`lymath` package: semantic low level math formulas

Sources available on `https://github.com/bc-latex/ly-math`.

Version `0.1.0-beta` developped and tested on Mac OS X.

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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. Let's consider the following standard LaTeX code

```
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`, you can write the following code.

```
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 **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 $\mathscr{C}_1$, $\mathscr{C}_2$, $\dots$

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 $\mathbb{k}_1$, $\mathbb{k}_2$, . . .

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, see on this page, shows legal associations between classical sets and suffixes.

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 this example, the syntax refers to **O**-pened and **C**-losed, and we will see that **CC** and **OO** are reduced to **C** and **O**.

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

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.

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

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

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 this example, the syntax refers to **P**-arenthesis.

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

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

In this example, the syntax refers to $\mathbb{Z}$ the set of integers.

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

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

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 $[\![a; b[\![$.

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

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

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

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

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

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

— `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 $\ttau = 2 \ppi$ is the youngest one:
$\ggamma$, $\ppi$, $\ttau$, $\ee$, $\ii$, $\jj$ and $\kk$.
```

List of all classical constants where $\tau = 2\pi$ 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 ${}_1^4F_2^3$.

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

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

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

Example of use #2

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

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

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

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 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

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

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

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 $F(x)|_a^b$ instead of $\left[F(x)\right]_a^b$.

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.

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

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

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

Technical IDs

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

— Argument: the content inside the braces after the symbol $\mathcal{O}$ or 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 $\mathbf{\Omega}$ 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 $f(n) \geqslant m g(n)$.
```

$f(n) = \mathbf{\Omega}(g(n))$ 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 $\mathbf{\Omega}$.

4.7.3 The $\mathbf{\Theta}$ notation

Example of use #1

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

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

$f(n) = \mathbf{\Theta}(g(n))$ 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 $\mathbf{\Theta}$.

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 $\vec{\imath}$ and $\vec{\jmath}_2$ 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 $\|\vec{\imath}\|$, $\displaystyle \left\|\frac{2}{7}\overrightarrow{e}_k\right\|$, or $\displaystyle \|\frac{2}{7}\overrightarrow{e}_k\|$ 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 $\hat{\imath}$ and $\hat{\jmath}_2$ 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 $\overset{\frown}{ABCDEF}$ using a lot of letters, and you can write $\overset{\frown}{A}_{rot}$ instead of $\overset{\frown}{A_{rot}}$.

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 $\overset{\frown}{\imath}$ and $\overset{\frown}{\jmath}_2$ 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 $\widehat{up}_{down}$ 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

This example is not the best way to do as we will see later.

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

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

Example of use #3

Here 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

In this example, the prefix **gp** is for **g**-eometric **p**-oint.

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

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

Example of use #5 - No star version here

In this example, the prefix `v` is for **v**-ector.

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

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

Example of use #6 - No star version here

In this example, the prefix `gpv` adds the features of the prefixes `gp` and `v`.

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

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

In the example, 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}$
```

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

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

Here is how to write generalized continued fractions.

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

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

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

The existence of the macro below just comes from its use internally.

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

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.

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

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

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 `0.0.0-beta` of the package.