SKILLPILLS

Skill Pill: LaTeX

Day 2: Math, tables and figures

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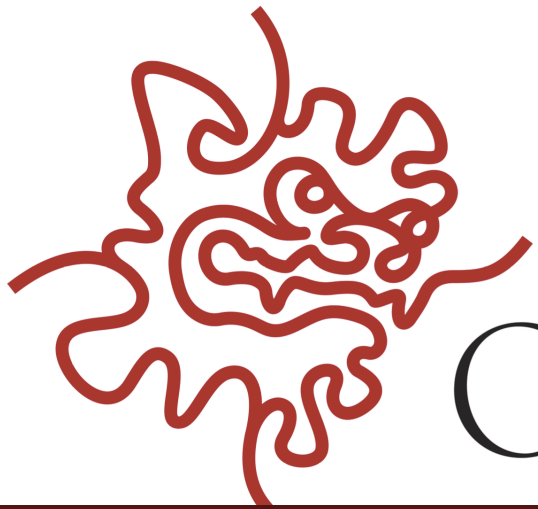
February 2nd, 2017



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Equations

One of the great advantages of LaTeX is the typesetting of equations. Equations can be placed directly in the text, such as $e^{i\pi} + 1 = 0$, or they can be set separate from the text:

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Equations inside the text are created with \$ $\cdots$ \$. Equations that take a full line with

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```
\begin{equation}
...
\end{equation}
```

It is recommended to use the $\mathcal{AMS}$-packages, since those extend the whole equation typesetting enormously. Those packages are included via

```
\usepackage{amsmath,amssymb}
```

Math 101

$$a + b = c \tag{1}$$

Equations

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`X_{12}`	creates	X_{12}

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`X_{12}`	creates	X_{12}

- Super- and subscript can be combined and nested:

`X^3_{n_i^2}` creates $X^3_{n_i^2}$

Equations

- Letters, numbers and symbols such as + - * / = < > , . ( ) [ ] may be directly used in math mode. For many other symbols one needs to use special commands (see separate list), e.g. for multiplication:

  `2 \cdot 3=6` creates $2 \cdot 3 = 6$

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- Fractions are created with `\frac{}{}`:

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- Vector arrows are created using `\vec`:

  `\vec{a}` creates $\vec{a}$

- We can put sums/integrals (and similar structures) with their limits:

`\int_0^1`	creates	$\int_0^1$
`\sum_{n=0}^\infty`	creates	$\sum_{n=0}^{\infty}$
`\lim_{x\to 0^+}`	creates	$\lim_{x\to 0^+}$

- Brackets created with `\left` and `\right` adapt to the content:

`( \frac{x+y}{2} )` creates $(\frac{x+y}{2})$

`\left( \frac{x+y}{2} \right)` creates $\left(\frac{x+y}{2} \right)$

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- Many options!
  `[...]`, `\{...\}`, `|...|`, `\|...\|`, `\langle...\rangle`, ...

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  `\left[ ... \right)`

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- Many options!
  `[...]`, `\{...\}`, `|...|`, `\|...\|`, `\langle...\rangle`, ...
- They can be combined in any way:

  `\left[ ... \right)`
- A dot (used with `\left` or `\right`) represents an invisible bracket:

  `\left. ... \right|`

- The `amsmath`-packages provides additional environments in order to enumerate and/or vertically align equations:

$$\partial_\mu F^{\mu\nu} = j^\nu \tag{2}$$

$$\partial_{[\mu} F_{\nu\lambda]} = 0 \tag{3}$$

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    \partial_\mu F^{\mu\nu} &= j^\nu \\
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The & symbols indicate where to align the equations.

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```

The & symbols indicate where to align the equations.

- There are many options with slightly different behaviour: `\[ ... \]`, `align`, `eqnarray`, `gather`

- For case definitions you can use the cases environment:

