About JMP 2.0...

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JMP® began as a research project in statistical software design, but is now a commercial product for the Macintosh® market with a continuing commitment to bring innovative statistical techniques to the researcher. JMP is small yet capable, focused yet widely understandable, unified and up-to-date in its methodology as well as in its technology.

For the second release of JMP, our focus has been on enriching and deepening current areas as well as some broadening into new areas. The personality of the product has not changed, but it can do a lot more things.

The One-way Layout

The richness of a software tool involves how deep a set of questions can be addressed and how much insight can be gained by the results.

Suppose that you have a one-way layout, i.e. a continuous response from several groups. In JMP this is done by the "Fit Y by X" platform for an interval Y by a nominal X.

The first level of questions concern the estimation of means and quantiles. In JMP this is shown graphically. The means are shown with diamonds, centers at the mean, ends at the confidence interval, and the width showing the sample size. Quantiles are shown with quantile box plots.

The natural question is the test that all the means are the same. This is done in the analysis of variance report with the F test.

The next question is which means are different. Since these questions involve many comparisons, there are lots of ways of controlling for the level of the tests using various multiple comparisons procedures. JMP implements what is felt to be the best test in each of four different situations (Hsu 1989). For the situation of simply looking at one pair of means at a time, there is the standard Student's t test. JMP Version I pioneered "comparison circles", the only graphical technique that works to show the significance relationships on the scale of the response for unequal sample sizes. This technique can be applied to the other three tests also. For the situation of looking at all the comparisons, the Tukey-Kramer HSD approach is offered. The circles get much bigger because it is guarding against falsely declaring significant differences among many more comparisons. For the situation of asking if a mean is not the maximum (or minimum) in the group, we offer the Hsu MCB test. [The graphic for this is conservative, rather than equivalent to the textual version.] For the situation of comparing many treatments against one control group, JMP offers Dunnett's test. This is done using the actual sample sizes, rather than a harmonic-mean approximation.

The next question is which means are different if I wish to use a nonparametric test.

Nonparametric tests do not assume that the errors are normally distributed. In SAS® this would be done by PROC NPARIWAY. In JMP it is built into the same one-way platform. JMP offers the Wilcoxon, Median, and van der Waerden rank tests.

The next natural question is whether the variances are equal from group-to-group. This issue has not been addressed by most statistical packages. The literature is not solid behind any single test, so JMP offers the four tests that we feel are best represented in the literature. If one concludes that the variances are different, then one would consult the Welch anova included in the report automatically.
All these features follow naturally from the same situation, and in JMP they are all implemented from one menu in the same platform.

Features in the One-way Layout

- Fit Means
- Fit Quantiles
- Compare Each Pair
- Compare All Pairs
- Compare with Control
- Set Alpha Levels
- Nonpar-Grubbs
- Nonpar-Median
- Nonpar-Wilcoxon
- Test Variances (equal)
- Power Details
- Multiple Comparisons
- Student’s t, LSD
- Tukey HSD
- Dunnett’s test
- Nonparametrics
- Homogeneity of Variances
- Test Details

Multifaceted Insight from an F test

There has been continuing progress in the portrayal of F tests. Early programs gave only stark test statistics. Later, the exact p-value significances were added. GLM pioneered in hypothesis construction. With leverage plots you could see the point-by-point composition of the sums of squares for the hypothesis.

In JMP Version 2, we have added the ability to see the test in three more scales.

- in the scale of "type-one error", we show the estimate of the power of the test, i.e. the probability of declaring the test significant given data with the same structure. (S.Paul Wright and Ralph G. O’Brien and , 1989).

Previously, statisticians have labored over these questions with side-calculations. Novices usually don’t even think of these questions and often have a mistaken notion of using significance tests “prove there was no effect.” By bringing these test details to the surface, we hope to make the expert’s job easier, and to help the novice address the right issues.

Our commitment with JMP is to show each test in multiple perspectives to bring about the most understanding of how the test is supported by the data.

But these reports still don’t answer some of the natural questions a user would ask, especially if an effect is not significant: “What magnitude of difference would I be able to detect with this data?” and “How much more data would I need to show the current difference to be significant?”

In JMP Version 2, we have added the ability to see the test in three more scales.

