WRITING YOUR THESIS WITH LATEX

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UNIVERSITI SAINS MALAYSIA

2007

WRITING YOUR THESIS WITH LATEX

by

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Thesis submitted in fulfilment of the requirements
for the degree of
Master of Science

December 2007

ACKNOWLEDGEMENTS

Many thanks to Prof. Donald Knuth for giving us TEX, and Leslie Lamport for LATEX.

Dr. Dhanesh's effort in officially raising awareness about LATEX at USM during NaCSPC'05 was incredibly refreshing and much welcome. Dr. Dhanesh also followed this up by suggesting that I give an introductory workshop on LATEX during CSPC'07, and to LATEX the programme book cum abstract collections (a first!). Many, many thanks to him and Dr. Azman, who was *very* supportive during the last minute changes and glitches. Also, thanks to Nur Hussein, Adib, Seng Soon and Anusha for happily trying out early versions of my LATEX thesis templates, and for their feedbacks, and to everyone who attended my talk, requested tutorials, downloaded from my website (http://liantze.googlepages.com/latextypesetting), etc, etc.

Hope everyone graduates quickly then!

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LIST OF ABBREVIATIONS

IPS Institut Pengajian Siswazah

PPSK Pusat Pengajian Sains Komputer

USM Universiti Sains Malaysia

UTMK Unit Terjemahan Melalui Komputer

LIST OF SYMBOLS

lim limit

θ angle in radians

PENULISAN TESIS DENGAN LATEX

ABSTRAK

Ini merupakan abstrak Melayu untuk tesis USM. Ianya disediakan dengan sistem penyediaan dokumen LaTeX.

WRITING YOUR THESIS WITH LATEX

ABSTRACT

This is the English abstract of a USM thesis. It was prepared with the LaTeX document typesetting system.

CHAPTER 1

INTRODUCTION: SAMPLES OF BASIC LaTeX COMMANDS

Hello and welcome, fellow Universiti Sains Malaysia (USM) research postgrad! The `usmthesis` package and template files were written in the hope that they may help you prepare your research thesis using LaTeX, based on the Institut Pengajian Siswazah (IPS) requirements (IPS, 2007). **Please note that this version is based on the *new* guidelines, in force 17 Dec 2007 onwards.**

LaTeX is powerful and produces beautiful documents. However, there is definitely a learning curve to it – one that is worth the effort. If you find any errors in these templates or documents, or have any suggestions or feedback, do e-mail me about it (`liantze@gmail.com`). The author cannot always guarantee prompt response, however. ☺

MiKTeX, my recommended LaTeX distribution for Windows, is available on the CSPC'07 CD. A step-by-step installation walkthrough is available at (Lim, 2007).

1.1 Some Simple Command Usages

There are plenty of free LaTeX tutorials online, some of which are listed in the bibliographies or available at http://e-office.cs.usm.my. This sample thesis includes some examples to do some common tasks. We start with some examples for lists (both bulleted and numbered), highlighting texts in bold and italic, and URLs:

1. bulleted and numbered lists,

```
\begin{enumerate}
\item bulleted and numbered lists,
\item footnotes\footnote{This is a footnote. However note that footnotes
    are not encouraged for the sciences.},
\item font effects such as

\begin{itemize}
\item \textbf{bold},
\item \emph{italic}, and
\item \texttt{typewriter-like}
\end{itemize}

\item URLs and e-mail addresses: \url{http://www.cs.usm.my/~llt/}, \url{
    dummy.add@hotmail.com};
\item citations: see Chapter \ref{chap:review}.
\end{enumerate}
```

Figure 1.1: Common Layout and Formatting Tasks

2. footnotes[1],

3. font effects such as

    - **bold**,
    - *italic*, and
    - `typewriter-like`

4. URLs and e-mail addresses: http://www.cs.usm.my/~llt/, dummy@hotmail.com;

5. citations: see Chapter 2

Incidentally, if you feel that the lists above are too far apart vertically, use the **compactenum** and **compactitem** environments instead. The effect is then like the following:

1. item one,
2. item two,
3. item three.

