A Technical Publication for JMP® Users
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JMPer Cable

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Introducing JMP 7

By John Sall, SAS Institute

JMP 7: Talking to the Next Level

When we hear from researchers with 16 gig of memory in their computer, who want to read tables with 500,000 columns, and want to put to work all 8 cpu cores of their machine, we aren't just doing small jobs anymore. JMP needed to grow up in many ways to handle these kinds of jobs. JMP had to learn new tricks, too, and using advances in algorithms as well as computing power has made huge differences.

Imagine doing a hierarchical cluster analysis on 30,000 rows in a few seconds, or estimating defect rates of one in a million in simulations so fast that it re-simulates and shows results as you move the mouse. Imagine getting true *p*-values from saturated screening models. Imagine getting optimal experimental designs for split-split plot designs. All these new tricks would seem difficult to impossible until now, but are easy in JMP 7.

A Summary of New Features in JMP 7

For business applications:

- Extensive SAS Interface that makes JMP an intelligent SAS client
- More visualization features, with 3D and dynamic bubble plots
- Handling larger problems with multithreading and better algorithms
- Dynamic data filtering
- Survey analysis, including multiple response models
- Better presentation-quality graphics with more customization
- Ability to save projects that embed many datasets in one file
- Smart color-coded script editor

For engineering and science:

- Enriched capability analysis, including goal plots that show hundreds of the process capability variables in one plot.
- Computer experiments, more space filling designs, Gaussian Process fits
- Improved Simulation that can use filtered Monte Carlo methods
- Defect profiling, tolerance design, and robust process engineering
- Model selection for screening designs
- Improved estimates of variance models
- Multivariate control chart
- Time series transfer functions

Better Visualizations

Dynamic Visualization With Bubble Plots

Graphs are usually thought of as static entities, even if they have drill-down and customization features. A graph isn't usually an action story where you see things happen across time. But, if graphs could be put into motion, you would have a more powerfully immersive, compelling, and engaging experience. You would also have more sensitivity to the data. Motion-sensitive vision is a powerful survival skill that has evolved in humans; we are here today because our motion-sensitive vision has served us for spotting prey and predators.

The pioneer of dynamic plots, Hans Rosling, has videos of flash-enabled world demographics presentations on his web site

http://www.ted.com

The motion-enabled graph in JMP 7 is the *Bubble Plot*. The idea is to harness and show more dimensions of data. A bubble plot is an entity that works in up to six dimensions:

- X axis
- Y axis
- size of bubble
- color of bubble
- time variable
- aggregation variable

When there is a time variable, you can play the graph in continuous time, with the positions, colors, and sizes interpolated across the time data points into smooth motion. All these dimensions let you watch a story unfold. The story replays so you can absorb more detail. You see the movers and the shakers among the points. You see which points are leaders, which are followers, and which are contrarians. You aggregate groups and disaggregate a group to see if it really does behave as a group or if it actually behaves as an individual.

The data tables for the following examples (shown in *Figures 1-4*) are available with this JMPer Cable on the JMP web site at

www.jmp.com/about/newsletters/jmpercable/

Scripts are included with the data tables that run the examples. Scripts for the pollution example include coordinates for the United States and selected cities.

Property and Violent Crime Rates

A bubble plot of crime statistics across regions of the United States for the last 30 years shows any regions that had major changes over time. *Figure 1* shows the bubble plots for 1975 and 1998. The south appears to have had an increase in violent crimes. But, highlight the south region bubble and use the **Split** command to see how the crimes rates appear within each state within the region. This example uses the CrimeData.jmp data table.

SAT Scores

Figure 2 shows SAT Math and Verbal test scores in 1992 by state, sized by percent of population taking the test. Iowa appears to have done the best, but few students there took the test. Hawaii and California did much better on math than verbal, which might indicate that a large proportion of the population has English as a second language. This example uses the SATbyYear.jmp data table. You can open this table, run one of the scripts saved with the table and click on **Go** to see these bubbles move as the bubble plot cycles through twenty years of data.

Pollution in the United States

Figure 3 shows average maximum temperature in January for a number of US Cities. This example does not have a time variable (is not motion enabled), and simply displays selected cities with bubbles sized by population. This example uses the PollutantsMap.jmp data table.

The Baby Boom

The bubble plot is a perfect tool to look at age group distributions in countries of the world and see how they changed in the last 40 years. You can see how the baby boom happened in many countries, then aged through the groups, and how some countries still have young-dominated populations. *Figure 4* shows the change in age distribution over time (first and last frames) for selected countries. The bubble plot moves over the span of years to create a dynamic view of the population age distribution as it changes. This example uses the PopAgeGroupSubset.jmp data table.

There are many examples of business and scientific data that are already in time series, and dynamic motion-enabled bubble plots can tell their stories.

