learning LaTeX

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Library of Congress Cataloging-in-Publication Data

Griffiths, D. F. (David Francis)
Learning LATEX / David F. Griffiths, Desmond J. Higham.
p. cm.
Includes bibliographical references and index.
ISBN 0-89871-383-8 (pbk.)
1. LaTeX (Computer file) 2. Computerized typesetting.
3. Mathematics printing--Data processing. I. Higham, D. J.
(Desmond J.) II. Title.
Z253.4.L38G75 1996
686.2'2544536--dc20 96-43340

learning LATEX

To Anne and Catherine

Preface

In this book you will find a brief introduction to the LaTeX system for typesetting documents. LaTeX, usually pronounced “lay-teck”, is widely used throughout the sciences and is available, free of charge, for almost any computer. We describe version LaTeX 2_ε, usually pronounced “lay-teck two-ee”, which has superseded the older version, commonly referred to as LaTeX 2.09.

Because of its popularity, every year a new batch of students and researchers want to pick up the rudiments of LaTeX. Although many books about LaTeX have been written, we feel that there is a niche for a short, lively introduction that covers the essential material while avoiding unnecessary detail. (In practice, most LaTeX users get by with a small vocabulary of commands.)

This book is aimed squarely at LaTeX beginners who wish to learn the basics with a minimum of fuss. We see our target audience falling into two main groups: students faced with the prospect of producing a report or thesis for the first time, and more experienced users of older typesetting systems like `troff` who have long planned to learn LaTeX. Various incarnations of this book have been used in undergraduate and postgraduate classes at the University of Dundee, and we have found the treatment to be suitable for a short course on mathematical typesetting with LaTeX (typically two hours of lectures and three hours of supervised computer laboratories).

We firmly believe that the best way to teach LaTeX is by example. Hence, a large part of the book consists of “before and after” illustrations showing the effect of LaTeX commands.

The book is organized as follows. Chapter 1 lists possible motivations for learning LaTeX, introduces the key high-level concepts, and points to other resources that are available.

Chapter 2 deals with common low-level formatting commands and Chapter 3 covers mathematical typesetting. Essential high-level commands are introduced in Chapter 4, which also gives tips on troubleshooting. In Chapter 5, more advanced issues are treated, including the use of packages.

Appendix A outlines how LaTeX’s current version, LaTeX 2_ε, differs from the older version, LaTeX 2.09. Examples of complete LaTeX documents are provided in Appendix B and Appendix C, and the production of slides is treated in Appendix D. Finally, Appendix E lists some LaTeX-related Internet sites.

This book was prepared when both authors were at the University of Dundee. We thank the UNIX administrators Nick Dawes, Colin Macleod, and Brian Russell for their technical support. David Carlisle, Penny Davies, and Larry Shampine commented on an almost-final version of the book, and numerous students provided feedback on the material. Nick Higham gave expert advice on many of the issues that we faced and scrutinized several versions of the manuscript (on the implicit understanding that we would refer to [4]).

Finally, we acknowledge the efforts of all those who have helped to make LaTeX such a valuable tool for the scientific community, especially Donald Knuth [5], Leslie Lamport [6], and the team members involved in the LaTeX3 Project.

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Chapter 1

Preamble

1.1 Should You Be Reading This Book?

Most readers of this book will have already heard something about LaTeX. Perhaps a friend or colleague recommended it to you, or maybe your professor advised you to learn about it. LaTeX is a computer typesetting system that specializes in producing mathematically oriented documents. It provides transparent access to the time-honored craft of mathematical typesetting and can be used to produce a range of documents, including class handouts, reports, letters, overhead transparencies, theses, journal articles, and books.

We have written this book for LaTeX beginners and have strived to present a palatable and readable introduction with a minimum of fuss and detail. The only prerequisite is a certain amount of computing experience. You should know how to produce ASCII files with an editor, and you should have the LaTeX package available. (Information about where to obtain LaTeX software over the Internet can be found on page 70.) To appreciate the basic idea of controlling the output with a sequence of commands, knowledge of at least one programming language would be helpful.

In the interest of brevity and clarity, some of the things we say about LaTeX are slightly incomplete and a vast amount is left unsaid. We hope that this book will build your expertise to the extent that, on those occasions when you need to know more, you feel confident enough to consult one of the comprehensive references (see §1.4).

We describe the current version of LaTeX, that is, LaTeX 2_{ε}. In Appendix A we discuss how this differs from the older version, LaTeX 2.09.

