MSRI-UP introduction to LaTeX

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Abstract

This document is a brief introduction to the typesetting program called LaTeX. Some parts of this document where taken from [3]. The purpose of this is to provide you with the basic instructions so you can write a document using LaTeX. See References for more information about LaTeX.

1 Introduction

LaTeX is one of the typesetting programs most used in sciences because it provides commands to write formulas and mathematical symbols. It also has predefined styles for preparing articles, write theorems and other features used in mathematics.

The main difference between LaTeX and word-processors like MS Word is that when you use word-processing programs you see exactly what you will get in your document. It is a "markup language" like HTML where you add instructions in the manuscript that tell the software how to display the text. With LaTeX, you will need to use an editor to create a file (with a ".tex" extension) with the text of your document and some special commands that will format the document. After you create the document, you use LaTeX to compile it and produce another file (with a ".dvi" or ".pdf" extension) that has the document in the desired format. The process is similar to the one used when writing a computer program in a language like, for example, C^{++}: you write the program and then compile it to get the output.

If you look at the tex file that produced this document you will find explanations for many useful commands. In that file, you will see that you need a lot more than just text to produce a LaTeX document and this might make you think that it is not worth so much work. It will give you some extra work at the beginning but only until you get used to it. After some practice, you will see that it is a lot easier to use LaTeX than MS Word for your mathematics documents.

2 Basic Commands

In LaTeX the end of the words and sentences are defined by spaces. It does not matter how many spaces you add between two words or sentences, in the output file you will only get one space. If you want to begin a new paragraph you need to add one or more lines after the preceding paragraph.

Commands in LaTeX are usually preceded by a "\". In some cases you will need to add braces. Examples of some commands are:

bold: If you want your text in **bold** you need to write `\bf` and the text that you want in bold between braces. For example, `{\bf student }` will produce **student**.

italics: If you want your text in *italics*, write `\it` and the text that you want in italics, both between braces.

large: If you want your text in large letters , write `\large` and the text that you want in large size, both between braces.

other sizes: Other examples of letter sizes are tiny, small, larger, huge. These sizes can be obtained with `\tiny`, `\small`, `\Large` and `\Huge` respectively.

footnotes: To include footnotes[1], write `\footnote` and write between braces your footnote text. For example, the footnote on the previous sentence was obtained writing `\footnote{Like this}`.

reserved characters: There are certain symbols that are reserved and you will need special commands to produce them. For example, the dollar

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[1]Like this

sign \$ is reserved to mark the beginning and the end of a mathematics expression. To obtain the dollar sign you need to write \ before; that is, you need to write \\$. The percent sign is reserved for comments; everything that it is written after the percent sign and in the same line will not show in your output document. Other characters that are reserved are: &, #, {, and }. To produce them write the " \ " before the character. To produce the " \ " symbol, write `$ \backslash $`.

accents and other symbols: To write María Pérez, we write `Mar\'{\i}a P\'erez`. The ñ is obtained using `\~` before the n.

verbatim: Another command that is useful and that was used very much when generating this document is the "`\verb`" or `\verbatim` command. The command tells LaTeX that the text between the "!"'s is to be printed verbatim, that is, without typesetting it. This is useful if you are trying to type out some of the commands that you used in a computer program. For example, if in your paper, you would like to have several lines of Matlab code, the best way to do it is to use something like

```
\verb! This is where the Matlab code would go. !
```

Essentially, the verbatim commands turn LaTeX into a typewritter.

3   Mathematics Expressions

The main advantage of LaTeX is its use for mathematical expressions. If you want to write something like $x - 3y + \bar{x} \cdot \bar{y} = 12\omega - f(12.4)$ or $a_1 > \frac{x^{2n}}{\beta^\alpha} > \sum_{n=0}^{\infty} x^{n-1}$ you will rather use LaTeX than any word processor. The second expression was obtained using
`$a_1 > \frac{x^{2n}}{\beta^\alpha} > \sum_{n=0}^\infty x^{n-1}$`.
We have said before that the dollar sign before and after a mathematical expression lets LaTeX know that what is between the dollar signs should be in mathematics format: the letters will be in italic and the commands are mathematics commands. To write exponents use `^` and if there is more than one symbol in the exponent it should be written between braces. For example, `$x^2n$` produces $x^2 n$ and not x^{2n}. To produce x^{2n} we use `x^{2n}`. We get the subscripts using `_`. For example, to produce x_{2n} we use `x_{2n}`.

The spaces between characters in mathematics format are ignored. If you want more space in mathematics format you can write \ and then a space. For example, `$9 y + 18  \delta$` produces $9y + 18\delta$; whereas `$9\ y + 18\ \ \delta$` produces $9\ y + 18\ \ \delta$.

