CSST 2022

使用 Markdown 和 LaTeX 成為筆記大師

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Quick Links

https://github.com/nevikw39/CSST2022

$whoami

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In case somebody is of interest,
please refer to previous slides.

Section 1

Markdown

Where could Markdown be used or seen?

Why Markdown?






What's Markdown?

Markup Languages

Describes some plain text files in a certain fashion that are easily read, written and transferred.

Human friendly HTML, TEX, Markdown, etc.

Machine friendly XML, JSON, YAML, TOML, ...

Markdown is a lightweight markup language for human's purpose.

How to use Markdown?

Ad-hoc softwares Typora, Notion, ...

Ordinary editors VS Code, Sublime, Atom, Notepad++, ...

Online services HackND, GitHub Gist, ...

Demo Time!

Demo Time!

Section 2

LaTeX

Where could TeX/LaTeX be used or seen?

Why TeX/LaTeX?

1.1. Exercises 1.1.

EXERCISE 1.1.1. *Suppose* $f(x) = \frac{x^3+8}{x+2}$, *find* $\lim_{x\to -2} f(x)$.

Sol.

$$\lim_{x\to -2} f(x) = \lim_{x\to -2} \frac{(x+2)\left(x^2-2x+4\right)}{x+2} = \lim_{x\to -2} \left(x^2-2x+4\right) = 4.$$

3. (20%) Find the coefficient of x^n in the following generating function:

$$\frac{1}{(x^2-2)(1-3x^2)}.$$

Hint: Think a bit more before working on this problem

Cayley–Hamilton method [edit]

The Cayley–Hamilton theorem allows the inverse of $\mathbf{A}$ to be expressed in terms of $\det(\mathbf{A})$, traces and powers of $\mathbf{A}$:[8]

$$\mathbf{A}^{-1} = \frac{1}{\det(\mathbf{A})} \sum_{s=0}^{n-1} \mathbf{A}^s \sum_{k_1,k_2,\ldots,k_{n-1}} \prod_{l=1}^{n-1} \frac{(-1)^{k_l+1}}{l^{k_l} k_l!} \operatorname{tr}\left(\mathbf{A}^l\right)^{k_l},$$

where n is dimension of $\mathbf{A}$, and $\operatorname{tr}(\mathbf{A})$ is the trace of matrix $\mathbf{A}$ given by the sum of the main diagonal. The sum is taken over s and the sets of all $k_l \geq 0$ satisfying

$$s + \sum_{l=1}^{n-1} l k_l = n - 1.$$

The formula can be rewritten in terms of complete Bell polynomials of arguments $t_l = -(l-1)!\operatorname{tr}(A^l)$ as

$$\mathbf{A}^{-1} = \frac{1}{\det(\mathbf{A})} \sum_{s=1}^{n} \mathbf{A}^{s-1} \frac{(-1)^{n-1}}{(n-s)!} B_{n-s}(t_1, t_2, \ldots, t_{n-s}).$$

A balanced BST could perform insertion and deletion in $O(\log N)$ even despite of the worst case, whereas a hash table has a average $O(1)$ time complexity in amortized analysis yet decline to $O(N)$ when collision, i.e., different keys have the same hash value, occurred.

Though **hash tables** are faster than **BSTs** in the most cases, it's easy to construct test cases which lead to many collisions, if we know the hash function the **hash table** used. So everytime you use `unordered_set` / `map`, be care of this pitfall.

So how to avoid this? We could use other hash tables and custom hash function (random and/or time-dependent argument), or simply use `set` / `map` alternatively.

Input

There is an integer N in the first line, indicating the number of recycled resources to be auctioned.

The next line contains N integers a_i, representing the values of each recycled resource.

The test case is ended by an integer V mentioned above.

$$1 \leq N \leq 10^6, 0 \leq a_i \leq 10^6, -2^{31} \leq V < 2^{31}$$

Output

For V, please print out an integer which is the number of (i, j) such that $i < j \wedge a_i + a_j = V$.

Introduction

- TeX is a free, professional typesetting software widely used in academia
- Developed by Knuth, D. E. for his chef d'œuvre *The Art of Computer Programming*
- Nowadays there are quite a few TeX derivations, such as LaTeX, XeTeX, LuaTeX, XeLaTeX, LuaLaTeX, ConTeXt...
- Many projects and solution port the core TeX feature — math typesetting — onto webpages, other document softwares, etc.

Characteristics

- Classic yet chic Computer Modern font family built with METAFONT
- Detailed and elaborate font settings, such as *kerning*, *ligature*, *glyph variant*, ...
- Expertise in displaying mathematical formulae (enhanced even further on top of $\mathcal{AMS}$-TEX)
- Apt and elegant algorithms for *spacings*, *breaks*, *justification*, *hyphenation*...
- Rich support from vigorous community; that is, there are plenty of packages (e.g., to draw diagrams, etc.) and it's easy to seek answers online

Distribution Installation & Online Environment

TeX Distributions

One could install suitable TeX Distribution for his OS, e.g. TeX Live for Linux, MacTeX (derived from TeX Live) for macOS or MikTeX for Windows.
Nevertheless, TeX requires large disk space – ≈ 7.2 G for TeX Live 2021 by MacTeX–, and the install process is a bit tricky.