1.2 Motivation

There are several good reasons for learning LaTeX.

- Mathematical formulas can be produced quite easily. TeX [5], the program underneath LaTeX, incorporates a great deal of knowledge about formatting mathematics and hence your documents will look polished.

- Equations, citations, figures, tables, etc. can be labeled, so that cross-referencing is automated.

- LaTeX is installed at many universities and research institutions and can be run on PCs, workstations, and mainframe computers. The program, plus many add-on enhancements written by enthusiasts throughout the world, is freely available over the Internet.

- The `tex` files have the standard ASCII format, and hence they can be produced using your favorite text editor and e-mailed to your friends and colleagues.

- The `dvi` files produced by the system can be sent to a variety of output devices, including the computer screen and virtually all types of printers.

- LaTeX skills are useful if you are pursuing an academic career. Many journals now encourage authors to submit manuscripts electronically using LaTeX (or similar systems such as TeX and AMS-TeX).

LaTeX is not a WYSIWYG (What You See Is What You Get) system. Hence it lacks the obvious attraction of a real-time display of the formatted output. However, the alternative *logical design* approach of LaTeX offers advantages for most scientific authors. Scientific documents contain structures such as sections, subsections, computer program listings, theorems, and mathematical variables. LaTeX forces you to think in terms of these structures, rather than concentrating on the appearance of the final product. In other words, your creative efforts are focused on content rather than style. After creating the document, you can completely alter its appearance by changing a small number of formatting commands. For example, it is a simple matter to change the size of the typeface or to move from one to two columns per page.

A word of warning is in order. LaTeX makes it possible to produce an impressive-looking document that is riddled with mistakes and inconsistencies. Hence, you should not be deceived by the æsthetics of the output. When you write a scientific document, your main concern should be to present your ideas clearly and correctly. LaTeX has been designed to relieve you of the burden of typesetting so that you can concentrate on the substance. If you wish to learn more about *writing* in the mathematical sciences then we recommend [4], which covers a range of topics, including choosing notation, formatting equations, English usage, punctuation, revising a draft, writing slides for a talk, and publishing a paper. It also discusses computing aids such as filters, pipes, and spellcheckers.

1.3 Running LaTeX

The precise details of how to run LaTeX depend upon the type of computer that you are using. Your local system administrator (or, if you installed the program yourself, the accompanying documentation) should tell you what commands to use. However, the general approach is common to all versions—you must create a file with a **tex** extension, let us call it **first.tex**. This file contains the text of your document, interspersed with commands that tell LaTeX how it is to be formatted. The contents of the file **first.tex** do not depend on your computer system—the same file is valid for all systems. On most systems, the command to run LaTeX on **first.tex** is

```
latex first.tex
```

and this produces the file **first.dvi**. The extension **dvi** stands for *device independent*. This file can be understood by any one of several output devices, in particular it can be displayed on screen or sent to a printer. In addition to **first.dvi**, files with extensions **aux** and **log** are created. (Other files with extensions such as **toc**, **idx**, and **bbl**, may also be generated.)

There are two general points to note. First, to save paper and money, you should always check that the output is correct before printing by displaying it on the screen. This is called *previewing*. Second, the **dvi** file (and the corresponding **ps** file if you have converted from **dvi** to PostScript®) can be very large, taking up a lot of disk space. Hence, it is good practice to delete such files (but not, of course, your **tex** file) as soon as you have made use of them—they can be regenerated from the **tex** files if necessary.

