oststud — OST-Stud Style and Macros*

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Contents

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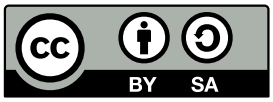

*This document corresponds to oststud v0.4, last revised 2023/05/20.

1 Purpose of this Package

This package is made for the OST Studenten organization to provide an easy to use interface that gives a more consistent look and feel to the works produced by its members. This package is the successor after the fusion of the old `hsrstud` package.

2 Package Options

`dontrenew` Do not renew existing LaTeX commands and environments. This is useful when the package is loaded on a document that is already partially written.

`textvecdiff` Disables the "Nabla" or "Del" notation for vector derivatives. Instead the symbols $\boldsymbol{\nabla}, \boldsymbol{\nabla}\cdot, \boldsymbol{\nabla}\times, \nabla^2, \boldsymbol{\nabla}^2$ are be replaced with grad, div, curl and div grad.

`bfemph` Change the behaviour of `\emph` to use a bold font for emphasis (instead of italics). This option cannot be used together with the `dontrenew` option.

`bbprobability` Use blackboard symbols $\mathbb{P}$, $\mathbb{E}$ and $\mathbb{V}$ instead of Pr, E and Var for the probability, expectation and variance respectively.

`scrtransforms` *Work in progress.*

3 Usage

3.1 Vectors and Vector Calculus

`\vec` `\uvec` In the physics used by electrical engineers it is common to use lowercase bold letters for vectors (with the exception of electromagnetic fields $\mathbf{E}, \mathbf{B}, \mathbf{A}, \ldots$). If the `dontrenew` option is set a new macro `\bvec` (bold `\vec`) that takes a `{`⟨*symbol*⟩`}` defines the bold vector notation. Otherwise the default vector notation with the tiny ugly arrow ($\vec{u}$) is replaced by bold and the arrow notation saved in `\oldvec`. In vector calculus it is common to denote unit vectors by putting a hat, so there is a macro `\uvec` that does just that:

$$\hat{\mathbf{u}} = \mathbf{u}/u.$$

`\dotp` `\crossp` To differentiate the dot and cross products (between vectors) from normal product between scalars ($a \cdot b$ and $a \times b$), the macros `\dotp` and `\crossp` provide a bold variant:

```
\vec{u} \dotp \vec{v},        \vec{u} \crossp \vec{v}
```

$$\mathbf{u}\cdot\mathbf{v}, \qquad \mathbf{u}\times\mathbf{v}.$$

`\grad` `\div` `\curl` The macros `\grad`, `\div` and `\curl` provide symbols for the gradient, divergence and curl operators used in vector calculus. If the option `textvecdiff` is set, they symbols are written as words, otherwise they will he written (ab)using the Nabla symbol, i.e. by pretending that the symbol $\boldsymbol{\nabla}$ is a "vector" (sometime referred to as "del") of partial derivates: $\boldsymbol{\nabla} = (\partial_x, \partial_y, \partial_z)^\mathsf{T}$. Unless the option

`dontrenew` is set, the division symbol is replaced by the divergence and the symbol ÷ is saved in `\divsymb`. For a scalar field ϕ or a vector field $\mathbf{F}$ the notation (in order) of the gradient, divergence and curl appear as follows:

```
\grad \phi,    \div \vec{F},    \curl \vec{F}
```

$$\boldsymbol{\nabla}\,\phi, \quad \boldsymbol{\nabla}\cdot\mathbf{F}, \quad \boldsymbol{\nabla}\times\mathbf{F}.$$

`\laplacian` `\vlaplacian` Continuing with the (ab)use of the "Nabla" or "Del" notation, the there is a macro `\laplacian` for the Laplacian operator

```
\laplacian \equiv \div \grad \equiv \sum_i \partial^2_i
```

$$\nabla^2 \equiv \boldsymbol{\nabla}\cdot\boldsymbol{\nabla} \equiv \sum_i \partial_i^2.$$

Notice that the Nabla symbol is not bold, that is because the Laplacian operator results in a scalar value. Though, sometimes in electrodynamics the vector Laplacian is used (which applies the Laplacian operator to each component). To differentiate the two there is a macro `\vlaplacian` which uses the bold nabla symbol: $\boldsymbol{\nabla}^2$. If the option `dontrenew` is set both symbols are replaced by div grad.

