`lymath` package:
semantic low level math formulas

(developped and tested on Mac OS X)

Christophe BAL

2017-11-01

Contents

1 Introduction

LaTeX is a great tool for writing mathematics, maybe it is the best, but the power of LaTeX allows very poor semantic writings. The modest purpose of the package `lymath` is to give some semantic macros to write elementary mathematic formulas. Here is an example of LaTeX code that you can use with `lymath`.

```
% Without lymath

Knowing that $\frac{df}{dx}(x) = 4 cos(x^2)$ on $[a ; b]$, we have:
$\int_a^b cos(x^2) dx = \left[ \frac{1}{4} f(x) \right]_a^b$.

% With lymath

Knowing that $\derfrac{f}{x}(x) = 4 cos(x^2)$ on $\intervalC{a}{b}$, we have:
$\int_a^b cos(x^2) \dd{x} = \hook{\frac{1}{4} f(x)}{a}{b}$.
```

Even if some commands are longest to write than direct LaTeX commands, there are two benefits.

1. The formatting inside your document is consistent.
2. `lymath` resolves some ”complex” problems automatically for you.

2 Semi-colon and spacing with the french option of `babel`

```
Only \textbf{if you use \texttt{babel} with the option \texttt{francais}}, then
you will see the same spacing around the semi-colon in $A(x;y)$. Que c’est beau !
```

Only **if you use `babel` with the option `francais`**, then you will see the same spacing around the semi-colon in $A(x;y)$. Que c’est beau !

3 Sets

3.1 Different kind of sets

3.1.1 Sets vs braces

Example of use #1

```
A set of beautiful numbers : $\geneset{1 ; 3 ; 5}$ .
```

A set of beautiful numbers : $\{1;3;5\}$.

Example of use #2

```
Choose your team :
$\displaystyle \geneset{\frac{1}{3} ; \frac{5}{7} ; \frac{9}{11}}$
or
$\displaystyle \geneset*{\frac{1}{3} ; \frac{5}{7} ; \frac{9}{11}}$ .
```

Choose your team : $\displaystyle \left\{\frac{1}{3} ; \frac{5}{7} ; \frac{9}{11}\right\}$ or $\displaystyle \{\frac{1}{3} ; \frac{5}{7} ; \frac{9}{11}\}$.

Technical IDs

`\geneset (1 Argument)`
`\geneset* (1 Argument)`

— `Argument:` the definition of the set.

3.1.2 Sets for geometry

Example of use #1

```
You can semantically write $\geoset{C}$, $\geoset{D}$ and $\geoset{d}$ but you can
not write things like \verb+$\geoset{ABC}$+.
```

You can semantically write $\mathscr{C}$, $\mathscr{D}$ and $\mathscr{d}$ but you can not write things like `$\geoset{ABC}$`.

Example of use #2

```
Subscripts can be used like in $\geoset*{C}{1}$, $\geoset*{C}{2}$, \dots
```

Subscripts can be used like in $\mathscr{C}_1$, $\mathscr{C}_2$, ...

Technical IDs

`\geoset (1 Argument)`

— `Argument:` one single `ASCII` letter indicating a geometrical set.

`\geoset* (2 Arguments)`

— `Argument #1:` one single `ASCII` letter indicating $\mathscr{U}$ in the name $\mathscr{U}_d$ of a geometrical set.

— `Argument #2:` one text indicating d in the name $\mathscr{U}_d$ of a geometrical set.

3.1.3 Sets for probability

Example of use #1

```
You can semantically write $\probaset{E}$ and $\probaset{G}$ but you can not write
things like \verb+$\probaset{ABC}$+.
```

You can semantically write $\mathcal{E}$ and $\mathcal{G}$ but you can not write things like `$\probaset{ABC}$`.

Example of use #2

```
Subscripts can be used like in $\probaset*{E}{1}$, $\probaset*{E}{2}$, \dots
```

Subscripts can be used like in $\mathcal{E}_1$, $\mathcal{E}_2$, $\dots$

Technical IDs

`\probaset (1 Argument)`

— `Argument:` one single upper `ASCII` upper letter indicating a probabilistic set.

`\probaset* (2 Arguments)`

— `Argument #1:` one single `ASCII` letter indicating $\mathcal{U}$ in the name $\mathcal{U}_d$ of a geometrical set.

— `Argument #2:` one text indicating d in the name $\mathcal{U}_d$ of a geometrical set.

3.1.4 Sets for rings and fields theory

Example of use #1

```
You can semantically write $\fieldset{A}$, $\fieldset{K}$, $\fieldset{h}$ and
$\fieldset{k}$, but you can't write things like \verb+$\fieldset{ABC}$+.
```

You can semantically write $\mathbb{A}$, $\mathbb{K}$, $\mathbb{h}$ and $\mathbb{k}$, but you can't write things like `$\fieldset{ABC}$`.

