Introduction to LaTeX

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Introduction

LaTeX is not a word processor!

Word, for instance, is a WYSIWYG - What you see is what you get.

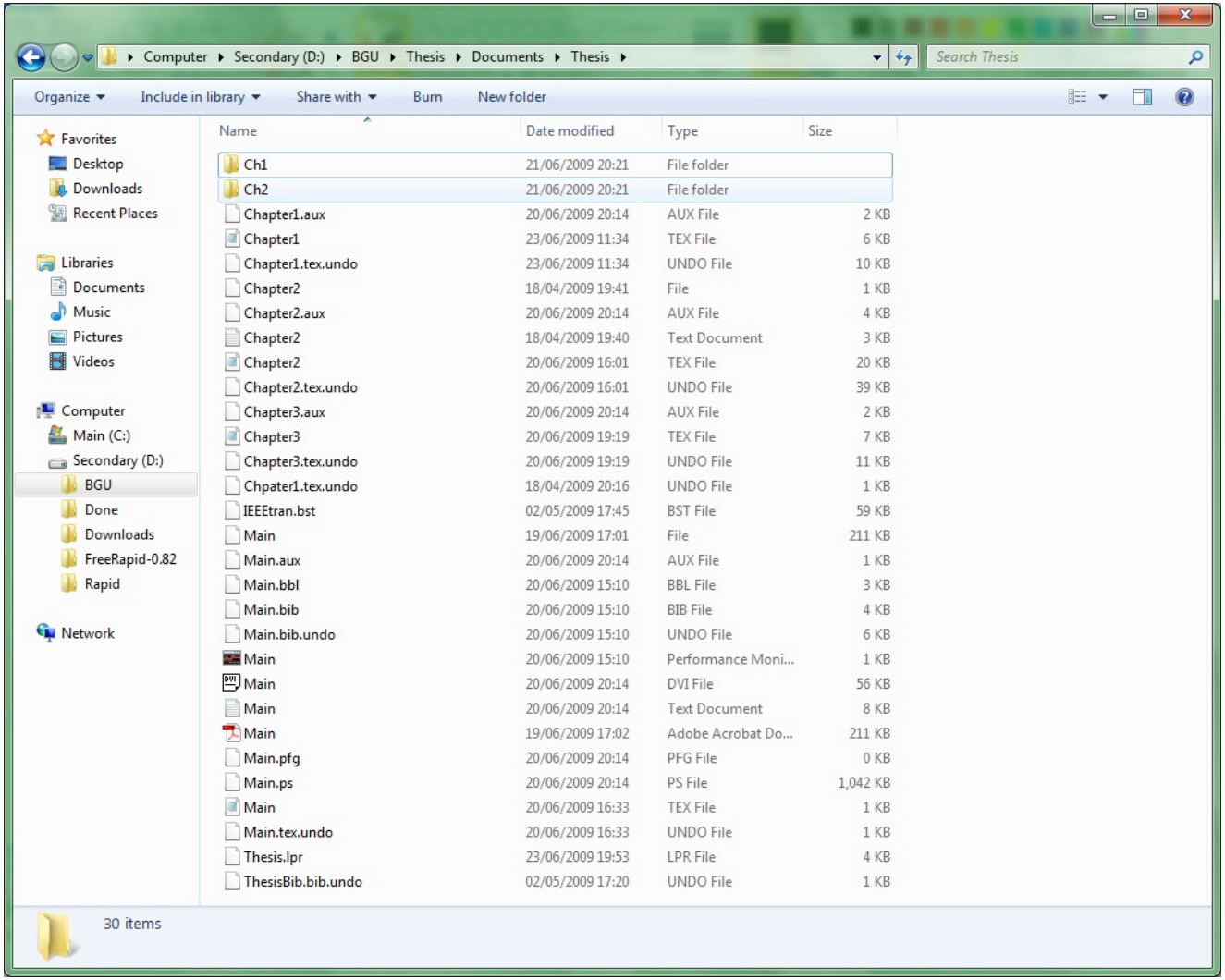
LaTeX is WYSIWYM - What you see is what you mean.

What you can do in LaTeX is:

- Generate papers for journals and conferences
- Control and organize large documents
- Generate complex math formulas
- Manage bibliographies, references and indexes
- Support endless number of fonts and styles

Some examples: organize large documents

Document is actually a project, consist of few files.



