Install and Run Carto3F for cartograms

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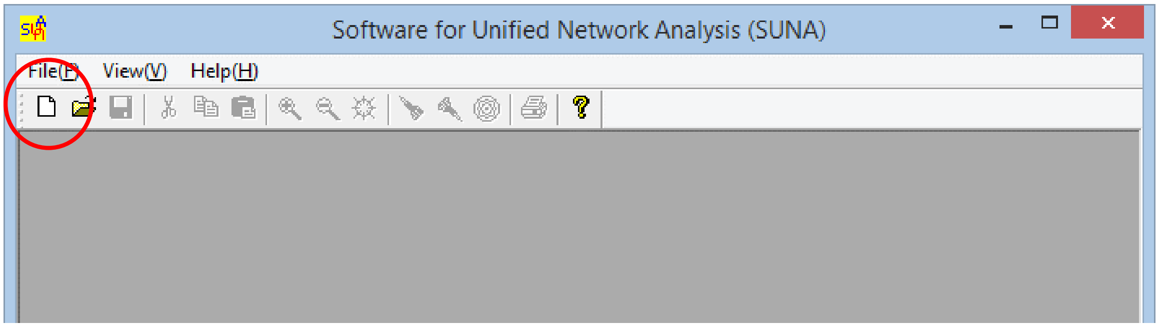
Installation

Standard Win32 setup program. Use the Carto3F_Setup.msi to install the program and example data. Currently, the program only works on Windows platform (7 & 8 verified).

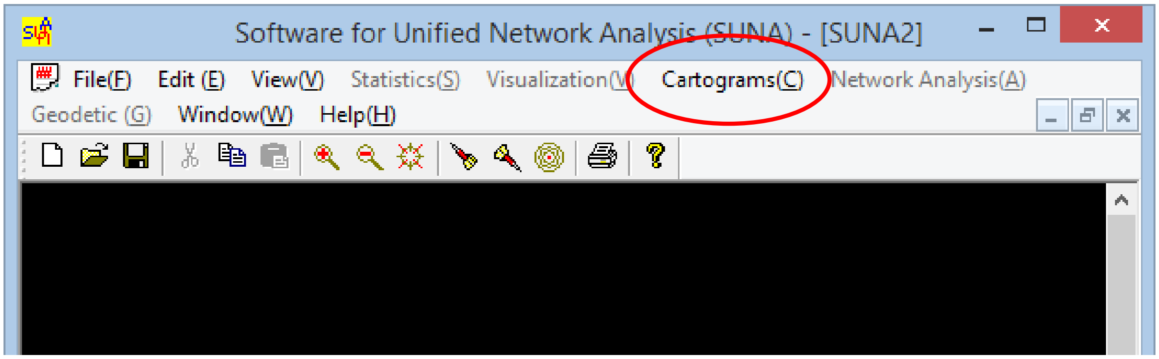
Program Interface

The program is a thinned version of a more comprehensive program. All unrelated functions are currently disabled.

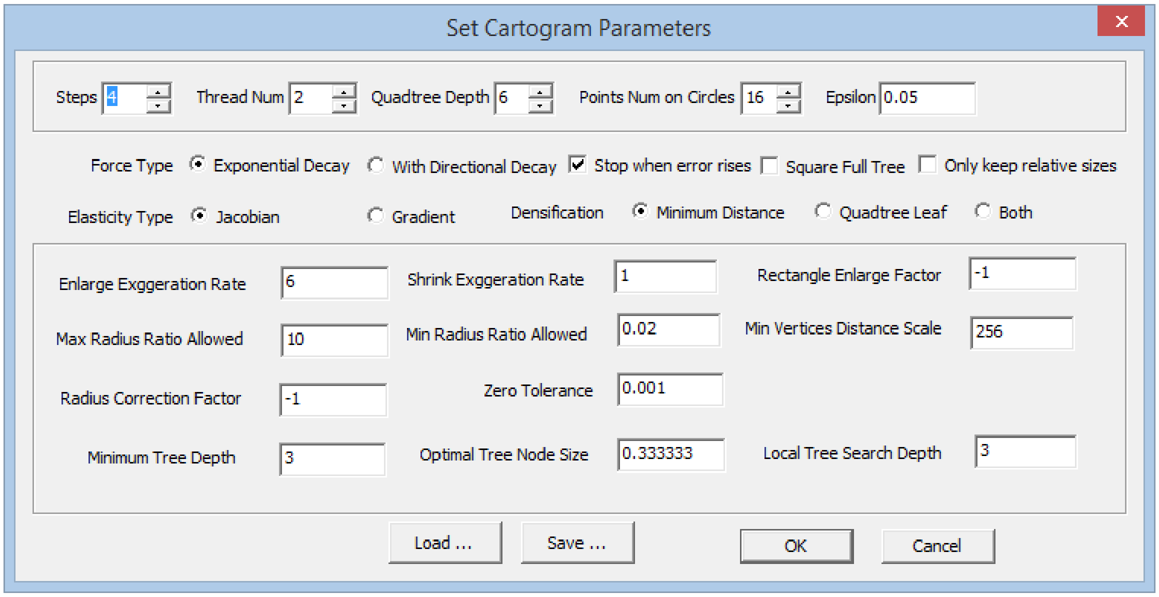
Using File – New, start a new document.



