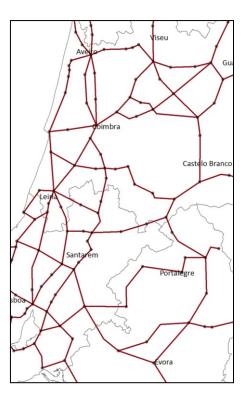
Geo_graph Model Geographic model for graph analysis

User's Guide



Paulo morgado, 2010 Modelling, Urban and Regional Planning (MOPT) research group Centre of Geographic Studies. Institute of Geography and Spatial Planning. University of Lisbon (MOPT/CEG/UL)

HOW TO BUILD A GRAPH (Geometric network)

in ArGIS - NETWORK ANALYST extension is needed.

- In ArcCatalog, on a particular folder, click on the mouse right bottom and ... New > Personal Geodatabase. Give a name.
- Once in a new Personal Geodatabase, click again with the mouse right bottom and chose option New > Feature Dataset. First give a name and next click on the Edit bottom, under Spatial Reference.
- 3) Click on the option **Import** go until **input line layer**, which should correspond the polyline file, namely the shape, feature or layer we would like to transform into a graph; Next click on **Add**, and click **OK** twice, for get a **feature dataset**.
- 4) Click with the mouse right bottom and new feature dataset; chose Import > Feature Class (single). This way you load the polyline feature to the feature dataset, and make sure you have chose the same feature to 'Input Features' on the previous step.
- 5) Click with the mouse right bottom (yes, again) on feature dataset and New > Geometric Network. We advice you that for a non-planar graph or random graph, all options should be default until the end (finish).

Once you have draw (**IMPORTANT:** *Snapping is fundamental, because every time you want to get a connection – node - between any lines, you have to finish sketch and grab the finish line exactly on the same point, so a vertice or node can after – geometric network - be created*) your network in a GIS program and transform them into a graph (geometric network procedures in Network analyst from ArcGis), you are ready to go to the geo_graph model.

1) Open ArcMap, set on the properties and then import the features from your geodatabse.

💐 prn2000_prj - ArcMap - ArcInfo						
<u>File Edit View Bookmarks Insert Selec</u>	tion <u>T</u> ools <u>W</u> indow <u>H</u> elp					
🗅 🚅 🖶 🚭 👗 🖻 🖻 🗙 🗠	🖙 📢 Editor Toolbar	🔄 📝 🔌 🕲 🛌	Spatial Analyst	Layer		
Editor - 🕨 🖋 - Task: Create New	v Fea Graphs	•	XOEX			
	Reports	× ×	•]	~	-
🗉 🗲 Layers	Geoco <u>d</u> ing	•	ē.		Vitato Cassio Angenta	
□ centralF_NOS1	± Add XY Data	Ð	**		Brana Via Real	
centralF_CITY	Add Route Events		22		Graga Via Real Braganca	
□ IP_IC_2000_Net_Junctions		y Tools	ংশ্য		And The	
•	My Places	Tools 🖸	۹		K STERFAN	
cidade2000	Online Services		.		And Austa	
□ 🗹 pt_line	<u>M</u> acros	Macros Alt+R			A Star I S	
	<u>C</u> ustomize	🚈 Visual Basic Editor Alt+F1			Samera C	
□ IP_IC_2000	<u>E</u> xtensions <u>S</u> tyles	▶ Is ols	-		Castele Branco	
E DISTS	Options	ols	0		HASING June	
□ 🗹 Nute2			44		Al and the Contraction	
		Ê	×y		N Tronsidgen	
ELIPSE_NOS			≟		Links Ly	
			<i>¥</i>		and the second of	
conc_total			•		Settoal	
PRN2000_small.tif			~		K Y	
RGB Red: Band 1						
Green: Band_2					$- \eta \gamma \gamma$	
Blue: Band_3					fut	
					and the set	-
Display Source Selection	Favorites Index Sea	rch Results	0004		~ ¥-	1
Drawing - R 💿 💷 🗆 - A -		• 10 • B Z U A				,
Display the Visual Basic Editor	,				Pos:	

2) Open the VBA interface from the Menu – tools (figure 1)

