Using LaTeX for High Quality Project Report Generation

A PROJECT REPORT

Submitted in partial fulfilment for the award of the degree of

MS

in

Sofware Engineering

By

Santhos Baala RS, 09MSE038

Under the Guidance of

Dr. Krishna Chandramouli

Associate Professor

SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING

VIT UNIVERSITY

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(Estd. u/s 3 of UGC Act 1956)

Vellore - 632 014, Tamil Nadu, India

DECLARATION BY THE CANDIDATE

I here by declare that the project report titled, **"Using LaTeX for High Quality Project Report Generation"** submitted by me to VIT University, Vellore in partial fulfilment of the requirement for the award of the degree of **M.S. (Software Engineering)** is a record of bonafide project work carried out by me under the guidance of **Dr. Krishna Chandramouli(Associate Professor)**. I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place: Vellore Signature of the Candidate

Date:

Santhos Baala RS (09MSE038)

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(Estd. u/s 3 of UGC Act 1956)
Vellore - 632 014, Tamil Nadu, India

SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING [SITE]

SOFTWARE ENGINEERING DIVISION

BONAFIDE CERTIFICATE

This is to certify that the project report titled, **"Using LaTeX for High Quality Project Report Generation"**, submitted by **Santhos Baala RS (09MSE038)** to VIT University, Vellore in partial fulfillment of the requirement for the award of the degree of M.S. (Software Engineering) is a record of bonafide work carried out by him/her under my guidance. The project fulfills the requirements as per the regulations of this institute and in my opinion meets the necessary standards for submission. The contents of this report have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Dr. Krishna Chandramouli
Internal Guide
Associate Professor,
School Of Information Technology & Engineering

Internal Examiner **External Examiner**

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Executive Summary

This document describes how to use the vitmsprojectreport class with LaTeX to produce high quality typeset project report that is suitable for submission to the School of Information Technology and Engineering (SITE). The class can further be extended to various courses and department by modifying the title page and department information.

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1. Introduction

1.1 About the Template

With a basic understanding of the LaTeX language and say 10 to 20 commands, an author can produce beautiful typeset project report quickly, with minimal effort. The purpose of this document is to serve as a user guide for the project report template and document its special behaviours. Examples have also been provided for common tasks such as insertion of images, table, equation, etc., that can be copied as is by the users. It is assumed that the user has a basic knowledge on working of the LaTeX system. Those lacking are strongly urged to lookup some excellent literature through [2].

Sufficient examples have been given in the document and as users request solutions for specific problems that they encounter, more will be added. However, an understanding of the LaTeX system will help the user in unexplainable ways[1]. The main advantage of using the custom class is that, the user need not worry about the final layout. The class may be changed during the development of the project report, the user needs to just place the latest version of the class file, without touching the content[2]. LaTeX, along with the custom class file gives an incredible expressive power its users so that they can focus on the semantics of the document.

1.2 Generic LaTeX Commands

LaTeX contains many commands and with it comes numerous built-in packages that add many features and provide options to customise the output. However, the user is advised to stick to the basic commands, illustrated in this document so that unexpected or incorrect output can be avoided. If, however a specific feature is requested it shall be considered and incorporated into the template. The class file for project report has been extended from the standard *report* class, supplied by LaTeX. Therefore, whatever applied for report also applies for the custom class file.

---

[1] The LaTeX system is a vast ocean. That said, you can mostly get away with copy-paste skills. You have to observe the source code of the examples and learn

[2] It is always recommended to get the latest class file from the repository and compile before project report submission.

1.3 Generating the Final Document

The template development is an ongoing process. It is mature at this point from the point of view of semantics. Layout or default contents (e.g bonafide, acknowledgement, etc.,) may change at a later point in time. Therefore, before generating the final document, please make sure to check out a frozen version of the class file from the repository before compiling the class file.

1.4 Asking Questions

You can post your questions in the forum or if you encounter any problem related to unexpected/incorrect output due to the template send an e-mail to the contributors at the github page.

1.5 Contributing

The project is hosted on GitHub [3] and uses the GIT repository management system. Contributors can fork the project and send pull requests to the repository for the changes to be merged. The patch will be evaluated and if found to be good, merged into the master branch of the repository. If however, a separate template is required for other departments and courses, the project can be forked and maintained separately. Issues, pertaining to the template, such as rendering faults, can be posted in the issues section of the repo. The contributors shall also put up a list of items that need improvement or new features in progress that people can contribute to.

