

## SOFTWARE REVIEW

StatXact version 6 with Cytel Studio. Cytel Software Corporation, Cambridge, MA, USA, 2004. Academic price: US\$995.

I reviewed StatXact version 5 in 2002 and commended it to biomedical investigators.<sup>1</sup> Version 6 was released in January 2004. It has a number of new features, which I shall discuss. StatXact's originator was Cyrus Mehta. He is supported by a strong team, almost all of whom have published papers in refereed statistical journals.

What exactly are exact tests? I trust that all who read this will know of Fisher's exact test on  $2 \times 2$  tables of frequencies, described in 1935. Few will know of the permutation test on the equality of means, also described by RA Fisher (in 1935–6). Many will know of and will have used rank-order tests, which were first popularized (if not first described) by Wilcoxon in 1945. The dates are important, because all these tests were invented in the pre-computer era. Yet, all depend on intense computation and have become practicable only since computers, and especially personal computers, have become available. I have not explained exactly how exact tests work. They depend on listing all possible permutations of the observed data, within certain constraints, then extracting the permutations in which the statistic of interest is equal to, or exceeds, that observed. These tests are valid under the randomization model of inference.<sup>1,2</sup> This model of inference requires no assumptions except that a sample of convenience is taken and its members are assigned randomly to 'treatments'. This is the normal design of biomedical experiments. Under the population model of inference, random samples are taken from defined populations. This almost never occurs in biomedical experimentation. Yet, most experimenters still analyse their results using tests that are valid only under the population model, such as *t*-tests and ANOVA.

Some of the new features in StatXact version 6 are as follows: (i) extensions of exact tests on  $2 \times 2$  and  $r \times c$  tables of frequencies; (ii) Cytel Studio now provides parametric tests, such as *t*-tests, one- and two-way ANOVA and multiple linear regression (i.e. parametric tests corresponding to some of the exact tests already provided); and (iii) the output of tests is now much more elegant and the output–printer interface is now seamless.

To run StatXact one needs at least 256 Mb RAM, at least 200 Mb hard disk space, Windows 2000, XP or NT and a CD-ROM drive. I enter tabular data directly, but prepare continuous data on a spreadsheet and use DBMS/COPY (DataFlux, Cary, NC, USA) to translate it into the StatXact format.

Those readers who use SPSS (SPSS Inc., Chicago, IL, USA) for their statistical analyses should know that parts of StatXact are licensed to that package as the SPSS Exact module. In addition, the Cytel Software Corporation has developed various exact PROC modules for SAS. I must also mention two features that have been around since StatXact version 3. These are: (i) excellent manuals by Cyrus Mehta and Nitin Patel, which are remarkable for the way in which tests are documented and examples (often biomedical) given; and (ii) within the front cover of each manual is a tabulated recipe book of what is available.

I have found much to praise and little to criticize in StatXact version 6 with Cytel Studio. Readers who think I may be biased should be reassured by an exhaustive, two-part review of statistical software packages that deal in exact tests on categorical data.<sup>3</sup> That review ends with the sentence: 'In conclusion, I still believe that all statisticians and all data analysts and researchers who perform categorical and/or non-parametric statistical analysis, will want to have StatXact'. I again urge clinical and experimental pharmacologists and physiologists to purchase this package.

### REFERENCES

1. Ludbrook J. Software review. *Clin. Exp. Pharmacol. Physiol.* 2002; **29**: 739–40.
2. Kempthorne O. The randomization theory of experimental inference. *J. Am. Stat. Assoc.* 1955; **56**: 946–67.
3. Oster RA. An examination of statistical software packages for categorical data analysis using exact methods: Part II. *Am. Statistician* 2003; **57**: 201–13.

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