

Heat Map and Map Chart using TIBCO Spotfire®

Ajay Gupta, PPD, Morrisville, USA

ABSTRACT

TIBCO Spotfire is an analytics and business intelligence platform which enables data visualization in an interactive mode. Users can create heat maps and map charts using inbuilt functions in Spotfire. The easiest way to understand a heat map is to think of a cross table or spreadsheet which contains colors instead of numbers. The default color gradient sets the lowest value in the heat map to dark blue, the highest value to a bright red, and mid-range values to light gray, with a corresponding transition (or gradient) between these extremes. Heat maps are well-suited for visualizing large amounts of multi-dimensional data and can be used to identify clusters of rows with similar values, as these are displayed as areas of similar color. Patterns in heat maps are clear, because colors are used to display the frequency of observations in each cell of the graph. Also, Map chart can be useful to show the population density in the world map. This paper will demonstrate some basic heat maps and map chart created using spotfire.

INTRODUCTION

TIBCO Spotfire is an analytics and business intelligence platform which enables data visualization in an interactive mode that has grown in popularity within the healthcare and various industries over the last few years. With its increasing implementation in the field of safety monitoring and data review, TIBCO Spotfire presents its capabilities for exploratory analysis.

Heat Maps are extremely versatile and efficient in drawing attention to trends, and it's for these reasons they've become increasingly popular within the analytics community, but that's just the tip of the iceberg as to why. While other data visualizations must be interpreted – either by analysts or business users – Heat Maps are innately self-explanatory. The darker the shade, the greater the quantity (the higher the value, the tighter the dispersion, etc.). When existing data visualizations are paired with Heat Maps, their ability to rapidly communicate key data insights to the viewer is greatly enhanced.

Heat maps use colors to communicate numeric data by varying the underlying values that represent red, green, and blue (RGB) as a linear function of the data. You can use heat maps to display spatial data, plot big data sets, and enhance tables. You can use colors on the spectrum from blue to red to show population density in a US map. In fields such as epidemiology and sociology, colors and maps are used to show spatial data, such as how rates of disease or crime vary with location. With big data sets, patterns that you would hope to see in scatter plots are hidden in dense clouds of points. In contrast, patterns in heat maps are clear, because colors are used to display the frequency of observations in each cell of the graph. Heat maps also make tables easier to interpret. For example, when displaying a correlation matrix, you can vary the background color from white to red to correspond to the absolute correlation range from 0 to 1. You can shade the cell behind a value, or you can replace the table with a shaded grid. Also, Map chart can be useful to show the population density e.g. site, subject, different parameters in the world map. This paper focuses on creating heat maps and map charts using inbuilt function and properties in Spotfire on a fly.

TECHNIQUE AND MECHANISM

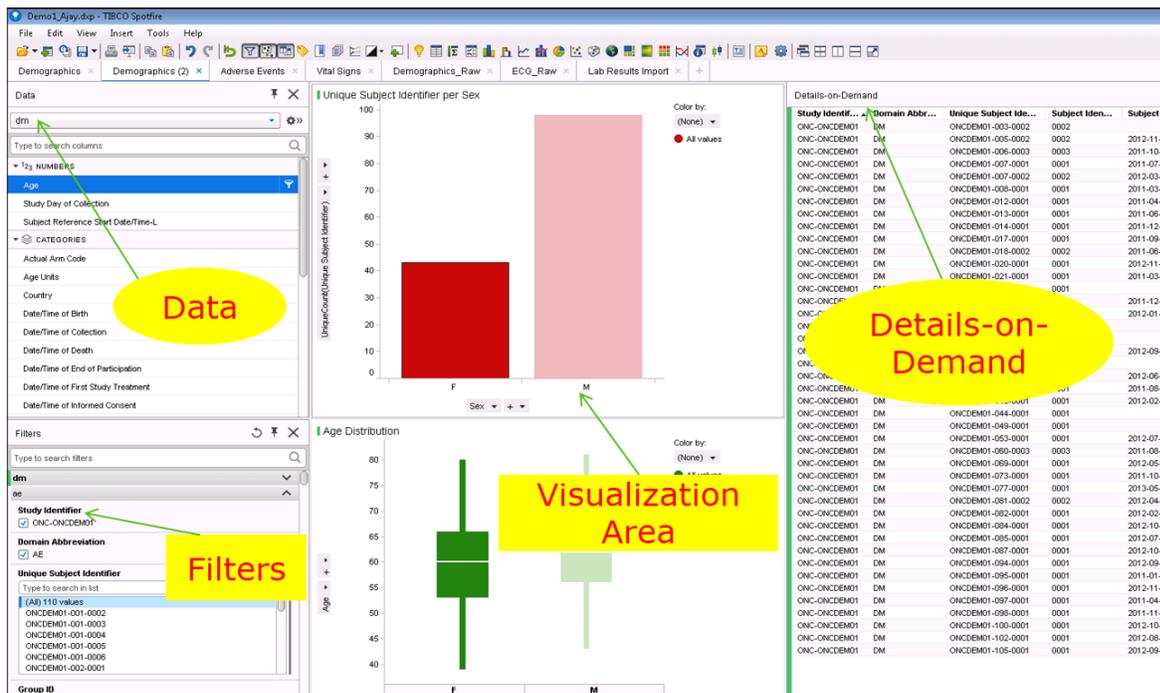
The general process of creating data visualizations in TIBCO Spotfire is as follows:

1. Import Data in Tibco Spotfire containing the required variables.
2. Create visualizations e.g. Heatmap and Map chart as per user specifications.