2. Auto-Generated Pages

The parts of the document, unique to the project report are generated by a predefined template, using simple commands. The order in which the commands are issued determine the corresponding order of these individual pages. The arguments that need to be passed to these commands are explained in the following sections. The sequence of commands to generate such pages have already been placed in the example document and it is recommended not to touch those, expect when inserting your project specific information.

2.1 The Title Page

The user can generate the title page using the `\maketitlepage` command. The detailed syntax is given in Figure 2.1.

```
%--------- Copy-Paste For Title Page ---------%
\maketitlepage
{Project Title}
{Name}
{RegNo}
{Guide Name}
{Guide Title}
%--------- Copy-Paste For Title Page ---------%
```

Figure 2.1: The syntax of \maketitlepage command

Note that you should always set the title page to be the first page of the document, so issue this command right after the document begins. The template also collects information like your name and regno when you declare the title page so that it can be auto-inserted into other pages like declaration and bonafide. The following subsections d

2.1.1 Project Title

Your project title should be placed here. If your title is long and you are not satisfied with the way the lines break, use \\ to insert line breaks at suitable locations. Note the inclusion of blank space after the backslashes.

E.g. `{A very very\\ long long title}`.

2.1.2 Regno

Supply your register number here. A long name will automatically push the register number to the next line. However, to be safe, prepend your RegNo with \\.
E.g. `{\\09MSE038}`.

2.1.3 Guide Name

Your guide's name goes here. Make sure to add your guide's title too, Prof., Dr., etc. Also, be sure to add a non-breaking space "~" after the title so that unintended line breaks are prevented. Follow the regular convention of first name, last name.
E.g. `{Prof.~Robert}` or `{Dr.~John}`.

2.1.4 Guide Title

Your Guide's title(designation) goes here. Do not abbreviate anything.
E.g `{Assistant Professor (Senior)}`.

2.2 Declartion Page

Use `\makedeclarationpage` command, rest is automatically generated!

2.3 Bonafide Page

Use `\makebonafidepage` command, rest is automatically generated!

2.4 Acknowledgement Page

Use `\makeackpage` command to generate the page. The generated text is more than sufficient for acknowledgement. However, if there is a request for custom writeup for the acknowledgement page, we'll consider that[1]. There are three arguments to this page as given in Figure 2.2. Make sure to prepend the names with appropriate titles, Mr, Dr, etc., and remember to give a non-breaking space character just after the title as you did for your guide's name in 2.1.3

[1] We don't want to kill creativity!

```
%--------- Copy-Paste For Acknowledgement Page ----------%
\makeackpage
{Dean Name}
{Program Manager Name}
{Year Co-Ordinator Name}
%--------- Copy-Paste For Acknowledgement Page ----------%
```

Figure 2.2: The syntax of \makeackpage command.

2.5 Executive Summary Page

The command `\makeexecsummarypage` creates the executive summary page. The only argument to this function is your executive summary. Keep it down to 1-2 paragraphs. An example is given in Figure 2.3.

```
%--------- Copy-Paste For Executive Summary Page ----------%
\makeexecsummarypage{
This document describes how to use the vitmsprojectreport
class with \LaTeX\ to produce high quality typeset project
report that is suitable for submission to the School of
Information Technology and Engineering (SITE). The class
can further be extended to various courses and department
by modifying the title page and department information.
}
%--------- Copy-Paste For Executive Summary Page ----------%
```

Figure 2.3: Example usage of the \makeexecsummarypage command.

2.6 Single Command to Generate All the Starting Pages

The shortcut `\makestartingpages`, renders all the starting pages. The format of the parameters that applied to individual commands mentioned previously apply here to.

```
%--------- Copy-Paste for Starting Pages ----------%
\makestartingpages
{Project Title}
{Name}{Regno}
{Guide Name}{Guide Title}
{Dean Name}
{Program Manager Name}
{Year Co-Ordinator Name}
{Executive Summary Contents}
%--------- Copy-Paste for Starting Pages ----------%
```

Figure 2.4: Single command to render all the starting pages.

