Scientific WorkPlace and Scientific Notebook

Reviewed by Barry Murphy
Department of Economics, University of Portsmouth
email: Barry.Murphy@port.ac.uk, WWW: http://www.pbs.port.ac.uk/~murphyb/

Scientific WorkPlace Version 3.0  **and Scientific Notebook** 

System Requirements: Operating Systems: Windows®95, 98 or Windows NT 4.0, minimum of 16 MB of RAM (for Scientific WorkPlace, not specified for Scientific Notebook); Disk Space: Scientific WorkPlace: 55–180 MB; Scientific Notebook: minimal installation–approximately 2 MB, full installation–100 MB; Other: CD-ROM drive; optional internet connection; Publisher: MacKichan Software, Inc., 600 Ericksen, Suite 300, Bainbridge Island, WA 98110, USA, Phone: 1-206-780-2799, Fax: 1-206-780-2857, email: info@mackichan.com, WWW: http://www.mackichan.com/; UK Distribution: Scientific Word Ltd., 49 Queen Street, Peterhead, Aberdeenshire AB42 ITU, United Kingdom, Phone: (0845) 766 0340, +44 (1779) 490500, Fax: +44 (1779) 490600, email: christopher@sciword.demon.co.uk, WWW: http://www.sciword.demon.co.uk/; UK Prices: Scientific WorkPlace: £520 (with 33% educational discount for bona fide academic sites, £345) on CD-ROM; diskettes £25 extra; Scientific Notebook £90, (with 33% educational discount for bona fide academic sites, £60) on CD-ROM; no diskette option for Scientific Notebook. Add £5 carriage and VAT.

Introduction

Scientific WorkPlace 3.0 (*SWP*) provides

- mathematical word processing
- computer algebra–an interface to Maple (Maple V Release 4 Student Edition)
- typesetting–an interface to TeX via LaTeX

TeX is a typesetting system written by Donald E. Knuth, who says in the preface to his book on TeX (Knuth (1984)) that it is “intended for the creation of beautiful books –and especially for books that contain a lot of mathematics”. The ‘X’ stands for the Greek letter Chi, and is pronounced by English-speakers either a bit like the ‘ch’ in ‘loch’ or like ‘k’. It definitely is not pronounced ‘ks’. To clarify matters further, Knuth is pronounced Ka-NOOTH, according to Knuth himself. LaTeX is a TeX macro package, originally written by Leslie Lamport (Lamport (1992)), that provides a document processing system and allows markup to describe the structure of a document so that the user need not think about presentation, and by using document classes and add-on packages can produce the same document in a variety of different layouts. Lamport says that LaTeX “represents a balance between functionality and ease of use”.TeX and LaTeX are widely used in mathematics and science, and are also used specifically in economics (see, for example, Varian (1992), p. xiv and Varian (1999) p. xxiii). Many publishers have developed their own LaTeX styles for journals and books, and insist that authors stick closely to their markup. TeX is free, apparently because Knuth chose to make it so, though many commercial implementations exist. (This paragraph is abstracted from UK TeX User Group FAQ 1999).

Maple V is an interactive computer algebra system that provides a mathematical environment for the manipulation of symbolic algebraic expressions, arbitrary-precision numerics, both two-dimensional and three-dimensional graphics, and programming. The current release, Maple V Release 5.1, features several thousand functions that are used in many scientific and engineering applications and is available for a wide range of computer systems.

In short, *SWP* provides an integrated interface to Maple, and to TeX via LaTeX, and will principally appeal to those who wish to use features of these systems while avoiding technical difficulties or refinements. Scientific Notebook (*SN*) differs from *SWP* principally in that it does not provide the typesetting features of TeX and LaTeX. This is discussed further below. Another product, Scientific Word (*SW*), not reviewed here, differs from *SN* principally in not providing symbolic algebra features. *SW* and *SWP* are available in an earlier version, not reviewed here, for Macintosh.

Features

Computer Algebra

SWP in its earlier versions has been reviewed in relation to economics elsewhere (Shone (1995), Murphy (1996a), (1996b)), and so is only briefly discussed here. Commands can be implemented by toolbars, or by menus, or in many cases by keyboard shortcuts. Text, diagrams, and mathematics can be entered, manipulated and displayed easily. For example:

