LaTeX Basic Usage

Preparation for Independent Study

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Contents

Chapter 1 Latex Basic Usage

1.1 Chapter settings

In Latex, we can divide the content into chapter, section, subsection and subsubsection.

1.1.1 Advantage of Latex

Latex can automatically number

1.1.2 The method to divide chapters

A good book usually has chapters from three to ten. The content of each chapter is basically independent with each other, while have inner connections. Usually, using chapter and section is enough.

1.1.3 The method to divide pages

We can use **\newpage** to move to a new page

```
\newpage
% use \textbackslash to get \ in texts
% use $\backslash$ to get \ in formulas
```

1.2 Inline formula and display formula

(Inline formula) We can get $f(x) = ax^2 + bx + c$ using

```
$f(x) = ax^2 + bx + c$
```

(Display Formula) We can get

$$g(x) = \frac{ax^2 + bx + c}{dx^2 + ex + f}$$

using

```
\[g(x) = \frac{ax^2 + bx + c}{dx^2 + ex + f}\]
% use \frac to get fraction
```

The following example shows the difference between $g(x) = \frac{ax^2 + bx + c}{dx^2 + ex + f}$ and $g(x) = \frac{ax^2+bx+c}{dx^2+ex+f}$

```
$\displaystyle g(x) = \frac{ax^2 + bx + c}{dx^2 + ex + f}$ % former
$g(x) = \frac{ax^2 + bx + c}{dx^2 + ex + f}$ % latter
```

If we want to use inline fraction, $g(x) = \left(ax^2 + bx + c\right) / \left(dx^2 + ex + f\right)$ is preferred.

```
$g(x) = \left(ax^2 + bx + c\right)/\left(dx^2 + ex + f\right)$
% \left and \right is use to automatically adjust the size of angle, square brackets,
    parentheses, absolute value, rounding up and rounding down.
```

Here is more examples of **\left** and **\right**

1. $$h(x) = \left|\frac{\sqrt[3]{x^2+1}}{x^4+1}\right|$$
2. $$A = \left[n^2, n^2 + 1\right)$$
3. $$C = \left\{x \in \mathbb{R} : \frac{x^2}{x^2+1}\right\}$$
4. $$p \left| \frac{a}{gcd(b,c)} \right.$$
5. $$\langle v, w \rangle = v \cdot w$$

```
% use \begin{enumerate} to get the ordered list
\begin{enumerate}
    \item \[h(x) = \left|\frac{\sqrt[3]{x^2+1}}{x^4+1}\right|\]
    \item \[A = \left[ n^2, n^2 + 1 \right)\]
    \item \[C = \left\{ x \in \mathbb{R}: \frac{x^2}{x^2+1} \right\}\]
    \item \[p \left| \frac{a}{gcd(b,c)} \right. \]
\end{enumerate}
```

1.3 Superscript and subscript

(Superscript) We can get

$$f(x) = x^{a^{b^2}} + y^{ab} + z^{cd}$$

using

```
\[f(x) = x^{a^{b^2}} + y ^ {ab} + z ^ {cd}\]
```

(Subscript) To get $x_1, \cdots, x_n \in \mathbb{R}$, or equivalently, $\{x_n\} \subset \mathbb{R}$, we can use

```
$x_1, \cdots, x_n \in \mathbb{R}$
$\left\{x_n\right\} \subset \mathbb{R}$
```

Moreover, to get the subsequence $\{x_{q_n}\} \subseteq \{x_n\}_{n\in\mathbb{N}}$, we can use

```
$\left\{x_{q_n}\right\} \subseteq \left\{x_n\right\}_{n \in \mathbb{N}}$
```

In fact, we can use subscript and superscript in many cases. (We use **\newcommand**[1] in the following text).

