Generating Heat Maps in Simple GIS

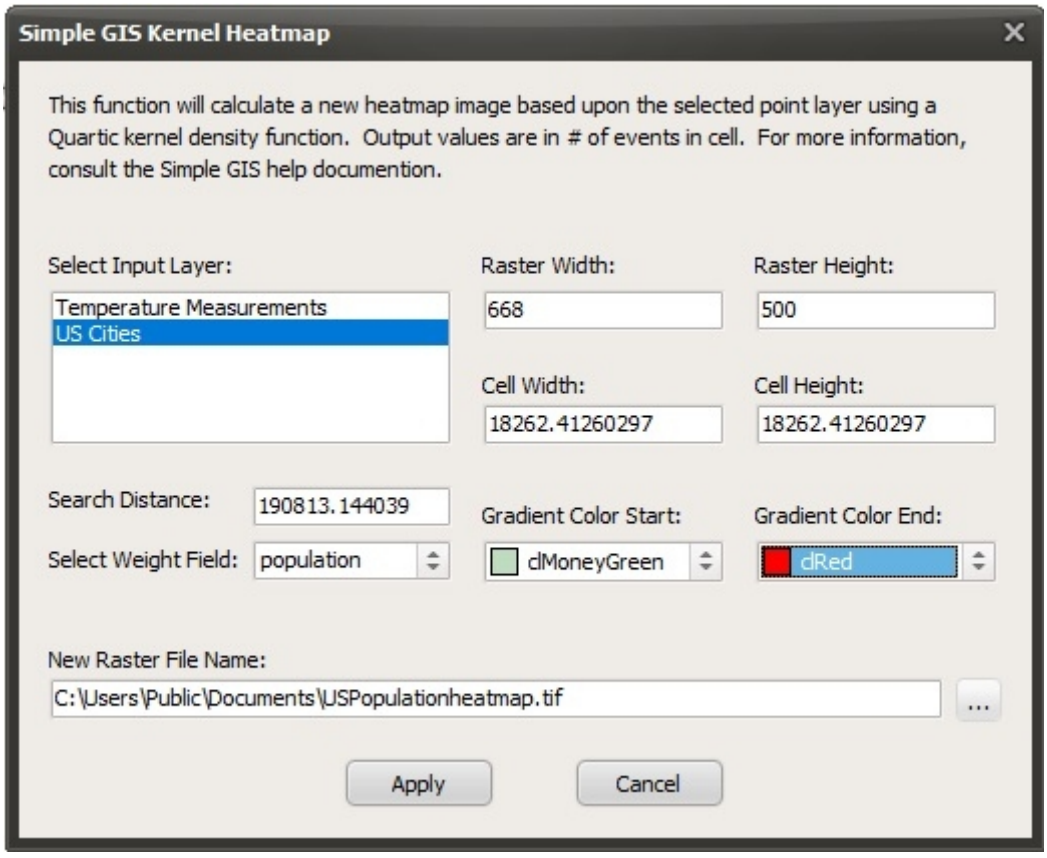
Heat Maps provide a way to geographically visualize the concentration or densities of events across an area. Heat maps can be a useful tool to visualize or analyze concentration of events such as crime activity, population, or measurements. Simple GIS generates heat maps by taking an input point or polygon shape file and interpolating the data to a continuous surface. In the case of Simple GIS, this surface is represented as a raster Tiff file. To generate the surface, Simple GIS considers three different parameters. The first parameter is the individual cell sizes in the raster. The raster surface will be made up of square cells of a given width and height. The smaller these cell sizes the smoother the resulting surface but the slower the processing time. Therefore, there is a trade off as to the resolution of the surface versus processing time. The second parameter is the search radius. This determines the area of influence assigned to each point. The greater the search radius, the more generalized the density patterns will be on the resulting surface. The smaller the search radius the density patterns may become too restricted to interpret significant patterns. The third parameter involves the type of calculation to use to interpret cell values. There are two distinct ways Simple GIS interpolates this data. The first is to use a kernel density function which uses a quartic probability density function to calculate the density distribution across the surface. The kernel density function is best for data that may not exist across the entire surface. For example, population data. There would likely be areas across your surface where it may be reasonable and likely to have no population. Areas covered by seas, deserts, or other uninhabitable areas for instance. The second calculation Simple GIS can use is the inverse distance weighted function. This method is best for data or measurements you would expect to find across the entire surface. Temperature data for instance would be a good example as every area covered by the surface would have a temperature value. The Heat Map generating functions are found under the “Geo Processing” of the Map Data View document. Each calculation is described in further detail below.