3. Text Elements

The chapters, sections and subsections in the document are created with the standard commands `\chapter`, `\section` and `\subsection` respectively. The text sections are automatically numbered using arabic numerals and also added to the table of contents. You can create a deeper level using `\subsubsection`. It is recommended to keep the depth restricted to the subsection level. The template doesn't guarantee proper output for beyond that. The following sections illustrate on creating various text structures in the document and cross-references.

3.1 Chapters, Sections and Sub-Sections

Chapters are created with the `\chapter` command. The chapter title is passed as an argument. Each chapter is automatically placed in a separate page. Sections and Sub-Sections under a chapter are created with the `\section` and `\subsection` respectively. The syntax of all the commands are given in Figure 3.1.

```
%--------- Copy-Paste for Chapter/Section/Sub-Section ----------%
\chapter{The Chapter Title}
\section{The Section Title}
\subsection{The Sub-Section Title}
%--------- Copy-Paste for Chapter/Section/Sub-Section ----------%
```

Figure 3.1: Commands to create text structures.

If you want to place a section inside a chapter, place it under that chapter. Similarly, a sub-section meant to be placed inside a section is placed under the corresponding section. That's how levels are created. The sequence of commands in Figure 3.1 will create a sub-section, under a section, which in turn is under a chapter.

3.2 Lists

List is inherited directly from vanilla LaTeX list. You can look them up from any tutorial for LaTeXlists, preferably from [2]. We give a short example of an unordered list and an ordered list over here. Changing the list style, bullet shape, etc., is your choice. *Note that an empty list(list with no items) will throw an error during compilation.* More information

on the list structure is available at http://en.wikibooks.org/wiki/LaTeX/List_Structures#Enumerate.

3.2.1 Unordered

An unordered list is generated by the `\begin{itemize}...\end{itemize}` environment with `\item` commands inside. The listing in Figure 3.2 generates an unordered list, placed to the right of the same figure.

```
%--------- Copy-Paste for Unordered List ----------%
\begin{itemize}
\item C
\item C++
\item Java
\end{itemize}
%--------- Copy-Paste for Unordered List ----------%
```

- C
- C++
- Java

Figure 3.2: Unordered list example.

3.2.2 Ordered

Ordered lists can be generated by the `\begin{enumeration}...\end{enumeration}` environment with `\item` commands inside. The listing in Figure 3.3 generates an orders list, placed to the right of the same figure.

```
%--------- Copy-Paste for Ordered List ----------%
\begin{enumerate}
\item C
\item C++
\item Java
\end{enumerate}
%--------- Copy-Paste for Ordered List ----------%
```

1. C
2. C++
3. Java

Figure 3.3: Ordered list example.

The default numbering scheme of the template is arabic and it is recommended not to change that. The numbering scheme for nested ordered lists is automatically managed.

3.2.3 Description List

Sometimes, it is required to render something like a definition list. Although semantically it isn't a list, it follows the same syntax structure. Such special type of lists can be created with the `\begin{description}...\end{description}` environment and the `\item[...]` command. The usage of one such special list is illustrated in Figure 3.4 along with the output.

```
%--------- Copy-Paste for Description List ----------%
\begin{description}
\item[C] The first item's description
\item[C++] The second item's description
\item[Java] The third item's description
\end{description}
%--------- Copy-Paste for Description List ----------%
```

C The first item's description

C++ The second item's description

Java The third item's description

Figure 3.4: Description list example.

3.3 Footnotes

A footnote is an ancillary piece of information, something that is additional but less important. They are placed at the bottom of the page[1]. The template automatically adds a horizontal rule to separate it from the main flow of the document. Each footnote is numbered, specific to the chapter in which it resides. A footnote is added through the `\footnote` command, with the actual contents of the footnote as the argument. Footnotes are meant to be added along the regular flow of the document. It is illustrated by Figure 3.5.

There may be multiple pages in the same page. The placement of the footnote, flow into the next page, numbering, etc., are all automatically managed.

[1] This is a sample footnote

```
%--------- Copy-Paste for Footnote ----------%
This is the regular flow of document\footnote{This piece of
text is treated as a footnote}.
%--------- Copy-Paste for Footnote ----------%
```

Figure 3.5: An example footnote.

3.4 Cross-References

Other elements in the document can be referenced via the `\ref` command at the location where a reference is to be inserted and the target identifies itself with a `\label` command.