Example of use #2

```
Subscripts can be used like in $\fieldset*{k}{1}$, $\fieldset*{k}{2}$, \dots
```

Subscripts can be used like in $\mathbb{k}_1$, $\mathbb{k}_2$, $\dots$

Technical IDs

`\fieldset (1 Argument)`

— `Argument:` either one of the letters `h` and `k`, or one single upper `ASCII` letter indicating a field or ring like set.

`\fieldset* (2 Arguments)`

— `Argument #1:` one single `ASCII` letter indicating $\mathbb{U}$ in the name $\mathbb{U}_d$ of a geometrical set.

— `Argument #2:` one text indicating d in the name $\mathbb{U}_d$ of a geometrical set.

3.1.5 Classical sets

```
You can directly use $\nullset$, $\NN$, $\ZZ$, $\DD$, $\QQ$, $\RR$, $\CC$, $\HH$
and $\OO$.
```

You can directly use $\varnothing$, $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{D}$, $\mathbb{Q}$, $\mathbb{R}$, $\mathbb{C}$, $\mathbb{H}$ and $\mathbb{O}$.

3.1.6 Classical sets with suffixes

```
It is easy to type $\RRn$, $\RRp$, $\RRs$, $\RRsn$ and $\RRsp$.
```

It is easy to type $\mathbb{R}_-$, $\mathbb{R}_+$, $\mathbb{R}^*$, $\mathbb{R}_-^*$ and $\mathbb{R}_+^*$.

We have used suffixes `n` for `Negative`, `p` for `Positive`, and `s` for `@star` with the additional composite suffixes `sn` et `sp`.

Note that you can't use `$\CCn$` for $\mathbb{C}_-$ because the set $\mathbb{C}$ doesn't have any standard powerful ordered structure. Take a look at the next section to see how to write $\mathbb{C}_-$ if you need it.

Remark. The table 1 on page 6 shows when you can add one of the suffixes `n`, `p`, `s`, `sn` and `sp`.

Table 1: Suffixes

	n	p	s	sn	sp
N			×		
Z	×	×	×	×	×
D	×	×	×	×	×
Q	×	×	×	×	×
R	×	×	×	×	×
C			×		
H			×		
O			×		

3.1.7 Suffixes on demand

Example of use

```
You can indeed write things like $\specialset{\CC}{n}$ or $\specialset{\HH}{sp}$.
There is also $\specialset*{\probaset{P}}{n}$ with another formatting.
```

You can indeed write things like $\mathbb{C}_-$ or $\mathbb{H}_+^*$. There is also $\mathcal{P}_{\leq 0}$ with another formatting.

Technical IDs

`\specialset` (2 Arguments)
`\specialset*` (2 Arguments)

— `Argument #1:` the set to be "suffixed".

— `Argument #2:` one of the suffixes `n`, `p`, `s`, `sn` and `sp`.

3.2 Intervals

3.2.1 Real intervals - French (?) notation

Example of use #1

```
In $I = ]a ; b] = \intervalOC{a}{b}$, you can see that the macro used solves
a spacing problem.

% The syntax refers to O-pened and C-losed but CC and OO are reduced to C and O.
```

In $I =]a;b] = \left]a;b\right]$, you can see that the macro used solves a spacing problem.

Example of use #2

The delimiters automatically stretches vertically, but you can use the @star version of a macro if you don't want this feature. In that case, the delimiters are a little bigger than traditional hooks. Here is an example.

```
$\displaystyle \intervalC{ \frac{1}{2} }{ 1^{2^{3}} }
             = [ \frac{1}{2} ; 1^{2^{3}} ]
             = \intervalC*{ \frac{1}{2} }{ 1^{2^{3}} }$
```

$$\left[\frac{1}{2};1^{2^3}\right] = [\frac{1}{2};1^{2^3}] = \big[\frac{1}{2};1^{2^3}\big]$$

Technical IDs

For all the macros above, the @star version produces intervals with delimiters that fit vertically with the bounds of the interval.

`\intervalCO` (2 Arguments)
`\intervalCO*` (2 Arguments)

— `Argument #1:` lower bound a of the interval $[a;b[$.

— `Argument #2:` upper bound b of the interval $[a;b[$.

`\intervalC` (2 Arguments)
`\intervalC*` (2 Arguments)

— `Argument #1:` lower bound a of the interval $[a;b]$.

— `Argument #2:` upper bound b of the interval $[a;b]$.

`\intervalO` (2 Arguments)

`\intervalO*` (2 Arguments)

— `Argument #1`: lower bound a of the interval $]a; b[$.

— `Argument #2`: upper bound b of the interval $]a; b[$.

`\intervalOC` (2 Arguments)
`\intervalOC*` (2 Arguments)

— `Argument #1`: lower bound a of the interval $]a; b]$.

— `Argument #2`: upper bound b of the interval $]a; b]$.