Generate Kernel Heat Map

This function uses a quartic kernel density function to calculate the density of points in a given raster cell. The density function defines a circular region around each point with a given search radius r. The highest value is located at the point and decreases in value as the distance increases away from the point, reaching zero as the distance approaches the search radius r. The quartic function used by Simple GIS approximates the number of events by cell using the following function

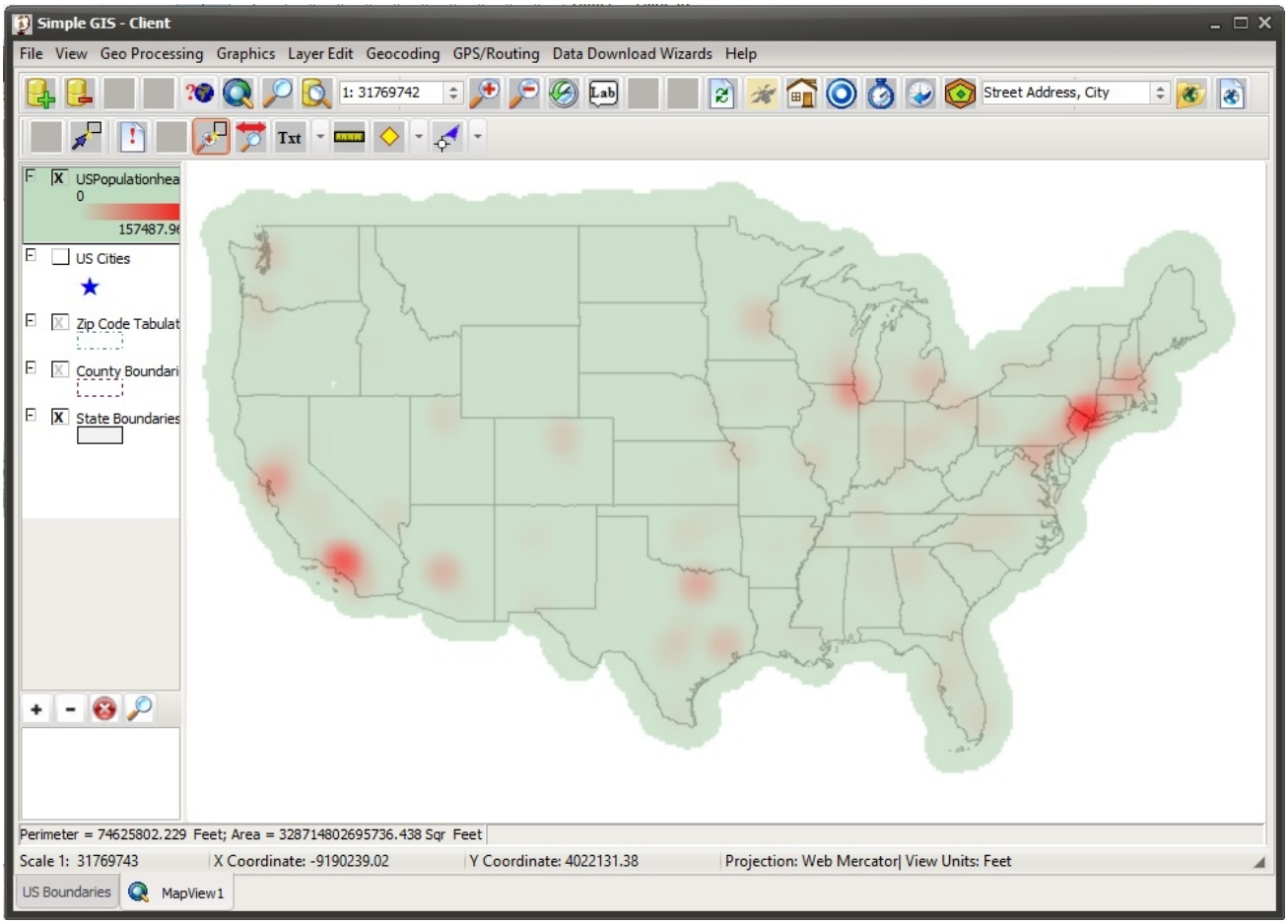
$$\sum_{i=1}^{n}\left[\frac{3}{\pi}\left(1-\frac{{d_{ij}}^2}{h^2}\right)^2\right]$$ where dij is the distance from center of cell to point and h is the search distance.