TIBCO SPOTFIRE OVERALL VIEW

Below display will provide you a brief overview of the TIBCO Spotfire Development area. The

development area consists of the following four main windows which can be resized as per need:



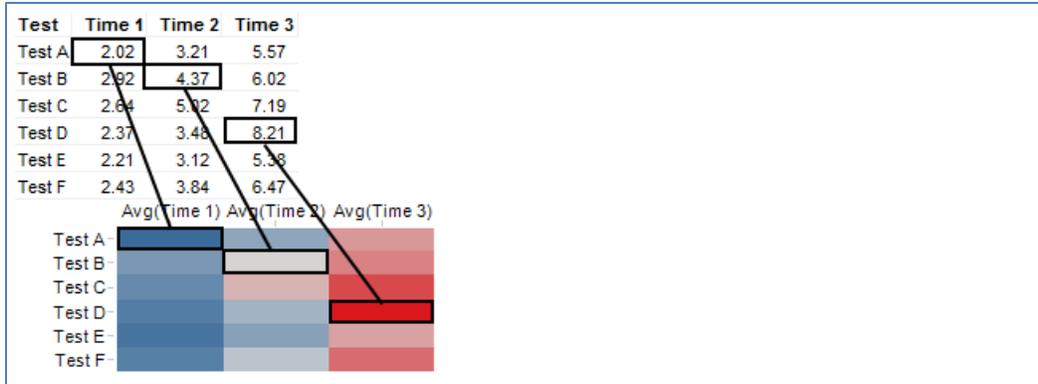
Display 1. TIBCO Spotfire Overall View

1. **Data:** This window will provide the list of all data sets and variables available for the visualization. This window can be closed from the view tab.
2. **Filters:** This window will provide the list of variables available for sub setting the data. This list includes the common variables and modified flags added by the data prep macro. This window can be closed from the view tab.
3. **Details-on-Demand:** This window will provide a data set view of selected data in the visualization. It will provide information about the data set used for the visualization and the list of variables available in the data set. This data can be exported into Excel or .CSV files for further evaluation. This window can be closed from the view tab.
4. **Visualization Area:** This area contains all the visualizations. Multiple visualizations (e.g. graphs, bar chart, tree map, pie chart, box plot, heat map, map chart) can be added in one tab.

HEAT MAP USING TIBCO SPOTFIRE

The easiest way to understand a heat map is to think of a cross table or spreadsheet which contains colors instead of numbers. The default color gradient sets the lowest value in the heat map to dark blue, the highest value to a bright red, and mid-range values to light gray, with a corresponding transition (or gradient) between these extremes.

The example below shows how the values in the table are displayed as color gradients in the heat map cells. Here you can see that each value in the cross table is represented by specific color.



Display 2. Example of Heat Map

EXAMPLE 1: RACE DISTRIBUTION

Below interactive visualization heatmap is created using the Demographics (DM) from the SDTM database. This heat map will give an interactive view using RGB color gradient where user can easily identify the population density based on the intensity of color e.g. red is high and blue is low.

Step 1: Import the demographic data in Spotfire. See display 3 below.

dm	Subject Mod...	Row Modified...	Study Identifier	Domain Abbr...	Unique Subje...	Subject Ident...	Subject Refer...	Subject Refer...	Date/Time of ...	Subject Des...	Study Site Id...	Invest				
	Modified	Modified	DEMO-DEMO	DM	DEMO-001-0002	0010002	2012-07-19	2012-08-23						001	USA	
	Modified	Modified	DEMO-DEMO	DM	DEMO-001-0004	0010004	2012-07-17	2012-08-10						001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0006	0010006	2012-07-18	2012-08-19						001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0008	0010008								001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0010	0010010	2012-07-25							001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0012	0010012								001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0014	0010014								001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0016	0010016								001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0018	0010018	2012-08-10							001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0020	0010020								001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0024	0010024	2012-08-17							001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0026	0010026								001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0028	0010028	2012-08-29							001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-001-0030	0010030	2012-08-27	2012-08-12						001	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0002	0020002								002	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0004	0020004	2013-01-02							002	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0002	0020002	2012-08-27							003	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0004	0020004								003	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0008	0020008								003	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0010	0020010	2013-12-18	2013-01-24						003	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0012	0020012	2013-01-16							003	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-002-0014	0020014	2013-01-25							003	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0002	0050002								005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0004	0050004								005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0006	0050006	2012-08-22	2012-10-08						005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0008	0050008								005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0014	0050014	2012-10-23							005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0016	0050016	2013-01-17							005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0018	0050018								005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-005-0020	0050020								005	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-007-0002	0070002	2013-08-23							007	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-007-0004	0070004								007	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-007-0006	0070006	2013-02-21							007	USA	
	Modified	Modified	DEMO-DEMO	DM	DEMO-008-0002	0080002								008	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-008-0004	0080004								008	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-008-0010	0080010	2012-10-03							008	USA	
	No Change	No Change	DEMO-DEMO	DM	DEMO-008-0014	0080014								008	USA	

Display 3. Demographics data

Step 2: Right click on the table and switch to heat map visualization (see display 4 below).

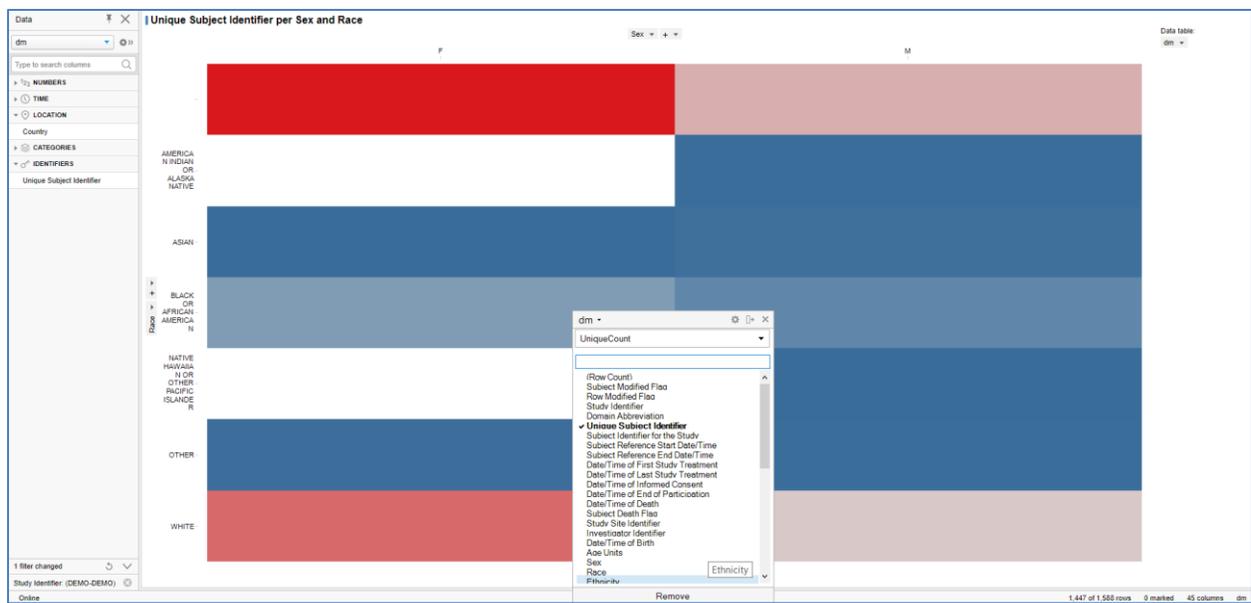
Step 3: Right click and select properties. Select variable sex on X axis, variable race on Y axis, select cell values as unique subject count (see display 5 and 6 below). User can adjust the properties as per user specifications.