1. $$A = \{x_i\}_{i=1}^{n}$$
2. $$\sum_{i=1}^{n} = 1 + \cdots + n = \frac{(1+n)n}{2}$$
3. $$\prod_{i=1}^{n} i = n!$$
4. the n^{th} Fourier coefficient
5. $$V = \bigoplus_{i=1}^{n} V_i$$

```
\begin{enumerate}
    \item \[A = \z\{x_i\y\}_{i=1}^n\]
    \item \[\sum_{i=1}^n = 1 + \cdots + n = \frac{(1+n)n}{2}\]
    \item \[\prod_{i=1}^ni = n!\]
    \item the $n^{\text{th}}$ Fourier coefficient
    \item \[V = \bigoplus_{i=1}^n V_i\]
\end{enumerate}
```

1.4 New command

We can use **newcommand.tex** to custom command

```
% newcommand.tex
\newcommand{\mycommand}{\original_command}
```

[1] Configuration of newcommand.tex is put in **Appendix A**.

1.5 Mathematics environment in Elegantbook

You can check elegantbook-template for details.

Definition 1.1 (Directional Derivative) ♣

Proof The proof is left to the reader.

Theorem 1.1 (Chinese Remainder Theorem) ♡

Proposition 1.1 (Important) ♠

Example 1.1 $\mathbb{Z}_n$

1.6 Formula Alignment

We use **\begin{align}** (numbered), **\begin{align*}** (unnumbered) and **&** to align formulas.

1.

$$(a+b)(c+d) = a(c+d) + b(c+d) \tag{1.1}$$
$$= ac + ad + bc + bd \tag{1.2}$$
$$= ac + bc + ad + bd \tag{1.3}$$

2.

$$\iff (x,y) \in (A \times B) \cap (C \times D)$$
$$\iff x \in A \cap C, y \in B \cap D$$
$$\iff (x,y) \in (A \cap C) \times (B \times D)$$

```
\begin{enumerate}
    \item
    \begin{align}
    (a+b)(c+d) &= a(c+d) + b (c+d) \\ % We use & to identify the places to align with
    &= ac + ad + bc + bd \\
    &= ac + bc + ad + bd
    \end{align}
    \item
    \begin{align*}
    & \iff (x, y) \in (A \times B) \cap (C \times D) \\
    & \iff x \in A \cap C, y \in B \cap D \\
    & \iff (x, y) \in (A \cap C) \times (B \times D)
    \end{align*}
\end{enumerate}
```

1.7 Special symbols

1. $\sin^2 x + \cos^2 x = 1$
2. $\log \exp x = x$
3. $\gcd(a,b)\text{lcm}(a,b) = ab$

```
\begin{enumerate}
    \item $\sin^2x + \cos^2x = 1$
    \item $\log\exp {x} = x$
    \item $\gcd(a,b)\lcm(a,b) = ab$
\end{enumerate}
```

1.7.1 Equality and inequality

1. less than : $<$
2. greater than : $>$
3. less than or equal to: $\leq$ or $\leqslant$
4. greater than or equal to : $\geq$ or $\geqslant$
5. not equal : $\neq$

```
\begin{enumerate}
    \item less than : $<$
    \item greater than : $>$
    \item less than or equal to: $\leq$ or $\lqs$
    \item greater than or equal to : $\geq$ or $\gqs$
    \item not equal : $\neq$
\end{enumerate}
```

1.7.2 Logic

1. and: $\land$
2. or: $\lor$
3. not: $\lnot$
4. imply: $\to$
5. equivalent: $\iff$, $\Leftrightarrow$ or $\leftrightarrow$
6. universal quantifier: $\forall$
7. existential quantifier: $\exists$

```
\begin{enumerate}
    \item and: $\land$
    \item or: $\lor$
    \item not: $\lnot$
    \item imply: $\to$
    \item equivalent: $\iff$, $\Leftrightarrow$ or $\leftrightarrow$
    \item universal quantifier: $\forall$
    \item existential quantifier: $\exists$
\end{enumerate}
```

