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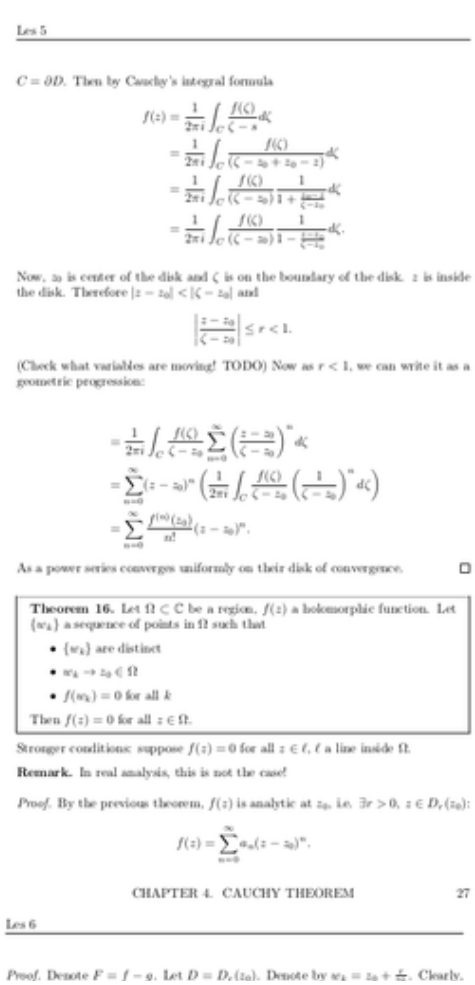
How I'm able to take notes in mathematics lectures using LaTeX and Vim

A while back I answered a question on Quora: Can people actually keep up with note-taking in Mathematics lectures with LaTeX. There, I explained my workflow of taking lecture notes in LaTeX using Vim and how I draw figures in Inkscape. However, a lot has changed since then and I'd like to write a few blog posts explaining my workflow.

I started using LaTeX to write lecture notes in the second semester of my bachelor in mathematics, and I've been using it ever since, which makes for a total of more than 1700 pages of notes. To give you an idea of what those notes look like, here are some examples:



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$C = \partial D$. Then by Cauchy's integral formula

$$\begin{aligned} f(z) &= \frac{1}{2\pi i}\int_C \frac{f(\zeta)}{\zeta - s}\,d\zeta \\ &= \frac{1}{2\pi i}\int_C \frac{f(\zeta)}{(\zeta - z_0 + z_0 - z)}\,d\zeta \\ &= \frac{1}{2\pi i}\int_C \frac{f(\zeta)}{(\zeta - z_0)}\frac{1}{1 + \frac{z_0 - z}{\zeta - z_0}}\,d\zeta \\ &= \frac{1}{2\pi i}\int_C \frac{f(\zeta)}{(\zeta - z_0)}\frac{1}{1 - \frac{z - z_0}{\zeta - z_0}}\,d\zeta. \end{aligned}$$

Now, z_0 is center of the disk and ζ is on the boundary of the disk. z is inside the disk. Therefore $|z - z_0| < |\zeta - z_0|$ and

$$\left|\frac{z - z_0}{\zeta - z_0}\right| \leq r < 1.$$

(Check what variables are moving! TODO) *Now as* $r < 1$, we can write it as a geometric progression:

$$\begin{aligned} &= \frac{1}{2\pi i}\int_C \frac{f(\zeta)}{\zeta - z_0}\sum_{n=0}^{\infty}\left(\frac{z - z_0}{\zeta - z_0}\right)^n d\zeta \\ &= \sum_{n=0}^{\infty}(z - z_0)^n\left(\frac{1}{2\pi i}\int_C \frac{f(\zeta)}{\zeta - z_0}\left(\frac{1}{\zeta - z_0}\right)^n d\zeta\right) \\ &= \sum_{n=0}^{\infty}\frac{f^{(n)}(z_0)}{n!}(z - z_0)^n. \end{aligned}$$

As a power series converges uniformly on their disk of convergence. □

Theorem 16. Let $\Omega \subset \mathbb{C}$ be a region, $f(z)$ a holomorphic function. Let $\{w_k\}$ a sequence of points in Ω such that

- $\{w_k\}$ are distinct
- $w_k \to z_0 \in \Omega$
- $f(w_k) = 0$ for all k

Then $f(z) = 0$ for all $z \in \Omega$.

Stronger conditions: suppose $f(z) = 0$ for all $z \in \ell$, ℓ a line inside Ω.

Remark. In real analysis, this is not the case!