- differentiation:

$$\frac{d}{dx}\left(\frac{\ln x}{x}\right) = -\frac{-1+\ln x}{x^2}$$

$$\frac{d^2}{dx^2}\left(\frac{\ln x}{x}\right) = \frac{-3+2\ln x}{x^3}$$

$$\frac{d}{dx}\left(\frac{g(x)}{h(x)}\right) = \frac{\frac{\partial g(x)}{\partial x}h(x) - g(x)\frac{\partial h(x)}{\partial x}}{h^2(x)}$$

  for generically defined functions g and h

- partial differentiation:

$$\frac{\partial}{\partial x}(Ax^2y^3) = 2Axy^3$$

$$\frac{\partial^2}{\partial x \partial y}(Ax^2y^3) = 6Axy^2$$

- integration:

$$\int x^2\sqrt{x^3+1}\,dx = \frac{2}{9}\left(\sqrt{(x^3+1)}\right)^3, \int_0^1 x^2\sqrt{x^3+1}\,dx = \frac{4}{9}\sqrt{2} - \frac{2}{9} = 0.406317$$

  to six places of decimals

- matrix algebra: $\left[\begin{pmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{pmatrix}\right]$, determinant: $\cos^2\alpha + \sin^2\alpha$, eigenvalues: $\cos\alpha + \sqrt{(\cos^2\alpha - 1)}, \cos\alpha - \sqrt{(\cos^2\alpha - 1)}$, inverse: $\begin{pmatrix} \frac{\cos\alpha}{\cos^2\alpha+\sin^2\alpha} & \frac{\sin\alpha}{\cos^2\alpha+\sin^2\alpha} \\ -\frac{\sin\alpha}{\cos^2\alpha+\sin^2\alpha} & \frac{\cos\alpha}{\cos^2\alpha+\sin^2\alpha} \end{pmatrix}$

- differential equations:

$$y' = x$$

$$x' = -y$$

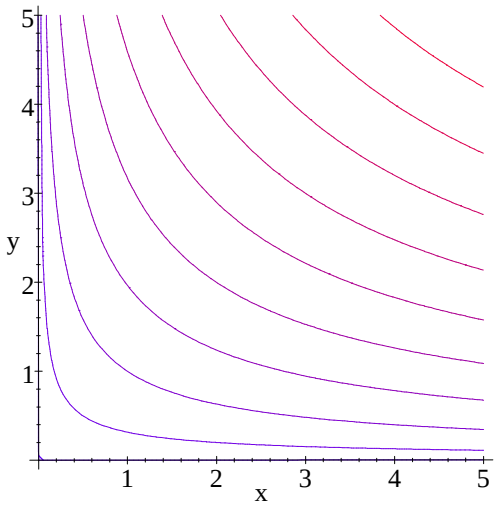
  Exact solution is :

$$y(t) = (\cos t)C_1 + (\sin t)C_2$$
$$x(t) = -(\sin t)C_1 + (\cos t)C_2$$

Laplace solution is :

$$y(t) = y(0)\cos t + x(0)\sin t$$
$$x(t) = x(0)\cos t - y(0)\sin t$$

- plotting:



Contour plot of $x^{\frac{2}{5}}y^{\frac{3}{5}}$

Word Processing

SWP and *SN* format text and mathematics by systematic application of tags within the context of a style. The appearance of a document can therefore be altered by tags, by modifying the appearance of tags within a style, or by generating a new style using a separate style editor. This has advantages and disadvantages: many word processing decisions are taken for the user, but ad hoc alterations to fonts, numbering and justification are not straightforward. The approach is not dissimilar to that of HTML. The quality of screen and printed output is high. It seems most unlikely that this will be approached by commercial implementations of MathML for a long time, and in any case, TeX and LaTeX are very well established.

Typesetting

Perhaps the most individual feature of *SWP* is the distinction between the screen document and the document typeset with LaTeX. At first this seems unappealing, but it is often worth the advantages it brings. In *WYSIWYG* word processors, what you see is sometimes not what you get, especially in mathematics, and, more particularly, sometimes not what you want. In fact the distinction between the screen and printed document is extremely useful, and, combined with the new feature of previewing and printing without typesetting (see below), enables the same document to have independent screen and print existences. This is discussed further below, both generally, and in specific relation to World Wide Web documents.

New Features

There are many new features, only some of which are considered here. Except where otherwise stated these apply both to *SWP* and to *SN*.

Printing and previewing with and without typesetting

First the logical distinction between the screen and print documents is carried a stage further by providing the option of previewing and printing without typesetting (i.e. without using TeX and LaTeX). This change is particularly relevant to *SN* (below), and greatly increases the potential audience for *SWP*/*SN* files. For example the printed version of this document was produced without typesetting. Style (for printing or previewing without typesetting) and typesetting specifications are entirely independent.

Document links, a special form of hypertext linking, provide a navigation system for sets of documents with a logical structure. For example, the Help system has been rewritten as a series of linked documents, and has been greatly extended to include full details of word processing, typesetting, and Maple commands in *SWP*. Both it and the similarly structured Mathematics Reference Library are now very useful.