Figure 1 Proportion of Violent Crime Rate by Proportion of Property Crime Rate, Sized and Shaded by Region, for Years 1975 and 1998: South Delineated by State Shows the Effect of Florida

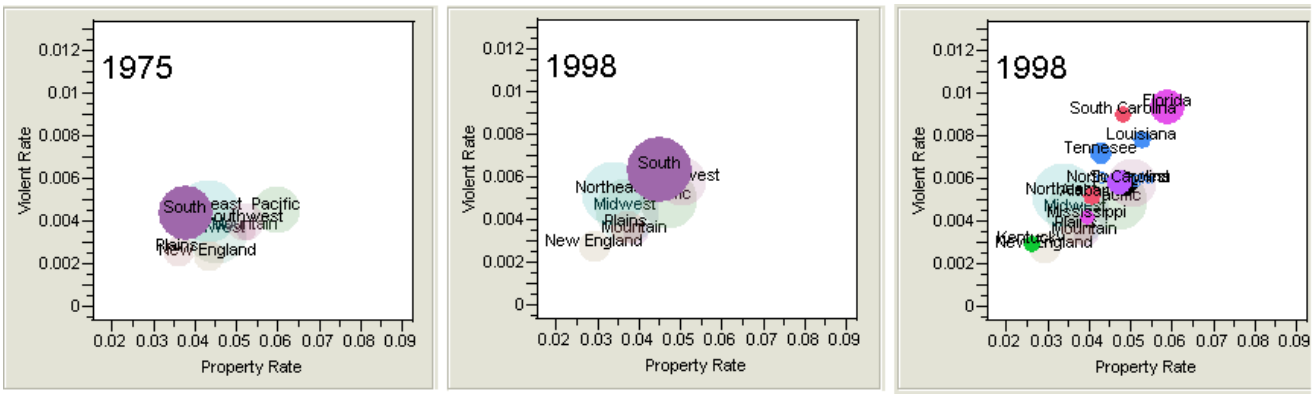


Figure 2 SAT Verbal and Math Scores for States in 1992 Sized by Proportion of Population

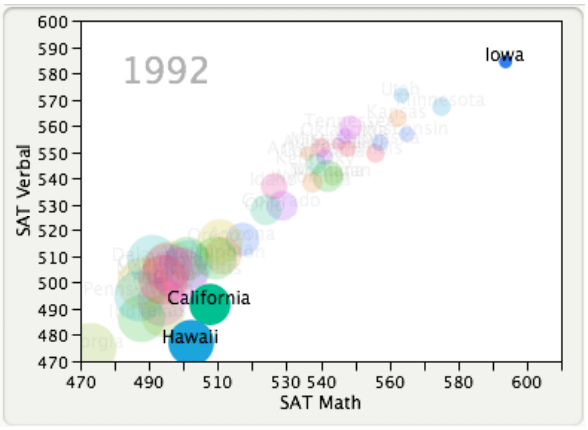


Figure 3 Bubble Shading Indicates Maximum January Temperature and Size of Bubble shows City Population

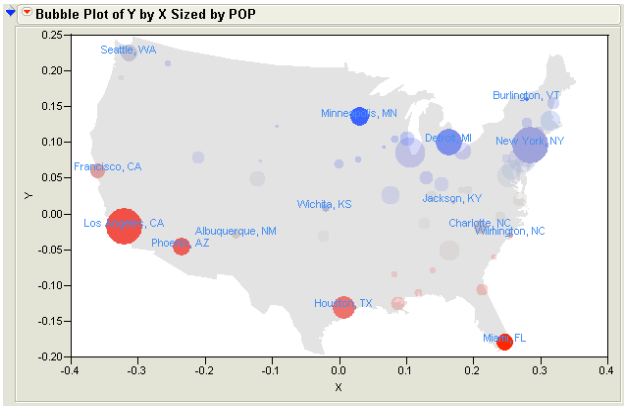
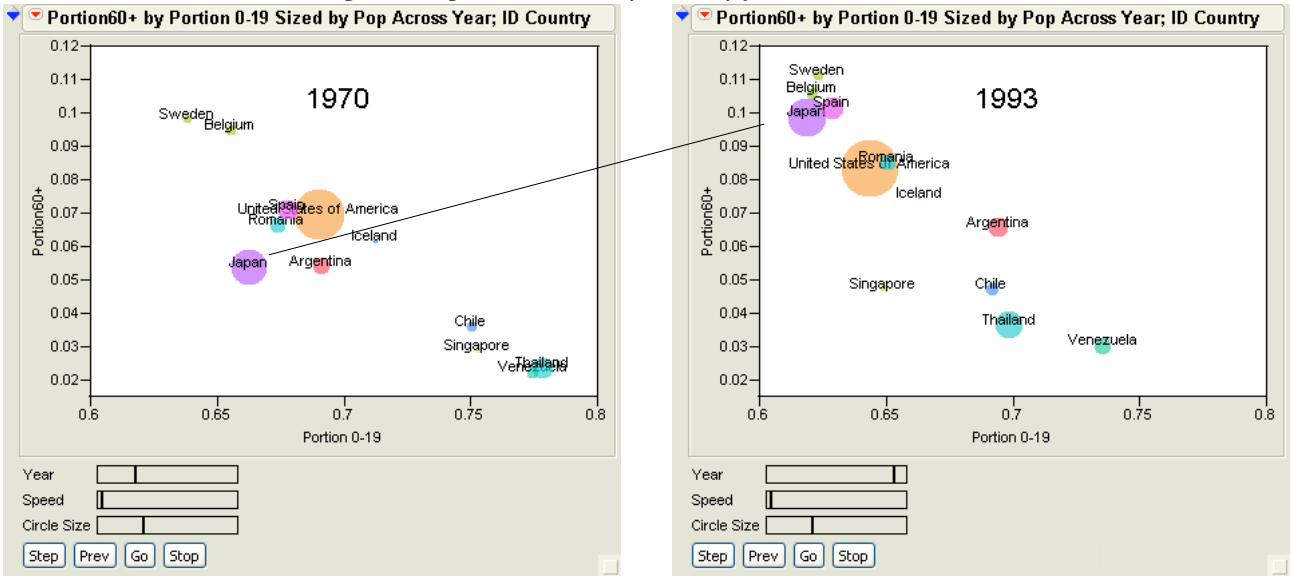