```
|x| =
\begin{cases}
    -x & \text{if } x<0, \\
    x & \text{if } x\geq0.
\end{cases}
```

$$|x| = \begin{cases} -x & \text{if } x < 0, \\ x & \text{if } x \geq 0. \end{cases}$$

A (VERY!) detailed list of symbols and their corresponding packages may be found here:

`http://ftp.jaist.ac.jp/pub/CTAN/info/symbols/comprehensive/symbols-a4.pdf`

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This online tool can help us find a symbol by just drawing it:

`http://detexify.kirelabs.org/classify.html`

Equations

LaTeXiT is a very versatile (Mac only, sorry!) LaTeXformula editor (to put in presentations,...)

`https://www.chachatelier.fr/latexit/`

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KLatexFormula looks like a promising alternative for Windows

`http://klatexformula.sourceforge.net/`
(but I haven't tried it!)

Your turn to do something!

We can calculate $6^2 - 5 = 36 - 5 = 31$.

Euler's identity is $e^{i\pi} + 1 = 0$.

$$(x - \alpha)(x + \alpha) = x^2 - \alpha^2 \tag{1}$$

$$E_k = \frac{1}{2}mv^2 \tag{2}$$

$$\sin(\phi) = \cos(\phi + \pi/2) \tag{3}$$

$$\int_a^b x^\alpha \mathrm{d}x = \frac{x^{\alpha+1}}{\alpha+1}\bigg|_a^b \tag{4}$$

$$f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!}(x-a)^n \tag{5}$$

$$g'(x) = \lim_{\Delta x \to 0} \frac{g(x+h) - g(x)}{\Delta x} \tag{6}$$

$$\lim_{n\to\infty} 2^n \underbrace{\sqrt{2 - \sqrt{2 + \sqrt{2 + \ldots + \sqrt{2}}}}}_{n} = \pi \tag{7}$$

$$\lim_{x\to 0^-} \frac{1}{x^r} = \begin{cases} -\infty, & \text{if } r \text{ is odd} \\ +\infty, & \text{if } r \text{ is even} \end{cases} \tag{8}$$

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Tables

The `tabular`-environment is used to create tables.

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```
\begin{tabular}{l|cr}
    flush left & centered & flush right\\
    \hline
    text & more text & even more text
\end{tabular}
```

flush left	centered	flush right
text	more text	even more text

Tables

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\begin{tabular}{l|cr}
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    \hline
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\end{tabular}
```

- `l` left aligned column (as wide as the widest entry)
- `c` centered column
- `r` right aligned column
- `p{1cm}` justified (with the value of the column width)
- `|` division of the columns with a vertical line (more than one possible)

Tables

```
\begin{tabular}{l|cr}
    flush left & centered & flush right\\
    \hline
    text & more text & even more text
\end{tabular}
```

`&` separates the columns

`\\` separates the rows

`\hline` horizontal line over the whole width of the table (more than one possible)

`\cline{1-2}` horizontal line from column 1 to column 2

There are advanced options for tables with cells taking multiple columns or rows with the `\multicolumn` and `\multirow` packages.

Atoms	Ions	
	Cations	Anions
H, Ne	Na^+	Cl^-

	per 100 g	**per serving (40 g)**
Caloric Value	1.705 kJ 406 kcal	682 kJ 162 kcal
Fat	way too much	

- A crappy table about nature to practice lines:

Mountains	Rivers	Lakes	Beaches and Deserts
rough	fast	standing	sandy

- A summary of the Skill Pill (fixed width):

Teacher	**Class summary**
Jérémie	He did a very good job in explaining the basics. I didn't like his hairstyle.
Albert	He made us do a bunch of useless mathy things, but he had an amazing soul patch.
James	What is this sorcery about changing formats? I could never get tired of listening to him.
Alexandru	Thanks to him I am ready to tackle my thesis. I will never be the same after his class.

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Matrices

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```
\[
    A =
    \begin{pmatrix}
        1 & 2\\
        3 & 4
    \end{pmatrix}
\]
```

