which refer to the human settlements, or human activities in general on the earth's surface that are extracted from check-in points or locations. This tutorial aims to show, in a step by step fashion with ArcGIS, how to derive natural cities using the social media check-in data and to visualize their evolution of the year 2008 using animation techniques. The data used in this tutorial came from the check-in data in US mainland of former location-based social medium Brightkite.

Getting Started

Go to Geoprocessing menu>Environment. Click on Workspace and assign both the Current and Scratch workspaces to your project folder, H:\NaturalCity. This assures that all the data you create in this practical are automatically saved in the said location.



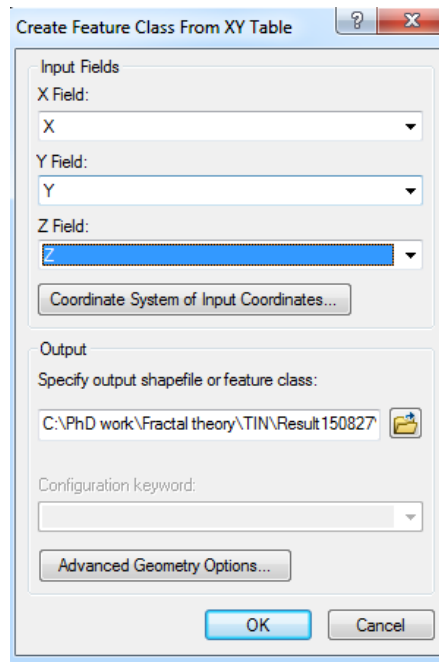
Part 1: Derive natural cities

The check-in data of the first month is in excel format with two columns namely x, y, respectively representing longitude and latitude. We need to transfer them into 3D points since ArcGIS relies on 3D points for creating a TIN.

Add a third column z, and set all column values as 1 (or any arbitrary value, tip: type “1” in the first cell, then scroll down to the last cell, hold shift and click it to select all the cells of column z, then go to Home menu bar and choose Fill>Down). Then save and close.



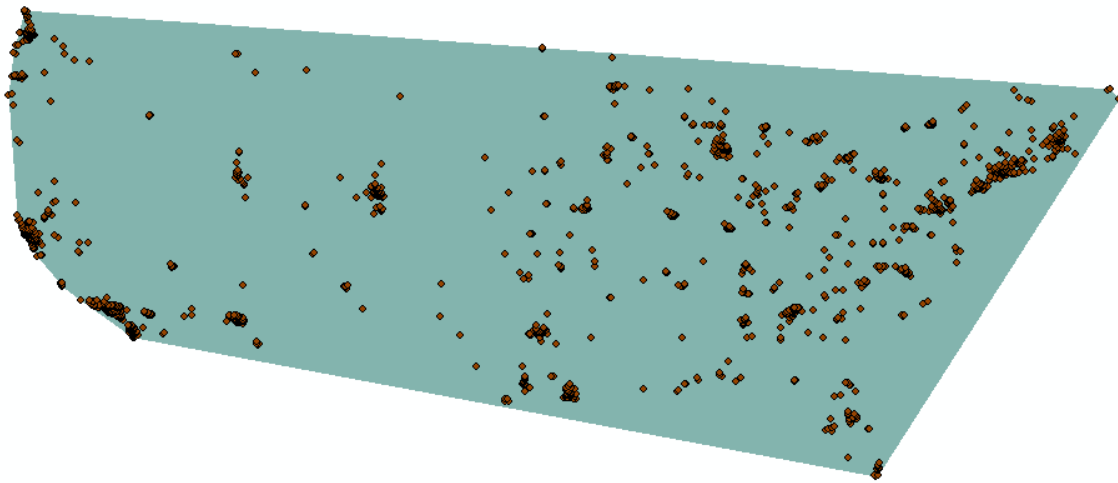
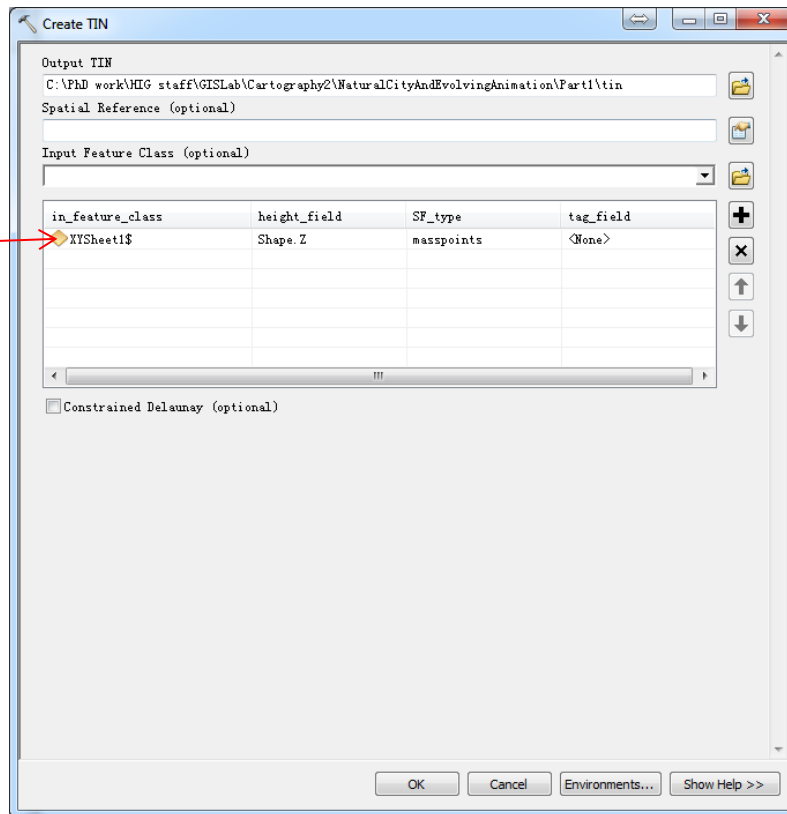
Open “0804.mxd” file, insert the Excel sheet as a shape file data layer in ArcGIS by right clicking sheet1\$ >Create feature class > From XY table. Choose Z for Z field. Specify the output directory and click ok. Add the point data layer and right click > open attribute table. If it shows “Point ZM” in the second column, the 3D points are successfully created.



