Speeding up LaTeX

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- Tiny Mountainous Country, area comparable to PA
- Our language is Nepali, written in Devangari Script, देवनागरी लिपी

LaTeX

- LaTeX is a document preparation system
- TeX is the typesetting engine,
    - Low level macros, very hard to remember and write
- LaTeX is layer over TeX which is widely used
- Various variants of these available, pdfLatex, luaLatex, xeLatex, conTex
- Multiple distributions for different architecture, Tex-Live, MikTex, etc

PHYS :516 Quantum Mechanics I

Homework #1

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(a) Consider two kets $|\alpha\rangle$ and $|\beta\rangle$. Suppose $\langle a'|\alpha\rangle, \langle a''|\alpha\rangle, \cdots$ and $\langle a'|\beta\rangle, \langle a''|\beta\rangle, \cdots$ are all known, where $|a'\rangle, |a''\rangle, \cdots$ form a complete set of base kets. Find the matrix representation of the operator $|\alpha\rangle\langle\beta|$ in this basis.

Solution:

We know every ket can be written as the sum of its component in the 'direction' of base ket $|\gamma\rangle$ (completeness) so $|\gamma\rangle$ can be written as

$$|\gamma\rangle = \sum_i |a^i\rangle\langle a^i|\gamma\rangle$$

Let the operator $|\alpha\rangle\langle\beta|\gamma\rangle$ act on an arbitrary ket $|\gamma\rangle$.

$$|\alpha\rangle\langle\beta|\gamma\rangle = \sum_i |\alpha\rangle\langle\beta|a^i\rangle\langle a^i|\gamma\rangle$$

So the component of this $|\alpha\rangle\langle\beta|\gamma\rangle$ in the direction of another eigen ket $|a^j\rangle$ is then given by the inner product of it with $|a^j\rangle$

$$(|\alpha\rangle\langle\beta|\gamma\rangle)_j = \langle a^j|\alpha\rangle\langle\beta|\gamma\rangle = \sum_i \underbrace{\langle a^j|\alpha\rangle\langle\beta|a^i\rangle}_{N\times N}\langle a^i|\gamma\rangle \tag{1}$$

This anove expression can be written as the matrix form as

$$\begin{bmatrix} (|\alpha\rangle\langle\beta|\gamma\rangle)_1 \\ (|\alpha\rangle\langle\beta|\gamma\rangle)_2 \\ \vdots \\ (|\alpha\rangle\langle\beta|\gamma\rangle)_N \end{bmatrix} = \begin{bmatrix} \langle a^1|\alpha\rangle\langle\beta|a^1\rangle & \langle a^1|\alpha\rangle\langle\beta|a^2\rangle & \cdots & \langle a^1|\alpha\rangle\langle\beta|a^N\rangle \\ \langle a^2|\alpha\rangle\langle\beta|a^1\rangle & \langle a^2|\alpha\rangle\langle\beta|a^2\rangle & \cdots & \langle a^2|\alpha\rangle\langle\beta|a^N\rangle \\ \vdots & \vdots & \ddots & \vdots \\ \langle a^N|\alpha\rangle\langle\beta|a^1\rangle & \langle a^N|\alpha\rangle\langle\beta|a^2\rangle & \cdots & \langle a^N|\alpha\rangle\langle\beta|a^N\rangle \end{bmatrix} \begin{bmatrix} (|\gamma\rangle)_1 \\ (|\gamma\rangle)_2 \\ \vdots \\ (|\gamma\rangle)_N \end{bmatrix}$$

Since every $\langle a'|\beta\rangle$ is known each element $\langle\beta|a^i\rangle$ in above matrix can be written as the complex conjugate of known $\langle a^i|\beta\rangle^*$. So the matrix representation becomes

$$|\alpha\rangle\langle\beta| \equiv \begin{bmatrix} \langle a^1|\alpha\rangle\langle a^1|\beta\rangle^* & \langle a^1|\alpha\rangle\langle a^2|\beta\rangle^* & \cdots & \langle a^1|\alpha\rangle\langle a^N|\beta\rangle^* \\ \langle a^2|\alpha\rangle\langle a^1|\beta\rangle^* & \langle a^2|\alpha\rangle\langle a^2|\beta\rangle^* & \cdots & \langle a^2|\alpha\rangle\langle a^N|\beta\rangle^* \\ \vdots & \vdots & \ddots & \vdots \\ \langle a^N|\alpha\rangle\langle a^1|\beta\rangle^* & \langle a^N|\alpha\rangle\langle a^2|\beta\rangle^* & \cdots & \langle a^N|\alpha\rangle\langle a^N|\beta\rangle^* \end{bmatrix}$$

Which is the required matrix representation of $|\alpha\rangle\langle\beta|$ ∎

Compilation

- `lualatex <source_file.tex>`
- `latexmk` is a useful tool, which handles
  - multiple compilations
  - missing cross references
- `latexmk <cource_file.tex>`