3.2.2 Real intervals - American notation

Example of use

```
In America, we write a semi-closed interval $\intervalPC{a}{b} = (a ; b]$ and
an opened one $\intervalP{a}{b} = (a ; b)$.

% The syntax refers to P-arenthesis.
```

In America, we write a semi-closed interval $(a; b] = (a; b]$ and an opened one $(a; b) = (a; b)$.

Technical IDs

For all the macros above, the @star version produces intervals with delimiters that fit vertically with the bounds of the interval.

`\intervalCP` (2 Arguments)
`\intervalCP*` (2 Arguments)

— `Argument #1`: lower bound a of the interval $[a; b)$.

— `Argument #2`: upper bound b of the interval $[a; b)$.

`\intervalP` (2 Arguments)
`\intervalP*` (2 Arguments)

— `Argument #1`: lower bound a of the interval $(a; b)$.

— `Argument #2`: upper bound b of the interval $(a; b)$.

`\intervalPC` (2 Arguments)
`\intervalPC*` (2 Arguments)

— `Argument #1`: lower bound a of the interval $(a; b]$.

— `Argument #2`: upper bound b of the interval $(a; b]$.

3.2.3 Discrete intervals of integers

Example of use

```
By definition, $\ZintervalC{-1}{4} = \{ -1 ; 0 ; 1 ; 2 ; 3 ; 4 \}$. So we also have
$\ZintervalC{-1}{4} = \ZintervalO{-2}{5}$.

% The syntax refers to Z the set of integers.
```

By definition, $\llbracket -1; 4 \rrbracket = \{-1; 0; 1; 2; 3; 4\}$. So we also have $\llbracket -1; 4 \rrbracket = \rrbracket -2; 5 \llbracket$.

Technical IDs

For all the macros above, the @star version produces intervals with delimiters that fit vertically with the bounds of the interval.

`\ZintervalCO` (2 Arguments)
`\ZintervalCO*` (2 Arguments)

— `Argument #1:` lower bound a of the interval $\llbracket a; b \llbracket$.

— `Argument #2:` upper bound b of the interval $\llbracket a; b \llbracket$.

`\ZintervalC` (2 Arguments)
`\ZintervalC*` (2 Arguments)

— `Argument #1:` lower bound a of the interval $\llbracket a; b \rrbracket$.

— `Argument #2:` upper bound b of the interval $\llbracket a; b \rrbracket$.

`\ZintervalO` (2 Arguments)
`\ZintervalO*` (2 Arguments)

— `Argument #1:` lower bound a of the interval $\rrbracket a; b \llbracket$.

— `Argument #2:` upper bound b of the interval $\rrbracket a; b \llbracket$.

`\ZintervalOC` (2 Arguments)
`\ZintervalOC*` (2 Arguments)

— `Argument #1:` lower bound a of the interval $\rrbracket a; b \rrbracket$.

— `Argument #2:` upper bound b of the interval $\rrbracket a; b \rrbracket$.

4 Analysis

4.1 Constants

4.1.1 Classical constants

Complete list

```
List of all classical constants where $\ttau = \frac{\ppi}{2}$ is the youngest one:
$\ggamma$, $\ppi$, $\ttau$, $\ee$, $\ii$, $\jj$ and $\kk$.
```

List of all classical constants where $\tau = \frac{\pi}{2}$ is the youngest one: γ, π, τ, $\mathbf{e}$, $\mathbf{i}$, $\mathbf{j}$ and $\mathbf{k}$.

Remark. Take care that `{\Large $\ppi \neq \pi$}` produces $\pi \neq \pi$. As you can see, the symbols are not the same. Indeed, this is true for all the greek constants.

4.1.2 User's latine constants

Example of use

```
It is easy to write $\ct{a} x^2 + \ct{b} x + \ct{c}$ instead of $a x^2 + b x + c$
such as to stress the fact that $\ct{a}$, $\ct{b}$ and $\ct{c}$ are constants.
```

It is easy to write $\mathbf{a}x^2 + \mathbf{b}x + \mathbf{c}$ instead of $ax^2 + bx + c$ such as to stress the fact that $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$ are constants.

Technical ID

`\ct` (1 Argument)

— `Argument:` a latine text, and not a formula, indicating one constant.

4.2 Absolute value function

Example of use

```
It is easy to write $\abs{2}$ or $\displaystyle \abs{\frac{3}{5}}$ or even
$\displaystyle \abs*{\frac{3}{5}}$ if you prefer or need little vertical rules.
```

It is easy to write $|2|$ or $\displaystyle \left|\frac{3}{5}\right|$ or even $\displaystyle |\frac{3}{5}|$ if you prefer or need little vertical rules.

Remark. The LaTeX code comes directly from this post: `https://tex.stackexchange.com/a/43009/6880`.

Technical IDs

`\abs` (1 Argument)
`\abs*` (1 Argument)

— `Argument:` the number on which we apply the absolute value function

4.3 Special named functions

4.3.1 Some examples of use

```
Some additional special named functions :
$\ch x \neq ch x$, $\ppcm(x;y)$, $\lg x =\logb{2} x$ and $\expb{6} y$.
```

Some additional special named functions : $\operatorname{ch} x \neq chx$, $\operatorname{ppcm}(x;y)$, $\lg x = \log_2 x$ and $\exp_6 y$.