Microsoft Visual Basic - Normal.mxt - [MAIN (Code)]	
🤻 Eile Edit View Insert Format Debug Run Iools Add-Ins Window Help 😪 📴 - 属 😹 🐁 🐘 🛤 🥙 ♥ 🕨 💷 🐭 📚 🗺 😚 🎌 🕺 Ln 1, Col 1	_ # ×
	<u>E</u>
roject - project X (General)	▼ (Declarations) ▼
GLOBAL CONSTANTS	
ArdMap Objects Public Const FILENAME STATISTICS = "stats"	
Public Const FILENAME INDEXES = "NodeIndixes"	
ArcID Public Const FILENAME_MATRIX_Cn = "C"	' matriz de conectividade - n° caminhos possíveis entre i e j com n arcos 🦷
Public Const FILENAME_MATRIX_Tn = "T"	' matriz que representa o n° diferente de ligações entre o nós i j
MAIN Public Const FILENAME MATRIX Dn = "D"	' matriz de caminho mais curto em arcos entre o nós i j
NetworkMetrics Public Const FILENAME_MATRIX_Ln = "L"	' valued graph matrix - matriz de distancias reais entre i e j
NetworkMXDAnalysis Public Const FILENAME_MATRIX_M = "M"	' valued graph matrix - Matrix M - Mij represnts Mass of node ij
Utls Public Const FILENAME_MATRIX_P = "P"	' valued graph matrix - Matrix P - Pij represents Gravitic Potencial of node
🖻 🚔 Class Modules	
' ToDO : this path is not in use	
Project (prn2000_prj.mxd) Public Const FILENAME_OUTPUT_FOLDER = "C:\"	
' Fields automatically search by MXD analyser	
Public Const FIELDNAME_OBJECTID = "OBJECTID"	' The length of a line (edge), i.e. the name of a column in attribute tak
Public Const FIELDNAME_EDGE_LENGTH = "Shape_L	
Public Const FIELDNAME JUNCTION M = "M"	' The name of filed in attribute junction table with Mass value
roperties - MAIN X Public Const FIELDNAME_CoordX = "X"	' The X coordinate, i.e. the name of a column in attribute table
TAIN Module Public Const FIELDNAME_CoordY = "Y"	' The Y coordinate, i.e. the name of a column in attribute table
Alphabetic Categorized Public Const MAX_NODES = 10000	' The maximum number of allowed vertex
Public Const OUTPUT ALL MATRIXES = True	' If true output all intermediate matrixes (C1Cn, T1Tn, L1Ln)
Public Const CALCULATE CN TN LN = True	' true or false
Public Const POTENCIAL K = 0.000001	' Constant to be used in Potencial model calculations
•••••••••••••••••••••••••••••••••••••••	
'// M & T N	
·// n.k.i.n	
Sub main()	
	۲. Example 2. Example
Orawing - K 🔿 🖓 🗆 - A - 🖾 🖉 Aial - 10 - B I U A - 🗞 -	<u>.4 × •</u> ×
nlav the Visual Basic Editor	-168535.36 284920.37 Meters

- 3) Copy the codes (*geo_graph*) into the VBA interface (figure 2). Note that you have to create a project (Normal.mxt will due it) and then create new 5 Modules and 1 class module as *geo_graph*.
- 4) After copy the codes to each one of the modules and Class module
- 5) You are now ready to go (run the *geo_graph model*).

METRICS

IMPORTANT: *Geo_graph* model has been limited for a 10 000 nodes. Of course you can always change this value (goes the MAIN code and look for MAX_NODES), but probably it will take too much time running the model!

name	Planar Index	Non-planar index	range	Remark
Cyclomatic number	$\mu = A - N + G$	$\mu = A - N + G$	$0 \le \mu \rightarrow \infty$	Number of fundamental circuits in the network
Prihar index or degree of connectivity		$Cst = \frac{n(n-1)}{2a}$	1≤µ≤n/2	Compares the relative position of an observed networks connectivity on a scale limited by maximum and minimum connectivity ratios
Alfa index	$\alpha = \left(\frac{\mu}{2n-5}\right)$	$\alpha = \frac{\frac{\mu}{n^2 - 3 \times n + 2}}{2}$	$0 \le \alpha \le 1$	Ratio of the number of actual circuits to the maximum number possible
Beta index	$\beta = \frac{a}{n}$	$\beta = \frac{a}{n}$	0≤β≤3	Ratio measure between the numbers of edges to the number of nodes. It differentiates simple topological structures from complicated ones.
Gama index	$\gamma = \left(\frac{a}{3(n-2)}\right)$	$\gamma = \frac{2a}{n^2 - n}$	$0 \le \gamma \le 1$	Ratio of the number of edges in a network to the maximum number possible
Zagozdzon index		$Gp = \frac{n^2 - n}{\frac{2 - a}{n}}$	Gp≥0	It indicates the number of missing nodes for the network become complete.
Diameter	$d = \max d_{ij}$	$d = \max d_{ij}$	Shortest path between i th and j th	Measure the span of a network. Is the minimum number of linkages required to connect the two nodes that are the greatest distance apart.

Connectivity measures

Accessibility measures

Name	Índex	Meaning	Remark
Shimbel Índex of accessiblitiy	$ac_i = \sum_{j=1}^n dij$	Indicates the number of links to get from node <i>i</i> to node <i>j</i> , taking the shortest-path.	Lower the value, higher the node accessibility.
Average Shimbel Índex of accessiblitiy	$AC_i = \frac{\sum_{j=1}^{n} dij}{n-1}$	Indicates the average of the sum of the shimbel index of a node to all other networks nodes.	Lower the value, higher the network accessibility.
Dispersion index	$d = \sum_{i=1}^n \sum_{j=1}^n dij$	It's the sum of the accessibility index sums of all networks nodes.	Higher the value, higher the network dispersion and therefore higher the network complexity.
Average dispersion index	$D = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} dij}{(n-1)*n}$	Useful for compare networks complexities.	Higher the value, higher the network dispersion e therefore higher the network complexity.

Others measures

Name	Index	Meaning	Remark
Spatial interaction potential (P _i)	$P_i = M_i M_j / d_{ij}^2 K$	Indicates the settlements potential of interaction which is proportional to the inhabitants of that settlements and is inversely proportional to the topological distance (D) between them	factor K (0.000001) was introduced to simplify the values obtained.

Enjoy and please give us any feedback: comments, problems you have, ideas for more algorithms, anything you consider relevant to make our code better and useful to network analysis.

paulo@campus.ul.pt