1.7.3 Set theory

1. in: $\in$
2. contain (element): $\ni$
3. be contained in: $\subset$
4. contain (set): $\supset$
5. be contained in but not equal to: $\subsetneq$
6. contain but not equal to: $\supsetneq$
7. intersection: $\cap$ or $\bigcap$
8. union: $\cup$ or $\bigcup$
9. difference: $-$ or $\backslash$ or $\backslash$
10. complement: $\cdot^C$
11. Cartesian product: $\times$ or $\prod$
12. disjoint union: $\sqcup$ or $\bigsqcup$

```
\begin{enumerate}
   \item in: $\in$
   \item contain (element): $\ni$
   \item be contained in: $\subset$
   \item contain (set): $\supset$
   \item be contained in but not equal to: $\subsetneq$
   \item contain but not equal to: $\supsetneq$
   \item intersection: $\cap$ or $\bigcap$
   \item union: $\cup$ or $\bigcup$
   \item difference: $-$ or $\backslash$ or $\setminus$
   \item complement: $\cdot^C$
   \item Cartesian product: $\times$ or $\prod$
   \item disjoint union: $\sqcup$ or $\bigsqcup$
\end{enumerate}
```

1.7.4 Relation and map

1. homeomorphism/isomorphism: $\simeq$
2. equivalent: $\sim$
3. map: $f : A \to B$
4. composition: $\circ$

```
\begin{enumerate}
   \item homeomorphism/isomorphism: $\simeq$
   \item equivalent: $\sim$
   \item map: $f: A \to B$
   \item composition: $ \circ $
\end{enumerate}
```

1.7.5 Calculus

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

$$\int_a^b f(x)dx = F(b) - F(a)$$

$$\int_a^b f(x)dx = \lim_{n \to \infty} \sum_{i=1}^{n} f\left(x_i^*\right)\left(x_i - x_{i-1}\right)$$

$$\limsup_{n \to \infty} a_n = \inf_{n \geqslant 1} \sup_{k \geqslant n} a_k$$

$$\liminf_{n \to \infty} a_n = \sup_{n \geqslant 1} \inf_{k \geqslant n} a_k$$

```
\[f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}\]
\[\int_a^bf(x)dx = F(b) - F(a)\]
\[\int_a^bf(x)dx = \lim_{n \to \infty} \sum_{i=1}^n f\z(x_i^*\y)\z(x_i-x_{i-1}\y)\]
\[ \limsup_{n \to \infty}a_n = \inf_{n \gqs 1} \sup_{k \gqs n}a_k \]
\[ \liminf_{n \to \infty}a_n = \sup_{n \gqs 1} \inf_{k \gqs n}a_k \]
```

1.7.6 Matrix

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

$$\det(B) = \begin{vmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{vmatrix}$$

```
\[
A = \begin{pmatrix}
    1&2&3 \\
    4&5&6 \\
    7&8&9
\end{pmatrix}
\]

\[
\det(B) = \begin{vmatrix}
    1&2&3 \\
    0&4&5 \\
    0&0&6 \\
\end{vmatrix}
\]
```

1.7.7 Bar, tilde and hat

$$\overline{z+w} = \overline{z} + \overline{w}$$

$$\tilde{f}$$

$$\hat{f}$$

```
\[\overline{z+w} = \overline{z} + \overline{w}\]
\[\tilde{f}\]
\[\hat{f}\]
```

Chapter 2 Latex Advanced Usage

2.1 Formula

2.1.1 Numbering

Here we show the difference of **\equation \align** in numbering equations.

1.

$$F = ma \tag{2.1}$$

$$E = mc^2 \tag{2.2}$$

2.

$$\begin{aligned} A + B &= C \\ C + D &= E \\ E + F &= G \end{aligned} \tag{2.3}$$

3.

$$A + B = C \tag{2.4a}$$

$$C + D = E \tag{2.4b}$$

```
\begin{enumerate}
    \item
    \begin{align}
        & F = ma \\
        & E = mc^2
    \end{align}
    \item
    \begin{equation}
        \begin{aligned}
        & A + B = C \\
        & C + D = E \\
        & E + F = G
        \end{aligned}
    \end{equation}
    \item
    \begin{subequations}
        \begin{equation}
            A + B = C
        \end{equation}
        \begin{equation}
            C + D = E
        \end{equation}
    \end{subequations}

\end{enumerate}
```

