

# Guide To Using the Crime Analytics for Space-Time (CAST) Desktop Software Program\*

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# 1 Purpose

The purpose of this guide is to provide an overview of how to use the main functionality of the *Crime Analytics for Space-Time* program (CAST), which was developed by Arizona State University’s GeoDa Center for Geospatial Analysis and Computation under a 2009-12 cooperative agreement with the National Institute of Justice.<sup>1</sup> Since we have made detailed explanations about the methods implemented in CAST available through other GeoDa Center resources, this guide does not include these explanations but it references the relevant sources.<sup>2</sup>

## 2 Overview of CAST

CAST is designed to detect spatial patterns and trends in crime data.<sup>3</sup> The idea is to make it easy to represent different dimensions and contexts of crime –like crime types or neighborhood characteristics– in views such as maps, graphs, and calendars that can be animated over time. All of these views are linked to allow analysts to identify how selected subsets of the data, such as particular beats, are characterized across these dimensions. Using statistical significance tests, CAST includes several cluster maps and trend graphs to detect where concentrations of crimes are higher or lower than expected.

The program runs on three operating systems: Windows, MacOSX and Linux (Figure 1). It is designed as a user-friendly interface to PySAL, the spatial analysis library developed at the GeoDa Center in Python that serves as the code base for its functionality.<sup>4</sup> PySAL grew out of Professors Luc Anselin’s and Sergio Rey’s previous software development efforts, including GeoDa and STARS.<sup>5</sup> The PySAL framework provides a flexible background software engine for delivering a range of functionality customized to specific applications and using different user interfaces. These applications include free-standing desktop software such as

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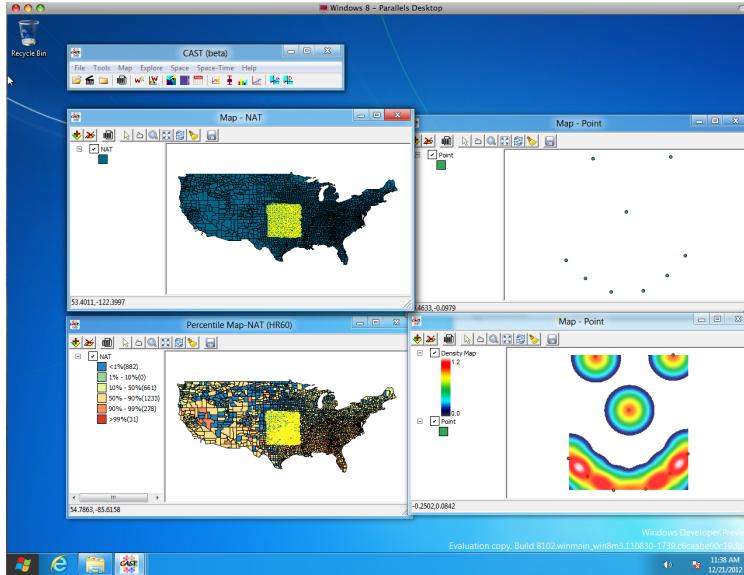
<sup>1</sup>CAST can be downloaded at <https://geodacenter.asu.edu/software>. The license agreement can be found at <https://geodacenter.asu.edu/license>.

<sup>2</sup>See the PySAL documentation at <http://pysal.geodacenter.org/1.5/contents.html>, the Open-GeoDa tutorial at <https://geodacenter.asu.edu/system/files/geodaworkbook.pdf>, and the e-slides at <https://geodacenter.asu.edu/eslides>. Relevant sections of these sources are referenced below.

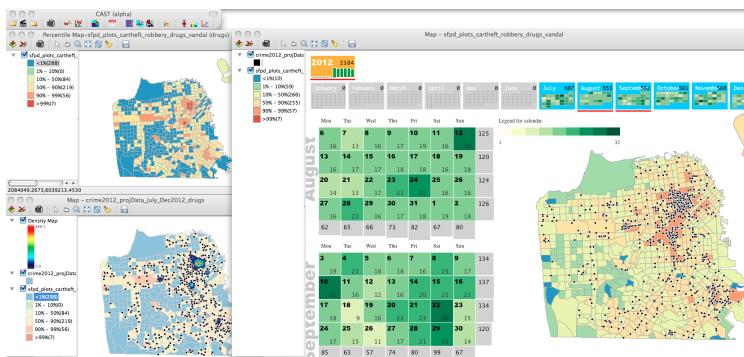
<sup>3</sup>It can also be used for other time-stamped events such as diseases.

<sup>4</sup>PySAL can be downloaded at <http://pysal.org>

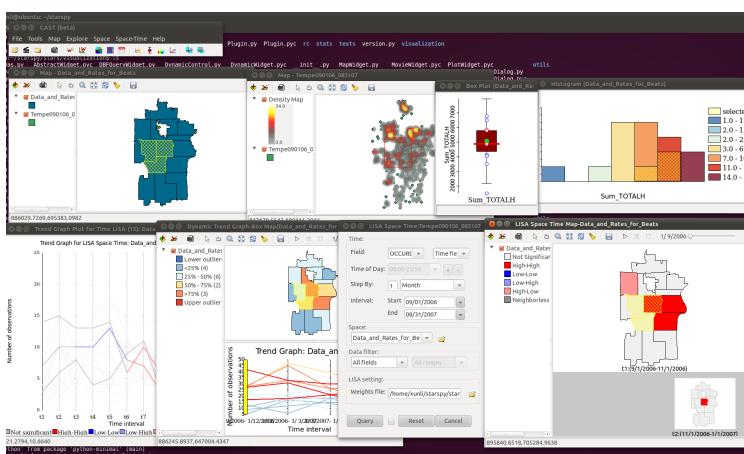
<sup>5</sup>Both programs can be downloaded at <https://geodacenter.asu.edu/software>



(a) CAST for Windows



(b) CAST for Mac OSX



(c) CAST for Linux (Ubuntu)

Figure 1: CAST on Windows, Mac OSX and Linux/Ubuntu

CAST, GeoDaNet and GeoDaSpace. CAST and these programs can be downloaded on the GeoDa Center website for free.<sup>6</sup> Its linked views for interactive exploratory spatial data analysis are similar to OpenGeoDa but OpenGeoDa is designed for the analysis of one area-level dataset at a time while CAST can display multiple shapefiles simultaneously as layers in one view and/or as separate views. Like OpenGeoDa, CAST reads so-called shapefiles, the geographic file format related to ESRI's ArcGIS software, the most widely used commercial Geographic Information System (GIS).

## 3 Prerequisites

To get started with analyzing data in CAST, you need a point or polygon shapefile (which, at a minimum, consists of three files with .shp, .shx and .dbf extensions). If you want to load multiple layers in one view or link shapefiles across views, as usual, they need to have the same spatial extent. The tools in CAST will only work with shapefiles that are currently open in CAST (e.g., if you open a shapefile and close it, the shapefile dropdown selection option in the query views might still list shapefiles from memory but they need to be open in order to be mapped or graphed).

### 3.1 Projections

To load a point and area shapefile in the same view, the coordinates of the point shapefile need to be in the same projection as the area shapefile. For instance, if the points have latitude-longitude coordinates (such as -122.50022, 37.718954) but the area shapefile is based on a projected coordinate system (e.g. NAD 1983 State Plane California), then the point coordinates need to be converted to projected coordinates in order to be displayed in the same view or linked across views in CAST (in this example, the projected coordinates would be 5983167.999905, 2090431.999985).<sup>7</sup>.

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<sup>6</sup>At <http://www.geodacenter.asu.edu/software>

<sup>7</sup>To convert lat-long coordinates in ArcGIS 10, project the shapefile and add two new fields such as X\_pr and Y\_pr to the table (float, e.g. 20, 10 for precision and scale). Then right-click on each of these fields and "Calculate Geometry" based on X and Y, respectively, for the desired projection. Next, import the dbf file back into ArcGIS through File-Add Data-Add XY Data and select the X\_pr and Y\_pr fields. Save as a new shapefile at which point you can load both the point and area shapefile with the same projection in one view

## 3.2 Date Fields

CAST allows analysts to aggregate point data on the fly to areas and to specified time periods (and to save the space- and time-aggregated data as a new dbf file). To analyze crime over time, a date field needs to be specified. For point shapefiles, each record will have a time stamp, often with the date and time (for the San Francisco sample data, use the *Date* and *Time* fields). You can specify custom formats for these date and time fields in CAST but for automatic detection of the date field, it is easiest to have a separate field for the date and time of an event. For instance, if the data field is recorded as '05/01/2011 00:00:00', then analysts should turn this into two separate fields such as date = '05/01/2011' and time = '00:00:00', before loading the data into CAST.<sup>8</sup> For polygon shapefiles without point data, crimes need to already be aggregated for specific time periods (one period per column).

## 3.3 Data Used in this Guide

The data used in this guide represent crime incidents obtained from San Francisco Police Department's (SFPD) Crime Incident Reporting system through San Francisco's open data portal.<sup>9</sup> It includes four separate shapefiles of incidents of robberies (*sf\_robbery*), drugs/narcotics possession or sale (*sf\_drugs*), vehicle theft (*sf\_cartheft*), and vandalism (*sf\_vandalism*) for July 1 to December 31, 2012 and one polygon shapefile for SFPD reporting plots that these data were aggregated to (*sfpd\_plots*). The date and time fields to use are *Date* and *Time*.

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in CAST.

<sup>8</sup>In ArcGIS, the date part in this example can be extracted through *Left([Date], 10)* or through *DatePart()*. Otherwise, any program to parse text will work (in this example the space indicates the break line).