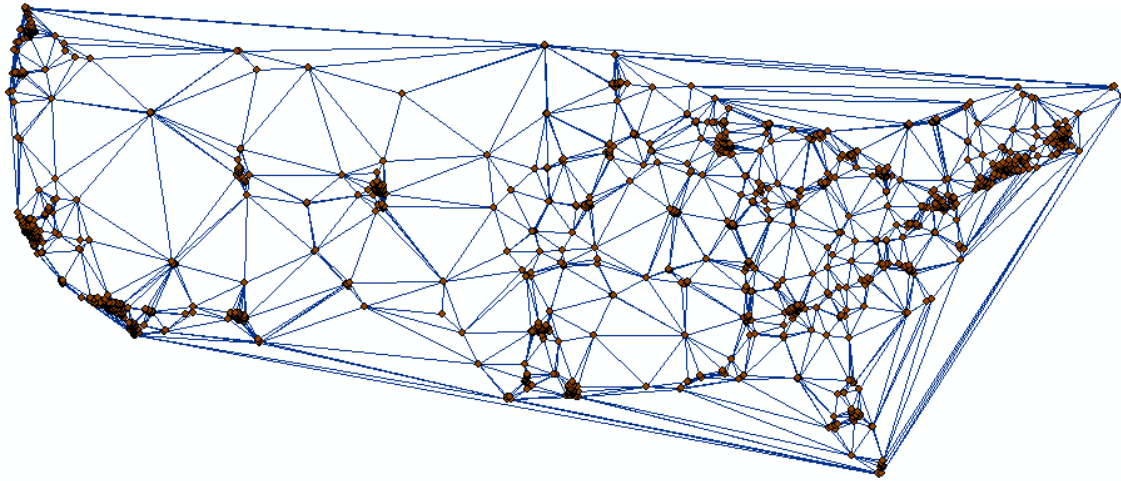
	FID	Shape *
▶	0	Point ZM
	1	Point ZM
	2	Point ZM
	3	Point ZM
	4	Point ZM
	5	Point ZM
	6	Point ZM
	7	Point ZM
	8	Point ZM

Create a TIN from the point layer, using ArcToolbox > 3D analyst tools > TIN management > Create TIN.

Points as input feature



Convert the TIN into TIN edge, using ArcToolbox > 3D analyst tools > Conversion > From TIN > TIN Edge.



