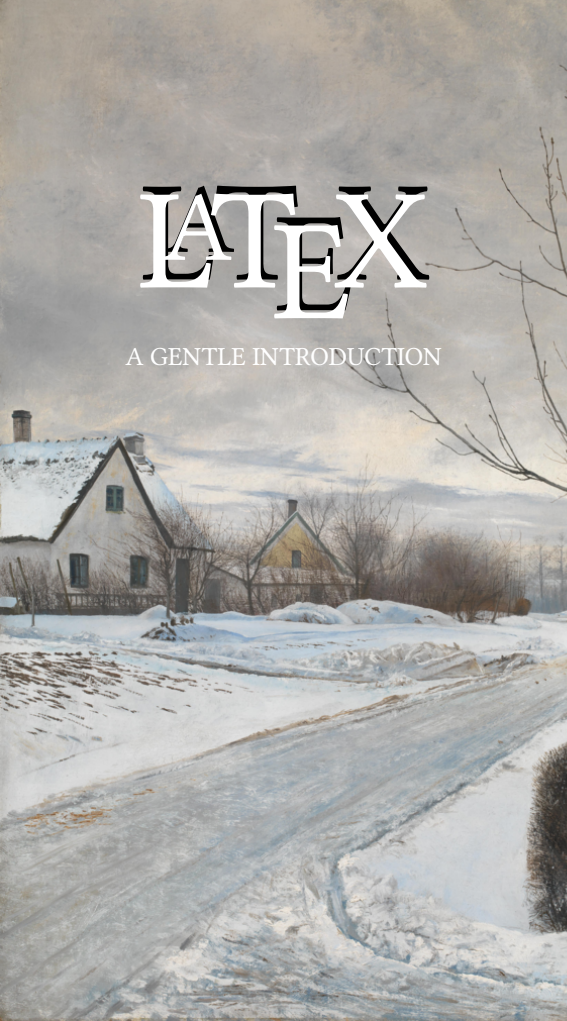
LaTeX

A GENTLE INTRODUCTION



LaTeX—A Gentle Introduction

CV Radhakrishnan

(English: tech. notes)

The electronic versions were generated from sources marked up in LaTeX in a computer running GNU/LINUX operating system. PDF was typeset using XeLaTeX from TeXLive 2020. The base font used was Linux Libertine developed by Philipp H. Poll.

Cover: Road in the Village of Baldersbrønded, a painting by L. A. Ring (1854–1933). The image is taken from Wikimedia Commons and is gratefully acknowledged.

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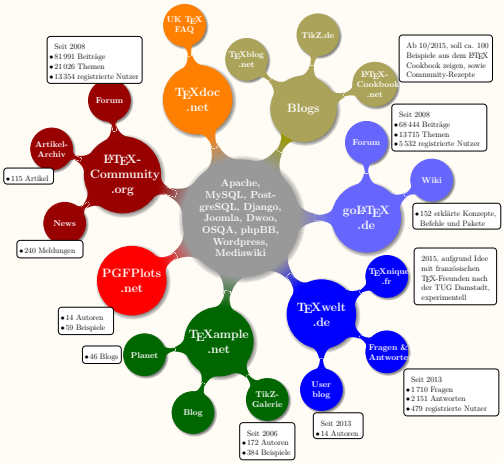
Contents

LaTeX—A Gentle Introduction for the Impatient

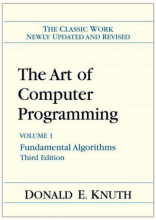


A mind-map diagram created with TEX.

1 Introduction

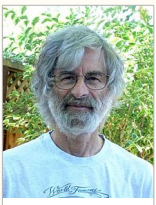
Don Knuth

TEX is a markup based, classic typesetting system, developed by Prof. Donald Knuth of Stanford University in early eighties of twentieth century. He started developing the TEX system when he was frustrated with the poor typographical quality and aesthetics of the galley proofs of his monumental volumes, *The Art of Computer Programming*, provided by his publisher. His intention was to write a system to create the best typeset books in the world. Indeed, he succeeded in this mission with the release of the final bug free version of TEX in 1984 which he began to work nearly a decade ago.



