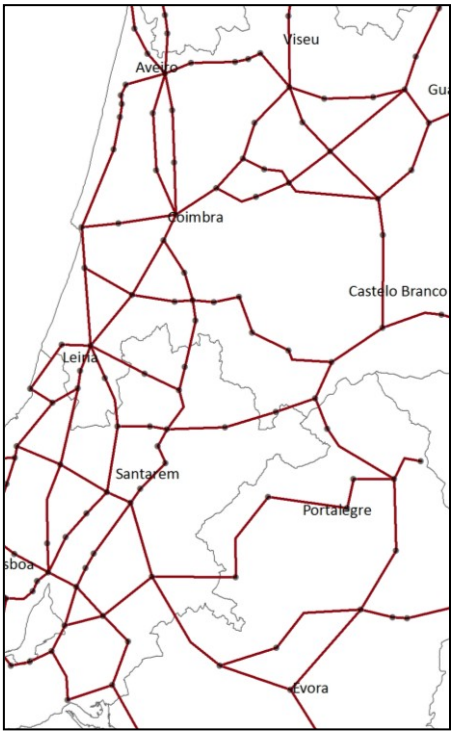
*Geo*_graph Model
Geographic model for graph analysis

User's Guide



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HOW TO BUILD A GRAPH
(Geometric network)

in ArcGIS – NETWORK ANALYST extension is needed.

1) In ArcCatalog, on a particular folder, click on the mouse right bottom and … **New > Personal Geodatabase**. Give a name.

2) 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**.

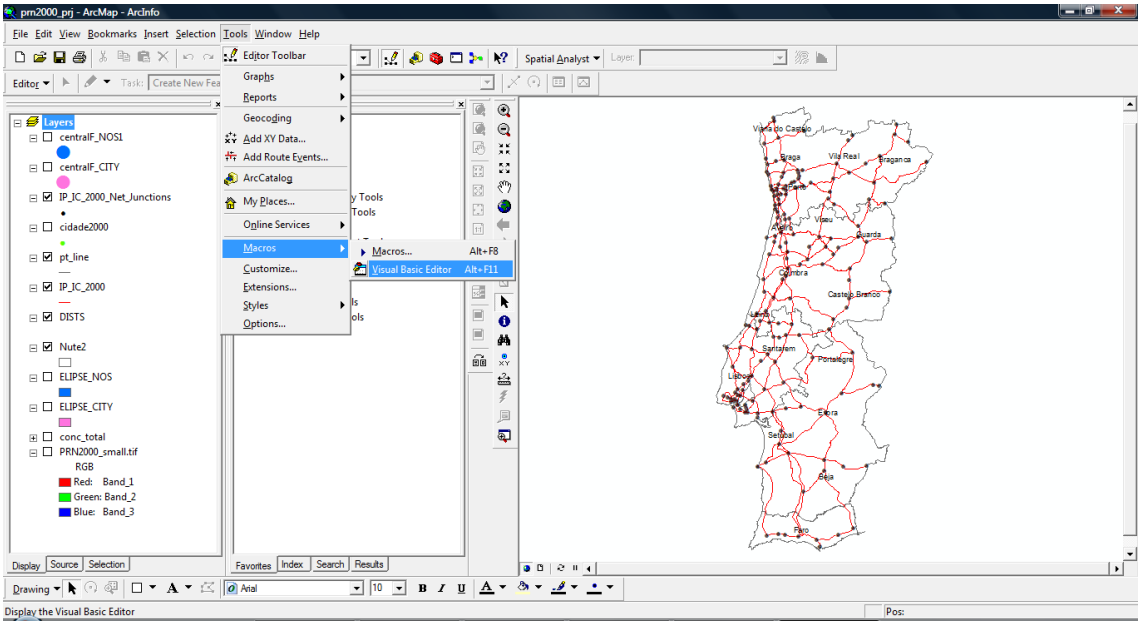
4) Click with the mouse right bottom and **new feature dataset;** chose **Import > Feature Class (single).** This way you load the polyline feature to the feature dataset, and make sure you have chose the same feature to 'Input Features' on the previous step.