<sup>9</sup>The formatted data, ready for CAST, and metadata, can be downloaded at [http://geodacenter.org/downloads/data-files/SFCrime\\_July\\_Dec2012.zip](http://geodacenter.org/downloads/data-files/SFCrime_July_Dec2012.zip)

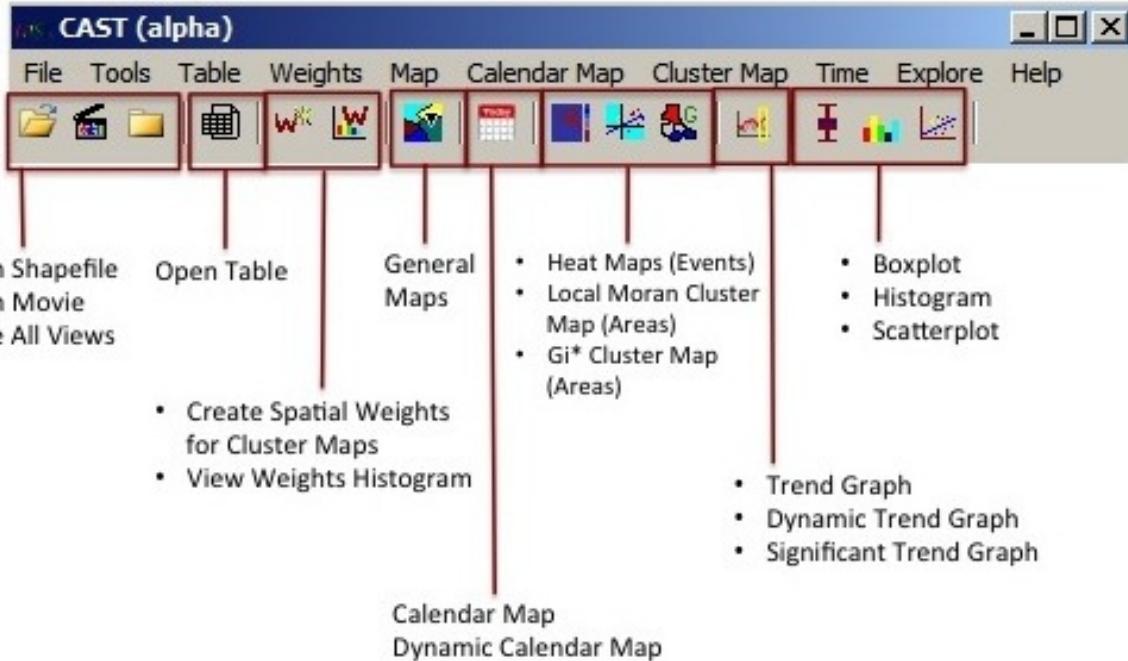


Figure 2: Main CAST Menu

## 4 Main Menu and Context Options

### 4.1 Menus and Toolbars

Figure 2 shows the floating menu bar that is displayed when CAST is first opened. In contrast to a typical Geographic Information System, this menu bar is not associated with a fixed window to allow analysts to more flexibly open as many views as needed, possibly across multiple screens without the constraint of a bounding box. The starting point is the *open folder* icon or *File-Open Shape File* menu option to open a shapefile. Other file options include *open map movie* if you previously saved an animated .gif file in CAST and *close file* to close all open views. The *Tools Menu* also includes the option to create a grid with the same spatial extent as another shapefile. This enables analysts who have crime events but no area shapefile to create a polygon shapefile that can be displayed in the same view as the crime incidents. The *table* option can be chosen to view the dbf table that is associated with any open shapefile. This is useful for viewing attribute details of incidents or areas selected in a view.

Next are tools to create so-called spatial weights and view the number of neighbors of

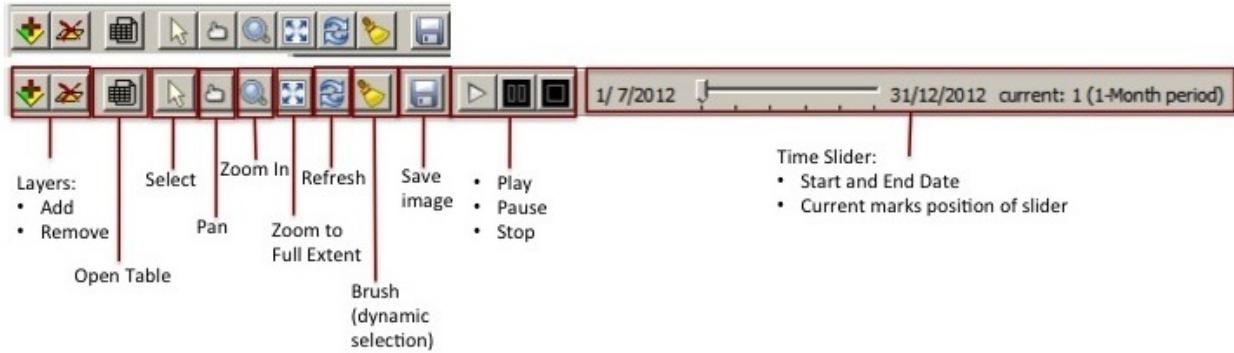


Figure 3: Static and Dynamic Map Menu Options

an area in a histogram (see the W icons). When a spatial weights file is created, a text file is saved that lists the IDs of all the observations that are considered neighbors of a given observation. The criteria for defining neighbors in CAST include contiguity (shared borders (rook) and corners (queen)) and distance (within a specified radius or the closest fixed number of neighbors). Details about weights creation and the weights histogram can be found in chapters 15 and 16 of OpenGeoDa’s free tutorial.<sup>10</sup>

There are three types of map options to detect concentrations of crimes: 1) general maps, 2) calendar maps and 3) cluster maps. General maps include options to identify unusual areas (e.g. box maps in analogy to boxplots, percentile maps that highlight the bottom and top one percentiles of a sorted distribution of crimes, and standard deviation maps) as well as typical map classifications based on natural breaks, unique values, and equal intervals.<sup>11</sup> The *Map* menu or icon option also allows analysts to create rates and rate-smoothed maps to adjust for small underlying population bases that distort risk estimates. Details about rates and rate smoothing can be found in chapters 15 and 16 of OpenGeoDa’s free tutorial and in PySAL’s online documentation.<sup>12</sup> The calendar map and cluster map options are discussed below in more detail.

Three trend graph options are available: 1) A regular trend graph for user-specified time periods and areas, 2) a dynamic trend graph, which links a regular trend graph to a map

<sup>10</sup>The OpenGeoDa tutorial can be downloaded at <https://geodacenter.asu.edu/system/files/geodaworkbook.pdf>

<sup>11</sup>For more technical detail about the map classifications implemented in CAST, see the online PySAL documentation at <http://pysal.geodacenter.org/1.5/library/esda/mapclassify.html>

<sup>12</sup>The OpenGeoDa tutorial can be downloaded at <https://geodacenter.asu.edu/system/files/geodaworkbook.pdf> PySAL’s online documentation on rate smoothing is available at <http://pysal.geodacenter.org/1.5/users/tutorials/smoothing.html>

- Change the map's transparency to view multiple layers.
- Open the associated dbf table and view linked observations.
- Zoom to the full extent of the map.

Cluster Map (Local Moran's I). See <http://pysal.geodacenter.org/1.4/users/tutorials/autocorrelation.html#id24>

For map classification details, see <http://pysal.geodacenter.org/1.4/library/esda/mapclassify.html>

Removes the map classification

## Map Legend Dropdown Options

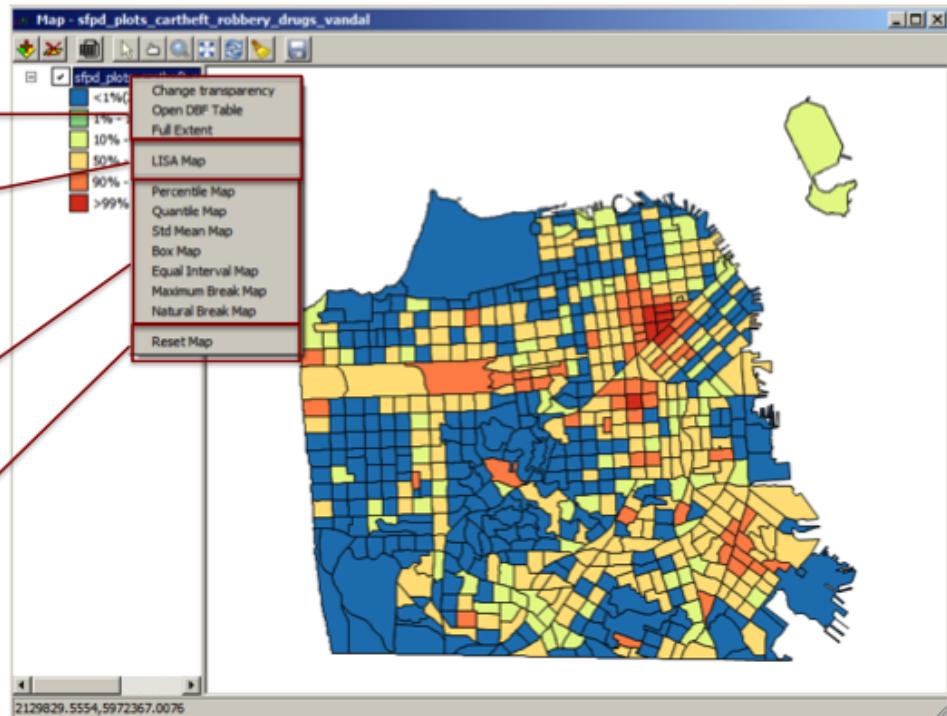


Figure 4: Map Legend Dropdown Options

and then automatically displays crime patterns across time and space, and 3) a significant trend graph, which identifies statistically significant time runs within an area compared to the overall trend in this area. The final set of tools include standard non-spatial descriptive statistical views of the data, namely boxplots, histograms and bivariate scatterplots.

