

# MATHSEMANTICS.STY – SEMANTIC MATH COMMANDS

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May 6, 2022, v 1.0.0

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## 1 INTRODUCTION

This package aims to provide semantic commands for ease of use in mathematics to see better *what* you semantically mean which should be distinct/split from *how* it is realised in  $\LaTeX$ .

The package is a spin-off and developed in the suite of packages from the former numapde-group in Chemnitz, see the original repository at <https://gitlab.hrz.tu-chemnitz.de/numapde-public/numapde-latex>.

Throughout this documentation most commands are directly illustrated by examples, which are both displayed as code (`</>` or `</>` for math examples) and its rendered result in L<sup>A</sup>T<sub>E</sub>X (👁). Two examples are

`</> \bbR`    👁  $\mathbb{R}$

and

`</> \eg`    👁 e. g.

The aim is to first ease the use of some often used letters and low-level formats like bold face letters `</> \bbR`    👁  $\mathbb{R}$ , but also to provide high level commands that make typing mathematics easier, for example using `</> \abs{\frac{1}{2}}`    👁  $|\frac{1}{2}|$  and `</> \abs[Big]{\frac{1}{2}}`    👁  $\left|\frac{1}{2}\right|$ . This is the main goal in [Section 4](#) about syntactical commands for mathematics. A next more support/helping section about abbreviations and names is [Section 5](#).

The first main part on general semantic commands is [Section 7](#).

While all these are loaded by default. The next part, [Section 8](#), introduces semantic commands for specific topics. These are given in separate sub-packages and can be loaded if you work in this area and want to use the commands.

The package should be loaded late, since it might overwrite a few commands, currently most prominently `\d` which is overwritten by `cleveref` in case `minted` is loaded. So for more flexibility, there is the alternative command `\dInt`.

## 2 PACKAGE OPTIONS

**shorttbb**                      use shorter notations for the blackboard-bold math letters `\C`, `\K`, `\N`, `\Q`, `\R`, `\Z`

## 3 REQUIRED PACKAGES

**amssymb.sty** defines mathematical symbol fonts

**ifthen.sty** facilitates the definition of conditional commands

**ifxetex.sty** provides a way to check if a document is being processed by X<sub>Y</sub>L<sup>A</sup>T<sub>E</sub>X and company

**mathtools.sty** provides lots of improvements for math typesetting (includes `amsmath.sty`)

**xifthen.sty** extends ifthen.sty by adding new boolean conditions

**xparse.sty** provides a high-level interface to define new commands

**xspace.sty** adds space depending on context

## 4 SYNTAX

The mathsemantics-syntax.sty package provides mainly symbols and short commands, which can be used in semantic definitions for ease of notation. They usually are rather simple commands without too many parameters.

### 4.1 LETTERS

<b>ba. . . bz</b>	lower-case <b>bold-face</b> letters $\backslash br, \backslash bf$ $\alpha, f$
<b>bA. . . bZ</b>	upper-case <b>bold-face</b> letters $\backslash bR, \backslash bF$ $R, F$
<b>balpha. . . bomega</b>	lower-case <b>bold-face</b> Greek letters $\backslash balpha, \boldsymbol{\delta}$ $\alpha, \eta$ (the latter being an exception)
<b>bAlpha. . . bOmega</b>	upper-case <b>bold-face</b> Greek letters $\backslash bGamma, \backslash bDelta$ $\Gamma, \Delta$
<b>bnull</b>	<b>bold-face</b> zero $\backslash bnull$ $0$
<b>bone</b>	<b>bold-face</b> one $\backslash bone$ $1$
<b>cA. . . cZ</b>	upper-case <b>calligraphic</b> letters $\backslash cM, \backslash cN$ $\mathcal{M}, \mathcal{N}$
<b>fA. . . fZ</b>	upper-case <b>fraktur</b> letters $\backslash fM, \backslash fN, \backslash fX$ $\mathfrak{M}, \mathfrak{N}, \mathfrak{X}$
<b>sA. . . sZ</b>	upper-case <b>script</b> letters $\backslash sM, \backslash sN, \backslash sX$ $\mathscr{M}, \mathscr{N}, \mathscr{X}$
<b>va. . . vz</b>	lower-case letters with a <b>vector</b> accent $\backslash va, \backslash vb$ $\vec{a}, \vec{b}$
<b>vA. . . vZ</b>	upper-case letters with a <b>vector</b> accent $\backslash vA, \backslash vB$ $\vec{A}, \vec{B}$
<b>valpha. . . vomega</b>	lower-case Greek letters with a <b>vector</b> accent $\backslash valpha, \backslash vbeta$ $\vec{\alpha}, \vec{\beta}$

<b>vAlpha. . . vOmega</b>	upper-case Greek letters with a vector accent $\vec{\Gamma}, \vec{\Delta}$ <code>\vGamma, \vDelta</code>
<b>vnull</b>	vector zero $\vec{0}$ <code>\vnull</code>
<b>vone</b>	vector one $\vec{1}$ <code>\vone</code>
<b>bbA, . . . , bbZ</b>	blackboard-bold uppercase letters  <code>\bbC, \bbK, \bbN, \bbQ, \bbR, \bbS, \bbZ</code> C, K, N, Q, R, S, Z use the package option shortbb to introduce <code>\C, \K, \N, \Q, \R, \Z</code> C, K, N, Q, R, Z if not already defined elsewhere (i. e. they are not redefined, only <i>provided</i> ).

## 4.2 SYNTAX HELPERS

<b>enclspacing</b>	provides spacing after the opening and before the closing delimiters for <code>\enclose</code> . This is by default set to be empty.
<b>enclose</b>	is a command which encloses some content in scaled delimiters. It is meant as a helper to facilitate the definition of other commands. Its syntax is <code>\enclose[#1]{#2}{#3}{#4}</code> . The first (optional) argument is used to scale the delimiters to the standard amsmath sizes. <sup>1</sup> The second and fourth arguments specify the opening and closing delimiters, respectively. The third argument is the content to be enclosed.

