MathSemantics.sty – Semantic Math Commands

Ronny Bergmann Roland Herzog

2022-05-04

Contents

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 LaTeX (👁). 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}} 👁 $\Big|\frac{1}{2}\Big|$ 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

shortbb 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 XeTeX 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

ba…bz	lower-case **b**old-face letters \br, \bf $\boldsymbol{r}, \boldsymbol{f}$
bA…bZ	upper-case **b**old-face letters \bR, \bF $\boldsymbol{R}, \boldsymbol{F}$
balpha…bomega	lower-case **b**old-face Greek letters \balpha,\boldeta $\boldsymbol{\alpha}, \boldsymbol{\eta}$ (the latter being an exception)
bAlpha…bOmega	upper-case **b**old-face Greek letters \bGamma,\bDelta $\boldsymbol{\Gamma}, \boldsymbol{\Delta}$
bnull	**b**old-face zero \bnull 0
bone	**b**old-face one \bone 1
cA…cZ	upper-case **c**alligraphic letters \cM, \cN $\mathcal{M}, \mathcal{N}$
fA…fZ	upper-case **f**raktur letters \fM, \fN, \fX $\mathfrak{M}, \mathfrak{N}, \mathfrak{X}$
sA…sZ	upper-case **s**cript letters \sM, \sN, \sX $\mathscr{M}, \mathscr{N}, \mathscr{X}$
va…vz	lower-case letters with a **v**ector accent \va,\vb $\vec{a}, \vec{b}$
vA…vZ	upper-case letters with a **v**ector accent \vA,\vB $\vec{A}, \vec{B}$
valpha…vomega	lower-case Greek letters with a **v**ector accent \valpha,\vbeta $\vec{\alpha}, \vec{\beta}$
vAlpha…vOmega	upper-case Greek letters with a **v**ector accent \vGamma,\vDelta $\vec{\Gamma}, \vec{\Delta}$

vnull — vector zero `\vnull` $\vec{0}$

vone — vector one `\vone` $\vec{1}$

bbA,...,bbZ — blackboard-bold uppercase letters

`\bbC,\bbK,\bbN,\bbQ,\bbR,\bbS,\bbZ` $\mathbb{C}, \mathbb{K}, \mathbb{N}, \mathbb{Q}, \mathbb{R}, \mathbb{S}, \mathbb{Z}$

use the package option shortbb to introduce `\C,\K,\N,\Q,\R,\Z` $\mathbb{C}, \mathbb{K}, \mathbb{N}, \mathbb{Q}, \mathbb{R}, \mathbb{Z}$ if not already defined elsewhere (i. e. they are not redefined, only *provided*.

4.2 Syntax Helpers

enclspacing — provides spacing after the opening and before the closing delimiters for \enclose. This is by default set to be empty.

enclose — 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 \enclose[#1]{#2}{#3}{#4}. The first (optional) argument is used to scale the delimiters to the standard amsmath sizes.[1] 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}}{]}` $[\dfrac{1}{2}]$

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

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

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

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 nicer command to use

[1] big, Big, bigg, Bigg or auto, which uses left and right as well as none to easily deactivate brackets.

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 ams-math sizes.[1] 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\bbR}{|}{x>5}{\}}` $\big\{x \in \mathbb{R} \,\big|\, x > 5\big\}$

`\encloseSet[auto]{\{}{x\in\bbR}{|}{x>\dfrac{1}{2}}{\}}` $\left\{x \in \mathbb{R} \,\middle|\, x > \dfrac{1}{2}\right\}$

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}}` $\Big[\dfrac{1}{2}\Big]$

`\paren[Big][]{\dfrac{1}{2}}` $\Big[\dfrac{1}{2}\Big]$

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

4.3 Spacing Helpers

clap complements the standard LaTeX commands \llap and \rlap. These commands horizontally smash their arguments.

`Let us \llap{smash} something.` Isetmaussh something.

`Let us \clap{smash} something.` Let usmasbmething.

`Let us \rlap{smash} something.` Let us smashthing.

mathllap corresponds to \llap in math mode.

`\sum_{\mathllap{1\le i\le j\le n}} X_{ij}` $\sum_{\mathllap{1\le i\le j\le n}} X_{ij}$

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

`\sum_{\mathclap{1\le i\le j\le n}} X_{ij}` $\sum_{\mathclap{1\le i\le j\le n}} X_{ij}$

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

`\sum_{\mathrlap{1\le i\le j\le n}} X_{ij}` $\sum_{\mathrlap{1\le i\le j\le n}} X_{ij}$

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` $\mathrlap{1}-1$

`\mrep[c]{1}{-1}-1` $\mathclap{1}-1$

`\mrep[r]{1}{-1}-1` $1-1$

5 Abbreviations

5.1 English

aa — almost all `\aa` a.a.

ale — almost everwhere `\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.

wrt	with respect to </> \wrt w.r.t.