[1] This is a footnote. However note that footnotes are not encouraged for the sciences.

```
\begin{compactenum}
\item item one,
\item item two,
\item item three.
\end{compactenum}

\begin{compactitem}
\item item one,
\item item two,
\item item three.
\end{compactitem}
```

Figure 1.2: Compact Lists

- item one,
- item two,
- item three.

Granted, the lists are still wide, but this is because we need to honour the requirement for double line-spacing.

1.2 Special Characters

Bear in mind that certain characters are special LaTeX symbols and need to be escaped, as shown in Table 1.1.

Table 1.1: Special Characters in LaTeX

Symbol	Name	Escape code
#	hash, pound	`\#`
$	dollar	`\$`
%	percent	`\%`
^	"hat"	`\^{}`
&	ampersand	`\&`
_	underscore	`\_`
{	left brace	`\{`
}	right brace	`\}`
~	tilde	`\~{}`
∼	wide tilde	`$\sim$`
"	open double quotes	` `` `
"	close double quotes	`''`

Note that for quotation marks, you might prefer ``this'' and `that' (“this” and ‘that’) instead of "this" and 'that' ("this" and 'that').

If you need to typeset special characters (such as ⛔, ☣, ☺, ⌒, etc), take a look at the Comprehensive LaTeX Symbol List. It should be under `C:\ProgramFiles\MiKTeX2.5\doc\info\symbols\comprehensive\symbols-a4.pdf` if you installed MiKTeX on a Windows machine.

1.3 Useful Resources

(Mittelbach et al., 2004) is a *very* useful book — but it's quite an investment at RM180++. A worthy one, nevertheless. Roberts (2005) has a website with very good LaTeX tutorials at http://www.comp.leeds.ac.uk/andyr/misc/latex/, too. Don't forget the famous `lshort` tutorial (Oetiker et al., 2006).

I've also compiled a list that I find useful at http://liantze.googlepages.com/latextypesetting (Lim, 2007), which also hosts slide materials I presented at the Introductary LaTeX Workshop at CSPC'07.

CHAPTER 2

CITATIONS AND BIBLIOGRAPHY

This chapter should have been a survey on the history of TEX and LATEX, and a comparison to conventional word processors in preparing academic documents. Due to lack of time on the author's part, and also the abundance of such discussions on the web, we look at ways to prepare the bibliography and citations instead.

2.1 The `*.bib` File

First of all, bear in mind that your bibliography file (`*.bib` files) is like a database. That means you can maintain a centralised list, and reuse it for all your publications. LATEX will only list sources that you actually cite in the text for each document, according to the bibliography and citation style you select in each document. But you can still hack it so that your own publications are listed, even if you did not cite it.

```
@BOOK{latex:companion,
  title = {The \LaTeX{} Companion},
  publisher = {Addison-Wesley},
  year = {2004},
  author = {Frank Mittelbach and Michel Goosens and Johannes Braams and
      David Carlisle and Chris Rowley},
  series = {Addison-Wesley Series on Tools and Techniques for Computer
      Typesetting},
  address = {Boston, MA, USA},
  edition = {2nd}
}
```

Figure 2.1: A BibTeX Entry

As an example, in `mybib.bib` I created a BibTEX entry with JabRef, the source text of which is shown in Figure 2.1.

One thing to note about authors' names: BibTEX recognises "Mittelbach" as the last name for both `Frank Mittelbach` and `Mittelbach, Frank`. So for a name like "Lim Lian Tze", you would have to specify it as either `Lian Tze Lim` or `Lim, Lian Tze` for BibTEX to recognise "Lim" as the last name correctly. In addition, if the surname or family name of an author consists of multiple words, enclose it with braces to avoid surprises, like so: `Syed Muhammad Naquib {al-Attas}`.

2.2 Citations using the `natbib` package

The `usmthesis` package imports the `natbib` package which provides flexible citation mechanisms, so see its documentation for more details. On a MiKTEX or ProTEXt installation, use the command prompt to issue `mthelp --view natbib` to access the documentation. On teTeX, simply type `texdoc natbib` and the documentation will be displayed automatically, if it's found on your machine.

The basic citation commands are `\citet` and `\citep`, which stands for *textual* and *parenthetical* citation respectively. They take extra arguments, too, for adding notes in the citations.