2.1.2 Overbrace and underbrace

$$\mathbf{0} = \underbrace{\alpha_1 \boldsymbol{x_1} + \cdots + \alpha_n \boldsymbol{x_n}}_{\text{this is the underbrace}} + \overbrace{\beta_1 \boldsymbol{y_1} + \cdots + \beta_m \boldsymbol{y_m}}^{\text{this is the overbrace}}$$

```
% use \bm{} to (b)old fonts in (m)athematics mode.
\[\bm{0} = \underbrace{\alpha_1\bm{x_1} + \cdots + \alpha_n\bm{x_n}}_{\text{this is the
    underbrace}} + \overbrace{ \beta_1\bm{y_1} + \cdots + \beta_m\bm{y_m}}^{\text{this is
    the overbrace}}\]
```

2.2 Table

A	B	C
C	D	E
F	G	H

A_1	B	C
C	D_2	E
F	G	H_3

Table 2.1: ABCDEFGH

$A_1BCDEFG$	A B C D E F G	A B C D E F G	A B C D E F G
C	D_2	E	F
F	G	H_3	G

```
\begin{center}
    \begin{tabular}{|c|c|c|}
    A & B & C \\
    C & D & E \\
    F & G & H
    \end{tabular}
\end{center}
\begin{center}
    \begin{tabular}{|c|c|c|}
    \hline
    $A_1$ & B & C \\
    \hline
    C & $D_2$ & E \\
    \hline
    F & G & $H_3$ \\
    \hline
    \end{tabular}
    \captionof{table}{ABCDEFGH}
```

```
\end{center}
\begin{center}
    \begin{tabular}{|p{3cm}<\centering|p{2cm}|m{2cm}<\rz|b{2cm}<\ry|}
    \hline
    {\cellcolor{red!25}$A_1 B C D E F G$} & A B C D E F G & A B C D E F G & A B C D E F G \\
    \hline
    C & $D_2$ & E & F \\
    \hline
    F & G & $H_3$ & G\\
    \hline
    \end{tabular}
\end{center}
```

2.3 Figure

We use **\includegrahics** to insert png file; **\includesvg** to insert svg file [1].

