

# lymath package: semantic low level math formulas

(developped and tested on Mac OS X)

Christophe BAL

2017-10-21

## 1 Introduction

L<sup>A</sup>T<sub>E</sub>X is a great tool for writing mathematics, maybe it is the best, but the power of L<sup>A</sup>T<sub>E</sub>X 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 L<sup>A</sup>T<sub>E</sub>X 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  $\frac{df}{dx}(x) = 4 \cos(x^2)$  on  $\text{intervalC}\{a\}\{b\}$ , 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 L<sup>A</sup>T<sub>E</sub>X 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 :  $\left\{\frac{1}{3}; \frac{5}{7}; \frac{9}{11}\right\}$  or  $\left\{\frac{1}{3}; \frac{5}{7}; \frac{9}{11}\right\}$  .

#### 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  $\mathcal{C}$ ,  $\mathcal{D}$  and  $\mathcal{d}$  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  $\mathcal{C}_1$ ,  $\mathcal{C}_2$ , ...

## Technical IDs

`\geoset` (1 Argument)

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

`\geoset*` (2 Arguments)

— **Argument #1**: one single ASCII letter indicating  $\mathcal{U}$  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.

### 3.1.3 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  $\mathbb{F}_{\text{fieldset}*\{k\}_{1}}$ ,  $\mathbb{F}_{\text{fieldset}*\{k\}_{2}}$ ,  $\dots$

Subscripts can be used like in  $k_1, k_2, \dots$

## Technical IDs

$\backslash\text{fieldset}$  (1 Argument)

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

$\backslash\text{fieldset}*$  (2 Arguments)

— **Argument #1**: one single ASCII letter indicating  $U$  in the name  $U_d$  of a geometrical set.

— **Argument #2**: one text indicating  $d$  in the name  $U_d$  of a geometrical set.

### 3.1.5 Classical sets

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

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

### 3.1.6 Classical sets with suffixes

It is easy to type  $\mathbb{R}_n$ ,  $\mathbb{R}_p$ ,  $\mathbb{R}_s$ ,  $\mathbb{R}_{sn}$  and  $\mathbb{R}_{sp}$ .

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  $\text{@star}$  with the additional composite suffixes  $sn$  et  $sp$ .

Note that you can't use  $\mathbb{C}_n$  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 5 shows when you can add one of the suffixes  $n$ ,  $p$ ,  $s$ ,  $sn$  and  $sp$ .

### 3.1.7 Suffixes on demand

#### Example of use

You can indeed write things like  $\mathbb{C}_n$  or  $\mathbb{H}_{sp}$ . There is also  $\mathbb{P}_n$  with another formatting.

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

Table 1: Suffixes

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

## 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  $I = ]a ; b] = \text{\intervalOC{a}{b}}$, 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  $I = ]a; b] = ]a; b]$ , 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.

```

$$\text{\intervalC{ \frac{1}{2} }}{ 1^{2^3} }$$


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


$$= \text{\intervalC*{ \frac{1}{2} }}{ 1^{2^3} }$$

```

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

## 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  $\text{\textbackslash intervalPC\{a\}\{b\}} = (a ; b]$  and an opened one  $\text{\textbackslash intervalP\{a\}\{b\}} = (a ; b)$ .

*% 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,  $\mathbb{Z}_{\text{intervalC}\{-1\}\{4\}} = \{-1; 0; 1; 2; 3; 4\}$ . So we also have  $\mathbb{Z}_{\text{intervalC}\{-1\}\{4\}} = \mathbb{Z}_{\text{interval0}\{-2\}\{5\}}$ .

*% The syntax refers to  $\mathbb{Z}$  the set of integers.*

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

#### Technical IDs

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

`\ZintervalC0 (2 Arguments)`  
`\ZintervalC0* (2 Arguments)`

- Argument #1: lower bound  $a$  of the interval  $\llbracket a; b \rrbracket$ .
- Argument #2: upper bound  $b$  of the interval  $\llbracket a; b \rrbracket$ .

`\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  $\llbracket a; b \rrbracket$ .