3.5 External References

TODO

4. Figures and Algorithms

Elements that are treated as figures the document are discussed here. In the following sections, examples have been provided on how to include figures and algorithms in the document.

4.1 Figures

Figures are handled in the standard LaTeX manner. An minimalistic example is given in Figure 4.1. The figure is placed inside the `\begin{figure}...\end{figure}` environment. The options passed to the environment is the figure placement priority preference, h - at the current location, t - top and b - bottom. `\centering` indicates that the figure and caption should be placed at the centre. `\includegraphics` is self explanatory, with the width option and the source file. The source file extension is optional, left blank, LaTeX chooses the best available format automatically. The rest of the section contains image inclusion and subfigure examples. The output generated is Figure 4.2.

```
%--------- Copy-Paste for Simple Figure ----------%
\begin{figure}[htb]
\centering
\includegraphics[width=0.5\textwidth]{images/105003.jpg}
\caption{The big cat}
\label{fig:big_cat}
\end{figure}
%--------- Copy-Paste for Simple Figure ----------%
```

Figure 4.1: Using 50% of the textbox to place the image.

4.1.1 Sub-Figures

Figures inside figures. The subfigures are suitable when you want to explain a progressive concept through images. For example, a solar eclipse, amoeba fisson, etc. Figure 4.3 partially lists the code for rendering subfigures[1], Figure 4.4 is the output.

[1] Refer the source code of this document for more

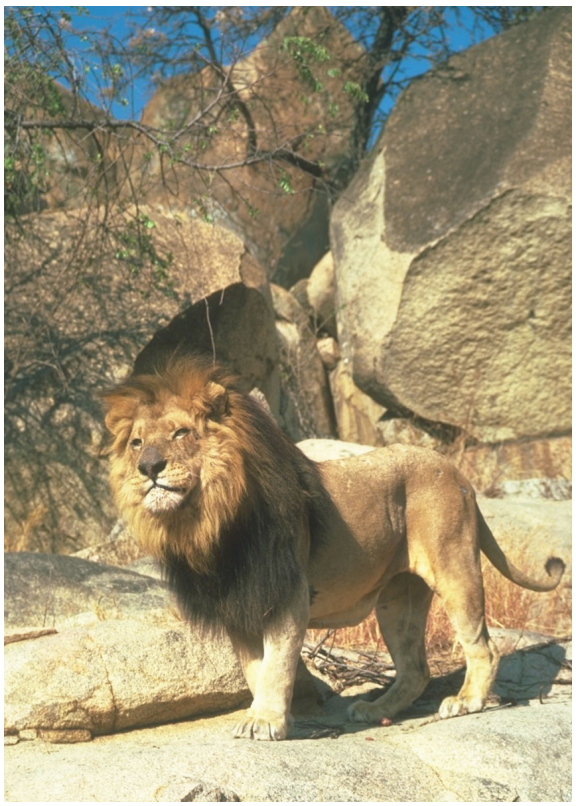


Figure 4.2: The big cat

4.2 Algorithms

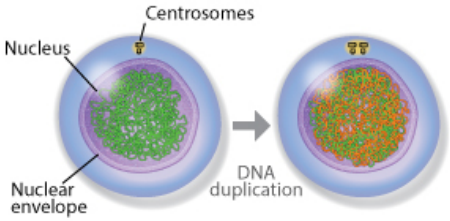
In this template, algorithms are treated as figures for the sake of simplicity. They too get listed in the list of figures. Similar to a figure, algorithms need to be placed in the `{algorithm}` environment. The actual algorithm is represented by the statements inside the `{algorithmic}` environment. It defines its own set of commands. We strongly recommend the algorithmic environment compared to other packages offering similar functionality since it has been tested on the template and has a compact vocabulary. Figure 4.5 lists the algorithmic code for generating the output in Figure 4.6. Learn more about the algorithmic commands from [1].

Another informal way of defining algorithms is to use an enumeration list, suppose you are not concerned with the specifics of your algorithm or it simply needs to be descriptive. Figure 4.8 is one such listing, generated by the sample source in Figure 4.7[2].