Proof. By the previous theorem, $f(z)$ is analytic at z_0, i.e. $\exists r > 0$, $z \in D_r(z_0)$:

$$f(z) = \sum_{n=0}^{\infty} a_n(z - z_0)^n.$$

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Proof. Denote $F = f - g$. Let $D = D_r(z_0)$. Denote by $w_k = z_0 + \frac{r}{n}$. Clearly,

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Let us prove that $f(z) = 0$ for all z in some neighbourhood of z_0. Suppose not. Therefore, there exists a first N such that a_N is not 0. Then

$$\begin{aligned} f(z) &= (z - z_0)^N \sum_{n=N}^{\infty} a_n(z - z_0)^{n-N} \\ &= (z - z_0)^N\left(a_N + \sum_{n=N+1}^{\infty} a_n(z - z_0)^{n-N}\right) \end{aligned}$$

$$g(z) := \sum_{n=N+1}^{\infty} a_n(z - z_0)^{n-N}$$

$$f(z) = (z - z_0)^N(a_N + g(z))$$

$g(z) \xrightarrow{z \to z_0} 0$ because of the definition of g

In particular, $g(w_k) \xrightarrow{k \to \infty} 0$

And $f(z) = (z - z_0)^N(a_N + \underbrace{g(z)}_{\xrightarrow{z \to z_0} 0})$.

So $\exists M : n \geq M \Rightarrow a_N + g(w_k) \neq 0$.

Then

$$0 = f(w_k) = \underbrace{(w_k - z_0)^N}_{\neq 0}\underbrace{(a_N + g(w_k))}_{\neq 0}.$$

$w_k \neq z_0$ if we look far enough.

This is a contradiction to the fact that $\exists a_N \neq 0 \Rightarrow f(z) = 0 \quad \forall z$ in some neighbourhood of z_0.

So we've proved the theorem for a neighbourhood of x_0. Denote by U the interior $\{z \in \Omega \mid f(z) = 0\}$. $U \neq \emptyset$, since $f(z)$ is zero in some neighbourhood of z_0.

- U is open, since it is the interior of a set.
- U is closed , let z_0 be a limit point of U. Therefore, $\exists$ a sequence of points $z_k \in U$ and $z_k \to z_0$. We know that $f(z_k) = 0$, because $z_k \in U$. By the same arguments of above, $f(z) = 0$.

Therefore $V = \Omega \setminus U$ is open and $\Omega = U \cup V$. As Ω is connected, therefore V should be empty (as U is not.) Therefore V is empty! □

Remark. As $\mathbb{C}$ is the only non empty clopen set, we've proved that $\mathbb{C} \subset \Omega$, as $U \subset \Omega$.

Corollary 8. Let Ω be a region and D be a disk in Ω. Let f, g bet holomorphic on Ω. If $f(z) = g(z)$ for all $z \in D$, then $f(z) = g(z)$ for all $z \in \Omega$.

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Proof. Let $z_0 \in \Omega$. Since Ω is open, there exists $r > 0$ such that $\overline{D_r(z_0)} \subset \Omega$. Let

$w_k \to z_0$, w_k are distinct, $F(w_k) = 0$. Therefore, $F \equiv 0$ on Ω, therefore $f(z) = g(z)$ for all $z \in \Omega$. □

Definition 51. Let Ω, Ξ be regions such that $\Xi \subset \Omega$. Let f be a holomorphic function on Ξ, F be a holomorphic function on Ω. If $F(z) = f(z)$ for all $z \in \Xi$, then F is called *the* analytic continuation of $f(z)$ from Ξ to Ω.

Remark. By the previous result, the analytic continuation is unique!

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Theorem 17 (Morera)**.** Let D be a disk, and f be a continuous function on D. If for all $T \subset D$, $\int_T f = 0$, then f is holomorphic on D.

Proof. Let $z \in D$. Changing variables, we can assume that D is centred at the origin. Construct figure 4.4, construct γ. Let $F(z) = \int_\gamma f(\zeta)d\zeta$. Using the same method as in the proof about the existence of a primitive on a disk, we can prove that $F(z)$ is a primitive for $f(z)$ on D.

This means that $F(z)$ is holomorphic on D (and $F'(z) = f(z)$) This implies that $F(z)$ is infinitely many times differentiable on D. Therefore, $f(z)$ is differentiable on D. □

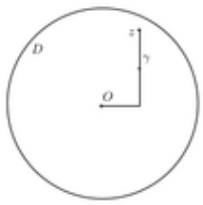


Figure 4.4: Proof of Morera.

Theorem 18 (About sequences of holomorphic functions)**.** Let $\Omega \subset \mathbb{C}$ be open, $\{f_n\}$ a sequence of holomorphic functions on Ω. If f_n converges to f uniformly on compact subsets of Ω, then f is holomorphic.

This result is not true in real analysis. (Every real continuous? function can be approximated by polynomials? But Weierstrass exists?)

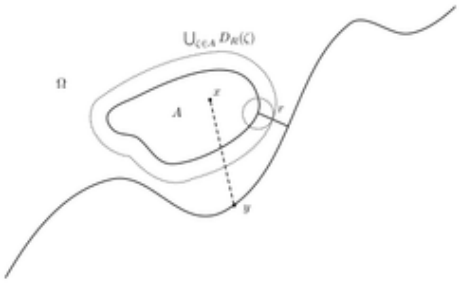


Figure 4.5: Proof of Theorem 7.