In addition, **Overleaf** is an online LaTeX environment that supports partial-WYSIWYG, in-time collaboration.
Account with NTHU email address could gain premium **Overleaf** access for free!

Two modes for math expressions

Inline mode

Enclose math commands in `\( \)` or `$` like `$\hat{F}(x)=(1-5x)^\frac{-2}{5}$` to make the expression be within context like $\hat{F}(x) = (1-5x)^{\frac{-2}{5}}$.

Display mode

Enclose math commands in `\[ \]` or two consecutive `$`s like `$$\hat{F}(x)=(1-5x)^\frac{-2}{5}$$` to make the expression stand out of context like:

$$\hat{F}(x) = (1-5x)^{\frac{-2}{5}}$$

.

Examples

Limit

Sources

```
$$\lim_{x\to c}f(x)=L\iff\forall\varepsilon>0,\exists\
    delta>0,0<|x-c|<\delta\implies|f(x)-L|<\varepsilon$$
```

Results

$$\lim_{x\to c} f(x) = L \iff \forall\varepsilon > 0, \exists\delta > 0, 0 < |x - c| < \delta \implies |f(x) - L| < \varepsilon$$

Examples

Integral

Sources

```
$$\int_a^bf(x)dx=\lim_{n\to\infty}\sum_{i=1}^n\frac{
    b-a}{n}f(a+\frac{b-a}{n}i)$$
```

Results

$$\int_a^b f(x)\,dx = \lim_{n\to\infty}\sum_{i=1}^{n}\frac{b-a}{n}f(a+\frac{b-a}{n}i)$$

Examples

Sources

```
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
```

Results

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

Examples

Stirling's formula

Sources

```
$$n!\approx\sqrt{2\pi n}(\frac{n}{e})^n$$
```

Results

$$n! \approx \sqrt{2\pi n}(\frac{n}{e})^n$$

Examples

Generalized Binomial Theorem

Sources

```
$$(1+x)^r=\sum_{k=0}^\infty\binom{r}{k}x^k$$
```

Results

$$(1+x)^r=\sum_{k=0}^\infty\binom{r}{k}x^k$$

Examples

Master Theorem

Sources

```
$$T(n)=aT(\frac{n}{b})+O(n^d)=\left\{\begin{array}{
    ll} O(n^d), & d>\log_b a \\ O(n^d\log n), & d=\
    log_b a \\ O(n^{\log_b a}),&d<\log_b a \end{array
    }\right.$$
```

Results

$$T(n) = aT(\frac{n}{b}) + O(n^d) = \begin{cases} O(n^d), & d > \log_b a \\ O(n^d \log n), & d = \log_b a \\ O(n^{\log_b a}), & d < \log_b a \end{cases}$$

Examples

Block Matrix LDU Decomposition

Sources

```
\small
$$\begin{pmatrix}A_{0,0}&A_{0,1}\\A_{1,0}&A_{1,1}\
    end{pmatrix}=\begin{pmatrix}I&O\\A_{1,0}A
    _{0,0}^{-1}&I\end{pmatrix}\begin{pmatrix}A_{0,0}&
    O\\O&A_{1,1}-A_{1,0}A_{0,0}^{-1}A_{0,1}\end{
    pmatrix}\begin{pmatrix}I&A_{0,0}^{-1}A_{0,1}\\O&I
    \end{pmatrix}$$
```

Results

$$\begin{pmatrix}A_{0,0}&A_{0,1}\\A_{1,0}&A_{1,1}\end{pmatrix}=\begin{pmatrix}I&O\\A_{1,0}A_{0,0}^{-1}&I\end{pmatrix}\begin{pmatrix}A_{0,0}&O\\O&A_{1,1}-A_{1,0}A_{0,0}^{-1}A_{0,1}\end{pmatrix}\begin{pmatrix}I&A_{0,0}^{-1}A_{0,1}\\O&I\end{pmatrix}$$

Simple LaTeX template

Preamble & Body

```
\documentclass[12pt, a4paper]{article}

\title{This is the Title}
\author{nevikw39}
\date{\today}

% This is the preamble. Use packages, set up some
    options, ... here

\begin{document}
\maketitle % Generate title, author & date
\tableofcontents % Generate TOC
\end{document}
```

在文件中使用中文

採用 XeLaTeX 並引用 xeCJK package

```
\documentclass[12pt, a4paper]{article}

\title{標題}
\author{nevikw39}
\date{\today}

\usepackage{xeCJK}

\setCJKmainfont{Apple LiSung}
\setCJKsansfont{Apple LiGothic}
%\setCJKmonofont{Noto Sans Mono CJK TC}

\begin{document}
\maketitle % Generate title, author & date
\tableofcontents % Generate TOC
\end{document}
```