When you select the “Generate Kernel Heat Map” menu option, you will be presented a dialog box similar to the one shown below.



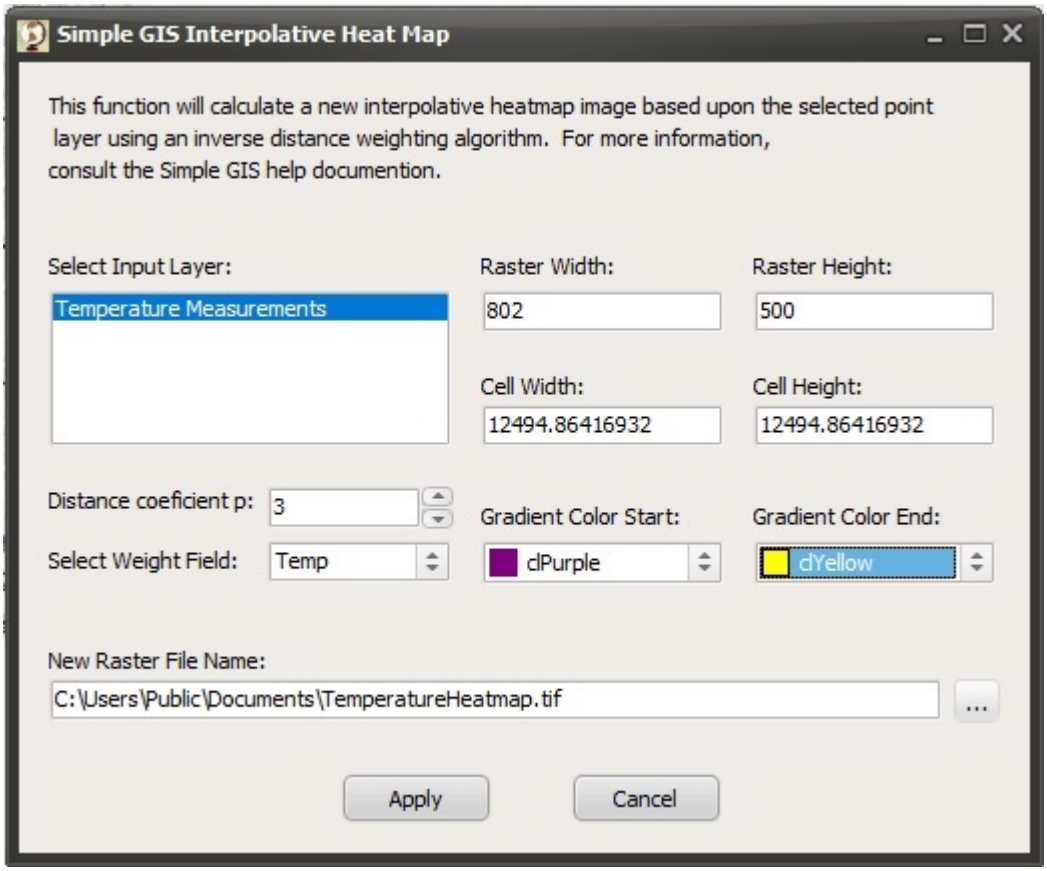
This dialog box will contain a list box from which you will select the input layer from which to generate our heat map. This list box is pre-populated with all point and polygon layers contained in our current MapDataView document. In the case of a polygon layer, Simple GIS will use the centroid of each polygon feature as the input point into the calculations. In this example, we are going to select the US Cities point layer contained in our current MapDataView document. This point layer contains a field named population that represents the total population for each city. If you only wanted to generate your heat map from a sub set of features from the point layer, you could have selected the features your wanted to use in the shapefile before clicking the “Generate Kernel Heat Map” menu. Otherwise, if you have less than two features selected in the input layer, Simple GIS will select all features to use in generating the heat map. The Raster Width and Raster Height text boxes allow you specify the width and height of the resulting raster image in pixels while the Cell Width and Cell Height boxes specify the area a pixel covers in map units. Therefore, these inputs are interdependent. If you change the width and height of the raster image, you will also change the cell size of the pixels. Likewise, if you change the cell size, you will change the width and height of the raster image. Simple GIS will pre-populate these fields with default values based upon the input layer selected. The Search Distance field allows you to specify the search radius to use for points in the input layer. Simple GIS will pre-populate this value as well based upon the input layer selected using a standard distance calculation on the points in the input layer. However, you can override this value if you so choose by typing a new value in this input field. In addition, if the selected input layer contains a numeric field that can be used to weight the value of a point feature, you can select this field from the “Select Weight Field” drop down box. In our example above, our US Cities point layer contains a field named population which contains the total population for each city. Otherwise, if you leave the “Select Weight Field” input set to “None”, each point would be assigned a value of one. In addition, you will need to select the colors you would like to use to define the color gradient for your heat map. The Gradient Color Start defines the color you wish to use for cells with