5.2 German

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

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

6 Names

adimat	ADiMat
ampl	AMPL
BibTeX	BibTeX
BibLaTeX	BibLaTeX
cg	CG
cpp	C++
cppmat	cppmat
dolfin	Dolfin
dolfinplot	Dolfin-Plot
dolfinadjoint	Dolfin-Adjoint

doxygen	Doxygen
femorph	FEMorph
fenics	FEniCS
ffc	FFC
fmg	FMG
fortran	Fortran
gitlab	GitLab
gmres	Gmres
gmsh	Gmsh
ipopt	Ipopt
libsvm	LIBSVM
liblinear	LIBLINEAR
macmpec	MacMPEC
manifoldsjl	Manifolds.jl
manopt	Manopt
manoptjl	Manopt.jl
mathematica	Mathematica
matlab	Matlab
maple	Maple
maxima	Maxima
metis	Metis
minres	Minres
mshr	mshr
mvirt	MVIRT

numpy	👁	NumPy
paraview	👁	Paraview
pdflatex	👁	PDFLaTeX
perl	👁	Perl
petsc	👁	PETSc
pymat	👁	pymat
python	👁	Python
scikit	👁	SciKit
scikitlearn	👁	SciKit-learn
scipy	👁	SciPy
sphinx	👁	Sphinx
subgmres	👁	SubGmres
subminres	👁	SubMinres
superlu	👁	SuperLU
svmlight	👁	SVM light
tritetmesh	👁	TriTetMesh
ufl	👁	UFL
uqlab	👁	UQLab
viper	👁	Viper
xml	👁	XML

7 Semantic Commands

Build upon Syntax from Section 4 this part provides semantical mathematical commands.

abs

absolute value. Its syntax is `\abs[#1]{#2}`. The first (optional) argument is used to scale the deliminters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the argument.

`\abs{a}` $|a|$

`\abs[Big]{\dfrac{1}{2}}` $\Big|\dfrac{1}{2}\Big|$

`\abs[auto]{\dfrac{1}{2}}` $\left|\dfrac{1}{2}\right|$

aff

affine hull `\aff` aff

arcosh

area hyperbolic cosine `\arcosh` arcosh

arcoth

area hyperbolic cotangens `\arcoth` arcoth

argmax

maximizer of a function `\argmax_{x \in \bbR} f(x)` $\operatorname*{arg\,max}_{x\in\mathbb{R}} f(x)$

Argmax

set of maximizers of a function `\Argmax_{x \in \bbR} f(x)` $\operatorname*{Arg\,max}_{x\in\mathbb{R}} f(x)$

argmin

minimizer of a function `\argmin_{x \in \bbR} f(x)` $\operatorname*{arg\,min}_{x\in\mathbb{R}} f(x)$

Argmin

set of minimizers of a function `\Argmin_{x \in \bbR} f(x)` $\operatorname*{Arg\,min}_{x\in\mathbb{R}} f(x)$

arsinh

area hyperbolic cotangens `\arsinh` arsinh

artanh

area hyperbolic tangens `\artanh` artanh

bdiv

bold (meaning: vector) divergence of a matrix-valued function `\bdiv` $\mathbf{div}$

ceil

integer larger or equal to input. Its syntax is `\ceil[#1]{#2}`. The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the argument.

`\ceil{a}` $\lceil a \rceil$

`\ceil[Big]{\dfrac{1}{2}}` $\Big\lceil\dfrac{1}{2}\Big\rceil$

clconv	closure of the convex hull of a set `\clconv M`	$\overline{\operatorname{conv}} M$
closure	closure of a set `\closure M`	$\operatorname{cl} M$
cofac	cofactor matrix `\cofac(A)`	$\operatorname{cof}(A)$
compactly	compact embedding of topological spaces `\compactly`	$\hookrightarrow\hookrightarrow$
cone	conic hull `\cone`	cone
conv	convex hull of a set `\conv M`	$\operatorname{conv} M$
corresponds	binary operator for correspondence `A\corresponds B`	$A \mathrel{\widehat{=}} B$
cov	covariance `\cov`	Cov
curl	the curl operator `\curl`	curl