`\enclose{[]}{\dfrac{1}{2}}{[]}`  $\left[\frac{1}{2}\right]$

`\enclose[Big][\dfrac{1}{2}]`  $\left[\frac{1}{2}\right]$

`\enclose[auto][\dfrac{1}{2}]`  $\left[\frac{1}{2}\right]$

`\enclose[none][\dfrac{1}{2}]`  $\frac{1}{2}$

**Note 1.** none is merely meant for testing when having arguments in brackets whether it is useful to omit them. You can also deactivate the absolute value vertical lines this way, so *use this option with care*.


**Note 2.** This command should normally be used only in the definition of other commands. For instance, `\abs` is using it internally. See `\paren` for the


<sup>1</sup>big, Big, bigg, Bigg or auto, which uses left and right as well as none to easily deactivate brackets.

nicer command to use

**enclspacingSet** provides spacing before and after the center delimiter `\encloseSet`. This is by default set to `\,`.


**encloseSet** is a command which encloses some content in scaled delimiters. It is meant as a helper to facilitate the definition of other commands. Its syntax is `\encloseSet[#1][#2]{#3}{#4}{#5}{#6}`. The first (optional) argument is used to scale the delimiters including the center one to the standard amsmath sizes.<sup>1</sup> The second and sixth arguments specify the opening and closing delimiters, respectively. The fourth argument specifies the center delimiter and The third and fifth argument are the content to be enclosed.


`</> \encloseSet[big]{\{x\in\mathbb{R}}{\mid}{x>5}{\}}`      $\{x \in \mathbb{R} \mid x > 5\}$


`</> \encloseSet[auto]{\{x\in\mathbb{R}}{\mid}{x>\dfrac{1}{2}}{\}}`      
 $\left\{x \in \mathbb{R} \mid x > \frac{1}{2}\right\}$

**Note.** This command should normally be used only in the definition of other commands. For instance, `\setDef` is using it internally.

**paren** is an alternative to `\enclose`, with a different ordering of arguments. Its syntax is `\paren[#1][#2]{#3}{#4}`, which is simply mapped to `\enclose[#1][#2]{#4}{#3}`.


`</> \paren[Big][\dfrac{1}{2}]`      $\left[\frac{1}{2}\right]$


`</> \paren[Big][\dfrac{1}{2}]`      $\left[\frac{1}{2}\right]$


`</> \paren[auto][\dfrac{1}{2}]`      $\left[\frac{1}{2}\right]$

### 4.3 SPACING HELPERS


**clap** complements the standard  $\text{\LaTeX}$  commands `\llap` and `\rlap`. These commands horizontally smash their arguments.

`</> \llap{smash} something.`     ~~Let us~~ something.


`</> \clap{smash} something.`     Let ~~us~~ something.

`</> \rlap{smash} something.`     Let us ~~smash~~ something.


**mathllap** corresponds to `\llap` in math mode.

`</> \sum_{\mathllap{1\le i\le j\le n}} X_{ij}`   $\sum_{1 \leq i \leq j \leq n} X_{ij}$


**mathclap** corresponds to `\clap` in math mode.


`</> \sum_{\mathclap{1\le i\le j\le n}} X_{ij}`   $\sum_{1 \leq i \leq j \leq n} X_{ij}$


**mathrlap** corresponds to `\rlap` in math mode.

`</> \sum_{\mathrlap{1\le i\le j\le n}} X_{ij}`   $\sum_{1 \leq i \leq j \leq n} X_{ij}$

**mrep** stands for *math replace* and it typesets an argument while reserving the space for another. Its syntax is `\mrep[#1]{#2}{#3}`. The first (optional) argument is one of {l, c, r} and it is used to define the alignment. c is the default.

`</> \mrep[l]{1}{-1}-1`   $1 \quad -1$


`</> \mrep[c]{1}{-1}-1`   $1 \quad -1$


`</> \mrep[r]{1}{-1}-1`   $1 \quad -1$


## 5 ABBREVIATIONS


### 5.1 ENGLISH


**aa** almost all `</> \aa`  a.a.


**ale** almost everywhere `</> \ale`  a.e.


**eg** exempli gratia (for example) `</> \eg`  e. g.



















**etc** et cetera (and so on) `</> \etc`  etc.












**ie** id est (id est) `</> \ie`  i. e.

**iid** independent and identically distributed `</> \iid`  i. i. d.









**spd** symmetric positive definite `</> \spd`  s. p. d.

**st** such that or subject to `</> \st`  s. t.














<b>wrt</b>	with respect to $\langle / \rangle$ <code>\wrt</code>  w.r.t.
<b>5.2 GERMAN</b>	
<b>bspw</b>	beispielsweise (for example) $\langle / \rangle$ <code>\bspw</code>  bspw.
<b>bzgl</b>	bezüglich (with regard to) $\langle / \rangle$ <code>\bzgl</code>  bzgl.
<b>bzw</b>	beziehungsweise (respectively) $\langle / \rangle$ <code>\bzw</code>  bzw.
<b>Dah</b>	Das heißt (That is, beginning of phrase) $\langle / \rangle$ <code>\Dah</code>  D. h.
<b>dah</b>	das heißt (that is) $\langle / \rangle$ <code>\dah</code>  d. h.
<b>evtl</b>	eventuell (possibly) $\langle / \rangle$ <code>\evtl</code>  evtl.
<b>fs</b>	fast sicher $\langle / \rangle$ <code>\fs</code>  f. s.
<b>fue</b>	fast überall $\langle / \rangle$ <code>\fue</code>  f. ü.
<b>IA</b>	Im Allgemeinen (beginning of phrase) $\langle / \rangle$ <code>\IA</code>  I. A.
<b>iA</b>	im Allgemeinen $\langle / \rangle$ <code>\iA</code>  i. A.
<b>idR</b>	in der Regel $\langle / \rangle$ <code>\idR</code>  i. d. R.
<b>IdR</b>	In der Regel (beginning of phrase) $\langle / \rangle$ <code>\IdR</code>  I. d. R.
<b>iW</b>	im Wesentlichen $\langle / \rangle$ <code>\iW</code>  i. W.
<b>IW</b>	Im Wesentlichen (beginning of phrase) $\langle / \rangle$ <code>\IW</code>  I. W.
<b>mE</b>	meines Erachtens $\langle / \rangle$ <code>\mE</code>  m. E.
<b>oBdA</b>	ohne Beschränkung der Allgemeinheit $\langle / \rangle$ <code>\oBdA</code>  o. B. d. A.
<b>OBdA</b>	ohne Beschränkung der Allgemeinheit (beginning of phrase) $\langle / \rangle$ <code>\OBdA</code>  O. B. d. A.
<b>og</b>	oben genannt $\langle / \rangle$ <code>\og</code>  o. g.
<b>oae</b>	oder ähnliche $\langle / \rangle$ <code>\oae</code>  o. ä.