Figure 4 Age Distribution by Country for 1970 and 1993



Immersive Visualization – Scatterplot 3D

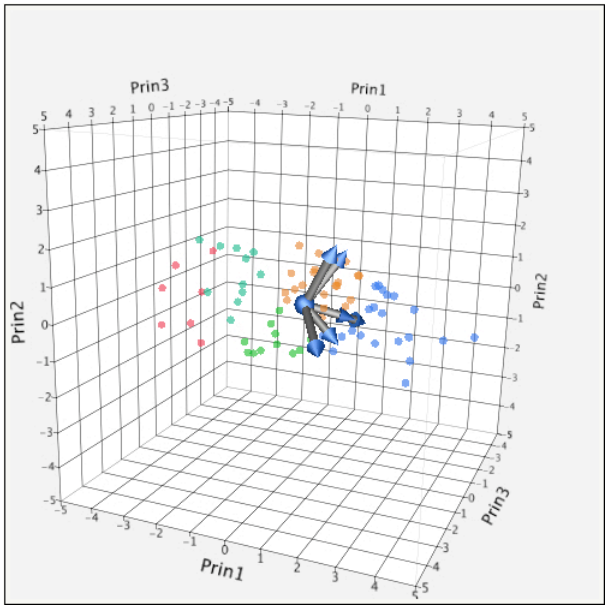
Harnessing the 3rd dimension has been a long-established goal of JMP. Version 1 of JMP introduced the spinning plot, and Version 4 introduced the surface plot. JMP 7 builds on that progress with a new platform called Scatterplot 3D and a number of 3D plots inside of statistical platforms.

First, our priority was to bring a faithful and cusomizable environment to show points in space. We developed the axes, walls, lights, and controls to make this world. You can click to identify points, drag axes, and drag to spin the whole plot. When a wall moves in front of the point space, it disappears and another wall appears behind the points.

Scatterplot 3D, as the replacement for spinning plot, needed to support the principal components and biplot rays. Suppose that you have six or eight dimensions, but the data is correlated across those dimensions. This means that if you rotate the data (in six dimensions) and orient those rotations to align the most variation in the data in the first three dimensions, then you capture most of the variation of the data in a graph that you can now see in a spinning three-dimensional plot. If you add arrows (rays) showing the directions of the original variables in that space, what you get is called a 3D biplot. *Figure 5* shows a biplot as it is displayed by the Scatterplot 3D platform.

If your data is grouped, and has a somewhat multivariate normally shaped distribution, then you can capture the essence of the data by adding normal contour ellipsoids in the space, with each one describing a percentage of the distribution captured by each group. *Figure 6* shows normal contour ellipsoids imposed on Fisher's Iris data (Iris.jmp in the sample data folder).

Figure 5 Biplot in the Scatterplot 3D Platform



If your data has a more irregularly shaped distribution, and you want to see that distribution to gain a better picture than you would get with a point cloud, then a 3D kernel density estimate with semi-transparent contours will be valuable. Use the Cytometry.jmp sample data table to create the contours in *Figure 7*.

Figure 6 Scatterplot 3D with Normal Contour Ellipsoids

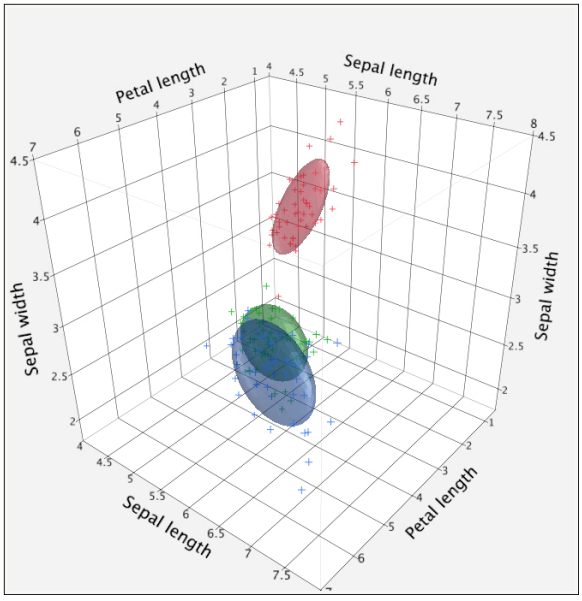
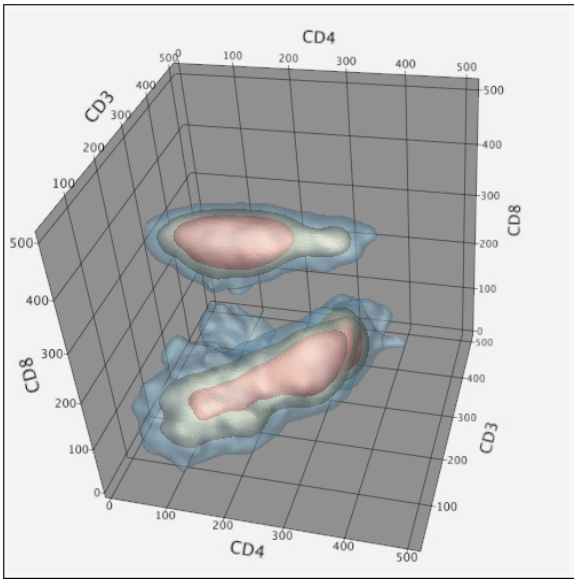


Figure 7 Scatterplot 3D with Kernel Density Estimates



Software from SAS and JMP Join Forces and Work Together

JMP began in 1989 trying to be as different from SAS as a spreadsheet is from a database. JMP was for scientists and engineers, SAS was for business analysts, IT specialists, and statisticians. JMP was point-and-click easy to use. SAS was programmable and powerful. But over the years, this distinction made less sense. JMP and SAS are grounded in the same talents, produced by the same company, and have the same overall analytics theme: *The Power to Know*.

