My First Article

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Abstract

In this brief LaTeX training we covered a lot. We presented the basic elements of an article, lists, tables, equations, etc. On the Github page, we added references to Overleaf documentation so you can explore more in depth material. Finally, LaTeX is a very well established, so you will have no problem finding how to do all sorts of things. As Alan Kay said "Simple things should be simple, complex things should be possible." That is definitely true for Overleaf and LaTeX.

Contents

1 Introduction

2 My section

2.1 My subsection

2.1.1 My subsubsection

My paragraph

My subparagraph Note that you can label a section (like equations, tables, and figures), and reference it later

2.2 A Very Important Section

This section has some very important results. In this section we find the answer to the ultimate question of life and more.

2.3 A Section

Using the results from Sec. (2.2) we now can say for sure that the number "42" is the answer for ultimate questions of life, universe, and everything.

3 Text Formatting

This text is in **bold**, and this is in *italic*, and this one has underline.

Specifier	Switches To
`\textnormal{}`	normal document text
`\emph{}`	*emphasis*
`\texttt{}`	`Typewriter style font family`
`\textit{}`	*italic text*
`\textbf{}`	**bold text**
`\textrm{}`	Roman font family
`\textsf{}`	Sans-serif font family

This text is emphasized, and we put emphasis inside *a block that is already emphasized!*

4 Lists

LaTeX has the basic types of lists: bullet and enumerate. They are also known as "unordered" or "ordered". We will add these two types of list, then we mix them. We finish adding another type of list: description list.

A unordered list:

- This is the first item on a bullet list.

- This the second item.

And an ordered list:

1. First item in an enumerate list.
2. And the second item.

Of course you can combine the two types:

1. The ingredients
    - Eggs
    - Milk
    - Flour
2. Mix all ingredients in a bowl
3. Put in the oven.
4. After 30 minutes, remove the cake from the oven.
5. Enjoy it.

Now we present the "description" list:

The Red Sea is a small body of water.

The Red Sea also has extensive shallow shelves, noted for their marine life and corals. The sea is the habitat of over 1,000 invertebrate species and 200 types of soft and hard coral. It is the world's northernmost tropical sea, and has been designated a Global 200 ecoregion.

5 Computer Code

Adding computer code to your text

```
from flask import Flask
app = Flask(__name__)
@app.route('/')
def home():
    return 'Flask with docker!'
```

6 Images

Now we are going to add pictures to the document

In Fig. (1) we see a picture from a bay in Madagascar, where the salty waters of the Mozambique Channel penetrate inland to join with the freshwater outflow of the Betsiboka River, forming Bombetoka Bay.

Next we have another beautiful picture from somewhere in planet Earth. In the next picture will have a different number from the previous picture.

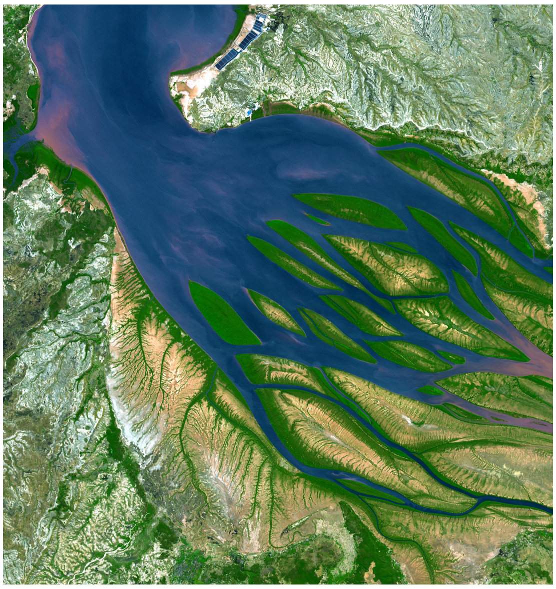


Figure 1: An Otherworldly-Looking Bombetoka Bay, Madagascar

In Fig. (2) we see the Susquehanna River cutting through the folds of the Valley-and-Ridge province of the Appalachian Mountains in this photograph taken by the crew of the International Space Station.

We can combine pictures into "one big picture" using the `subfigure` environment. You can think as nesting pictures inside the `picture` environment. You can reference the "big picture" as the places of planet Earth in Pic (3), or individual pictures, like the beautiful picture of Bombetoka Bay in Pic (3a).

7 Equations

Here we present what is probably the strongest points of LaTeX: mathematical typesetting.

7.1 Simple Maths

In this document we will add equations, and other mathematical stuff. We start with the *inline* mode, where the equation is directly on the text.

