
An Applet for Teacher

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How often have you accessed teaching materials via a Web browser, merely to find a static page which offers nothing more than the printed page? Such disappointing experiences are due simply to the fact that incorporating dynamic aspects in a Web page can be very difficult.

The Choices

For on-line learning materials linked to a lecture course with set mathematical or statistical software, there can be an easy way out-namely, to supply macros written for that software. While this should suffice in a University computing laboratory, for instance, this may not prove useful if students cannot access the software from their personal machines. In addition, the interactivity provided by the macros is separated from the learning materials, severing the link between theory and practice.

There do now exist items of software which are designed to introduce interactive features into Web pages. **LiveMath** [1], for example, provides a basis for mathematical and graphing capabilities to be contained within a Web page via a plug-in. **StatServer/Analytic Server** [2] allows for S-Plus functions to be called from within a browser at the user's request. With such software, however, there are drawbacks-cost can be one, and another is that you are limited by what the software can provide.

A third possibility is to write java applications for running within web pages as applets. This is certainly the most demanding option; largely, useful applets require considerable coding expertise and effort. However, the results of such efforts provide some of the most interesting and innovative teaching materials available on the Web. Perhaps the major benefit of using applets is that by their nature they are linked to Web pages and hence can form a stronger link between on-line teaching material and experimentation as part of learning. Furthermore, tools are being developed which should make the creation of java applets in a mathematical/statistical context much easier, as we shall see. The remainder of this article is devoted to examples of java applets and repositories, but cannot hope to be exhaustive.

Examples

The **STATLETS** collection [3] is a clear example of the potential of utilising the power of Java within a Web page. There are more than 50 applets available on-line (you are required to log-in); they cover a range of basic statistics and

quality control topics, concentrating on technical application rather than teaching or experimentation. Each applet features tabs for separating information into several pages. There are also many options available—for example, the applet for studying probability distributions contains 24 different distributions. This applet resource is one of a growing number which, encouragingly, allow users to download the archives for installation locally, apparently without cost for academic purposes. Furthermore, SG Corp market development tools for writing one's own applets, providing a suite of statistical and graphical tools in java.

Based at the University of Alabama in Huntsville, USA, the **Probability/Statistics Object Library** [4] is another Web site which provides development tools alongside statistical applets for access or download. All the java tools here are intended for academic use and are free of charge. The suite of tools consists of: objects for graphs and tables; "virtual" objects for probability distributions etc.; and images, such as dice and playing cards. Here the emphasis is on trying things out, rather than attempting to teach mathematical detail. A number of the applets are called "Experiments", and concern the illustration of basic probability and statistics with appropriate contextualisation where possible. This site features one of a number of applets devoted to the so-called "Monty Hall" problem; this one contains the best picture of a goat, as illustrated by Figure 1. In addition, the applets are linked in with the Virtual Laboratory in Statistics, on the same site, which provides more expository learning material.

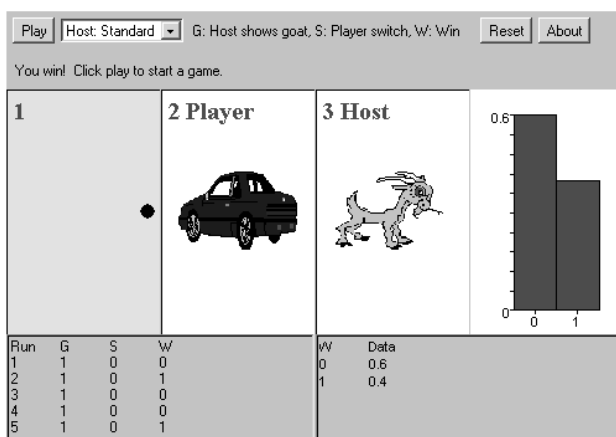


Figure 1

Another innovation is the mini-statistics package provided by **WEBSTAT** [5]. When launched from within a Web page, Webstat appears in its own pop-up window. Here the tactic is different from, say, the

Statlets collection, in that everything is contained within the one java application. Standard statistical methods are covered, up to and including regression and ANOVA. Data can be entered via a spreadsheet interface, although there are many interesting examples included. Instructions are given for the inclusion of Webstat in your own web page, and the ability to read data from a URL means that you can supply your own data to Webstat without requiring students to key in large amounts of data. However, Webstat must be run from the developer's website in the USA, thus limiting its considerable potential.