The screenshot shows a data table with columns: Subject Modif..., Row Modified..., Study Identifier, Domain Abbr..., Unique Sube..., Subject Ident..., Subject Refer..., Subject Refer..., Date/Time of..., Date/Time of..., Date/Time of..., Date/Time of..., Subject Deat..., Study Site Id..., Inver. The table contains multiple rows of data. A context menu is open over the table, listing various visualization options. The 'Heat Map' option is highlighted in blue. Other options include 'Cross Table', 'Graphical Table', 'Bar Chart', 'Waterfall Chart', 'Line Chart', 'Combination Chart', 'Pie Chart', '3D Scatter Plot', 'Map Chart', 'Treemap', 'KPI Chart', 'Parallel Coordinate Plot', 'Summary Table', and 'Box Plot'. The 'Heat Map' option is selected.

Display 4. Switching from Table view to Heat map view

The screenshot shows a 'Properties' dialog box for a visualization titled 'Unique Subject Identifier per Sex and Race Properties'. The 'General' tab is active. The 'Title' field contains '\$_{Auto Title}' and the 'Description' field is empty. There are two checkboxes: 'Show title bar' (checked) and 'Show description in visualization' (checked). There are 'Edit...' buttons next to the Title and Description fields. A 'Help' button is at the bottom left and a 'Close' button is at the bottom right.

Display 5. Select Properties



Display 6. Select variables for X and Y axis

Step 4: To understand the heat map user can add a cross table view and heat map on same visualization this will provide one-one matching between the value and color in heat map through tool tip information (see display 7 below).

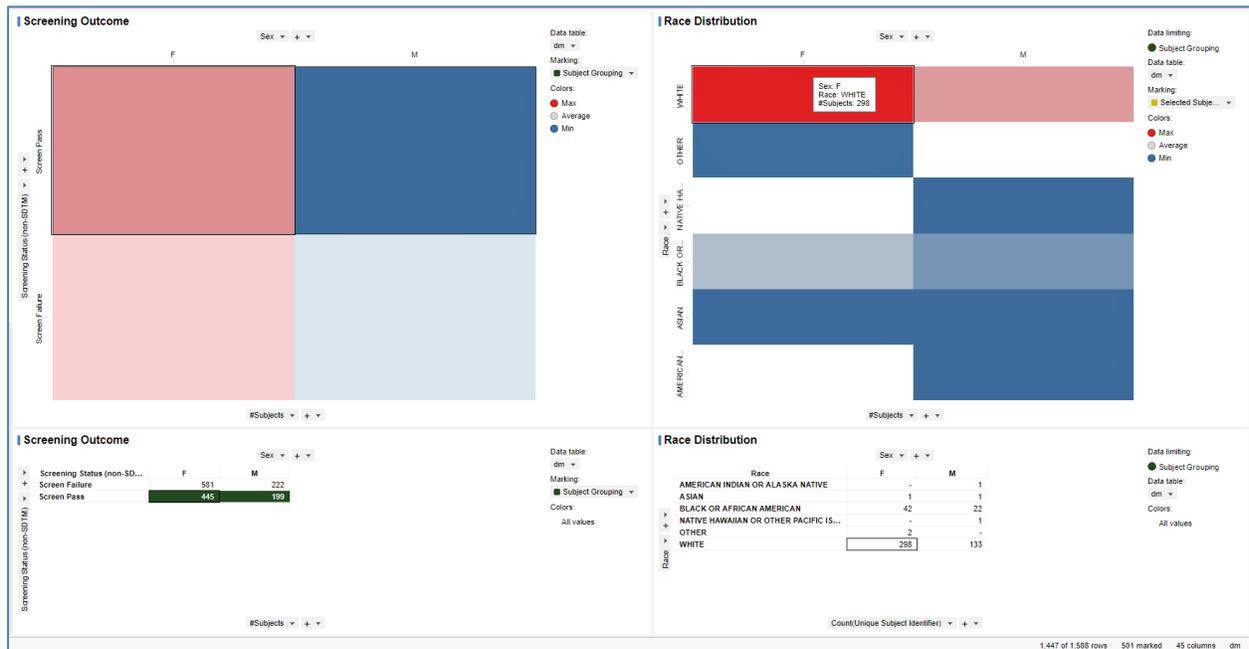


Display 7. Race distribution heatmap and table view

EXAMPLE 2: RACE DISTRIBUTION AND SCREENING OUTCOME

Below interactive visualization heatmap is created using the Demographics (DM) from the SDTM database. This heatmap will give an interactive view using RGB color gradient where user can easily identify the population density based on the intensity of color e.g. red is high and blue is low. Here screening outcome heatmap and cross-table are added with the race distribution heatmap to give a good

overview of study. Since, the x-axis variable sex is common in both heat maps the color gradient will be combination of data values in both heat maps (see display 8 below).