`\Zinterval0 (2 Arguments)`  
`\Zinterval0* (2 Arguments)`

- Argument #1: lower bound  $a$  of the interval  $\llbracket a; b \rrbracket$ .
- Argument #2: upper bound  $b$  of the interval  $\llbracket a; b \rrbracket$ .

`\Zinterval0C (2 Arguments)`  
`\Zinterval0C* (2 Arguments)`

- Argument #1: lower bound  $a$  of the interval  $\llbracket a; b \rrbracket$ .
- Argument #2: upper bound  $b$  of the interval  $\llbracket a; b \rrbracket$ .

## 4 Analysis

### 4.1 Constants

#### 4.1.1 Classical constants

##### Complete list

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

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

**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  $\left|\frac{3}{5}\right|$  or even  $\left|\frac{3}{5}\right|$  if you prefer or need little vertical rules.

**Remark.** The L<sup>A</sup>T<sub>E</sub>X 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 :

$\backslash\mathrm{ch}\ x \neq \mathrm{ch}\ x$ ,  $\backslash\mathrm{ppcm}(x;y)$ ,  $\backslash\lg x = \log_2 x$  and  $\backslash\expb{6} y$ .

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

### 4.3.2 Named functions without parameter

All the following macros don't have any parameter.

$\backslash\mathrm{pgcd}$	$\backslash\mathrm{ppcm}$	$\backslash\mathrm{ch}$	$\backslash\mathrm{sh}$
$\backslash\mathrm{th}$	$\backslash\mathrm{ach}$	$\backslash\mathrm{ash}$	$\backslash\mathrm{ath}$
$\backslash\mathrm{arccosh}$	$\backslash\mathrm{arcsinh}$	$\backslash\mathrm{arctanh}$	$\backslash\mathrm{acos}$
$\backslash\mathrm{asin}$	$\backslash\mathrm{atan}$		

### 4.3.3 Named functions with parameters

#### The complete list

All the following macros have at least one parameter.

$\backslash\expb$  (1 parameter)                       $\backslash\logb$  (1 parameter)

#### Technical IDs

$\backslash\expb$  (1 Argument)

$\backslash\logb$  (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  $\backslash\mathrm{seqplus}\{F\}{1}{2}$  or  $\backslash\mathrm{hypergeo}\{F\}{1}{2}$  and crazy -wo-men really (?) love  $\backslash\mathrm{suprgeo}\{F\}{1}{2}{3}{4}$ .

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

#### Technical IDs

$\backslash\mathrm{seqplus}$  (2 Arguments)

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

— **Argument #2**: the right indice.

$\backslash\mathrm{hypergeo}$  (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 $\partial$ 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  $dx$  and  $\partial t$  and also  $d^5x$  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  $\partial$  or  $d$ .

— Argument: the variable of differentiation at the right of the symbol  $\partial$  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)
```

$$f'(a) = f^{(1)}(a) = \frac{df}{dx}(a) = d_x f(a)$$

## Example of use #2

```

$$\begin{aligned} f'''(a) &= \text{\derpow[3]{f}}(a) \\ &= \text{\derfrac[3]{f}{x}}(a) \\ &= \text{\dersub[3]{f}{x}}(a) \end{aligned}$$
and
$$\cos'''a = \text{\derfrac[3]{\cos}{x}}(a).$$

```

$$f'''(a) = f^{(3)}(a) = \frac{d^3 f}{dx^3}(a) = d_x^3 f(a) \text{ and } \cos'''a = \frac{d^3 \cos}{dx^3}(a).$$

## Example of use #3

If  $f(x) = \frac{1}{x^2+3}$ , then we can write :

```

$$\begin{aligned} \text{\derpow[3]{f}}(a) \\ = \text{\derfrac*[3]{\left(\frac{1}{x^2+3}\right)}}{x}(a) \end{aligned}$$

```

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

## 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 differentiated.

`\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 differentiated.

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

### 4.5.3 Partial derivation

#### Example of use #1

```

$$\begin{aligned} \text{\partialfrac{f}{x}}(a;b) \\ = \text{\partialsub{f}{x}}(a;b) \\ = \text{\partialprime{f}{x}}(a;b) \end{aligned}$$

```

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

## Example of use #2

