MathSemantics.sty – Semantic Math Commands

Ronny Bergmann

ronny.bergmann@ntnu.no

Department of Mathematical Sciences
NTNU, Trondheim, Norway.

Roland Herzog

roland.herzog@iwr.uni-heidelberg.de

Interdisciplinary Center for Scientific Computing
Heidelberg University, Germany.

May 6, 2022, v 1.0.0

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 X$_\exists$TEX 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` 👁 r, f	
`bA...bZ`	upper-case **b**old-face letters ⟨/⟩ `\bR`, `\bF` 👁 R, F	
`balpha...bomega`	lower-case **b**old-face Greek letters ⟨/⟩ `\balpha,\boldeta` 👁 α, η (the latter being an exception)	
`bAlpha...bOmega`	upper-case **b**old-face Greek letters ⟨/⟩ `\bGamma,\bDelta` 👁 Γ, Δ	
`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 vector 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}}{]}   👁 $[\frac{1}{2}]$

‹/› \enclose[Big][{\dfrac{1}{2}}]   👁 $\Big[\frac{1}{2}\Big]$

‹/› \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

---

[1] 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.[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}{\}}`   👁 $\left\{ x \in \mathbb{R} \,\middle|\, x > 5 \right\}$

⟨/⟩ `\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}}`   👁 $\left[\dfrac{1}{2} \right]$

⟨/⟩ `\paren[Big][]{\dfrac{1}{2}}`   👁 $\left[\dfrac{1}{2} \right]$

⟨/⟩ `\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.   👁 smash something.

⟨/⟩ Let us `\clap{smash}` something.   👁 Let us smash omething.

⟨/⟩ Let us `\rlap{smash}` something.   👁 Let us smash thing.

mathllap corresponds to `\llap` in math mode.

‹/› `\sum_{\mathllap{1\le i\le j\le n}} X_{ij}`   👁 $\displaystyle\sum_{1\le i\le j\le n} X_{ij}$

mathclap   corresponds to `\clap` in math mode.

‹/› `\sum_{\mathclap{1\le i\le j\le n}} X_{ij}`   👁 $\displaystyle\sum_{1\le i\le j\le n} X_{ij}$

mathrlap   corresponds to `\rlap` in math mode.

‹/› `\sum_{\mathrlap{1\le i\le j\le n}} X_{ij}`   👁 $\displaystyle\sum_{1\le i\le j\le n} X_{ij}$

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`   👁 $1 \quad -1$

‹/› `\mrep[c]{1}{-1}-1`   👁 $\ 1 \ \ -1$

‹/› `\mrep[r]{1}{-1}-1`   👁 $\quad 1-1$

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.

`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$^{\text{LIGHT}}$
`tritetmesh`	👁	TRITETMESH
`ufl`	👁	UFL
`uqlab`	👁	UQLAB
`viper`	👁	VIPER
`xml`	👁	XML

7 SEMANTIC COMMANDS

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

abs

absolute value. Its syntax is `\abs`[#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.

    ◈ `\abs`{a}   ◉ $|a|$

    ◈ `\abs`[Big]{`\dfrac`{1}{2}}   ◉ $\left|\dfrac{1}{2}\right|$

    ◈ `\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)   ◉ $\underset{x\in\mathbb{R}}{\arg\max} f(x)$

Argmax

set of maximizers of a function ◈ `\Argmax`_{x `\in` `\bbR`} f(x)   ◉ $\underset{x\in\mathbb{R}}{\mathrm{Arg\,max}} f(x)$

argmin

minimizer of a function ◈ `\argmin`_{x `\in` `\bbR`} f(x)   ◉ $\underset{x\in\mathbb{R}}{\arg\min} f(x)$

Argmin

set of minimizers of a function ◈ `\Argmin`_{x `\in` `\bbR`} f(x)   ◉ $\underset{x\in\mathbb{R}}{\mathrm{Arg\,min}} f(x)$

arsinh

area hyperbolic cotangens ◈ `\arsinh`   ◉ arsinh

artanh

area hyperbolic tangens ◈ `\artanh`   ◉ artanh

bdiv

bold (meaning: vector) divergence of a matrix-valued function ◈ `\bdiv` ◉ **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}}   ◉ $\left\lceil\dfrac{1}{2}\right\rceil$