Although SAS has complete and comprehensive statistics and data management abilities, JMP augments the SAS offerings. Think of JMP as a SAS client (like SAS Enterprise Guide) that specializes in bringing your data to you in a way that lets you slice and spin, and make it come alive. SAS Enterprise Guide is a powerful client to SAS that provides a complete set of dialogs for creating SAS code to run SAS procedures, allowing you to author stored processes and generate code. JMP is great at letting you play with your data and *see* key things.

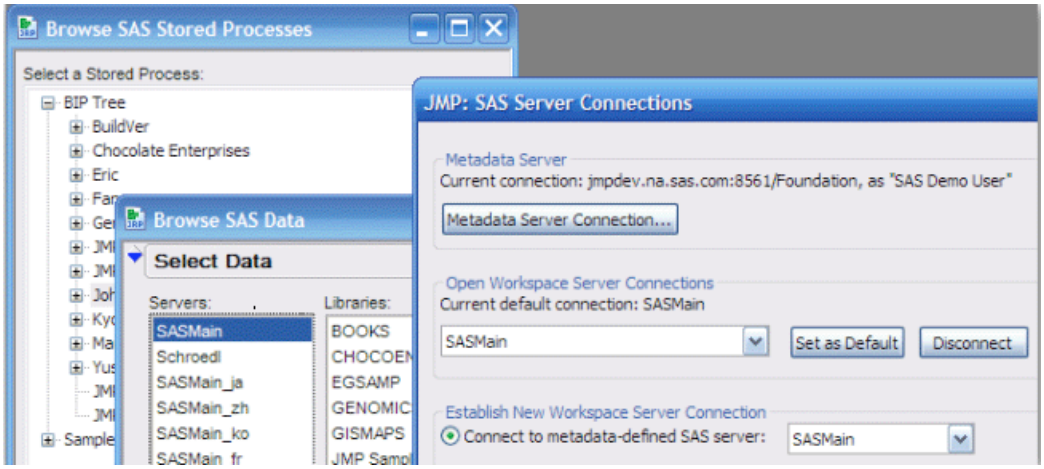
JMP has an attitude toward data that is close, personal, and allows direct data manipulation. JMP has the feel of a spreadsheet, but with the supportive structure of a database and much more graphical responsiveness. Everything in JMP is active on the user interface surface; changes happen instantly, eliminating the usual step of sending a job to the server and retrieving the results

While JMP is great by itself for isolated projects, it needs the server applications to knit together systems of data and applications. JMP 7 interfaces with SAS in many ways: to data, to metadata, to stored processes, to server pools.

If your data or metadata is in SAS, JMP can access it. You can develop SAS jobs in the JMP graphical environment, submit them from JMP, and get back the results in JMP. You can open SAS data sets and dynamically analyze them in JMP. You can browse metadata libraries for data and stored processes. In a couple of cases (including Fit Model), JMP will even generate SAS code so you can compare SAS and JMP results for the same analysis. This is important in a regulated environment when validation is required.

Now the products are joined. JMP users get the power of SAS. SAS users get the visualization front end of JMP. JMP readily connects to SAS Workspace servers and to the SAS Metadata server. JMP can access and run stored processes, can browse SAS data, and Business Intelligence users can take advantage of the power of dynamic visualization of their data through JMP. *Figure 8* shows an example of the interface between JMP and SAS.

Figure 8 Example Windows Showing JMP and SAS Integration



Dynamic Data Filter

JMP Users treasure the ability to select rows with simple mouse clicks, select groups by clicking histogram bars, or select ranges by dragging a selection rectangle across a scatterplot. This gave us the idea for the new **Data Filter** command, found in the **Rows** menu. With JMP 7's data filter, selection just got more convenient and more powerful.

- Convenience comes with access from a compact side panel on the data filter interface.
- Power comes with one-click access, not just for selection, but also for hiding and excluding—or the reverse, showing an including.

The Data Filter panel lets you select groups defined by many variables. In addition to selecting rows, you can also hide/unhide, and exclude/include them. On the Data Filter panel, you click on values of categorical variables to select them. Clicking on a slider panel selects intervals of continuous variables (See *Figure 9*).

Click on a group when the Include mode box is checked, and graphs and analyses focus on that group instantly. This one click is equivalent to

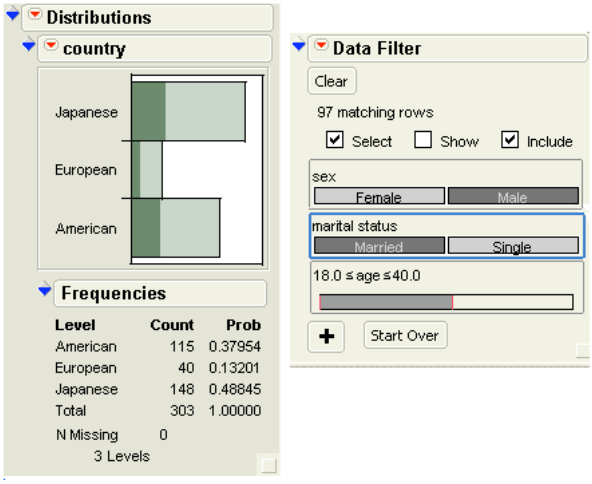
1) Select
2) Invert Selection
3) Exclude
4) Deselect, then
5) Rerun

Let's take a look at Car Poll.jmp from the sample data folder, which records the country-brand preference of cars in a group of car owners, identified by age, sex, marital status, and other variables.