Figure 3 shows the toolbar available for all map views. Dynamic map views have an extended toolbar that also includes *play-pause-stop* and other typical movie options. The toolbar icons will be familiar to many analysts and are labeled in Figure 3. Starting from the left, the first option is the *Add Layer* feature to, for instance, load a time-stamped point shapefile and a polygon shapefile with the same projection, which are input files for several tools. The only non-standard feature is so-called brushing, i.e. dynamic selection of observations, which can be accessed through the *brush* icon.

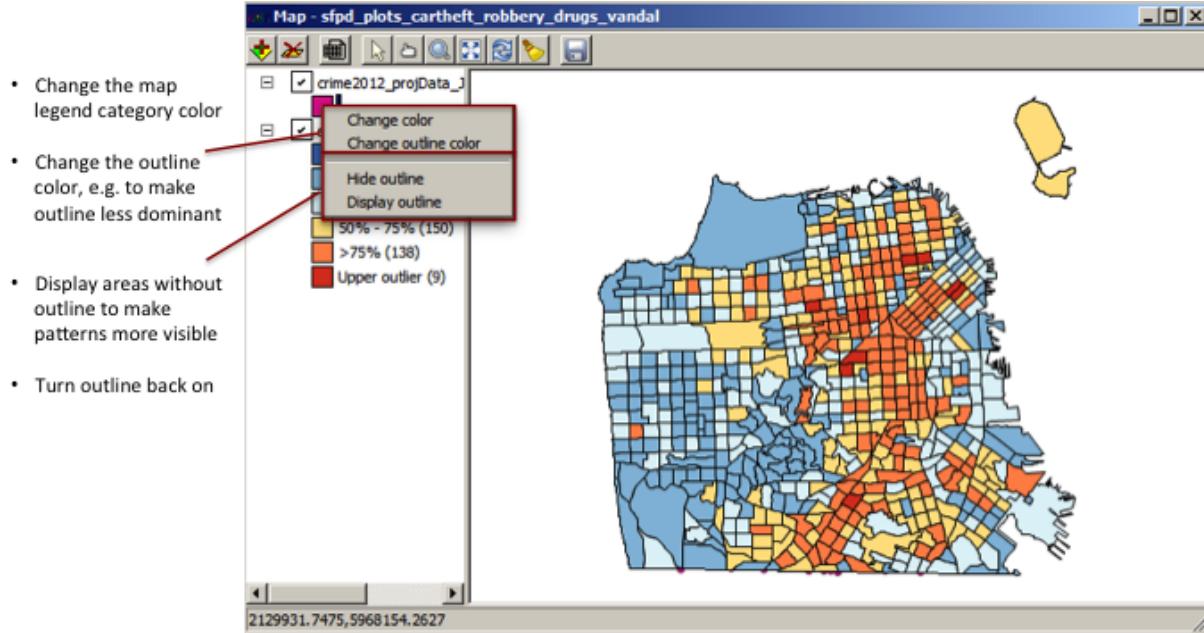


Figure 5: Map Legend Color Dropdown Options

## 4.2 Context-Specific Dropdown Menus

Right-clicking on a layer in a map view will result in the display of the dropdown menu shown in Figure 4. The *LISA map* choice is one of the cluster maps described below while the map classifications are the same as described above. *Change transparency* is useful when applied to a top layer for displaying additional layers below. When right-clicking on the color legend of a layer displayed in the map view, the dropdown menu shown in Figure 5 provides options to change the legend color and polygon or point outline color, and to hide or display these outlines for improved pattern detection. The order of layers can be changed by dragging and dropping one layer on top of another. Once this occurs, the dropdown menu shown in Figure 6 becomes available, which grants the choice to move the dragged layer above or below the existing one.

## 4.3 Query Windows

Figure 7 presents the query window where analysts can specify the date and (optional) time fields for their point data and, based on this, define the date start, end, and time intervals for aggregating the data. Filters for time of day and crime type also exist. The polygon

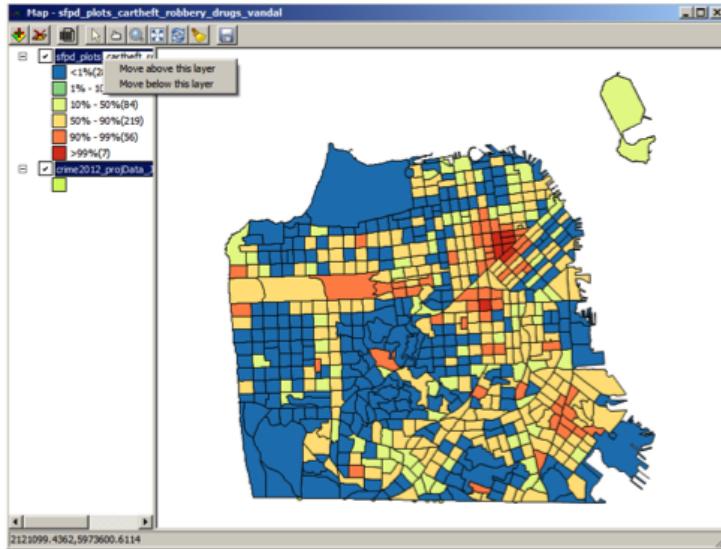


Figure 6: Changing the Order of Map Layers

file that is selected in the *Space* field is used to aggregate points to areas. The dbf file with the aggregated points by time and space can be saved and used elsewhere (e.g. to access OpenGeoDa’s time-enabled features). For cluster maps, the query window also contains the option to specify a spatial weights file.

## 5 Functionality

### 5.1 Multiple Layers

As is common in Geographic Information Systems, CAST allows analysts to load multiple layers in one view. Figure 8 shows examples of how multiple layers can be used in CAST, for instance, to display incidents of robberies with percentile maps, heatmaps, and cluster maps.

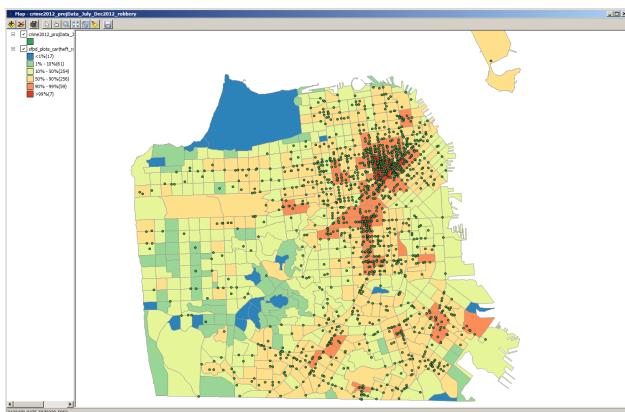
### 5.2 Separate Views with Different Shapefiles

One of the special features in CAST is that analysts can load multiple shapefiles at the same time in separate views that each contain several layers, e.g., separate point shapefiles for robberies, burglaries, and vehicle theft, each with area shapefiles as second layers or density

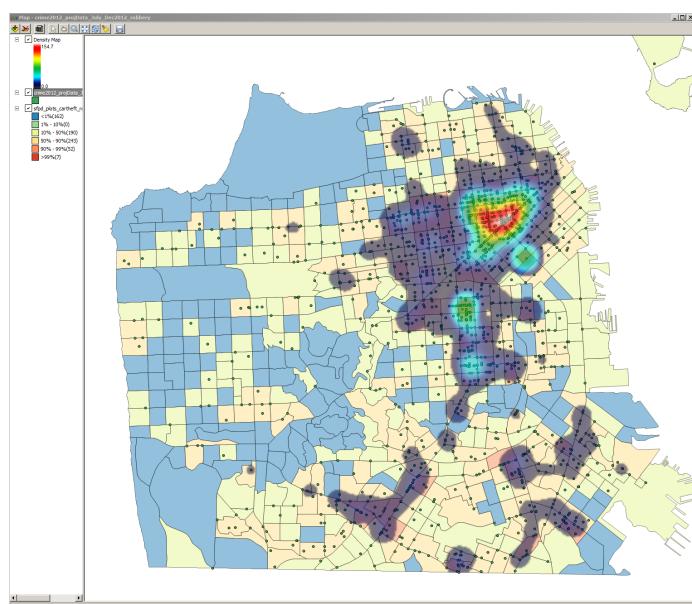
1. Select a date field and (optional) a time field.
2. If a time field is selected, events for a specified time frame can be chosen in military time (the default is set to midnight – 11:59pm)
3. In the "Step By" field you can identify the time steps you want to aggregate the events for
4. The time interval defines the start and end date of your query. By default the first and last days in your data are displayed.
5. Select one of the area shapefiles that you opened in CAST before from the dropdown or open a new area shapefile.
6. If you want to filter your data, specify the field and subcategory to do so (optional).
7. The weights file identifies neighboring areas. If you do not already have a weight file, create a new one (W\* icon or Weights-Create menu) and then select it here.
8. After selecting "Run" you have the option to save a new dbf file for your area shapefile from 5. It contains the fields from this area shapefile plus the events aggregated to the time periods you specified in 2-4. You can e.g. use your area shapefile from 5 with this new dbf (instead of the old one) with OpenGeoDa's time-enabled views.