3.2 Linear Algebra

`\mx` Similarly to vectors it is common to write matrices as uppercase bold letters, thus the `\mx` macro takes a `{`⟨*symbol*⟩`}` and typesets it as upright bold.

`\mt` `\mh` The "normal" and Hermitian (complex conjugate) transpose of a matrix $\mathbf{F}$ are denoted by a superscript sans-serif T or H respectively ($\mathbf{F}^{\mathsf{T}}$ resp. $\mathbf{F}^{\mathsf{H}}$). The `\mt` and `\mh` macros (matrix transpose and Hermitian transpose) provide this notation; They both take a `{`⟨*symbol*⟩`}`. In abstract vector spaces the Hermitian transpose becomes the adjoint, for which it is common to use a superscript dagger (adjoint of $\mathcal{Q}$ is $\mathcal{Q}^\dagger$), but since it does not come up very often this package does *not* provide a macro for the adjoint.

`\minv` Another common matrix operation that is annoying to write is the matrix inverse, which is usually written as a superscript -1. The `\minv` command takes a `{`⟨*matrix*⟩`}` and adds the -1 superscript.

Using all of the above we can typeset the matrix form of the linear least squares approximation by writing

```
\vec{a} = \minv{(\mt{\mx{Q}} \mx{Q})} \mt{\mx{Q}}\vec{y}
```

which results in the following:

$$\mathbf{a} = \left(\mathbf{Q}^{\mathsf{T}}\mathbf{Q}\right)^{-1}\mathbf{Q}^{\mathsf{T}}\mathbf{y} \iff \underset{(a_1,a_2)}{\arg\min}\left(\sum_{i=0}^{n} y_i - a_1 x_i + a_2\right).$$

`\tr` This package also provides a macro for the trace of a matrix.

3.3 Mathematical Programming

`\argmin` `\argmax` *Work in progress.*

3.4 Complex Numbers

\Re
\Im

AMS maths's default notation for the real and imaginary parts of a complex number use the Fraktur font capital letters $\mathfrak{R}$ and $\mathfrak{I}$. However, in engineering it is more common to see the notation $\operatorname{Re}\{z\}$ and $\operatorname{Im}\{z\}$, thus, unless the `dontrenew` option is set this package replaces the notation with the former symbols. Both of the macros were also modified to take an argument `{`⟨*expression*⟩`}`, to surround the expression with opening and closing curly brackets.

3.5 Probability Operators

\Pr
\E
\Var

Since according to quantum mechanics it seems that ultimately the universe can only be described using probabilities there are the operators `\Pr`, `\E` and `\Var` for the probability, expectation and variance respectively. If the `dontrenew` option is set, the probability is defined in the csname `\P`.

All three operators take an argument `{`⟨*expression*⟩`}` which is automatically surrounded using curly braces. If the expression contains multiple random variables, to disambiguate with respect to which variable the operation is being taken it is possible to specify an optional argument `[`⟨*rv*⟩`]`. An example:

```
\E[x]{g(x)} = \int_\mathcal{X} g(\bar{x}) p_x(\bar{x}) \, d\bar{x}
```

$$\mathop{\mathrm{E}}_{x}\{g(x)\} = \int_{\mathcal{X}} g(\bar{x}) p_x(\bar{x})\, d\bar{x}.$$

Because some people like to use the blackboard font for the probability operators (such as in the machine learning community), there is an option `bbprobability` that changes the look of the three operators to $\mathbb{P}$, $\mathbb{E}$ and $\mathbb{V}$.

3.6 Transformation Operators

\corresponds
\rcorresponds

When working with transformations it is common to use the "correspondence symbol" show below for example with the Laplace transformation:

```
\laplace\{f(t)\} = F(s) \corresponds f(t) \rcorresponds F(s)
```

$$\mathcal{L}\{f(t)\} = F(s) \circ\!\!-\!\!\bullet\, f(t) \,\bullet\!\!-\!\!\circ F(s)$$