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

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 parentheses 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}}   👁 $\operatorname{dist}_C\!\left(\dfrac{x}{2}\right)$

         ‹/› `\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 $A : B = \sum_{i,j} A_{ij} B_{ij} = \mathrm{trace}(A^\mathsf{T} B)$

         ‹/› `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}}`   👁 $\left\lfloor \dfrac{1}{2} \right\rfloor$

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   injectivity (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}}`   👁 $\left(a, \dfrac{b}{2} \right)$

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}}`   👁 $\left[\!\left[\dfrac{1}{2} \right]\!\right]$

laplace   the Laplace operator ⟨/⟩ `\laplace` u   👁 Δu

lin linear hull of a set of vectors ❮/❯ `\lin\{v_1,v_2\}` 👁 $\lin\{v_1, v_2\}$

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 parentheses 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)` 👁 $\proj(x)$

❮/❯ `\proj{\cC}` 👁 $\proj_C$

❮/❯ `\proj{\cC}(x)` 👁 $\proj_C(x)$

❮/❯ `\proj[Big](\dfrac{x}{2})` 👁 $\proj\Big(\dfrac{x}{2}\Big)$

❮/❯ `\proj[Big]{\cC}(\dfrac{x}{2})` 👁 $\proj_C\Big(\dfrac{x}{2}\Big)$

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 parentheses 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}   👁 $\text{prox}_{\lambda F}$

</> \prox{\lambda F}(x)   👁 $\text{prox}_{\lambda F}(x)$

</> \prox[auto]{\lambda F}(\dfrac{x}{2})   👁 $\text{prox}_{\lambda F}\left(\dfrac{x}{2}\right)$

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}   👁 $\left.\dfrac{\mathrm{d}}{\mathrm{d}t}(f \circ \gamma)(t)\right|_{t=0}$

ri   relative interior </> \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 parentheses 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}}   👁 $\left\{x \in \mathbb{R} \,\middle|\, x > \dfrac{1}{2}\right\}$

setMid   divider within \setDef (set definitions).
This defaults to </> \setMid   👁 | .

sgn   sign </> \sgn   👁 sgn

Sgn   sign (set valued) </> \Sgn   👁 Sgn

supp   support (of a function) </> \supp F   👁 $\text{supp}\, F$

sym   symmetric part (of a matrix) </> \sym A   👁 $\text{sym}\, A$

trace	trace (of a matrix) ⟨/⟩ `\trace` A 👁 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 `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 $\mathcal{M}$.
	⟨/⟩ `\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})`   👁 $\exp_p\!\left(\dfrac{X}{2}\right)$

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.[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})   👁 $\gamma_{\widehat{p,q}}\left(\dfrac{t}{2}\right)$

‹/› \geodesic<p>{p}{X}   👁 $\gamma_{p,X}$

‹/› \geodesic<p>{p}{X}(t)   👁 $\gamma_{p,X}(t)$

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

‹/› \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   👁 $\mathrm{retr}_p^{-1} q$

    ⟨/⟩ `\inverseRetract{p}(q)`   👁 $\mathrm{retr}_p^{-1}(q)$

    ⟨/⟩ `\inverseRetract[Big]{p}(q)`   👁 $\mathrm{retr}_p^{-1}\Big(q\Big)$

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 parentheses 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]`   👁 $\mathrm{P}_{q\leftarrow p}^c(X)$

    ⟨/⟩ `\parallelTransport{p}{q}[c]`   👁 $\mathrm{P}_{q\leftarrow p}^c$

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 th 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)` 👁 $P_{p,Y}\big(X\big)$

</> `\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` 👁 $\mathrm{retr}_p X$

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

</> `\retract[Big]{p}(\frac{X}{2})` 👁 $\mathrm{retr}_p\left(\dfrac{X}{2}\right)$

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 parentheses 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]`   👁 $\left(\dfrac{1}{2}X_1\,,\,X_2\right)_p$

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.[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]`   👁 $\left\|\dfrac{1}{2}X\right\|_p$

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}`   👁 $\mathrm{D}^2_{X,Y}T$

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 parentheses 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]   👁 $\mathrm{T}_{p,Y}^{\mathrm{retr}}(X)$

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.[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 parentheses 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 parentheses 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 parentheses 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}   👁 $\mathcal{T}_A\big(x^2\big)$