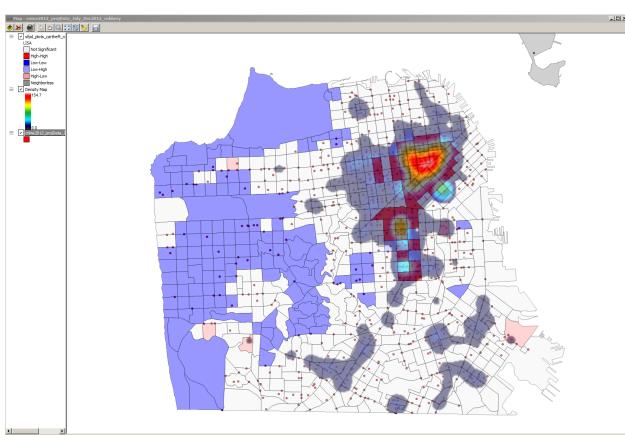
Figure 7: Options to Aggregate Points in Time and Space and Subset Data



(a) Incidents and Percentile Map



(b) Incidents, Heatmap and Percentile Map



(c) Incidents, Heatmap and LISA Cluster Map

Figure 8: Multiple Layers of Robberies

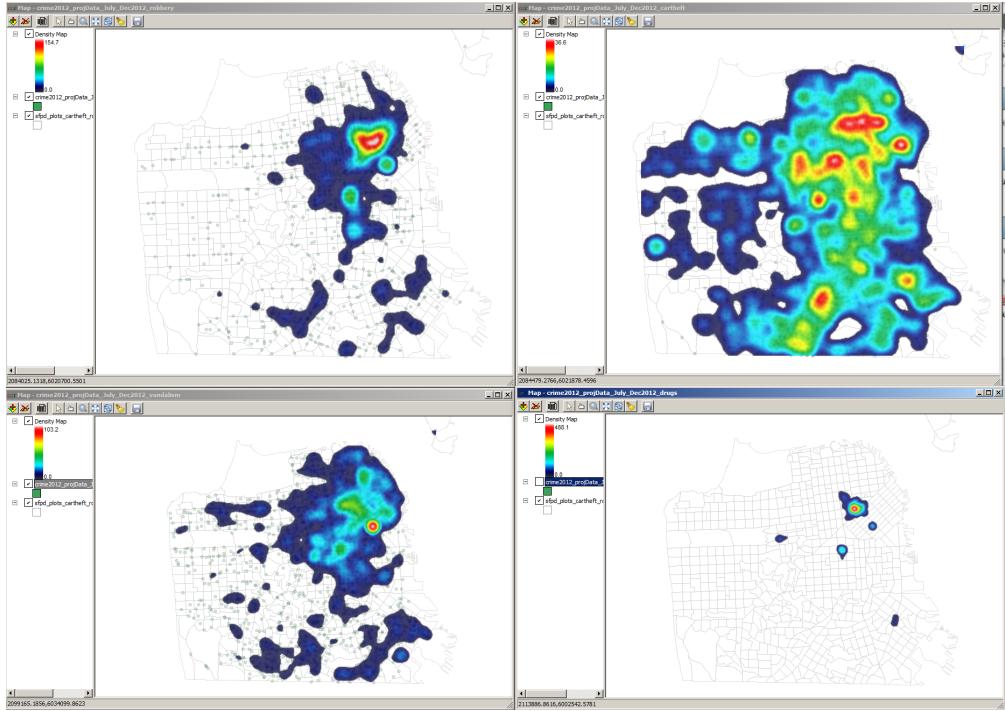


Figure 9: Heatmaps for Four Crime Types

surfaces as third layers, as shown in Figure 8. Shapefiles can be opened in separate views with the same spatial extent or with different spatial extents (selecting subsets of the data will work between shapefiles that share the same spatial extent). Figure 9 shows an example of four different crime types in San Francisco (one in each view) which illustrates that drug arrests are more spatially concentrated than vehicle thefts.

### 5.3 Linking and Brushing

Figure 10a illustrates that the linked selection of observations works across views, scales, and map types:<sup>13</sup> In this case, points associated with a heatmap are linked to grids and police districts in a percentile map and a LISA cluster map. The figure is based on four shapefiles and their associated tables: SF plots, drug points, vandalism points and grids that all share the same spatial extent. When a rectangular subset of this spatial extent is selected in one view, the same subset is selected in the other views. If the same shapefile is loaded in two views, they will share the same table - hence, a selection in both map views is associated with

<sup>13</sup>Observations within the selection rectangle are selected. The selection of areas is based on the centroid of an area.

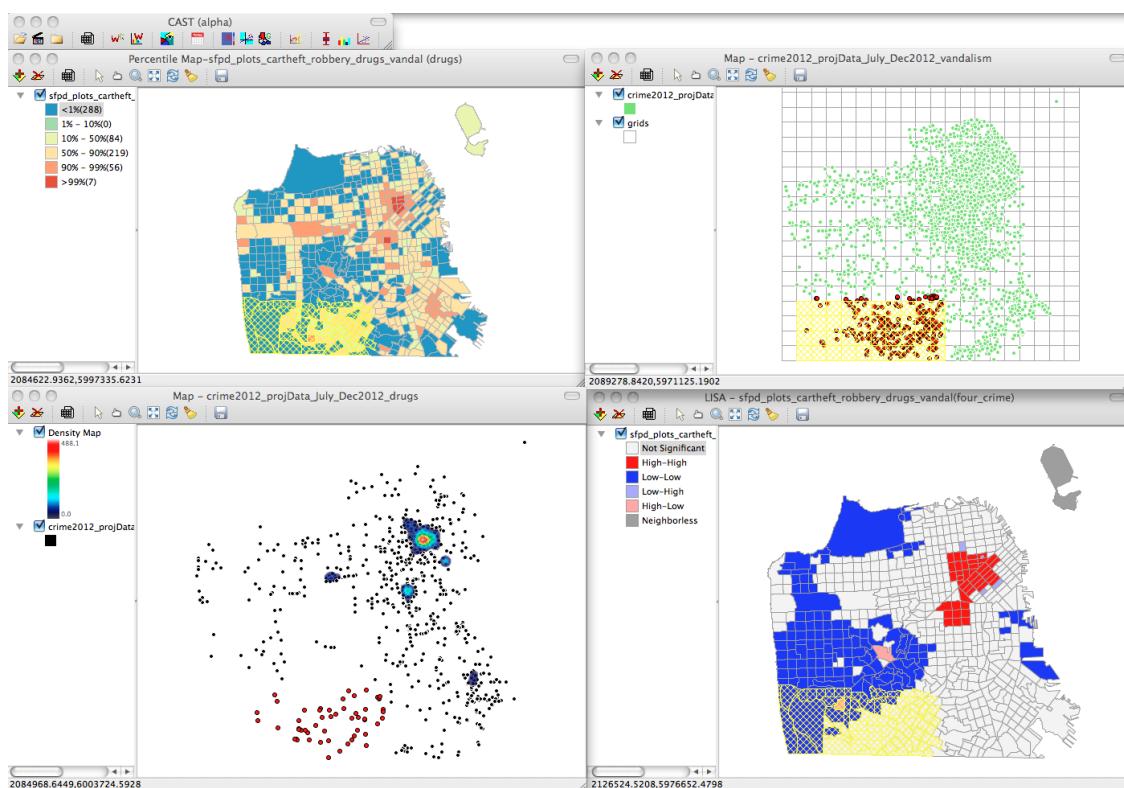
a selection of the same records in their shared table. However, the other shapefiles (grids and two point files) are each associated with their own tables. The respective observations inside the selected spatial extent are highlighted in each of the three tables. To compare which observations from the different shapefiles fall within the same selected subset, the four tables can be opened and displayed next to each other.

In Figure 10 the distribution of the four crime types is visualized with the help of the four boxplots that are linked to a map and histogram (although the boxplot scales are not standardized). The six districts with the highest frequency of robberies are highlighted in the boxplot to see how they compare to the other three crime types: They coincide with the top ten areas for drug offenses and overlap with higher incidents of vandalism but the areas with the highest car thefts are generally elsewhere. Figure 11a shows percentile maps of four offense types in San Francisco: Robbery, vandalism, drugs, and vehicle theft. The scatterplots below assess the strength of the statistical relationship between robbery and the other three offense types: Robberies and drug offenses are most strongly correlated, followed by robbery and vandalism while the association between robbery and car theft is much weaker.