4.3.2 Named functions without parameter

All the following macros don't have any parameter.

`\pgcd`	`\ppcm`	`\ch`	`\sh`
`\th`	`\ach`	`\ash`	`\ath`
`\arccosh`	`\arcsinh`	`\arctanh`	`\acos`
`\asin`	`\atan`		

4.3.3 Named functions with parameters

The complete list

All the following macros have at least one parameter.

`\expb` (1 parameter) `\logb` (1 parameter)

Technical IDs

`\expb (1 Argument)`
`\logb (1 Argument)`

— `Argument:` the base of the exponential or the logarithm

4.4 Extended notations for special sequences

Example of use

```
Sometimes we need to write $\seqplus{F}{1}{2}$ or $\hypergeo{F}{1}{2}$ and crazy
-wo-men really (?) love $\suprageo{F}{1}{2}{3}{4}$.
```

Sometimes we need to write F_1^2 or ${}_1F_2$ and crazy -wo-men really (?) love ${}^4_1F^3_2$.

Technical IDs

`\seqplus (2 Arguments)`

— `Argument #1:` the right exponent like expression.

— `Argument #2:` the right indice.

`\hypergeo (2 Arguments)`

— `Argument #1:` the left indice.

— `Argument #2:` the right indice.

`\suprageo (4 Arguments)`

— `Argument #1:` the left indice.

— `Argument #2:` the right indice.

— `Argument #3:` the right exponent.

— `Argument #4:` the left exponent.

4.5 Differential calculus

4.5.1 The ∂ and d operators

Example of use

```
You can write $\dd{x}$ and $\pp{t}$ and also $ \dd[5]{x}$ or $\pp[n]{x}$.
```

You can write $\mathrm{d}x$ and ∂t and also $\mathrm{d}^5 x$ or $\partial^n x$.

Technical IDs

`\dd [1 Option] (1 Argument)`
`\pp [1 Option] (1 Argument)`

— `Option:` if used, this argument will be the exponent of the symbol ∂ or d.

— `Argument:` the variable of differentiation at the right of the symbol ∂ or d.

4.5.2 Total derivation

Example of use #1

```
$\displaystyle f'(a)
             = \derpow{f} (a)
             = \derfrac{f}{x} (a)
             = \dersub{f}{x} (a)$
```

$f'(a) = f^{(1)}(a) = \dfrac{\mathrm{d}f}{\mathrm{d}x}(a) = \mathrm{d}_x f(a)$

Example of use #2

```
$\displaystyle f'''(a)
             = \derpow[3]{f} (a)
             = \derfrac[3]{f}{x} (a)
             = \dersub[3]{f}{x} (a)$
and
$\displaystyle \cos''' a = \derfrac[3]{\cos}{x} (a)$.
```

$f'''(a) = f^{(3)}(a) = \dfrac{\mathrm{d}^3 f}{\mathrm{d}x^3}(a) = \mathrm{d}_x^3 f(a)$ and $\cos''' a = \dfrac{\mathrm{d}^3 \cos}{\mathrm{d}x^3}(a)$.

Example of use #3

```
If $\displaystyle f(x) = \frac{1}{x^2+3}$, then we can write :
$\displaystyle \derpow[3]{f} (a)
             = \derfrac*[3]{\left( \frac{1}{x^2+3} \right)}{x} (a)$.
```

If $f(x) = \dfrac{1}{x^2+3}$, then we can write : $f^{(3)}(a) = \dfrac{\mathrm{d}^3}{\mathrm{d}x^3}\left(\dfrac{1}{x^2+3}\right)(a)$.

Technical IDs

`\derpow [1 Option] (1 Argument)`

— `Option:` if used, this argument will be the exponent of derivation put inside braces.

— `Argument:` the function to be differenciated.

`\derfrac [1 Option] (2 Arguments)`
`\derfrac* [1 Option] (2 Arguments)`
`\dersub [1 Option] (2 Arguments)`

— `Option:` if used, the exponent of derivation.

— `Argument #1:` the function to be differenciated.

— `Argument #2:` the variable used for the derivation.