the lowest densities while the Gradient Color End is the color you wish to use for cells with the highest densities. Lastly, you would select a filename for your new heat map image. Click the "..." button to bring up a file dialog box allowing you to select a location and filename for your new heat map image. When you click "Apply" Simple GIS will generate the new heat map and then prompt you whether you want to add the new heat map image to your current Map Data View document. Below is an example of the heat map image created from our city point layer and added to our current Map Data View document with its opacity set to 75%.

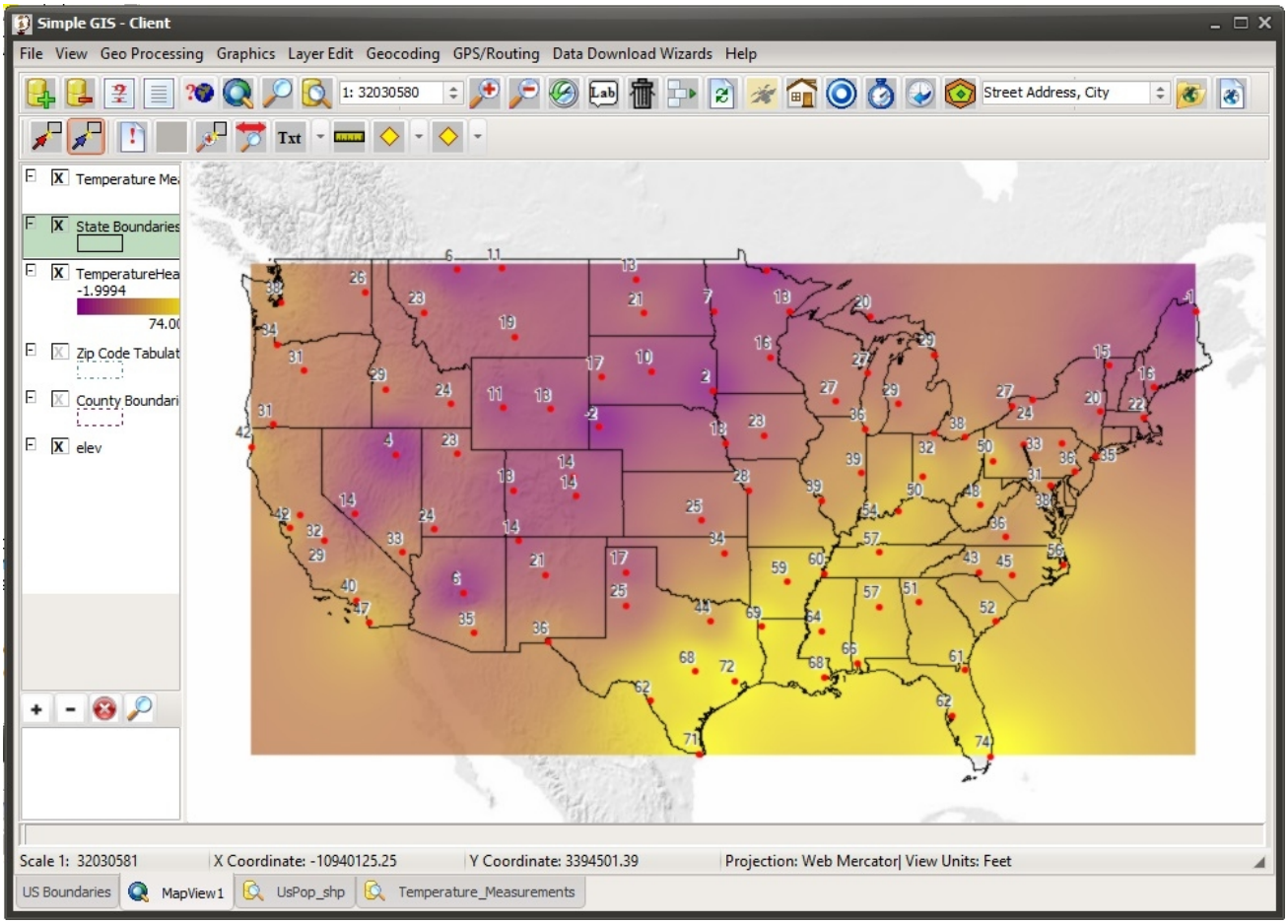


Generate Interpolative Map

This function uses inverse distance weighting to interpolate values for each cell in the output raster image. Unlike the kernel density map, in this case every cell of the resulting raster will have a value based upon this interpolation. The influence of a given point to neighboring cells decreases as the distance between the point and cell increases. When you select the "Generate Interpolative Map" menu option, you will be presented with a dialog box similar to the one shown below:



Just like for the kernel density heat map, you would select your input point or polygon layer and adjust the raster width and height, or the cell width and height or accept the default. Also, the weight field, gradient color start, gradient color end, and new raster file name work the same as described for the kernel density function above. However, in this case you may notice a new parameter named “Distance coefficient p”. This parameter determines how much influence is attributed to points located at greater distances from a cell. The smaller the value of p, the greater the influence attributed to points located at greater distances from a given cell. The larger the value of p, the greater the influence attributed to points closer to the cell. In this way, by varying the value of p, you can achieve different effects in your heat map. In the example below, we show the resulting heat map created from temperature data from select cities using the attributes shown in the dialog box above.


Simple GIS - Client
File View Geo Processing Graphics Layer Edit Geocoding GPS/Routing Data Download Wizards Help
1: 32030580
Street Address, City
Temperature Me
State Boundaries
TemperatureHea
-1.9994
74.0
Zip Code Tabulat
County Boundari
elev
Scale 1: 32030581
X Coordinate: -10940125.25
Y Coordinate: 3394501.39
Projection: Web Mercator| View Units: Feet
US Boundaries
MapView1
UsPop_shp
Temperature_Measurements