$$A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

Matrices

```
B=\begin{bmatrix}
    1 & 2\\
    3 & 4
\end{bmatrix}
```

$$B = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

```
C=\begin{Bmatrix}
    1 & 2\\
    3 & 4
\end{Bmatrix}
```

$$C = \begin{Bmatrix} 1 & 2 \\ 3 & 4 \end{Bmatrix}$$

```
D=\begin{vmatrix}
    1 & 2\\
    3 & 4
\end{vmatrix}
```

$$D = \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$$

```
E=\begin{Vmatrix}
    1 & 2\\
    3 & 4
\end{Vmatrix}
```

$$E = \begin{Vmatrix} 1 & 2 \\ 3 & 4 \end{Vmatrix}$$

Matrices

- In case you do not need brackets or you want to set them yourself with `\left ... \right` you can use the `matrix` environment:

```
\begin{matrix}
    1 & 2\\
    3 & 4
\end{matrix}
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Matrices

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\begin{matrix}
    1 & 2\\
    3 & 4
\end{matrix}
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$$\begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix}$$

- For smaller matrices in-line you can use the `smallmatrix` environment.

```
\begin{smallmatrix}
    1 & 2\\
    3 & 4
\end{smallmatrix}
```

$\begin{smallmatrix} 1 & 2 \\ 3 & 4 \end{smallmatrix}$

Create some matrices!

- The identity matrix:

$$\mathbb{I} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- 2D rotation matrix:

$$U(\theta) = \begin{pmatrix} \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \cos(\theta) \end{pmatrix}$$

- Whatever this is:

$$X = \left| \begin{matrix} 3 \\ 2 \\ 1 \end{matrix} \right\rangle$$

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The graphicx Package

To include pictures you can use the graphicx packages. Supported formats are .jpg, .png, .pdf, and .eps (using epstopdf).

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The syntax is:

```
\includegraphics[arguments]{filename.jpg}
```

Optional Arguments for \includegraphics

Size related arguments:

`width`	Width, e.g. `width=10cm`
`height`	Height, e.g. `height=5cm`
`scale`	Scaling, e.g. `scale=0.5`

Optional Arguments for `\includegraphics`

SKILLPILLS

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It can be very useful to use relative sizes like `\textwidth`, `\columnwidth`, `\textheight`, ...

Example:

```
\includegraphics[width=0.5\textwidth]{figure.jpg}
```

Optional Arguments for \includegraphics

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Cropping arguments:

`clip`	Trim figure by lengths defined by `trim`
`trim=l d r u`	Lengths by which the figure is trimmed in the left (`l`), down (`d`), right (`r`) and up (`u`) directions.

Example:

```
\includegraphics[clip, trim=1cm 2.5cm 1cm 0cm]{figure.pdf}
```

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Float Environments

It is useful to place tables and figures in a float environment for the following advantages:

- 'optimized' placing
- referencing
- simple labeling
- automatic listing of figures and tables

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- referencing
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For figures you can use the `figure` environment and for tables you can use the `table` environment.

```
\begin{figure}[placing] ... \end{figure}

\begin{table}[placing] ... \end{table}
```

In general you can place any object within a float environment. A typical application is given below:

```
\begin{figure}
    \centering
    \includegraphics[width=10cm]{SPwhite.png}
    \caption{The Skill Pills logo.}
\end{figure}
```

Content of Float Environments

In general you can place any object within a float environment. A typical application is given below:

```
\begin{figure}
    \centering
    \includegraphics[width=10cm]{SPwhite.png}
    \caption{The Skill Pills logo.}
\end{figure}
```

`\centering` Centers the content of the environment.

`\caption{}` Includes a caption with successive numbering. It can be placed either above or below the object.

Figure 1: The Skill Pills logo.

Positioning Arguments:

```
\begin{figure}[!ht]
    \centering
    \includegraphics[width=10cm]{SPwhite.png}
    \caption{The Skill Pills logo.}
\end{figure}
```

- `h` 'here' – The floating object is placed at the same location as in the source code.
- `t` 'top' – The floating object is placed at the top of the page.
- `b` 'bottom' – The floating object is placed at the bottom of the page.
- `p` 'page' – The floating object is placed on its own page.
- `!` The floating object is prioritized.

Lists of Figures and Tables

The lists of figures and tables can be created using `\listoffigures` and `\listoftables` respectively. The entries are the captions.

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If you want to use a customized caption (e.g. if the original caption is to long) you can do this with an optional argument of the `\caption` command.