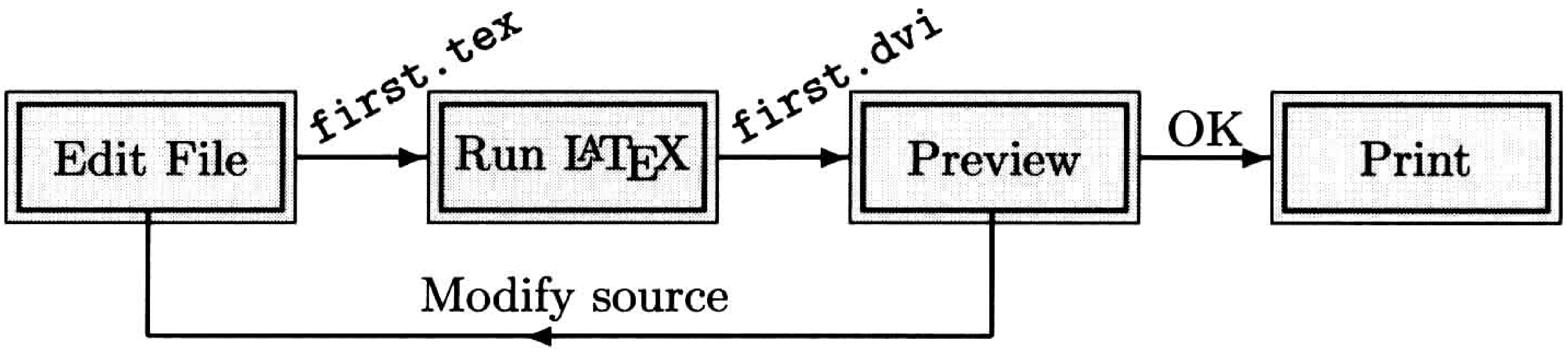

Figure 1.1: The usual sequence of commands for generating a LaTeX document.

1.4 Resources

The authoritative LaTeX references are [3, 6]. Lamport's book [6] is a comprehensive manual; the first few chapters give a detailed, but relatively gentle, introduction and the latter part constitutes a complete technical specification. The encyclopedic [3] is packed with information about LaTeX and the many packages that are available for its customization and extension. Anyone who uses LaTeX regularly should have access to [3] or [6].

Many other guides to LaTeX have been written. To date, only a small fraction of these apply to the current version, LaTeX 2_{ε}, although this will undoubtedly change in the future. It is our belief that, after mastering the fundamentals of LaTeX outlined in this book, the interested reader will be sufficiently well equipped to pass directly to [3] or [6], without the use of any "intermediate" guides.

By far the most valuable resource is a friend, colleague, or teacher who is skilled in LaTeX. Seeking advice from fellow humans and studying chunks of relevant LaTeX will help greatly in your ascent of the learning curve.

A third source of information is the Internet. Some details of what is available and how it may be accessed are given in Appendix E.

Chapter 2

Basic LaTeX

2.1 Sample Document and Key Concepts

We begin with an example. Illustrated on the next page is a LaTeX document generated from the source file `example.tex`. The contents of the file are reproduced on the left and the box on the right shows the output produced when the file is run through LaTeX and displayed. We follow this convention throughout the book: raw LaTeX on the left, output on the right. Of course, rather than appearing in a little box, your output will be formatted in full-size pages.

If you glance through the raw LaTeX on the left of the next page (and at this stage you shouldn't look too carefully at the details) you will see various extra words preceded by the "backslash" character "\" such as `\begin{equation}` and `\end{equation}`, and special characters like `$`, `^`, and `_`. These tell LaTeX how to format the document. LaTeX knows a large number of formatting commands, but we hope to make it clear in this book that most situations can be handled with a relatively small subset.

You will also notice the lines

```
\documentclass{article}

\begin{document}
```

at the beginning of the file and

```
\end{document}
```

at the end. Lines like these must appear in every LaTeX document; their use is discussed in §4.1. The rest of the examples in the book are to be regarded as small chunks of LaTeX that live inside a complete document, and hence they will not include these commands. Extra commands are sometimes placed between `\documentclass` and `\begin{document}`; this part of the document is known as the *preamble* (see Figure 4.1, page 37).

```
\documentclass{article}

\begin{document}

This is a short document
to illustrate the basic use of
\LaTeX.

Simply leave a blank line to
get a new paragraph;
indentation is automatic.

Mathematical expressions
such as $y = 3 \sin x$
are obtained with dollar signs.
Equations can be displayed,
as in
\[
  y = 3 \sin x.
\]
Numbered equations are also
possible:
\begin{equation}\label{equa}
  y = 3 \sin x.
\end{equation}
Because we have labeled this
equation we can refer to it
without having to know its
number.  Thus, the preceding
equation was
number~(\ref{equa}).

Powers (superscripts), as in $x^2$,
are obtained with \verb"^";
more complicated powers must live
in curly braces: $x^{2+\alpha}$.

Likewise, subscripts are obtained
with the underscore: $y_3$ or
$y_{n+1}$.

We can get both with
$x_{n+1}^{2+\alpha}$.

\end{document}
```

This is a short document to illustrate the basic use of LaTeX.

Simply leave a blank line to get a new paragraph; indentation is automatic.

Mathematical expressions such as $y = 3\sin x$ are obtained with dollar signs. Equations can be displayed, as in

$$y = 3\sin x.$$

Numbered equations are also possible:

$$y = 3\sin x. \tag{2.1}$$

Because we have labeled this equation we can refer to it without having to know its number. Thus, the preceding equation was number (2.1).