Definition 52. A $\Omega \subset \mathbb{C}$ is called symmetric iff

$$z \in \Omega \Leftrightarrow \overline{z} \in \Omega.$$

Denote by

$$\Omega^+ = \Omega \cap \{z \mid \operatorname{Im} z > 0\}$$
$$\Omega^- = \Omega \cap \{z \mid \operatorname{Im} z < 0\}$$
$$I = \Omega \cap \mathbb{R}.$$

Theorem 20 (Symmetry principle)**.** Let $\Omega \subset \mathbb{C}$, open and symmetric. Let $f^+(z)$ be a function holomorphic on Ω^+, and continuous on $\Omega^+ \cup I$. Let $f^-(z)$ be a function holomorphic on Ω^-, and continuous on $\Omega^- \cup I$. If $f^-|_I = f^+|_I$, then

$$f(z) = \begin{cases} f^+(z) & z \in \Omega^+ \\ f^+(z) = f^-(z) & z \in I \\ f^-(z) & z \in \Omega^-, \end{cases}$$

is holomorphic on Ω.

Proof. It is clear that $f(z)$ is holomorphic on $\Omega \setminus I$. We need to prove that $f(z)$ is holomorphic on I. Let $z_0 \in I$, $r > 0$ such that $D_r(z_0) \subset \Omega$.

Let T be a triangle in D There are multiple possibilities.

- $T \subset (D \cap \Omega^+) \cup (D \cap \Omega^-)$. Goursats handles this case.

$T \subset \overline{D_r(z_0)}$ be a triangle in this disk. Since f_n are holomorphic, $\int_T f_n(z)dz = 0$, by Goursat's theorem. Since, $f_n \to f$ uniformly on compact subsets, and therefore $f_n \to f$ on $\overline{D_r(z_0)}$, we have that[1]

$$\int_T f_n(z)dz \to \int_T f(z)dz = 0.$$

Therefore, by Morera, $f(z)$ is holomorphic on this disk, $\overline{D_r(z_0)}$. Therefore, $f(z)$ is holomorphic on Ω. □

Theorem 19 (About sequence of holomorphic functions and their derivatives)**.** Let $\Omega \subset \mathbb{C}$ be open, $\{f_n\}$ be a sequence of functions holomorphic on Ω. If $f_n \to f$ uniformly on compact subsets of Ω, then $\forall k \geq 0$,

$$f_n^{(k)} \to f^{(k)} \text{ uniformly on all compact subsets of } \Omega.$$

Proof. It is enough to prove the theorem only for $k = 1$. Let $A \subset \Omega$ a compact subset of Ω. Denote by $r = \inf_{x \in A, y \in \partial\Omega} |x - y|$ Since A is compact, $r > 0$ (ex). Denote by $R = \frac{r}{2}$.

$$A \subset \bigcup_{z \in A} D_R(z) \subset \Omega.$$

Let $F_n = f_n - f$. By evaluation of derivatives from the previous lecture, we have

$$|F_n'(z)| \leq \frac{1}{R} \sup_{w \in C_R(z)} |F_n(w)|.$$

Therefore

$$\sup_{z \in A} |F_n'(z)| \leq \frac{1}{R} \sup_{z \in A, w \in C_R(z)} |F_n(w)|$$
$$= \frac{1}{R} \sup_{z \in \bigcup_{\zeta \in A} D_r(\zeta)} |F_n(z)| \xrightarrow{n \to \infty} 0.$$

since f_n converges uniformly on compact subsets of Ω, and $\bigcup_{\zeta \in A} D_r(\zeta)$ is compact. As R is fixed,

$$\sup_{z \in A} |F_n'(z)| \to 0.$$

Since $F_n'(z) = f_n'(z) - f'(z)$, we have that

$$f_n'(z) \to f'(z).$$

uniformly on compact subsets of Ω. □

We can use this for power series, as this is a limit of a sequence.

[1] Uniform convergence implies dominated convergence

- $T \subset D \cap (\Omega^+ \cup I)$ or $T \subset D \cap (\Omega^- \cup I)$ Denote by T_ε a smaller triangle. T_ε satisfies the first case. As $\int_{T_\varepsilon} \to \int_T$, since $f(z)$ is continuous, we get that $\int_T = 0$.
- Other case, split the triangle in T_1, T_2, T_3.

Now as $f(z)$ is holomorphic on $D_r(z_0)$, $f(z)$ is holomorphic on Ω. □

Note that we didn't really use the symmetry of the set.

Note that the analytical continuation is unique, f is the *only* holomorphic function on Ω.