Some examples: tables

Fruits	**Summer**	**Autumn**	**Winter**	**Spring**
Apple	✓	✓	✓	✓
Pear				✓
Watermelon	✓			
Grapes	✓			
Orange		✓	✓	

Some examples: complex math formulas

Automatic numbering:

$$y = \int_0^{\infty} \frac{\beta x^2}{2\pi \arcsin(\frac{x}{\pi})} dx \tag{1}$$

$$E = mc^2 \tag{2}$$

Avoid numbering, ident and provide array of equations:

$$\begin{aligned} \left| \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n e^{j2\pi kn\Delta fT} \right|^2 &\leq \frac{1}{N} \sum_{n=0}^{N-1} \left| X_n e^{j2\pi kn\Delta fT} \right|^2 \\ &= \frac{1}{N} \sum_{n=0}^{N-1} |X_n|^2 \sum_{n=0}^{N-1} \left| e^{j2\pi kn\Delta fT} \right|^2 \end{aligned}$$

Start writing in LaTeX

- Install MiKTeX
- Install Ghostscript
- Install either TeXnicCenter or LEd
- Start writing!

Start writing in LaTeX

Setting the document:

LaTeX code

```
\documentclass{article}
\begin{document}
Hello world!
\end{document}
```

And the result is:

Result

Hello world!

I have a comment to make ...

LaTeX code

```
\documentclass{article}
\begin{document}
Hello world!
%But I have a comment to make!
\end{document}
```

And the result is:

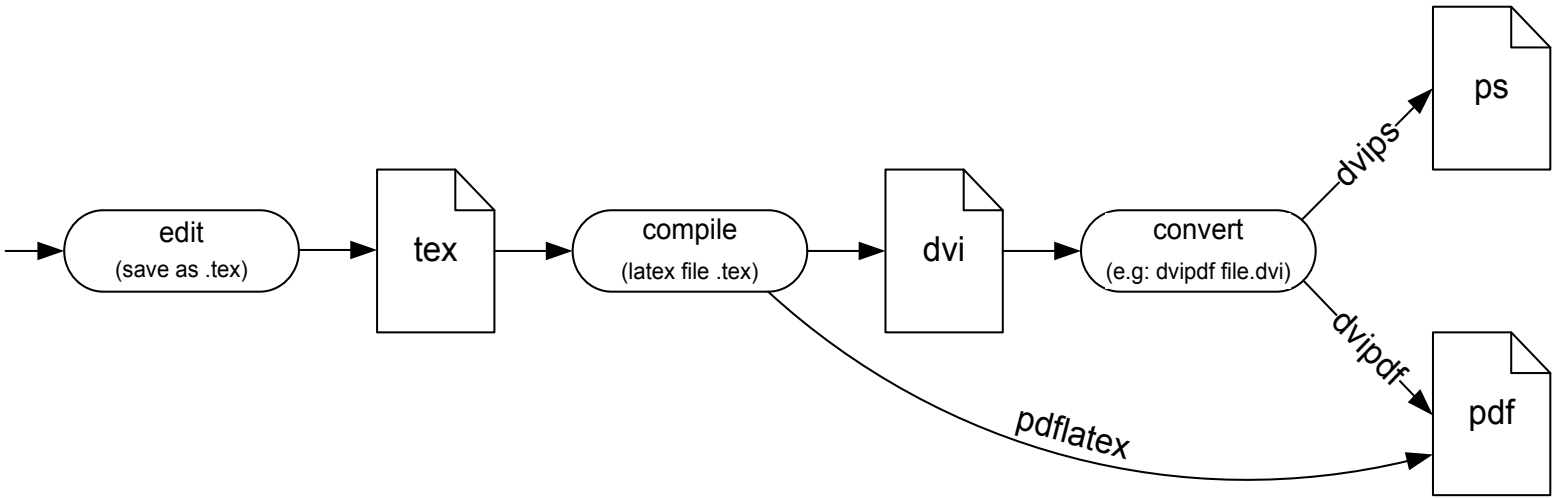
Result

Hello world!

Files, files, files

It is time to save the text into a file!

Simple LaTeX file extension is `*.tex`



Files, files, files

Common file types:

- `*.tex` - document description file (text).
- `*.bib` - bibliography information (text).
- `*.dvi` - document description file (binary), can be converted to ps/pdf or be preview using YAP.
- `*.ps` - description language of documents.
- `*.pdf` - evolution of *.ps files, commonly used.
- `*.bst` - BibTeX style description file (text).
- `*.sty` - document style description file (text).