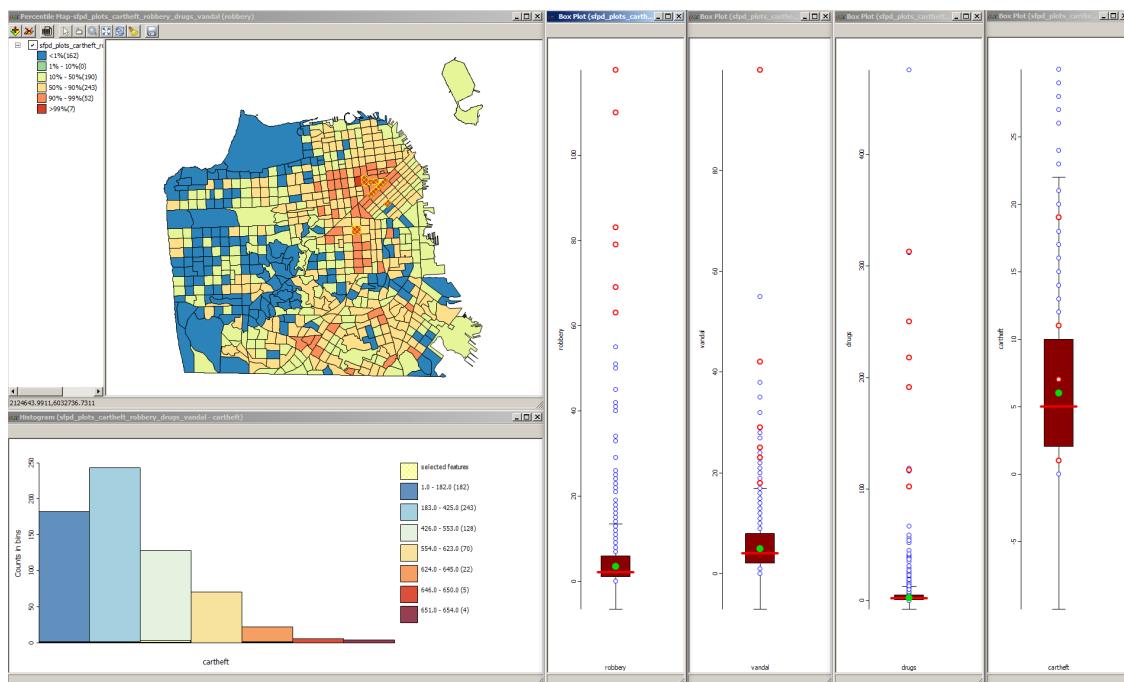
The next Figure 11b shows how the regression slopes and statistics are recomputed on the fly when a subarea in the map is selected: The red slope and numbers correspond to selected observations, the blue ones to unselected ones and the pink to the area as a whole. This suggests that the relationship between robbery and vandalism is stronger in the selected than unselected areas while the reverse is true for robbery and drugs. The Chow test below the statistics at the top indicates whether the difference between the selected and unselected slopes is statistically significant (the p-value of 0.000 in all three cases suggests these differences are indeed larger than expected). Brushing (using the *brush* icon) allows the dynamic selection of observations.

## 5.4 Dynamic Maps and Graphs

To visualize crime patterns in space and time, CAST offers dynamic views of cluster maps, calendar maps and trend graphs. Three types of cluster maps are implemented in CAST: 1) heatmaps for events (based on kernel density estimation), LISA maps for area data (based on

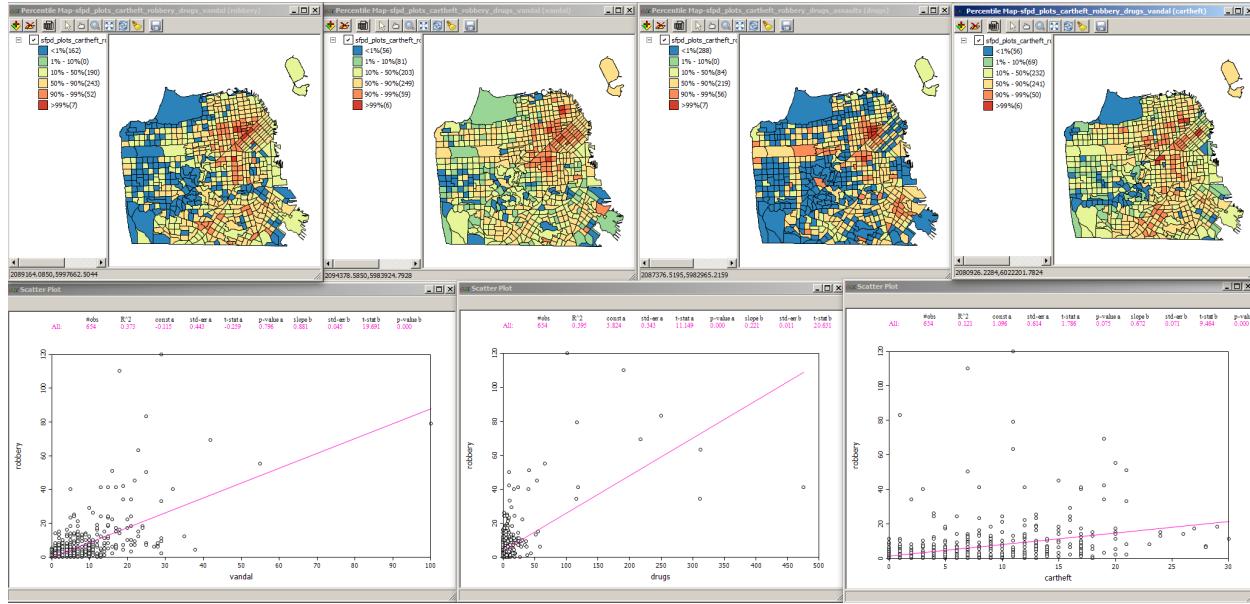


(a) Linked Views Across Scales

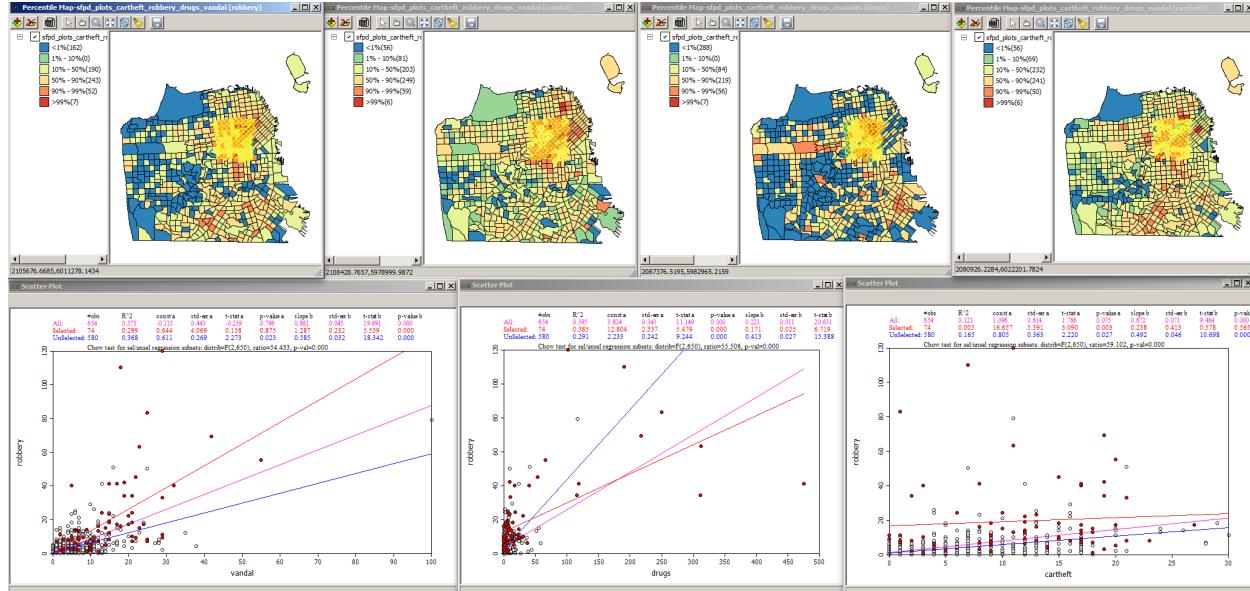


(b) Selected Areas in Map, Boxplot and Histogram

Figure 10: Linked Views



(a) Maps and Scatterplots before Selection



(b) Maps and Scatterplots after Selection

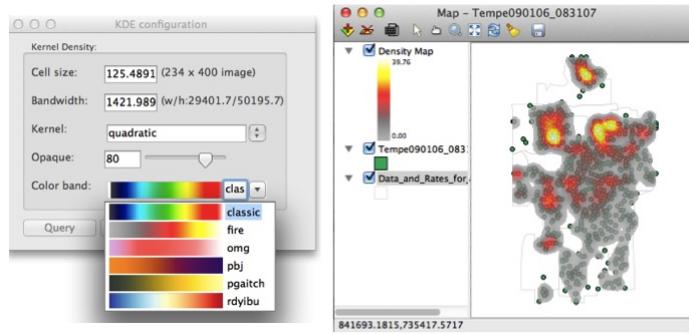
Figure 11: Linking and Brushing

local Moran's I), and 3) local G statistics maps for area data (based on Getis-Ord). Figure 12a shows the settings and results for a heatmap where all crime incidents are pooled across time. The settings for the dynamic heatmap are displayed in Figure 12b. The interface for dynamic cluster maps contains a series of micromaps for each specified time period (such as 1-month intervals) below a larger map of the respective time period that is highlighted in the micromaps (Figure 12c). The micromaps can be displayed or hidden by right-clicking on the main map. Further, the animation can be started, paused and stopped through the controls in the toolbar (see Figure 3) for all dynamic maps and graphs (including calendar maps and trend graphs). For the dynamic cluster maps, analysts can also manually move the micromaps forward or backward by clicking to the left or right of a highlighted micromap. As in all map views, additional layers can be added that will be shown in the large map view.