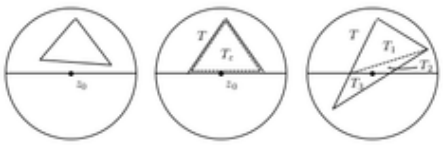


Figure 4.6: Symmetry principle

Theorem 21 (Shwarz reflection principle)**.** Let Ω be an open connected symmetric set. $f(z)$ is a holomorphic function on Ω^+, $f(z)$ is continuous on $\Omega^+ \cup I$, and for all $z \in \mathbb{R}$, $f(z) \in \mathbb{R}$. Then (z) can be analytically continued on Ω.

Proof. For $z \in \Omega^-$, define $g(z) = \overline{f(\overline{z})}$. Let us prove that $g(z)$ is holomorphic on Ω^-.

It is obvious that $g(z)$ is continuous on $\Omega^- \cup I$.

Let $z_0 \in \Omega^-$, then $\overline{z_0} \in \Omega^+$. Since $f(z)$ is holomorphic on Ω^+, $\exists r > 0, \forall z \in D_r(\overline{z_0})$, we have

$$f(z) = \sum_{n=0}^{\infty} a_n (z - \overline{z_0})^n.$$

For $w \in \Omega^-$,

$$g(w) = \overline{f(\overline{w})}$$
$$= \overline{\sum_{n=0}^{\infty} a_n (\overline{w} - \overline{z_0})^n}$$
$$= \sum_{n=0}^{\infty} \overline{a_n} (w - z_0)^n$$

Therefore, g is analytic at z_0, therefore g is holomorphic at z_0.

These lecture notes — including figures — are made while attending the lecture and have not been edited afterwards. To make note taking using LaTeX viable, I had four goals in mind:

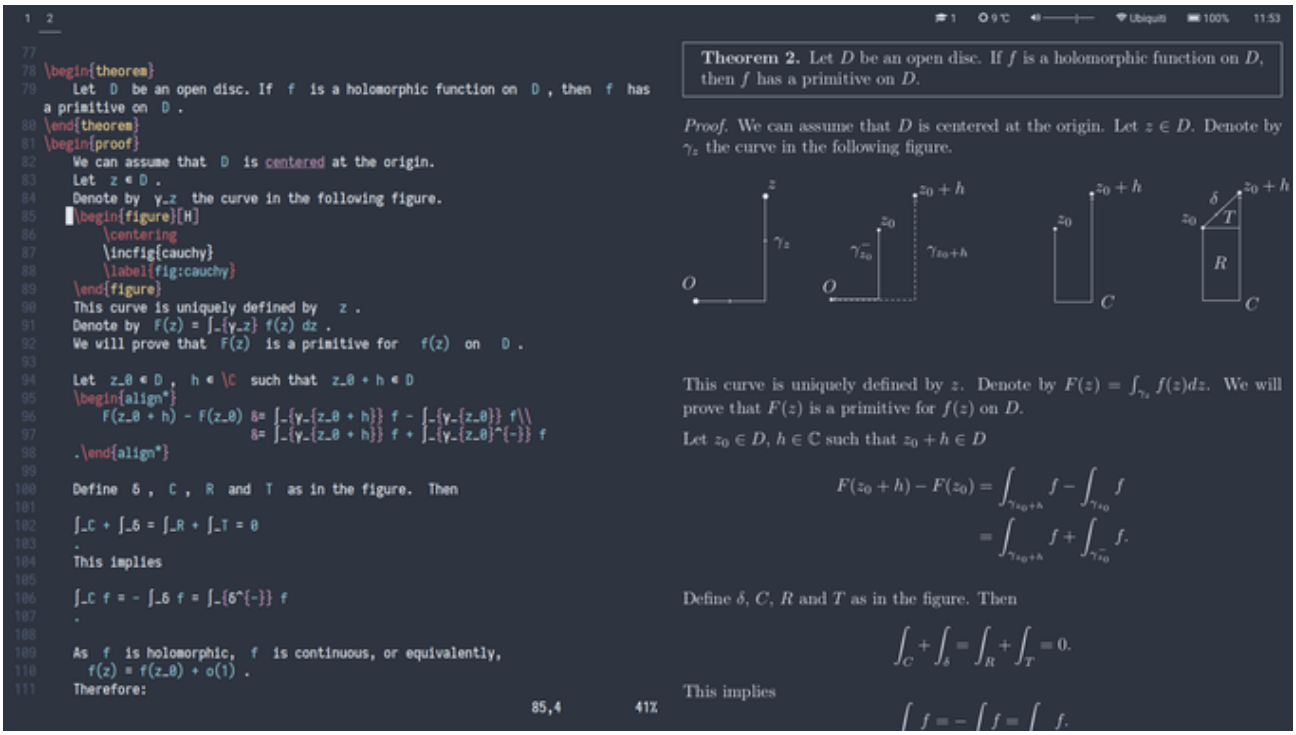
- Writing text and mathematical formulas in LaTeX should be as fast as the lecturer writing on a blackboard: no delay is acceptable.