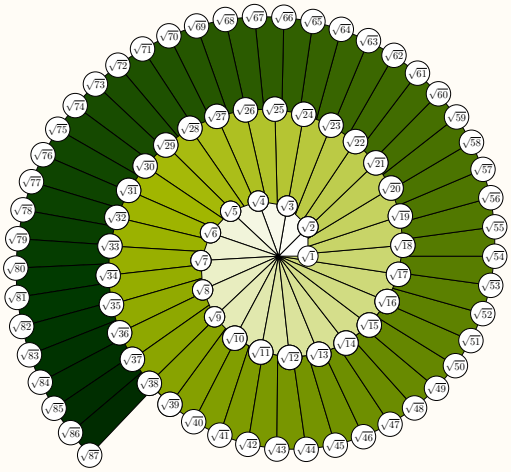
TEX is a free software, maybe the earliest of the kind published even before the advent of Free Software Foundation. The *free software* means that any user can use, study, modify, copy and distribute the program at ones will. It is also available for free without paying any money. And therefore, thousands of academics around the world started using TEX system, suggested improvements and modified the system, developed supporting libraries, often called packages in TEX's parlance, added more and more free fonts, extended the system to different operating systems and computer systems, extended TEX to accept Unicode input, non-Latin scripts, and in short became the supreme typesetting engine of choice of academics.

2 What is LaTeX



L. Lamport

TEX is the name of the system and also the name of compiler (or the program) that does the typesetting job. TEX also has a powerful, highly programmable macro language that can simulate any mainstream language. Knuth used TEX's native primitive commands coupled with quite a few functions he wrote to typeset his book series. This combination of macros and native commands is called *plain format*. The macros are not generic in nature, meaning, one has to write one's own functions to typeset own content. To circumvent this problem, Leslie Lamport developed a set of macro libraries with which he defined all the functions needed to typeset content, be it book, article, letter, report and the like. This is called LaTeX. TEX and LaTeX are often used synonymously, but be informed that this different does exist.



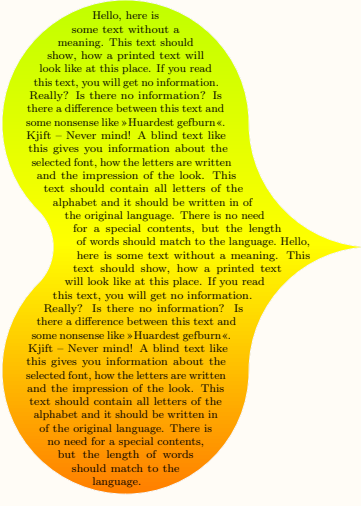
A helix diagram.

The academics around the world do use LaTeX when they say that they use TEX. Thousands of supporting macro libraries were written by informed users around the world and distributed for free among users. Thus the system has now grown to roughly seven Gigs of software if you want to have a complete installation of TEX typesetting system. Such is the vibrant nature of the system and the community of users as well.

3 Why LaTeX?

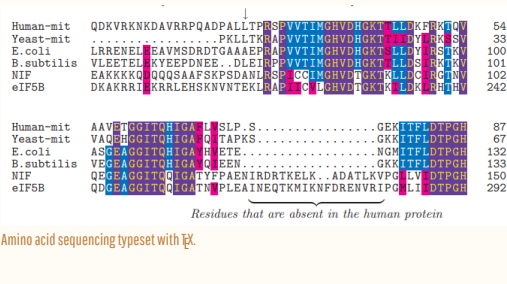
The users might be perplexed to think why we should we go to a four decade old typesetting system to process present day documents when we have modern graphical driven word processors and typesetting systems? There are several reasons for the same. First, let us see the historical reasons.