The Cartogram related functions are in the Cartograms Menu.



First, users should set parameters for the program. All parameters can be set using the following interface. Parameters can be saved to an ASCII (text) file or loaded from such a file. Exemplar parameters are available with the program installation. Detailed explanation of parameters is available below. Users should use caution when changing those parameters. It is always safer to start with the example values provided by the program and then change some of them gradually.



Set Cartogram Parameters

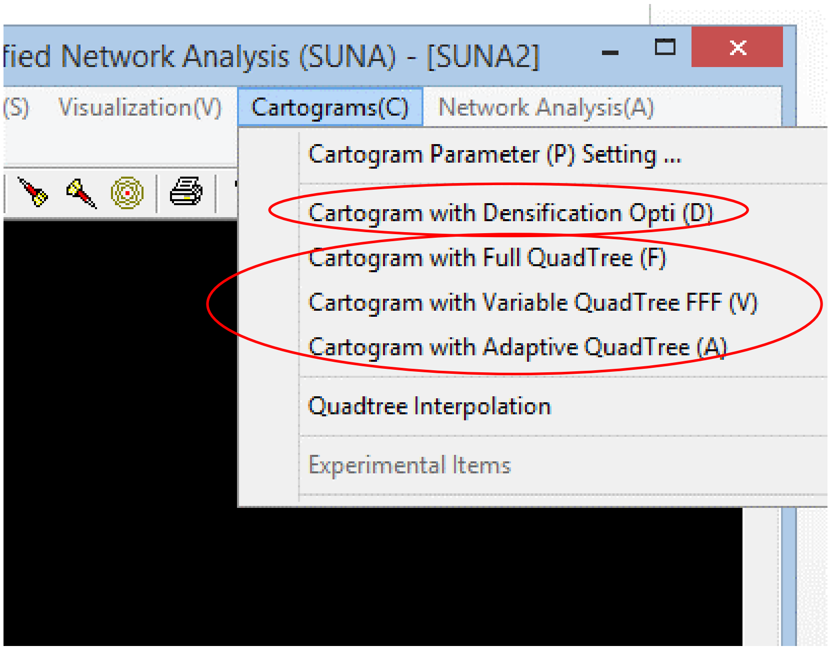
Steps 4 Thread Num 2 Quadtree Depth 6 Points Num on Circles 16 Epsilon 0.05

Force Type ● Exponential Decay ○ With Directional Decay ☑ Stop when error rises □ Square Full Tree □ Only keep relative sizes

Elasticity Type ● Jacobian ○ Gradient Densification ● Minimum Distance ○ Quadtree Leaf ○ Both

Enlarge Exggeration Rate	6	Shrink Exggeration Rate	1	Rectangle Enlarge Factor	-1
Max Radius Ratio Allowed	10	Min Radius Ratio Allowed	0.02	Min Vertices Distance Scale	256
Radius Correction Factor	-1	Zero Tolerance	0.001		
Minimum Tree Depth	3	Optimal Tree Node Size	0.333333	Local Tree Search Depth	3

Once parameters are set, there are a few options for cartogram production. One is a variant of Opti-DCN algorithm. The other three are variants of Carto3F using quadtrees. For most cartograms, the Variable Quadtree FFF (Carto3F) method is strongly recommended. All these methods require the same inputs explained below, although some methods might ignore certain parameters that don't apply.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(S)
Visualization(V)
Cartograms(C)
Network Analysis(A)
Cartogram Parameter (P) Setting ...
Cartogram with Densification Opti (D)
Cartogram with Full QuadTree (F)
Cartogram with Variable QuadTree FFF (V)
Cartogram with Adaptive QuadTree (A)
Quadtree Interpolation
Experimental Items

Parameters

Steps: The maximum iterations allowed. The program will stop once its iteration reaches this number.