Document with class!

The `\documentclass[options]{class}` sets some basic document properties.

class:

- **article** - for journals (no chapters, just sections)
- **report** - used for thesis (chapters allowed)
- **book**, **letter** and additional custom made...

options:

- **11p** - or any other value, set the font size
- **a4paper** - set the page size
- **onecolumn, twocolumn** - split (or not) the text into 2 columns

I have a package for you

LaTeX allows adding additional packages.

Those packages enriches the LaTeX fonts, symbols and possibilities.

For instance: `\usepackage{slashbox}` allows:

X \ Y	0	1
0	1/3	1/3
1	0	1/3

Where in regular LaTeX, this table slash is not supported.

Some order

LaTeX has a simple way to make the document be in order, there are:

- `\part{}` - everything but a *letter* class
- `\chapter{}` - books and reports
- `\section{}` - everything but a *letter* class
- `\subsection{}` - everything but a *letter* class
- `\subsubsection{}` - everything but a *letter* class
- `\paragraph{}` - everything but a *letter* class
- `\subparagraph{}` - everything but a *letter* class

Some order - example:

LaTeX code

```
\section{Introduction}
\subsection{Sub Introduction}
\section{Another Introduction}
\section*{Just Introduction}
\subsection{Sub Just Introduction}
```

Result

1 Introduction

1.1 Sub Introduction

2 Another Introduction

Just Introduction

2.1 Sub Just Introduction

Shopping list

LaTeX code

```
\begin{itemize}
\item Item 1.
\begin{itemize}
\item List 2, Item 1
\end{itemize}
\item Item 2.
\end{itemize}
```

Result

- Item 1.
  - List 2, Item 1
- Item 2.

Shopping list, what else do we have in the basket?

On top of bullets, one can have:

enumerate:

1. enumerate
2. enumerate (too)

description:

description 1. description

description 2. description too

list:

same label: First item in the list

same label: Second item in the list

Setting up the table

LaTeX code

```
\begin{tabular}[h]{|l||c|c|}
\hline
this & is & a table\\ \hline
this is & the second & row \\ \hline \hline
\end{tabular}
```

Result

this	is	a table
this is	the second	row

Font fashion

LaTeX code

```
\tiny{tiny}
\large{large}
\Large{Large}
```

Result

tiny large Large

Sizes, from tiny to huge:
\tiny, \scriptsize, \footnotesize, \small, \normalsize, \large, \Large, \LARGE, \huge, \Huge.

Font fashion, the bold and the beautiful

LaTeX code

```
\textit{Italic}
\textbf{Bold}
\underline{Underline}
\textsc{Small Capital}
\emph{Emphasize}
```

Result

Italic

Bold

Underline

Small Capital

Emphasize

Font fashion, the text collection

LaTeX code

```
\textrm{roman font}
\textsf{sans serif font}
\texttt{teletype font, it also called monospace font}
```

Result

roman font

sans serif font

`teletype font, it also called monospace font`

Font fashion, the math collection

LaTeX code

```
\begin{align*}
&\mathcal{X,Y} ~ \text{like in information theory} \\
&\mathfrak{L,F} ~ \text{like Laplace and Fourier transforms} \
&\mathbb{R,C} ~ \text{like Real numbers and Complex numbers}
\end{align*}
```

Result

$\mathcal{X}, \mathcal{Y}$ like in information theory

$\mathfrak{L}, \mathfrak{F}$ like Laplace and Fourier transforms

$\mathbb{R}, \mathbb{C}$ like Real numbers and Complex numbers

Do the math

One of the most powerful parts of LaTeX is the formula formating and writing.

In addition to the LaTeX basic math support, additional packages can provide more symbols and can make formulas look better.

Some of the popular packages are the `amsmath` and `amssymb`.

Math, the ABC

There are few main ways to write equations and formulas in LaTeX:

- `$y=x$` is used to insert formula or equation inside text
- `\begin{equation}` coupled with `\end{equation}`
- `\begin{eqnarray}` coupled with `\end{eqnarray}`
- `\leftеqn` is rarely used for splitting formulas

While the `equation` can support only one line of equations, `eqnarray` supports multiple lines and helps align the equations.