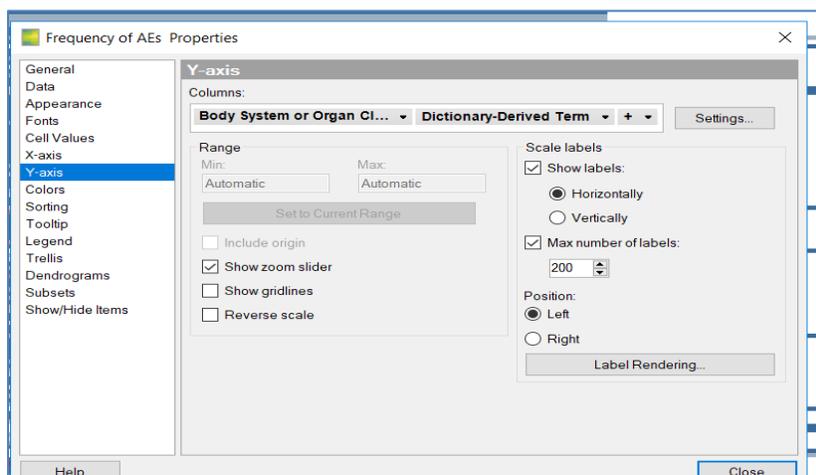


Display 8. Multiple heat maps and cross table on one visualization

EXAMPLE 3: ADVERSE EVENTS

Adverse events (AEs) are a key focus of any safety review, for example the ability to quickly locate and isolate relevant AEs especially serious one.

Below interactive visualization heatmap is created using the Adverse Events (AE) from the SDTM. For, AE summary heatmap, serious adverse events were selected on the x-axis and y-axis is group by system organ class and derived dictionary term. Here user can easily identify a particular adverse event by severity and color index and later drill down the adverse events on patient level. The tooltip displays some summary information about the respective area (see display 9 and 10 below).



Display 9. Frequency of AE heat map properties

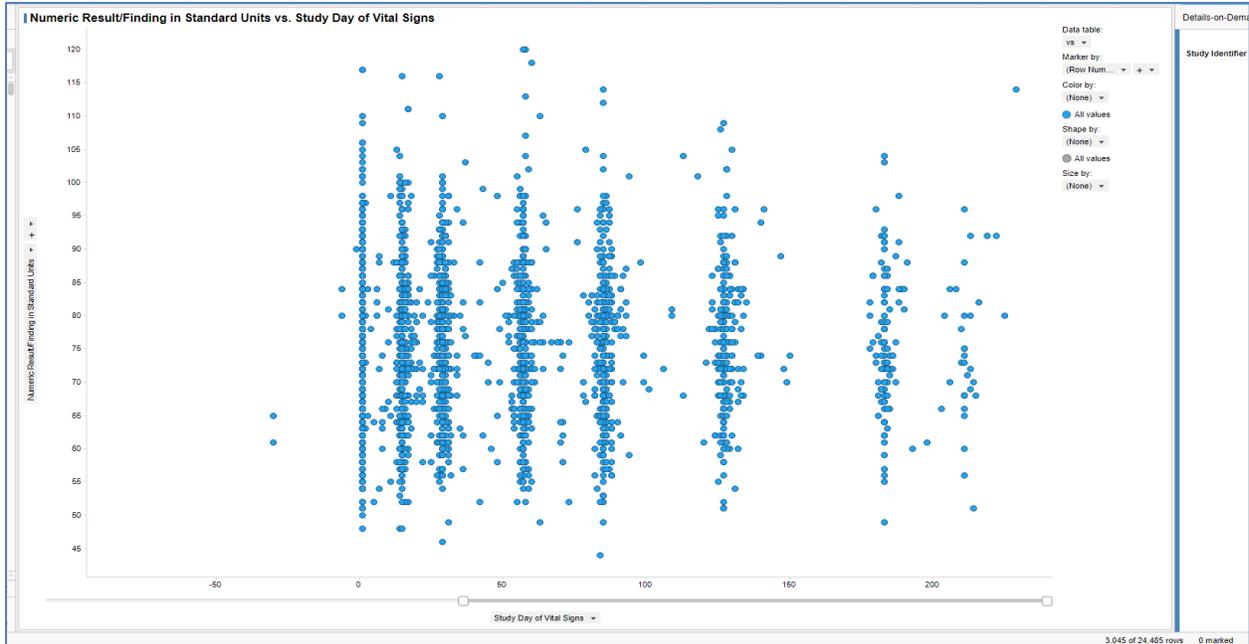


Display 10. Summary of Adverse Events through heat map

EXAMPLE 4: VITAL SIGNS SCATTER PLOT HEAT MAP TYPE VIEW

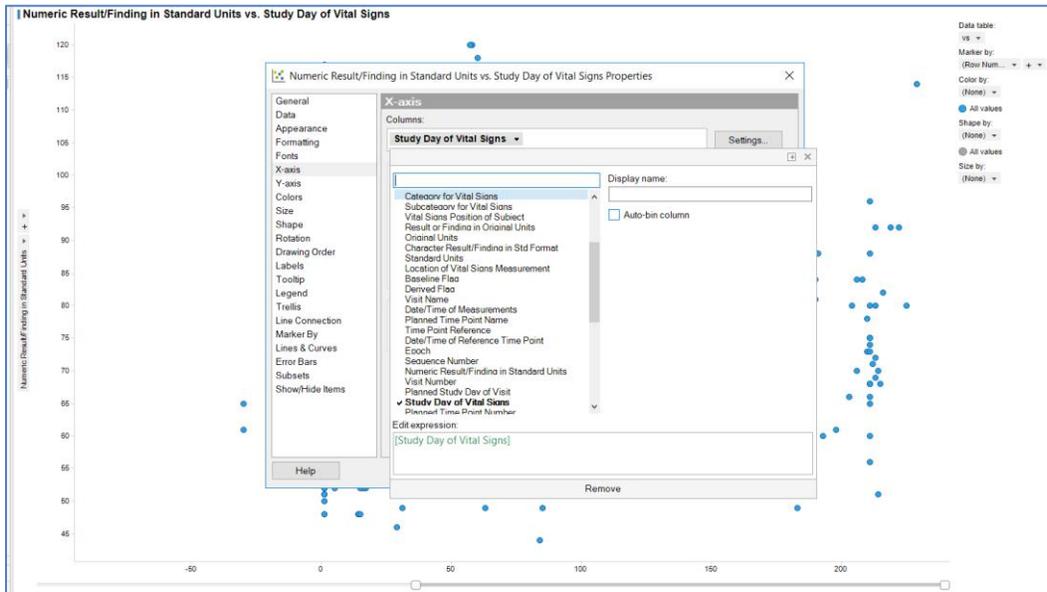
Scatter plots display a marker at the intersection of the values of an X variable and a Y variable. In contrast, heatmaps divide the graph into rectangular (or hexagonal) bins and use colors to show how many observations fall in each bin. If you have a large number of data points, then ordinary scatter plots, fit plots, residual plots, and so on become hard to interpret. If you have enough data, then points merge into large blobs that do not always reveal the underlying structure of the data. Heat maps differentiate more clearly between the denser and less dense portions of the data.