`~/.latexmkrc`

```
$pdflatex = "xelatex --synctex=1 %O
↪   %S";
$pdf_mode = 1;
$dvi_mode = $postscript_mode = 0;

add_cus_dep('glo', 'gls', 0,
↪   'makeglo2gls');
add_cus_dep('acn', 'acr', 0,
↪   'makeglo2gls');
sub makeglo2gls {
        system("makeglossaries
↪       $_[0]");
}
```

```
|-- PGSATalk.tex
|-- PGSATalk.aux
|-- PGSATalk.fdb_latexmk
|-- PGSATalk.fls
|-- PGSATalk.glo
|-- PGSATalk.ist
|-- PGSATalk.log
|-- PGSATalk.nav
|-- PGSATalk.out
|-- PGSATalk.pdf
|-- PGSATalk.snm
|-- PGSATalk.synctex.gz
|-- PGSATalk.toc
`-- PGSATalk.vrb
```

Basics

- A good and customizable text editor is very essential
- Using syntax highlighting
- Using proper indentation
- Code folding makes it a lot easier.

File Organization

- Break large file into multiple small files.
- Use `\input {file.tex}`.

```
% Author : Other Name
% Date   : 17-11-2019 18:47:14
%
\documentclass[a4paper]{article}

\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{physics}
\usepackage{graphicx}

\author{Prakash Gautam}

\begin{document}
    \input{chapters/chapter0.tex}
    \input{chapters/chapter1.tex}
    \input{chapters/chapter2.tex}
\end{document}
```

```
.
|-- images
|   |-- image1.png
|   |-- image2.png
|   `-- image3.jpg
|-- References
|   |-- AllnoSpace.tex
|   `-- CombinedMine.tex
|-- chapters
|   |-- chapter0.tex
|   |-- chapter1.tex
|   `-- chapter2.tex
|-- Thesis.tex
`-- Thesis.pdf
```

File Organization

- Break large file into multiple small files.
- Use `\input {file.tex}`.
- Use `~/texmf` directory for common repeated files.

```
% Author : Other Name
% Date   : 17-11-2019 18:47:14
%
\documentclass[a4paper]{article}

\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{glossaries}
\usepackage{graphicx}

\author{Prakash Gautam}

\input{EXOAcronyms.tex}
\input{STAcronyms.tex}

\begin{document}
    Talk about \gls{sm}, and its
    ↪  \gls{sm}.
    %Talk about Standard Model(SM)
    ↪  and its SM.
    \input{chapters/chapter0.tex}
    \input{chapters/chapter0.tex}
    \input{chapters/chapter0.tex}
    \input{chapters/chapter0.tex}
\end{document}
```

```
~/texmf
|-- bibtex
|   |-- bib
|   |   |-- Bibliographies.bib
|   |   `-- QuantumPhysics.bib
|   `-- bst
|       |-- ieeetr85.bst
|       |-- unsrt85.bst
|       `-- utphys85.bst
|-- tex
|   `-- latex
|       |-- Acronyms
|       |   |-- EXOAcronyms.tex
|       |   `-- STAcronyms.tex
|       |-- Drexel
|       |   |-- DrexelColour.tex
|       |   `-- DrexelStyle.tex
|       |-- EXO
|       |   `-- images
|       |       `-- EXO_logo.pdf
|       |-- Prakash
|       |   |-- PReport.cls
|       |   |-- homework.sty
|       |   `-- pgmath.sty
|       |-- styles
|       |   |-- ListingColour.tex
|       |   `-- TikzFeynmanStyle.tex
|       `-- tikz
|           `-- feynman
|               |-- 0nbb.tex
|               |-- 0nbb_with_arraow.tex
|               `-- 2nbb.tex
|-- ls-R
`-- README.md
```
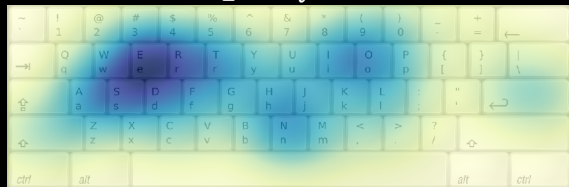
Character Heatmap (aka Fancy 1D histogram)