On a slightly more mathematical note, the Geometer's Sketchpad project has resulted in the **JavaSketchpad** [6] for interactive demonstrations of concepts of geometry in applets. The regression example [7] illustrated in Figure 2 is an imaginative exploration of the least squares principle. The small red squares are active and can be dragged around. Dragging the squares marked "y-intercept" and "slope" changes the regression line, and the "squared error" for each data point (shown by the squares with the data points at a corner) changes to reflect the residual associated with the individual points. The larger square in the bottom right reflects the sum of squared error, and a numerical value is given. Thus a student is provided with the most transparent illustration of how least squares works.

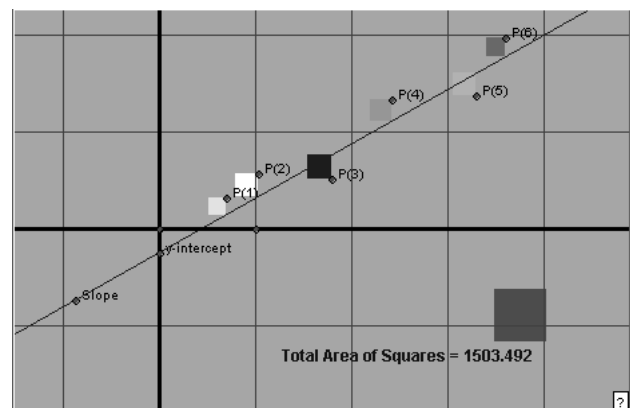


Figure 2

The **Rice Virtual Lab in Statistics** [8] is another collection which allows the applets therein to be downloaded and installed locally. There are four sections to this site: an on-line textbook covering introductory statistics up to ANOVA (but not including regression); applets demonstrating statistical concepts; case studies in statistics; and a selection of applets as tools for analysis. The textbook and case studies use applets from the other sections as appropriate, and the material provided as whole is well integrated. Some of the applets here are especially good for illustrating statistical concepts. For

example, Figure 3 shows the relationship of between- and within-sum of squares via the pie chart on the right-hand side-different data sets can be selected which show different characteristics, so that a student can see how differences in variance or mean levels affects ANOVA. Figure 4 shows another example of "guessing" regression fits, also including correlations. This applet will plot the least-squares regression line on request, so that one can compare the guessed MSE with the optimal value.

group variance in ANOVA) in a very transparent way. **Probability by Surprise** [12] is a collection of applets intended to explore various concepts in probability, stressing the occasionally counter-intuitive nature of the topic. For example, here you will find opportunities to experiment with the birthday problem, Polya urns and traffic jams, as well as constructing probability trees.

There are a couple of applets hosted by **Aranya Consulting** [13] which are worth a mention, primarily because they are concerned with time series analysis, and represent a rare foray into statistical methods beyond the elementary.

Worth a mention here is the project at **Vassarstats** [14]. Although not technically a site devoted to applets, the JavaScript material here is an interesting alternative. The graphing facilities are relatively limited, but given the JavaScript platform, surprisingly good. As the authors point out, JavaScript can sometimes be used where Java itself has been turned off for reasons of security, perhaps.