Math, you need to give me an example

LaTeX code

```
This is a text with an equation $y=2x + 3.1S + 1.2f$ inside.
\begin{eqnarray}
y &=& (x+2)^2\\
  &=& (x+2)(x+2)\\
  &=& x^2+2x+2x+4\\
  &=& x^2+4x+4
\end{eqnarray}
```

Result

This is a text with an equation $y = 2x + 3.1S + 1.2f$ inside.

$$\begin{aligned} y &= (x+2)^2 && (1)\\ &= (x+2)(x+2) && (2)\\ &= x^2+2x+2x+4 && (3)\\ &= x^2+4x+4 && (4) \end{aligned}$$

My two cents...

LaTeX code

```
\begin{eqnarray}
y & = & (x+2)^{10}\\
  & = & (x+2)(x+2)(x+2)(x+2)(x+2) \nonumber \\
  &   &(x+2)(x+2)(x+2)(x+2)(x+2)  \\
  & = & \dots \nonumber
\end{eqnarray}
```

Result

$$
\begin{aligned}
y &= (x+2)^{10} && (1)\\
&= (x+2)(x+2)(x+2)(x+2)(x+2)\\
&\quad (x+2)(x+2)(x+2)(x+2)(x+2) && (2)\\
&= \dots
\end{aligned}
$$

Greek alphabet

The Greek alphabet is used in math mode.
Capital Greek letters are spelled the same as lower case Greek letters but with capital letter in the start:

LaTeX code

```
$\alpha$, $\gamma$, $\Gamma$, $\epsilon$ and $\varepsilon$\\
$\lambda$, $\omega$, $\tau$ and $\sigma$\\
$\Sigma$, $\theta$, $\beta$ and  $\Omega$\\
$\aleph$
```

Result

α, γ, Γ, ϵ and ε
λ, ω, τ and σ
Σ, θ, β and Ω
$\aleph$

SUPERscript

Adding argument superscript or subscript notation is very simple

LaTeX code

```
\begin{eqnarray*}
&t_0&\\
&f_{cutoff}&\\
&x^2&\\
&e^{j (2\pi f t+\phi)}&
\end{eqnarray*}
```

Result

$$t_0$$

$$f_{cutoff}$$

$$x^2$$

$$e^{j(2\pi ft+\phi)}$$

Getting on top of things

LaTeX code

```
\begin{eqnarray*}
&\frac{1}{2}&\\
&\frac{x}{\frac{x+y}{2y+z}}&\\
&2x+4\stackrel{(a)}{=}4&\\
&\binom{5}{2}=\frac{5!}{3!2!}&
\end{eqnarray*}
```

Result

$$\frac{1}{2}$$

$$\frac{x}{\frac{x+y}{2y+z}}$$

$$2x+4 \stackrel{(a)}{=} 4$$

$$\binom{5}{2} = \frac{5!}{3!2!}$$

The collection

Summation, multiplication and integration are very easy:

LaTeX code

```
\begin{eqnarray}
\prod_{l=1}^L
\sum_{n=0}^{N-1}
\int_0^{\infty}
\iiint
\oint
\int_{\frac{3\pi}{4}}^{\frac{7\pi}{4}} \nonumber
\end{eqnarray}
```

Result

$$\prod_{l=1}^{L} \sum_{n=0}^{N-1} \int_{0}^{\infty} \iiint \oint \int_{\frac{3\pi}{4}}^{\frac{7\pi}{4}}$$

Parenthesis

Writing () or [] may result sometimes with parenthesis size which doesn't fit the equation.

LaTeX code

```
\begin{eqnarray*}
&\left(\frac{\sum_{n=1}^Nb^n}{\sum_{n=1}^Nb^{2n}}\right)&\\
&\left[\frac{\sum_{n=1}^Nb^n}{\sum_{n=1}^Nb^{2n}}\right]&\\
&\left\{\frac{\sum_{n=1}^Nb^n}{\sum_{n=1}^Nb^{2n}}\right\}&
\end{eqnarray*}
```

Result

$$\left(\frac{\sum_{n=1}^{N} b^n}{\sum_{n=1}^{N} b^{2n}}\right)$$

$$\left[\frac{\sum_{n=1}^{N} b^n}{\sum_{n=1}^{N} b^{2n}}\right]$$

$$\left\{\frac{\sum_{n=1}^{N} b^n}{\sum_{n=1}^{N} b^{2n}}\right\}$$

Parenthesis

Self generated parenthesis are in the case of commands like `\binom{}{}` or `\begin{cases}`, `\end{cases}` and other...