Below interactive visualization is created using the Vital Signs (VS) data set from SDTM database. It consists of a scatter plot of vital signs numeric results/findings over study timeline (see display 11 below). It is not straight forward to give scatter plot a density heat map type view. But, user can follow steps below to create the density heat map from scatter plot.

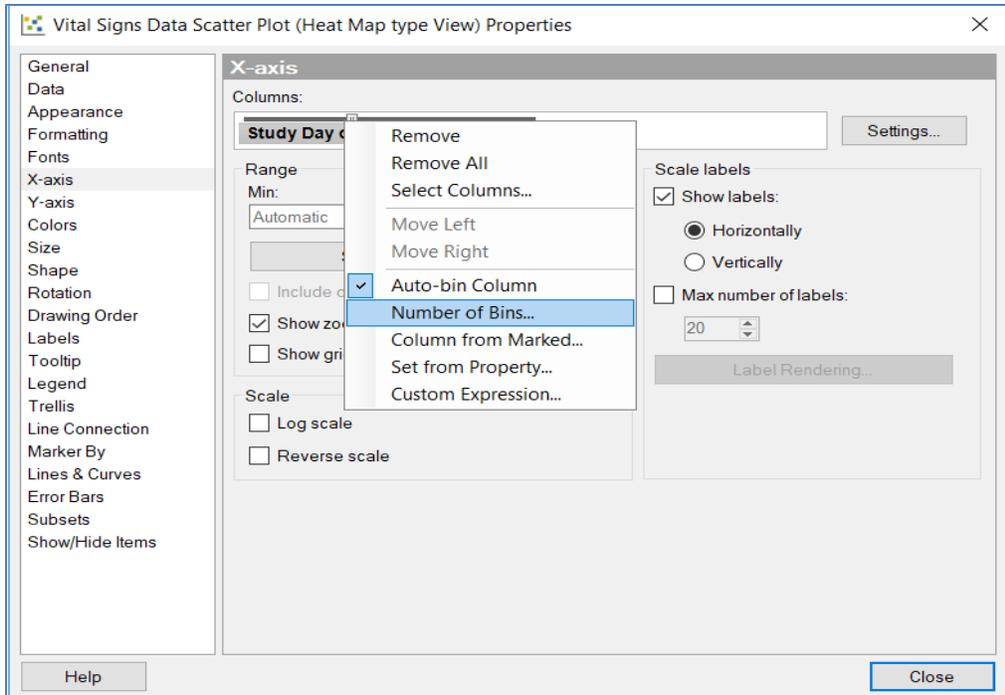


Display 11. Vital signs scatter plot

Step 1: Go to the properties and check the auto-bin column for both X and Y axis variables. This will give grid type view on the plot. Later, right click on the slider above the variable name and add the number of bin as per the view requirements. See display below 12 and 13 below.