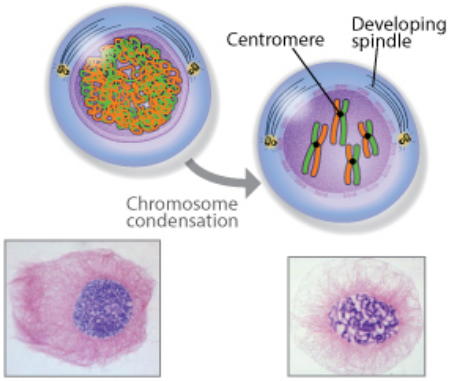
[2]Refer to the complete listing in this document's source code

```
\begin{figure}[htb]
\centering
\begin{subfigure}[b]{0.4\textwidth}
\includegraphics[width=\textwidth]{images/interphase.png}
\caption{Interphase}
\label{fig:mitosis_interphase}
\end{subfigure}
% Spacing %
\hspace{0.1\textwidth}
% Spacing %
\begin{subfigure}[b]{0.4\textwidth}
\includegraphics[width=\textwidth]{images/prophase.png}
\caption{Prophase}
\label{fig:mitosis_prophase}
\end{subfigure}
% Spacing %
\linebreak\linebreak
% Spacing %
\begin{subfigure}[b]{0.4\textwidth}
\includegraphics[width=\textwidth]{images/prometaphase.png}
\caption{Prometaphase}
\label{fig:mitosis_prometaphase}
\end{subfigure}
% Spacing %
\hspace{0.1\textwidth}
% Spacing %
...
...
...
% End of subfigures
\caption{The steps of mitosis.}
\label{fig:mitosis}
\end{figure}
```

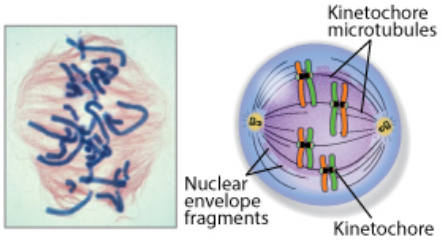
Figure 4.3: Subfigure example.



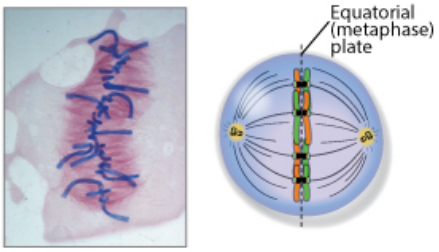
(a) Interphase



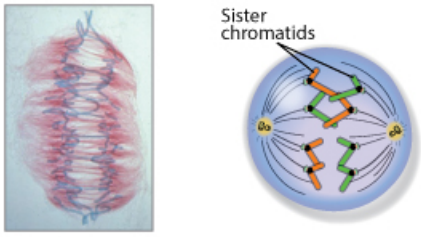
(b) Prophase



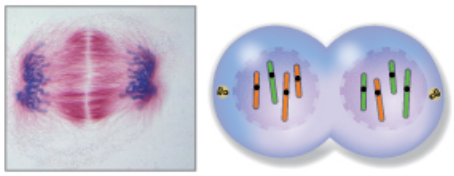
(c) Prometaphase



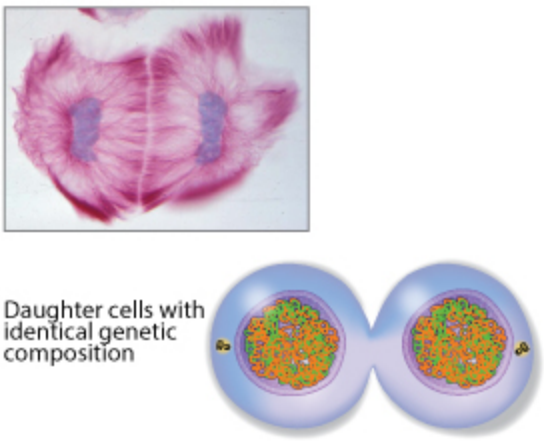
(d) Metaphase



(e) Anaphase



(f) Telophase



(g) Cytokinesis

Figure 4.4: The steps of mitosis.

```
%--------- Copy-Paste for Algorithms ----------%
\begin{algorithm}
\begin{algorithmic}[1]
\Procedure{Euclid}{$a,b$}\Comment{The g.c.d. of a and b}
\State $r\gets a\bmod b$
\State $a\gets b$
\State $b\gets r$
\State $r\gets a\bmod b$
\State \textbf{return} $b$\Comment{The gcd is b}
\EndProcedure
\end{algorithmic}
\caption{Euclid's Algorithm}
\label{algo:euclid_algorithm}
\end{algorithm}
%--------- Copy-Paste for Algorithms ----------%
```

Figure 4.5: Euclid's algorithm, written in algorithmic.