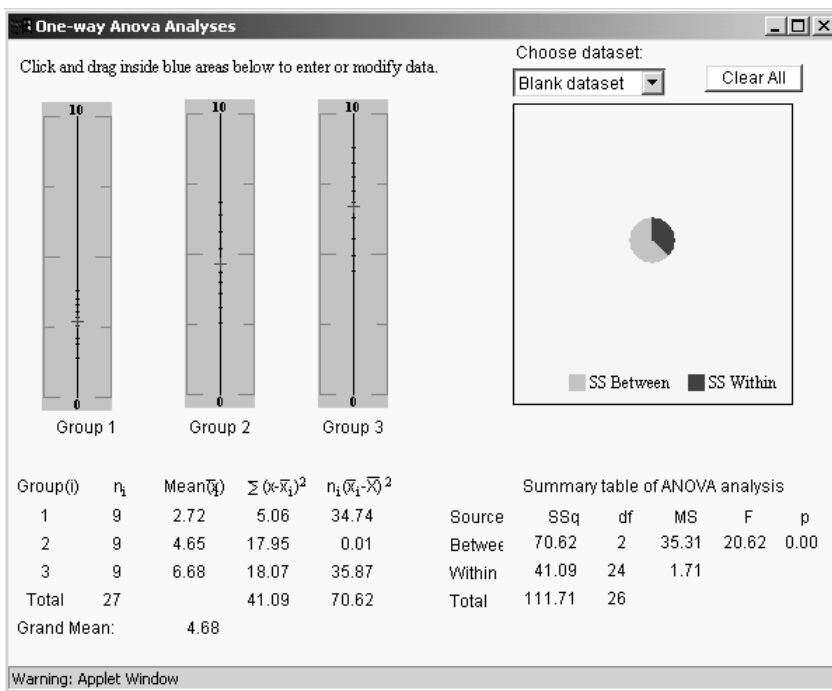


Figure 3

The **CUWU Statistics Program** [9] does not go as far as providing an entire statistics package like Webstats, but the data applet illustrated by Figure 5 provides access to a huge bank of data sets, and basic summary statistics and graphs can be created as shown. Effectively. This provides several applets in one, which can be a useful feature. Again here, the applets at CUWU are downloadable for local installation.

Surfstat [10] is another on-line textbook which makes use of applets. The best on-line textbook of all has to be **CAST** [11] by Doug Stirling at Massey University in New Zealand. The (many) applets in CAST make inspired use of "sliders"-that is, you have the ability to change certain parameters (such as within-

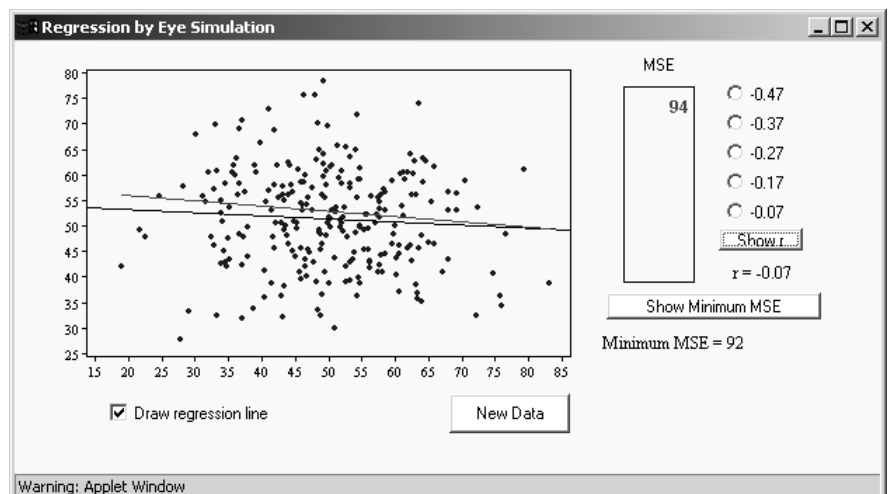


Figure 4

Some Thoughts

One thing that should be clear from this article is that much effort has been spent on developing Java applets for introductory statistics material—clearly this level has by some distance the largest market, so this should not be surprising. However, many of the aforementioned applications essentially repeat the same work. It would be beneficial to the statistical teaching community as a whole if more effort were spent on developing applet-based learning materials for higher-level statistics material. In time, this should happen, especially with the development of toolkits designed to help the construction of statistical/mathematical Java applications.

Crucially, for effective implementation in one's own learning materials, Java applets need to be available for download and installation locally. Internet access and connections, while improving, are still not reliable enough to rely on having tens of students constantly accessing applet repositories halfway around the world. This will mean developers giving their services "for free", but hopefully sharing of resources in this way will be to the benefit of all.