Thread Number: The number of computing threads used to do the calculation. The program will automatically detect the number of cores of the CPU and use all of them by default.

Quadtree Depth: The maximum depth of the quadtree (should not go over 10 in most cases). Depending on the details that the program needs to catch, values between 5 and 10 are recommended.

Point number on circles: the number of points on the approximate circles.

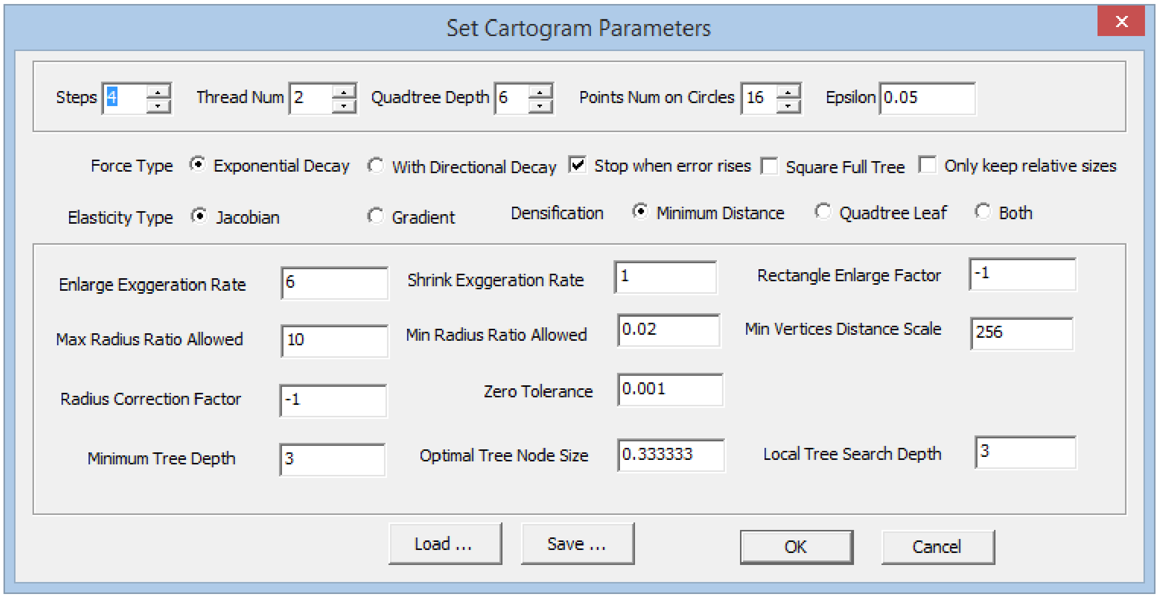
Epsilon: the epsilon (the indefinitely small number) value

Force Type: The transforming force type: 0 exponential distance decay (default) 1 with directional decay. Normally, 0 should be used.

Stop when Error goes up: whether to stop the iteration if the error metrics go up. If false, the program is essentially controlled by Steps parameter.

Full Square Tree: when using full quadtree to generate transforming points, the program could use a square coverage or use a rectangle coverage. The rectangle coverage will reduce the number of points.

Only Keep Relative Size: whether the sizes are controlled by relative sizes or absolute sizes. If relative, the ratio between the polygons and "blank" areas is not maintained.



Set Cartogram Parameters

Steps 4 Thread Num 2 Quadtree Depth 6 Points Num on Circles 16 Epsilon 0.05

Force Type ● Exponential Decay ○ With Directional Decay ☑ Stop when error rises □ Square Full Tree □ Only keep relative sizes

Elasticity Type ● Jacobian ○ Gradient Densification ● Minimum Distance ○ Quadtree Leaf ○ Both

Enlarge Exggeration Rate 6 Shrink Exggeration Rate 1 Rectangle Enlarge Factor -1

Max Radius Ratio Allowed 10 Min Radius Ratio Allowed 0.02 Min Vertices Distance Scale 256

Radius Correction Factor -1 Zero Tolerance 0.001

Minimum Tree Depth 3 Optimal Tree Node Size 0.333333 Local Tree Search Depth 3

Elasticity Type: method of calculating elasticity coefficient 0 Jacobian 1 gradient. Jacobian is recommended for complete topological equivalence.