The converted TIN edge is a polyline layer. Right click the polyline layer to Open Attribute Table in order to get statistics about the length of the edges. Click Table Options > Add Field, add a new field “length” whose data type is double. To get the length of each edge, right click length column and choose Calculate Geometry. When calculation finished, we right click the length column again and click Statistics. From the statistics window we can get the mean value of edge length, and the figure shows that the frequency distribution that is apparently L-shaped, indicating that there are far more short edges than long ones.

Table

tinEdge

FID	Shape *	Index	Edge Type
0	Polyline ZM	9318	0
1	Polyline ZM	9317	0
2	Polyline ZM	9316	0
3	Polyline ZM	821	0
4	Polyline ZM	820	0
5	Polyline ZM	6891	0
6	Polyline ZM	6890	0
7	Polyline ZM	6897	0
8	Polyline ZM	6895	0
9	Polyline ZM	6903	0
10	Polyline ZM	6901	0
11	Polyline ZM	6906	0
12	Polyline ZM	6905	0

Add Field

Name: Length

Type: Double

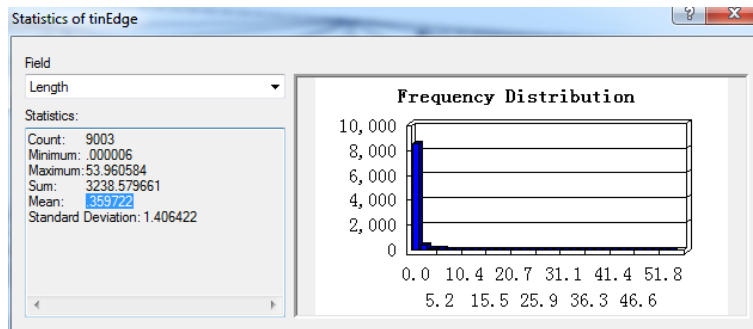
Field Properties

Precision	0
Scale	0

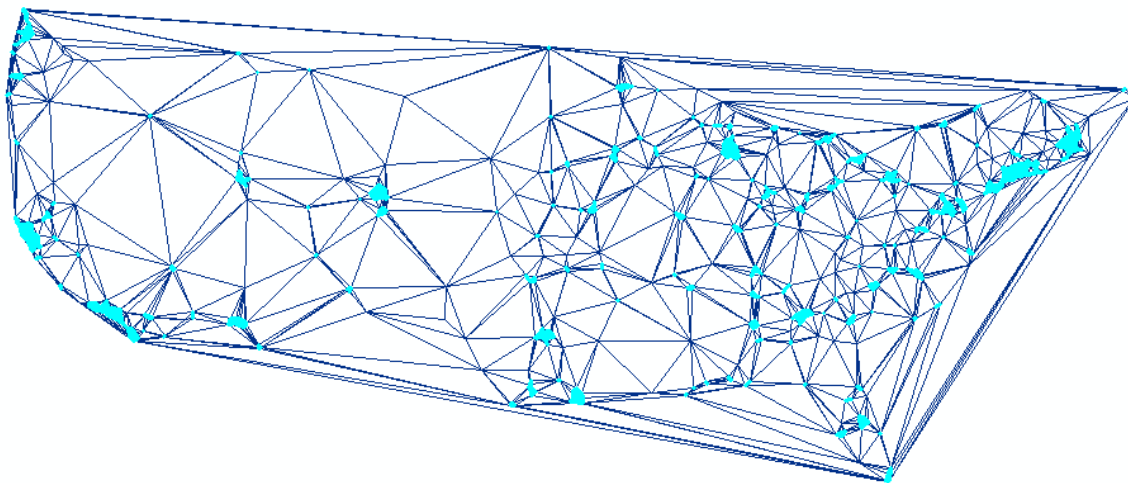
OK Cancel

Length

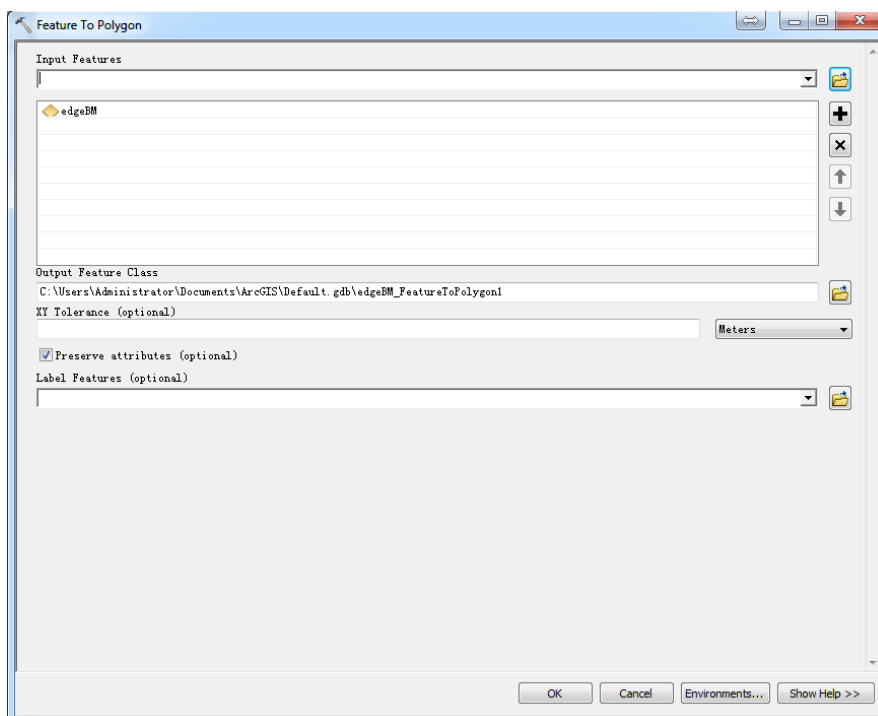
- Sort Ascending
- Sort Descending
- Advanced Sorting...
- Summarize...
- Statistics...
- Field Calculator...
- Calculate Geometry...
- Turn Field Off
- Freeze/Unfreeze Column



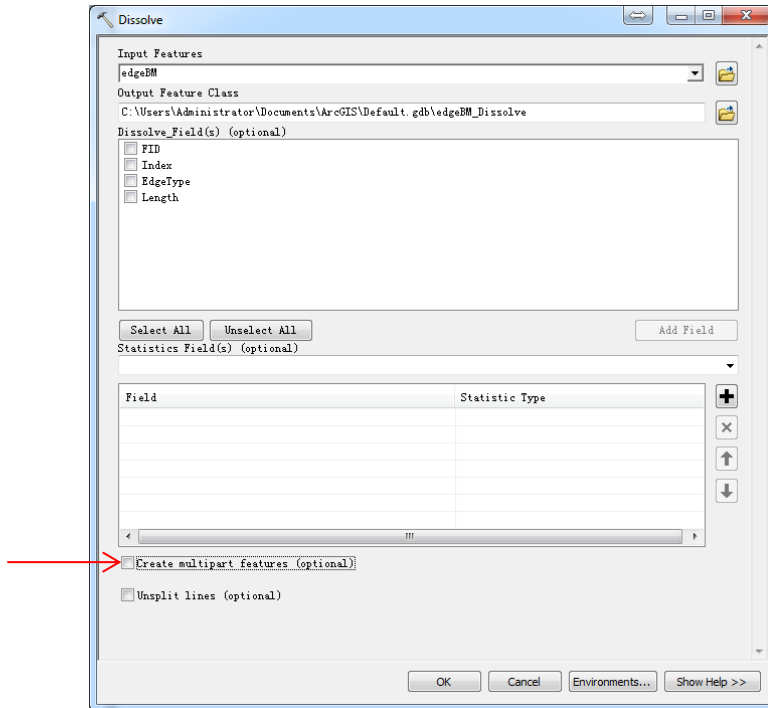
Select those shorter edges than this mean following menu Selection > Select by Attributes (Using “length” < mean value as query sentence). The selected edges are then highlighted. The selected shorter edges refer to high density locations. After selection, export the shorter edges as a new shapefile (Right click the edge layer> Data> Export)