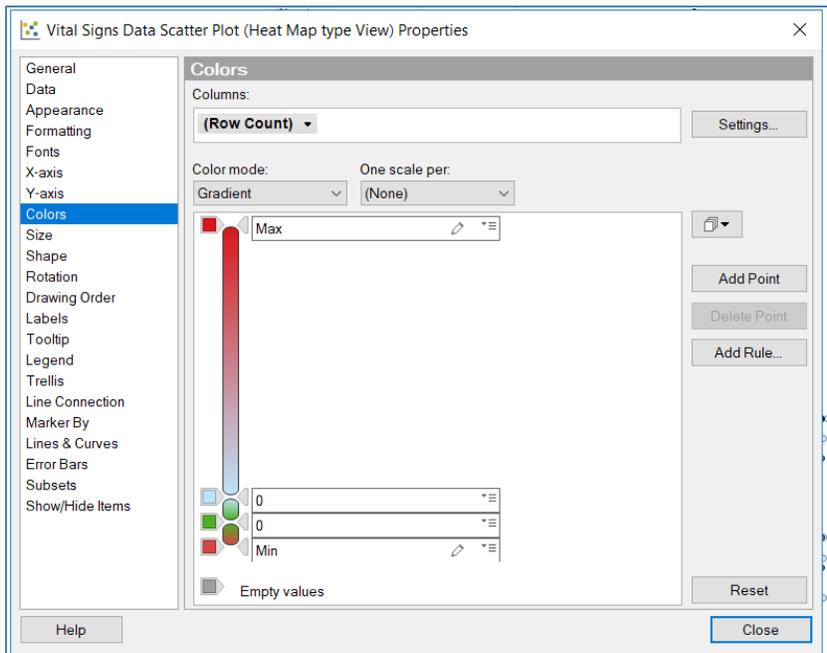


Display 12. Select Auto-bin column from scatter plot

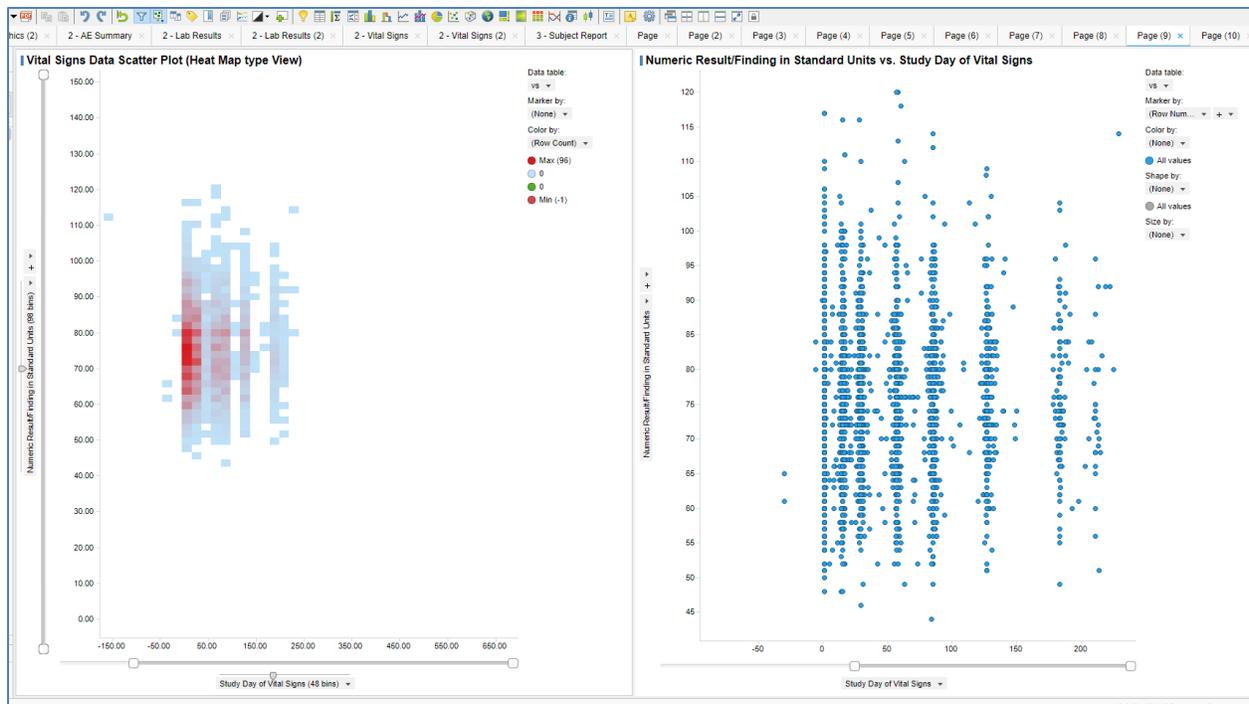


Display 13. Add number of bin to the scatter plot

Step 2: Select the shape in properties as “Tiles” marker and select marker by to “None”. Later, select the color columns as row count and pick the available color gradient scheme or create your own (see display 14). This will give the scatter plot a heat map type density view shown in side by side display 15 below. This map is useful to quickly identify the outliers based on colors.



Display 14. Select the color gradient for heat map type view



Display 15. Scatter plot and density type heat map view side by side

MAP CHART USING TIBCO SPOTFIRE

Map charts allow you to position your data in a context, often geographical, using different layers. The layers can be either data layers, such as marker layers or feature layers, or reference layers such as map layers. Here we will use the map layers inbuilt in Spotfire to visualize our geographical data as marker layers.

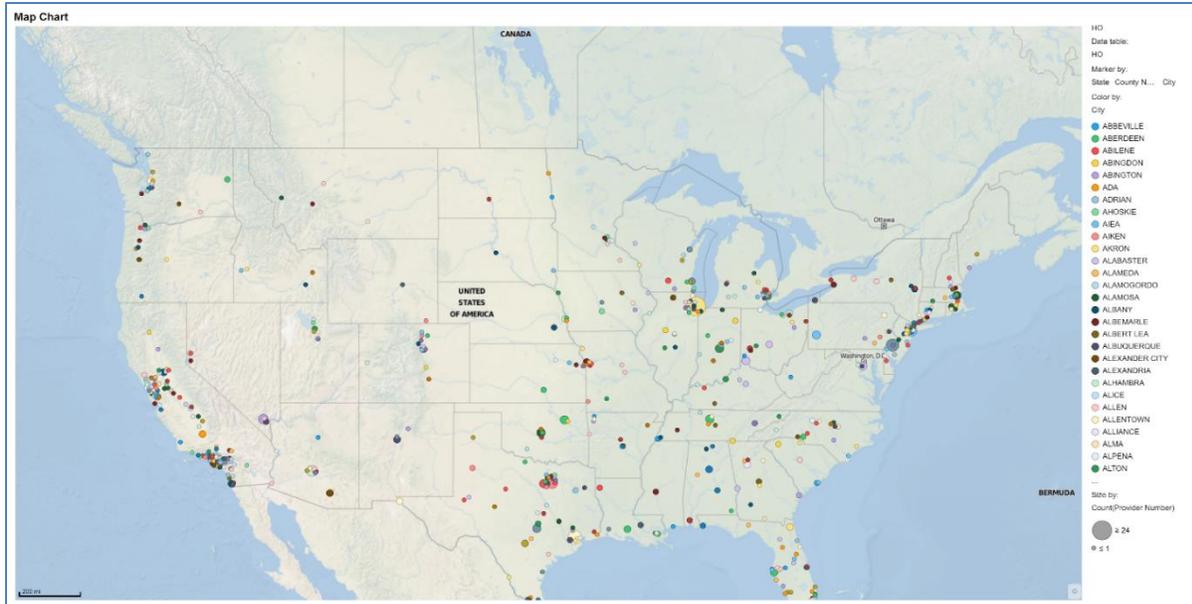
EXAMPLE 5: MAP CHART REPRESENTING STUDY SITES ACROSS GLOBE.

Below interactive visualization map chart is created using the Demographics (DM) from the SDTM database. This can be quickly created by switching the demographics data to map chart and later selecting the require variable and properties (these steps are already cover in example 1). See display 16 and 17 below.