4.5.3 Partial derivation

Example of use #1

```
$\displaystyle \partialfrac{f}{x} (a;b)
             = \partialsub{f}{x} (a;b)
             = \partialprime{f}{x} (a;b)$
```

$\dfrac{\partial f}{\partial x}(a;b) = \partial_x f(a;b) = f'_x(a;b)$

Example of use #2

```
$\displaystyle \partialfrac[3]{G}{f^2 // v} (a;b)
             = \partialfrac{G}{f^2 // v} (a;b)
             = \partialsub{G}{f^2 // v} (a;b)
             = \partialprime{G}{f^2 // v} (a;b)$
```

$$\frac{\partial^3 G}{\partial f^2 \, \partial v}(a;b) = \frac{\partial G}{\partial f^2 \, \partial v}(a;b) = \partial_{f(2)\,v} G(a;b) = G'_{f(2)\,v}(a;b)$$

Example of use #3

```
If $\displaystyle f(x;y) = \frac{cos(x y)}{x^2+y^2}$, then we can study
$\displaystyle \partialfrac[2]{f}{x // y}
= \partialfrac*[2]{\left( \frac{cos(x y)}{x^2 + y^2} \right)}{x // y}$.
```

If $\displaystyle f(x;y) = \frac{cos(xy)}{x^2+y^2}$, then we can study $\displaystyle \frac{\partial^2 f}{\partial x \, \partial y} = \frac{\partial^2}{\partial x \, \partial y}\left(\frac{cos(xy)}{x^2+y^2}\right)$.

Technical IDs

`\partialfrac [1 Option] (2 Arguments)`
`\partialfrac* [1 Option] (2 Arguments)`

— `Option:` if used, the exponent of ∂ associated to the function differenciated.

— `Argument #1:` the function to be partially differenciated.

— `Argument #2:` the variables used for the partial derivation. The syntax is particular : for example, `x // y^3 // ...` indicates regarding to the variables x one time, y three times... and so on.

`\partialsub (2 Arguments)`
`\partialprime (2 Arguments)`

— `Argument #1:` the function to be partially differenciated.

— `Argument #2:` the variables used for the partial derivation. The syntax is particular : for example, `x // y^3 // ...` indicates regarding to the variables x one time, y three times... and so on.

4.6 Integral calculus

4.6.1 The hook operator - 1st version

Example of use #1

```
By definition, $\displaystyle \int_{a}^{b} f(x) \dd{x} = \hook{F(x)}{a}{b}$ where
$\hook{F(x)}{a}{b} = F(b) - F(a)$.
```

By definition, $\displaystyle \int_a^b f(x)\,\mathrm{d}x = \big[F(x)\big]_a^b$ where $\big[F(x)\big]_a^b = F(b) - F(a)$.

Example of use #2

By default, the hooks stretch vertically, but if you don't want this you just have to use the @star version as in the example below.

```
$\displaystyle \hook{\frac{x - 1}{5 + x^2}}{a}{b}
            = \hook*{\frac{x - 1}{5 + x^2}}{a}{b}$.
```

$\displaystyle \left[\frac{x-1}{5+x^2}\right]_a^b = [\frac{x-1}{5+x^2}]_a^b$.

Technical IDs

\hook (3 Arguments)
\hook* (3 Arguments)

— Argument #1: the content inside the hooks.

— Argument #2: the lower bound displayed as an index.

— Argument #3: the upper bound displayed as an exponent.

4.6.2 The hook operator - 2nd version

Example of use #1

```
You can use $\vhook{F(x)}{a}{b}$ instead of $\hook{F(x)}{a}{b}$.
```

You can use $F(x)\big|_a^b$ instead of $\big[F(x)\big]_a^b$.

Example of use #2

Like with first version of the hook operator, you can use a @star version to not have the default behavior of vertical stretch. Here is an example.

```
$\displaystyle \vhook{\frac{x - 1}{5 + x^2}}{a}{b}
            = \vhook*{\frac{x - 1}{5 + x^2}}{a}{b}$.
```

$\displaystyle \left.\frac{x-1}{5+x^2}\right|_a^b = \frac{x-1}{5+x^2}|_a^b$.

Technical IDs

\vhook (3 Arguments)
\vhook* (3 Arguments)

— Argument #1: the content before the vertical line | .

— Argument #2: the lower bound displayed as an index.

— Argument #3: the upper bound displayed as an exponent.

4.6.3 Several integrals

The package minimizes spacings between consecutive symbols of integration. Here is an example.

```
$\displaystyle \int \int \int F(x;y;z) \dd{x} \dd{y} \dd{z}
= \int_{a}^{b} \int_{c}^{d} \int_{e}^{f} F(x;y;z) \dd{x} \dd{y} \dd{z}$
```

$$\iiint F(x;y;z)\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z = \int_a^b\!\!\int_c^d\!\!\int_e^f F(x;y;z)\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$$

Remark. By default, LaTeX prints $\displaystyle \int \int \int F(x;y;z)\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z = \int_a^b \int_c^d \int_e^f F(x;y;z)\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$.

4.7 Asymptotic comparisons of sequences and functions

4.7.1 The $\mathcal{O}$ and $\mathcal{o}$ notations

Example of use #1

```
You can use the symbols $\bigO{}$ and $\smallO{}$ created by Landau.
```

You can use the symbols $\mathcal{O}$ and $\mathcal{o}$ created by Landau.