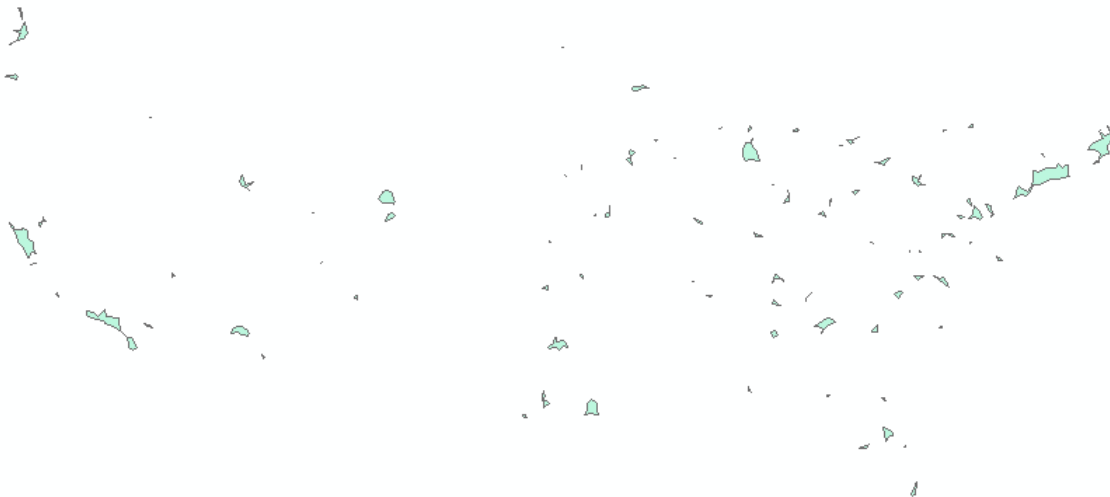
Cover the shorter edges into polygons, following ArcToolbox > Data Management Tools > Features > Feature to Polygon.



Finally, dissolve all the polygons to be individual natural cities, ArcToolbox > Data Management Tools > Generalization > Dissolve, or alternatively following menu Geoprocessing > Dissolve (the option 'Create multipart features' should be unchecked).



The natural cities of first month check-in data of BrightKite are now derived, as shown below.

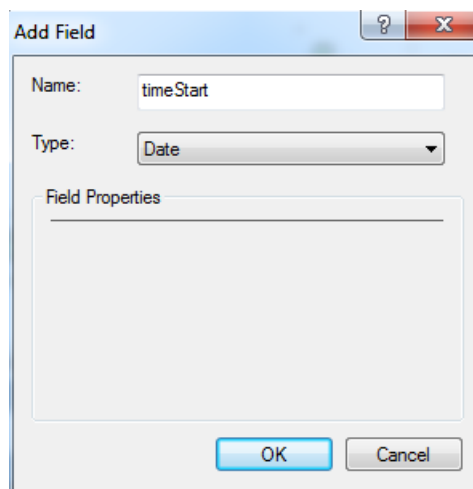


Part 2: Create an animation to show the natural city evolution of the year 2008

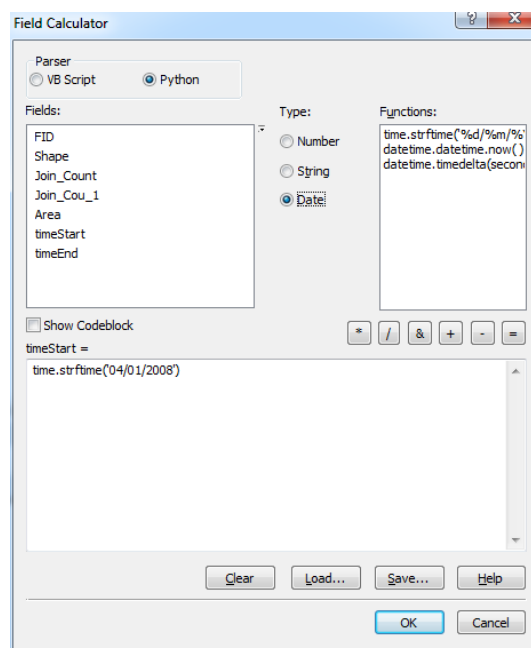
It is also interesting to see how the natural cities evolve with time. To visualize the evolution, we need to use the built-in animation function in ArcGIS. Here the tutorial will guide you how to visualize the evolution of the natural cities during the year 2008.

Firstly, some preparations on data processing need to be done. Open the folder “part2” you will see the related shapefiles of which names indicate the year and month. Browse for “2008.mxd” and open.

To enable the animation in ArcGIS, the data itself should contain temporal information. We can see that there is no temporal information in each city feature now. Here we take natural city of April, 2008 (“NC0804”) as an example to demonstrate how to add time into city features. We firstly right click the layer and add two fields in the attribute table, name them as “timeStart” and “timeEnd” and data type is “Date”.