\fourier
\ifourier
\laplace
\ilaplace
\ztransf
\iztransf
\hilbert

As shown in the example above the for the Laplace transform operator symbol there is a macro `\laplace`. Similar operators are also defined for other transformations and their inverses. Here is their usual definition:

$$\mathcal{F}\{f(t)\}(\omega) = \frac{1}{\sqrt{2\pi}} \int_{\mathbb{R}} f(t) e^{-i\omega t}\, dt, \quad \mathcal{F}^{-1}\{F(\omega)\}(t) = \frac{1}{\sqrt{2\pi}} \int_{\mathbb{R}} F(\omega) e^{i\omega t}\, d\omega,$$

$$\mathcal{L}\{f(t)\}(s) = \int_{\mathbb{R}^+} f(t) e^{-st}\, dt, \qquad \mathcal{L}^{-1}\{F(s)\}(t) = \frac{1}{2\pi i} \int_{\gamma+i\mathbb{R}} F(s) e^{st}\, ds,$$

$$\mathcal{Z}\{f_k\}(z) = \sum_{k\in\mathbb{Z}^+} f_k z^{-k}, \qquad \mathcal{Z}^{-1}\{F(z)\}(k) = \frac{1}{2\pi i} \oint_C F(z) z^{k-1}\, dz,$$

$$\mathcal{H}\{f(t)\}(\tau) = \mathrm{P.V.}\frac{1}{\pi} \int_{\mathbb{R}} \frac{f(t)}{\tau - t}\, dt,$$

in order they are the Fourier transform (`\fourier`, `\ifourier`), the Laplace transform (`\laplace`, `\ilaplace`), the Z-transform (`\ztransf`, `\iztransf`), and the Hilbert transform (`\hilbert`). The Hilbert has no inverse since $-\mathcal{H}\,\mathcal{H}\,f(t) = f(t)$, tough of course one could write `\hilbert^{-1}` to get $\mathcal{H}^{-1}$.

3.7 References

Work in progress.

3.8 OST Colors

The official OST color palette provides the following "primary" or "accent" colors.

OSTBlack OSTGray OSTBlackberry OSTRaspberry

And then there are the other "design colors".

OSTDarkOrange	OSTOrange	OSTLightOrange
OSTDarkRed	OSTRed	OSTLightRed
OSTDarkPurple	OSTPurple	OSTLightPurple
OSTDarkBlue	OSTBlue	OSTLightBlue
OSTDarkGreen	OSTGreen	OSTLightGreen

3.9 Sane Defaults

Work in progress.

4 Implementation

4.1 Dependencies and Parse Options

First, we have the dependencies necessary for typesetting.

```
\RequirePackage{xcolor}
\RequirePackage{amsmath}
\RequirePackage{amssymb}
\RequirePackage{bm}
```

This package also sets sane defaults to the following packages.

```
\RequirePackage{hyperref}
\RequirePackage{listings}
```

Then we create the options for the package.

```
\SetupKeyvalOptions{
    family=ost,
    prefix=ost@
}
\DeclareBoolOption[false]{dontrenew}
\DeclareBoolOption[false]{textvecdiff}
\DeclareBoolOption[false]{bfemph}
\DeclareBoolOption[false]{bbprobability}
% \DeclareBoolOption[false]{scrtransforms}
\ProcessLocalKeyvalOptions*
```

4.2 Bold emphasis

`\emph` Change the behaviour of `\emph`.

```
\ifost@bfemph
    \ifost@dontrenew
        \PackageError{The options \noexpand\dontrenew and \noexpand\bfemph cannot be used at
    \fi
    \long\expandafter\def\csname em \endcsname{%
        \@nomath\em
        \if b\expandafter\@car\f@series\@nil
            \itshape\else\bfseries\fi
    }
\fi
```

4.3 Vectors and Vector Calculus

`\vec` Set up bold notation for vectors.

```
\newcommand{\ost@vec}[1]{\mathbf{\bm{#1}}}
\ifost@dontrenew
    \newcommand{\bvec}[1]{\ost@vec{#1}}
\else
    \let\oldvec\vec
    \renewcommand{\vec}[1]{\ost@vec{#1}}
\fi
```

`\uvec` In vector calculus unit vectors are usually denoted by a hat.

```
\newcommand{\uvec}[1]{\vec{\hat{#1}}}
```

`\dotp` To differentiate them from `\cdot` and `\times` which are for scalars.