Example of use #2

```
You can write $\bigO{x} \neq \smallO{x}$ and $e^{t + \smallO{t}} = e^{\bigO{t}}$.
```

You can write $\mathcal{O}(x) \neq \mathcal{o}(x)$ and $e^{t+\mathcal{o}(t)} = e^{\mathcal{O}(t)}$.

Technical IDs

`\bigO (1 Argument)`
`\smallO (1 Argument)`

— `Argument:` the content inside the braces after the symbol $\mathcal{O}$ or $\mathcal{o}$.

4.7.2 The Ω notation

Example of use #1

```
You can use the symbol $\bigomega{}$ created by Hardy and Littlewood.
```

You can use the symbol $\boldsymbol{\Omega}$ created by Hardy and Littlewood.

Example of use #2

```
$f(n) = \bigomega{g(n)}$ means: $\exists (m, n_0)$ such that
$n \geqslant n_0$ implies $f(n) \geqslant m g(n)$.
```

$f(n) = \boldsymbol{\Omega}(g(n))$ means: $\exists (m, n_0)$ such that $n \geqslant n_0$ implies $f(n) \geqslant mg(n)$.

Technical ID

`\bigomega` (1 Argument)

— `Argument`: the content inside the braces after the symbol $\boldsymbol{\Omega}$.

4.7.3 The $\boldsymbol{\Theta}$ notation

Example of use #1

```
Here is the last symbol $\bigtheta{}$ that can be helpful.
```

Here is the last symbol $\boldsymbol{\Theta}$ that can be helpful.

Example of use #2

```
$f(n) = \bigtheta{g(n)}$ means: $\exists (m, M, n_0)$ such that $n \geqslant n_0$
implies $m g(n) \leqslant f(n) \leqslant M g(n)$.
```

$f(n) = \boldsymbol{\Theta}(g(n))$ means: $\exists (m, M, n_0)$ such that $n \geqslant n_0$ implies $mg(n) \leqslant f(n) \leqslant Mg(n)$.

Technical ID

`\bigtheta` (1 Argument)

— `Argument`: the content inside the braces after the symbol $\boldsymbol{\Theta}$.

5 Geometry

5.1 Points

Example of use #1

```
$\gpt{I}$ indicates a point named "I".
```

I indicates a point named ”I”.

Remark. `\gpt` is for ”**g**eometric **p**oin**t**”. This name has been chosen so as to avoid a conflict with `lyxam` another project of the author of `lymath`.

Example of use #2

```
A list of points : $\gpt*{I}{1}$, $\gpt*{I}{2}$, \dots
```

A list of points : I_1, I_2, ...

Technical ID

`\gpt (1 Argument)` where `gpt = G-eometric P-oin-T`

— `Argument:` one text indicating the name of a point.

`\gpt* (2 Arguments)`

— `Argument #1:` one text indicating Up in the name Up_{down} of a point.

— `Argument #2:` one text indicating *down* in the name Up_{down} of a point.

5.2 Writing vectors

Example of use #1

```
Here is one vector $\vect{ABCDEF}$ using a lot of letters and you can write
$\vect*{e}{rot}$ instead of $\vect{e_{rot}}$.
```

Here is one vector $\overrightarrow{ABCDEF}$ using a lot of letters and you can write $\overrightarrow{e}_{rot}$ instead of $\overrightarrow{e_{rot}}$.

Example of use #2

```
You can also simply write $\vect{i}$ and $\vect*{j}{2}$ without points below the
arrows only for vectors named "i" or "j".
```

You can also simply write $\overrightarrow{\imath}$ and $\overrightarrow{\jmath}_2$ without points below the arrows only for vectors named "i" or "j".

Technical IDs

`\vect (1 Argument)`

— `Argument:` one text indicating the name of a vector.

`\vect* (2 Arguments)`

— `Argument #1:` one text indicating *up* in the name $\overrightarrow{up}_{down}$ of a vector.

— `Argument #2:` one text indicating *down* in the name $\overrightarrow{up}_{down}$ of a vector.

5.3 Norm of a vector

Example of use

```
Let's write $\norm{\vect{i}}$, $\displaystyle \norm{\frac{2}{7} \vect*{e}{k}}$, or
$\displaystyle \norm*{\frac{2}{7} \vect*{e}{k}}$ with little vertical rules.
```

Let's write $\|\vec{\imath}\|$, $\displaystyle \left\|\frac{2}{7}\vec{e}_k\right\|$, or $\|\frac{2}{7}\vec{e}_k\|$ with little vertical rules.

Remark. The LaTeX code comes directly from this post: `https://tex.stackexchange.com/a/43009/6880`.

Technical IDs

`\norm (1 Argument)`
`\norm* (1 Argument)`

— `Argument:` the vector on which we apply the norm

5.4 Inner angles

Example of use #1

```
Here is one inner angle $\anglein{ABCDEF}$ using a lot of letters, and you can
write $\anglein*{A}{rot}$ instead of $\anglein{A_{rot}}$.
```

Here is one inner angle $\widehat{ABCDEF}$ using a lot of letters, and you can write $\widehat{A}_{rot}$ instead of $\widehat{A_{rot}}$.