Other new features

The exam builder has been revised to take account of the new features of the program, and permits on-line tests using radio buttons, check boxes, and other objects. Other new features include data import from certain calculators, computation with physical units, new fonts and graphics filters, use of the system registry rather than an .ini file, and update of the Maple V kernel to Release 4.

Formula objects are now available, as the following example shows. Make, for example, the Maple definition $f = Ax^2y^3$. The following represents the Hessian matrix of f and will update as often as the definition of f is updated (the left-hand side indicates one of the many notations that the Maple processor of *SWP* recognises for second-order partial differentiation).

$$\begin{bmatrix} D_{xx}f & D_{xy}f \\ D_{yx}f & D_{yy}f \end{bmatrix} = \begin{bmatrix} 2Ay^3 & 6Axy^2 \\ 6Axy^2 & 6Ax^2y \end{bmatrix}$$

The extensive applications of formula objects in creating multiple-choice tests with variations across students, and in designing interactive mathematical documents for learning, are clear.

In *SWP* only there is now a Portable LaTeX filter for saving files, which, it is claimed, greatly increases portability of files to other platforms and LaTeX installations. The publisher claims that “about 80% of the LaTeX documents out there can be read without difficulty, 15% can be read after making changes to the file, and 5% are in a form that [that] can’t be dealt with …. These numbers are approximations. Plain TeX documents by definition cannot be opened …. Since plain TeX documents and LaTeX documents are related, it is sometimes possible to place a LaTeX ‘wrapper’ around a plain TeX document and then be able to read the document …. This process must be done by users.”

While I have not experimented greatly with LaTeX refinements I found, for example, that I had little difficulty in including Osborne’s (1999) TeX macros for strategic and extensive-form games in typeset documents (not demonstrated in this review).

The general speed of performance, and the intuitiveness and ease of use of *SWP* has been improved greatly by a large number of other changes, which also apply to *SN*.

World Wide Web

Reference was made above to hypertext linking in the context of structured documents. In fact, the programs can open their own hypertext links to other *SWP* and *SN* files on the World Wide Web. Such files are read-only files; when saved locally, the user can work with the information and perform computations on the mathematics they contain. Hypertext links to HTML files via Netscape Navigator or Microsoft Internet Explorer are also implemented. In fact the on-line *SWP*/*SN* file for this review of *SWP* and *SN* (see

end) is full of clickable links to other parts of the review, and to *SWP*/*SN* files and HTML files elsewhere on the internet, without affecting the print appearance.

A free viewer for *SN* is available for download from the distributor. This enables *SWP*/*SN* files to be viewed and printed, though it does not permit files to be saved or access to Maple V. The viewer is therefore an alternative to Adobe System's Portable Document Format (PDF) files for communicating mathematics on the internet, and *SN* itself seems preferable to PDF.

Printing and previewing without typesetting

HTML and its extensions simply do not permit easy production of interactive on-line mathematical documents with text, equations, and graphics. A general alternative is to use other software, either as a helper application within a HTML browser or directly as a viewer. Because of the new features *SWP* and *SN* are very suitable for this task.

Until now the easiest way to generate such documents was by using MathSoft Inc.'s Mathcad (current version Mathcad 2000), with document preparation using Mathcad and document browsing using the free browser, Mathcad Explorer, which is available for download. Despite Mathcad's many advantages it has considerable limitations (Murphy (1996c), (1996d), (1996e), and (1996f)), and in particular it is inconvenient to design documents which are easy to read both on screen and in print.

I have developed a fully interactive and comprehensive on-line lecture course in intermediate microeconomics using Mathcad (Murphy (1999a)). For comparative purposes, a few of these files have been recreated as *SWP*/*SN* documents (Murphy (1999b)).

Limitations

The main limitations are as follows. The programs can open ANSI and ASCII text files, Rich Text Format (RTF) files, and many if not most LaTeX files, as well as its own SW/*SN* files, but no others. Output formats are even more restricted: apart from special formats relating to preparing files for email transmission and exam builder files, *SWP* can only save in *SWP*/*SN* format and in Portable LaTeX format. *SN* can only save in *SWP*/*SN* format. So neither program can save in text, RTF, or HTML formats, the latter despite the fact that basic *SWP*/*SN* markup has structural similarities with HTML. This is presumably a strategic decision by the publisher, and of course exactly the same is true of PDF files. Work-arounds can be found on the internet for converting from LaTeX to HTML or to text, but this is a mild nuisance.