<b>so</b>	siehe oben <code>&lt;/&gt; \so</code>  s. t.
<b>ua</b>	unter anderem <code>&lt;/&gt; \ua</code>  u. a.
<b>Ua</b>	Unter anderem (beginning of phrase) <code>&lt;/&gt; \Ua</code>  U. a.
<b>ug</b>	unten genannt <code>&lt;/&gt; \ug</code>  u. g.
<b>usw</b>	und so weiter (and so on)  usw.
<b>uU</b>	unter Umständen <code>&lt;/&gt; \uU</code>  u. U.
<b>UnU</b>	Unter Umständen (beginning of phrase) <code>&lt;/&gt; \UnU</code>  U. U.
<b>vgl</b>	vergleiche (compare) <code>&lt;/&gt; \vgl</code>  vgl.
<b>zB</b>	zum Beisiel <code>&lt;/&gt; \zB</code>  z. B.
<b>ZB</b>	Zum Beispiel (beginning of phrase) <code>&lt;/&gt; \ZB</code>  Z. B.
<b>zHd</b>	zu Händen <code>&lt;/&gt; \zHd</code>  z. Hd.

## 6 NAMES

<b>adimat</b>	 ADIMAT
<b>ampl</b>	 AMPL
<b>BibTeX</b>	 BIB <sub>T</sub> EX
<b>BibLaTeX</b>	 BIB <sub>L</sub> A <sub>T</sub> EX
<b>cg</b>	 CG
<b>cpp</b>	 C++
<b>cppmat</b>	 CPPMAT
<b>dolfin</b>	 DOLFIN
<b>dolfinplot</b>	 DOLFIN-PLOT
<b>dolfinadjoint</b>	 DOLFIN-ADJOINT





<b>doxygen</b>	 DOXYGEN
<b>femorph</b>	 FEMORPH
<b>fenics</b>	 FENICS
<b>ffc</b>	 FFC
<b>fmg</b>	 FMG
<b>fortran</b>	 FORTRAN
<b>gitlab</b>	 GITLAB
<b>gmres</b>	 GMRES
<b>gmsb</b>	 GMSH
<b>ipopt</b>	 IPOPT
<b>libsvm</b>	 LIBSVM
<b>liblinear</b>	 LIBLINEAR
<b>macmpec</b>	 MACMPEC
<b>manifoldsjl</b>	 MANIFOLDS.JL
<b>manopt</b>	 MANOPT
<b>manoptjl</b>	 MANOPT.JL
<b>mathematica</b>	 MATHEMATICA
<b>matlab</b>	 MATLAB
<b>maple</b>	 MAPLE
<b>maxima</b>	 MAXIMA
<b>metis</b>	 METIS
<b>minres</b>	 MINRES
<b>mshr</b>	 MSHR
<b>mvirt</b>	 MVIRT

















<b>numpy</b>	👁 NUMPy
<b>paraview</b>	👁 PARAVIEW
<b>pdflatex</b>	👁 PDFL <sup>A</sup> T <sub>E</sub> X
<b>perl</b>	👁 PERL
<b>petsc</b>	👁 PETSc
<b>pymat</b>	👁 PYMAT
<b>python</b>	👁 PYTHON
<b>scikit</b>	👁 SciKit
<b>scikitlearn</b>	👁 SciKit-LEARN
<b>scipy</b>	👁 SciPy
<b>sphinx</b>	👁 SPHINX
<b>subgmres</b>	👁 SUBGMRES
<b>subminres</b>	👁 SUBMINRES
<b>superlu</b>	👁 SUPERLU
<b>svmlight</b>	👁 SVM <sup>LIGHT</sup>
<b>tritetmesh</b>	👁 TriTETMESH
<b>ufl</b>	👁 UFL
<b>uqlab</b>	👁 UQLAB
<b>viper</b>	👁 VIPER
<b>xml</b>	👁 XML

## 7 SEMANTIC COMMANDS














Build upon Syntax from [Section 4](#) this part provides semantic mathematical commands.
















