Introduction to Using LaTeX*
for use in ST 8353 *Statistical Computations*

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*Lamport, Leslie (1986) *LaTeX: User's Guide & Reference Manual*. Reading, Massachusetts: Addison-Wesley.

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1 Introduction

This document is a quick example on using some of the features of the document preparation system LaTeX. LaTeX is a special version of Donald Knuth's TeX program which adds to TeX a collection of commands that simplify typesetting by letting the user concentrate on the structure of the text rather than on formatting commands.

1.1 Using LaTeX

While LaTeX makes formatting and referencing much easier, it is also difficult to change the appearance of the resulting document. Furthermore, there are TeX commands that are made obsolete by LaTeX and so cannot be used when using LaTeX. However, these obsolete commands are very few, and so this need not be a deterrent to using LaTeX.

2 Typing Math in LaTeX

Almost all of the TeX commands will work in LaTeX. However, LaTeX has some typing conventions that make typesetting a little easier at times that in TeX. Some TeXcommands (such as the `\cases` command) are obsolete in LaTeX. Subsection 2.1 contains a brief description of typesetting mathematics that is to appear within text. Subsection 2.2 explains how to display equations, and includes examples on typesetting cases and matrices in LaTeX.

2.1 Typesetting Mathematics to Appear Within Text

In TeX all mathematical expressions contained within the text of a sentence are included in `$`. For example `$ 3x + 7 = 5 $` results in $3x + 7 = 5$. This does not change in LaTeX, although you can replace the $ with a \(. For example `\( 3x + 7 = 5 \)` produces $3x + 7 = 5$.

2.2 Typesetting Displayed Equations

To type displayed equations, you can either use `$$` (as in TeX), `\[` and `\]` or you can use `\begin{equation}`, `\end{equation}`. There is also a LaTeX command for typesetting (and numbering) equations that are aligned on a equal sign. Consider the following five examples.

1. This first example is an example of an unnumbered centered (displayed) equation using the traditional $$.

$$\mathrm{E}(X) = \int_0^\infty x\lambda e^{-\lambda x}\,dx, \quad x > 0.$$

2. The second example uses the LaTeX `\[` and `\]` convention. There is no difference in the result between this and the first example.

$$\mathrm{E}(X) = \int_0^\infty x\lambda e^{-\lambda x}\,dx \quad x > 0.$$

3. This example is an example of a numbered displayed equation.

$$\mathrm{E}(X) = \int_0^\infty x\lambda e^{-\lambda x}\, dx, \quad x > 0. \tag{1}$$

4. The next example is how to align equations on an equal sign without numbering any of the expressions that are aligned. Pay special attention to the subtle differences between this and the TeX command `\eqalign`.

$$\begin{aligned} \mathrm{Var}(x) &= \mathrm{E}(X^2) - \mu^2 \\ &= \frac{(N+1)(2N+1)}{6} - \left(\frac{N+1}{2}\right)^2 \\ &= \frac{(N+1)(N-1)}{12}. \end{aligned}$$

5. This last example is for aligning equations on an equal sign and assigning numbers to some (or all) of the expressions that are aligned. You should also pay very close attention to the order in which things appear within the eqnarray field. Changing up these orders will cause equations to be misnumbered within the text.

$$\begin{aligned} \mathrm{Var}(x) &= \mathrm{E}(X^2) - \mu^2 && (2) \\ &= \frac{(N+1)(2N+1)}{6} - \left(\frac{N+1}{2}\right)^2 \\ &= \frac{(N+1)(N-1)}{12}. && (3) \end{aligned}$$

Equation (2) in the last example is the "short-cut" formula for calculating variances, and equation (3) is the expression for the variance of a discrete uniform$(1, N)$ distribution.

To refer back to the equation in the last example the `\ref{`*labelname*`}` command is used. Note that the first equation in the two examples does not have a number, but that equation (1) does. LaTeX will automatically keep up with equation numbers for you so you don't have to worry about going back and renumbering!

Creating Cases and Matrices The `\cases` and `\matrix` TeX commands are obsolete in LaTeXand do not work! Therefore, you need to know how to produces these two important mathematical structures using LaTeX commands. Both are done using the `array` environment.