```


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


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


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


```

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

## Example of use #3

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

```


$$\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2}{\partial x \partial y} \left( \frac{\cos(xy)}{x^2 + y^2} \right)$$


```

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

## Technical IDs

```

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

```

- **Option**: if used, the exponent of  $\partial$  associated to the function differenciaded.
- **Argument #1**: the function to be partially differenciaded.
- **Argument #2**: the variables used for the partial derivation. The syntax is particular : for example,  $x // y^3 // \dots$  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 differenciaded.
- **Argument #2**: the variables used for the partial derivation. The syntax is particular : for example,  $x // y^3 // \dots$  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,  $\int_a^b f(x) \, dx = \text{hook}\{F(x)\}_a^b$  where  $\text{hook}\{F(x)\}_a^b = F(b) - F(a)$ .

By definition,  $\int_a^b f(x) \, dx = [F(x)]_a^b$  where  $[F(x)]_a^b = F(b) - F(a)$ .

## 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.

```

$$\backslash\displaystyle \backslash\hook{\frac{x - 1}{5 + x^2}}{a}{b}$$

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

```

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

## Technical IDs

$\backslash\hook$  (3 Arguments)

$\backslash\hook*$  (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  $\backslash\vhook{F(x)}{a}{b}$  instead of  $\backslash\hook{F(x)}{a}{b}$ .

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

## 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.

```

$$\backslash\displaystyle \backslash\vhook{\frac{x - 1}{5 + x^2}}{a}{b}$$

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

```

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

## Technical IDs

$\backslash\vhook$  (3 Arguments)

$\backslash\vhook*$  (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) \, \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
```

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

**Remark.** By default, L<sup>A</sup>T<sub>E</sub>X prints  $\int \int \int F(x;y;z) \, \mathrm{d}x \, \mathrm{d}y \, \mathrm{d}z = \int_a^b \int_c^d \int_e^f F(x;y;z) \, \mathrm{d}x \, \mathrm{d}y \, \mathrm{d}z$ .

## 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  $\mathcal{O}$  and  $\mathcal{o}$  created by Landau.

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

Example of use #2

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

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 $\Omega$ notation

Example of use #1

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

You can use the symbol  $\Omega$  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  $f(n) \geqslant m g(n)$ .

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

## Technical ID

`\bigomega (1 Argument)`

— **Argument:** the content inside the braces after the symbol  $\Omega$ .

### 4.7.3 The $\Theta$ notation

#### Example of use #1

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

Here is the last symbol  $\Theta$  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  $m g(n) \leqslant f(n) \leqslant M g(n)$ .

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

## Technical ID

`\bigtheta (1 Argument)`

— **Argument:** the content inside the braces after the symbol  $\Theta$ .

## 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 "geometric point". 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 :  $\text{\gpt*{I}{1}}$ ,  $\text{\gpt*{I}{2}}$ ,  $\dots$

A list of points :  $I_1, I_2, \dots$

## Technical ID

$\text{\gpt}$  (1 Argument) where  $\text{\gpt}$  = G-eometric P-oin-T

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

$\text{\gpt*}$  (2 Arguments)

— Argument #1: one text indicating Up in the name  $\text{Up}_{down}$  of a point.

— Argument #2: one text indicating *down* in the name  $\text{Up}_{down}$  of a point.

## 5.2 Writing vectors

### Example of use #1

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

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

### Example of use #2

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

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

## Technical IDs

$\text{\vect}$  (1 Argument)

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

$\text{\vect*}$  (2 Arguments)

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

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



## 5.3 Norm of a vector

### Example of use

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

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

**Remark.** The L<sup>A</sup>T<sub>E</sub>X 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  $\angle ABCDEF$  using a lot of letters, and you can write  $\angle A_{\text{rot}}$  instead of  $\angle A_{\text{rot}}$ .

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

### Example of use #2

You can also simply write  $\angle i$  and  $\angle j_2$  without points below the angle symbol only for inner angles named "i" or "j".

You can also simply write  $\hat{i}$  and  $\hat{j}_2$  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  $\widehat{up}_{\text{down}}$  of an inner angle.