The very famous Einstein's equation is $E = mc^2$, where m is the mass of the object, and c is the speed of light in the vacuum. You put something a little more interesting in the in line equation, like an integral: $\int \zeta^2(x)\,dx$, or a simple fraction: $\frac{1}{x+y}$.

Using the *displaymath* environment

$$\int_{-\infty}^{\infty} e^{-x^2}\,dx = \sqrt{\pi}$$

The *displaymath* environment is so common that it has a shortcut `\[` and `\]`. Using the shortcut to rewrite the equation above, we should get the same result

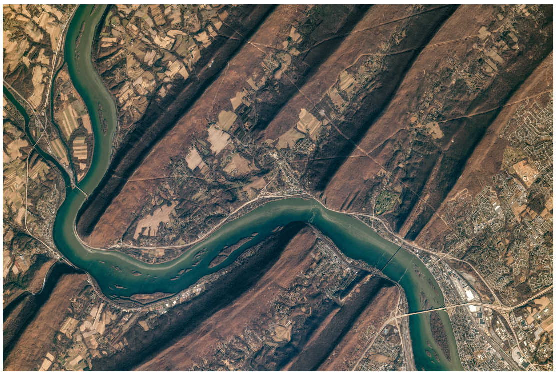
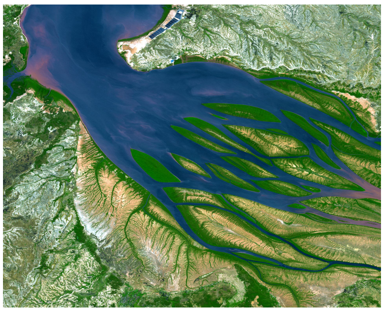
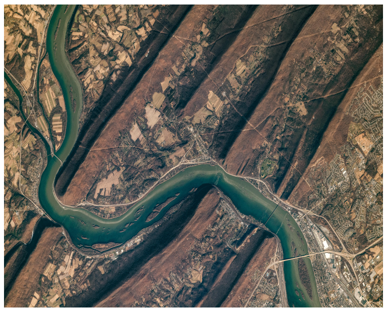


Figure 2: The Susquehanna River



(a) The Bombetoka Bay



(b) The Susquehanna River

Figure 3: Pictures from the planet Earth

$$\int_{-\infty}^{\infty} e^{-x^2}\,dx = \sqrt{\pi}$$

$$\int_{-\infty}^{\infty} e^{-x^2}\,dx = \sqrt{\pi} \tag{1}$$

Consider the following equation

$$\int_a^b f(x)\,dx = F(a) - F(b) \tag{2}$$

The Eq. (2) is known as *Fundamental Theorem of Calculus.*

7.1.1 Boxed Formula

The `\boxed{}` commands put its argument in a box

$$\boxed{\int_{-\infty}^{\infty} e^{-x^2}\,dx = \sqrt{\pi}}$$

7.1.2 Tagging a Formula

The amsmath allows to give a name to an equation with the \tag{} command

$$F = G\frac{m_1 m_2}{r^2} \tag{Newton}$$

The Eq. (Newton) shows that we can reference a tagged equation.

7.2 Gathering Formulas

The gather environment group several one-line formulas

$$x_l x_2 + x_1\ 2x_2\ 2 + x_3, \tag{3}$$
$$x_l x_3 + x_1\ 2x_3\ 2 + x_2, \tag{4}$$
$$x_l x_2 x_3. \tag{5}$$

Formulas (3)-(5) are type as

```
\begin{gather}
x_{l} x_{2} + x_{1}~{2} x_{2}~{2} + x_{3},\label{E:mml.1}\\
x_{l} x_{3} + x_{1}~{2} x_{3}~{2} + x_{2},\label{E:mml.2}\\
x_{l} x_{2} x_{3}.\label{E:mml.3}
\end{gather}
```

A better result can achieved by putting the gather inside the subequations environment

```
\begin{subequations}\label{E:gp}
\begin{gather}
x_{l} x_{2} + x_{1}~{2} x_{2}~{2} + x_{3},\label{E:gp1}\\
x_{l} x_{3} + x_{1}~{2} x_{3}~{2} + x_{2},\label{E:gp2}\\
x_{l} x_{2} x_{3},\label{E:gp3}
\end{gather}
\end{subequations}
```

Which produces the following output

$$x_l x_2 + x_1\ 2x_2\ 2 + x_3, \tag{6a}$$
$$x_l x_3 + x_1\ 2x_3\ 2 + x_2, \tag{6b}$$
$$x_l x_2 x_3, \tag{6c}$$

Then with \eqref{E:gp} you can reference the whole group as (6), while with \eqref{E:gp1} will reference an individual equation, like Eq. (6a).