1: **procedure** EUCLID(a, b) ▷ The g.c.d. of a and b
2: $r \leftarrow a \bmod b$
3: $a \leftarrow b$
4: $b \leftarrow r$
5: $r \leftarrow a \bmod b$
6: **return** b ▷ The gcd is b
7: **end procedure**

Figure 4.6: Euclid's Algorithm

```
%--------- Copy-Paste for Descriptive Algorithm ----------%
\begin{algorithm}
\begin{enumerate}
    \item Initialize a population array of particles with
     random positions and velocities on $d$ dimensions,
     in the problem space.
    ...
    ...
    ...
    \item Loop to 2, until the stoping criterion is satisfied.
\end{enumerate}
\caption{Steps to perform Brownian motion.}
\label{alto:brownian_motion_steps}
\end{algorithm}
%--------- Copy-Paste for Descriptive Algorithm ----------%
```

Figure 4.7: Listing to generate an enumerated list of steps.

1. Initialize a population array of particles with random positions and velocities on d dimensions, in the problem space.
2. For each particle, evaluate the desired optimization fitness function in d variables.
3. Compare particles fitness evaluation with particles $pbest$. Then set $pbest$ value (to make it) equal to the current value, and the $pbest$ location equal to the current location in d-dimensional space.
4. Compare fitness evaluation with the populations overall previous best. If current value reduces the error to achieve global minima than previous $gbest$, then update gbest value.
5. Update the velocity and position of the particle according to equation 1 and 2.
6. Loop to 2, until the stoping criterion is satisfied.

Figure 4.8: Steps to perform Brownian motion.

5. Tables

Tables are created with the tabular environment. The following sections illustrate the various types of tables.

5.1 A Simple Table

Processor	**Pentium Dual Core 2.00GHz**
Hard Disk	4GB
Mouse	Logitech
RAM	2GB
KeyBoard	110 Keys Enhance

Table 5.1: A padded table with cell spacing

5.2 A Plain Table

Tables that just present key-values are best suited for the plain layout.

5.3 A Somewhat Big Table

5.4 A Very Big Table

5.5 Rotated Table

When you want a horizontally big table to be placed, you have to rotate it[1]. Placing a table inside of the `\begin{sidewaystable}..\end{sidewaystable}` environment, instead of the `\table` environment renders it 90° counter-clockwise rotated. Note that the caption is also rotated.

[1] It is recommended not to span tables across multiple pages, especially when it is being rotated. In case a big data sheet is to be placed, print it separately and attach it to an appendix at the end of your report

Concepts	Ground truth [no img.]
lion	102
water	1081
grass	1064
building	1271
car	182
cloud	708
rock	922
tiger	102
elephant	109
flower	730
boat	234
flower fields	32
modern city view	168
rural garden	182
mountain view	598
waterfalls	15
wild life	322
city street	191

Table 5.2: Number of images in 18 concepts according to ground truth.

Table 5.3: Concept detection accuracy

Training set proportion(%)	5 supported concepts				10 supported concepts			
10	52.06%	51.28%	33.73%	**57.77%**	45.18%	29.10%	21.98%	**49.26%**
30	**64.60%**	63.77%	27.21%	62.99%	56.49%	**56.99%**	21.15%	52.53%
50	**70.67%**	69.58%	25.45%	63.72%	61.88%	**62.37%**	19.76%	50.25%
Method	SVM	GA	SOM	PSO	SVM	GA	SOM	PSO