- Drawing figures should be almost as fast as the lecturer.
- Managing notes, i.e. adding a note, compiling all my notes, compiling the last two lectures, searching in notes, etc. should be easy and quick.
- Annotating pdf documents using LaTeX should be possible for when I want to write notes alongside a pdf document.

This blog post will focus on the first item: writing LaTeX.

Vim and LaTeX

For writing text and mathematical formulas in LaTeX, I use Vim. Vim is a powerful general purpose text editor that's very extensible. I use it for writing code, LaTeX, markdown, ... basically everything that's text-based. It has a fairly steep learning curve, but once you've got the basics down, it's hard to get back to an editor without Vim keybindings. Here's what my screen looks like when I'm editing LaTeX:



On the left you see Vim and on the right my pdf viewer, Zathura, which also has Vim-like keybindings. I'm using Ubuntu with bspwm as my window manager. The LaTeX plugin I'm using in Vim is vimtex. It provides syntax highlighting, table of contents view, synctex, etc. Using vim-plug, I configured it as follows:

```
Plug 'lervag/vimtex'
let g:tex_flavor='latex'
let g:vimtex_view_method='zathura'
let g:vimtex_quickfix_mode=0
set conceallevel=1
let g:tex_conceal='abdmg'
```

The last two lines configure the concealment. This is a feature where LaTeX code is replaced or made invisible when your cursor is not on that line. By making `\[`, `\]`, `$` invisible, they're less obtrusive which gives you a better overview of the document. This feature also replaces `\bigcap` by by `∩`, `\in` by `∈` etc. The following animation should make that clear.

```
\[
A = ∩_{i ∈  I} A_i
,  and

B = ∩_{i ∈  I} B_i
.
~
```

With this set up, I come to the crux of this blog post: writing LaTeX as fast as the lecturer can write on the blackboard. This is where snippets come into play.

Snippets

What's a snippet?

A snippet is a short reusable piece of text that can be triggered by some other text. For example, when I type `sign` and press `Tab`, the word `sign` will be expanded to a signature:

```
~
~
~
~
~
~
```

Snippets can also be dynamic: when I type `today` and press `Tab`, the word `today` will be replaced by the current date, and `box` `Tab` becomes a box that automatically grows in size.

You can even use one snippet inside another:

Using UltiSnips to create snippets

I use the plugin UltiSnips to manage my snippets. My configuration is

```
Plug 'sirver/ultisnips'
let g:UltiSnipsExpandTrigger = '<tab>'
let g:UltiSnipsJumpForwardTrigger = '<tab>'
let g:UltiSnipsJumpBackwardTrigger = '<s-tab>'
```

The code for the `sign` snippet is the following:

```
snippet sign "Signature"
Yours sincerely,

Gilles Castel
endsnippet
```

For dynamic snippets, you can put code between backticks `` which will be run when the snippet is expanded. Here, I've used bash to format the current date: `date + %F`.

```
snippet today "Date"
`date +%F`
endsnippet
```

You can also use Python inside a `` `!p ... ` `` block. Have a look at the code for the `box` snippet:

```
snippet box "Box"
`!p snip.rv = '┌' + '─' * (len(t[1]) + 2) + '┐'`
| $1 |
`!p snip.rv = '└' + '─' * (len(t[1]) + 2) + '┘'`
$0
endsnippet
```

These Python code blocks will be replaced by the value of the variable `snip.rv`. Inside these blocks, you have access to the current state of the snippet, e.g. `t[1]` contains the first tab stop, `fn` the current filename, ...

LaTeX snippets

Using snippets, writing LaTeX is a lot faster than writing it by hand. Especially some of the more complex snippets can save you a lot of time and frustration. Let's begin with some simple snippets.

Environments

To insert an environment, all I have to do is type `beg` at the beginning of a line. Then I type the name of the environment, which is mirrored in the `\end{}` command. Pressing `Tab` places the cursor inside the newly created environment.

The code for this snippet is the following.

```
snippet beg "begin{} / end{}" bA
\begin{$1}
    $0
\end{$1}
endsnippet
```

The `b` means that this snippet will only be expanded at the beginning of a line and `A` stands for auto expand, which means I do not have to press `Tab` to expand the snippet. Tab stops — i.e. places you can jump to by pressing `Tab` and `Shift`+`Tab` — are represented by `$1`, `$2`, ... and the last one with `$0`.

Inline and display math

Two of my most frequently used snippets are `mk` and `dm`. They're the snippets responsible for starting math mode. The first one is a snippet for inline math, the second one for displayed math.

The snippet for inline math is 'smart': it knows when to insert a space after the dollar sign. When I start typing a word directly behind the closing `$`, it adds a space. However, when I type a non-word character, it does not add a space, which would be preferred for example in the case of `$p$-value`.