<b>abs</b>	absolute value. Its syntax is <code>\abs[#1]{#2}</code> . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the argument.
	$\backslash\abs{a}$ $ a $
	$\backslash\abs[Big]{\dfrac{1}{2}}$ $\left \frac{1}{2}\right $
	$\backslash\abs[auto]{\dfrac{1}{2}}$ $\left \frac{1}{2}\right $
<b>aff</b>	affine hull $\backslash\aff$ $\text{aff}$
<b>arcosh</b>	area hyperbolic cosine $\backslash\arcosh$ $\text{arcosh}$
<b>arcoth</b>	area hyperbolic cotangens $\backslash\arcoth$ $\text{arcoth}$
<b>argmax</b>	maximizer of a function $\backslash\argmax_{x \in \mathbb{R}} f(x)$ $\arg \max_{x \in \mathbb{R}} f(x)$
<b>Argmax</b>	set of maximizers of a function $\backslash\Argmax_{x \in \mathbb{R}} f(x)$ $\text{Arg} \max_{x \in \mathbb{R}} f(x)$
<b>argmin</b>	minimizer of a function $\backslash\argmin_{x \in \mathbb{R}} f(x)$ $\arg \min_{x \in \mathbb{R}} f(x)$
<b>Argmin</b>	set of minimizers of a function $\backslash\Argmin_{x \in \mathbb{R}} f(x)$ $\text{Arg} \min_{x \in \mathbb{R}} f(x)$
<b>arsinh</b>	area hyperbolic cotangens $\backslash\arsinh$ $\text{arsinh}$
<b>artanh</b>	area hyperbolic tangens $\backslash\artanh$ $\text{artanh}$
<b>bdiv</b>	bold (meaning: vector) divergence of a matrix-valued function $\backslash\bdiv$ $\div$
<b>ceil</b>	integer larger or equal to input. Its syntax is <code>\ceil[#1]{#2}</code> . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the argument.
	$\backslash\ceil{a}$ $\lceil a \rceil$
	$\backslash\ceil[Big]{\dfrac{1}{2}}$ $\left\lceil\frac{1}{2}\right\rceil$

<b>clconv</b>	closure of the convex hull of a set <code>\clconv M</code>  $\overline{\text{conv}} M$
<b>closure</b>	closure of a set <code>\closure M</code>  $\text{cl } M$
<b>cofac</b>	cofactor matrix <code>\cofac(A)</code>  $\text{cof}(A)$
<b>compactly</b>	compact embedding of topological spaces <code>\compactly</code>  $\hookrightarrow\hookrightarrow$
<b>cone</b>	conic hull <code>\cone</code>  $\text{cone}$
<b>conv</b>	convex hull of a set <code>\conv M</code>  $\text{conv } M$
<b>corresponds</b>	binary operator for correspondence <code>A\corresponds B</code>  $A \hat{=} B$
<b>cov</b>	covariance <code>\cov</code>  $\text{Cov}$
<b>curl</b>	the curl operator <code>\curl</code>  $\text{curl}$
<b>d, dInt</b>	integral symbol with prepended space, as in  <code>\int_{\mathbb{R}} \exp(-x^2) \, \mathrm{d} x</code>  $\int_{\mathbb{R}} \exp(-x^2) \, \mathrm{d} x$ Since <code>\mathrm{d}</code> is often overridden, <code>\mathrm{dInt}</code> is the safe alternative
<b>dev</b>	deviator of a matrix <code>\dev A</code>  $\text{dev } A$
<b>diag</b>	diagonal matrix composed of entries in a vector, or diagonal of a matrix  <code>\diag(a)</code>  $\text{diag}(a)$ <code>\diag(A)</code>  $\text{diag}(A)$
<b>diam</b>	diameter <code>\diam(M)</code>  $\text{diam}(M)$
<b>distOp</b>	the mathematical operator denoting the distance  <code>\distOp</code>  $\text{dist}$
<b>dist</b>	distance from a point to a set. Its syntax is <code>\dist[#1]{#2}{#3}</code> or <code>\dist[#1]{#2}</code> . The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes. <sup>1</sup> The second argument denotes the set. The third argument denotes the point; it can be omitted. The command <code>\distOp</code> is used to typeset the operator.  <code>\dist[Big]{\cC}{\dfrac{x}{2}}</code>  $\text{dist}_C\left(\frac{x}{2}\right)$

	<code>\dist{\mathbb{C}}</code>  $\text{dist}_{\mathbb{C}}$
	<code>\dist</code>  $\text{dist}$
<b>div</b>	divergence <code>\div</code>  $\text{div}$
<b>Div</b>	(row-wise) divergence <code>\Div</code>  $\text{Div}$
<b>dom</b>	domain <code>\dom</code>  $\text{dom}$
<b>dotcup</b>	distinct union <code>\dotcup</code>  $\dot{\cup}$
<b>dprod</b>	double contraction of matrices $A : B = \sum_{i,j} A_{ij} B_{ij} = \text{trace}(A^T B)$ <code>A \dprod B</code>  $A : B$
<b>dual</b>	duality pairing. Its syntax is <code>\dual[#1]{#2}{#3}</code> . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the first factor. The third argument denotes the second factor. <code>\dual{x^*}{x}</code>  $\langle x^*, x \rangle$ <code>\dual[Big]{x^*}{\dfrac{1}{2}}</code>  $\left\langle x^*, \frac{1}{2} \right\rangle$
<b>e</b>	Euler's number <code>\e</code>  $e$
<b>embed</b>	embedding of topological spaces <code>\embed</code>  $\hookrightarrow$
<b>embeds</b>	synonym of <code>\embed</code> <code>\embeds</code>  $\hookrightarrow$
<b>epi</b>	epigraph <code>\epi</code>  $\text{epi}$
<b>eR</b>	extended real line <code>\eR = \bbr \cup \{\pm\infty\}</code>  $\overline{\mathbb{R}} = \mathbb{R} \cup \{\pm\infty\}$
<b>essinf</b>	essential infimum <code>\displaystyle\essinf_{x \in \bbr} f(x)</code>  $\text{ess inf}_{x \in \mathbb{R}} f(x)$
<b>esssup</b>	essential supremum <code>\displaystyle\esssup_{x \in \bbr} f(x)</code>  $\text{ess sup}_{x \in \mathbb{R}} f(x)$