2.2.1 Author-Year System

Author-year styles include those in the Harvard package, such as `agsm, dcu, kluwer` and others. If you're using an author-year system, like I did for this sample thesis, you get the following:

- `\citet{latex:companion}` → Mittelbach et al. (2004)
- `\citet[chap.~2]{latex:companion}` → Mittelbach et al. (2004, chap. 2)
- `\citep{latex:companion}` → (Mittelbach et al., 2004)
- `\citep[chap.~2]{latex:companion}` → (Mittelbach et al., 2004, chap. 2)

- `\citep[see also][]{latex:companion}` → (see also Mittelbach et al., 2004)
- `\citep[see also][chap.~2]{latex:companion}` → (see also Mittelbach et al., 2004, chap. 2)
- `\citet{latex:companion,roberts}` → Mittelbach et al. (2004); Roberts (2005)
- `\citep{latex:companion,roberts}` → (Mittelbach et al., 2004; Roberts, 2005)

You may also want to write only the author's name or year occassionally:

- `\citeauthor{latex:companion}` → Mittelbach et al.
- `\citeyear{latex:companion}` → 2004
- `\citeyearpar{latex:companion}` → (2004)

2.2.2 Numeric System

If you prefer the plain, numerical system, do the following steps first:

1. In `usmthesis.cls`, search for the line `\RequirePackage{natbib}` and modify it to:

   `\RequirePackage[numbers]{natbib}`
2. In `usmthesis.tex`:
   - comment out the line starting with `\citestyle{...}`
   - modify the `biblography` styles to:

     `\bibliographystyle{plainnat}`

     `\bibliographystyleown{plainnat}`

   or any other number system style that you prefer.

You will then get the following citation outputs:

- `\citet{latex:companion}` → Mittelbach et al. [1]

- `\citet[chap.~2]{latex:companion}` → Mittelbach et al. [1, chap. 2]
- `\citep{latex:companion}` → [1]
- `\citep[chap.~2]{latex:companion}` → [1, chap. 2]
- `\citep[see also][]{latex:companion}` → [see also 1]
- `\citep[see also][chap.~2]{latex:companion}` → [see also 1, chap. 2]
- `\citet{latex:companion,roberts}` → Mittelbach et al. [1], Roberts [3]
- `\citep{latex:companion,roberts}` → [1, 3]
- `\citeauthor{latex:companion}` → Mittelbach et al.
- `\citeyear{latex:companion}` → 2004
- `\citeyearpar{latex:companion}` → [2004]

CHAPTER 3

FIGURES, TABLES, EQUATIONS, ALGORITHMS, ETC

(This is supposed to be the design or methodology chapter. Instead, we include examples on inserting figures, tables, mathematical equations. . . i.e. things that you might want to include in your thesis.)

3.1 Inserting Figures

You can draw diagrams with special LaTeX commands, but this may take some extra time to learn. I've had some forays into the `pgf` and `tikz` packages and must say I quite like the results; but as I said, they take time to learn. If you want a faster solution, you can draw your diagrams using other applications, and saving them as graphic files (EPS, PNG, JPG, PDF).

LaTeX requires EPS (encapsulated postscript) graphic files when generating DVI output, and PNG, JPG or PDF when generating PDF output. (I have never got GIF files to work. If you have, please let me know.)

For exporting to EPS, I use GIMP, the open-source (and free-of-charge) equivalent of Photoshop[1]. I see an export to EPS option too in Photoshop, but the resultant file just doesn't seem to work with LaTeX.

Do note that IPS **discourages** the use of colours in your thesis, including diagrams and figures. Phographs and colour plates are exceptions to this rule: see Section 3.2.

[1] GIMP runs on Windows too, but remember to install GTK2+ first. You'll find the download links on the GIMP website at http://www.gimp.org/. If you're comfortable with the command line interface, you may consider ImageMagick, too.