- In the scale of "type-one error", we show the traditional p-value, the probability that we are wrong if we declare the effect significant.
- In the scale of the estimate, we show the least significant value, i.e. that value of an estimate that would be significant at a specified alpha level for data with that structure. As a bonus, this happens to also be the radius of the confidence interval.
- In the scale of the sample size, we show the least significant number, i.e. the number of observations that would make the test have the specified significance for data with that structure.

Looking at an F test from four different perspectives.

<table>
<thead>
<tr>
<th>type 1 Error</th>
<th>p-value</th>
<th>The probability of being wrong if you declare an effect significant.</th>
</tr>
</thead>
<tbody>
<tr>
<td>the estimate</td>
<td>least significant value (LSV)</td>
<td>The value of an estimate that would be significant at the alpha level.</td>
</tr>
<tr>
<td>sample size</td>
<td>least significant number (LSN)</td>
<td>The sample size that would be needed for an effect to be significant.</td>
</tr>
<tr>
<td>type 2 Error</td>
<td>power</td>
<td>The probability of getting a significant result.</td>
</tr>
</tbody>
</table>

Repeated Measures

When Version 1 of JMP came out, we did not have the time to include support for random effects or for multivariate responses. Though JMP was very good at bringing graphical portrayals of hypothesis tests, it did not have the machinery to match GLM breadth. With Version 2, we have caught up to most of the features that GLM offers. These new features in JMP will be of particular importance to people that deal with repeated measures or longitudinal data.

If you have repeated measures data, there are now two full approaches:

- You can model it as a mixed model, declaring certain effects as random. The fitting system figures out the expected means squares, estimates variance components w.r.t. the expected mean squares, and then for each effect it synthesizes a denominator that has the right expectation to test that effect.
You can model it as a multivariate model and specify a response design. This method also affords the opportunity for univariate calculations, including the Greenhouse-Geisser and Huynh-Feldt adjustments.

Although the user interface is different, JMP offers these features in a manner similar to the GLM procedure. However, there are some aspects unique to JMP:

- Canonical plots of the centroids, i.e. the least squares means in the first two canonical components of the test space. The means are shown with confidence circles, as described by Mardia, Kent and Bibby (1980).
- Canonical scores output, which helps avoid the need for a separate canonical correlation procedure.
- Discriminant scores output, which helps avoid the need for a separate discriminant analysis procedure. The discriminant output features live-formulas that calculate the distances, posterior probabilities, and most-likely level. However, the procedure is limited to considering the normal-theory equal-covariances-across-groups case.

Canonical plots of the centroids, i.e. the least squares means in the first two canonical components of the test space. The means are shown with confidence circles, as described by Mardia, Kent and Bibby (1980).

JMP cannot avoid the difficulties of finding a solution -- it offers the standard Gauss-Newton and Newton-Raphson methods. But it does surface the iteration process to the user, bringing it under interactive control. This means the user can stop the iterations at any time, reset parameter values, start iterations again. The iterations run in the background, so you can go about other work while the iterations are proceeding. In figure X you see the control panel in its initial state.

Once the solution is found, most packages only show the approximate standard errors, or confidence intervals derived from these. With nonlinear models, these confidence intervals are not very trustworthy. With JMP you can request the system to search for the exact likelihood-based confidence interval. This is somewhat expensive, since each search point needs a complete set of iterations on all the parameters except the one being searched. But the search is worth it, since the alternative confidence intervals are just not reliable enough. As you can see in the example below, the 95% confidence limits are not very close to 1.96 times the standard error from the estimate.
When the estimation is finished, often one wants a plot of the fitted function, at least if the function is of one variable. In JMP, such a plot is produced automatically. This is a true function plot, not just a connected set of points corresponding to data values. The data values are superimposed.

One of the up-and-coming uses of nonlinear regression programs these days is in their use for finding maximum likelihood estimates. There are at least three ways in which nonlinear programs can be used for this purpose. These usually involve extra work, particularly in calculating weight functions. To use JMP for maximum likelihood is very direct. You just supply a formula for the loss function, the sum of which is to be minimized. JMP can then apply the Gauss-Newton, or preferably the Newton-Raphson method directly. This involves JMP automatically finding the first two derivatives of the loss function with respect to the model. Currently, this technique is limited to loss functions that do not themselves have parameters, but we expect to generalize it in the future so that the platform can calculate robust estimators, for example.