Font Families

or Typefaces

Roman	Referred to serif font. `{\rmfamily ...}` or `\textrm{...}`
Sans	Referred to sans serif font. `{\sffamily ...}` or `\textsf{...}`
Typewiter	Referred to monospace font. `{\ttfamily ...}` or `\texttt{...}`

Font Series

in Roman family

Medium `{\mdseries ...}` Or `\textbf{...}`

Bold `{\bfseries ...}` **Or** `\textbf{...}`

Font Shapes

in Roman family

Upright {\upshape ...} Or \textup{...}

Italic {\itshape ...} *Or* \textit{...}

Slant {\slshape ...} *Or* \textsl{...}

Small Caps {\scshape ...} Or \textsc{...}

Font Sizes

Tiny {\tiny ...}

Script Size {\scriptsize ...}

Footnote Size {\footnotesize ...}

Small {\small ...}

Normal Size {\normalsize ...}

large {\large ...}

Large {\Large ...}

LARGE {\LARGE ...}

huge {\huge ...}

Huge {\Huge ...}

Mainly-used Sectioning

```
\section{...}
\subsection{...}
\subsubsection{...}
```

Itemize

Unordered list

```
\begin{itemize}
\item An item
\item Another item
\item ...
\end{itemize}
```

- An item
- Another item
- ...

Enumerate

Ordered list

```
\begin{enumerate}
\item First item
\item Second item
\item ...
\end{enumerate}
```

1. First item
2. Second item
3. ...

Description

Definition list

```
\begin{description}
\item[A term] Definition.
\item[Another term] Or
    description.
\end{description}
```

A term Definition.

Another term Or description.

Include Images

```
\begin{figure}[htbp]
\centering
\includegraphics[width=
    \linewidth]{nevikw39}
\caption{This is the caption.}
\label{fig:label}
\end{figure}
```

Figure: This is the caption.

Create Tables

```
\begin{table}[htbp]
\caption{This is a caption}
\centering
\begin{tabular}{c|l|r}
Col. 0 & Col. 1 & Col. 2 \\
\hline
Center & Left & Right \\
Row 2 & &
\end{tabular}
\label{tab:label}
\end{table}
```

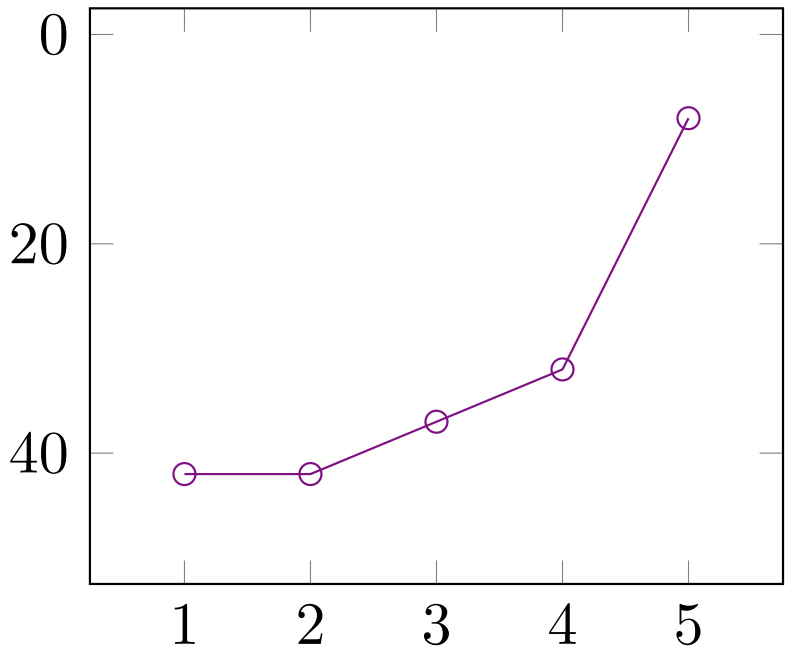
Table: This is a caption

Col. 0	Col. 1	Col. 2
Center	Left	Right
Row 2		

TikZ & PGF

Plot lines

```
\begin{tikzpicture}
\begin{axis}[
    xmin=0.5, xmax=5.5,
    xtick distance=1,
    ymin=0, ymax=50,
    y dir = reverse,
    width=\linewidth,
    height=.875\linewidth,
    enlargelimits=0.05,
]
\addplot[color=nthu, mark=o]
coordinates {
    (1,42) (2,42) (3,37) (4,32)
(5,8)
};
\end{axis}
\end{tikzpicture}
```



Section 3

Appendix

Convert Markdown to TEX *(or vice versa)*

Using pandoc

If you have TEX programs and `pandoc` installed on your computer, then you could easily convert a Markdown file into PDF via LATEX:

```
pandoc file.md -o file.pdf
```

Note that `pandoc` support various Markdown extensions.

Reference

- Learn LaTeX in 30 minutes and other documents by Overleaf
- 大家來學 LaTeX by 李果正