Lists of Applet Sites

The following URLs provide links to lists of Java applet resources. Many of the resources described in this article will be found therein, and there will be a lot of duplication. However, such lists should hopefully update when new resources become available.

- [a] Globally Accessible Statistical Procedures at www.stat.sc.edu/rsrch/gasp/
- [b] Links under "Educational Resources" on Clay Helberg's Statistics on the Web page at www.execpc.com/~helberg/statistics.html
- [c] Webster West has some more applets at www.stat.sc.edu/~west/applets/
- [d] Duke University hosts a list at www.stat.duke.edu/sites/java.html
- [e] Mikael Bonnier has some applets at www.df.lth.se/~mikaelb/java.shtml
- [f] An enormous list can be found at members.aol.com/johnp71/javastat.html
- [g] There is a list based at the University of Tennessee, which can be found at archives.math.utk.edu/topics/statistics.html
- [h] Another list of statistical applets: www.bbns.org/us/math/ap_stats/applets/applets.html
- [i] Last but not least!!! Go to www.ltsn.gla.ac.uk/resources/subject.asp?subject=Interactivity

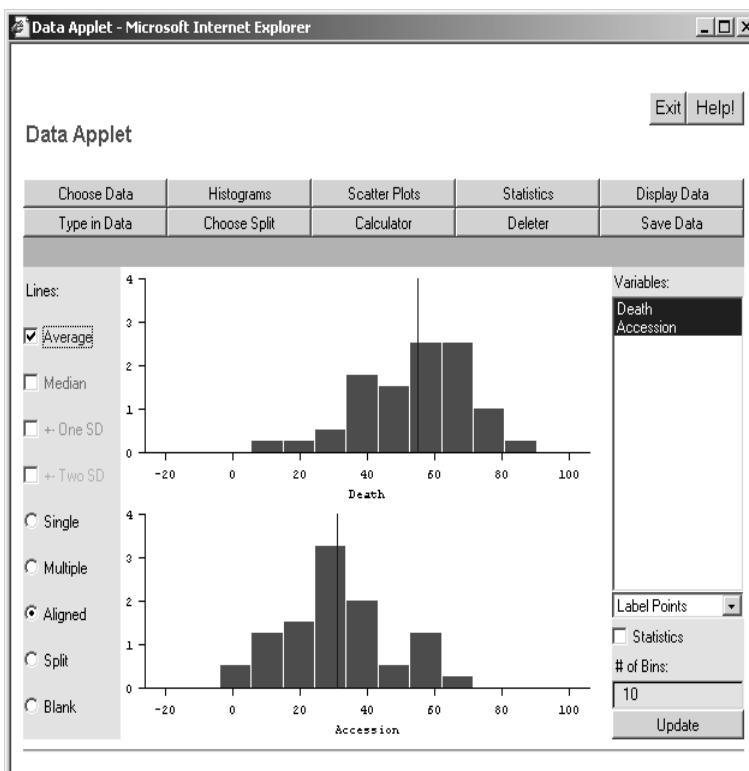


Figure 5

References

- [1] www.livemath.com
- [2] www.insightful.com/products/s+as/
- [3] www.sgcorp.com/statlets.htm
- [4] www.math.uah.edu/psol/applets/index.html
- [5] www.stat.sc.edu/webstat/
- [6] www.keypress.com/sketchpad/java_gsp/index.html
- [7] www.keypress.com/sketchpad/java_gsp/squares.html
- [8] www.ruf.rice.edu/~lane/rvls.html
- [9] neyman.stat.uiuc.edu/~stat100/cuwu/index.html
- [10] www.anu.edu.au/nceph/surfstat/surfstat?home/surfstat.html
- [11] cast.massey.ac.nz/CASTprog/
- [12] www.stat.stanford.edu/~susan/surprise/
- [13] www.aranya.com/resources/java/
- [14] faculty.vassar.edu/lowry/VassarStats.html