- **Creating cases.** To create a displayed equation with "cases," the `array` environment is used like this

```
$$
F(x) = \left\{
        \begin{array}{ll}
         0                & {\mbox{for $X < A$}}          \\
         \frac{x-A}{B-A} & {\mbox{for $A \le X \le B$}} \\
         1                & {\mbox{for $X > B$}}          \\
         \end{array}
        \right.
$$
```

to produce this.

$$F(x) = \begin{cases} 0 & \text{for } X < A \\ \frac{x-A}{B-A} & \text{for } A \le X \le B \\ 1 & \text{for } X > B \end{cases}$$

- **Creating matrices.** To create a matrix, use the `array` environment like this

```
$$
\begin{array}
{\bf X} = \left[
           \begin{array}{cccc}
            X_{11} & X_{12} & \ldots & X_{1m} \\
            X_{21} & X_{22} & \ldots & X_{2m} \\
            \vdots & \vdots &        & \vdots \\
            X_{m1} & X_{m2} & \ldots & X_{mn}
           \end{array}
          \right]
$$
```

to produce this:

$$\mathbf{X} = \begin{bmatrix} X_{11} & X_{12} & \ldots & X_{1m} \\ X_{21} & X_{22} & \ldots & X_{2m} \\ \vdots & \vdots & & \vdots \\ X_{m1} & X_{m2} & \ldots & X_{mn} \end{bmatrix}$$

3 Tables and Figures

LaTeX also has table and figure environments. Creating tables in LaTeX is quite a bit easier than in TeX. The following LaTeX code will produce Table 1.

```
\begin{table}[h]
\begin{center}
\begin{tabular}{||l|l|c|c||} \hline \hline
```

```
              &                  & \multicolumn{2}{|c||}{Document style} \\ \cline{3-4}
Printing Style & Command          & {\tt book, report} & {\tt article}    \\ \hline
two-sided      & {\tt markboth}   & {\tt chapter}      & {\tt section}    \\ \cline{2-4}
               & {\tt markright}  & {\tt section}      & {\tt subsection} \\ \hline
one-sided      & {\tt markright}  & {\tt chapter}      & {\tt section}    \\ \hline \hline
\end{tabular}
\caption{Section Commands to Set Page Headings}
\label{table1}
\end{center}
\end{table}
```

Printing Style	Command	Document style	
		book, report	article
two-sided	markboth	chapter	section
	markright	section	subsection
one-sided	markright	chapter	section

Table 1: Section Commands to Set Page Headings

If you don't want the table to have a number, replace `table` with `table*` and omit the `label` command.

To create Figure 1 use the standard package `psfig`. What follows will include a postscript figure within the text. *S-Plus* and *SAS* both have the capability of translating their graphics to postscript files.

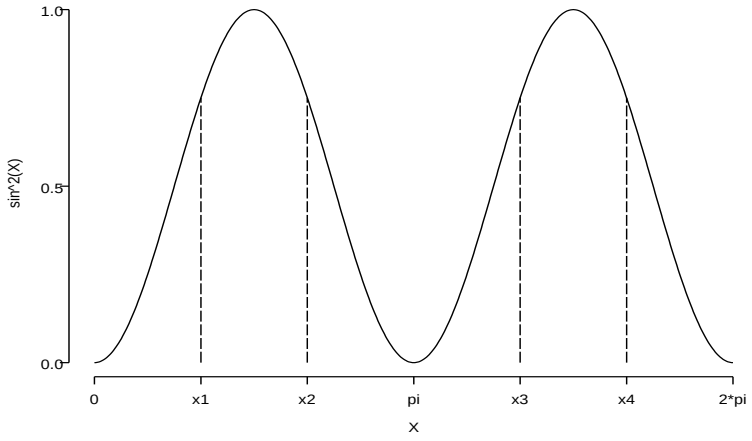

Figure 1: Sine Curve from 0 to 2π.

```
\begin{figure}[h]
\centerline{\psfig{figure=sinecurve.eps,height=2.75truein,width=4.25truein}}
\caption{Sine Curve from 0 to $2\pi$.}
\label{fig1}
\end{figure}
```