<b>file</b>	typesets a file name (using <code>nolinkurl</code> )  $\text{\textbackslash file}\{test.txt\}$ $\text{test.txt}$
<b>floor</b>	integer less or equal to input. Its syntax is $\text{\textbackslash floor}\{#1\}\{#2\}$ . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the argument.  $\text{\textbackslash floor}\{a\}$ $\lfloor a \rfloor$  $\text{\textbackslash floor}[Big]\{\text{\textbackslash dfrac}\{1\}\{2\}\}$ $\left\lfloor \frac{1}{2} \right\rfloor$
<b>grad</b>	gradient (of a function) $\text{\textbackslash grad } F$ $\text{grad } F$
<b>Graph</b>	graph of a function $\text{\textbackslash Graph}$ $\text{Graph}$
<b>id</b>	identity operator $\text{\textbackslash id}$ $\text{id}$
<b>image</b>	image of a function $\text{\textbackslash image}$ $\text{image}$
<b>inj</b>	injectivity (radius) $\text{\textbackslash inj}$ $\text{inj}$
<b>inner</b>	inner product. Its syntax is $\text{\textbackslash inner}\{#1\}\{#2\}\{#3\}$ . The first (optional) argument is used to scale the parentheses enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the first factor. The third argument denotes the second factor.  $\text{\textbackslash inner}\{a\}\{b\}$ $(a, b)$  $\text{\textbackslash inner}[Big]\{a\}\{\text{\textbackslash dfrac}\{b\}\{2\}\}$ $\left(a, \frac{b}{2}\right)$
<b>interior</b>	$\text{\textbackslash interior}$ $\text{int}$
<b>jump</b>	jump of a quantity, e. g., across a finite element facet. Its syntax is $\text{\textbackslash jump}\{#1\}\{#2\}$ . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the argument.  $\text{\textbackslash jump}\{a\}$ $\llbracket a \rrbracket$  $\text{\textbackslash jump}[Big]\{\text{\textbackslash dfrac}\{1\}\{2\}\}$ $\left\llbracket \frac{1}{2} \right\rrbracket$
<b>Laplace</b>	the Laplace operator $\text{\textbackslash laplace } u$ $\Delta u$

<b>lin</b>	linear hull of a set of vectors $\text{\textbackslash lin}\{v_1, v_2\}$  $\text{lin}\{v_1, v_2\}$
<b>norm</b>	norm of a vector. Its syntax is $\text{\textbackslash norm}[#1]\{#2\}$ . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the argument.  $\text{\textbackslash norm}\{a\}$  $\ a\ $  $\text{\textbackslash norm}[Big]\{\text{\textbackslash dfrac}\{c\}\{2\}\}$  $\left\ \frac{c}{2}\right\ $  $\text{\textbackslash norm}[auto]\{\text{\textbackslash dfrac}\{c\}\{2\}\}$  $\left\ \frac{c}{2}\right\ $
<b>projOp</b>	the mathematical operator denoting the projection $\text{\textbackslash projOp}$  $\text{proj}$  $\text{\textbackslash projOp}$  $\text{proj}$
<b>proj</b>	projection onto a set. Its syntax is $\text{\textbackslash proj}[#1]\{#2\}(\#3)$ or $\text{\textbackslash proj}[#1]\{#2\}$ . The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes. <sup>1</sup> The second argument denotes the set and can also be left out. The third argument denotes the point; it can be omitted. The command $\text{\textbackslash projOp}$ is used to typeset the operator.  $\text{\textbackslash proj}$  $\text{proj}$  $\text{\textbackslash proj}(x)$  $\text{proj}(x)$  $\text{\textbackslash proj}\{\text{\textbackslash cC}\}$  $\text{proj}_C$  $\text{\textbackslash proj}\{\text{\textbackslash cC}\}(x)$  $\text{proj}_C(x)$  $\text{\textbackslash proj}[Big](\text{\textbackslash dfrac}\{x\}\{2\})$  $\text{proj}\left(\frac{x}{2}\right)$  $\text{\textbackslash proj}[Big]\{\text{\textbackslash cC}\}(\text{\textbackslash dfrac}\{x\}\{2\})$  $\text{proj}_C\left(\frac{x}{2}\right)$
<b>proxOp</b>	the mathematical operator denoting the proximal map  $\text{\textbackslash proxOp}$  $\text{prox}$
<b>prox</b>	the proximal operator of a function. Its syntax is $\text{\textbackslash prox}[#1]\{#2\}(\#3)$ or $\text{\textbackslash prox}[#1]\{#2\}$ . The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes. <sup>1</sup> The second argument denotes the set. The third argument denotes the point; it can be omitted. The command $\text{\textbackslash proxOp}$ is used to typeset the operator.

	$\backslash prox$  $prox$
	$\backslash prox{\lambda F}$  $prox_{\lambda F}$
	$\backslash prox{\lambda F}(x)$  $prox_{\lambda F}(x)$
	$\backslash prox[auto]{\lambda F}(\frac{x}{2})$  $prox_{\lambda F}\left(\frac{x}{2}\right)$
<b>rank</b>	rank (of a matrix) $\backslash rank$  $rank$
<b>range</b>	range of some operator $\backslash range$  $range$
<b>restr</b>	restriction/evaluation. Its syntax is $\backslash restr[\#1][\#2][\#3]$ . The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes. <sup>1</sup> The second argument denotes the argument to be restricted/evaluated. The third argument denotes the restriction set/evaluation point.
	$\backslash restr[auto]{\frac{d}{dt}}(f \circ \gamma)(t) _{t=0}$  $\left. \frac{d}{dt}(f \circ \gamma)(t) \right _{t=0}$
<b>ri</b>	relative interior $\backslash ri$  $ri$
<b>setDef</b>	define a set, where $\backslash setMid$ serves as the center divider. Its syntax is $\backslash setDef[\#1][\#2][\#3]$ . The first (optional) argument is used to scale the parentheses enclosing the argument and the center divider to the standard amsmath sizes. <sup>1</sup> The second argument denotes the left part of the definition, naming the potential elements of the set being defined. The third argument denotes the condition to include the elements in the set.
	$\backslash setDef{x \in \mathbb{R}}{x > 5}$  $\{x \in \mathbb{R} \mid x > 5\}$
	$\backslash setDef[Big]{x \in \mathbb{R}}{x > \frac{1}{2}}$  $\left\{x \in \mathbb{R} \mid x > \frac{1}{2}\right\}$
<b>setMid</b>	divider within $\backslash setDef$ (set definitions). This defaults to $\backslash setMid$  $ $ .
<b>sgn</b>	sign $\backslash sgn$  $sgn$
<b>Sgn</b>	sign (set valued) $\backslash Sgn$  $Sgn$
<b>supp</b>	support (of a function) $\backslash supp F$  $supp F$
<b>sym</b>	symmetric part (of a matrix) $\backslash sym A$  $sym A$