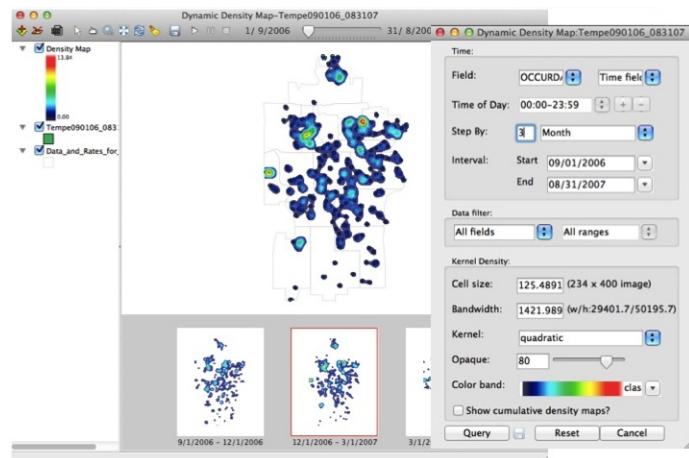
## 6 Specialized Maps and Graphs

### 6.1 Cluster Maps

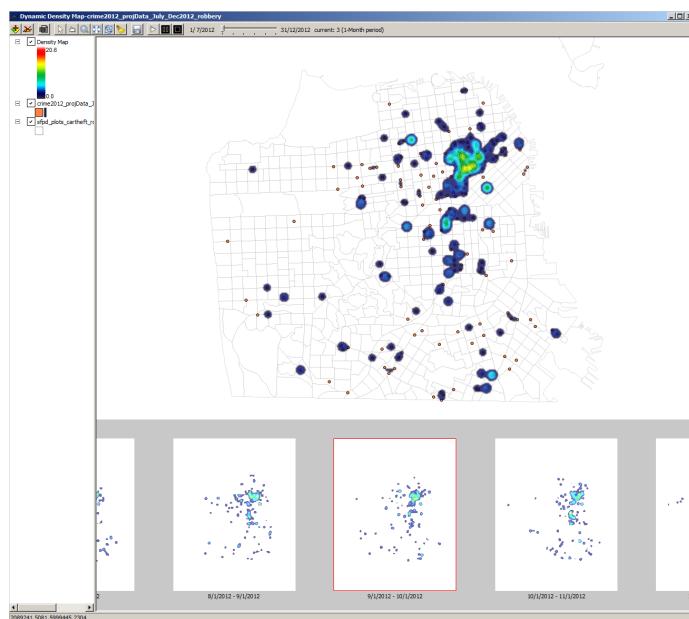
CAST contains two types of cluster maps for area data that are based on statistical tests: local Moran's I and local G statistics. The local Moran's I test that the Local Indicators of Spatial Association (LISA) maps are based on assesses to what extent values in one area are similar to the average value of neighboring areas. CAST applies this test to compare the observed value of Moran's I to a spatially random reference distribution of Moran's I values. The LISA map displays four significant options: Hotspots (high values in a given area surrounded by high values in a neighboring area), coldspots (low area values near low neighboring values), and two so-called spatial outliers (low values surrounded by high and vice versa). The local G statistics maps display significant hotspots and coldspots but no spatial outliers. There are two options for these maps:  $Gi$  and  $Gi^*$ . The  $Gi$  map identifies neighboring areas with average values that are significantly higher (hotspots) or lower (coldspots) compared to all areas. The  $Gi^*$  map finds areas and its neighbors with



(a) Heatmap and Settings for All Time Periods Combined



(b) Dynamic Heatmap and Settings



(c) Dynamic Heatmap

Figure 12: Static and Dynamic Heatmaps

significantly higher or lower values compared to the overall area.<sup>14</sup>

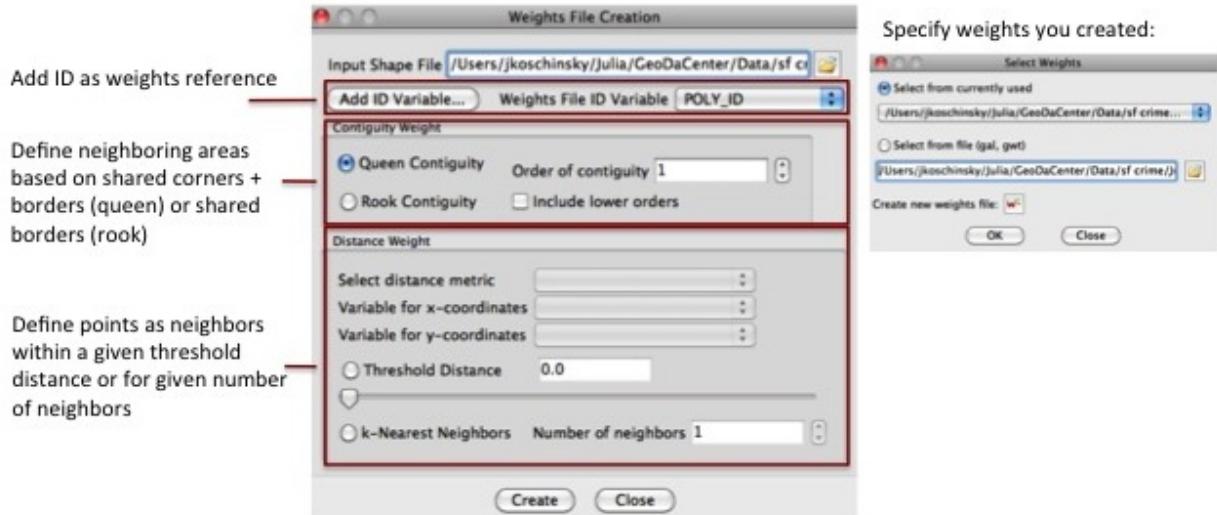
To create these cluster maps, one first needs to define what constitutes a neighboring area. This is done through a so-called spatial weights matrix, which in CAST allows analysts to define neighboring areas in terms of shared borders and/or corners or neighboring points in terms of distance bands and a given number of closest points. Figure 13a shows the options for specifying spatial weights matrices in CAST. Note that the local cluster maps display the *cores* of significant clusters that do not include the neighbors since one area can belong to multiple clusters (or represent a core and neighbor). To display cores and neighbors (in other words, the whole cluster), right click on the static or dynamic cluster map (Figure 13b) and select your spatial weights matrix. This enables the selection of an area (yellow highlight) with its neighboring areas highlighted in red. It also works for dynamic area selection (brushing). Figure 13c gives an example of a dynamic LISA map - the dynamic local G statistics map has the same interface.

## 6.2 Calendar Maps

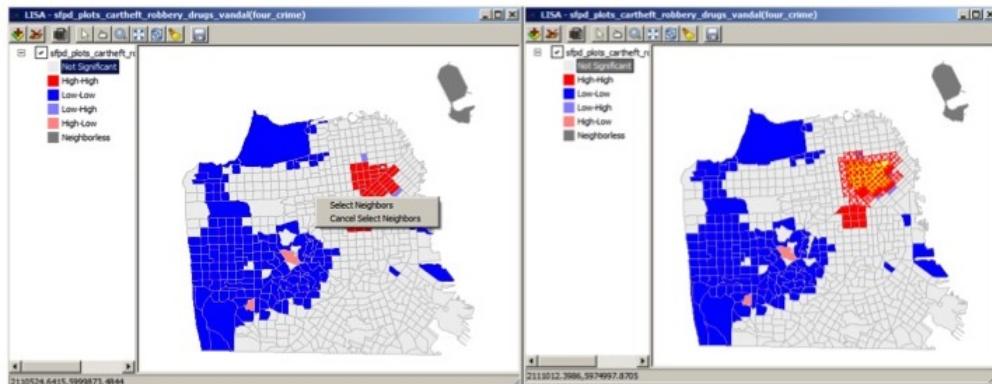
In calendar maps, two monthly calendar views are integrated with a regular CAST map view (Figure 14a: 1) Micro calendars from January to December and enlarged versions of two months that correspond to a selection of months in the micro calendars. The days in the two calendars are color-coded based on the number of crimes (events) that occurred on each day, with lighter green colors for smaller frequencies and darker green shading for larger ones. In addition, the enlarged two-month calendar also includes the date and frequency count for each day. Finally, bar charts on the vertical axis of the calendar summarize the number of crimes for each week while bar charts on the horizontal axis display the sum of crimes for each day of the week. In the dynamic version of the calendar map each day in the enlarged

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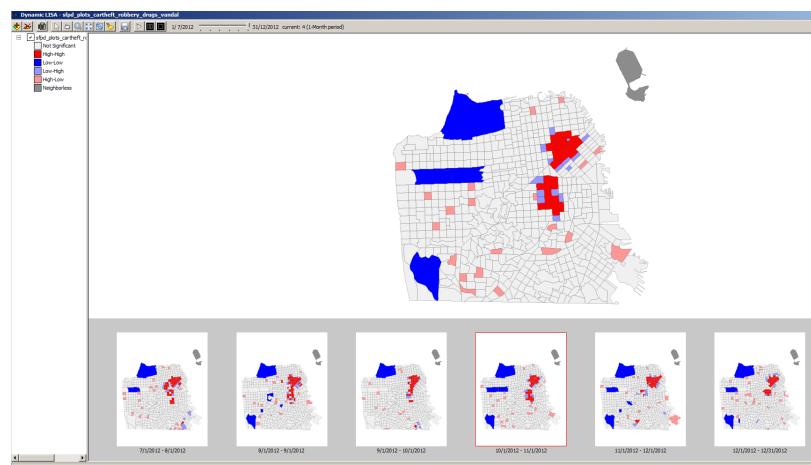
<sup>14</sup>For more information about spatial weights, local cluster map settings and interpretation, see chapters 15 and 16 (weights) and 19 (LISA maps) in the OpenGeoDa tutorial at <https://geodacenter.asu.edu/system/files/geodaworkbook.pdf> and the video tutorials at <https://geodacenter.asu.edu/eslides>. For background on the methods, see Anselin, Luc. (1995). Local indicators of spatial association - LISA. *Geographical Analysis*, 27:93-115 and the free e-course about local spatial autocorrelation at <http://moodle.geodacenter.org/course/view.php?id=7>). For information about the local G statistics methods, see Getis, A. and Ord, J. K. (1992). The analysis of spatial association by use of distance statistics. *Geographical Analysis*, 24:189206; Ord, J. K. and Getis, A. (1995). Local spatial autocorrelation statistics: Distributional issues and an application. *Geographical Analysis*, 27:286306.