Despite certain facilities, the programs provide no competition for dedicated optimisation software, or statistical or econometrics packages. To solve anything other than fairly trivial linear or non-linear programming problems numerically, or to perform any more than routine curve-fitting or data analysis is impossible or excessively laborious. A facility is provided to pass Maple V commands directly to the Maple V engine, and to access user-defined functions written in the Maple language, but Maple users will, presumably, usually prefer to develop their own Maple files. While graphics output is adequate it is inferior to that provided by Maple (e.g. for two-variable linear programs), and no legend or annotation facilities are provided. *SWP* and *SN* do not permit programming.

The most serious limitation of *SWP* and *SN* relates to their use as a facility for on-line interactive mathematical documents. Documents with graphs, especially documents depending on defined parameters, will often cause the programs to crash if printing or previewing (even without typesetting) is attempted. A work-around is to generate a snapshot of the graph for particular parameters and to replace the interactive graph with it, providing a link to the interactive graph, and warning the user not to attempt to print the latter. This is a serious imperfection in a system designed for on-line mathematics, and should be addressed as a priority by the publisher.

Conclusions

Scientific WorkPlace and Scientific Notebook are to be warmly welcomed. Scientific Notebook, in particular, is very good value, and should be considered by all students who take courses with a mathematical component. It should also be useful for teachers who wish to present mathematical documents in lectures and seminars with the flexibility to adjust presentation in response to questions. It now seems the best easy way to generate interactive mathematical documents on the World Wide Web. Scientific WorkPlace meets the additional need of providing TeX and LaTeX to enable high-quality preparation of books and papers.

References

Judge, Guy, and Barry Murphy, "Interactive Economics on the Web", presented at the Computing in Economics Sessions of the Allied Social Science Associations meeting in Chicago in January 1998 (report in Computers in Higher Education Economics Review (CHEER) Volume 12, Issue 1, 1998, and also on-line at http://www.ilrt.bris.ac.uk/ctiecon/cheer/ch12_1/ch12_1p31.htm (abstract only)), 1998

Knuth, Donald, The TeXbook, Addison-Wesley, 1984

Lamport, Leslie, LaTeX, a Document Preparation System, second edition, Addison Wesley, 1994

Barry Murphy, Mathcad 6 Resource Site in Intermediate Microeconomics, http://www.pbs.port.ac.uk/~murphyb/ and http://www.pbs.port.ac.uk/~murphyb/mcad/resource.mcd, 1999

Barry Murphy, Sample Scientific Notebook Resources, http://www.pbs.port.ac.uk/~murphyb/ and http://www.pbs.port.ac.uk/~murphyb/tex/prefs.tex, 1999

Barry Murphy, "Examples of Scientific WorkPlace 2.01 in Use", Computers in Higher Education Economics Review (CHEER), Volume 10, Issue 1, 1996a

Barry Murphy, "Scientific WorkPlace 2.5", Computers in Higher Education Economics Review (CHEER), Volume 10, Issue 2, 1996b

Barry Murphy, "Student Editions of Mathcad and Maple", Computers in Higher Education Economics Review (CHEER), Volume 10, Issue 3, pp. 28-31, 1996c

Barry Murphy, "Mathcad 6.0", Computers in Higher Education Economics Review (CHEER), Volume 10, Issue 2, pp. 20-23, 1996d

Barry Murphy, "Scientific Workplace 2.5", Computers in Higher Education Economics Review (CHEER), Volume 10, Issue 2, pp. 24-27, 1996e

Barry Murphy, "Mathcad Plus 5.0: A Review", Economic Journal, Vol. 106, No. 437, pp. 1115-1122, 1996f

Osborne, Martin J., "LaTeX style files for articles and games (strategic and extensive)", http://www.chass.utoronto.ca/~osborne/latex/STYLES.HTM, 1999

Shone, Ronald, "Scientific Word and Scientific WorkPlace", Economic Journal, Volume 105, No. 433, November, 1995

UK TeX User Group FAQ http://www.tex.ac.uk/cgi-bin/texfaq2html, 1999

Varian, Hal R., Microeconomic Analysis, third edition, W.W. Norton & Company, 1992

Varian, Hal R., Intermediate Microeconomics: A Modern Approach, fifth edition, W.W. Norton & Company, 1999

Note

This review is available on-line as follows:

- PDF file: http://www.pbs.port.ac.uk/~murphyb/pdf/swpsn.pdf
- SWP/SN file: http://www.pbs.port.ac.uk/~murphyb/tex/swpsn.tex
- Portable LaTeX .tex file: http://www.pbs.port.ac.uk/~murphyb/tex/swpsnla.tex
- DVI file: http://www.pbs.port.ac.uk/murphyb/tex/swpsnla.dvi