- TeX was developed by an academic for academics, hence, the system understands what an academic or researcher is looking forward to.
- LaTeX has become the *de facto* standard of math and technical communication in the academic world. So, also, the word processors and frameworks like Wikipedia have accepted LaTeX format as the default format for encoding mathematics in their systems.



Text within a shape.

- More than 36 years have passed since the development of TeX system, but it is going strong without any challenge in the academic world, needless to say, it is highly preferred among technical authors.
- The longevity of documents marked up in LaTeX is remarkable. All documents that were written in the early days of TeX, *i.e.*, three-four decades ago, still generate exactly the same output as that produced thirty-forty years ago which is something unheard of in modern day systems that are hardly backward compatible even across consecutive versions.
- TeX provides guaranteed backward compatibility. *The TeXBook* which is the manual written by Donald Knuth in early eighties, the sources of which are publicly available, still generated the very same book with modern day TeX systems.



Amino acid sequencing typeset with TeX.

4 Semantic reasons

It separates the content and format unlike other WYSIWYG systems. For instance see the following source of a document:

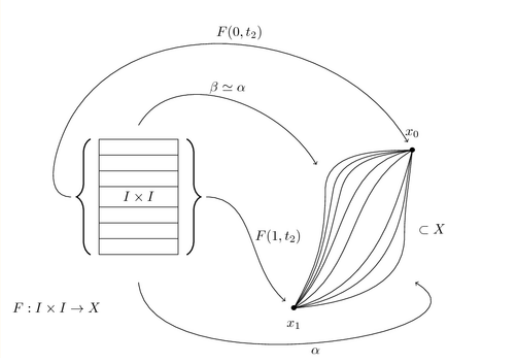
```
\head{Historical reasons}
\begin{itemize}
\item Developed by Donald Knuth, an academic.
\item Developed to typeset his own books,
 notably, \emph{The Art of Computer
 Programming}.
\end{itemize}
```

which would create an output as shown below:

> Historical reasons
>
> - Developed by Donald Knuth, an academic.
> - Developed to typeset his own books, notably, *The Art of Computer Programming*.

It may be noted that formatting of text is done by simple instructions like `\emph`, `\item`, `\head`, . . ., which unlike in the WYSIWYG applications are not chosen from the menu, instead, it is written to the text along with content. The formatting of those elements can uniformly be changed throughout the document if the definition for the instruction is changed at one place which is the biggest advantage of keeping content and format separated.

The separation of format and content allows the author to concentrate on the content without breaking the train of thought and without losing himself within the intricacies of the format of the content which often happens with WYSIWYG applications.



A homotopy diagram created with TEX.

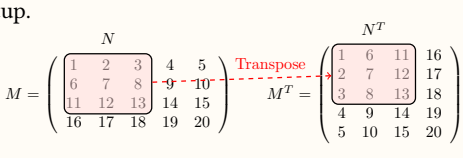
Since the format is driven by separate style libraries, it is difficult to mess around the content and output.

LATEX allows for logical division of the content — books into parts, parts into chapters, chapters into sections, sections into subsections, so on and so forth. This helps to build up the content in the most logical and well structured order which provides extra control.

5 Technical reasons

Unlike word processors, the source file of a TEX document is simple text format making it more susceptible to any file corruption and is also light weight allowing easy transport across networks.

Various numbered objects in the document like section, figure, table, equation, theorem and the like are not numbered in the document. A section will simply be marked up as `\section{...}`, the number is serially computed and added to the heading by TEX during output creation. This allows author the freedom to move around the object in future if needed and also remove or insert an object at any location without bothering the tedious task of re-numbering the objects as in the conventional word-processing setup.



A matrix diagram.

LATEX has an excellent cross referencing system which will seldom let the user down. Each object that needs to be referred to is denoted by a *key* with the markup `\label{<key>}` which in turn will be recalled with the help of another markup, `\ref{<key>}` which will faithfully typeset the number of the object referred to. The user need not be worried in case any intervening objects are removed or inserted, the newly recomputed number will be correctly referred to. This saves a lot of time, drudgery and clumsiness and at the same time enhances the accuracy of the document remarkably with disproportionately less effort.