(a) Creation and Selection of Spatial Weights



(b) LISA Cluster Cores and Neighbors



(c) Dynamic LISA Cluster Map

Figure 13: LISA Cluster Maps

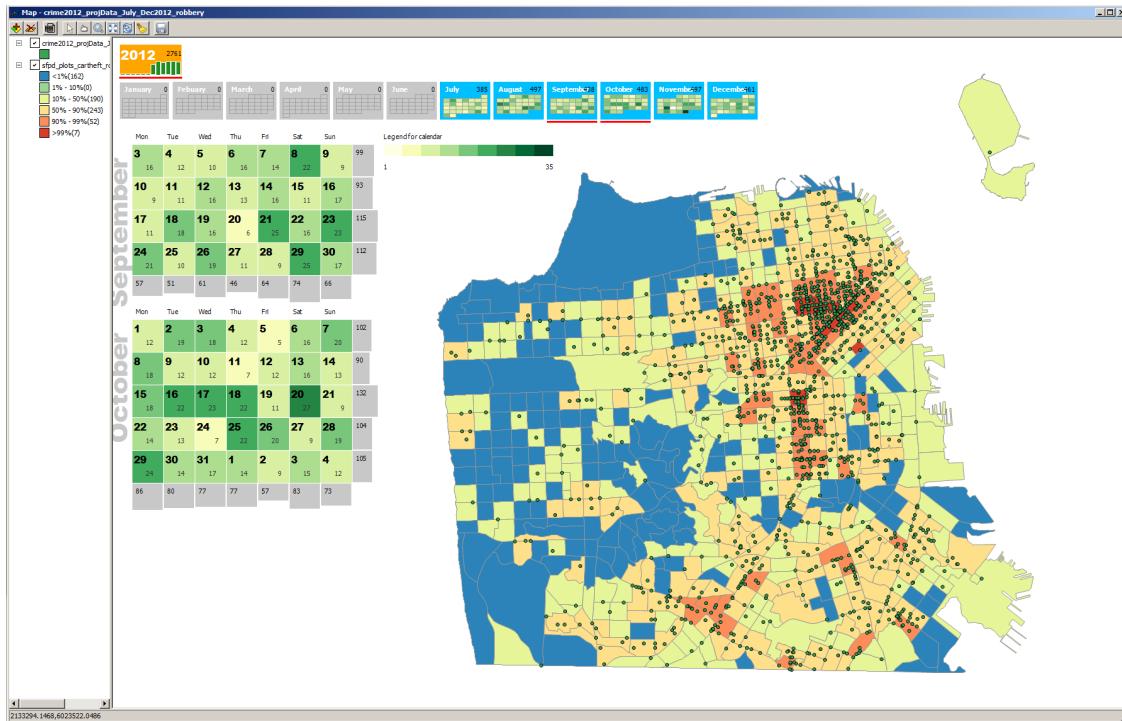
calendars is highlighted sequentially and the corresponding points for this day are displayed on the map (Figure 14b).

### 6.3 Trend Graphs

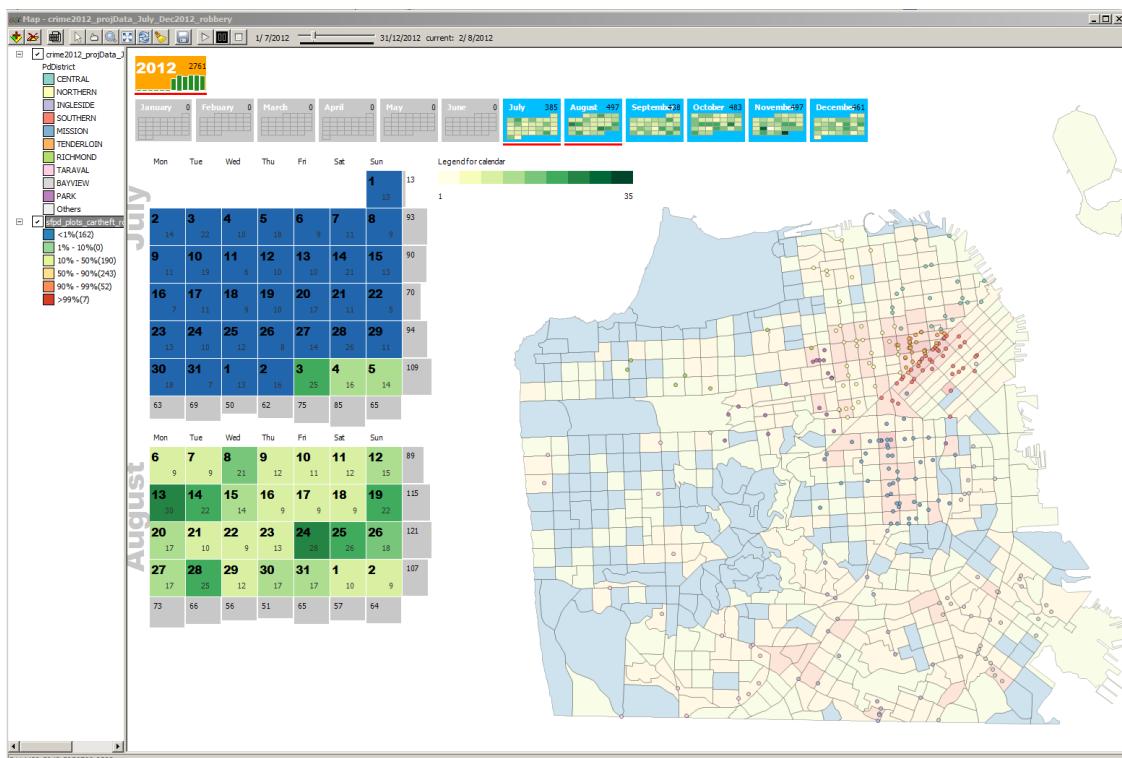
To track frequencies of crime over time, CAST includes three types of trend graphs: 1) a stand-alone static trend graph with crime counts on the vertical axis and time periods on the horizontal axis, 2) a dynamic trend graph that integrates this stand-alone trend graph with a map view, and 3) a significant trend graph that highlights statistically significant time runs within the time series associated with an area. Static trend graphs can be linked to other views like maps, as in Figure 15a where the top row shows a map and trend graph for robberies and the bottom row for car theft. The selection of three reporting districts is reflected in all four views and demonstrates that the high frequency of robberies in these areas coincides with low car theft incidences. The trend lines in the dynamic trend graph are colored according to the colors of the map classification. The *Play* button moves a horizontal yellow line through each time period in the series as the image of the map for the same period changes as well.

The significant trend graph adds a significance test to a time series of events in a given area to determine subsets in time that are below or above average. As for the local cluster maps for areas, the two tests that are implemented here are local Moran's I and local G statistics. In the trend graph case, the test is applied separately to each area. Within each area, the number of time periods constitutes the unit of analysis. The test compares values in one time period to a specified number of previous and/or future time periods. For instance, for a 6-month period as found in the sample data of this guide, aggregating crimes to 1-week periods provides a sufficiently large number of intervals (about 25 - a rule of thumb is to have at least 20 periods for this analysis). If five past time periods are selected as neighbors (Figure 16a), the local Moran's I test will compare the crime count in a given time period (e.g. the week of Dec. 25-31, 2012) to the average count of the previous 5 weeks to determine if this relationship differs from the average of all time periods.

The selection of neighbors in time creates a so-called time weights matrix in analogy to the spatial weights matrix. This time weights matrix identifies as many previous or past time