4 Compiling LaTeX Files

Just as in TeX, it is best to save any LaTeX file with a `.tex` extension. To compile the LaTeX file, issue the command

```
latex filename
```

from the UNIX prompt. This action will create a `.log`, `.aux` and `.dvi` file having the same filename as the original `.tex` file. If there is any cross-referencing within the `.tex` file (as there is in this one), you will need to `latex` the file twice. The second compilation reads the `.aux` file created by the first and creates all the numbering and cross-references within the `.dvi` file. After this, all actions are the same as when using TeX; that is, viewing is done with `xdvi`, printing with `dvips`, etc.

Disclaimer: This document is in no way intended to teach you everything you need to know about LaTeX. On the contrary, there are volumes of material written on using TeX and LaTeX. However, it is hoped that by reading this document and comparing it with the LaTeX code that generated it, you will get a feel for using the LaTeX package. For more information, refer to the *LaTeX User's Guide & Reference Manual* by Leslie Lamport (cited in the footnote at the beginning of this document). A quick reference card is also added for your information.

```
%-----------------------------------------------------------------------
%
%  LaTeX file containing tutorial
%
%       ``Using LaTeX''
%
%  Created for use in ST 8353 ``Statistical Computations.''
%
%  Created: 9/14/00 JLH
%  Modified: 8/21/03 JLH
%
%-----------------------------------------------------------------------
%
%  The beginning of every LaTeX document is the following 2 lines.
%  The syntax of this line is
%  \documentclass[option1,option2,]{style}
%  \usepackage{packagename}
%
%  options include (but are not limited to)
%          11pt, 12pt, twoside, twocolumn
%
%  styles are article, report, book, letter
%
%  There are standard packages that have special functions.  The package
%  fullpage uses most of the page for printing, and the package psfig
%  is one (of several) that lets you incorporate postscript graphics
%  documents into your output.
%
\documentclass[12pt,twoside]{article}
\pagestyle{headings}
\usepackage{psfig}
%
%  The \pagestyle specifies the current pagestyle.  There are four
%  standard style options:
%  1. plain - the head is empty and the foot has only a page number.
%             plain is the default page style.
%  2. empty - the head and foot are both empty.
%  3. headings - the head contains information determined by the
%                document style (usually a section-unit heading) and
%                the page number; the foot is empty.
%  4. myheadings - same as headings, except head information is
%                  specified by \markboth and \markright commands
%
\pagestyle{headings}
%  Margin values are one inch less than the desired value
\oddsidemargin=-0.5truein
\evensidemargin=-0.5truein
\topmargin=-0.25truein
%  Height and width of text (not including headings, footers, etc.)
\textheight=9.0truein
\textwidth=7.25truein
%
%  The \def TeX command works in LaTeX.  There is also a \newcommand
%  to define newcommands in LaTeX.  Both features (\def and \newcommand)
%  have the same function.
%
%  Note that in this newcommand (for making a E in math mode) we have
%  an \mbox (as opposed to a \hbox).  Either \mbox or \hbox will work,
%  but \mbox is better since it is specifically designed by LaTeX
%  creators to produce text within math mode.
```

```
%
\newcommand{\E}{{\mbox{E}}}
\newcommand{\Var}{{\mbox{Var}}}
%
%  If you choose to have a title, this is how to make one.
%
\title{Introduction to Using \LaTeX\footnote{Lamport, Leslie (1986)
{\it \LaTeX: User's Guide \& Reference Manual}.  Reading, Massachusetts:
Addison-Wesley.} \\
for use in ST 8353 {\it Statistical Computations}}
\author{Jane L.~Harvill}
\date{Second Edition \\ Fall, 2003}
%
%  When you are ready to begin the document, you start with