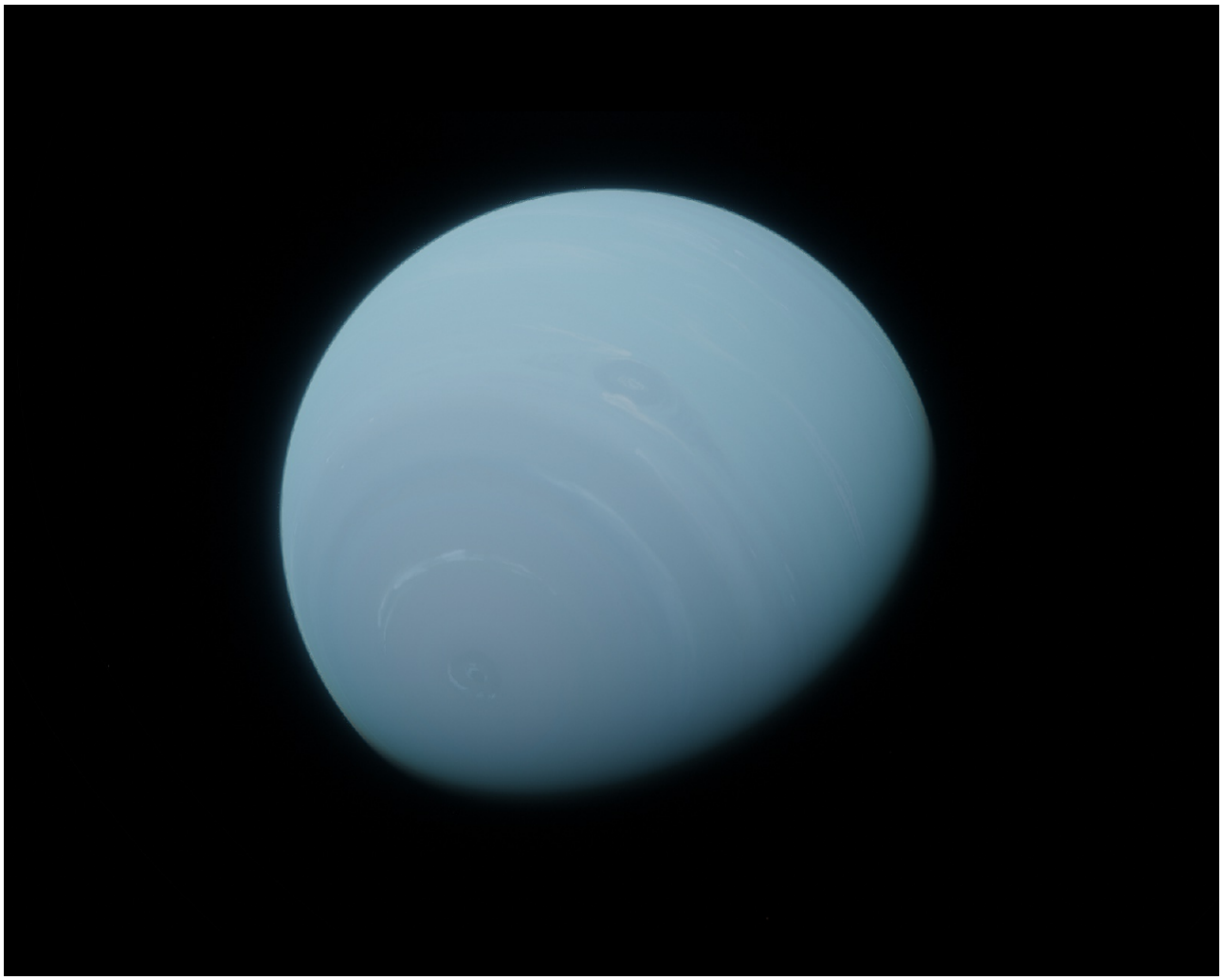

Figure 2.1: Neptune

[1] We can also insert pdf (including .pdf and .pdf_tex) to insert figure, but we omit it.

```
\begin{center}
    \includegraphics[scale=0.5]{figure/cover-neptune.png}
    \captionof{figure}{Neptune}
\end{center}
```

We can use **\begin{minipage}** to divide one page into arbitrary columns.

Lemma 2.1

This is Neptune.

This is a blue plane.

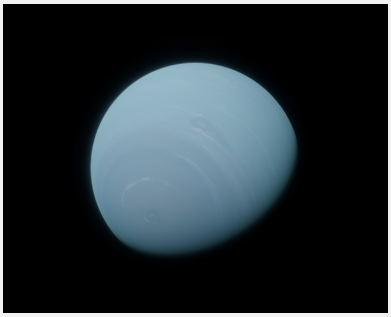

Figure 2.2: Neptune2

♡

```
\begin{lemma}
    \begin{minipage}{0.3\textwidth}
        This is Neptune.
    \end{minipage}
    \begin{minipage}{0.3\textwidth}
        This is a blue plane.
    \end{minipage}
    \begin{minipage}{0.4\textwidth}
        \begin{center}
            \includegraphics[scale=0.15]{figure/cover-neptune.png}
            \captionof{figure}{Neptune2}
        \end{center}
    \end{minipage}
\end{lemma}
```

We can also use the environment **\figure** and **\table** to insert figure and table. Latex will automatically arrange the location of figures or tables using this method. The details are omitted.

2.4 Cross-reference

We can refer to the following objects[2].

can be referred	normal mode	elegant book template	characteristic character
\chapter{}	✓	✓	ch:
\section{}	✓	✓	sec:
formula	✓	✓	eq:
table	✓	✓	tab:
figure	✓	✓	fig:
theorem	-	✓	thm:
example	-	✓	exa:
proof	-	×	×

2.4.1 Chapter and section reference

Chapter 1 mainly talks about the basic usage of latex.

```
%In chatper1.tex, edit your label using
\label{your label}
%In chatper2.tex, refer to your label using
\ref{your label}
```

Section 2.1 mainly talks about the usage of formulas. The reference method is just the same as the chapter.