d, dInt — integral symbol with prepended space, as in

`\int_\bbR \exp(-x^2) \d x` $\int_{\mathbb{R}} \exp(-x^2) \,\mathrm{d}x$

Since `\d` is often overridden, `\dInt` is the safe alternative

dev — deviator of a matrix `\dev A` $\operatorname{dev} A$

diag — diagonal matrix composed of entries in a vector, or diagonal of a matrix

`\diag(a)` $\operatorname{diag}(a)$

`\diag(A)` $\operatorname{diag}(A)$

diam — diameter `\diam(M)` $\operatorname{diam}(M)$

distOp — the mathematical operator denoting the distance

`\distOp` dist

dist — distance from a point to a set. Its syntax is `\dist[#1]{#2}{#3}` or `\dist[#1]{#2}`. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] The second argument denotes the set. The third argument denotes the point; it can be omitted. The command `\distOp` is used to typeset the operator.

`\dist[Big]{\cC}{\dfrac{x}{2}}` $\operatorname{dist}_{\mathcal{C}}\Big(\dfrac{x}{2}\Big)$

	`\dist{\cC}` dist_C
	`\dist` dist
div	divergence `\div` div
Div	(row-wise) divergence `\Div` Div
dom	domain `\dom` dom
dotcup	distinct union `\dotcup` $\dot\cup$
dprod	double contraction of matrices $A : B = \sum_{i,j} A_{ij} B_{ij} = \operatorname{trace}(A^\intercal B)$
	`A \dprod B` $A : B$
dual	duality pairing. Its syntax is `\dual[#1]{#2}{#3}`. The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the first factor. The third argument denotes the second factor.
	`\dual{x^*}{x}` $\langle x^* , x \rangle$
	`\dual[Big]{x^*}{\dfrac{1}{2}}` $\Big\langle x^* , \dfrac{1}{2} \Big\rangle$
e	Euler's number `\e` e
embed	embedding of topological spaces `\embed` $\hookrightarrow$
embeds	synonym of `\embed` `\embeds` $\hookrightarrow$
epi	epigraph `\epi` epi
eR	extended real line `\eR = \bbR \cup \{\pm \infty\}` $\overline{\mathbb{R}} = \mathbb{R} \cup \{\pm\infty\}$
essinf	essential infimum
	`\displaystyle\essinf_{x \in \bbR} f(x)` $\displaystyle\operatorname*{ess\,inf}_{x \in \mathbb{R}} f(x)$
esssup	essential supremum
	`\displaystyle\esssup_{x \in \bbR} f(x)` $\displaystyle\operatorname*{ess\,sup}_{x \in \mathbb{R}} f(x)$

file — typesets a file name (using nolinkurl)

`\file{test.txt}` → test.txt

floor — integer less or equal to input. Its syntax is `\floor[#1]{#2}`. The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the argument.

`\floor{a}` → $\lfloor a \rfloor$

`\floor[Big]{\dfrac{1}{2}}` → $\Big\lfloor \dfrac{1}{2} \Big\rfloor$

grad — gradient (of a function) `\grad F` → $\operatorname{grad} F$

Graph — graph of a function `\Graph` → Graph

id — identity operator `\id` → id

image — image of a function `\image` → image

inj — injedctivity (radius) `\inj` → inj

inner — inner product. Its syntax is `\inner[#1]{#2}{#3}`. The first (optional) argument is used to scale the parentheses enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the first factor. The third argument denotes the second factor.

`\inner{a}{b}` → $(a\,,\, b)$

`\inner[Big]{a}{\dfrac{b}{2}}` → $\Big(a\,,\, \dfrac{b}{2}\Big)$

interior — `\interior` → int

jump — jump of a quantity, e. g., across a finite element facet. Its syntax is `\jump[#1]{#2}`. The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the argument.

`\jump{a}` → $[\![a]\!]$

`\jump[Big]{\dfrac{1}{2}}` → $\Big[\!\!\Big[\dfrac{1}{2} \Big]\!\!\Big]$

laplace — the Laplace operator `\laplace u` → Δu

lin — linear hull of a set of vectors `\lin\{v_1,v_2\}` $\operatorname{lin}\{v_1, v_2\}$

norm — norm of a vector. Its syntax is `\norm[#1]{#2}`. The first (optional) argument is used to scale the delimiters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the argument.

`\norm{a}` $\|a\|$

`\norm[Big]{\dfrac{c}{2}}` $\Big\|\dfrac{c}{2}\Big\|$

`\norm[auto]{\dfrac{c}{2}}` $\left\|\dfrac{c}{2}\right\|$

projOp — the mathematical operator denoting the projection `\projOp` proj

`\projOp` proj

proj — projection onto a set. Its syntax is `\proj[#1]{#2}(#3)` or `\proj[#1]{#2}`. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] The second argument denotes the set and can also be left out. The third argument denotes the point; it can be omitted. The command `\projOp` is used to typeset the operator.