The code for this snippet is the following.

```
snippet mk "Math" wA
$${1}$`!p
if t[2] and t[2][0] not in [',', '.', '?', '-', ' ']:
    snip.rv = ' '
else:
    snip.rv = ''
`$2
endsnippet
```

The `w` at the end of the first line means that this snippet will expand at word boundaries, so e.g. `hellomk` won't expand, but `hello mk` will.

The snippet for displayed math is more simple, but it also is quite handy; it makes me never forget ending equations with a period.

```
snippet dm "Math" wA
\[
$1
.\] $0
endsnippet
```

Sub- and superscripts

Another useful snippet is one for subscripts. It changes changes `a1` to `a_1` and `a_12` to `a_{12}`.

The code for this snippet uses a regular expression for its trigger. It expands the snippet when you type a character followed by a digit, which encoded by `[A-Za-z]\d`, or a character followed by `_` and two digits: `[A-Za-z]_\d\d`.

```
snippet '([A-Za-z])(\d)' "auto subscript" wrA
`!p snip.rv = match.group(1)`_`!p snip.rv = match.group(2)`
endsnippet

snippet '([A-Za-z])_(\d\d)' "auto subscript2" wrA
`!p snip.rv = match.group(1)`_{`!p snip.rv = match.group(2)`}
endsnippet
```

When you wrap parts of a regular expression in a group using parenthesis, e.g. `(\d\d)`, you can use them in the expansion of the snippet via `match.group(i)` in Python.

As for superscripts, I use `td`, which becomes `^{}`. However, for squared, cubed, complement and a handful of other common ones, I use dedicated snippets such as `sr`, `cb` and `comp`.

```
snippet sr "^2" iA
^2
endsnippet

snippet cb "^3" iA
^3
endsnippet

snippet compl "complement" iA
^{c}
endsnippet

snippet td "superscript" iA
^{$1}$0
endsnippet
```

Fractions

One of my most convenient snippets is one for fractions. This makes the following expansions:

`//` → `\frac{}{}`
`3/` → `\frac{3}{}`

`4\pi^2/` → `\frac{4\pi^2}{}`
`(1 + 2 + 3)/` → `\frac{1 + 2 + 3}{}`
`(1+(2+3)/)` → `(1 + \frac{2+3}{})`
`(1 + (2+3))/` → `\frac{1 + (2+3)}{}`

```
/
3
4π^2
(1 + 2 + 3)
(1 + (2 + 3))
(1 + (2 + 3))
```

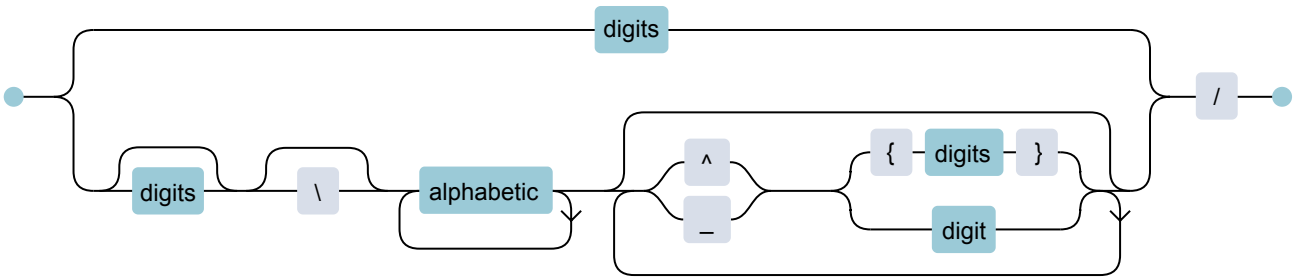
The code for the first one is easy:

```
snippet // "Fraction" iA
\\frac{$1}{$2}$0
endsnippet
```

The second and third examples are made possible using regular expressions to match for expressions like `3/`, `4ac/`, `6\pi^2/`, `a_2/`, etc.

```
snippet '((\d+)|(\d*)(\\)?([A-Za-z]+)((\^|_)(\{\d+\}|\d))*)/' "Fraction" wrA
\\frac{`!p snip.rv = match.group(1)`}{$1}$0
endsnippet
```

As you can see, regular expressions can become quite overwhelming, but here's a diagram that should explain it:



In the fourth and fifth cases, it tries to find the matching parenthesis. As this isn't possible using the regular expression engine of UltiSnips, I resorted to using Python:

```
priority 1000
snippet '^.*\)/' "() Fraction" wrA
`!p
stripped = match.string[:-1]
depth = 0
i = len(stripped) - 1
while True:
    if stripped[i] == ')': depth += 1
    if stripped[i] == '(': depth -= 1
    if depth == 0: break;
    i -= 1
snip.rv = stripped[0:i] + "\\frac{" + stripped[i+1:-1] + "}"
`{$1}$0
endsnippet
```

The last snippet concerning fractions I'd like to share is one that uses your selection to make a fraction. You can use it by first selecting some text, then pressing `Tab`, typing `/` and pressing `Tab` again.

```
1 + 2 + 3 + 4 + 5
~
~
~
~
```

