

# Review of Teach/Me – Data Analysis

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Teach/Me – Data Analysis is a package published by Springer consisting of a CD-ROM and a printed guide part of which contains material on introductory statistics entitled ‘Data Analysis in a Nutshell’. The material has been developed at the Vienna University of Technology and is co-ordinated by Hans Lohninger. The examples used in the material are all based in fields of science and engineering.

## Lessons

Teach/Me – Data Analysis consists primarily of a number of ‘lessons’ on a wide variety of statistical topics. Each lesson is essentially a page of text that summarises the topic in question. An example of such a page for a one-sample t-test is given in figure 1. For each page links to other related topic are suggested at the top of the screen. In addition there are links within the text. These may be to definitions of terms used such as, for this example, degrees of freedom or to other lessons, in this case linking to the z-test.

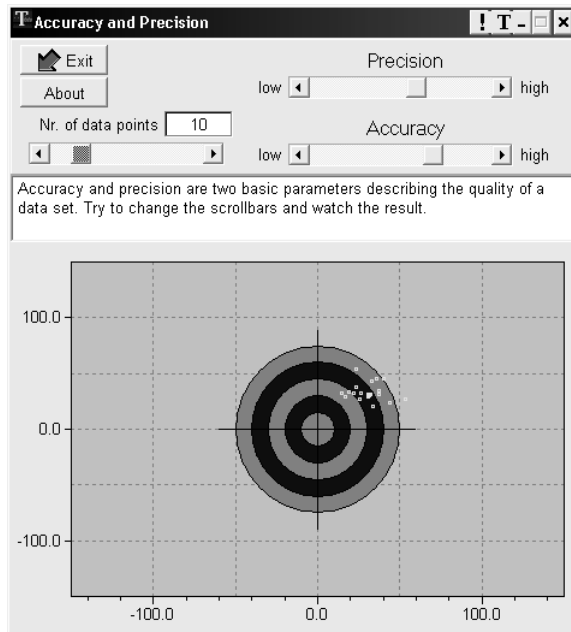
	one-tailed test		two-tailed test
<b>hypothesis</b>	$H_0: \mu_1 \geq \mu_0$ $H_1: \mu_1 < \mu_0$	$H_0: \mu_1 \leq \mu_0$ $H_1: \mu_1 > \mu_0$	$H_0: \mu_1 = \mu_0$ $H_1: \mu_1 \neq \mu_0$
<b>test statistic</b> (t distribution)	$t = \frac{\bar{x} - \mu_0}{s / \sqrt{n}}$		
<b>deg. of freedom</b>	n - 1		
<b>rejection</b>	reject $H_0$ if $t < -t_{\alpha}$	reject $H_0$ if $t > t_{\alpha}$	reject $H_0$ if $ t  > t_{\alpha/2}$

Fig 1 One-sample t-test

Many lessons also contain links to interactive examples or to the DataLab which allows the student to analyse supplied data sets or to input their own data for analysis. There are approximately 60 interactive examples which are designed to help the student understand the concepts and ideas behind a particular method. This may be done by, for example, changing parameters or experimenting with different set-ups.

As an example, an interactive application which illustrates the difference between the concepts of accuracy and precision is illustrated in figure 2. The student can vary the levels of accuracy and precision and observe the effect on the cluster of points on the dartboard.

The DataLab allows the student to gain hands on experience of analysing a set of data using the methods referred to in the lesson. It is possible for the students to use the DataLab to analyse their own set of data. However if they have been referred to the DataLab via a particular lesson then an appropriate set of data is already loaded and additional instructions on how to use the DataLab to obtain the particular analysis in question are given.



**Fig 2 Accuracy and precision illustrated interactively**

### Topics covered

The material was developed at the Vienna University of Technology and has been used there in a course on chemometrics. The statistical content and the examples used therefore are most appropriate for science students. The lessons cover a wide range of topics under the headings:

- Univariate Data Analysis
- Statistical Tests
- Bivariate Data Analysis
- Multivariate Data Analysis

The multivariate methods section includes principal components analysis, cluster analysis and neural networks. The hypothesis testing section covers all the common parametric tests for means and variances, the chi-squared test for testing normality and tests for outliers. There is also a small section on time series that includes lessons on Fourier transforms.

Basic probability and most of the commonly used probability distributions are covered and in addition some lessons are supplied on mathematical topics that back up the statistical material. These are mainly concerned with vectors and matrices.

### Courses

The software includes a Textbook that touches on all the main topics listed above. The contents of the Textbook are shown in figure 3. The main pages of the lessons contained in this electronic textbook are also printed in the manual accompanying the software. In addition there are other, shorter courses readily available on the CD. These range from introductory courses on descriptive statistics to a course on neural networks.

The main selling point on this package however must be the opportunity it gives to lecturers to put together an appropriate subset of the lessons available into a course tailored to their own needs. This course can then be made available to their students via the web.

For example a course on correlation and regression could be put together in this way. Each course will have an index page similar to the one illustrated for the Textbook. Comments and headings can be added to these pages as well as questions that allow the student to control the content of the course to suit their need. For example, the question 'Do you want to include multiple regression?' could be inserted. If the student answers 'no', the material on this topic would then be excluded from the course.

In addition to this the lecturers can also add their own notes to any lesson page thus extending the material provided. These notes could, for example, be additional explanations or suggestions for further study.

**Fig 3 Contents of Textbook**

### Exams

As well as providing the facility to put together appropriate courses that can be made available on the web, the software also allows lecturers to design exams that can be carried out in a network environment.