Densification Type: 0: using minimum distance; 1: using intersections with quadtree edges and diagonals (grid equivalent), guarantee no-error in theory; 2: both methods

Enlarge Exaggeration Rate & Shrink Exaggeration Rate: The extra exaggeration parameters for enlarging and shrinking shapes

If enlargeExaggerationRate <= 1 and shrinkExaggerationRate <= 1, there will be no exaggeration. If enlargeExaggerationRate > 1 but shrinkExaggerationRate <= 1, enlargeExaggerationRate will serve as the parameter for the uniform logarithm function and shrinkExaggerationRate will be a cooling factor. If both are greater than one, a separate function will be applied.

Rectangle Enlarge Factor: The method to generate approximate rectangles, value > 0. If <= 0, no point pairs will be generated from rectangles/squares.

Maximum radius ratio allowed & Minimum radius ratio allowed: All ratios will be scaled according to this max and min ratios in order to avoid extreme values.

Min Vertices Distance Scale: scale used to calculate the maximum distance between vertices, max distance = min(height, width)/this scale.

Radius Correction Factor: radius correction parameter used to tackle the within-polygon force cancellation. -1 means no correction at all, > 0 this will be multiplied to change the radius for smaller than average circles.

Zero Tolerance: For Shapefile with low precision, if the distance between two points is below 1E-6, they will be treated as one point and causes self-intersection error. This is not our program's problem. It is ESRI's data model problem. In total, the number can have 15 digits, to be safe let it be 12. max(x,y)=z. (int)(log(z)/log(10)) + 1 digits for the integral parts.

The default resolution/precision in ArcGIS is 0.0001 meter (ArcGIS will translate other units into meters). And the default tolerance is 0.001 meter. So, any points that are closer to 0.001 meter will be treated as one point.

Min Tree Node Depth: The minimum tree node depth when using the adaptive tree. All nodes must have at least this depth.

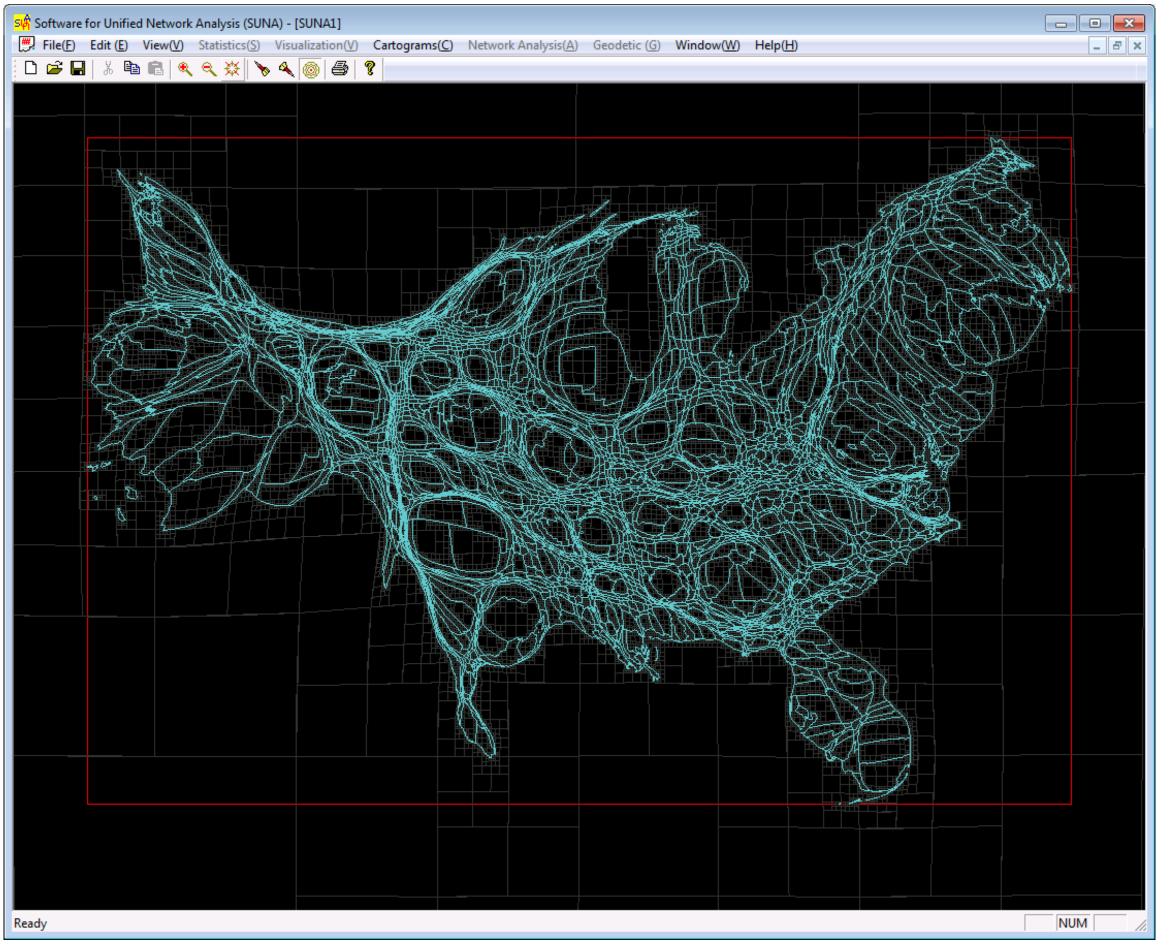
Optimal Tree Node Size Scale: The scale factor used to determine the optional tree node depth. If a polygon is small, its points should have higher depth to capture its geometry. Big polygons do not need fine quadtree nodes. Node size will be roughly min(polygon width, height)*optimalTreeNodeSizeScale*Poly_Area/MBR_Area