<b>trace</b>	trace (of a matrix) $\langle / \rangle \S \backslash \text{trace}$ A $\text{trace } A$
<b>transp</b>	transpose of a vector or matrix. $\langle / \rangle \S A^{\backslash \text{transp}}$ $A^T$
<b>transposeSymbol</b>	symbol to use for the transpose $\langle / \rangle \S \backslash \text{transposeSymbol}$ $T$
<b>var</b>	variance $\langle / \rangle \S \backslash \text{var}$ $\text{Var}$
<b>weakly</b>	weak convergence of a sequence $\langle / \rangle \S \backslash \text{weakly}$ $\rightharpoonup$
<b>weaklystar</b>	weak star convergence of a sequence $\langle / \rangle \S \backslash \text{weaklystar}$ $\rightharpoonup^*$

## 8 ADDITIONAL SEMANTICS BY TOPIC

While semantic commands might be suitable for all mathematical topics, the following subsections collect commands which are most useful in one particular mathematical area and hence might clutter the general semantic file. Any semantic topic files should always build on `mathsemantics-semantic.sty`.

### 8.1 MANIFOLDS: `mathsemantics-manifolds.sty`

The semantic file `mathsemantics-manifolds.sty` collects definitions and notations for Riemannian manifolds.

**bitangentSpace** the bi tangent space. Its syntax is `\bitangent{#1}[#2]`. The first argument denotes the base point. The second (optional) argument denotes the manifold, which defaults to  $\mathcal{M}$ .

$$\langle / \rangle \S \backslash \text{bitangentSpace}\{p\} \quad \text{eye} \quad \mathcal{T}_p^{**} \mathcal{M}$$

$$\langle / \rangle \S \backslash \text{bitangentSpace}\{q\}[\backslash \text{cN}] \quad \text{eye} \quad \mathcal{T}_q^{**} \mathcal{N}$$

**bitangentSpaceSymbol** the symbol used within `\bitangentSpace`.

$$\langle / \rangle \S \backslash \text{bitangentSpaceSymbol} \quad \text{eye} \quad \mathcal{T}^{**}$$

**cotangentSpace** the cotangent space. Its syntax is `\cotangentSpace{#1}[#2]`. The first argument denotes the base point. The second (optional) argument denotes the manifold, which defaults to  $\mathcal{M}$ .

`</> \cotangentSpace{p}`  $\mathcal{T}_p^*\mathcal{M}$

`</> \cotangentSpace{q}[\backslash\mathcal{N}]`  $\mathcal{T}_q^*\mathcal{N}$

**cotangentBundle** the cotangent bundle. Its syntax is `\cotangentBundle[#1]`. The (optional) argument denotes the manifold, which defaults to  $\mathcal{M}$ .

`</> \cotangentBundle`  $\mathcal{T}^*\mathcal{M}$

`</> \cotangentBundle[\backslash\mathcal{N}]`  $\mathcal{T}^*\mathcal{N}$

**cotangentSpaceSymbol** the symbol used within `\cotangent`.

`</> \cotangentSpaceSymbol`  $\mathcal{T}^*$

**covariantDerivative** is the covariant derivative. Its syntax is `\covariantDerivative{#1}[#2]`. The first argument is the vector (or vector field) determining the direction of differentiation. The second (optional) argument denotes the tensor field being differentiated.

`</> \covariantDerivative{X}{Y}`  $D_X Y$

**covariantDerivativeSymbol** the symbol used for the covariant derivative `\covariantDerivative`.

`</> \covariantDerivativeSymbol`  $D$

**exponential** the exponential map. Its syntax is `\exponential[#1][#2](#3)`. The first argument can be used to scale the third. The second argument denotes the base point and is mandatory. The third argument denotes the tangent vector, which is optional, but if provided, the argument is put in brackets. The first following example illustrates the case, where no brackets are put. Note that the space is mandatory.

`</> \exponential{p}X`  $\exp_p X$

`</> \exponential{p}(X)`  $\exp_p(X)$


`</> \exponential[Big]{p}(\frac{X}{2})`  $\exp_p\left(\frac{X}{2}\right)$


**expOp** the symbol used within the `\exponential`.


`</> \expOp`   $\exp$


### geodesic


a geodesic. Its syntax is `\geodesic#1-;#2;[#3]-#4"-#5"(#6)-`. The first argument can be used to use a different symbol (locally) for the geodesic. The second (optional) argument is used to modify the style of the geodesic (symbol, long, arc or plain, where the last is the default). The third (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> It is ignored when the sixth argument is not given. The fourth argument denotes the initial point (at  $t = 0$ ). The fifth argument denotes either the final point (at  $t = 1$ ) for types `l` and `a`, or the initial tangent vector for type `p`. The sixth (optional) argument denotes the evaluation point. The command `\geodesicSymbol` is used to typeset the geodesic symbol default (i.e. globally)


`</> \geodesic<s>`   $\gamma$


`</> \geodesic<s>(t)`   $\gamma(t)$


`</> \geodesic<l>\{p\}\{q\}`   $\gamma(\cdot; p, q)$


`</> \geodesic<l>\{p\}\{q\}(t)`   $\gamma(t; p, q)$


`</> \geodesic<a>\{p\}\{q\}`   $\gamma_{p,q}$

`</> \geodesic<a>[Big]\{p\}\{q\}(\dfrac{t}{2})`   $\gamma_{p,q}\left(\frac{t}{2}\right)$

`</> \geodesic<p>\{p\}\{X\}`   $\gamma_{p,X}$

`</> \geodesic<p>\{p\}\{X\}(t)`   $\gamma_{p,X}(t)$

`</> \geodesic<p>[Big]\{p\}\{X\}(\dfrac{t}{2})`   $\gamma_{p,X}\left(\frac{t}{2}\right)$