**Summaries and Charts**

With JMP 1.0 we felt a little embarrassed by not being able to generate a simple bar chart, something that all spreadsheets can do. Our tables of summary statistics were all oriented for statistical tests, not just for exposition. In version 2 we have addressed these issues with commands in the new Summarize menu.

In making a chart, we thought it best to separate the "what" from the "how", i.e. the numeric content of the values from how those values are to be presented. This would make us more consistent with the spreadsheet world, where the numbers are already summaries, and the chart just presents them. Also it would allow us to make the summary process independently useful.

So a summary chart now involves two steps. The summarization step is done with the "Grouping..." command. The presentation is done by the "Chart" command. The result of a "Grouping..." command is not a report, but rather a specialized data table. The rows in the data table correspond to the groups in the original data. The columns correspond to grouping variables and summary statistics.

**Real-time Statistical Quality Control**

Consider monitoring a manufacturing line. You want Shewhart charts to observe the process and to insure that it does not go out of control. If the basic goal of a Shewhart chart is to detect when a process is going out of control, then it is important to get the data analyzed in real time, close to the point of manufacture, rather than later at a remote location.

You connect the measuring instrument to the serial port on your Mac and start Version 2 of JMP. Open a data table that has a character variable to accept measurement records from the instrument. Then create other columns with formulas to extract the values from the measurement record. Then start a Shewhart chart.

Each time a measurement is made on the instrument, it sends a record to become the value of a new row in the data table. Formulas for
other columns in the data table extract the values from the record. This all happens in real-time as the measurements are made.

Each time a batch of points is added (usually 5 to 20 points), a point is instantly added to the Shewhart chart. If the chart runs out of room, it contracts the scale and reformats the plot.

If the process goes out of control, as defined by any of several available criteria, then JMP will start playing a prerecorded sound to signal the condition. The event-oriented character of JMP made this facility a natural one to add for Version 2.

Correspondence Analysis

JMP has always aimed to give graphical presentations of data, and though many additions of JMP are non-graphical, there are some important graphical enhancements too. For analyzing contingency tables, JMP Version 1 offered a mosaic plot. This was fine for showing when data was marginally homogeneous, but less effective for describing what the differences are, especially when there are many levels. With Version 2, we have added the Correspondence Analysis graph, a technique championed by the French for showing relationships of rows and columns in a contingency table. For each row and column, there is a point. Row points that are close together represent rows in the table that have similar profiles. The technique is symmetric and thus column profile similarities are also shown. In the following example, the columns are the Y values 1 through 9 showing a preference value for four different cheeses, the X values of A, B, C, and D. The relationship is hard to read in the mosaic plot (first graph below), but easy to see in the correspondence analysis plot (second graph).

Other Improvements

- There is more customization available. You can double-click on a numeric axis and rescale it. Double-click on a report column to change its format. Resize a whole set of plots rather than one plot at a time.
- A by-group facility hooked into grouping tables.
- An overlay-plotting platform.
- Pareto charts.
- In the univariate "Distribution of Y" platform, a test for normality, Student and Signed Rank tests for the mean equaling some specified value, and capability analysis.
- In the Fit Y by X platform for continuous variables: a grouping feature for fitting equations or ellipses by groups, prediction confidence intervals.
- In the Y's by Y's platform: a jackknife distance option to achieve more robustness.
- In the Spin platform, varimax rotated components, which gives JMP a rudimentary Factor analysis.
- A Guide facility to obtain help on where to find a statistical method.
- In Specify Model, buttons for saving and retrieving models, and check options for No intercept and No Plots.
- In the fitting platform, an estimate facility, to construct custom tests across parameters, improved parameterization of nested effects, sequential (Type 1) sums of squares, plots showing structure, such as response surface contours and main effect and interaction profiles.
- In the calculator, there are new operators for summary functions, probability functions, matching and selection. A dragging feature makes it easier to reorganize formulas.
- Date values are supported.

**Summary**

JMP is a growing and maturing product. We continue the commitments to empower users to discover more, interact more, and understand more. Version 2 offers many of the most-requested features that were lacking in Version 1.

**References**


Hsu, Jason (1989) "Multiple Comparison Procedures" ASA Short Course notes, 1989.


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