Suppose you want to see the country distribution for married males between the ages of 18 and 40. You could use multiple histograms and carefully highlight the appropriate bars, but the new Data Filter compactly represents the values in many columns, both categorical and continuous.

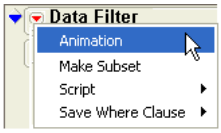
Figure 9 shows this complex subset as defined by the Data Filter. The menu on the Data Filter title bar has a **Make Subset** command. Also, there is a **Save Where Clause** command that can save a script command defining that subset. Note that the Distribution report is for all 303 observations in the data table, but only 97 are selected.

Figure 9 Identify a Complex Subset with the Data Filter



Using the Data Filter for Animation

Using histograms, you can see how groups are arranged in plots by clicking on histogram bars and watching how the points highlight. The animation feature in the Data Filter causes sequential highlighting of the values of a single variable, showing how results change in plots, charts, and in the data table. Individual values can always be highlighted in the data table. However, patterns are more interesting if you first create a plot and then invoke the animation of a variable using the Data Filter to see how it behaves on the plot.



To use the animation feature, first click on one of the variables on the Data Filter control panel to select it (see Marital Status in *Figure 9*). Then choose **Animation** from the Data Filter menu to display the Animation control panel, as shown here. Use the control panel to start and stop the animation, and control animation speed and direction. The animation cycles through values of either character or numeric variables.

Automatic Recalculation

Instant updating, done for Include/Exclude by the data filter, is also done for the simpler statistics and graphics platforms but not for the more complex modeling platforms that can take more time to update. On the Distribution platform, the title bar menu now has a new command, **Automatic Recalc**. When this command is in effect, the Distribution reports automatically recalculate whenever you exclude rows or change values in the data table. Automatic recalculation will be expanded in future releases of JMP.

Power Features and the JMP 7 Interface

Richard Potter, SAS Institute

JMP Projects: A Better Way to Organize Your Work

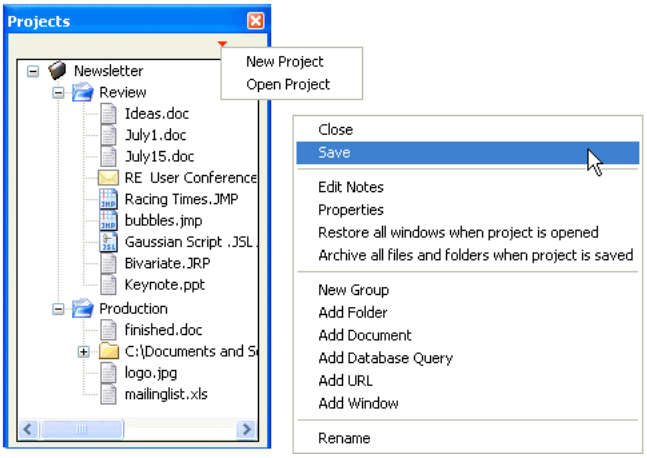
A new feature for JMP on Windows is the ability to save a complete project that can include data tables, journals, scripts, and many other kinds of files. By saving files in a JMP project you can easily share all of these files with a coworker. Before the project manager in JMP 7, it was time-consuming to find all these files and collect them together. If you link to the files from a journal, your link paths in the journal can easily break, even though you could edit them to use relative paths.

In a JMP 7 project, drag or open files, folders, mail from Outlook, URL links, windows, and other elements to the project window, then save the project. The project is saved as a compressed file. You have the option of saving the project with links to all of its elements, or having the project save its own copies of all the project elements. When a colleague opens the project, it places all the files into a single folder, and preserves all saved paths. Also, you can document your project with the **Edit Notes** command from the Project menu.

To create a JMP project, choose **File** > **New** > **Project** or **View** > **Projects**. The Project window then appears on the left side of the JMP application window. The project window can be moved (undocked) from the JMP application window. To access elements for the project, use **View** > **Window List** and **View** > **File System** to open these lists, which can also be either docked or undocked from the JMP application window. Then just drag or open the items you want from these windows.

Figure 1 shows an example of a Projects window. The project name is Newsletter. It has two groups named Review and Production. The Review group has word processing documents, JMP data tables, a JMP script, the results of a bivariate analysis, and a PowerPoint® presentation. The Production group has the final newsletter document, a folder containing a set of pictures for the document, a graphic of a logo, and an Excel® spreadsheet containing the mailing list for the newsletter. This example newsletter project contains all the relevant pieces needed for all parties involved in a document creation process.

Figure 1 Projects Window and Commands



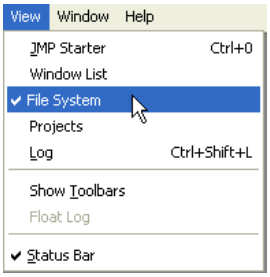
The project is saved with .JMPPRJ appended to its name. Although you can only create a JMP project on Windows, you can open a project with JMP on the Windows, Macintosh, and Linux operating systems.

Notice the list of project commands shown on the right in *Figure 1*. In addition to commands that add elements to a project, there are commands that determine how a project is to be saved and reopened. To open a project on the Mac or a Linux machine you must save the project with all its files, and specify that the files be opened when the project is again opened using these commands:

- When **Restore all windows when project is opened** is checked, all files open automatically when you again open the project.
- When **Archive all files and folders when project is saved** is checked, copies of the project elements are saved with the project instead of just links to the elements.