If you want a mathematics formula on a single line, you can enclose the expression between double dollar signs. For example, the commands
`$$\int_0^1 \frac{(1-x)^4 x^4}{1+x^2}\, dx = \frac{22}{7}-\pi.$$`
produce

$$\int_0^1 \frac{(1-x)^4 x^4}{1+x^2}\, dx = \frac{22}{7} - \pi.$$

TeXnic Center, a free LaTeX editor that you can download (see Section 8) has buttons and pull-down menus that will help you to write mathematical expressions, make lists, tables and others. For example, to write $\sqrt[3]{x}$ using the editor buttons you write $ to indicate that you will start a mathematics expression; press the icon with the radical symbol; select the icon with the box in the radical index; write 3 between the [ ] ; write x between the braces and write $ again to indicate that you finished the mathematics expression. Another option is to write `$\sqrt[3]{x}$` directly.

Let us see the difference between expressions that are produced in different ways. A mathematics expression inside the text can be something like $\int_0^\infty \frac{x}{x^3+2x^2-3x+90}\, dx$. It is produced by writing the commands between single dollar signs.

If we want to number the expression to reference it later we write

```
begin{equation}\label{Suma}
\sum_{n=1}^\infty
\frac{1}{n^{1.00001} + 10\sqrt{n}} < \infty
\end{equation}
```

This produces

$$\sum_{n=1}^\infty \frac{1}{n^{1.00001} + 10\sqrt{n}} < \infty \tag{1}$$

Note that among the instructions there is the command `\label{Suma}`. This is how we give a name to the expression. This name will not show in the expression but we can refer to it later by writing `\ref{Suma}`. This is very useful because we do not have to remember the number and we can move

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the expression to another place and LaTeX will change and reference the new number automatically. For example, if we write
`See equation (\ref{Suma}) above.`, LaTeX substitutes `ref{Suma}` by the equation number and we get "See equation (1) above.". If we write the mathematics expression between double dollar signs we will get the expression in a single line, the expression will not have a number, and we will not be able to reference the expression later. If we want to align a set of equations we can use an "equation array".

Instructions:

```
\begin{eqnarray*}
      x & + \ 10y         & =\ 30              \\
      2x & - \ 3y & = \ -2 \\
       4x & - \  9y        & =\ 40
\end{eqnarray*}
```

Output:

$$
\begin{array}{rcrcl}
x & + 10y & = & 30 \\
2x & - 3y & = & -2 \\
4x & - 9y & = & 40.
\end{array}
$$

The command `\begin{eqnarray*}` tells LaTeX that what follows should be written in columns. You delimit each column with & and the end of each line except the last one is marked with \\, which is the "newline" command. To indicate the end of the array you write `\end{eqnarray*}`. Note that this expression is not numbered; this is because of the ∗ after eqnarray. If you want the equation to be numbered, just remove the ∗. In this case, every line will be numbered unless you write `\nonumber` at the end of the line.

It is easy to generate matrices using LaTeX. To obtain

$$
\left(\begin{array}{ccc} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & -\pi \end{array} \right)^{-1} = \left(\begin{array}{ccc} 1 & 0 & 0 \\ 0 & \frac{1}{2} & 0 \\ 0 & 0 & \frac{-1}{\pi} \end{array} \right)
$$

you use

`$$\left(\begin{array}{ccc}`

```
1 & 0 & 0\\
0 & 2 & 0\\
0 & 0 & -\pi\\
\end{array}\right)^{-1} =
\left(\begin{array}{ccc}
1 & 0 & 0\\
0 & \frac{1}{2} & 0\\
0 & 0 & \frac{-1}{\pi}\\
\end{array}\right)$$
```

A math command that you might be using this summer is `\choose`. For example, `${ a+b \choose b-1}$` produces $\binom{a+b}{b-1}$.

You can get more details about mathematics symbols in some of the references.

4 Tables and lists

It is easy to produce lists with LaTeX.

enumerate If you write `\begin{enumerate} \item apples \item oranges \end{enumerate}`, you produce a list with numbers like:

1. apples
2. oranges

itemize If you write `\begin{itemize} \item apples \item oranges \end{itemize}`, you produce a list with bullets like:

- apples
- oranges

description This list with descriptions was produced using `\begin{description} \item[enumerate] \item [itemize] \item [description] \end{description}`.

Tables are a little more complicated. To produce the following:

| (n, d)	GRev	Lex	GLex	SPB	GVB
(4,2)	8	8	8	16	8
(5,2)	16	16	16	32	16
(6,2)	32	32	32	64	32
(7,2)	64	64	64	128	64
(8,2)	128	128	128	256	128

we use

```
\begin{center}
\begin{tabular}{|c|c|c|c|c|c|}\hline
$(n,d)$ & GRev & Lex & GLex &  SPB & GVB  \\ \hline
(4,2) & 8    & 8   & 8    & 16   & 8     \\
(5,2) & 16   & 16  & 16   & 32   & 16    \\
(6,2) & 32   & 32  & 32   & 64   & 32    \\
(7,2) & 64   & 64  & 64   & 128  & 64    \\
(8,2) & 128  & 128 & 128  & 256  & 128   \\ \hline
\end{tabular}
\end{center}.
```

5   Graphics and pictures

It is easy to include pictures or graphics in a document. You can include graphics in pdf and jpg formats. For this you need to include the graphics package with `\usepackage{graphicx}`. The command `\includegraphics[scale=0.25]{grafica.jpg}` create the following picture
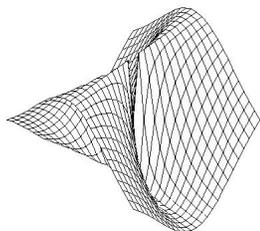
This graphic was created using Maple, selecting the graphic with a right click and then using the command "Export As" and selecting jpeg. The picture file has to be saved in the same directory where the LaTeX document is.