Example of use #2

```
You can also simply write $\anglein{i}$ and $\anglein*{j}{2}$ without points below
the angle symbol only for inner angles named "i" or "j".
```

You can also simply write $\widehat{\imath}$ and $\widehat{\jmath}_2$ without points below the angle symbol only for inner angles named "i" or "j".

Technical IDs

`\anglein (1 Argument)`

— `Argument:` one text indicating the name of an inner angle.

`\anglein* (2 Arguments)`

— `Argument #1:` one text indicating *up* in the name $\widehat{up}_{down}$ of an inner angle.

— `Argument #2:` one text indicating *down* in the name $\widehat{up}_{down}$ of an inner angle.

5.5 Circular arcs

Example of use #1

```
Here is one arc $\arc{ABCDEF}$ using a lot of letters, and you can write
$\arc*{A}{rot}$ instead of $\arc{A_{rot}}$.
```

Here is one arc $\wideparen{ABCDEF}$ using a lot of letters, and you can write $\wideparen{A}_{rot}$ instead of $\wideparen{A_{rot}}$.

Example of use #2

```
You can also simply write $\arc{i}$ and $\arc*{j}{2}$ without points below the arc
only for arcs named "i" or "j".
```

You can also simply write $\wideparen{\imath}$ and $\wideparen{\jmath}_2$ without points below the arc only for arcs named "i" or "j".

Technical IDs

`\arc` (1 Argument)

— `Argument:` one text indicating the name of a circular arc.

`\arc*` (2 Arguments)

— `Argument #1:` one text indicating *up* in the name $\wideparen{up}_{down}$ of a circular arc.

— `Argument #2:` one text indicating *down* in the name $\wideparen{up}_{down}$ of a circular arc.

5.6 Naming axes

Example of use #1

```
In a plane, three points $\gpt{O}$, $\gpt{I}$ and $\gpt{J}$ not aligned define
a cartesian system of coordinates $\axis{\gpt{O} // \gpt{I} // \gpt{J}}$.

% We give more efficient ways to name axies in some particular cases.
```

In a plane, three points O, I and J not aligned define a cartesian system of coordinates $(\mathrm{O}; \mathrm{I}, \mathrm{J})$.

Example of use #2

```
$\displaystyle \axis{\gpt{O} // \frac{7}{3} \vect{i} // \vect{j}}$
or
$\displaystyle \axis*{\gpt{O} // \frac{7}{3} \vect{i} // \vect{j}}$
```

$\displaystyle \left(\mathrm{O}; \frac{7}{3}\vec{\imath}, \vec{\jmath}\right)$ or $\displaystyle (\mathrm{O}; \frac{7}{3}\vec{\imath}, \vec{\jmath})$

Example of use #3

```
% You must at least use two "pieces" separated by //, but there is no maximum !

$\axis{\gpt{O} // \vect*{i}{1} // \vect*{i}{2} // \vect*{i}{3} // \dots
// \vect*{i}{9}// \vect*{i}{10}}$
```

$(\mathrm{O}; \vec{\imath}_1, \vec{\imath}_2, \vec{\imath}_3, \dots, \vec{\imath}_9, \vec{\imath}_{10})$

Example of use #4 - No star version here

```
$\gpaxis{O // I // J // K}$ is just the same than
$\axis{\gpt{O} // \gpt{I} // \gpt{J} // \gpt{K}}$.

% The prefix "gp" is for "geometric point".
```

$(\mathrm{O}; \mathrm{I}, \mathrm{J}, \mathrm{K})$ is just the same than $(\mathrm{O}; \mathrm{I}, \mathrm{J}, \mathrm{K})$.

Example of use #5 - No star version here

```
$\vaxis{\gpt{O} // i // j}$ is just the same than
$\axis{\gpt{O} // \vect{i} // \vect{j}}$.

% The prefix "v" is for "vector".
```

$(\mathrm{O}; \vec{\imath}, \vec{\jmath})$ is just the same than $(\mathrm{O}; \vec{\imath}, \vec{\jmath})$.

Example of use #6 - No star version here

```
$\gpvaxis{O // i // j}$ is just the same than
$\axis{\gpt{O} // \vect{i} // \vect{j}}$.

% The prefix "gpv" adds the features of the prefixes "gp" and "v".
```

$(\mathrm{O}; \vec{\imath}, \vec{\jmath})$ is just the same than $(\mathrm{O}; \vec{\imath}, \vec{\jmath})$.

Technical IDs

`\axis (1 Argument)`
`\axis* (1 Argument)`

— `Argument:` the argument is made of formulas separated by `//` with the following meanings.

- The first one is the origin of the cartesian system of coordinates.
- Then there are points or vectors which ”define” each axis.

`\gpaxis (1 Argument)` where `gp = G-eometric P-oint`

— `Argument:` the argument is made of formulas separated by `//` with the following meanings.