```
\caption[short caption]{long caption}
```

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Labels and References

Labels are used to refer to the following objects in the body of the document.

- numbered sections (`\section`, `\subsection`, `\subsubsection`)
- pages
- floating objects (`figure`, `table`)
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Example:

For all $x \in \mathbb{R}$

$$\cos^2 x + \sin^2 x = 1 \tag{4}$$

Equation (4) is also known as trigonometric Pythagoras identity.

Labels and References

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`\ref{xyz}` creates a reference for the object with the label `xyz`.

`\eqref{xyz}` creates a reference for the object with the label `xyz` and puts brackets around it.

`\pageref{xyz}` returns the page number where the object is placed.

Labels and References

For all $x \in \mathbb{R}$

$$\cos^2 x + \sin^2 x = 1 \tag{5}$$

Equation (5) is also known as trigonometric Pythagoras identity.

```
For all $x\in\mathbb{R}$
\begin{equation}
    \cos^2x+\sin^2x=1 \label{trigpyth}
\end{equation}
Equation \eqref{trigpyth} is also known as
   trigonometric Pythagoras identity.
```

The hyperref Package

The hyperref package turns all references into hyperlinks. This facilitates the navigation both within the document and for external links. Example:

```
\url{https://www.ctan.org/pkg/excel2latex}
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creates:

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The hyperref package should be included last since it can cause conflicts in combination with other packages.

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\multicolumn{Number}{Alignment}{Content}
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\multicolumn{Number}{Alignment}{Content}
```

Number	Number of columns to be connected.
Alignment	Alignment of text in the created cell (`l`, `c`, `r` as needed, with succeeding `|`)
Content	Content of the created cell.

The \multicolumn Command – Example

```
\begin{tabular}{|l|l|l|}
    \hline
    Atoms & \multicolumn{2}{c|}{Ions} \\
    \cline{2-3}
    & Cations & Anions \\
    \hline
    H, Ne & Na$^+$ & Cl$^-$ \\
    \hline
\end{tabular}
```

Atoms	Ions	
	Cations	Anions
H, Ne	Na^+	Cl^-

The \multirow Command

Similar to the \multicolumn command, the \multirow command is used to connect the entries of several rows of one column. In order to use it you need to add the multirow package:

```
\usepackage{multirow}
```

The syntax is simply:

```
\multirow{Number}{Width}{Content}
```

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```
\usepackage{multirow}
```

The syntax is simply:

```
\multirow{Number}{Width}{Content}
```

Number Number of columns to be connected.

Width With of the box in which the text will be set. (* automatically adjusts the width to the column-width)

Content Content of the created cell.

The \multirow Command – Example

```
\begin{tabular}{|l|l|l|}
    \hline
    Atoms & \multicolumn{2}{c|}{Ions} \\
    \cline{2-3}
    & Cations & Anions \\
    \hline
    H, Ne & Na$^+$ & Cl$^-$ \\
    \hline
\end{tabular}
```

Atoms	Ions	
	Cations	Anions
H, Ne	Na^+	Cl^-

The \multirow Command – Example

```
\begin{tabular}{|l|l|l|}
    \hline
    \multirow{2}{*}{Atoms} & \multicolumn{2}{c|}{Ions} \\
    \cline{2-3}
    & Cations & Anions \\
    \hline
    H, Ne & Na$^+$ & Cl$^-$ \\
    \hline
\end{tabular}
```

Atoms	Ions	
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	per 100 g	**per serving (40 g)**
Caloric Value	1.705 kJ 406 kcal	682 kJ 162 kcal
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