- Character heatmap shows the relative frequency of characters in a text file over keyboard image
- Apply gaussian smoothing for nicer look.
- Take a .tex source file generate heatmap
- Compile .tex to .pdf > extract text from pdf > Generate Heatmap
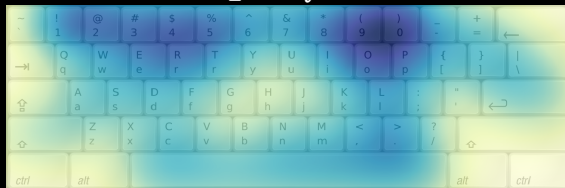
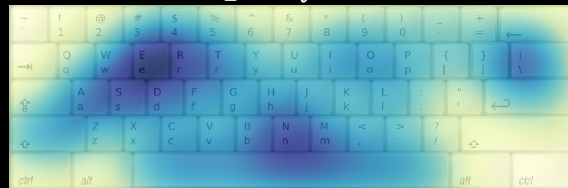`text_heavy.tex` file
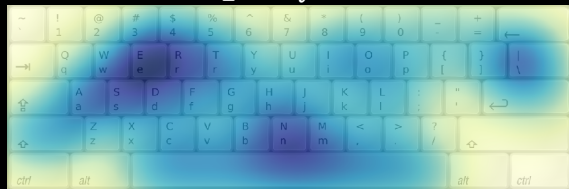
`text_heavy.txt` file
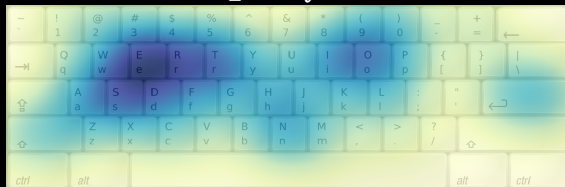
Heatmap Comparision
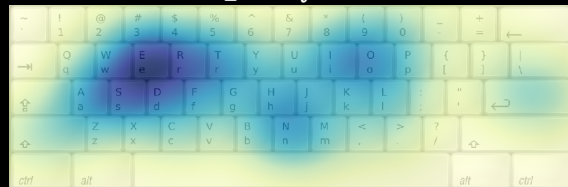
maths_heavy.tex file

text_heavy.tex file

maths_heavy.txt file

text_heavy.txt file

HeatmapGenerator

- `pip install kbhmap`

- `kbhmap -i <textfile> -o <imagefile>`

- github.com/pranphy/KeyboardHeatmap

Custom Styles

- Defining own macro is a very useful tool.

- They can be organized into a custom `.sty` files and used as `\usepackage{mystyle.sty}`

```
% define macro in mystyle.sty
\newcommand{\msun}{M_{\odot}}
\newcommand{\e}[1]{\times 10^{#1}}

% use macro in .tex source
Mass of sun is $\msun = 1.9\e{30}$kg.
% as opposed to
Mass of sun is $M_{\odot} = 1.9 \times 10 ^ {30}$kg
```

```
% Environments and stuffs
\newenvironment{questions}{%
\begin{enumerate} }{ \end{enumerate}%
}
\newcommand{\question}[1][]{%
    \ifthenelse{\equal{#1}{}}%
    {\item}{\item \textbf{(#1)}}%
}
\renewcommand{\part}{\item}
\newenvironment{solution}{ ~\\
↪   \textbf{Solution: }~\\}%
{\hfill $\square$ ~\\}
%
% general mathematics
% Unit vector
\newcommand{\uvec}[1]{\mathbf{\hat{#1}}}
\newcommand{\vecop}[1]{\mathbf{{#1}}}
%
% Astro constants
\newcommand{\msun}{M_{\odot}}
\newcommand{\e}[1]{\times 10^{#1}}
```

```
% Author : Other Name
% Date   : 17-11-2019 18:47:14
%
\documentclass[a4paper]{article}

\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{glossaries}
\usepackage{mystyle}

\author{Prakash Gautam}

\begin{document}
    \begin{questions}
        \question Find the mass of sun (\msun)
        %
        \begin{solution}
            The mass of sun is 6\e{24}
        \end{solution}
        %
        \question Find the follwoing field
        \begin{parts}
            \part Magnetic field
            \begin{solution}
                Magnetic field is $2 \uvec{i}$
            \end{solution}
            \part Electric Field
            \begin{solution}
                Electric field is $3 \uvec{j}$
            \end{solution}
        \end{parts}
    \end{questions}
\end{document}
```

Snippets (aka Lifesaver)

- Snippets are little piece of redundant code.
- They are easier to remember, (because you make it)
- They dramatically reduce the error and the speed of typesetting.

```
snippet alins " align asterisk " bA
\begin{align*}
    \$1
\end{align*}
endsnippet
```

```
snippet cases "cases from ams math" b
\begin{cases}
    $1 & \text{if} ${2:x\leq 0} \\\\
    $3 & \text{if} ${4:\text{otherwise}}
\end{cases}
endsnippet
```

Bibliography Management

- We read a lot of paper, and we need to cite them
- Use `.bib` file to manage bibliography.
- Zotero (free and Open Source) is a fantastic tool for bibliography management.

```latex
% Author : Other Name
% Date   : 17-11-2019 18:47:14
%
\documentclass[a4paper]{article}

\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{glossaries}

\author{Prakash Gautam}
\date{\today}

\begin{document}
    \section{Majorana Particles}
        Majorana proposed a new theory of symmetric
        ↪  particle\cite{bassani_symmetric_2006}
    \bibliographystyle{ieeetr85}
    \bibliography{QuantumPhysics.bib}
\end{document}
```