If you want to center the figure, set the size and label the picture you can use

```
\begin{figure}[h]
\begin{center}
\includegraphics[width=1.5in,height=1in]{grafica.jpg}
\caption{An example of a graphic created by Maple}
\label{grafica}
\end{center}
\end{figure}
```

The name of the file with the graphic is "grafica.jpg". The instruction \label{grafica} is to reference the figure later using \ref{grafica}. This is what we get with the instructions above:
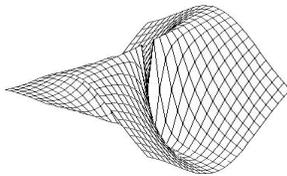
Figure 1: An example of a graphic created by Maple

6   Abstract, Sections, and References

We will provide a LaTeX template for your technical report so that all the technical reports are formatted similarly. In general, your paper will have a short introduction, a description of the problem, the methods used to solve it, your results, a conclusion that will include ideas for future work, and the bibliography. The specific guidelines for the structure of the report will be discussed by your research leader. The template will include a section for acknowledgements in which you thank anyone whom you want to thank. There and wherever you present work related to your results at MSRI-UP you need to acknowledge the grants that fund MSRI-UP: National Science Foundation grant No. 1156499 and National Security Agency grant No. H-98230-13-1-0262.

The bibliography is easy to make using LaTeX. The input file for this document shows you how to create it. You will label the entries with a particular tag and then you use the "tag" to cite that reference within the text. For example, suppose you want to be able to cite the following article: Briand, Emmanuel and Orellana, Rosa and Rosas, Mercedes, "The stability of the Kronecker product of Schur functions", *Journal of Algebra*, **331**, 2011, pp. 11–27. You could enter the following in your bibliography section
`\bibitem {BOR} E. Briand, R. Orellana, and M. Rosas,`
`''The stability of the Kronecker product of Schur functions'',`
`{\it Journal of Algebra}, {\bf 331}, 2011, pp. 11--27.`

The `{BOR}` is your tag for this reference. If you wanted to cite this article, you would use the command `\cite{BOR}` and LaTeX would produce [1].

7 To "run" LaTeX

To use LaTeX, we first need to create an source file; this is, a file that has your document and the format instructions. To edit this file, we use TeXnicCenter or any other LaTeX editor. On Section 8 you can find instructions on how to download and install the necessary programs. After you install the program on your computer, you can double click in any file with `.tex` extension; this will open the editor and you can modify the file. The template file tex file has instructions on how to edit it.

If you are using TeXnicCenter and you want to see how your document looks press the icon that has an arrow on top of a pile of papers. This will open a window (Output) in the lower part of your screen where you can see the results of the compiling process. This will also create a file with a pdf or dvi extension where you will be able to see the formated document. You can choose between creating a pdf or a dvi file in a pull-down menu on TeXnicCenter. If you included graphics on your document you should probably use the `LaTeX=>PDF` option.

If there where errors during compilation they will be indicated in the output window. There you will see the number of the line that has errors and you can go there by doing a search. To see the pdf or dvi file, press the icon with the magnifying glass. Another way to compile and see the output file is to press the icon that has the arrow and the magnifying glass on the pile of papers. You have to close the pdf file before compiling again.

You can find simple instructions on how to use LaTeX in [4]. You can also check [5] for any information related to LaTeX.

8 How to get the software

To use LaTeX in a Windows environment you first need to download and install the MiKTeX program and then TeXnicCenter (in this order). Simple instructions for downloading and installing these programs can be found in `http://www.artofproblemsolving.com/LaTeX/AoPS_L_Downloads.php`.

To use LaTeX in a Mac you can download the MacTeX.pkg from `http//tug.org/mactex/` and install it. You can obtain the LaTeX editor Texmaker from `http://www.xm1math.net/texmaker/download.html`.

If you do not want to install these programs you can also use resources available in the web. These resources also allow you to share documents as you do with Googledocs. Some sites are `http://www.scribtex.com`, `https://www.writelatex.com`, `http://www.sharelatex.com`

Acknowledgements

References

[1] E. Briand, R. Orellana, and M. Rosas, "The stability of the Kronecker product of Schur functions", *Journal of Algebra*, **331**, 2011, pp. 11–27.

[2] H. Kopka & P.W. Daly, *A Guide to LaTeX*, 4th ed., Addison-Wesley, New York, 2003.

[3] `http://www.uprh.edu/~simu/Resources/latexho.pdf`

[4] `http://www.artofproblemsolving.com/LaTeX/AoPS_L_About.php`

[5] `http://en.wikibooks.org/wiki/LaTeX`