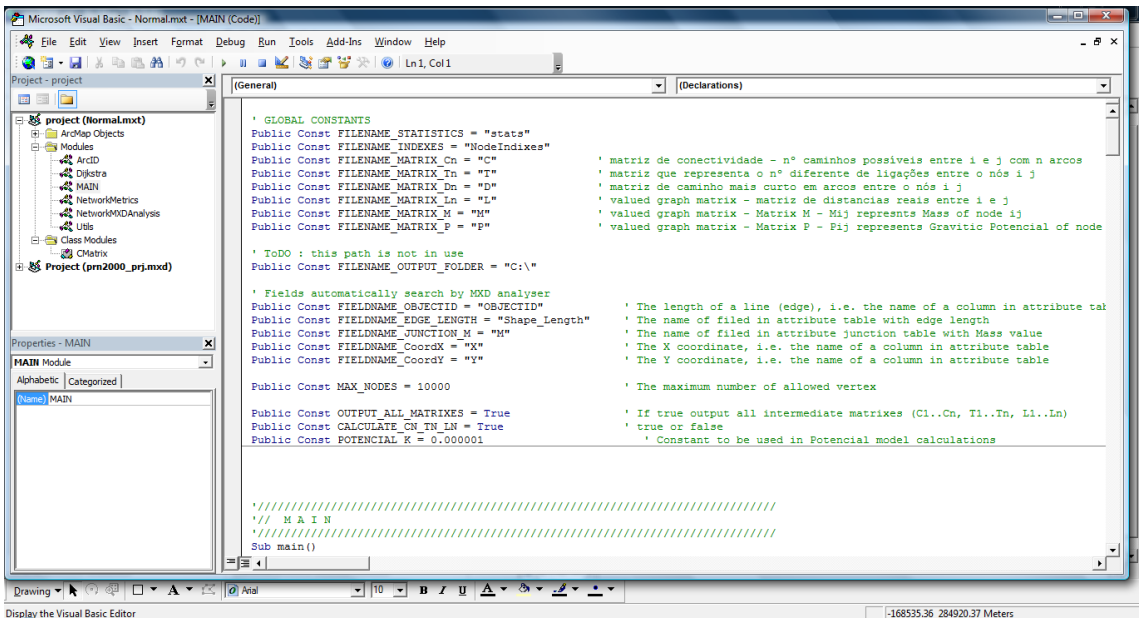
5) Click with the mouse right bottom (yes, again) on **feature dataset** and **New > Geometric Network**. We advice you that for a non-planar graph or random graph, all options should be default until the end (finish).

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.

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





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!

Connectivity measures

name	Planar Index	Non-planar index	range	Remark
Cyclomatic number	$\mu = A - N + G$	$\mu = A - N + G$	$0 \leq \mu \rightarrow \infty$	Number of fundamental circuits in the network
Prihar index or degree of connectivity		$Cst = \frac{n(n-1)}{2a}$	$1 \leq \mu \leq n/2$	Compares the relative position of an observed networks connectivity on a scale limited by maximum and minimum connectivity ratios
Alfa index	$\alpha = \left(\frac{\mu}{2n-5} \right)$	$\alpha = \frac{\mu}{\frac{n^2 - 3 \times n + 2}{2}}$	$0 \leq \alpha \leq 1$	Ratio of the number of actual circuits to the maximum number possible
Beta index	$\beta = \frac{a}{n}$	$\beta = \frac{a}{n}$	$0 \leq \beta \leq 3$	Ratio measure between the numbers of edges to the number of nodes. It differentiates simple topological structures from complicated ones.
Gama index	$\gamma = \left(\frac{a}{3(n-2)} \right)$	$\gamma = \frac{2a}{n^2 - n}$	$0 \leq \gamma \leq 1$	Ratio of the number of edges in a network to the maximum number possible
Zagozdzon index		$Gp = \frac{n^2 - n}{\frac{2-a}{n}}$	$Gp \geq 0$	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.

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* to node *j*, 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)	$P_i=M_iM_j/d_{ij}^2K$	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.

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