The File System Toolbar

Another new feature for Windows users in JMP 7 is the *File System* toolbar. This toolbar appears when you select the **File System** command from the **View** menu. Although this toolbar initially appears docked on the left-hand side of the main JMP window, it can be undocked so that it floats by clicking in its title area and dragging it away from the main window frame.



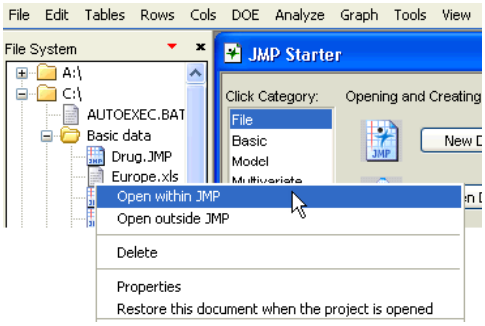
File System Toolbar (continued)

The File System toolbar shows the directories and files on your computer in a tree structure. You can use this toolbar to navigate into any directory or file on your computer. Once you've located a file, you can open it by double-clicking on the icon for that document.

Figure 2 shows navigating to a directory that has some sample data files and selecting an Excel file called Europe.xls. If you click on the icon in the tree, this spreadsheet opens as a JMP table. To open the file in Excel instead, right-mouse click on the icon and select the **Open outside JMP** command from the popup menu.

The options in the popup menu vary depending on the type of file selected. If the file you select is a JMP table or script, then you have the option to open the file within JMP or open and run the script.

Figure 2 File System Toolbar File Options



By default, the File System toolbar lists the files on your hard drive. However, you can add other network servers to the tree. Click on the red triangle at the top of the File System toolbar and select **Add Folder** from the popup menu. Then use the Browse for Folder dialog that appears to navigate to any server on your network. When you locate the volume you want, select it to see a new folder node inserted at the top of your tree hierarchy.

You can now expand that folder and navigate to any directory or file of interest. JMP will remember that you added that folder to your File System toolbar—whenever you launch JMP and display the File System toolbar, the new node is shown. If you decide you don't want that node in your File System view, right-click on it and select the **Remove Folder** command. This only removes the node for that folder from the tree presented by the File System toolbar—the directory itself as it exists is not affected.

Menu Customization

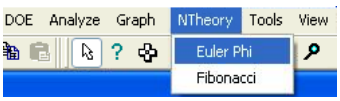
The menu customization implementation in previous versions of JMP had various shortcomings, which our users pointed out to us. In response to their feedback, we have made dramatic changes to menu customization in JMP 7.

First, JMP 7 allows you to merge customizations you made to your menus and toolbars in JMP 6. When you first launch JMP 7, it automatically prompts you to merge your customizations from JMP 6 (if there were any). This new merge process inserts into JMP 7's main menu and toolbars whatever commands, menus, and/or toolbars were unique to your customization of JMP 6. This is a huge improvement over previous versions of JMP, which did not support any kind of merge feature.

In previous versions of JMP, menu customization was an all-or-nothing affair. If you wanted to add a single new command, you had to add the command in the menu editor and then save it to a special JMPCMD file. That file contained the definition of your entire main menu; hence, if you gave that JMPCMD file to someone else and they applied it to their JMP session, it replaced their entire main menu.

Now, with JMP 7 you can define a single menu, toolbar, or command, which you can export to a file with the new .JMPMENU file extension. If someone else imports your JMPMENU file, your new command is added to their menus. When you export your menu definition, you can even specify whether or not JMP should preserve its context so that whenever someone else imports your JMPMENU file, your command will be inserted into their main menu in the same location as it is in your main menu.

Perhaps the biggest drawback to the old menu customization scheme was that your menu definitions and any JSL scripts upon which they depended were disconnected. This made it difficult to share your menu customizations with others. For example, suppose you were using JMP 6 and you added a new menu to the main menu called **NTheory** which contained two JLS script-based commands called **Euler Phi** and **Fibonacci**. Thus, the path to the script to be executed was coded into the definition of the command. If you wanted to share your new menu, it wasn't sufficient to provide only your JMPCMD file—you also had to supply the associated JSL files.



Menu Customization (continued)

Further, even if you supplied both the JMPCMD file and the script files, it was still unlikely that the new menu would function because the paths to copies of the JSL files would probably not match.

JMP 7 eliminates all these problems with the new JMPMENU file. When you export your customized menu, you are prompted whether you want JMP to save the JSL files that your menu commands use. If so, then these associated JSL scripts are saved into the JMPMENU file along with the new menu definition. When the JMPMENU file is imported, JMP extracts the JSL scripts, saves them into a special Dependencies directory, and changes the commands to point to those JSL files. After importing your JMPMENU file, everything needed for the customization is contained in just one file.

The JMPMENU file is really a Zip file. Therefore, if you're curious about what's inside your menu file, you can always examine it outside of JMP by using a tool such as WinZip. By default, if you are running the Windows operating system in an English locale, your JMPMENU files are stored in

C:\Documents and Settings\user-name\Local Settings\Application Data\JMP7 Data\English

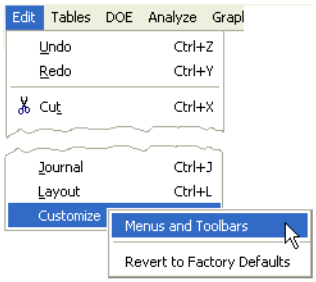
Lastly, JMP 7 automatically imports menu customizations if you put your jmpmenu file in a special folder of your installation directory. For example, if you're running under Windows with your locale set to English and you've installed JMP in the default location, then the following path takes you to the English support files that JMP depends upon:

C:\Program Files\SAS\JMP7\Support Files English

All you have to do is create a folder called Factory Default Menus and copy your JMPMENU files into that location. You are allowed to have as many such files as you like in that folder. Then, whenever JMP launches, it automatically imports each JMPMENU file in the Factory Default Menus folder into the main menu and toolbar list.