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

## 5.5 Circular arcs

### Example of use #1

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

Here is one arc  $\widehat{ABCDEF}$  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  $\text{\arc{i}}$  and  $\text{\arc*{j}{2}}$  without points below the arc only for arcs named "i" or "j".

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

### Technical IDs

$\text{\arc}$  (1 Argument)

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

$\text{\arc*}$  (2 Arguments)

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

— Argument #2: one text indicating *down* in the name  $\widehat{up_{down}}$  of a circular arc.

## 5.6 Naming axes

### Example of use #1

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

*% We give more efficient ways to name axes in some particular cases.*

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

### Example of use #2

$\text{\displaystyle \axis{\gpt{O} // \frac{7}{3} \vect{i} // \vect{j}}}$

or

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

$\left(O; \frac{7}{3} \vec{i}, \vec{j}\right)$  or  $\left(O; \frac{7}{3} \vec{i}, \vec{j}\right)$

### Example of use #3

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

```
 $\$ \backslash \text{axis} \{ \backslash \text{gpt} \{ 0 \} // \backslash \text{vect} * \{ i \} \{ 1 \} // \backslash \text{vect} * \{ i \} \{ 2 \} // \backslash \text{vect} * \{ i \} \{ 3 \} // \backslash \text{dots} // \backslash \text{vect} * \{ i \} \{ 9 \} // \backslash \text{vect} * \{ i \} \{ 10 \} \} \$$ 
```

---

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

### Example of use #4 - No star version here

$\$ \backslash \text{gpaxis} \{ 0 // I // J // K \} \$$  is just the same than  
 $\$ \backslash \text{axis} \{ \backslash \text{gpt} \{ 0 \} // \backslash \text{gpt} \{ I \} // \backslash \text{gpt} \{ J \} // \backslash \text{gpt} \{ K \} \} \$$ .

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

---

$(O; I, J, K)$  is just the same than  $(O; I, J, K)$ .

### Example of use #5 - No star version here

$\$ \backslash \text{vaxis} \{ \backslash \text{gpt} \{ 0 \} // i // j \} \$$  is just the same than  
 $\$ \backslash \text{axis} \{ \backslash \text{gpt} \{ 0 \} // \backslash \text{vect} \{ i \} // \backslash \text{vect} \{ j \} \} \$$ .

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

---

$(O; \vec{i}, \vec{j})$  is just the same than  $(O; \vec{i}, \vec{j})$ .

### Example of use #6 - No star version here

$\$ \backslash \text{gpvaxis} \{ 0 // i // j \} \$$  is just the same than  
 $\$ \backslash \text{axis} \{ \backslash \text{gpt} \{ 0 \} // \backslash \text{vect} \{ i \} // \backslash \text{vect} \{ j \} \} \$$ .

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

---

$(O; \vec{i}, \vec{j})$  is just the same than  $(O; \vec{i}, \vec{j})$ .

### Technical IDs

$\backslash \text{axis}$  (1 Argument)

$\backslash \text{axis}^*$  (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.

$\backslash \text{gpaxis}$  (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  $v = V\text{-ector}$

- **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).

$$u_0 + \frac{1}{u_1 + \frac{1}{u_2 + \frac{1}{\dots + \frac{1}{u_n}}}} = u_0 + \frac{1}{\left| u_1 \right|} + \frac{1}{\left| u_2 \right|} + \frac{1}{\left| \dots \right|} + \frac{1}{\left| u_n \right|}$$

#### 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 :

```

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


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

```

You can use similar notations for generalized continued fractions :

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

### 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  $\left| \frac{a}{b} \right|$ .

### 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:

```

$$\backslash\displaystyle$$


$$\backslash\contfracope_{\{k=1\}^{\{n\}}}(b_k:c_k)$$


$$= \cfrac{b_1}{\cfrac{c_1}{b_2} + \cfrac{c_2}{b_3} + \dots + \cfrac{c_n}{b_n}}$$

```

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

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

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

### Example of use #2

```

$$\backslash\displaystyle$$


$$u_0 + \backslash\contfracope_{\{k=1\}^{\{n\}}}(1:u_k)$$


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

```

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

## 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.