`\proj` proj

`\proj(x)` $\operatorname{proj}(x)$

`\proj{\cC}` proj_C

`\proj{\cC}(x)` $\operatorname{proj}_C(x)$

`\proj[Big](\dfrac{x}{2})` $\operatorname{proj}\Big(\dfrac{x}{2}\Big)$

`\proj[Big]{\cC}(\dfrac{x}{2})` $\operatorname{proj}_C\Big(\dfrac{x}{2}\Big)$

proxOp — the mathematical operator denoting the proximal map

`\proxOp` prox

prox — the proximal operator of a function. Its syntax is `\prox[#1]{#2}(#3)` or `\prox[#1]{#2}`. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] The second argument denotes the set. The third argument denotes the point; it can be omitted. The command `\proxOp` is used to typeset the operator.

	`\prox` prox
	`\prox{\lambda F}` $\operatorname{prox}_{\lambda F}$
	`\prox{\lambda F}(x)` $\operatorname{prox}_{\lambda F}(x)$
	`\prox[auto]{\lambda F}(\dfrac{x}{2})` $\operatorname{prox}_{\lambda F}\left(\dfrac{x}{2}\right)$
rank	rank (of a matrix) `\rank` rank
range	range of some operator `\range` range
restr	restriction/evaluation. Its syntax is `\restr[#1]{#2}{#3}`. The first (optional) argument is used to scale the deliminters enclosing the arguments to the standard amsmath sizes.[1] The second argument denotes the argument to be restricted/evaluated. The third argument denotes the restriction set/evaluation point.
	`\restr[auto]{\frac{\d}{\d t}(f \circ \gamma)(t)}{t=0}` $\left.\frac{\mathrm{d}}{\mathrm{d}t}(f\circ\gamma)(t)\right\rvert_{t=0}$
ri	relative inerior `\ri` ri
setDef	define a set, where `\setMid` serves as the center divider. Its syntax is `\setDef[#1]{#2}{#3}`. The first (optional) argument is used to scale the parantheses enclosing the argument and the center divider to the standard amsmath sizes.[1] 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.
	`\setDef{x\in\bbR}{x>5}` $\{x\in\mathbb{R} \mid x>5\}$
	`\setDef[Big]{x\in\bbR}{x>\dfrac{1}{2}}` $\Big\{x\in\mathbb{R} \Big\vert x>\dfrac{1}{2}\Big\}$
setMid	divider within `\setDef` (set definitions). This defaults to `\setMid` $\mid$.
sgn	sign `\sgn` sgn
Sgn	sign (set valued) `\Sgn` Sgn
supp	support (of a function) `\supp F` $\operatorname{supp} F$
sym	symmetric part (of a matrix) `\sym A` $\operatorname{sym} A$

trace — trace (of a matrix) \trace A $\operatorname{trace} A$

transp — transpose of a vector or matrix.

A^\transp A^{T}

transposeSymbol — symbol to use for the transpose

\transposeSymbol T

var — variance \var Var

weakly — weak convergence of a sequence \weakly $\rightharpoonup$

weaklystar — weak star convergence of a sequence \weaklystar $\overset{\star}{\rightharpoonup}$

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 numapde-semantic.sty.

8.1 Manifolds: numapde-manifolds.sty

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

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

\bitangentSpace{p} $\mathcal{T}_p^{**}\mathcal{M}$

\bitangentSpace{q}[\cN] $\mathcal{T}_q^{**}\mathcal{N}$

bitangentSpaceSymbol — the symbol used within \bitangentSpace.

\bitangentSpaceSymbol $\mathcal{T}^{**}$

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}[\cN] $\mathcal{T}_q^*\mathcal{N}$

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[\cN] $\mathcal{T}^*\mathcal{N}$

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} $\mathrm{D}_X Y$

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}) $\exp_p\Big(\frac{X}{2}\Big)$

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 parantheses enclosing the argument to the standard amsmath sizes.[1] 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> γ

\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} $\gamma_{\widehat{p,q}}$

\geodesic<a>[Big]{p}{q}(\dfrac{t}{2}) $\gamma_{\widehat{p,q}}\Big(\dfrac{t}{2}\Big)$