If any of the commands in your customized menus use JSL scripts, make sure they were saved when you exported your menus. When JMP imports the menu, it extracts the JSL files and places them in a Dependencies directory within the Factory Default Menus folder.

The Menu Editor: An example



The menu editor has a new interface in the Windows version of JMP 7. To access the menu editor, select **Edit** > **Customize** > **Menus and Toolbars**, as shown here. This command docks the Menus window on the left-hand side of the main window.

JMP 7 combines the ability to edit your main menu and toolbars in one window. This facilitates copying and/or moving commands between menus and toolbars. Previously, the menu editor was in a separate window from the toolbar editor.

Main menu and toolbars are represented using tree structures. The root of your main menu is the Main Menu node and the root of the list of toolbars is the Toolbars node. If you click on the plus (+) symbol next to Main Menu, the node expands and lists all its menus. Likewise, if you click on Toolbars, the list of all your toolbars appears. Click the minus (–) next to the node name to collapse its list.

Suppose you want to add a new menu called **NTheory** (shown previously) to the main menu, positioned between the **Graph** and the **Tools** menus. The **NTheory** menu has two commands: **Euler Phi** and **Fibonacci**.

1) Select **Edit** > **Customize** > **Menus and Toolbars** to see the Menus window (see Figure 3).
2) Click the **+** sign to the left of **Main Menu** (in the Menus window) to expand it (see Figure 3).
3) Right-click the **Graph** menu item.
4) Select **Insert After** from the menu that appears. A new **Untitled** item now shows beneath the **Graph** main menu item.
5) Double-click on the new **Untitled** item to see the Menu Item Properties dialog.
6) Type the new menu name (**NTheory**) into the Caption box.
7) For Menu Item Type, click the Submenu radio button and then click **OK**.
8) Now, right-click **NTheory** and select **Insert into Submenu** from the menu that appears. This

Menu Customization (continued)

creates an **Untitled** submenu item for **NTheory**.

9) Double-click the **Untitled** submenu item and use its Menu Item Properties dialog.

10) Name the item **Euler Phi** and complete the dialog to describe the properties for this command.

11) Right-click **Euler Phi** and select **Insert After** to add the second **Untitled** submenu command.

12) Again, double click **Untitled** and complete the Menu Item Properties dialog; name the command **Fibonacci** and give it the other properties you want.

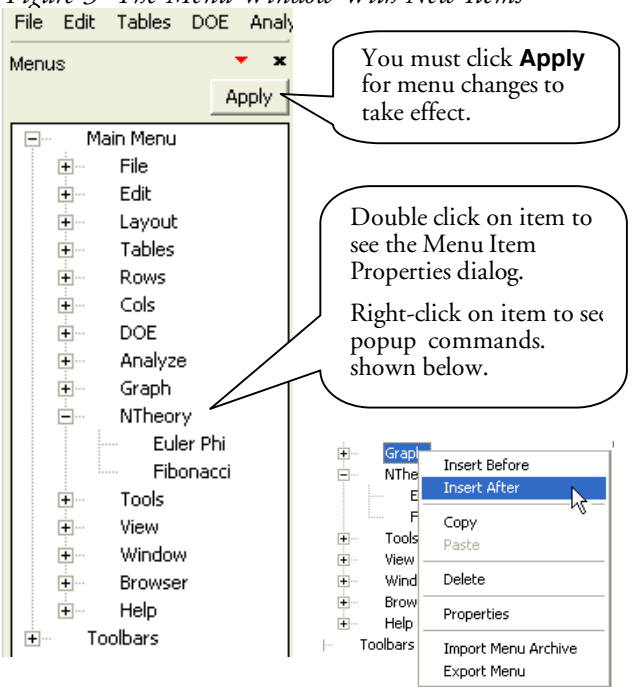
13) Click **Apply**.

You are finished modifying the main menu.

Important: In order for any modifications to take effect, you must click the **Apply** button in the top right-hand corner of the Menus window (See Figure 3).

In general, to add a submenu to any command, new or existing, the steps are exactly the same. First, you create a new item and set its type to be submenu in the Menu Item Properties dialog. Then, right-click and select the **Insert into Submenu** command. This adds a new item into the submenu itself. Continue and complete rest of your submenu using the **Insert Before** and **Insert After** commands as usual.

Figure 3 The Menu Window With New Items



What's New in DOE

Bradley Jones, SAS institute

JMP 7 has made major improvements to existing platforms and added new functionality, such as optimal design for

- random block designs
- split-split-plot designs
- strip-plot designs

There are now optimal designs for generalized linear models, including models with 0-1 responses or response that are counts such as

- binomial regression
- poisson regression

Optimal nonlinear regression is improved. It is faster, more efficient, and more robust to parameter mis-specification.

