Information and Inference: A Journal of the IMA (2021) **00**, 1–7
https://doi.org/DOI HERE

Math in LaTeX

FIRST AUTHOR*
Department, Organization, Street, Postcode, State, Country
*Corresponding author. email-id.com

[Received on Date Month Year; revised on Date Month Year; accepted on Date Month Year]

Abstracts must be able to stand alone and so cannot contain citations to the paper's references, equations, etc. An abstract must consist of a single paragraph and be concise. Because of online formatting, abstracts must appear as plain as possible.

Keywords: keyword1; Keyword2; Keyword3; Keyword4.

1. Introduction

There are two major modes for typesetting math in LaTeX — one is embedding the math directly into your text by encapsulating your formula either using single dollar signs — `$...$` or by enclosing the inline math with the following symbol `\(...\)` and the other is using a predefined math environment. This file provide basic samples for inline and display math equations. However, for detailed explanation, you are requested to refer "amsmath" package documentation.

2. Inline math examples

LaTeX needs to know when text is mathematical. This is because LaTeX typesets maths a_b^2 notation differently $[a+b]^2$ from normal text. Therefore, special $\sqrt{x^2+y^2}$ environments have been declared for this purpose.

3. Display math examples

3.1. *Default math environments*

The `\begin{equation}...\end{equation}` environment is used for numbered single line equations:

$$\mathbf{P} = \lim_{\Delta v \to 0} \varepsilon \left[\frac{1}{\Delta v} \sum_{i=1}^{N_e \Delta v} d\mathbf{p}_i \right] = N_e d\mathbf{p}_{\text{av}} \tag{3.1}$$

The `\begin{equation*}...\end{equation*}` environment is used for unnumbered single line equations:

$$L_s = \mu_1 h = \mu_1 = \frac{BW}{\omega_o \sqrt{\mu_2 \varepsilon_2}} = \frac{\mu_1}{\sqrt{\mu_2 \varepsilon_2}}$$

3.2. *amsmath package — math environments*

The `\begin{align}...\end{align}` environment is used for two or more equations when vertical alignment is desired; usually binary relations such as equal signs are aligned. To have several equation columns side-by-side, use extra ampersands to separate the columns. You can suppress the

number on any particular line by putting \notag before the end of that line; \notag should not be used outside a display environment as it will mess up the numbering. You can also override a number with a tag of your own by using \tag{<label>}, where <label> means arbitrary text such as * or \dag used to 'number' the equation:

$$\begin{aligned} z &= x+y & z &= x+y \\ &= z+y & x &= z+y \end{aligned} \tag{3.2}$$

$$\begin{aligned} a &= b+c & a &= b+c \\ &= z+y & x &= z+y \end{aligned} \tag{*}$$

$$\begin{aligned} b &= b+c & a &= b+c \end{aligned} \tag{†}$$

$$\begin{aligned} c &= b+c & a &= b+c \end{aligned} \tag{‡}$$

The \begin{align*}...\end{align*} environment is used for unnumbered math environments:

$$\begin{aligned} z &= x+y & z &= x+y \\ a &= b+c & a &= b+c \end{aligned}$$

The gather environment is used for a group of consecutive equations when there is no alignment desired among them; each one is centered separately within the text width. Equations inside gather are separated by a \\ command.

$$\begin{gathered} (a+b)^2 = a^2+2ab+b^2 \\ a_2 = b_2+c_2-d_2+e_2 \end{gathered} \tag{3.3}$$

The gather* environment is used for a group of consecutive unnumbered equations for which no alignment is required.

$$\begin{gathered} (a+b)^2 = a^2+2ab+b^2 \\ a_2 = b_2+c_2-d_2+e_2 \end{gathered}$$

A variant environment \begin{alignat}...\end{alignat} allows the horizontal space between equations to be explicitly specified. This environment takes one argument, the number of "equation columns" (the number of pairs of right-left aligned columns; the argument is the number of pairs): count the maximum number of &s in any row, add 1 and divide by 2

$$\begin{aligned} x &= y_1-y_2+y_3-y_5+y_8-\ldots && \text{by Axiom 1.} \\ &= y'\circ y^* && \text{by Axiom 2.} \\ &= y(0)y' && \text{by Axiom 3.} \end{aligned} \tag{3.4}$$

