The Power of LaTeX: From Research Papers to Résumés

July 25, 2022

Homework Number 10. Due Thursday, 14 April 2022.

In this course, unless stated otherwise, when a problem consists of a statement, then you are suppose to provide a proof or counterexample.

Problem 1. *Let U be an open subset in $\mathbb{R}^2$ containing the rectangle $R = [a, b] \times [c, d]$ and let $f: U \to \mathbb{R}$ be a smooth function. Use the Fubini Theorem and the Fundamental Theorem of Calculus to find the integrals*

$$\int_{(x,y)\in R} \frac{\partial^2 f}{\partial x \, \partial y}(x, y) \quad \text{and} \quad \int_{(x,y)\in R} \frac{\partial^2 f}{\partial y \, \partial x}(x, y)$$

Problem 2. *If $A, B \in \mathbb{M}_n$ and A and B are similar, then $N(A) = N(B)$.*

Problem 3. *Let $T: \mathbb{R}^3 \to \mathbb{R}^3$ be the linear transformation given by reflecting across the plane $x_1 - 2x_2 + 2x_3 = 0$. Use the change-of-basis formula to find its standard matrix.*

Problem 4. *Suppose $\mathcal{B} = \{v_1, \ldots, v_n\}$ is a basis for a vector space V and*

$$
\begin{array}{ccc}
V & \xrightarrow{\ T\ } & W \\
{\scriptstyle A}\Big\downarrow & & \Big\downarrow{\scriptstyle B} \\
X & \xrightarrow{\ S\ } & Y
\end{array}
$$

is a diagram of vector spaces and linear transformations. If for every $j = 1, \ldots, n$, $BT(v_j) = SA(v_j)$, then the diagram commutes; that is, for every vector $x \in V$, $BT(x) = SA(x)$.

Problem 5. *Let A be a 3×3 matrix with the following properties. A has exactly two eigenvalues: 1 and -2. Moreover, $\dim E(1) = 1$ and $\dim E(-2) = 2$. Is A diagonalizable? Why or why not? If it is, give a diagonal matrix D such that A is similar to D.*

Problem 6. *Find the eigenvalues and eigenvectors of the linear transformation*

$$T(x, y) = \begin{bmatrix} 2x + 2y \\ 5y - x \end{bmatrix}.$$

What is LaTeX?

- A way of making documents with formatting, but in "code" instead of with an editor like Word or Google Docs
- Code is mixed in with plaintext to define formatting for that text
- Can be used to make all sorts of things!
  - Documents with lots of formatting, like résumés or posters
  - Papers with lots of symbols, like equations and proofs
  - Presentations (like this one!)
- There are tools to write it online, just like a Google Doc!

Let's try it out!

Go to overleaf.com to start editing.

Adding Tables, Lists, Images etc.

LaTeX supports all the formatting that you would expect from Word or Google Docs. To demonstrate this, let us work through a simple example of writing a recipe book!

We will learn how to make Fried ~~Chicken~~ Squirrel.

LaTeX environments

- Environments define special formatting within a block
- \begin{environment} and \end{environment}, and then text inside is formatted in a specific way
  - The itemize environment styles \item to make it look like a list item
  - The align environment allows equations to be aligned
  - The tabular environment styles its content as a table (and takes extra parameters for table styling)

Equations

Let's say a professor gives you this equation, and you want to type it into your notes or a homework assignment:

$$\nabla J_{\theta_j}(\theta) = \frac{1}{m} \sum_{i=1}^{m} (h_\theta(x^{(i)}) - y^{(i)}) x_j^{(i)}$$

How would you write this in Google Docs or Microsoft Word?

Example: Calculus

Let's start with a basic calculus problem.

$$\int_0^1 x^2 dx$$

Example: Proof

How would we write a proof—for example, a proof that the sum of two even numbers is even?

Example: Normal Distribution

How would we write this equation?

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

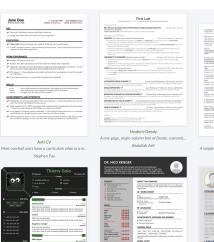How would you write this in Google Docs or Microsoft Word?

So, when should I use LaTeX?

~~at night~~

So, when should I use LaTeX?

- ▶ There are tons of classes where LaTeX can come in handy!
    - ▶ Discrete Structures & Algorithms
    - ▶ Math (especially more proof and symbol-heavy courses)
    - ▶ Machine Learning
    - ▶ Labs in the sciences with equations
- ▶ Résumés – allows you to add information easily, without lots of reformatting work
- ▶ Research papers

Résumés

Anti CV
Most overleaf users have a curriculum vitae or a re...
Stephen Fay

Modern-Deedy
A one-page, single-column fork of Deedy, customiz...
Abdullah Arif

resume template (CJK support)
A simple resume/CV template with CJK (Chinese J...
gobborg, timmy chan

Spider CV
LaTeX class template for CV/resume. Spider ...
RomainPC

my-resume
My take on a resume. Inspired by various other proj...
Nico Krieger

AltaCV | NicolasOmar Fork
A forked version of AltaCV template with Light/Da...
Nicolás Omar González Passerino

Other Cool Things in LaTeX

- ▶ Macros – custom commands with user-defined parameters that can expand into bigger commands
- ▶ Community packages, like `halloweenmath`! ☺ 🧹 👻

And when shouldn't I use LaTeX?

LaTeX is not the best tool for everything. For example, we didn't need LaTeX to make this presentation... and yet we did.

In general, if you think LaTeX is overkill for a project, it probably is.

But the payoff is that you only need to focus on the content of your document—not endless typesetting details.

Thank you!