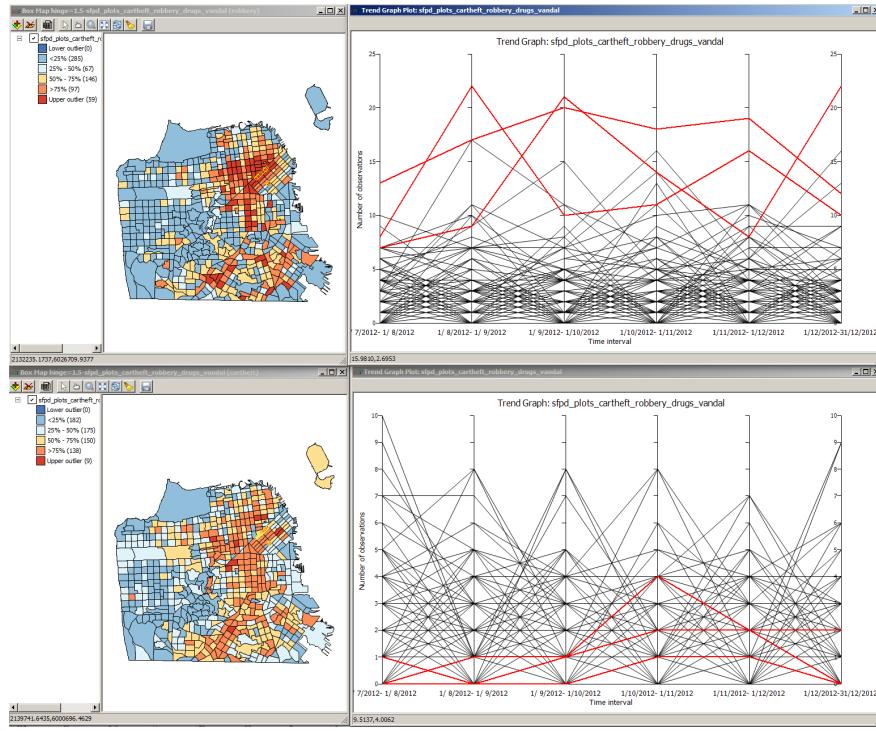


(a) Static Calendar Map

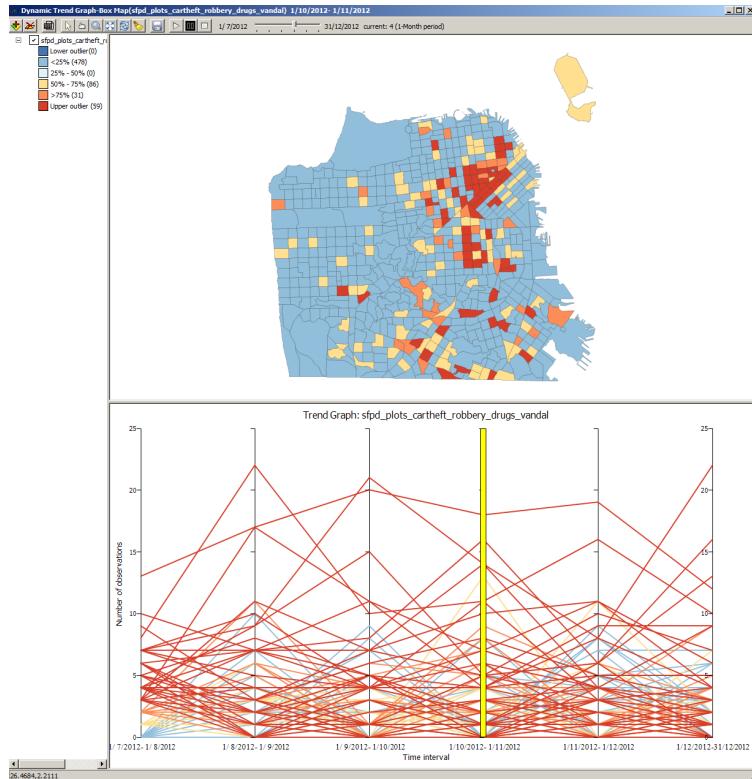


(b) Dynamic Calendar Map

Figure 14: Static and Dynamic Calendar Maps

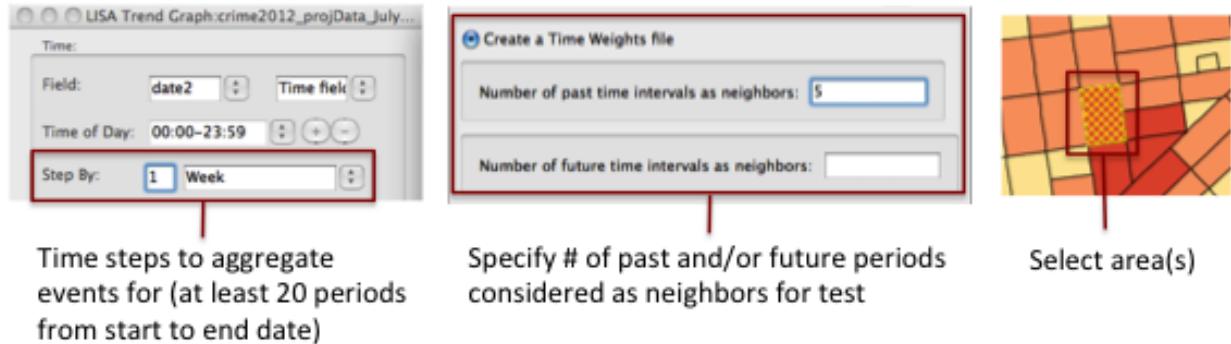


(a) Static Trend Graph



(b) Dynamic Trend Graph

Figure 15: Static and Dynamic Trend Graphs



(a) Steps Before Using a Significant Trend Graph

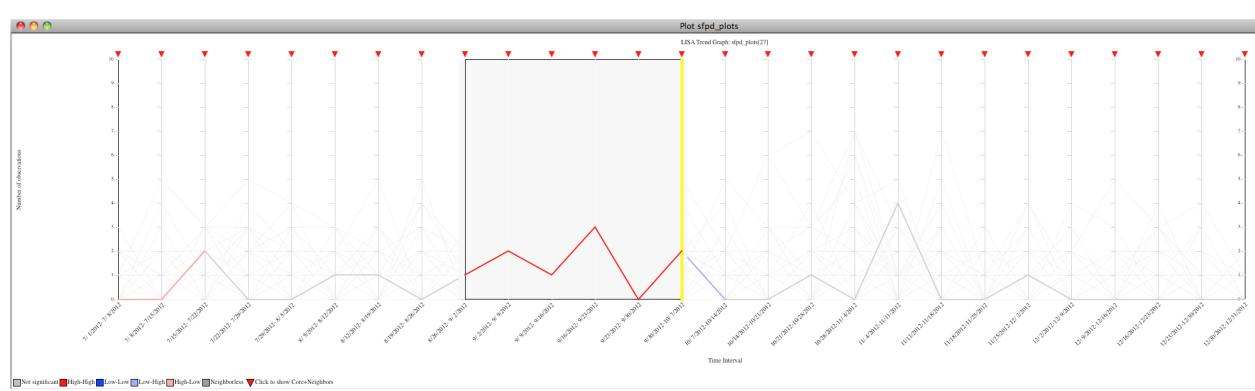
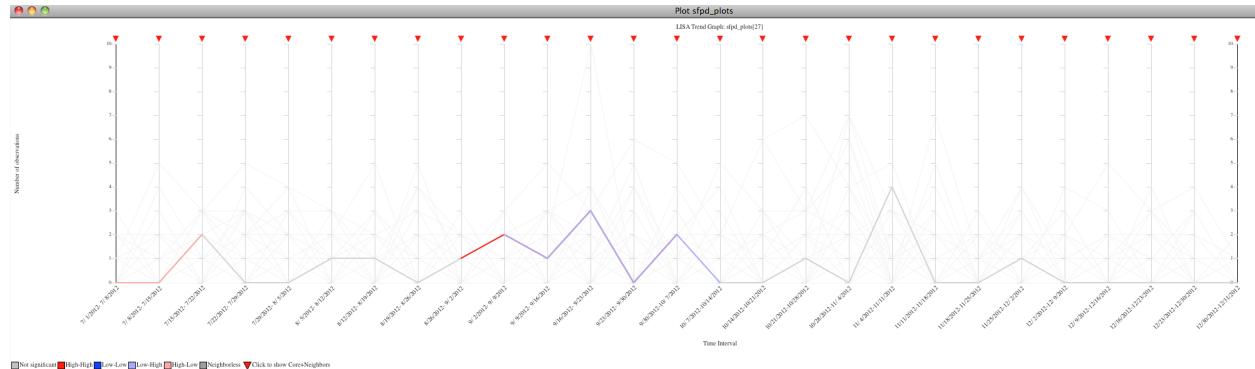


Figure 16: Trend Graph to Identify Periods with Significant Concentrations of Crime

periods as neighbors as specified that immediately precede or succeed a given time period. For instance, using the highlighted line in Figure 16b as an example, the crime counts in each week represent nodes that are connected through a trend line. The time matrix identifies the five previous nodes for each given time period. The Moran's I test is based on this neighbor definition to compare the count in the given period to the average count in the previous five periods.

As in the color-coding for LISA maps, those time runs that do differ from the average, are shown as high-high (above-average in a given time period compared to the previous and/or future ones), low-low (same for below-average), low-high (below average in a given period compared to above average for other periods), and high-low (vice versa).

As in the spatial case, the  $Gi$  and  $Gi^*$  tests compare the neighbors of a given period to the overall average or the neighbors and the given period to the overall average, respectively. For instance, in the example below, the  $Gi$  test assesses if the crime counts in the five previous time periods are above or below average compared to that of all time periods in an area. The  $Gi^*$  test also includes the crime counts in a given period, in addition to the previous five periods. In the time case,  $Gi$  and  $Gi^*$  also only identify hot and cold time runs, not spatial outliers (high-low or low-high) as in the LISA case described above.

The local cluster maps only visualize the cluster core. The full cluster (including neighbors) can be shown for selected areas through the *Select Neighbors* right-click map option since neighboring areas can be part of multiple clusters or represent cores and clusters. Similarly, a trend line can be a neighbor of several time periods: For instance, in the example above, the week of Dec 11-17, 2012 would be a (5-week) previous neighbor of both Dec. 25-31 and Dec. 18-25 and could be significantly related to one but not to the other. To display the results of the neighbors specified in the time weights file for a particular time period, one can click on the red triangle at the top of the trend graph. This will front-load the color-coding for the neighbors of this time period.

## 7 Outlook

The alpha release of CAST is currently available for free download on the GeoDa Center’s software page.<sup>15</sup> Alpha releases are the initial software releases that are still part of the testing phase with active debugging. As such, we are currently responding to bug reports with new uploaded versions of the software that addressed the reported bugs (since analysts sometimes also suggest improvements in the user interfaces, there might be slight divergences between the interfaces of the latest version and the screenshots in this guide but the core functionality remains the same). Analysts can send bug reports to [geodacenter@asu.edu](mailto:geodacenter@asu.edu). Releases are announced on the GeoDa Center’s *Openspace* listserv and twitter feeds (which are linked to its *Facebook* page).<sup>16</sup> Users of our NIJ-funded software can also utilize the Center’s *Openspace* listserv to address technical questions about these programs.

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<sup>15</sup>At <https://geodacenter.asu.edu/software>

<sup>16</sup>*Openspace* listserv: <https://geodacenter.asu.edu/support/community>; Twitter: <http://twitter.com/GeoDaCenter>; and *Facebook*: <http://www.facebook.com/geodacenter>