Powers (superscripts), as in x^2, are obtained with ^; more complicated powers must live in curly braces: $x^{2+\alpha}$.

Likewise, subscripts are obtained with the underscore: y_3 or y_{n+1}.

We can get both with $x_{n+1}^{2+\alpha}$.

LaTeX generally regards groups of characters separated by spaces as *words*; a "newline" generated by the Return (or Enter) key is also thought of as a space. The number of spaces between words is immaterial—the output will look the same with 1 or 20. Also, since a single "newline" character is treated as an interword space, it doesn't matter where newlines occur in the file; LaTeX will make up its own mind about how to break a paragraph into lines, hyphenating words if necessary to produce neat output.

A blank line—or any number of blank lines together—signifies the end of a paragraph. Judicious use of blank lines and spaces makes your `tex` file much easier for others to read and understand. A paragraph is automatically indented by LaTeX, except when it is the first in a section. If you want to override this feature, insert the `\noindent` command at the start of the new paragraph.

The following characters have a special meaning in LaTeX:

```
\   &   $   %   ~   _   {  }   #   ^
```

When you want one of these characters to appear in the output, most of them can be generated by preceding the character with a backslash.

```
The special characters \&, \$,
\%, \_, \{, \}, and \# may be
printed by preceding each with
a backslash. We can then put
text in \{curly braces\}.
```

The special characters &, $, %, _, {, }, and # may be printed by preceding each with a backslash. We can then put text in {curly braces}.

If a `%` sign is included in a line without being preceded by a backslash, the remainder of the line is ignored. This provides a mechanism for inserting comments into the LaTeX file. Look at the next example carefully and compare the input with the output.

```
It is likely that 50\% of the time
you will be frustrated because you
forgot to precede the % symbol by
a backslash.
```

It is likely that 50% of the time you will be frustrated because you forgot to precede the a backslash.

The special characters (and ordinary characters, too) can also be displayed in a typewriter font using the `\verb` command. For example, `\verb"%~and\"` produces `%~and\`. The character immediately following `\verb`, in this case `"`, acts as the opening delimiter—everything will be printed out "verbatim" up to the next occurrence of that character. The text between the delimiters should not be broken across lines in the source file. For this reason `\verb` is suitable only for short bursts of verbatim output.

2.2 Type Style

For variation and emphasis, the style of the type can be altered. More precisely, you can control the *shape*, *series*, and *family* of the type. There are four shapes

```
\textup{Upright type}
\textit{Italic type}
\textsl{Slanted type}
\textsc{Small caps type}
```

Upright type *Italic type* *Slanted type*
SMALL CAPS TYPE

and two series

```
\textmd{Medium} \textbf{Boldface}
```

Medium **Boldface**

and three families

```
\textrm{Roman} \textsf{Sans serif}
\texttt{Typewriter}
```

Roman Sans serif `Typewriter`

Note that the text whose type is to be changed is enclosed in curly braces after the command. You can combine the three features, as in

```
\textsl{Don't \textbf{overuse}
            type-changing.}
\textsf{It \textit{annoys} the
               \textsc{reader}.}
\texttt{And loses \textsl{impact}.}
```

Don't ***overuse*** *type-changing.* It *annoys* the READER. `And loses` *`impact`*`.`

In addition, LaTeX has the `\emph` command that causes the enclosed text to be emphasized. So `\emph{important}` becomes *important*. The particular effect produced by `\emph` depends on the type in current use.

```
\textsc{Pile on \emph{lots}
        of subtlety.}
\textsf{Sans serif adds a little
       \emph{je ne sais rien}.}
\textsl{Nouns should \emph{never}
        be verbed.}
```

PILE ON *lots* OF SUBTLETY. Sans serif adds a little *je ne sais rien*. *Nouns should* never *be verbed.*

Characters of different sizes are sometimes needed for titles, headings, etc. The default size is 10 points, a point being a printing term for approximately 1/72 of an inch. To produce an entire document in a different type size, the `11pt` or `12pt` options can be specified with `\documentclass`, as discussed in §4.1. The declarations

```
\Huge \huge \LARGE \Large \large \normalsize
\small \footnotesize \scriptsize \tiny
```

can be used to change the size selectively. These declarations, and the words to which they apply, are enclosed in curly braces to limit their scope. A space separates the command from the text.