7.3 Splitting Equations

LaTeX has a basic environment to split long formulas: multline

$$
\begin{multline}
(x_1x_2x_3x_4x_5x_6)^2\\
+(x_1x_2x_3x_4x_5\\
+x_1x_3x_4x_5x_6\\
+x_1x_2x_4x_5x_6\\
+x_1x_2x_3x_5x_6)^2 \tag{7}
\end{multline}
$$

Note that the first line is set flush left, and the last one is set flush to right, and ones in the middle are centered.

The `split` math environment is to split a (long) formula into aligned parts. There are two major reasons to use split:

- The math environment that contain it considers the `split` environment to be a single equation, so it generates only one number for it.
- If the `split` environment appears inside an `align` environment, the alignment point of the `split` environment is recognized by `align` as is used in aligning all the formulas in the `align` environement.

Consider the equation, despite the multiple lines, it's a single equation (point 1)

$$
\begin{split}
&(x_1x_2x_3x_4x_5x_6)^2\\
&\qquad +(x_1x_2x_3x_4x_5\\
&\qquad +x_1x_3x_4x_5x_6\\
&\qquad +x_1x_2x_4x_5x_6\\
&\qquad +x_1x_2x_3x_5x_6)^2
\end{split} \tag{8}
$$

To illustrate the second point, here is an example of `split` within an `align` environment. The `align` understands the align character inside the `split`

$$
\begin{align}
\begin{split}
f &= (x_1x_2x_3x_4x_5x_6)^2\\
&= (x_1x_2x_3x_4x_5+x_1x_3x_4x_5x_6+x_1x_2x_4x_5x_6+x_1x_2x_3x_5x_6)^2
\end{split} \tag{9}\\
g &= y_1y_2y_3 \tag{10}
\end{align}
$$

7.4 Matrices

The amsmath package provides the `matrix` environment. The `matrix` is a subsidiary environment, that means, it needs to be inside other mathematical environment, like `equation` or `displaymath`.

$$
\begin{matrix}
1 & 2 & 3\\
a & b & c
\end{matrix}
$$

Note that there are no parentheses, to have parentheses, use the `pmatrix` instead. Here is a more complete example

$$\mathbf{A} = \begin{pmatrix} a+b+c & uv \\ a+b & u+v \end{pmatrix} \begin{pmatrix} 30 & 7 \\ 3 & 17 \end{pmatrix}$$

Besides `matrix`, `pmatrix`, the other matrices environment include `bmatrix`, `Bmatrix`, `vmatrix`, and `Vmatrix`.

7.5 Cases

Cases, like matrices, are also a subsidiary environment, that is, it has to be inside another mathematical environment. An example of `cases` would be something like

$$f(x) = \begin{cases} -x^2, & \text{if } x < 0; \\ \alpha + x, & \text{if } 0 \leq x \leq 1; \\ x^2, & \text{otherwise.} \end{cases}$$

7.6 Typing a Big Formula

How to type a big formula step-by-step. By the end of this example you will have typed the formula:

$$\sum_{i=1}^{\left[\frac{n}{2}\right]} \binom{x_{i,i+1}^{i^2}}{\left[\frac{i+3}{3}\right]} \frac{\sqrt{\mu(i)^{\frac{3}{2}}(i^2-1)}}{\sqrt[3]{\rho(i)-2} + \sqrt[3]{\rho(i)-1}}$$

Type each step, and compile to double check that there are no mistakes.

1. Start with the $\left[\frac{n}{2}\right]$

   ```
   $\left[ \frac{n}{2} \right]$
   ```

2. Now type the sum:

   $$\sum_{i+1}^{\left[\frac{n}{2}\right]}$$

   For the superscript you can copy the formula above (removing the "$")

   ```
   \sum_{i+1}^{ \left[ \frac{n}{2} \right] }
   ```

3. Next the two formulas in the binomial

   $$x_{i,i+1}^{i^2} \qquad \left[\frac{i+3}{3}\right]$$

   Type as two separated formulas

```
x_{i, i + 1}^{i^{2}} \qquad \left[ \frac{i + 3}{3} \right]
```