%  the \begin{document} command.  At the end of the document,
%  this \begin{document} command will be closed with an
%  \end{document}.
%
\begin{document}
%
%  \maketitle and \tableofcontents automatically produced a nicely
%  formatted title and table of contents
%
\maketitle
\newpage
\tableofcontents
%
%  The list of tables and list of figures (both optional) are
%  automatically created using the \listoftables and \listoffigures
%  LaTeX commands.
%
\listoftables
\listoffigures
%
%  The \newpage command begins a new page.
%
\newpage
%
%  To get a section called ``Introduction'', simply use the
%  \section{Introduction}.  The \label{introduction} is used if
%  later on in the document you need to refer to the Introduction
%  section without needing to remember it's section number.  You
%  don't have to have the \label command if you aren't going to
%  refer back to the Introduction section.
%
\section{Introduction}
\label{introduction}
This document is a quick example on using some of the features of the
document preparation system \LaTeX.  \LaTeX\ is a special version of
Donald Knuth's \TeX\ program which adds to \TeX\ a collection of
commands that simplify typesetting by letting the user concentrate on
the structure of the text rather than on formatting commands.
%
%  In the article style, there is a \subsection, \subsubsection,
%  \paragraph, and \subparagraph.  (The book style is the only
%  style which also includes a \part and \chapter.)
%
\subsection{Using \LaTeX}
While \LaTeX\ makes formatting and referencing much easier, it is also
difficult to change the appearance of the resulting document.
```

```
Furthermore, there are \TeX\ commands that are made obsolete by \LaTeX\
and so cannot be used when using \LaTeX.  However, these obsolete
commands are very few, and so this need not be a deterrent to using
\LaTeX.
\section{Typing Math in \LaTeX}
\label{math}
Almost all of the \TeX\ commands will work in \LaTeX.  However,
\LaTeX\ has some typing conventions that make typesetting a little
easier at times that in \TeX.  Some \TeX commands (such as the {\tt
$\backslash$cases} command) are obsolete in \LaTeX.
%
%  Notice how the \ref{label} command is used to refer to subsections
%  automatically numbered by LaTeX.
%
Subsection~\ref{intext} contains a brief description of typesetting
mathematics that is to appear within text.  Subsection~\ref{displayeq}
explains how to display equations, and includes examples on
typesetting cases and matrices in \LaTeX.

\subsection{Typesetting Mathematics to Appear Within Text}
\label{intext}
In \TeX\ all mathematical expressions contained within the text of a
sentence are included in {\tt \$}.  For example {\tt \$ 3x + 7 = 5\ \$}
results in $3x + 7 = 5$.  This does not change in \LaTeX, although you
can replace the \$ with a $\backslash ($.  For example {\tt
$\backslash$( 3x + 7 = 5 $\backslash$)} produces \(3x + 7 = 5 \).

\subsection{Typesetting Displayed Equations}
\label{displayeq}
To type displayed equations, you can either use {\tt \$\$} (as in \TeX),
$\backslash${\tt [} and $\backslash${\tt ]} or you can use {\tt
$\backslash$begin\{equation\}, $\backslash$end\{equation\}}.  There is
also a \LaTeX\ command for typesetting (and numbering) equations that
are aligned on a equal sign.  Consider the following five examples.
%
%  Notice the enumerate environment automatically numbers each entry
%  beginning with a \item.  LaTeX has counters associated with every
%  many things: pages, chapters, parts, sections, subsections,
%  subsubsections, and enumerates.
%
\begin{enumerate}
\item This first example is an example of an unnumbered centered (displayed)
equation using the traditional \$\$.
$$
\E(X) = \int_0^\infty\! x\lambda e^{-\lambda x}\,dx, \quad x > 0.
$$
\item The second example uses the \LaTeX\ $\backslash${\tt [} and
$\backslash${\tt ]} convention.  There is no difference in the result
between this and the first example.
\[