LaTeX code

```
\begin{eqnarray*}
g(x) =
\begin{cases}
x^2 & \text{if } x \geq 1 \\
  1 & \text{if } x < 1
\end{cases}
\end{eqnarray*}
```

Result

$$g(x) = \begin{cases} x^2 & \text{if } x \geq 1 \\ 1 & \text{if } x < 1 \end{cases}$$

When you really need a reference

Labels are the method being used to add references in LaTeX documents. Adding a prefix, allows more than one element could have the same label.

LaTeX code

```
\begin{eqnarray}\label{Equation}
x[n]=\frac{1}{N}\sum_{k=0}^{N-1}X[k]e^{\frac{j2\pi n k}{N}}
\end{eqnarray}
See how to write a complicated equation in equation
\eqref{Equation}.
```

Result

$$x[n] = \frac{1}{N} \sum_{k=0}^{N-1} X[k] e^{\frac{j2\pi nk}{N}} \tag{3}$$

See how to write a complicated equation in equation (3).

When you really need a reference

LaTeX code

```
\begin{eqnarray}\label{eq:Eq1} X[1]=1 \end{eqnarray}
\begin{center} \begin{tabular}[h]{c|c} a & b \\
\hline c & d \label{tab:Eq1} \end{tabular} \end{center}
We use the same label in equation \eqref{eq:Eq1} and table
\ref{tab:Eq1}.
```

Result

$$X[1] = 1 \tag{4}$$

a	b
c	d

We use the same label in equation (4) and table 33.

A picture is worth a thousand words

LaTeX supports various kind of pictures, the most common format is `*.EPS` (encapsulated postscript). The following programs supports `*.EPS` format:

- Inkscape
- Ghostscript
- Matlab
- Adobe Illustrator
- And more ...

The following formats are also supported: `PDF`, `JPG` and `PNG`, but not all of them can be compiled into `DVI`, meaning, no preview.