`\crossp`

```
\DeclareMathOperator{\dotp}{\boldsymbol\cdot}
\DeclareMathOperator{\crossp}{\boldsymbol\times}
```

`\grad` Gradient of a vector valued scalar functon.

```
\ifost@textvecdiff
    \DeclareMathOperator{\grad}{grad}
\else
    \DeclareMathOperator{\grad}{\vec{\nabla}}
\fi
```

`\div` Divergence operator. If the option `dontrenew` is a new macro `\divg` is defined. Otherwise `\div` is renamed to `\divsymb`.

```
\ifost@textvecdiff
    \DeclareMathOperator{\ost@div}{div}
\else
    \DeclareMathOperator{\ost@div}{\vec{\nabla}\dotp}
\fi
\ifost@dontrenew
    \DeclareMathOperator{\divg}{\ost@div}
\else
    \let\divsymb\div
    \renewcommand{\div}{\ost@div}
\fi
```

`\curl` Curl of a vector field.

```
\ifost@textvecdiff
    \DeclareMathOperator{\curl}{curl}
\else
    \DeclareMathOperator{\curl}{\vec{\nabla}\crossp}
\fi
```

`\laplacian` Laplacian of a scalar and vector field.
`\vlaplacian`

```
\ifost@textvecdiff
    \DeclareMathOperator{\laplacian}{\div\grad}
    \DeclareMathOperator{\vlaplacian}{\div\grad}
\else
    \DeclareMathOperator{\laplacian}{\nabla^2}
    \DeclareMathOperator{\vlaplacian}{\vec{\nabla}^2}
\fi
```

4.4 Linear Algebra

`\mx` Notation for matrices as bold (uppercase) letters.

```
\newcommand{\mx}[1]{\mathbf{\bm{#1}}}
```

`\mt` Normal and Hermitian (conjugate) transpose of a matrix.
`\mh`

```
\newcommand{\mt}[1]{{#1}^\mathsf{T}}
\newcommand{\mh}[1]{{#1}^\mathsf{H}}
```

`\minv` Matrix inverse.

```
\newcommand{\minv}[1]{{#1}^{-1}}
```

`\tr` Trace of a matrix.

```
\DeclareMathOperator{\tr}{tr}
```

4.5 Mathematical Programming

`\argmin`
`\argmax`

```
\DeclareMathOperator*{\argmax}{arg\,max}
\DeclareMathOperator*{\argmin}{arg\,min}
```

4.6 Complex Numbers

\Re \Im Replace the real and imaginary operators to look "normal", that is not using the Fraktur fonts.

```
\ifost@dontrenew\else
    \let\oldRe\Re \let\oldIm\Im
    \renewcommand{\Re}[1]{\mathrm{Re} \left\{#1\right\}}
    \renewcommand{\Im}[1]{\mathrm{Im} \left\{#1\right\}}
\fi
```

4.7 Probability Operators

\E Expectation of a random variable.

```
\ifost@bbprobability
    \DeclareMathOperator*{\ost@expectation}{\mathbb{E}}
\else
    \DeclareMathOperator*{\ost@expectation}{E}
\fi
\newcommand*{\E}[2][]{\ost@expectation_{#1}\left\{#2\right\}}
```

\Var Variance of a random variable.

```
\ifost@bbprobability
    \DeclareMathOperator*{\ost@variance}{\mathbb{V}}
\else
    \DeclareMathOperator*{\ost@variance}{Var}
\fi
\newcommand*{\Var}[2][]{\ost@variance_{#1}\left\{#2\right\}}
```

\Pr Probability operator.

```
\ifost@bbprobability
    \DeclareMathOperator*{\ost@probability}{\mathbb{P}}
\else
    \DeclareMathOperator*{\ost@probability}{Pr}
\fi
\ifost@dontrenew
    \newcommand*{\P}[2][]{\ost@probabiliy_{#1}\left\{#2\right\}}
\else
    \renewcommand*{\P}[2][]{\ost@probabiliy_{#1}\left\{#2\right\}}
\fi
```

4.8 Transformation Operators

\fourier \ifourier Fourier transform and its inverse.

```
\DeclareMathOperator{\fourier}{\mathcal{F}}
\DeclareMathOperator{\ifourier}{\mathcal{F}^{-1}}
```

\laplace \ilaplace Laplace transform and its inverse.

```
\DeclareMathOperator{\laplace}{\mathcal{L}}
\DeclareMathOperator{\ilaplace}{\mathcal{L}^{-1}}
```

\ztransf \iztransf Z-transform and its inverse.

```
\DeclareMathOperator{\ztransf}{\mathcal{Z}}
\DeclareMathOperator{\iztransf}{\mathcal{Z}^{-1}}
```