Table 5.4: Retrieval Precision for each Concept from Corel Database

Concepts	Methods	Retrieval Precision				
Building	SOM	42%	34%	41%	42%	44%
	SVM	46%	**75%**	53%	50%	47%
	PSO	**52%**	68%	**73%**	**75%**	**76%**
Car	SOM	31%	33%	27%	28%	31%
	SVM	**58%**	**74%**	**67%**	**68%**	56%
	PSO	44%	54%	63%	64%	**66%**
Cloud	SOM	39%	40%	41%	42%	44%
	SVM	**80%**	**92%**	73%	70%	69%
	PSO	53%	68%	**75%**	**75%**	**77%**
Grass	SOM	**41%**	26%	34%	26%	37%
	SVM	27%	42%	28%	24%	27%
	PSO	40%	**57%**	**62%**	**65%**	**68%**
Elephant	SOM	31%	38%	36%	34%	40%
	SVM	**74%**	**96%**	**91%**	**83%**	**96%**
	PSO	50%	70%	78%	81%	83%
Lion	SOM	21%	25%	22%	23%	25%
	SVM	48%	59%	49%	48%	42%
	PSO	**53%**	**63%**	**68%**	**71%**	**76%**
Tiger	SOM	36%	29%	40%	32%	46%
	SVM	28%	60%	62%	58%	52%
	PSO	**58%**	**73%**	**78%**	**77%**	**76%**
Average	SOM	34%	32%	34%	32%	38%
	SVM	**51%**	**71%**	60%	57%	55%
	PSO	50%	64%	**71%**	**72%**	**74%**
User Iteration		1	2	3	4	5

Table 5.5: Concept detection accuracy with 15 concepts.

Training set proportion(%)	5 supported concepts				10 supported concepts				15 supported concepts			
10	52.06%	51.28%	33.73%	**57.77%**	45.18%	29.10%	21.98%	**49.26%**	41.87%	37.88%	9.87%	**43.80%**
30	**64.60%**	63.77%	27.21%	62.99%	56.49%	**56.99%**	21.15%	52.53%	53.76%	**53.85%**	20.69%	47.85%
50	**70.67%**	69.58%	25.45%	63.72%	61.88%	**62.37%**	19.76%	50.25%	59.05%	**59.91%**	20.87%	47.03%
Method	SVM	GA	SOM	PSO	SVM	GA	SOM	PSO	SVM	GA	SOM	PSO

6. Equations

Example of equations have been listed below. Refer to the document source code for more.

6.1 Inline

$\sum$ - Inline equation symbols can be inserted with the help of `$ ... $`

6.2 More examples

$\forall x \in X, \quad \exists y \leq \epsilon$

6.2.1 Greek Characters

$\alpha, \beta, \gamma, \pi, \Pi, \phi, \varphi, \Phi$

6.2.2 Operator

$\cos(2\theta) = \cos^2\theta - \sin^2\theta$

6.3 Subscript/Superscript

$\lim_{x \to \infty} \exp(-x) = 0$
$k_{n+1} = n^2 + k_n^2 - k_{n-1}$

6.4 Fractions and Binomials

$\frac{n!}{k!(n-k)!} = \binom{n}{k}$

$$\frac{n!}{k!(n-k)!} = \binom{n}{k}$$

6.5 Equation Environment

Things put into the `\begin{equation}...\end{equation}` environment will automatically be numbered and can be referred like 6.1.

$$\frac{\frac{1}{x}+\frac{1}{y}}{y-z} \tag{6.1}$$

6.6 Fractions

6.6.1 Inline

Fractions can be inline like:
Take $1/2$ cup of sugar, ... $3 \times 1/2 = 1 1/2$
Take $^1/_2$ cup of sugar, ... $3 \times {}^1/_2 = 1^1/_2$

6.6.2 Continued Fractions

$$x = a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cfrac{1}{a_3 + a_4}}} \tag{6.2}$$

6.6.3 Multiplication of two numbers

To make multiplication visually similar to a fraction, a nested array can be used, for example multiplication of numbers written one below the other.

$$\begin{array}{c} (x_1 x_2) \\ \times\, (x_1' x_2') \\ \hline (y_1 y_2 y_3 y_4) \end{array} \tag{6.3}$$

6.7 Fermat numbers

Numbers of the form $2^{2^n} + 1$, where n is a natural number, are called Fermat numbers

6.8 Roots

$$2\sqrt{2}\,, \quad 2^2\sqrt{2-\sqrt{2}}\,, \quad 2^3\sqrt{2-\sqrt{2+\sqrt{2}}}\,,$$

$$2^4\sqrt{2-\sqrt{2+\sqrt{2+\sqrt{2+\sqrt{2}}}}}\ldots$$

6.9 Mathematical Symbols

circ symbol: $x \circ y = x + y - xy$

box symbol: $x \,\square\, y = x^2 + y^2$

6.10 Sample Vectors

`$\vect$` can be used to generate sample vectors $(x_1, x_2, \ldots, x_n)$

Variable name as a parameter `$\expres{a}$` generates $(a_1, a_2, \ldots, a_n)$

`$\vecto{a}{p}$`, generates $(a_1, a_2, \ldots, a_p)$

6.11 More Mathematics

Remove equation numbers with `\begin{equation*}...\end{equation*}`.

