

[illegible]
$$\begin{array}{c} abc\overline{X}abc \\ \xrightarrow{W}, \quad \xleftarrow{Q}, \end{array}$$
$$X \quad XY \quad \tilde{x} \quad \tilde{i}$$

```

\ttfamily\small\meaning\overrightarrow

\long macro:->\mathpalette {\overarrow@ \rightarrowfill@ }

\makeatletter
\ttfamily\small\meaning\overarrow@
\makeatother

macro:#1#2#3->\vbox {\ialign {##\cr cr #1#2\cr cr \noalign {\nointerlineskip }$m@th \hfil #2#3\hfil $\cr cr }}

\makeatletter
\ttfamily\small\meaning\rightarrowfill@
\makeatother

macro:->\arrowfill@ \relbar \relbar \rightarrow

\makeatletter
\ttfamily\small\meaning\arrowfill@
\makeatother

macro:#1#2#3#4->{$m@th \thickmuskip 0mu\medmuskip \thickmuskip \thinmuskip \thickmuskip \relax #4#1\mkern -7mu\cleaders
\hbox {$#4\mkern -2mu#2\mkern -2mu$}\hfil \mkern -7mu#3$

```

Make `cmvec.sty` available to your \LaTeX installation. A simple way to do this is to copy `cmvec.sty` into the same directory as your source \LaTeX document. Then, add the following to your preamble:

```
\usepackage{cmvec}
```

The `cmvec` package provides a number of macros, but mostly, there are only two that you will need:

1. `\CMIndexedSymbol[arrowtype]{macroname}{symbol}`
2. `\CMSuperIndexedSymbol[arrowtype]{macroname}{symbol}{superscript}`

Each of these macros defines a macro `\macroname` that supports left, right, and leftright vector symbols and also provides Python-like indexing. These commands can be used anywhere in the document, but typically, one should declare them just once in the preamble. Valid arrowtypes are: `arrow` and `harpoon`; the default value is `harpoon`. The macro that is defined by this command supports the following syntax:

```
\macroname(direction)[start][end]
```

All three options (`direction`), `[start]` `[end]` are optional. Valid directions are `<`, `>`, `<>` for left, right, and leftright directions. This is best explained through example:

```
% Define the indexed symbol
\CMIndexedSymbol{harpoon}{MS}{X}

% Now use it
$\begin{matrix*}[l]
\MS & \MS[0] & \MS[0][L] & \MS[] [L] & \MS[L] [] \backslash \\
\MS(<) & \MS(>) & \MS(<>) & \MS(<)[0] & \MS(<>)[t] \\
\end{matrix*}$
```

$$\begin{matrix} X & X & X_L & X_L & X \\ \vec{X} & \vec{X} & \vec{X} & \vec{X}_0 & \vec{X}_t \end{matrix}$$

Note that practically one will choose to use the indexing notation (as in $X_{a:b}$) or the vector notation, but not both (with exception to adding a time index for a semi-infinite sequence).

Suppose you plan on indexing both X and Y , then you define both:

```
\CMIndexedSymbol{MSi}{X} % input
\CMIndexedSymbol{MSo}{Y} % output
$\lim_{L \to \infty} I[\MSi[0][L] : \MSo[0][L] ] \stackrel{?}{=} I[\MSi(<)[t] : \MSo(>)[t]]$
```

$$\lim_{L \rightarrow \infty} I[X_L : Y_L] \stackrel{?}{=} I[\vec{X}_t : \vec{Y}_t]$$

It may also be helpful to freeze arrow directions to certain macro names:

```
\CMIndexedSymbol{MS}{X}
\CMIndexedSymbol{ms}{x}
\newcommand{\Past}{\MS(<)}
\newcommand{\past}{\ms(<)}
\newcommand{\Future}{\MS(>)}
\newcommand{\future}{\ms(>)}
\begin{align*}
\Past[0] & \&= \cdots \MS[-3] \MS[-2] \MS[-1] & \\
\Future[0] & \&= \MS[0] \MS[1] \MS[2] \cdots \backslash \\
\past[0] & \&= \cdots \ms[-3] \ms[-2] \ms[-1] & \\
\future[0] & \&= \ms[0] \ms[1] \ms[2] \cdots \backslash \\
\end{align*}
```

$$\begin{aligned} \vec{X}_0 &= \cdots XXX \\ \vec{x}_0 &= \cdots xxx \end{aligned}$$

$$\begin{aligned} \vec{X}_0 &= XXX \cdots \\ \vec{x}_0 &= xxx \cdots \end{aligned}$$

That's pretty much it.

The package defines a number of other lower-level commands that *might* be of more general use, but probably not. These are described now.

- Proper argmin and argmax:

```
\begin{align*}
&\&\arg\min_x (2x^2 - 3x + 5) \\\
&\&\argmin_x (2x^2 - 3x + 5)
\end{align*}
```

$$\arg \min_x (2x^2 - 3x + 5)$$

$$\argmin_x (2x^2 - 3x + 5)$$

- For summations with wide subscripts...

```
\begin{align*}
A &= \sum_{i, j \in B_{ij}} X_i^j \\
A &= \sum_{\mathclap{i, j \in B_{ij}}} X_i
\end{align*}
```

$$A = \sum_{i, j \in B_{ij}} X_i^j$$

$$A = \sum_{i, j \in B_{ij}} X_i$$

- When you want to center math within a box whose width is specified by other math.

```
$aaabbbccc$\
$aaa\phantomword[c]{bbb}{0}ccc$
```

aaabbbccc
aaa Q ccc

- A customizable vector symbol. Macros should use this.

```
\CMvector[symbol=\leftarrow]{X} \quad
\CMvector[symbol=\leftarrow, pre=\Large\textcolor{red}, l]{X} \quad
\CMvector[symbol=\leftarrow, post=*]{X} \quad
\CMvector[symbol=\leftarrow, raise=1.8]{X}
```