`</> \geodesic[big]\{p\}\{X\}((1-t)t)`   $\gamma_{p,X}((1-t)t)$

`</> \geodesic|\dot{\gamma}| \{p\}\{X\}(t)`   $\dot{\gamma}_{p,X}(t)$


### geodesicSymbol

symbol to use for the geodesic in `\geodesic`

`</> \geodesicSymbol`   $\gamma$

### inverseRetract

use an inverse retraction, the arguments are similar to `\logarithm` but use the `\retractionSymbol`

`</> \inverseRetract\{p\}q`   $\text{retr}_p^{-1}q$

`\inverseRetract{p}(q)`     $\text{retr}_p^{-1}(q)$

`\inverseRetract[Big]{p}(q)`     $\text{retr}_p^{-1}(q)$

### logarithm

the logarithmic map. Its syntax is `\logarithm[#1]{#2}(#3)`. The first argument can be used to scale the third. The second argument denotes the base point and is mandatory. The third argument denotes another point, which is optional, but if provided, the argument is put in brackets. The first following example illustrates the case, where no brackets are put. Note that the space is mandatory.

`\logarithm{p}q`     $\log_p q$

`\logarithm{p}(q)`     $\log_p(q)$

`\logarithm[Big]{p}(q)`     $\log_p(q)$

### logOp

the symbol used within the `\logarithm`.

`\logOp`     $\log$

### parallelTransport

the parallel transport.

Its syntax is `\parallelTransport[#1]{#2}{#3}(#4){#5}`. The first (optional) argument is used to scale the parentheses enclosing the argument #4.<sup>1</sup> The second argument is the start point of parallel transport on a manifold. The third argument is the end point of parallel transport on a manifold. The fourth (optional) argument is the tangent vector that is transported. Putting it in brackets enables the scaling by the first argument. The fifth (optional) argument specifies an exponent, for example to parallel transport along a curve  $c$

`\parallelTransport{p}{q}X`     $P_{q \leftarrow p}X$

`\parallelTransport{p}{q}(X)`     $P_{q \leftarrow p}(X)$

`\parallelTransport[big]{p}{q}(X)`     $P_{q \leftarrow p}(X)$

`\parallelTransport{p}{q}(X)[c]`     $P_{q \leftarrow p}^c(X)$

`\parallelTransport{p}{q}[c]`     $P_{q \leftarrow p}^c$

### parallelTransportDir

similar to `\parallelTransport`, but the third argument is a direction to transport into. This can be rewritten to the classical notation applying an exponential map from the base point (#2) to the direction (#3). The fifth

(optional) argument specifies an exponent, for example to parallel transport along a curve  $c$

`\parallelTransportDir{p}{Y}X`     $P_{p,Y}X$

`\parallelTransportDir{p}{Y}(X)`     $P_{p,Y}(X)$

`\parallelTransportDir[big]{p}{Y}(X)`     $P_{p,Y}(X)$

`\parallelTransportDir{p}{Y}(X)[c]`     $P_{p,Y}^c(X)$

`\parallelTransportDir{p}{Y}[c]`     $P_{p,Y}^c$

**parallelTransportSymbol**    the symbol to use within `\parallelTransport` and `\parallelTransportDir`

`\parallelTransportSymbol`     $P$

**retract**

a retraction.

Its syntax is `\retract[#1]{#2}{#3}`. The first argument can be used to scale the third. The second argument denotes the base point. The third argument denotes the tangent vector, which is optional, but if provided, the argument is put in brackets. The first following example illustrates the case, where no brackets are put. Note that the space is mandatory.

`\retract{p}X`     $\text{retr}_p X$

`\retract{p}(X)`     $\text{retr}_p(X)$

`\retract[Big]{p}(\frac{X}{2})`     $\text{retr}_p\left(\frac{X}{2}\right)$

**retractionSymbol**    symbol to use for a retraction and an inverse retraction, see `\retract` and `\inverseRetract`.


`\retractionSymbol`     $\text{retr}$

**riemannian**

the Riemannian metric (family of inner products on the tangent spaces). Its syntax is `\riemannian[#1]{#2}{#3}[#4]`. The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> The second argument denotes the first factor. The third argument denotes the second factor. The fourth (optional) argument denotes the base point of the tangent space.

`\riemannian{X_1}{X_2}`     $(X_1, X_2)$

`\riemannian{Y_1}{Y_2}[q]`     $(Y_1, Y_2)_q$

`</> \riemannian[Big]{\dfrac{1}{2}X_1}{X_2}[p]`   $\left(\frac{1}{2}X_1, X_2\right)_p$


**riemanniannorm**

the norm induced by the Riemannian metric.

Its syntax is `\riemanniannorm[#1]{#2}[#3]`. The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> The second argument denotes the argument. The third (optional) argument denotes the base point of the tangent space.

`</> \riemanniannorm{X}`   $\|X\|$

`</> \riemanniannorm{Y}[p]`   $\|Y\|_p$

`</> \riemanniannorm[Big]{\dfrac{1}{2}X}[p]`   $\left\|\frac{1}{2}X\right\|_p$


**secondCovariantDerivative** is the second-order covariant derivative.

Its syntax is `\secondCovariantDerivative{#1}{#2}[#3]`. The first argument is the vector (or vector field) determining the first direction of differentiation. The second argument is the vector (or vector field) determining the second direction of differentiation. The third (optional) argument denotes the tensor field being differentiated.

`</> \secondCovariantDerivative{X}{Y}{T}`   $D_{X,Y}^2 T$

**secondCovariantDerivativeSymbol** the symbol used for the second covariant derivative.


This is used within `\secondCovariantDerivative`.

`</> \secondCovariantDerivativeSymbol`   $D^2$

**tangentSpace**

the tangent space. Its syntax is `\tangentSpace{#1}[#2]`. The first argument denotes the base point. The second (optional) argument denotes the manifold, which defaults to  $\mathcal{M}$ .