JMP 7 introduces new designs and also a new fitting method that specifically addresses the unique behavior of computer simulation models. There are two new space-filling designs:

- *Maximum entropy*, which measures the amount of information contained in the distribution of a set of data
- *Gaussian process IMSE optimal*, which creates a design that minimizes the integrated mean squared error of the Gaussian process over the experimental region

The new Gaussian Process platform (**Analyze** > **Modeling** > **Gaussian Process**) deals with no-error-term models, such as those found in computer simulation experiments, which often perfectly interpolates the data. The Gaussian Process platform fits a spatial correlation model to the data, where the correlation of the response between two observations decreases as the values of the independent variables become more distant.

The design of computer simulation experiments is one of the most important additions to JMP Design of Experiments.

Why Computer Experiments?

In an effort to speed the development of new products and processes, many companies are turning to computer simulations to avoid the expense and lost time of building prototypes. However, these computer simulations are often very complex and it may take

hours to complete a single run. If there are many variables affecting the results of the simulation, then it makes sense to design an experiment that gains the most information possible from a limited number of computer simulation runs.

The absence of noise is the key difference between computer simulation experiments and experiments in the real world. Since there is no variability in the results of computer experiments, optimal designs based on reducing variance have questionable utility. Replication, which is usually a good thing, is undesirable in computer experiments. Thus, a new approach to experimentation is necessary.

Because there are often many variables, and a single computer run might be lengthy, you want a *surrogate model* for the simulation. This model must be an adequate approximation to the computer simulation, and give fast predictions for new points. Gaussian Process (GASP) models are standard when designing a surrogate model because they are flexible and parsimonious in the number of unknowns. Further, the GASP model can interpolate data, which is necessary because there is no error for *x* when you have observed data.

Example: Heat Exchanger Study

An example given by Qian, et al. (2006) involved finding optimal settings of four characteristics of a heat exchanger, where maximizing heat transfer was critical. The unit was composed of many thousands of conduction areas, and evaluating the design space would require computationally extensive simulations.

However, preliminary work provided upper and lower bounds for four of the heat exchanger factors (design variables discussed in reference):

	m	input Temp	k	Wall Temp
Lower bound	0.00055	270.00	202.4	330
Upper bound	0.001	303.15	360.0	400

Using these variables with estimated bounds allowed JMP to create a space filling design; Responses, based on previous studies, give estimated heat transfer for the design points (*Figure 1*).

Figure 1 Heat Transfer Design Table with Response Data

heat exchanger FL
Gaussian Process
Columns (5/0)
m
Input Temp
k
Wall Temp
heat transfer
Rows
All rows 22

	m	Input Temp	k	Wall Temp	heat transfer
1	0.000552	293.53	318.63	388.29	23.54
2	0.000566	285.77	266.71	367.27	20.15
3	0.000578	302.17	358.13	343.72	10.17
4	0.00058	272.26	211.71	333.65	15.29
5	0.000589	278.16	225.78	351.83	18.39
6	0.000594	279.54	258.51	360.13	20.52
7	0.000612	280.83	291.53	394.72	30.12
8	0.000626	284.89	350.46	352.29	18.17
9	0.000627	287.6	243.96	382.54	24.68
10	0.000639	270.45	241.21	341.81	19.05

```
Gaussian Process(
     Y( :heat transfer ),
     X( :m, :Input Temp, :k, :Wall Temp )
)
```

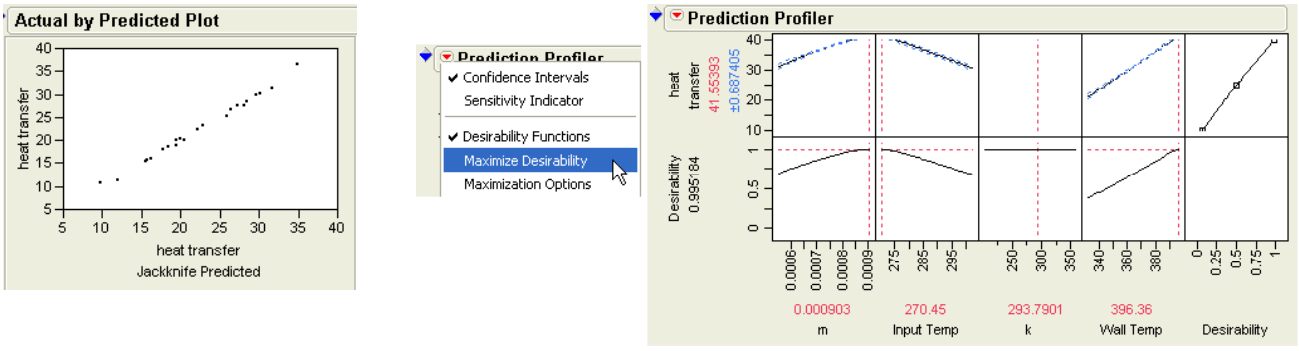
Space Filling designs automatically save a Gaussian Process analysis script with the design table. *Figure 2* shows the results of the analysis for the data in *Figure 1*.

The Gaussian Process analysis report first shows an Actual by Predicted Plot, where the predicted values are jackknifed; that is, the predicted values at each point are computed excluding the observed value at that point. A model report and plots (not shown) are based on function-driven variance computations. JMP uses the product exponential correlation function with a power of 2 as the estimated model.

The Prediction Profiler is available from the menu on the Gaussian Process title bar, and its **Maximum Desirability** command finds the optimal settings for the factors, as shown on the right in *Figure 2*.

Reference: Z. Qian, C. Seepersad, R. Joseph, J. Allen and C. F. J. Wu (2006). Building surrogate models with detailed approximate simulations. *ASME Journal of Mechanical Design*, **128** , 668-677.

Figure 2 Results of Gaussian Process Analysis, with Maximum Desirability to Identify Factor Settings



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