\E(X) = \int_0^\infty\! x\lambda e^{-\lambda x}\,dx\, \quad x > 0.
\]
\item This example is an example of a numbered displayed equation.
\begin{equation}
\E(X) = \int_0^\infty\! x\lambda e^{-\lambda x}\,dx, \quad x > 0.
\label{labelledeq}
\end{equation}
\item The next example is how to align equations on an equal sign
without numbering any of the expressions that are aligned.  Pay
special attention to the subtle differences between this and the \TeX\
```

```
command $\backslash${\tt eqalign}.
\begin{eqnarray*}
\Var(x) & = & \E(X^2) - \mu^2                                          \\
        & = & \frac{(N+1)(2N+1)}{6} - \left(\frac{N+1}{2}\right)^2 \\
        & = & \frac{(N+1)(N-1)}{12}.
\end{eqnarray*}
\item  This last example is for aligning equations on an equal sign and
assigning numbers to some (or all) of the expressions that are
aligned.  You should also pay very close attention to the order in
which things appear within the eqnarray field.  Changing up these
orders will cause equations to be misnumbered within the text.
\begin{eqnarray}
\label{partI}
\Var(x) & = & \E(X^2) - \mu^2                                          \\
\nonumber
        & = & \frac{(N+1)(2N+1)}{6} - \left(\frac{N+1}{2}\right)^2 \\
\label{partII}
        & = & \frac{(N+1)(N-1)}{12}.
\end{eqnarray}
%
%  Every \begin must have a closing \end.
%
\end{enumerate}
Equation (\ref{partI}) in the last example is the ``short-cut''
formula for calculating variances, and equation (\ref{partII}) is the
expression for the variance of a discrete uniform$(1,N)$ distribution.

To refer back to the equation in the last example the $\backslash${\tt
ref}\{{\it labelname}\} command is used.  Note that the first equation
in the two examples does not have a number, but that equation
(\ref{labelledeq}) does.  \LaTeX\ will automatically keep up with
equation numbers for you so you don't have to worry about going back
and renumbering!

\paragraph{Creating Cases and Matrices}
The $\backslash${\tt cases} and $\backslash${\tt matrix} \TeX\
commands are obsolete in \LaTeX and do not work!  Therefore, you need
to know how to produces these two important mathematical structures
using \LaTeX\ commands.  Both are done using the {\tt array} environment.
%
%  There is also an itemize environment which produces a bulleted
%  list.  To change the bullet to something different, use the
%  \begin{itemize}
%     \item[$\spade$]
%     \item[$\spade$]
%       ...
%  \end{itemize}
%
\newpage
\begin{itemize}
\item {\bf Creating cases.} To create a displayed equation with
``cases,'' the {\tt array} environment is used like this
\begin{verbatim}
     $$
     F(x) = \left\{
             \begin{array}{ll}
              0               & {\mbox{for $X < A$}}         \\
              \frac{x-A}{B-A} & {\mbox{for $A \le X \le B$}} \\
              1               & {\mbox{for $X > B$}}         \\
              \end{array}
```

```
            \right.
     $$
\end{verbatim}
to produce this.
$$
F(x) = \left\{
        \begin{array}{ll}
         0               & {\mbox{for $X < A$}}         \\
         \frac{x-A}{B-A} & {\mbox{for $A \le X \le B$}} \\
         1               & {\mbox{for $X > B$}}         \\
         \end{array}
        \right.
$$
\item {\bf Creating matrices.} To create a matrix, use the {\tt array}
environment like this
\begin{verbatim}
     $$
     \begin{array}
     {\bf X} = \left[
                \begin{array}{cccc}
                 X_{11} & X_{12} & \ldots & X_{1m} \\
                 X_{21} & X_{22} & \ldots & X_{2m} \\
                 \vdots & \vdots &        & \vdots \\
                 X_{m1} & X_{m2} & \ldots & X_{mn}
                \end{array}
               \right]
     $$
\end{verbatim}
to produce this:
$$
{\bf X} = \left[
           \begin{array}{cccc}
            X_{11} & X_{12} & \ldots & X_{1m} \\
            X_{21} & X_{22} & \ldots & X_{2m} \\
            \vdots & \vdots &        & \vdots \\
            X_{m1} & X_{m2} & \ldots & X_{mn}