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

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

\geodesic<p>[Big]{p}{X}(\dfrac{t}{2}) $\gamma_{p,X}\Big(\dfrac{t}{2}\Big)$

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

\geodesic|\dot\gamma|{p}{X}(t) $\dot\gamma_{p,X}(t)$

geodesicSymbol

symbol to use for the geodesic in \geodesic

\geodesicSymbol γ

inverseRetract

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

\inverseRetract{p}q $\operatorname{retr}_p^{-1} q$

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

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

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) $\log_p\Big(q\Big)$

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 parantheses enclosing the argument #4.[1] 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 $\mathrm{P}_{q\leftarrow p}X$

\parallelTransport{p}{q}(X) $\mathrm{P}_{q\leftarrow p}(X)$

\parallelTransport[big]{p}{q}(X) $\mathrm{P}_{q\leftarrow p}\big(X\big)$

\parallelTransport{p}{q}(X)[c] $\mathrm{P}^{c}_{q\leftarrow p}(X)$

\parallelTransport{p}{q}[c] $\mathrm{P}^{c}_{q\leftarrow p}$

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 th direction (#3). The fifth (optional) argument specifies an exponent, for example to parallel transport along a curve c

</> \parallelTransportDir{p}{Y}X 👁 $\mathrm{P}_{p,Y}X$

</> \parallelTransportDir{p}{Y}(X) 👁 $\mathrm{P}_{p,Y}(X)$

</> \parallelTransportDir[big]{p}{Y}(X) 👁 $\mathrm{P}_{p,Y}\big(X\big)$

</> \parallelTransportDir{p}{Y}(X)[c] 👁 $\mathrm{P}^{c}_{p,Y}(X)$

</> \parallelTransportDir{p}{Y}[c] 👁 $\mathrm{P}^{c}_{p,Y}$

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 👁 $\operatorname{retr}_p X$

</> \retract{p}(X) 👁 $\operatorname{retr}_p(X)$

</> \retract[Big]{p}(\frac{X}{2}) 👁 $\operatorname{retr}_p\Big(\frac{X}{2}\Big)$

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

</> \retractionSymbol 👁 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 parantheses enclosing the argument to the standard amsmath sizes.[1] 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] 👁 $\Big(\dfrac{1}{2}X_1\,,\,X_2\Big)_p$

riemanniannorm

the norm induced by the Riemannian metric.
Its syntax is \riemanniannorm[#1]{#2}[#3]. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] 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] $\Big\|\dfrac{1}{2}X\Big\|_p$

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} $\mathrm{D}^2_{X,Y}T$

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}[\cN] $\mathcal{T}_q\mathcal{N}$

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[\cN] $\mathcal{T}\mathcal{N}$

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

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 parantheses enclosing the argument #4.[1] 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` $\mathrm{T}_{q\leftarrow p}X$

`\vectorTransport{p}{q}(X)` $\mathrm{T}_{q\leftarrow p}(X)$

`\vectorTransport[big]{p}{q}(X)` $\mathrm{T}_{q\leftarrow p}\big(X\big)$

`\vectorTransport{p}{q}(X)[\retractionSymbol]` $\mathrm{T}^{\mathrm{retr}}_{q\leftarrow p}(X)$

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 $\mathrm{T}_{p,Y}X$

\vectorTransportDir{p}{Y}(X) $\mathrm{T}_{p,Y}(X)$

\vectorTransportDir[big]{p}{Y}(X) $\mathrm{T}_{p,Y}\big(X\big)$

\vectorTransportDir{p}{Y}(X)[\retractionSymbol] $\mathrm{T}^{\mathrm{retr}}_{p,Y}(X)$

vectorTransportSymbol   the symbol to use within \vectorTransport and \vectorTransportDir

\vectorTransportSymbol T

8.2 Optimization: numapde-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 parantheses enclosing the argument to the standard amsmath sizes.[1] The second argument denotes the set. The third argument denotes the base point.

\linearizingcone{A}{x} $\mathcal{T}_A^{\mathrm{lin}}(x)$

\linearizingcone{A}{x^2} $\mathcal{T}_A^{\mathrm{lin}}(x^2)$

\linearizingcone[big]{A}{x^2} $\mathcal{T}_A^{\mathrm{lin}}\big(x^2\big)$

normalcone   the normal cone. Its syntax is \normalcone[#1]{#2}{#3}. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] 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} $\mathcal{N}_A\big(x^2\big)$

polarcone   the polar cone of a set \polarcone{A} A°

radialcone   the radial cone. Its syntax is \radialcone[#1]{#2}{#3}. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] 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} $\mathcal{K}_A\big(x^2\big)$

tangentcone

the tangent cone. Its syntax is \tangentcone[#1]{#2}{#3}. The first (optional) argument is used to scale the parantheses enclosing the argument to the standard amsmath sizes.[1] 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} $\mathcal{T}_A\big(x^2\big)$