The code makes use of the `${VISUAL}` variable that represents your selection.

```
snippet / "Fraction" iA
\\frac{${VISUAL}}{$1}$0
endsnippet
```

Sympy and Mathematica

Another cool — but less used — snippet is one that uses sympy to evaluate mathematical expressions. For example: `sympy` `Tab` expands to `sympy | sympy`, and `sympy 1 + 1 sympy` `Tab` expands to `2`.

```
~
~
~
~
```

```
snippet sympy "sympy block " w
sympy $1 sympy$0
endsnippet

priority 10000
snippet 'sympy(.*)sympy' "evaluate sympy" wr
`!p
from sympy import *
x, y, z, t = symbols('x y z t')
k, m, n = symbols('k m n', integer=True)
f, g, h = symbols('f g h', cls=Function)
init_printing()
snip.rv = eval('latex(' + match.group(1).replace('\\', '') \
    .replace('^', '**') \
    .replace('{', '(') \
    .replace('}', ')') + ')')
`
endsnippet
```

For the Mathematica users out there, you can do something similar:

```
~
~
~
~
```

```
priority 1000
snippet math "mathematica block" w
```

```
math $1 math$0
endsnippet

priority 10000
snippet 'math(.*)math' "evaluate mathematica" wr
`!p
import subprocess
code = 'ToString[' + match.group(1) + ', TeXForm]'
snip.rv = subprocess.check_output(['wolframscript', '-code', code])
`
endsnippet
```

Postfix snippets

Some other snippets I find worth sharing are postfix snippets. Examples of such snippets are `phat` → `\hat{p}` and `zbar` → `\overline{z}`. A similar snippet is a postfix vector, for example `v,.` → `\vec{v}` and `v.,` → `\vec{v}`. The order of `,` and `.` doesn't matter, so I can press them both at the same time. These snippets are a real time-saver, because you can type in the same order the lecturer writes on the blackboard.

```
~
~
~
~
```

Note that I can still use `bar` and `hat` prefix too, as I've added them with a lower priority. The code for those snippets is:

```
priority 10
snippet "bar" "bar" riA
\overline{$1}$0
endsnippet

priority 100
snippet "([a-zA-Z])bar" "bar" riA
\overline{`!p snip.rv=match.group(1)`}
endsnippet
```

```
priority 10
snippet "hat" "hat" riA
\hat{$1}$0
endsnippet

priority 100
snippet "([a-zA-Z])hat" "hat" riA
\hat{`!p snip.rv=match.group(1)`}
endsnippet
```

```
snippet "(\\?\w+)(,\.|\.,)" "Vector postfix" riA
\vec{`!p snip.rv=match.group(1)`}
endsnippet
```

Other snippets

I have about 100 other commonly used snippets. They are available here. Most of them are quite simple. For example, `!>` becomes `\mapsto`, `->` becomes `\to`, etc.

```
\[
    |
\]
```

`fun` becomes `f: \R \to \R :`, `!>` → `\mapsto`, `->` → `\to`, `cc` → `\subset`.

```
\[
    |
\]
```

`lim` becomes `\lim_{n \to \infty}`, `sum` → `\sum_{n = 1}^{\infty}`, `ooo` → `\infty`

```
\[
    |
\]
```

```
\[
    |
\]
```

Course specific snippets

Beside my commonly used snippets, I also have course specific snippets. These are loaded by adding the following to my `.vimrc`:

```
set rtp+=~/current_course
```

where `current_course` is a symlink to my currently activated course (more about that in another blog post). In that folder, I have a file `~/current_course/UltiSnips/tex.snippets` in which I include course specific snippets. For example, for quantum mechanics, I have snippets for bra/ket notation.

`<a|` → `\bra{a}`
`<q|` → `\bra{\psi}`
`|a>` → `\ket{a}`
`|q>` → `\ket{\psi}`
`<a|b>` → `\braket{a}{b}`

As `\psi` is used a lot in quantum mechanics, I replace all instances of `q` in a braket with `\psi` when expanded.

```
~
~
~
~
~
~
```

```
snippet "\<(.*?)\|" "bra" riA
\bra{`!p snip.rv = match.group(1).replace('q', f'\psi').replace('f', f'\phi')`
endsnippet

snippet "\|(.*?)\>" "ket" riA
\ket{`!p snip.rv = match.group(1).replace('q', f'\psi').replace('f', f'\phi')`
endsnippet

snippet "(.*)\\bra{(.*?)}([^\|]*?)\>" "braket" riA
`!p snip.rv = match.group(1)`\braket{`!p snip.rv = match.group(2)`}{`!p snip.r
endsnippet
```

Context

One thing to consider when writing these snippets is, 'will these snippets collide with usual text?' For example, according to my dictionary, there are about 72 words in English and 2000 words in Dutch that contain `sr`, which means that while I'm typing the word `disregard`, the `sr` would expand to `^2`, giving me `di^2egard`.

