Getting Started with LaTeX

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1 Introduction to LaTeX

1.1 What is LaTeX?

LaTeX is a computer program for typesetting documents. It takes a computer file, prepared according to the rules of LaTeX and converts it to a form that may be printed on a high-quality printer, such as a laser writer, to produce a printed document of a quality comparable with good quality books and journals. Simple documents, which do not contain mathematical formulae or tables may be produced very easily: effectively all one has to do is to type the text straight in (though observing certain rules relating to quotation marks and punctuation dashes). Typesetting mathematics is somewhat more complicated, but even here LaTeX is comparatively straightforward to use when one considers the complexity of some of the formulae that it has to produce and the large number of mathematical symbols which it has to produce.

LaTeX is one of a number of 'dialects' of TeX, all based on the version of TeX created by D. E. Knuth which is known as Plain TeX. LaTeX (created by L. B. Lamport) is one of these 'dialects'. It is particularly suited to the production of long articles and books, since it has facilities for the automatic numbering of chapters, sections, theorems, equations etc., and also has facilities for cross-referencing. It is probably one of the most suitable version of LaTeX for beginners to use.

1.2 A Typical LaTeX Input File

In order to produce a document using LaTeX, we must first create a suitable *input file* on the computer. We apply the LaTeX program to the input file and then use the printer to print out the so-called 'DVI' file produced by the LaTeX program (after first using another program to translate the 'DVI' file into a form that the printer can understand). Here is an example of a typical LaTeX input file:

```
\documentclass[a4paper,12pt]{article}
\begin{document}

The foundations of the rigorous study of \textit{analysis}
were laid in the nineteenth century, notably by the
mathematicians Cauchy and Weierstrass. Central to the
study of this subject are the formal definitions of
\textit{limits} and \textit{continuity}.

Let $D$ be a subset of $\bf R$ and let
$f \colon D \to \textbf{R}$ be a real-valued function on
$D$. The function $f$ is said to be \textit{continuous} on
$D$ if, for all $\epsilon > 0$ and for all $x \in D$,
there exists some $\delta > 0$ (which may depend on $x$)
such that if $y \in D$ satisfies
\[ |y - x| < \delta \]
then
\[ |f(y) - f(x)| < \epsilon. \]

One may readily verify that if $f$ and $g$ are continuous
functions on $D$ then the functions $f+g$, $f-g$ and
$f.g$ are continuous. If in addition $g$ is everywhere
non-zero then $f/g$ is continuous.

\end{document}
```

When we apply LaTeX to these paragraphs we produce the text

> The foundations of the rigorous study of *analysis* were laid in the nineteenth century, notably by the mathematicians Cauchy and Weierstrass. Central to the study of this subject are the formal definitions of *limits* and *continuity*.
>
> Let D be a subset of $\mathbf{R}$ and let $f\colon D \to \mathbf{R}$ be a real-valued function on D. The function f is said to be *continuous* on D if, for all $\epsilon > 0$ and for all $x \in D$, there exists some $\delta > 0$ (which may depend on x) such that if $y \in D$ satisfies
>
> $$|y - x| < \delta$$

then

$$|f(y) - f(x)| < \epsilon.$$

One may readily verify that if f and g are continuous functions on D then the functions $f + g$, $f - g$ and $f.g$ are continuous. If in addition g is everywhere non-zero then f/g is continuous.

This example illustrates various features of LaTeX. Note that the lines

```
\documentclass[a4paper,12pt]{article}
\begin{document}
```

are placed at the beginning of the input file. These are followed by the main body of the text, followed by the concluding line

```
\end{document}
```

Note also that, although most characters occurring in this file have their usual meaning, yet there are special characters such as `\`, `$`, `{` and `}` which have special meanings within LaTeX. Note in particular that there are sequences of characters which begin with a 'backslash' `\` which are used to produce mathematical symbols and Greek letters and to accomplish tasks such as changing fonts. These sequences of characters are known as *control sequences*.

1.3 Characters and Control Sequences

We now describe in more detail some of the features of LaTeX illustrated in the above example.

Most characters on the keyboard, such as letters and numbers, have their usual meaning. However the characters

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

are used for special purposes within LaTeX. Thus typing one of these characters will not produce the corresponding character in the final document. Of course these characters are very rarely used in ordinary text, and there are methods of producing them when they are required in the final document.

In order to typeset a mathematical document it is necessary to produce a considerable number of special mathematical symbols. One also needs to be able to change fonts. Also mathematical documents often contain arrays of numbers or symbols (matrices) and other complicated expressions. These are produced in LaTeX using *control sequences*. Most control sequences consist of a backslash `\` followed by a string of (upper or lower case) letters. For example, `\alpha`, `\textit` and `\sum` are control sequences.

In the example above we used the control sequences `\textit` and `\textbf` to change the font to *italic* and **boldface** respectively. Also we used the control sequences `\to`, `\in`, `\delta` and `\epsilon` to produce the mathematical symbols $\to$ and $\in$ and the Greek letters δ and ϵ

There is another variety of control sequence which consists of a backslash followed by a *single* character that is not a letter. Examples of control sequences of this sort are `\{`, `\"` and `\$`.

The special characters `{` and `}` are used for *grouping* purposes. Everything enclosed within matching pair of such brackets is treated as a single unit. We have applied these brackets in the example above whenever we changed fonts. We shall see other instances where one needs to use `{` and `}` in LaTeX to group words and symbols together (e.g., when we need to produce superscripts and subscripts which contain more than one symbol).

The special character `$` is used when one is changing from ordinary text to a mathematical expression and when one is changing back to ordinary text. Thus we used

```
for all $\epsilon > 0$ and for all $x \in D$,
```

to produce the phrase

for all $\epsilon > 0$ and for all $x \in D$,

in the example given above. Note also that we used `\[` and `\]` in the example above to mark the beginning and end respectively of a mathematical formula that is displayed on a separate line.

The remaining special characters

```
^ _ % ~ # &
```

have special purposes within LaTeX that we shall discuss later.