$$ax + by + c = 0$$

$$x \leq |x| \quad \text{and} \quad x \geq |x|$$

and so

$$x \leq |x| \quad \text{for all } x \text{ in } R.$$

Use `\begin{multiline}...\end{multiline}` if your equation has to span multiple lines 6.4. Similar to the equation environment, equation numbers can be removed in multiline with `\begin{multiline*}..\end{multiline*}`. Including `\split` inside the multiline gives you a better alignment by splitting the equation into LHS and RHS[1] The various type of equations and techniques to arrange/align them are given the following sections.

[1] A few more examples have been commented out in the source code so that it doesn't look overwhelming to you! Check out the source code, you may find what you need.

6.11.1 Multiline Equations

$$\begin{aligned}(a+b+c+d+e)^2 = a^2 &+ b^2 + c^2 + d^2 + e^2 \\ &+ 2ab + 2ac + 2ad + 2ae + 2bc + 2bd \\ &+ 2be + 2cd + 2ce + 2de\end{aligned} \tag{6.4}$$

$$\begin{aligned}(a+b+c+d+e+f)^2 = a^2 &+ b^2 + c^2 + d^2 + e^2 + f^2 \\ &+ 2ab + 2ac + 2ad + 2ae + 2af \\ &+ 2bc + 2bd + 2be + 2bf \\ &+ 2cd + 2ce + 2cf \\ &+ 2de + 2df \\ &+ 2ef\end{aligned}$$

$$\begin{aligned}(a+b+c+d+e+f)^2 = a^2 &+ b^2 + c^2 + d^2 + e^2 + f^2 \\ &+ 2ab + 2ac + 2ad + 2ae + 2af \\ &+ 2bc + 2bd + 2be + 2bf \\ &+ 2cd + 2ce + 2cf \\ &+ 2de + 2df \\ &+ 2ef\end{aligned}$$

$$\begin{aligned}(a+b)^2 &= (a+b)(a+b) \\ &= a^2 + ab + ba + b^2 \\ &= a^2 + 2ab + b^2\end{aligned}$$

6.11.2 Cases

$$|x| = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x \leq 0 \end{cases}$$

6.11.3 Matrices

The system of equations

$$\begin{aligned} x + y - z &= 1 \\ x - y + z &= 1 \\ x + y + z &= 1 \end{aligned}$$

can be written in matrix terms as

$$\begin{pmatrix} 1 & 1 & -1 \\ 1 & -1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}.$$

Here, the matrix $\begin{pmatrix} 1 & 1 & -1 \\ 1 & -1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$ is invertible.

A Bracket Matrix: $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

$$\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{pmatrix}$$

$\begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = 0$, the matrix $\begin{pmatrix} a & h & g \\ h & b & f \\ g & f & c \end{pmatrix}$ is not invertible.

6.11.4 Symbols with alignment

$$\left.\begin{aligned} u_x &= v_y \\ u_y &= -v_x \end{aligned}\right\} \text{ Cauchy-Riemann Equations}$$

6.11.5 Summations

$$\left(\sum_{k=1}^{n} |x_k y_k|\right)^2 \leq \left(\sum_{k=1}^{n} |x_k|\right)\left(\sum_{k=1}^{n} |y_k|\right)$$

6.11.6 Limits and Integrals

$\lim_{x\to\infty} \int_0^x \frac{\sin x}{x}\,\mathrm{d}x = \frac{\pi}{2}$ and so by definition,

$$\int_0^\infty \frac{\sin x}{x}\,\mathrm{d}x = \frac{\pi}{2}$$

7. References

[1] Szasz Janos. *The algorithmicx package*. Indiana State University, USA, 2005. http://cs.indstate.edu/CS695/algorithmicx.pdf.

[2] Stefan Kottwitz. *LaTeX beginner's guide*. Packt, Birmingham, UK, 2011.

[3] RS Santhos Baala. Vit ms project report class, 2014. https://github.com/santhosbaala/vitmsprojectreport.