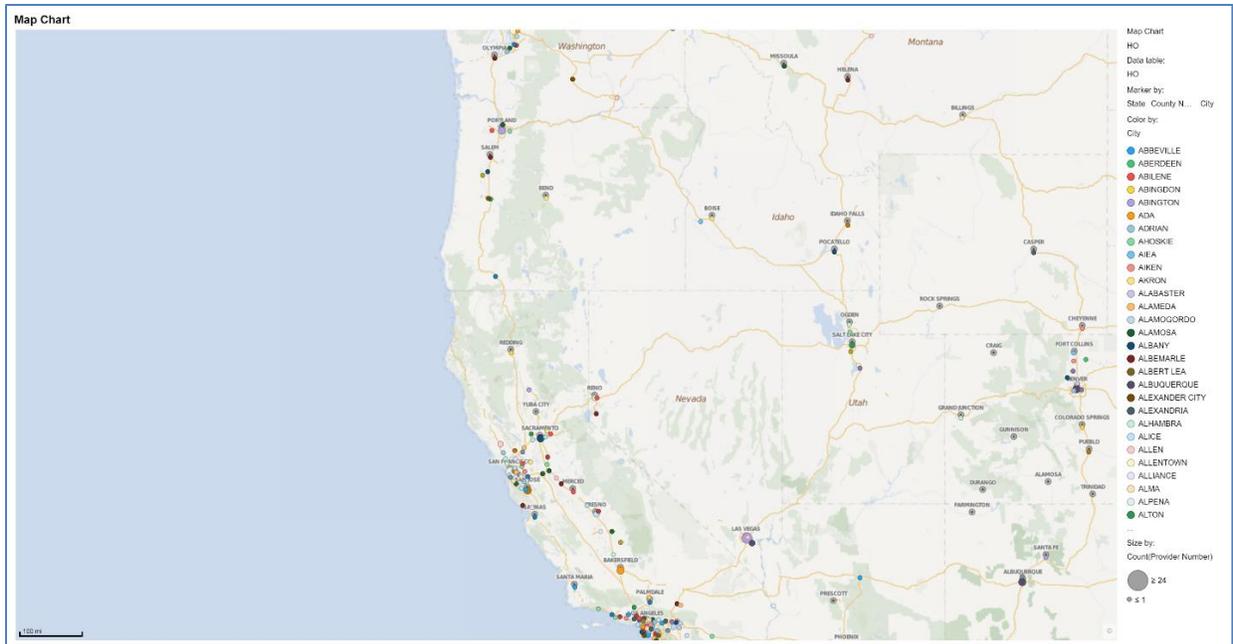
Provider Number	Hospital Name	Address	City	State	ZIP Code	County Name
10005	MARSHALL M...	2505 U S HIG...	BOAZ	AL	35957	Marshall
10012	DEKALB REG...	200 MED CEN...	FORT PAYME	AL	35968	DeKalb
10131	CRESTWOOD...	ONE HOSPRIT...	HUNTSVILLE	AL	35891	Madison
20018	YUKON KUSK...	PO BOX 287	BETHEL	AK	99559	Bethel
30071	FORT DEFLA...	PO BOX 849	FORT DEFLA...	AZ	85504	Apache
30073	TUBA CITY R...	PO BOX 600	TUBA CITY	AZ	86045	Coconino
30084	CHINLE COM...	US HWY 191...	CHINLE	AZ	86503	Apache
40007	CHI-ST VINC...	TWO ST VINC...	LITTLE ROCK	AR	72205	Pulaski
40050	OUACHITA C...	638 CALIFOR...	CAMDEN	AR	71701	Ouachita
40154	BAPTIST HEA...	1555 EXCHA...	CONWAY	AR	72032	Faulkner
50054	SAN GORGO...	600 NORTH H...	BANNING	CA	92220	Riverside
50103	WHITE MEMO...	1720 E CESA...	LOS ANGELES	CA	90033	Los Angeles
50145	COMMUNITY ...	23625 WR H...	MONTEREY	CA	93940	Monterey
50224	HOAG MEMO...	ONE HOAG D...	NEWPORT B...	CA	92663	Orange
50280	MERCY MEDI...	2175 ROSALI...	REDDING	CA	96001	Shasta
50309	SUTTER ROS...	ONE MEDICA...	ROSEVILLE	CA	95661	Placer
50488	EDEN MEDIC...	20103 LAKE C...	CASTRO VAL...	CA	94546	Alameda
50567	MISSION HO...	27700 MEDIC...	MISSION VIEO	CA	92691	Orange
50684	MENIFEE VAL...	28400 MCCAL...	SUN CITY	CA	92585	Riverside
50717	LAC/RANCHO...	7601 EAST IM...	DOWNEY	CA	90242	Los Angeles
70006	STAMFORD H...	ONE HOSPRIT...	STAMFORD	CT	6904	Fairfield
70008	JOHNSON M...	201 CHESTR...	STAFFORD S...	CT	6076	Tolland
70016	SANT MARY...	56 FRANKLIN...	WATERBURY	CT	6706	New Haven
70029	BRISTOL HO...	BREWSTER RD	BRISTOL	CT	6010	Hartford
80003	ST FRANCIS ...	7TH AND CLA...	WILMINGTON	DE	19805	New Castle
100054	TWIN CITIES ...	2190 HWY 85 N	NICEVILLE	FL	32578	Okaloosa
100075	ST JOSEPHS ...	3001 W MART...	TAMPA	FL	33677	Hillsborough
100137	HEART OF FL...	40100 US HW...	DAVENPORT	FL	33837	Polk
100183	CORAL GABL...	3100 DOUGL...	CORAL GABL...	FL	33134	Miami-Dade
100209	KENDALL RE...	11750 BIRD RD	MIAMI	FL	33175	Miami-Dade
110030	CARTERSVIL...	960 JOE FRA...	CARTERSVILLE	GA	30120	Barrow
110038	JOHN D ARC...	915 GORDON...	THOMASVILLE	GA	31792	Thomas
110128	MEADOWS R...	ONE MEADO...	VIDALIA	GA	30474	Toombs
120028	NORTH HAW...	67 1125 MAM...	KAMUELA	HI	96743	Hawaii
140002	ALTON MEMO...	ONE MEMORI...	ALTON	IL	62002	Madison
140015	BLESSING H...	BROADWAY...	QUINCY	IL	62305	Adams
140018	MT SINAI HO...	15TH STREE...	CHICAGO	IL	60608	Cook
140052	OSF SAINT A...	ST ANTHONY...	ALTON	IL	62002	Madison
140118	METROSOUT...	12955 S GRE...	BLUE ISLAND	IL	60406	Cook
140172	FRANCISCAN...	20201 S CRA...	OLIVARIA FIE...	IL	60461	Cook
140187	HSHS ST ELL...	ONE ST ELL...	O FALLON	IL	62289	Saint Clair
140210	HARRISBUR...	100 DOCTOR	HARRISBURG	IL	62346	Saline