           \end{array}
          \right]
$$
%
%  Every \begin has an \end
%
\end{itemize}

\section{Tables and Figures}
\LaTeX\ also has table and figure environments.  Creating tables in
\LaTeX\ is quite a bit easier than in \TeX.  The following \LaTeX\ code
will produce Table~\ref{table1}.
%
%  There are ways to easily enlarge or shrink font sizes.  Those commands
%  are \tiny, \scriptsize, \footnotesize, \small, \normalsize, \large,
%  \Large, \LARGE, \huge, and \Huge.
%
\footnotesize{
\begin{verbatim}
\begin{table}[h]
\begin{center}
\begin{tabular}{||l|l|c|c||} \hline \hline
               &                 & \multicolumn{2}{|c||}{Document style} \\ \cline{3-4}
Printing Style & Command         & {\tt book, report} & {\tt article}    \\ \hline
```

```
two-sided      & {\tt markboth}  & {\tt chapter}      & {\tt section}    \\ \cline{2-4}
               & {\tt markright} & {\tt section}      & {\tt subsection} \\ \hline
one-sided      & {\tt markright} & {\tt chapter}      & {\tt section}    \\ \hline \hline
\end{tabular}
\caption{Section Commands to Set Page Headings}
\label{table1}
\end{center}
\end{table}
\end{verbatim}}

\begin{table}[h]
\begin{center}
\begin{tabular}{||l|l|c|c||} \hline \hline
          &         & \multicolumn{2}{|c||}{Document style} \\ \cline{3-4}
Printing Style & Command & {\tt book, report} & {\tt article}   \\ \hline
two-sided & {\tt markboth} & {\tt chapter} & {\tt section} \\ \cline{2-4}
          & {\tt markright} & {\tt section} & {\tt subsection} \\ \hline
one-sided & {\tt markright} & {\tt chapter} & {\tt section} \\
\hline \hline
\end{tabular}
\caption{Section Commands to Set Page Headings}
\label{table1}
\end{center}
\end{table}
If you don't want the table to have a number, replace {\tt table} with
{\tt table*} and omit the {\tt label} command.

To create Figure~\ref{fig1} use the standard package {\tt psfig}.
What follows will include a postscript figure within the text.  {\it
S-Plus} and {\it SAS} both have the capability of translating their
graphics to postscript files.
\begin{figure}[h]
\centerline{\psfig{figure=sinecurve.eps,height=2.75truein,width=4.25truein}}
\caption{Sine Curve from 0 to $2\pi$.}
\label{fig1}
\end{figure}

\begin{verbatim}
\begin{figure}[h]
\centerline{\psfig{figure=sinecurve.eps,height=2.75truein,width=4.25truein}}
\caption{Sine Curve from 0 to $2\pi$.}
\label{fig1}
\end{figure}
\end{verbatim}

\section{Compiling \LaTeX\ Files}
\label{com}
Just as in \TeX, it is best to save any \LaTeX\ file with a {\tt .tex}
extension.  To compile the \LaTeX\ file, issue the command
\begin{verbatim}
   latex filename
\end{verbatim}
from the UNIX prompt.  This action will create a {\tt .log}, {\tt
.aux} and {\tt .dvi} file having the same filename as the original
{\tt .tex} file.  If there is any cross-referencing within the {\tt
.tex} file (as there is in this one), you will need to {\tt latex} the
file twice.  The second compilation reads the {\tt .aux} file created
by the first and creates all the numbering and cross-references within
the {\tt .dvi} file.  After this, all actions are the same as when
using \TeX; that is, viewing is done with {\tt xdvi}, printing with
```

```
{\tt dvips}, etc.

\vfill
\noindent
{\bf Disclaimer:} This document is in no way intended to teach you
everything you need to know about \LaTeX.  On the contrary, there are
volumes of material written on using \TeX\ and \LaTeX.  However, it is
hoped that by reading this document and comparing it with the \LaTeX\
code that generated it, you will get a feel for using the \LaTeX\
package.  For more information, refer to the {\it \LaTeX\ User's Guide
\& Reference Manual} by Leslie Lamport (cited in the footnote at the
beginning of this document).  A quick reference card is also added for
your information.


%
%  Just like every TeX file must end in \bye, every \LaTeX file
%  must end in \end{document} (which closes the \begin{document}.)
%
\end{document}
```