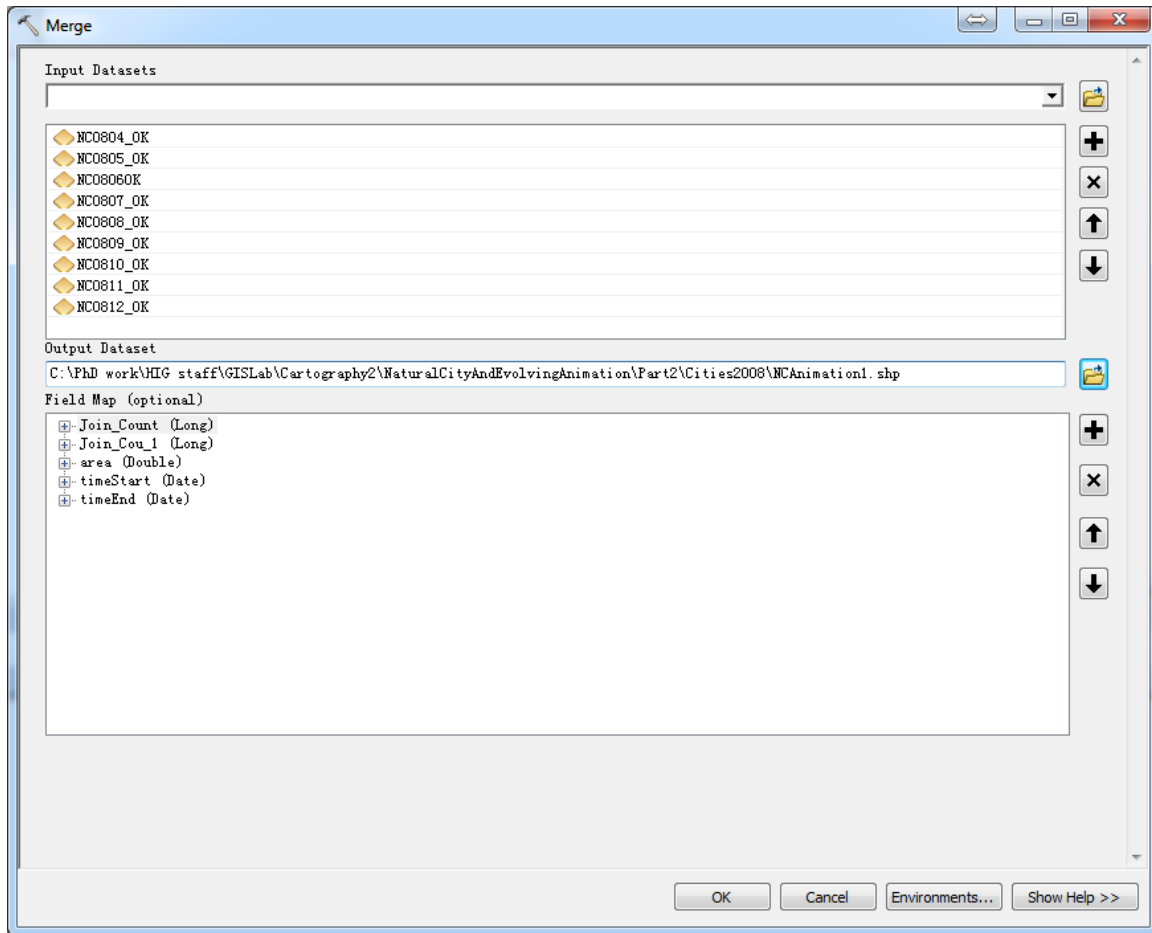


In this case, the value for timeStart and timeEnd should be “2008-04-01” and “2008-04-30”. To assign date value to field “timeStart”, we can right click the column and select “Field calculator”. In the pop-up window, we choose Parser as Python, Type as Date and Function as “time.strftime('%d/%m/%Y)”. Here we replace the ‘%d/%m/%Y’ as ‘01/04/2008’. Then repeat the same steps for timeEnd. Now temporal attributes have been assigned to natural city 200804.