When the students access the exam they are first asked to register by entering their name and whatever additional information is appropriate. The questions of the exam then appear on the screen and the student enters the answers directly into the forms provided by the Teach/Me examiner. When the exam has been finished, the student's answers are sent to the email address of the lecturer.

Unlike the course designer which uses supplied lessons there are no questions with the package but templates for standard forms of questions are supplied. The forms depend on the type of reply expected from the student which may be text input, numeric values, or multiple choice. The exam designer allows the random selection of questions from a pool of questions. In this way, students can be prevented from cheating since each student gets a unique set of questions from several possible choices.

### Help Facility

There is an extensive help facility describing the functions available in Teach/Me. This includes help on how to use the package to construct courses and exams. Some of these help pages are also reproduced in the accompanying manual.

Overall I often found the help less than informative. It is the usual problem of needing to have a reasonable knowledge of the package before being able to find the appropriate help and make sense of it. As I became more familiar with the structure and purpose of the package the help became more useful. Since the manual is made up of pages from the on screen help it was not really any better.

### Ease of Use

I used the package to put together a set of lessons into a short course. I also experimented with putting together a short exam that included the random selection of questions from a pool of questions.

Initially I turned to the help facility to do this

but found that, though it gave me some idea of what it was possible to do, it did not often help me to work out how to do it. I found neither the course designer nor the exam designer very user friendly. However by a process of trial and error and by studying the courses that were supplied, I was able in a relatively short time to put together both a basic course and a simple exam.

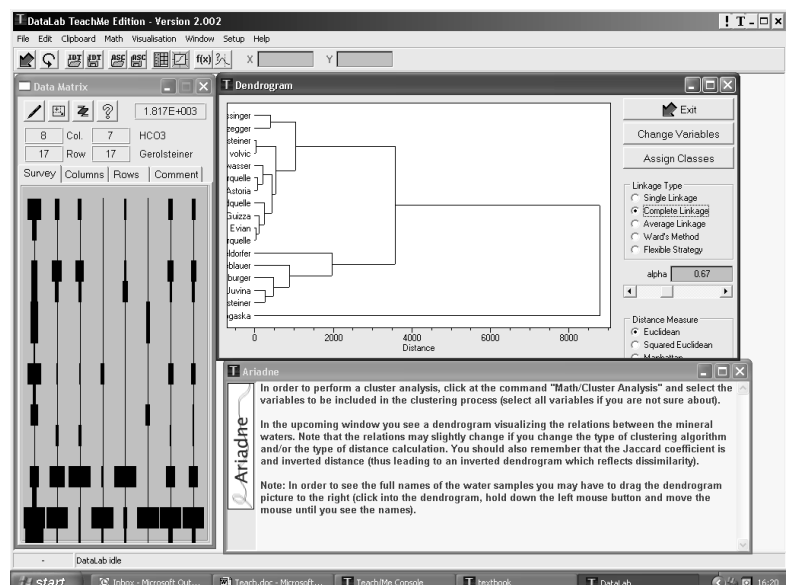
### DataLab

A number of data sets from applications in science are supplied with the software and can be accessed via the DataLab for analysis. Various graphical displays can be obtained and analyses of data, using any of the topics that are covered in the lessons, can be carried out. This includes constructing neural networks.

When the DataLab is accessed via a lesson instructions on how to obtain the particular analysis for a particular data set are given. In these instances I encountered few problems with obtaining the required results. In general however I found the DataLab tricky to use and again found the help facility limited in its usefulness.

There were however some features of the DataLab which could be helpful for teaching. For example, figure 4 shows a dendrogram obtained using the cluster analysis option within the DataLab. By simply clicking on one of the alternative linkage types or distance measures the student can instantly see the different dendrograms that can be obtained and hence compare the results. In regression a similar facility is available to investigate fitting different forms of equation to the data e.g. linear, quadratic, logarithmic.

Fig 4 Dendrogram obtained using cluster analysis



When a data set is entered into the DataLab it is shown in the form of a 'survey plot' which as seen on the left-hand side of figure 4. This is not a form of plot I have encountered previously and a listing of the data would, in my opinion, be more helpful. It is possible to see the actual data by selecting the data editor.

Overall I found the procedures in the DataLab cumbersome. Given the ease of use of most of the widely available statistical packages this aspect of the software was disappointing.

### **Potential Uses of Teach/Me – Data Analysis**

The lessons in Teach/Me–Data Analysis are not sufficient in themselves to teach any of the topics included in the material nor are they designed to be. They are designed to provide back up to teaching partly by using interactive demonstrations which use the power of the computer to help shed light on sometimes difficult concepts.

Some of the interactive demonstrations could be used in lectures to illustrate or elucidate certain points. In addition the lessons could be made available to students to enhance and consolidate the lectures. The basic pages can also serve as a useful summary of the methods and terms used in a given course.

The authors themselves state that

*'Our experience is that Teach/Me may provide substantial support for the teacher in preparing course material, and may also provide some kind of backbone for the learning process. However, the process of learning demands vivid and lively explanations by an excellent teacher, who understands what he or she is talking about. A program like 'Teach/Me may enhance teaching, but will not lead to the substitution of the teacher.'*

The facility to construct computer-based exams must be useful. Although I did not find the help as informative as it might have been, I was still able to put together a sample exam reasonably quickly and without too much difficulty. I did not test the procedures for running the exams from the net but, since most other aspects of the program ran smoothly, I have no reason to doubt that this would work as well.

The material is designed for science students and would generally be of limited use for other students because of the types of examples given. The range of topics covered would make it most useful with more advanced undergraduate students or even post-graduate students in science.

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