The \begin{alignat*}...\end{alignat*} is available for setting unnumbered equation with the above preferences.

$$\begin{aligned} x &= y_1-y_2+y_3-y_5+y_8-\ldots && \text{by Axiom 1.} \\ &= y'\circ y^* && \text{by Axiom 2.} \\ &= y(0)y' && \text{by Axiom 3.} \end{aligned}$$

The `aligned` environment inside `equation` environment can be used to produce the below equation: `\begin{equation}\begin{aligned}...\end{aligned}\end{equation}`

$$\left.\begin{aligned} B' &= -\partial \times E, \\ &= -\partial \times Z, \\ E' &= \partial \times B - 4\pi j, \end{aligned}\right\} \quad \text{Maxwell's equations} \tag{3.5}$$

Example for `aligned` environment inside `equation*` environment: `\begin{equation*}` `\begin{aligned}...\end{aligned}\end{equation*}`

$$\left.\begin{aligned} B' &= -\partial \times E, \\ &= -\partial \times Z, \\ E' &= \partial \times B - 4\pi j, \end{aligned}\right\} \quad \text{Maxwell's equations}$$

The `subarray` environment can be used to produce centered multiline subscript or superscript — `\begin{subarray}{c}. . .\end{subarray}`

$$\sum_{\substack{i\in\Lambda \\ 0<j<n}} P(i,j) = \partial \times B - 4\pi j, \tag{3.6}$$

Example for `subarray` with left aligned multiline subscript inside `equation` — `\begin{subarray}{l}...\end{subarray}`

$$\sum_{\substack{i\in\Lambda \\ 0<j<n}} P(i,j) = \partial \times B - 4\pi j, \tag{3.7}$$

The environment flalign ("full length alignment") stretches the space between the equation columns to the maximum possible width, leaving only enough space at the margin for the equation number, if present.

$$a_{11} = b_{11} \qquad a_{12} = b_{12}$$
$$a_{21} = b_{21} \qquad a_{22} = b_{22} + c_{22} \tag{3.8}$$
$$= b_{21} \qquad a_{22} = b_{22} + c_{22} \tag{3.9}$$

Example for `\begin{flalign*}...\end{flalign*}` environment.

$$a_{11} = b_{11} \qquad a_{12} = b_{12}$$
$$a_{21} = b_{21} \qquad a_{22} = b_{22} + c_{22}$$
$$= b_{21} \qquad a_{22} = b_{22} + c_{22}$$

The `multline` environment is a variation of the equation environment used for equations that don't fit on a single line. The first line of a multline will be at the left margin and the last line at the

right margin. Any additional lines in between will be centered independently within the display width `\begin{multline}...\end{multline}`

$$\begin{multline} a+b+c+d+e+f \\ a+b+c+d+e+f \\ a+b+c+d+e+f \\ +i+j+k+l+m+n \end{multline} \tag{3.10}$$

The `multline*` environment

$$\begin{multline*} a+b+c+d+e+f \\ a+b+c+d+e+f \\ a+b+c+d+e+f \\ +i+j+k+l+m+n \end{multline*}$$

For cases like constructions, `\begin{cases}...\end{cases}` inside `equation` environment can be used.

$$P_{r-j} = \begin{cases} 0 & \text{if } r-j \text{ is odd,} \\ r!\,(-1)^{(r-j)/2} & \text{if } r-j \text{ is even.} \end{cases} \tag{3.11}$$

For unnumbered cases like constructions, `\begin{cases}...\end{cases}` inside `equation*` environment can be used.

$$P_{r-j} = \begin{cases} 0 & \text{if } r-j \text{ is odd,} \\ r!\,(-1)^{(r-j)/2} & \text{if } r-j \text{ is even.} \end{cases}$$

3.3. *Matrices*

The amsmath package provides some environments for matrices beyond the basic array environment of LaTeX. The `pmatrix`, `bmatrix`, `Bmatrix`, `vmatrix` and `Vmatrix` have (respectively) `( )`, `[ ]`, `{ }`, `| |`, and `|| ||` delimiters built in. Example for `\begin{pmatrix}...\end{pmatrix}` environment

$$\alpha+\gamma_2 = \begin{pmatrix} 1 & 2-3 & a+b \\ 1 & 2-3 & c+d \\ 1 & 2-3 & c+d \end{pmatrix}$$