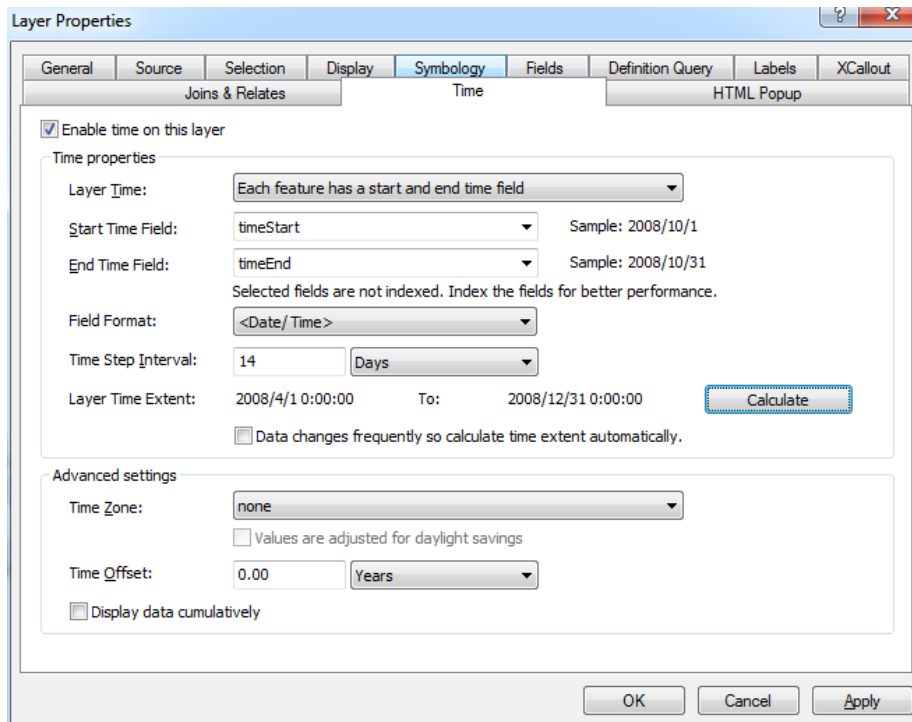





Add temporal information into other city files as well according to their layer names by following previous steps. Make sure that the name of the field for temporal attribute must be the same (either “timeStart” or “timeEnd”) for all city features.

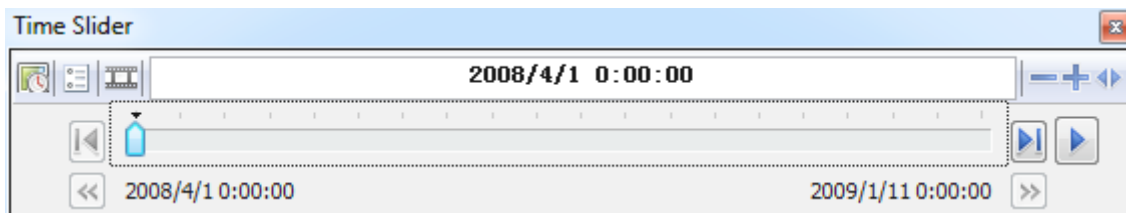
After assigning temporal attributes to cities at each month, go to Geoprocessing menu>Merge, select all the city features as input, name the output as “NCAnimation.shp”, then click OK.





Right click on “NCAnimation” layer, go to “Properties”, click on the “Time” tab, check the box “Enable time on this layer”, choose layer time as “each feature has a start and end time field”. Then click “Calculate” button, we can see the related fields are automatically filled. Note that do NOT check the box “Display data cumulatively” since we want to see city at each month respectively. Then click Apply and close the window.



Click the time slider button  on the top, the time slider window pops up, from where we can set up the animation. For example, click options , in the TimeDisplay tab, assign 15 days for time step intervals; in the TimeExtent tab we can change the start and end time to Min and Max Time. Then click  to enable the time on map.



Now you can click play  to visualize the evolution of US natural cities in the year of 2008. Note that you can also zoom in to see how the evolution is for those big cities, e.g. New York, Chicago, Los Angeles etc. Later you could export the animation as video file by clicking  and upload it onto YouTube which you can have your animation embedded in your personal google site for this course.

Ps: If you are interested in producing the animation of evolution of the natural cities during the entire timespan (approx. 2.5 years), the dataset can be downloaded here (<https://sites.google.com/site/naturalcitiesdata/>).

References

Jiang B. and Miao Y. (2015), The evolution of natural cities from the perspective of location-based social media, *The Professional Geographer*, 67(2), 295 – 306.