Display 18. Medicare providers across USA

Below map chart will visualize Medicare providers in USA by state, county, and city. User can update the color and size using the properties dialogue. See display 19 and 20 below.

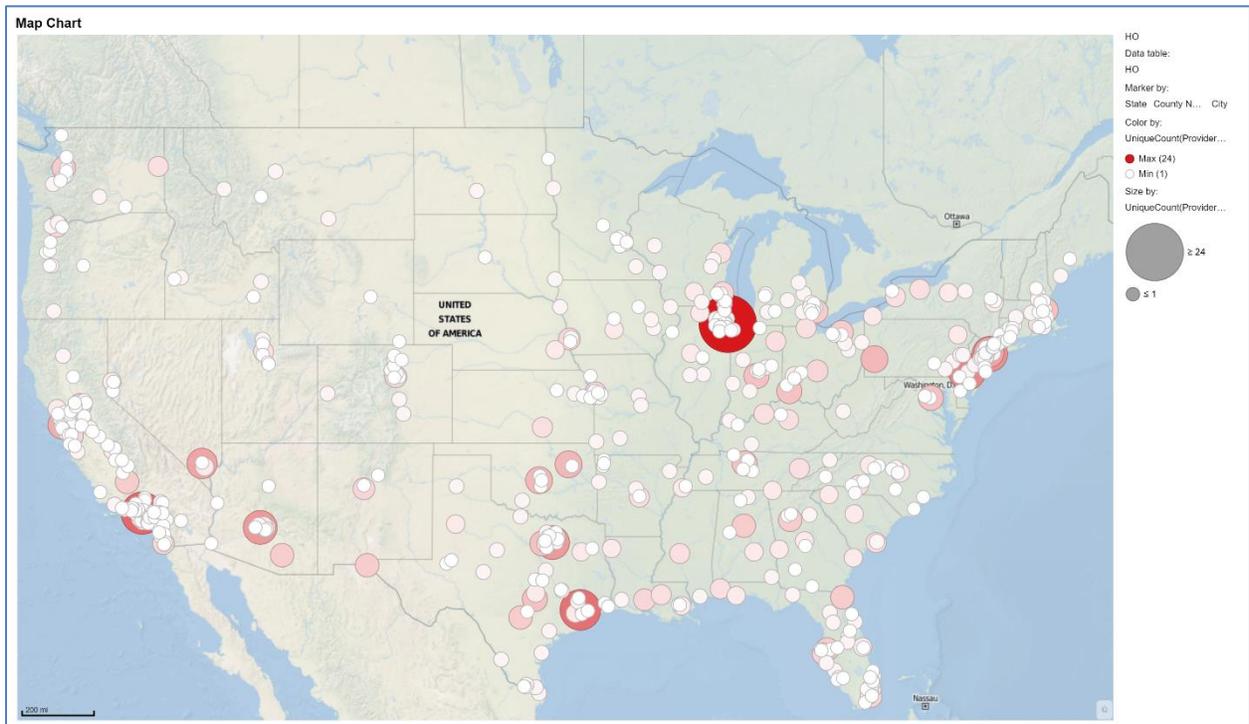


Display 19. Medicare providers across the USA



Display 20. State-wise view of Medicare providers in USA

If user want to give a heat map type view to the Medicare providers data to observe the density, then it is possible to adjust the size by unique provider ID count through properties. Later, user can adjust the color gradient (Min and Max) to give a heat map type view (see display 21 below). This map is very useful to quickly identify densely populated area across USA.



Display 21. Heat map type view of Medical providers across USA

CONCLUSION

TIBCO Spotfire provides an interactive platform for exploratory analysis using data from various fields. Using inbuilt functions and adjusting the properties in Spotfire user can create various heatmap and map chart quickly. With its simplicity to adjust axes symbols and text, and its ability to export data for further user analysis/query, TIBCO Spotfire enables faster data review, quality assessment and process improvement.

REFERENCES

Gupta Ajay, 2017. [Clinical Data Visualization using TIBCO Spotfire® and SAS®](#). Proceedings of the PharmaSUG 2017 Conference, paper BB18.

Gupta Ajay, 2018. [Advanced Data Visualization using TIBCO Spotfire® and SAS®](#). Proceedings of the PharmaSUG 2018 Conference.

Kuhfeld Warren, 2017. Heat Maps: Graphically Displaying Big Data and Small Tables. Proceedings of the SAS Global forum 2017 Conference.

<http://spotfire.tibco.com/>

<https://data.medicare.gov/Hospital-Compare/Heatmap/k7is-d4t4>

ACKNOWLEDGMENTS

Thanks to Ryan Wilkins, Lindsay Dean, Philip Bartle, Ken Borowiak, Richard DAmato, Lynn Clipstone, and PPD Management for their reviews and comments. Thanks to my family for their support.

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:

Ajay Gupta, M.S.
PPD
3900 Paramount Parkway
Morrisville, NC 27560
Work Phone: (919)-456-6461
Fax: (919) 654-9990
E-mail: Ajay.Gupta@ppdi.com,
Ajaykailasgupta@aol.com



DISCLAIMER

The content of this paper are the works of the authors and do not necessarily represent the opinions, recommendations, or practices of PPD.

SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. ® indicates USA registration.

Other brand and product names are trademarks of their respective companies.