Usually, separate files are used for each chapter (or an appropriate logical chunk of text) in LATEX. It makes housekeeping simpler, interchange of chapters at a later stage if needed becomes painless, meaning, several nifty gritty points that would have bothered otherwise are taken care of by TEX.

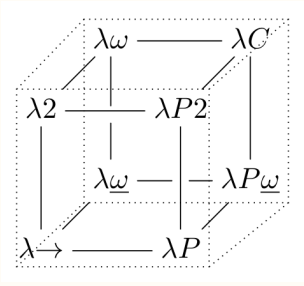
LATEX has the remarkable ability to typeset mathematics and adheres to the conventions of math typography without any extra effort. See for example,

```
$a+b$  and $+a$
```

You will see that in the first case, $+$ is considered as an operator, leaving operator space around the symbol while in the latter, $+$ is considered as a sign leaving no operator space between $+$ and a.

$a + b$ and $+a$

Some of the math constructs cannot be done as easily as in TEX in any other systems. For example:

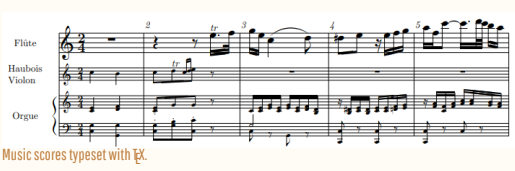


TEX directly writes out PDF documents, thereby saving investments on proprietary software to generate PDF. It can also dynamically create bookmarks, hyperlinks, standards compliant PDFs, different kinds of PDFs from the same source as in the case of this document which you are reading now.

LATEX can automatically generate table of contents, list of tables, figures and other objects, multiple indices, glossaries, sorted bibliographic listing, etc., without any errors or omissions.

It further allows to translate the content to other markup formats like XML, HTML, Media-Wiki, Markdown and the like seamlessly.

Contrary to popular belief that TEX is useful to typeset only mathematics, it can very well be used to typeset varied contents like music scores and chess games movements!



Music scores typeset with TEX.

TEX is now capable of accepting Unicode input and hence the best typesetting engine for Indic languages, South Asian scripts and CJK family languages. It can also typeset right to left scripts like Hebrew and Arabic. Text of any number of scripts can be typeset in a single document.

6 Where to get TEX?

TEX Users Group distributes TEXLive every year, which is the authorized version of the distribution for thirteen operating systems. It is free for members of the Group, but is available for others for the cost of the media.

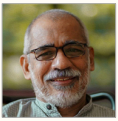
Online installation facility is available at https://tug.org/texlive.

Free package repository is available at: https://ctan.org and its thirty mirrors world-wide.

Free documentation of LATEX3 which is the newest incarnation of the macro library is available at: https://latex-project.org.

The LATEX Tutorial of Indian TEX Users Group is available for free at: http://books.sayahna.org/en/pdf/primer.pdf. The PDF of the primer is made available with this document also.

Radhakrishnan CV



Radhakrishnan is a free software activist and TEX programmer, one of the founders of the Free Software Foundation of India and Indian TEX Users Group. He had organized two annual meetings of the TEX Users Group in Trivandrum in 2002 and 2011. Wrote several packages (libraries) in LATEX and released under free license (LPPL) at Comprehensive TEX Archive Network (CTAN). He is one of the founders of Sayahna Foundation.

He is married and lives with his wife in Trivandrum.

Epilog

- The content that Sayahna includes in these Phone PDFs are those that can be read in under thirty to forty minutes. Computers or Desktop applications are not necessary for reading them.
- The PDFs are made available in beautiful, rich formats and can be easily read from your smart phones. They are customized to adhere perfectly with the dimensions of your phone screen.
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