\hilbert Hilbert transform.

```
\DeclareMathOperator{\hilbert}{\mathcal{H}}
```

\corresponds Correspondence symbols.
\rcorresponds

```
\newcommand{\corresponds}{%
    \mbox{\setlength{\unitlength}{0.1em}%
        \begin{picture}(20,10)%
          \put(5,3){\circle{4}}%
          \put(7,3){\line(1,0){7}}%
          \put(16,3){\circle*{4}}%
        \end{picture}}}
\newcommand{\rcorresponds}{%
    \mbox{\setlength{\unitlength}{0.1em}%
        \begin{picture}(20,10)%
          \put(5,3){\circle*{4}}%
          \put(7,3){\line(1,0){7}}%
          \put(16,3){\circle{4}}%
        \end{picture}}}
```

4.9 References

\skriptum Reference material in the skriptum (lecture notes) of the course.
\sref

```
\newcommand{\ost@skriptum}{\PackageWarning{No \noexpand\skriptum given}}
\newcommand{\skriptum}[1]{\gdef\ost@skriptum{#1}}
\newcommand{\sref}[1]{%
    \texttt{\textcolor{OSTBlackberry}{#1}}\nocite{\ost@skriptum}}
```

\textbook Reference material in the textbook of the course.
\bref

```
\newcommand{\ost@textbook}{\PackageWarning{No \noexpand\textbook given}}
\newcommand{\textbook}[1]{\gdef\ost@textbook{#1}}
\newcommand{\bref}[1]{%
    \texttt{\textcolor{OSTRaspberry}{#1}}\nocite{\ost@textbook}}
```

4.10 OST Colors

Define the colors according to the OST corporate design. The code was kindly stolen from H. Badertscher's `OSTColors.sty` [**?**]. First there are the "primary colors".

```
\definecolor{OSTBlack}{RGB}{25,25,25}
\definecolor{OSTGray}{RGB}{198,198,198}
\definecolor{OSTBlackberry}{RGB}{140,25,95}
\definecolor{OSTRaspberry}{RGB}{215,40,100}
```

Then the "design colors".

```
\definecolor{OSTPurple}{RGB}{149,96,164}
\definecolor{OSTDarkPurple}{RGB}{107,56,129}
\definecolor{OSTLightPurple}{RGB}{208,169,208}
\definecolor{OSTGreen}{RGB}{29,175,142}
\definecolor{OSTDarkGreen}{RGB}{0,126,107}
\definecolor{OSTLightGreen}{RGB}{167,213,194}
\definecolor{OSTRed}{RGB}{232,78,15}
\definecolor{OSTDarkRed}{RGB}{195,46,21}
\definecolor{OSTLightRed}{RGB}{243,154,139}
```

```
\definecolor{OSTBlue}{RGB}{0,134,205}
\definecolor{OSTDarkBlue}{RGB}{0,115,176}
\definecolor{OSTLightBlue}{RGB}{95,191,237}
\definecolor{OSTOrange}{RGB}{251,186,0}
\definecolor{OSTDarkOrange}{RGB}{209,143,0}
\definecolor{OSTLightOrange}{RGB}{253,214,175}
```

4.11 Sane Defaults

First, set up `hyperref` to not look hideous.

```
\hypersetup{
    colorlinks=true,
    linkcolor=OSTBlack,
    citecolor=OSTBlackberry,
    filecolor=OSTBlack,
    urlcolor=OSTDarkBlue,
}
```

Then create a listings style.

```
\lstdefinestyle{ost-base}{
    belowcaptionskip=\baselineskip,
    breaklines=true,
    frame=none,
    inputencoding=utf8,
    % margin
    xleftmargin=\parindent,
    % numbers
    numbers=left,
    numbersep=5pt,
    numberstyle=\ttfamily\footnotesize\color{OSTGray},
    % background
    backgroundcolor=\color{white},
    showstringspaces=false,
    % default language
    language=TeX,
    % break long lines, and show an arrow where the line was broken
    breaklines=true,
    postbreak=\mbox{\textcolor{OSTDarkBlue}{$\hookrightarrow$}\space},
    % font
    basicstyle=\ttfamily\small,
    identifierstyle=\color{OSTBlack},
    keywordstyle=\color{OSTBlue},
    commentstyle=\color{OSTGray},
    stringstyle=\color{OSTBlackberry},
}
```

Then we set this style to be default.

```
\lstset{style=ost-base, escapechar=`}
```

Change History

Index

Numbers written in italic refer to the page where the corresponding entry is described; numbers underlined refer to the code line of the definition; numbers in roman refer to the code lines where the entry is used.