Here's how to insert a picture with the filename `pythag.eps` or `pythag.png`. I'm going to display it here with 5cm width, and the caption "Pythagoras' Theorem".

```
\begin{figure}[hbtf!]\centering
\includegraphics[width=50mm]{pythag}
\caption{Pythagoras' Theorem}\label{fig:pythagoras}
\end{figure}
```

Figure 3.1: Including a Graphics File

The result would be:

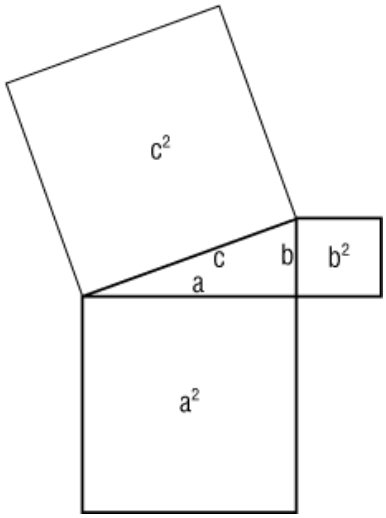

Figure 3.2: Pythagoras' Theroem

Don't specify the extension of the graphic file. The template will automatically look for the EPS or the PNG (or otherwise) versions, depending on whether `latex` or `pdflatex` was used. The `figure` environment will also ensure that that an entry is inserted into the *List of Figures* automatically – including the figure numbering, caption and page number.

In addition, the width of the included graphics can also be specified as a percentage of the text width, e.g. `width=.2\textwidth` would cause the graphics to occupy 20% of the text width.

Notice that I inserted a `\label` just after the `\caption`. This can be used for referencing the figure number, like this:

`Figure \ref{fig:pythagoras}` → Figure 3.2

This works the same for chapters, sections, tables, equations too. In `chap-intro.tex`, I labelled the Introduction chapter with `\label{chap:intro}`. I also labelled the section on inserting figures, `\label{sec:figure}`. So now I can do

`Chapter \ref{chap:intro}` → Chapter 1

`section \ref{sec:figure}` → section 3.1

Everytime the numbering of the heading changes, the reference will change automatically as well. **This is another advantage of using LaTeX**: you do not need to manually update the reference counters (nor the Table of Contents, List of Figures and Tables) whenever you add or remove figures, tables, sections or chapters.

You might also want to try out `JpgfDraw`: it is a vector graphics and drawing application (requiring Java), and can export to LaTeX code which you can paste into your LaTeX source. `JpgfDraw` is available from http://theoval.cmp.uea.ac.uk/~nlct/jpgfdraw/index.html.

3.2 Inserting Plates

Colour photographs are now regarded as *plates*. They must be listed in the *List of Plates* instead of the List of Figures, and should be printed in colour on glossy photo paper (IPS, 2007).

The `usmthesis` document class defines a new `plate` environment, as well as a corresponding `\listofplates` command. (The `\listofplates` command is already placed in the sample template file `usmthesis.tex`.) In short, all you need to do to insert a photograph or plate (as a graphics file `USMScience.{eps,png,jpg}`) is shown in Figure 3.3, and you will

then get Plate 3.1 as the result.

```
\begin{plate}[hbtf!]\centering
\includegraphics[width=.9\textwidth]{USMScience}
\caption{School of Computer Sciences, USM}\label{plate:ppsk:usm}
\end{plate}
```

Figure 3.3: Inserting a Plate

Plate 3.1: School of Computer Sciences, USM

3.3 Inserting Tables

Typesetting tables can be a little troublesome especially with complex layouts. Look up (Roberts, 2005) to learn about some tips, or you can use the LaTable program (http://www.g32.org/latable/) to help you.

If using LaTable, when you're done designing the table, copy the whole table as LaTeX code, and paste it in your source file. (You may add additional formatting commands, like bold, italics, etc.) If this is going to be a numbered table, remember to surround it with `\begin{table}`

and \end{table}, and give it a caption, like this:

```
\begin{table}[hbtf!]\centering
\begin{tabular}{| l | c || r |}
\hline
\textbf{Name} & \textbf{Category} & \textbf{Quantity} \\
\hline\hline
Apple & Fruit & 10 \\
\hline
Cucumber & Vegetable & 25 \\
\hline
Daisy & Flower & 5 \\
\hline
\end{tabular}
\caption{Sample Table Only} \label{table:sample}
\end{table}
```

Figure 3.4: Typesetting Tables

Table 3.1: Sample Table Only

Name	**Category**	**Quantity**
Apple	Fruit	10
Cucumber	Vegetable	25
Daisy	Flower	5

Note also that usmthesis is configured such that captions for figures are placed *below* the figures, and captions for tables are placed *above* them, in accordance with the formatting guidelines.