\vec{X} $\overset{\textcolor{red}{\leftarrow}}{X}$ \vec{X}^* $\overset{\leftarrow}{X}$

- Although `\leftharpoonup` and `\rightharpoonup` exist, there is no left-right harpoon. Here is a customized version that combines the ones that do exist. The spacing is hardcoded and probably will only look good with certain fonts.

```
$\leftharpoonup \: \leftrightharpoonup \: \rightharpoonup$
```

\leftharpoonup \leftrightharpoonup \rightharpoonup

- Convenience functions that use `\CMvector`.

```
\CMLarrow{X} \: \CMLrarrow{X} \: \CMrarrow{X} \\\
\CMLharpoon{X} \: \CMLrharpoon{X} \: \CMrharpoon{X} \\\
```

\vec{X} \vec{X} \vec{X}
 \vec{X} \vec{X} \vec{X}

- A macro that defines specialized vector symbols that make use of Python index notation and has clean support for the vector direction, depending on what notation you want to use.

```
\CMIndexedSymbol{MS}{X}
\[\begin{matrix}
\MS & & \MS[3] & & \MS[3][5] & & \MS[][5] & & \MS[5][] & & \\
\MS(<) & & \MS(<)[3] & & \MS(<)[3][5] & & \MS(<)[][5] & & \MS(<)[5][] & & \\
\MS(>) & & \MS(>)[3] & & \MS(>)[3][5] & & \MS(>)[][5] & & \MS(>)[5][] & & \\
\MS(<>) & & \MS(<>)[3] & & \MS(<>)[3][5] & & \MS(<>)[][5] & & \MS(<>)[5][] & & \\
\end{matrix}\]

\CMIndexedSymbol[arrow]{MS}{X}
\[\begin{matrix}
\MS & & \MS[3] & & \MS[3][5] & & \MS[][5] & & \MS[5][] & & \\
\MS(<) & & \MS(<)[3] & & \MS(<)[3][5] & & \MS(<)[][5] & & \MS(<)[5][] & & \\
\MS(>) & & \MS(>)[3] & & \MS(>)[3][5] & & \MS(>)[][5] & & \MS(>)[5][] & & \\
\MS(<>) & & \MS(<>)[3] & & \MS(<>)[3][5] & & \MS(<>)[][5] & & \MS(<>)[5][] & & \\
\end{matrix}\]
```

$$\begin{array}{ccccc}
\vec{X} & \vec{X} & \vec{X}_5 & \vec{X}_5 & \vec{X} \\
\vec{X} & \vec{X}_3 & \vec{X}_{3:5} & \vec{X}_{:5} & \vec{X}_{5:} \\
\vec{X} & \vec{X}_3 & \vec{X}_{3:5} & \vec{X}_{:5} & \vec{X}_{5:} \\
\vec{X} & \vec{X}_3 & \vec{X}_{3:5} & \vec{X}_{:5} & \vec{X}_{5:}
\end{array}$$

- Typically, you'll want to set up a few of these for regular use:

```
% Put this in preamble somewhere
\CMIndexedSymbol[harpoon]{MS}{X}
\CMIndexedSymbol[harpoon]{ms}{x}
\CMSuperIndexedSymbol[arrow]{FCS}{S}{+}

% Some familiar commands
\newcommand{\BiInfinity}{\MS(<>)}
\newcommand{\biinfinity}{\ms(<>)}
\newcommand{\Past}{\MS(<)}
\newcommand{\past}{\ms(<)}
\newcommand{\Future}{\MS(>)}
\newcommand{\future}{\ms(>)}

% Now we can use them
\begin{displaymath}
\begin{matrix}
\BiInfinity & \biinfinity & \Past & \past & \Future & \future \\
\FCS[0] & \FCS(>)[3] & \MS[0][3] & \past[3] & \MS(<>)[3] & \Future[3]
\end{matrix}
\end{displaymath}
```

$$\begin{array}{ccccc}
\vec{X} & \vec{x} & \vec{X} & \vec{x} & \vec{X} & \vec{x} \\
S_0^+ & \vec{S}_3^+ & X_3 & \vec{x}_3 & \vec{X}_3 & \vec{x}_3
\end{array}$$

- Notation for single symbol, range of symbols. Two different options for semi-infinite sequences. If you might be using bi-infinite sequences, it is recommended you use the second option for semi-infinite sequences.

```

\CMIndexedSymbol[harpoon]{MS}{X}
\begin{align*}
\MS      & \&\& \text{symbol}\\
\MS[t]    & \&\& \text{symbol at time } t\\
\MS[-1][3] & \&\& \MS[-1] \MS[0] \MS[1] \MS[2]\\
& \&\& \\
\MS[][3]   & \&\& \cdots \MS[0] \MS[1] \MS[2] \\
\MS[3][]   & \&\& \MS[3] \MS[4] \MS[5] \cdots \\
& \&\& \\
\MS(<)[3]  & \&\& \cdots \MS[0] \MS[1] \MS[2] \\
\MS(>)[3]  & \&\& \MS[3] \MS[4] \MS[5] \cdots \\
\MS(<>)[3] & \&\& \MS(<)[3] \MS(>)[3]
\end{align*}

```

| | |
|-----------------------|--|
| X | symbol |
| X | symbol at time t |
| X_3 | $XXXX$ |
| X_3 | $\cdots XXX$ |
| X | $XXX \cdots$ |
| \tilde{X}_3 | $\cdots XXX$ |
| \vec{X}_3 | $XXX \cdots$ |
| \overleftarrow{X}_3 | $\overleftarrow{X}_3 \overrightarrow{X}_3$ |