- The first one is the origin of the cartesian system of coordinates on which the macro `\gpt` will be automatically applied.
- Then there are points which "define" each axis, and on each of this points the macro `\gpt` will be automatically applied.

`\vaxis (1 Argument)` where `v = V-ector`

— `Argument:` the argument is made of formulas separated by `//` with the following meanings.

- The first one is the origin of the cartesian system of coordinates.
- Then there are vectors which "define" each axis, and on each of this vectors the macro `\vect` will be automatically applied.

`\gpvaxis (3 Arguments)` where `gpv = gp + v`

— `Argument:` the argument is made of formulas separated by `//` with the following meanings.

- The first one is the origin of the cartesian system of coordinates on which the macro `\vect` will be automatically applied.
- Then there are vectors which "define" each axis, and on each of this vectors the macro `\vect` will be automatically applied.

6 Continued fractions

6.1 Standard continued fractions

Example of use

```
It is easy to write what is just after where the inline notation seems to have been
introduced by Alfred Pringsheim (the left notation is always space consuming for a
better readability).

$ \contfrac{u_0 // u_1 // u_2 // \dots // u_n}
= \contfrac*{u_0 // u_1 // u_2 // \dots // u_n}$
```

It is easy to write what is just after where the inline notation seems to have been introduced by Alfred Pringsheim (the left notation is always space consuming for a better readability).

$u_0 + \cfrac{1}{u_1 + \cfrac{1}{u_2 + \cfrac{1}{\dots + \cfrac{1}{u_n}}}} = u_0 + \frac{1\,|}{|\,u_1} + \frac{1\,|}{|\,u_2} + \frac{1\,|}{|\,\dots} + \frac{1\,|}{|\,u_n}$

Technical IDs

`\contfrac (1 Argument)`
`\contfrac* (1 Argument)`

— `Argument:` all the elements of the continued fraction separated by `//`.

6.2 Generalized continued fractions

Example of use

```
You can use similar notations for generalized continued fractions :

$\displaystyle \contfracgene{a // b // c // d // e // f // \dots // y // z}
            = \contfracgene*{a // b // c // d // e // f // \dots // y // z}$
```

You can use similar notations for generalized continued fractions :

$$a + \cfrac{b}{c + \cfrac{d}{e + \cfrac{f}{\dots + \cfrac{y}{z}}}} = a + \frac{b|}{|c} + \frac{d|}{|e} + \frac{f|}{|\dots} + \frac{y|}{|z}$$

Technical IDs

`\contfracgene (1 Argument)`
`\contfracgene* (1 Argument)`

— `Argument:` all the elements of the generalized continued fraction separated by `//`.

6.3 Single like continued fraction

Example of use

```
Crazy men really (?) need to write things like $\singlecontfrac{a}{b}$.

% The existence of this macro just comes from its use internally.
```

Crazy men really (?) need to write things like $\frac{a|}{|b}$.

Technical ID

`\singlecontfrac (2 Arguments)`

— `Argument #1:` the pseudo numerator

— `Argument #2:` the pseudo denominator

6.4 The $\mathcal{K}$ operator

Example of use #1

```
The following notation is very closed to the one used by Carl Friedrich Gauss:

$\displaystyle
  \contfracope_{k=1}^{n} (b_k:c_k)
= \cfrac{b_1}{\contfracgene{c_1 // b_2 // c_2 // b_3 // \dots // b_n // c_n}}$
```

The following notation is very closed to the one used by Carl Friedrich Gauss:

$$\mathop{\mathcal{K}}_{k=1}^{n}(b_k : c_k) = \cfrac{b_1}{c_1 + \cfrac{b_2}{c_2 + \cfrac{b_3}{\dots + \cfrac{b_n}{c_n}}}}$$

Remark. The letter $\mathcal{K}$ comes from "kettenbruch" which means "continued fraction" in german.

Example of use #2

```
$\displaystyle
  u_0 + \contfracope_{k=1}^{n} (1:u_k)
= \contfrac{u_0 // u_1 // u_2 // \dots // u_n}$
```

$$u_0 + \mathop{\mathcal{K}}_{k=1}^{n}(1 : u_k) = u_0 + \cfrac{1}{u_1 + \cfrac{1}{u_2 + \cfrac{1}{\dots + \cfrac{1}{u_n}}}}$$

7 Change log

All the changes are described inside the folders `change_log` : see the sources of `lymath` on `github`. Here we just give a very short history of `lymath`.

2017-11-01 New minor version `0.1.0-beta` : changes and additional tools for sets, functions and geometry.

2017-10-21 Little history of `lymath` will be indicated from now in this PDF documentation.

2017-10-18 New patch version `0.0.2-beta` : additional tools for differential calculus.

2017-10-06 New patch version `0.0.1-beta` : additional tools for arithmetic, geometry, integral calculus and differential calculus.

2017-10-02 First version of the package.