3.4 Full-paged, Sideways Figures and Tables

To make a figure appear on a landscape, full-page layout, put your \includegraphics command in a sidewaysfigure environment (Figure 3.5).

```
\begin{sidewaysfigure}\centering
\includegraphics[width=\textheight]{latex-win-comp}
\caption{A full-page, sideways figure}\label{fig:sidewaysfig}
\end{sidewaysfigure}
```

Figure 3.5: Including a sideway, full-page graphic

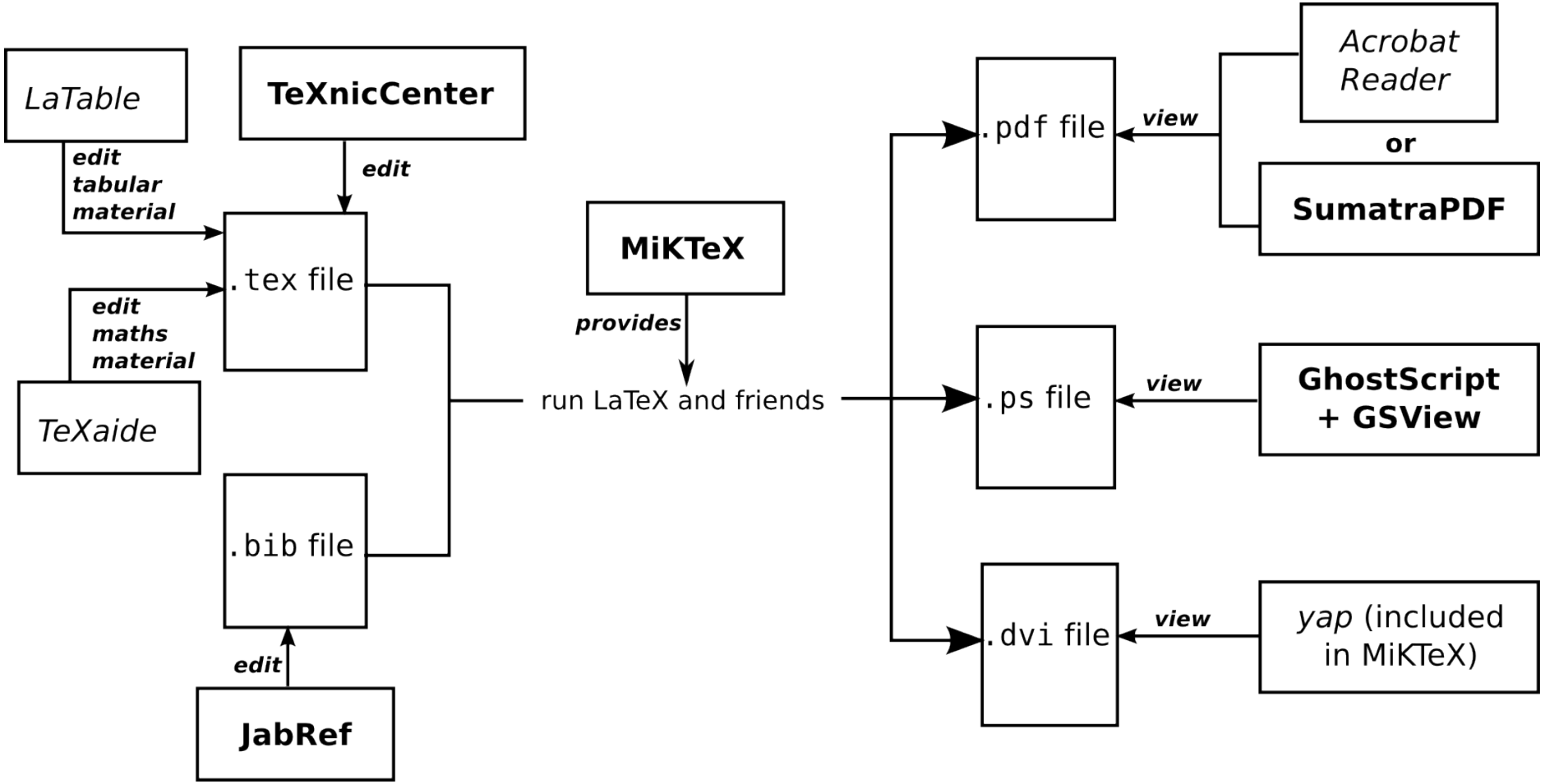

Figure 3.6: A full-page, sideways figure

The resultant figure (Figure 3.6) should appear on the next page.