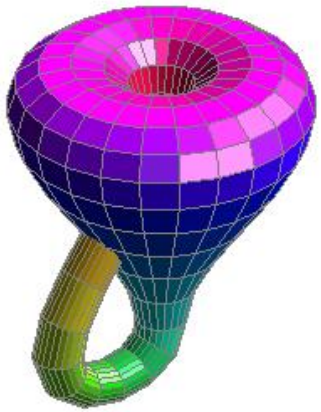
A picture is worth a thousand words

Don't forget to add: `\usepackage{graphicx}`

LaTeX code

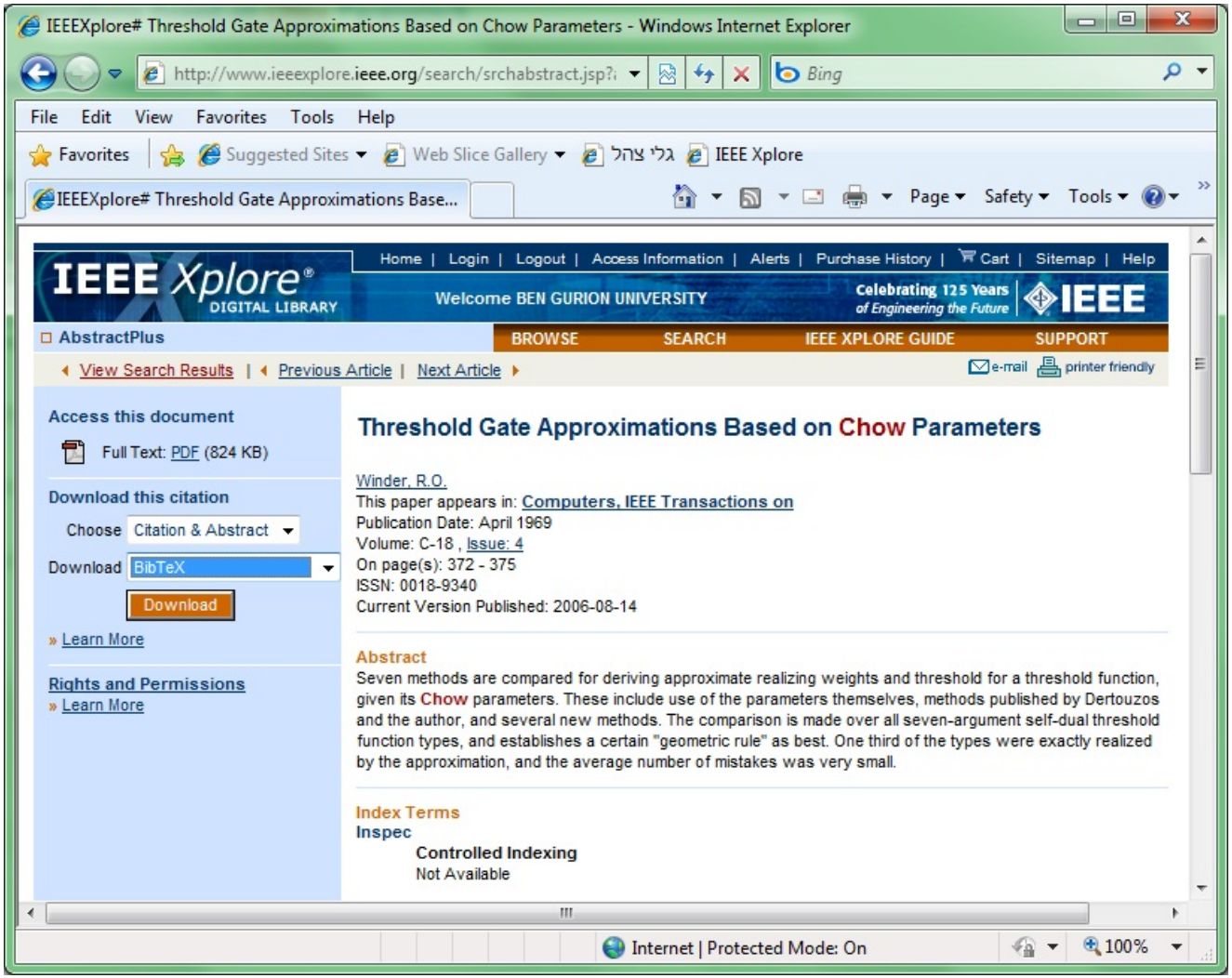
```
\includegraphics[width=0.5\textwidth]{bulb.jpg}
```

Result



It's time to thank someone

Additional strong part of the LaTeX is the bibliography management. Major articles sources supports a format called *BibTeX*.



It's time to thank someone

BibTeX format

```
@ARTICLE{1362497,
title={Pre-scrambling method for PAPR reduction in OFDM
communication systems},
author={Kwang Don Choe and Si Chul Kim and Park, S.K.},
journal={Consumer Electronics, IEEE Transactions on},
year={2004},
month={Nov.},
volume={50},
number={4},
pages={ 1044-1048},
doi={10.1109/TCE.2004.1362497},
ISSN={0098-3063}, }
```

It's time to thank someone

Bibliography

[1] S. H. Han and J. H. Lee, "An overview of peak-to-average power ratio reduction techniques for multicarrier transmission," *Wireless Communications, IEEE*, vol. 12, no. 2, pp. 56–65, April 2005.

[2] K. D. Choe, S. C. Kim, and S. Park, "Pre-scrambling method for papr reduction in ofdm communication systems," *Consumer Electronics, IEEE Transactions on*, vol. 50, no. 4, pp. 1044–1048, Nov. 2004.

[3] J. Forney, G.D. and M. Eyuboglu, "Combined equalization and coding using precoding," *Communications Magazine, IEEE*, vol. 29, no. 12, pp. 25–34, Dec 1991.

[4] R. G. Gallager, *Information Theory and Reliable Communication*. Wiley, 1968.

[5] R. Price, "Nonlinearly feedback equalized pam vs. capacity," in *Proc. ICC '72*, June 1972.

[6] P. Chow, J. Cioffi, and J. Bingham, "A practical discrete multitone transceiver loading algorithm for data transmission over spectrally shaped channels," *Communications, IEEE Transactions on*, vol. 43, no. 234, pp. 773–775, Feb/Mar/Apr 1995.

It's time to thank someone

Once a record is added to the bibliography `*.BIB` file. It can referred to with `\cite{}` command.
To refer the article in the previous slide the command would be `\cite{1362497}`.
The number can be changed to something more meaningful, like:

```
@ARTICLE{TheArticleIdontUnderstand,
title=....
```

And refer it by that name: `\cite{TheArticleIdontUnderstand}`.

Where to go from here?

There is a lot of additional material on LaTeX all over the internet: Forums, web pages and wikis.

You can either google or bing with latex + problem: *latex how to make my thesis to look cool*.

Or you can start here: latex wiki