2.4.2 Formula reference

There are 2 ways to refer to an equation. The first way is the same as previous, we omit it. The second way, which is defined in **elegantbook**, is to use **\eqref**.

This is the newton's second law (2.1) and this is the mass-energy equivalence (2.2)[3].

```
\begin{align}
    & F = ma \label{eq:newton's second law}\\
    & E = mc^2 \label{eq:-massenergy equivalence}
\end{align}

This is the newton's second law \eqref{eq:newton's second law} and this is the mass-energy
    equivalence \eqref{eq:-massenergy equivalence}.
```

2.4.3 Table and figure

Similarly, you can use **\ref** and **\tabref** or **\figref**(in elegantbook template) to refer to **Table** 2.1 or **Figure** 2.2.

[2]We can't refer to the environment with *, such as **\equation***.

[3]You can name the labels anything you want. Here I use characteristic characters conventionally.

2.4.4 Theorem

Sometimes we need to refer to a theorem when proving a problem, then **\overset{}{}** and **\underset{}{}** might be helpful.

$$\overset{Theorem 1.1}{\iff}$$

$$\underset{Theorem 1.1}{\iff}$$

```
\[\overset{Theorem\ref{thm:chinese remainder theorem}}{\iff}\]
\[\underset{Theorem\ref{thm:chinese remainder theorem}}{\iff}\]
```

However, the arrow here is obviously too short. We may use **\xLeftrightarrow[]{}**in **\usepackage{extarrows}**.

$$\xLeftrightarrow[\text{text in [] is under the arrow}]{\text{text in \{\}is over the arrow}}$$

```
\[\xLeftrightarrow[\text{text in [] is under the arrow}]{\text{text in \{\}is over the arrow
    }}\]
```

2.5 Hyperlink

Click on the following links you can see my github personal page.

```
Click on the following links you can see \href{https://github.com/tem2021}{my github
    personal page}.
```

2.6 Bibliography

Check whether you have **\addbibresource[location=local]{reference.bib}** in either your **.cls** file or **main document**. If not, add them to your .cls file or main document[4]. Check whether you have **reference.bib** in you project folder. If not, create a new one. Copy the **BibTex** of references from website, such as google scholar. Paste them to **reference.bib**. Use **\cite{}** to cite the material Add **\printbibliography** to get the reference page.

Here is an example [1].

```
% elegantbook.cls
\addbibresource[location=local]{reference.bib}

% reference.bib
@article{2002Topology,
  title={Topology of Superoxide Production from Different Sites in the Mitochondrial
      Electron Transport Chain},
  author={ St-Pierre, Julie and Buckingham, Julie A and Roebuck, Stephen J and Brand, Martin
       D },
  journal={Journal of Biological Chemistry},
  volume={277},
```

[4] You can customize the location and name of the bibliography file. Here I use the default configuration.

```
  number={47},
  pages={44784},
  year={2002},
}

%chapter2.tex
Here is an example \cite{2002Topology}.

%main.tex
\printbibliography
```

Appendix A Configuration of newcommand.tex

```
\newcommand{\z}{\left}
\newcommand{\y}{\right}
\newcommand{\rz}{\raggedleft}
\newcommand{\ry}{\raggedright}

\newcommand{\R}{\mathbb{R}}
\newcommand{\N}{\mathbb{N}}
\newcommand{\Q}{\mathbb{Q}}
\newcommand{\Z}{\mathbb{Z}}

\newcommand{\lcm}{\text{lcm}}

\newcommand{\lqs}{\leqslant}
\newcommand{\gqs}{\geqslant}
```

Bibliography

[1] Julie St-Pierre et al. “Topology of Superoxide Production from Different Sites in the Mitochondrial Electron Transport Chain”. In: *Journal of Biological Chemistry* 277.47 (2002), p. 44784.