For a sideways table, use the `sidewaystable` environment instead around your usual `tabular` material.

3.5 Mathematical Equations

Typesetting mathematical material is one of, if not *the*, strongest capabilities of LaTeX. After all, that was the Knuth's main motivation for creating TeX. As it is impossible to enumerate all possible mathematically-related commands and macros here, we will just give some examples. The reader is directed to the many well-written online tutorials, such as (Roberts, 2005), for more elaborate examples. TeXnicCenter also provides many shortcut buttons for inserting mathematical symbols.

```
\begin{equation}\label{eq:pythagoras}
z^2 = x^2 + y^2
\end{equation}

\begin{equation}\label{eq:golden:ratio}
\phi = \frac{1}{2} (1 + \sqrt{5})
\end{equation}

\begin{equation}\label{eq:golden:ratio}
\phi = \frac{1}{2} (1 + \sqrt{5})
\end{equation}
\begin{equation}\label{eq:golden:ratio:fibonacci}
\phi = 1 + \sum ^ {\infty} _ {n=1}
             \frac{ (-1) ^ {n+1} }{ F_n F_{n+1} }
\end{equation}

Equation~\ref{eq:pythagoras} is the Pythagoras Theorem.
\eqref{eq:golden:ratio} gives the golden ratio $\phi$, and
\eqref{eq:golden:ratio:fibonacci} relates it to the Fibonacci
series.
```

Figure 3.7: Typesetting Mathematical Equations

$$z^2 = x^2 + y^2 \tag{3.1}$$

$$\phi = \frac{1}{2}(1+\sqrt{5}) \tag{3.2}$$

$$\phi = 1 + \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{F_n F_{n+1}} \tag{3.3}$$

Equation 3.1 is the Pythagoras Theorem. (3.2) gives the golden ratio ϕ, and (3.3) relates it to the Fibonacci series.

The LaTeX code to generate the above mathematics materials are shown in Figure 3.7. As you can see, references to equations can be achieved with either `\ref` or `\eqref`.

A disclaimer: if you think the mathematic equations don't look as great as all those LaTeX advocates make them out to be, that's because IPS requires Times to be used and the current offerings of free LaTeX math fonts for Times don't look great. It would've been a different picture if we used Computer Modern.

3.6 Acronyms

If you have a list of acronyms or symbols, edit the file `loa.tex` as in Figure 3.8.

```
\begin{acronym}[UTMK] %% replace 'UTMK' with the longest acronym in your
    list
\acro{IPS}{Institut Pengajian Siswazah}
\acro{PPSK}{Pusat Pengajian Sains Komputer}
\acro{USM}{Universiti Sains Malaysia}
\acro{UTMK}{Unit Terjemahan Melalui Komputer}
\end{acronym}
```

Figure 3.8: The template `loa.tex` for acronyms

You can also use this acronym list to help expand it the first time you mention it in your text. For example, the first time you use `\ac{USM}`, 'Universiti Sains Malaysia (USM)' will be the output (without the quotes). After that, all calls to `\ac{USM}` will give 'USM' (without the

quotes). For more information, see the documentation for the `acronym` package.

3.7 Typesetting Algorithms

As computer scientists, it is quite common to include algorithms. The `algorithmic` package is very handy for this. Its documentation, found under the `doc/latex/algorithms` subdirectory of the LaTeX installation directory, is very helpful. We reproduce a short example from the documentation here.

```
\begin{algorithmic}
\REQUIRE $n \geq 0$
\ENSURE $y = x^n$
\STATE $y \Leftarrow 1$
\STATE $X \Leftarrow x$
\STATE $N \Leftarrow n$
\WHILE{$N \neq 0$}
\IF{$N$ is even}
\STATE $X \Leftarrow X \times X$
\STATE $N \Leftarrow N / 2$
\ELSE[$N$ is odd]
\STATE $y \Leftarrow y \times X$
\STATE $N \Leftarrow N - 1$
\ENDIF
\ENDWHILE
\end{algorithmic}
```