Local Search Depth: Because vertices in polygons are 'clustered', so local search should be tried when finding the tree node that contains a point. This parameter defines how far go up to parent, grandparent nodes.

Inputs and Output

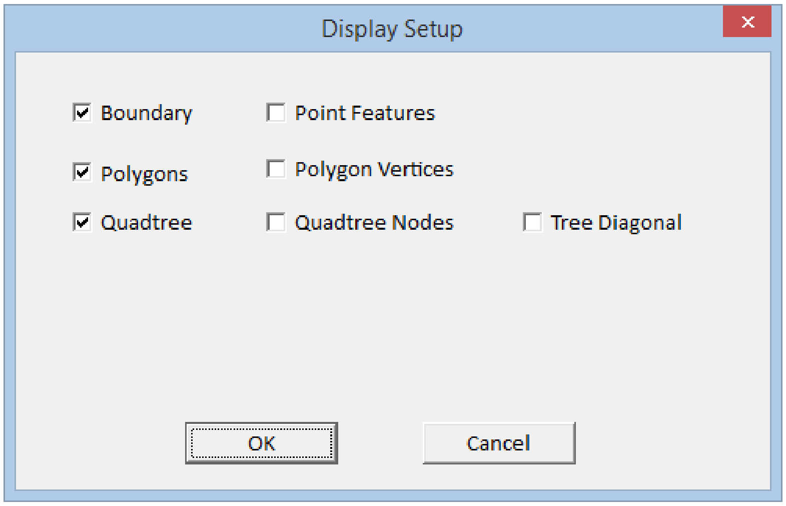
The program requires a well formatted Shapefile and a weighted ratio/fraction CSV file (comma separated file). In the CSV file, each number represents the area fraction of the corresponding polygon in the Shapefile (the summation of all fractions/ratios MUST be one). If the Shapefile name is FILENAME.shp|dbf|shx, the fraction file must be FILENAME_R.csv. The program will automatically search the file in the same folder with the naming rule. Please check your Documents\Carto3F folder for data and parameter file examples.

The program will produce a series of Shapefile data, named with XXX_0, XXX_1. Depending on the method that you chose, relevant EMF files will also be exported for illustration.



USA County Cartograms with 2010 Census Population

Carto3F also provides a basic visualization function to review results, particularly the quadtree. In the menu: View – Set Parameters, different display options can be specified.


Display Setup

☑ Boundary ☐ Point Features

☑ Polygons ☐ Polygon Vertices

☑ Quadtree ☐ Quadtree Nodes ☐ Tree Diagonal

Version and Control

V 1.0 for Public Release on Earth Day, April 22, 2015

Copyright and Contact

Should you have questions, feedbacks, suggestions, or want to use Carto3F for commercial purposes, please contact Dr. Shipeng Sun at sunsp.gis@gmail.com or cartogram@outlook.com.

Where and when appropriate and possible, please cite the following publications.

Sun, Shipeng (2013). A Fast, Free-Form Rubber-Sheet Algorithm for Contiguous Area Cartograms. *International Journal of Geographic Information Science* 27 (3): 567-93.

Sun, Shipeng (2013). An Optimized Rubber-Sheet Algorithm for Continuous Area Cartograms. *The Professional Geographer* 16 (1): 16-30.

Sun, Shipeng (2015). Carto3F Program: A Fast, Free-Form Algorithm Implementation for Area Cartograms. Available at http://sunsp.net.

Thank you for your interest in the Carto3F program and hope you find it useful.