`</> \tangentSpace{p}`   $\mathcal{T}_p \mathcal{M}$

`</> \tangentSpace{q}[\mathcal{N}]`   $\mathcal{T}_q \mathcal{N}$

**tangentBundle**

the tangent bundle. Its syntax is `\tangentBundle[#1]`. The (optional) argument denotes the manifold, which defaults to  $\mathcal{M}$ .

`</> \tangentBundle`   $\mathcal{T} \mathcal{M}$

`</> \tangentBundle[\mathcal{N}]`   $\mathcal{T} \mathcal{N}$


**tangentSpaceSymbol**


the symbol used within `\tangent`.

`\tangentSpaceSymbol`      $\mathcal{T}$

### tensorBundle


the tensor bundle. Its syntax is `\tensorBundle{#1}{#2}[#3]`. The first argument denotes the number  $r$  of elements of the cotangent space the tensors accept. The second argument denotes the number  $s$  of elements of the tangent space the tensors accept. The third (optional) argument denotes the manifold, which defaults to  $\mathcal{M}$ .


`\tensorBundle{r}{s}`      $\mathcal{T}^{(r,s)}\mathcal{M}$

`\tensorBundle{r}{s}[\mathcal{N}]`      $\mathcal{T}^{(r,s)}\mathcal{N}$

### tensorSpace

a tensor space over a vector space  $V$ . Its syntax is `\tensorSpace{#1}{#2}[#3]`. The first argument denotes the number  $r$  of elements of the dual space  $V^*$  the tensors accept. The second argument denotes the number  $s$  of elements of the space  $V$  the tensors accept. The third (optional) argument denotes the vector space, which defaults to empty.

`\tensorSpace{r}{s}`      $\mathcal{T}^{(r,s)}()$

`\tensorSpace{r}{s}[V]`      $\mathcal{T}^{(r,s)}(V)$

### tensorSpaceSymbol


the symbol used within `\tensorSpace` and `\tensorBundle`.


`\tensorSpaceSymbol`      $\mathcal{T}$


### vectorTransport


a vector transport.

Its syntax is `\vectorTransport[#1]{#2}{#3}(#4)[#5]`. The first (optional) argument is used to scale the parentheses enclosing the argument #4.<sup>1</sup> The second argument is the start point of vector transport on a manifold. The third argument is the end point of vector transport on a manifold. The fourth (optional) argument is the tangent vector that is transported. Putting it in brackets enables the scaling by the first argument. Finally a retraction symbol can be added in the exponent to distinguish vector transports as #5.

`\vectorTransport{p}{q}X`      $T_{q \leftarrow p}X$

`\vectorTransport{p}{q}(X)`      $T_{q \leftarrow p}(X)$

`\vectorTransport[big]{p}{q}(X)`      $T_{q \leftarrow p}(X)$

`\vectorTransport{p}{q}(X)[\retractionSymbol]`      $T_{q \leftarrow p}^{\text{retr}}(X)$

### vectorTransportDir

similar to `\vectorTransport`, but the third argument is a direction to transport into. This can be rewritten to the classical notation applying an retraction

from the base point (#2) to th direction (#3).

`</> \vectorTransportDir{p}{Y}X`  $T_{p,Y}X$

`</> \vectorTransportDir{p}{Y}(X)`  $T_{p,Y}(X)$

`</> \vectorTransportDir[big]{p}{Y}(X)`  $T_{p,Y}(X)$

`</> \vectorTransportDir{p}{Y}(X)[\retractionSymbol]`  $T_{p,Y}^{\text{retr}}(X)$

**vectorTransportSymbol** the symbol to use within `\vectorTransport` and `\vectorTransportDir`

`</> \vectorTransportSymbol`  $T$

## 8.2 OPTIMIZATION: mathsemantics-optimization.sty

The semantic file `mathsemantics-optimization.sty` collects definitions and notations related to optimization.

**linearizingcone** the linearizing cone. Its syntax is `\linearizingcone[#1]{#2}{#3}`. The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> The second argument denotes the set. The third argument denotes the base point.

`</> \linearizingcone{A}{x}`  $\mathcal{T}_A^{\text{lin}}(x)$

`</> \linearizingcone{A}{x^2}`  $\mathcal{T}_A^{\text{lin}}(x^2)$

`</> \linearizingcone[big]{A}{x^2}`  $\mathcal{T}_A^{\text{lin}}(x^2)$

**normalcone** the normal cone. Its syntax is `\normalcone[#1]{#2}{#3}`. The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> The second argument denotes the set. The third argument denotes the base point.

`</> \normalcone{A}{x}`  $\mathcal{N}_A(x)$

`</> \normalcone{A}{x^2}`  $\mathcal{N}_A(x^2)$

`</> \normalcone[big]{A}{x^2}`  $\mathcal{N}_A(x^2)$

**polarcone** the polar cone of a set `</> \polarcone{A}`  $A^\circ$



**radialcone**

the radial cone. Its syntax is `\radialcone[#1]{#2}{#3}`. The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> The second argument denotes the set. The third argument denotes the base point.

`</> \radialcone{A}{x}`     $\mathcal{K}_A(x)$

`</> \radialcone{A}{x^2}`     $\mathcal{K}_A(x^2)$

`</> \radialcone[big]{A}{x^2}`     $\mathcal{K}_A(x^2)$

**tangentcone**

the tangent cone. Its syntax is `\tangentcone[#1]{#2}{#3}`. The first (optional) argument is used to scale the parentheses enclosing the argument to the standard amsmath sizes.<sup>1</sup> The second argument denotes the set. The third argument denotes the base point.

`</> \tangentcone{A}{x}`     $\mathcal{T}_A(x)$

`</> \tangentcone{A}{x^2}`     $\mathcal{T}_A(x^2)$

`</> \tangentcone[big]{A}{x^2}`     $\mathcal{T}_A(x^2)$