Figure 3.9: Typesetting Algorithms

Require: $n \geq 0$
Ensure: $y = x^n$
  $y \Leftarrow 1$
  $X \Leftarrow x$
  $N \Leftarrow n$
  while $N \neq 0$ **do**
    if N is even **then**
      $X \Leftarrow X \times X$
      $N \Leftarrow N/2$
    else /**N is odd**/
      $y \Leftarrow y \times X$
      $N \Leftarrow N - 1$
    end if
  end while

Figure 3.10: Computing $x^n, n > 0$

3.8 Program Listings

You may have noticed that I used the `lstlisting` environment to typeset some of the LaTeX examples – with pretty-printing[2], too, including automatic line-breaking. For more information, see the documentation for the `listings` package: it's in the `doc/latex/listings` subdirectory of your LaTeX installation directory.

Just to give some simple example here. For example, to typeset a "Hello World" Java program with syntax highlighting, you can use the following code:

```
\lstset{basicstyle=\small\ttfamily, language=Java, breaklines=true, columns
    =fullflexible, tabsize=2}
\begin{lstlisting}
public class HelloWorld {
       public static void main( String arg[] ) {
       for (int i = 0; i < 10; i++) {
                     System.out.println( "Hello World!" + i);
              }
       }
}
\end{lstlisting}
```

Figure 3.11: Typesetting a Java program listing

```
public class HelloWorld {
  public static void main( String arg[] ) {
       for (int i = 0; i < 10; i++) {
     System.out.println( "Hello␣World!" + i);
    }
  }
}
```

Figure 3.12: A pretty-printed Java program listing with syntax highlighting

If you want to turn off the syntax highlighting, set `language={}`. (See the `listings` documentation for a list of programming languages for which syntax highlighting is supported.) You can also change the `basicstyle` value to get different effects: e.g. a different font family, size or text formatting.

[2]Whether you agree that it *is* pretty is another story altogether.

Here's another example for a C program:

```
\lstset{basicstyle=\sffamily, language=C, breaklines=true, columns=
    fullflexible, tabsize=2}
\begin{lstlisting}
int main() {
       int c = 0;
       c = c + 1;
       printf( "%d", c );
       return 0;
}
\end{lstlisting}
```

Figure 3.13: Typesetting a C program listing

```
int main() {
    int c = 0;
    c = c + 1;
    printf( "%d", c );
    return 0;
}
```

Figure 3.14: A pretty-printed C program listing with syntax highlighting

And here is the same C program listing *without* syntax highlighting (by setting `language={}`):

```
int main() {
    int c = 0;
    c = c + 1;
    printf( "%d", c );
    return 0;
}
```

Figure 3.15: A C program listing without syntax highlighting

CHAPTER 4

IMPLEMENTATION

Now is the time to "implement" your thesis with LaTeX. Go forth and typeset! Happy LaTeXing! ☺

4.1 Printing Your Thesis

This is *very* important. Assuming you're printing your thesis from Acrobat Reader, make sure the following settings are chosen correctly in the Print window:

- A4 paper size is selected.
- Make sure your Printer settings is using A4 too.
- No page scaling.

Otherwise, the margins of your printed outputs may go horribly wrong. Print one or two pages first to make sure everything looks fine before printing your entire thesis.

CHAPTER 5

DISCUSSION

Just a placeholder for the discussion chapter.

CHAPTER 6

CONCLUSION

T-that's all folks. Have fun with LaTeX!

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APPENDICES

APPENDIX A

DATA USED

Put some test data here.

APPENDIX B

UML DIAGRAMS

Yet another dummy placeholder for appendix material.

LIST OF PUBLICATIONS

Lim, L. T. (2007a). LaTeX: Beautiful typesetting, [Online]. [Accessed October 10, 2014]. Available from World Wide Web: http://liantze.googlepages.com/latextypesetting.

Lim, L. T. (2007b). Writing your thesis with LaTeX, Internal circulation, School of Computer Sciences, Universiti Sains Malaysia.