The solution to this problem is adding a *context* to snippets. Using the syntax highlighting of Vim, it can be determined whether or not UltiSnips should expand the snippet depending if you're in math or text. I came up with the following:

```
global !p
texMathZones = ['texMathZone'+x for x in ['A', 'AS', 'B', 'BS', 'C',
'CS', 'D', 'DS', 'E', 'ES', 'F', 'FS', 'G', 'GS', 'H', 'HS', 'I', 'IS',
'J', 'JS', 'K', 'KS', 'L', 'LS', 'DS', 'V', 'W', 'X', 'Y', 'Z']]

texIgnoreMathZones = ['texMathText']
```

```
texMathZoneIds = vim.eval('map('+str(texMathZones)+", 'hlID(v:val)')")
texIgnoreMathZoneIds = vim.eval('map('+str(texIgnoreMathZones)+", 'hlID(v:val)
ignore = texIgnoreMathZoneIds[0]

def math():
    synstackids = vim.eval("synstack(line('.'), col('.') - (col('.')≥2 ? 1 :
    try:
        first = next(
            i for i in reversed(synstackids)
            if i in texIgnoreMathZoneIds or i in texMathZoneIds
        )
        return first ≠ ignore
    except StopIteration:
        return False
endglobal
```

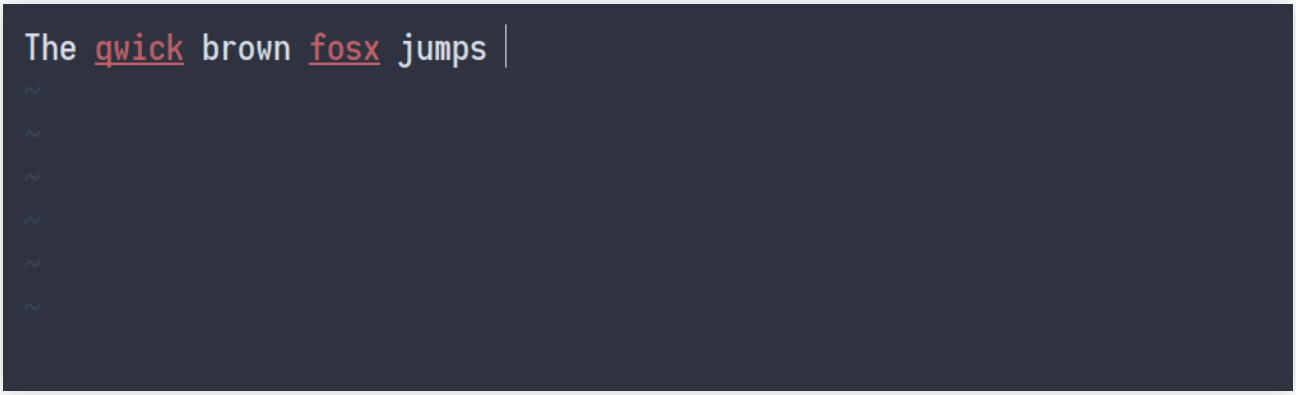
Now you can add `context "math()"` to the snippets you'd only want to expand in a mathematical context.

```
context "math()"
snippet sr "^2" iA
^2
endsnippet
```

Note that a 'mathematical context' is a subtle thing. Sometimes you add some text inside a math environment by using `\text{...}`. In that case, you do not want snippets to expand. However, in the following case: `\[ \text{$...$} \]`, they *should* expand. This is why the code for the `math` context is a bit complicated. The following animation illustrates these subtleties.

Correcting spelling mistakes on the fly

While inserting mathematics is an important part of my note-taking setup, most of the time I'm typing English. At about 80 words per minute, my typing skills are not bad, but I still make a lot of typos. This is why I added a keybinding to Vim that corrects the spelling mistakes, without interrupting my flow. When I press `Ctrl+L` while I'm typing, the previous spelling mistake is corrected. It looks like this:



My configuration for spell check is the following:

```
setlocal spell
set spelllang=nl,en_gb
inoremap <C-l> <c-g>u<Esc>[s1z=`]a<c-g>u
```

It basically jumps to the previous spelling mistake `[s`, then picks the first suggestion `1z=`, and then jumps back `` `]a ``. The `<c-g>u` in the middle make it possible to undo the spelling correction quickly.

In conclusion

Using snippets in Vim, writing LaTeX is no longer an annoyance, but rather a pleasure. In combination with spell check on the fly, it allows for a comfortable mathematical note-taking setup. A few pieces are missing though, for example drawing figures digitally and embedding them in a LaTeX document. This is a topic I'd like to tackle in a future blog post.

Liked this blog post? Consider buying me a coffee!

Written by **Gilles Castel**, who lives in Belgium studying mathematics at the university of Leuven.

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