4. Modify the formula above, by removing the `qquad`, and adding `binom` in the beginning

   ```
   \binom{ x_{i,i + 1}^{i^{2}} }{ \left[ \frac{i + 3}{3} \right] }
   ```

   You will get the binomial formula:

   $$\binom{ x_{i,i + 1}^{i^{2}} }{ \left[\frac{i + 3}{3} \right] }$$

5. Next type the formula under the square root $\mu(i)^{\frac{3}{2}}(i^{2} - 1)$ as

   ```
   \mu(i)^{ \frac{3}{2} } (i^{2} - 1)
   ```

   Then add the square root $\sqrt{\mu(i)^{\frac{3}{2}}(i^{2} - 1)}$

   ```
   \sqrt{ \mu(i)^{ \frac{3}{2} } (i^{2} - 1) }
   ```

6. Type the two cubic roots: $\sqrt[3]{\rho(i) - 2}$, and $\sqrt[3]{\rho(i) - 1}$

   ```
   \sqrt[3]{ \rho(i) - 2 }  \sqrt[3]{ \rho(i) - 1 }
   ```

7. Now get the fraction

   $$\frac{ \sqrt{ \mu(i)^{ \frac{3}{2}} (i^{2} -1) } }{ \sqrt[3]{ \rho(i) - 2 } + \sqrt[3]{ \rho(i) - 1 } }$$

   ```
   \frac{ \sqrt{ \mu(i)^{ \frac{3}{2}} (i^{2} -1) } }
       { \sqrt[3]{ \rho(i) - 2 }  + \sqrt[3]{ \rho(i) - 1 } }
   ```

8. Finally put everything together by copying-and-pasting from the steps above

   ```
       \sum_{i = 1}^{ \left[ \frac{n}{2} \right] }
       \binom{ x_{i, i + 1}^{i^{2}} }
           { \left[ \frac{i + 3}{3} \right] }
       \frac{ \sqrt{ \mu(i)^{ \frac{3}{2}} (i^{2} - 1) } }
           { \sqrt[3]{\rho(i) - 2} + \sqrt[3]{\rho(i) - 1} }
   ```

To get the complete formula

$$\sum_{i=1}^{\left[\frac{n}{2}\right]}\binom{x_{i,i+1}^{i^{2}}}{\left[\frac{i+3}{3}\right]}\frac{\sqrt{\mu(i)^{\frac{3}{2}}(i^{2}-1)}}{\sqrt[3]{\rho(i)-2}+\sqrt[3]{\rho(i)-1}}$$

Notice the use of:

- *spacing* to help distinguish the braces (Overleaf can help balancing the braces).
- Separated lines for each major part of the formula.

The points are for *your* readability, LaTeX itself doesn't care about spaces, but try to find the error in the formula below

```
\sum_{i=1}^{\left[\frac{n}{2}\right]}\binom{x_{i,i+1}^{i^{2}}}
{\left[\frac{i+3}{3}\right]}\frac{\sqrtt{\mu(i)^{\frac{3}{2}}(i^{2}-1)}}
{\sqrt[3]{\rho(i)-2}+\sqrt[3]{\rho(i)-1}}
```

8 Tables

Creating a simple table in LaTeX with 3 columns centered

cell1	cell2	cell3
cell4	cell5	cell6
cell7	cell8	cell9

Adding border to the table 1, and putting the table inside a proper "table" environment

Col 1	**Col 2**	**Col 3**
cell1	cell2	cell3
cell4	cell5	cell6
cell7	cell8	cell9

Table 1: Table with lines

Within a tabular environment, `&` jumps to the next column, `\\` starts a new line and `\hline` inserts a horizontal line. Add partial lines by using `\cline{i-j}`, where i and j are the column numbers the line should extend over. See Tab. (2).

7C0	hexadecimal
3700	octal
11111000000	binary
1984	decimal

Table 2: Table with partial lines

On Tab .(3) are placement options for the floating environment (like pictures and tables) in LaTeX.

Specifier	Placement
t	Place the table at the *top* of a text page
b	Place the table at the *bottom* of a text page
h	Place the table at the position in the text where the table environment is that is, *here*
p	Place the table on a separate float page
!	Used in addition to the other parameters, it overrides the restrictions of LaTeX over the floats (such as the maximum number of floats on a page) and helps to enforce the chosen parameter
H	Comes with the "float" package, it absolutely forces the table to appear at the position in the text where the table environment is

Table 3: Possible placement options for floating environment

9 References

The most important book for this training was [Grä04], which is really a deep dive into mathematics in LaTeX. I can't recommend this book enough. Next is a booklet of the same book, [Grä96], which is a good sample of the main book. A gentle short introduction to LaTeX is [Oet+01].

References

[Grä96] George Grätzer. *Math Into LaTeX, an introduction to LaTeX and AMS-LaTeX*. 1996. URL: `https://ctan.math.washington.edu/tex-archive/info/mil/mil.pdf`.

[Oet+01] Tobias Oetiker et al. *The Not So Short Introduction to LaTeXϵ*. 2001. URL: `https://tobi.oetiker.ch/lshort/lshort.pdf`.

[Grä04] George Grätzer. *Math Into LaTeX*. Birkhäuser, 2004. ISBN: 978-0-8176-4131-3.