

Make `cmvec.sty` available to your L^AT_EX installation. A simple way to do this is to copy `cmvec.sty` into the same directory as your source L^AT_EX 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
$\begin{matrix*}[l]
\MS & \MS[0] & \MS[0][L] & \MS[] [L] & \MS[L] [] \\\
\MS(<) & \MS(>) & \MS(<>) & \MS(<)[0] & \MS(<>)[t] \\
\end{matrix*}$
```

$$\begin{array}{ccccc} X & X_0 & X_{0:L} & X_{:L} & X_L \\ \bar{X} & \bar{X} & \bar{X} & \bar{X}_0 & \bar{X}_t \end{array}$$

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
$\lim_{L \rightarrow \infty} I[X_{0:L} : Y_{0:L}] \stackrel{?}{=} I[\bar{X}_t : \bar{Y}_t]$
```

$$\lim_{L \rightarrow \infty} I[X_{0:L} : Y_{0:L}] \stackrel{?}{=} I[\bar{X}_t : \bar{Y}_t]$$

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 \\
\past[0] & \&= \cdots \ms[-3] \ms[-2] \ms[-1] & \\
\future[0] & \&= \ms[0] \ms[1] \ms[2] \cdots \\
\end{align*}
```

$$\begin{aligned} \bar{X}_0 &= \cdots X_{-3} X_{-2} X_{-1} \\ \bar{x}_0 &= \cdots x_{-3} x_{-2} x_{-1} \end{aligned}$$

$$\begin{aligned} \vec{X}_0 &= X_0 X_1 X_2 \cdots \\ \vec{x}_0 &= x_0 x_1 x_2 \cdots \end{aligned}$$

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.

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

aaabbbccc
aaa Q ccc

- A customizable vector symbol. Macros should use this.

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

\vec{X} \overleftarrow{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} \\\
```

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

$$\begin{array}{ccccc}
X & X_3 & X_{3:5} & X_{:5} & X_{5:} \\
\overrightarrow{X} & \overrightarrow{X}_3 & \overrightarrow{X}_{3:5} & \overrightarrow{X}_{:5} & \overrightarrow{X}_{5:} \\
\overleftarrow{X} & \overleftarrow{X}_3 & \overleftarrow{X}_{3:5} & \overleftarrow{X}_{:5} & \overleftarrow{X}_{5:} \\
\overleftrightarrow{X} & \overleftrightarrow{X}_3 & \overleftrightarrow{X}_{3:5} & \overleftrightarrow{X}_{:5} & \overleftrightarrow{X}_{5:}
\end{array}$$

- 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}
```

$$\begin{array}{ccccc}
\overleftarrow{X} & \overleftarrow{x} & \overleftarrow{X} & \overleftarrow{x} & \overleftarrow{X} & \overleftarrow{x} \\
S_0^+ & \vec{S}_3^+ & X_{0:3} & \vec{x}_3 & \vec{X}_3 & \vec{x}_3
\end{array}$$

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

```

X	symbol
X_t	symbol at time t
$X_{-1:3}$	$X_{-1}X_0X_1X_2$
$X_{:3}$	$\cdots X_0X_1X_2$
$X_{3:}$	$X_3X_4X_5\cdots$
\bar{X}_3	$\cdots X_0X_1X_2$
\vec{X}_3	$X_3X_4X_5\cdots$
\overleftrightarrow{X}_3	$\bar{X}_3\bar{X}_3$