Example for `\begin{bmatrix}...\end{bmatrix}` environment

$$\alpha+\gamma_2 = \begin{bmatrix} 1 & 2-3 & a+b \\ 1 & 2-3 & c+d \\ 1 & 2-3 & c+d \end{bmatrix} \tag{3.12}$$

Example for `\begin{Bmatrix}...\end{Bmatrix}` environment

$$\alpha+\gamma_2 = \begin{Bmatrix} 1 & 2-3 & a+b \\ 1 & 2-3 & c+d \\ & 2-3 & c+d \end{Bmatrix}$$

Example for `\begin{vmatrix}...\end{vmatrix}` environment

$$\alpha+\gamma_2=\begin{vmatrix}1 & 2-3 & a+b\\ 1 & 2-3 & c+d\\ 1 & 2-3 & c+d\end{vmatrix}$$

Example for `\begin{Vmatrix}...\end{Vmatrix}` environment

$$\alpha+\gamma_2=\begin{Vmatrix}1 & 2-3 & a+b\\ 1 & 2-3 & c+d\\ 1 & 2-3 & c+d\end{Vmatrix}$$

The wrapper environment `\begin{subequations}...\end{subequations}` can be used along with a particular `align` or similar groups to produce a subordinate numbereing sequence.

$$A_1 = N_0(\lambda;\Omega') - \phi(\lambda;\Omega'),$$
$$A_2 = \phi(\lambda;\Omega') - \phi(\lambda;\Omega), \tag{3.13a}$$
$$A_3 = \mathscr{N}(\lambda;\omega). \tag{3.13b}$$

The `split` environment is for single equations that are too long to fit on one line and hence must be split into multiple lines. The `split` environment provides for alignment among the split lines, using `&` to mark alignment points. Unlike the other amsmath equation structures, the split environment provides no numbering, because it is intended to be used only inside some other displayed equation structure, usually an `equation`, `align`, or `gather` environment, which provides the numbering. For example:

$$\begin{aligned}H_c = \frac{1}{2n}\sum_{l=0}^{n}(-1)^l(n-l)^{p-2}\sum_{l_1+\cdots+l_p=l}\prod_{i=1}^{p}\binom{n_i}{l_i}\\ \cdot\left[(n-l)-(n_i-l_i)\right]^{n_i-l_i}\cdot\left[(n-l)^2-\sum_{j=1}^{p}(n_i-l_i)^2\right].\end{aligned} \tag{3.14}$$

3.4. *Additional math samples*

Integration with side limits - superscript and subscript:

$$\int^A \quad \int_A \quad \int_A^B$$

Summation with under/over limits:

$$\sum_A \quad \sum^{z+y} \quad \sum_{a+b}^{b}$$

Math with `underline`:

$$\underline{b+c=d}$$

Math with `underbar`:

$$\underline{\text{b+c+z=y}}$$

Math with `underbrace`:

$$\underbrace{a+b=c^2+y_2(a^2)^2}$$

3.5. *Over and under arrows*

Basic LaTeX provides `\overrightarrow` and `\overleftarrow` commands. Some additional over and under arrow commands are provided by the amsmath package to extend the set.

Math with `underrightarrow`:

$$\underrightarrow{a+b_c+y}$$

Math with `underleftarrow`:

$$\underleftarrow{a+b_c+y}$$

Math with `underleftrightarrow`:

$$\underleftrightarrow{a+b_c+y}$$

Math with `overline`:

$$\overline{(a+b=c)}$$

Math with `overbrace`:

$$\overbrace{a+b+c}$$

Math with `overrightarrow`:

$$\overrightarrow{a+b+c}$$

Math with `overleftarrow`:

$$\overleftarrow{a+b+c}$$

Math with `overleftrightarrow`:

$$\overleftrightarrow{a+b+c}$$

Math with `\underset{...}`:

$$= 2\cos(2\cdot \underbrace{327}_{\substack{\text{average}\\ \text{frequency}}} \pi t)\cos(\underbrace{130}_{\substack{\text{beats per}\\ \text{second}}} \pi t)$$

Math with `\overset{...}`:

$$\left(\frac{BW}{\omega_o}\right)\overset{a}{\overbrace{=}}B\left(\frac{BW}{\omega_o}\right)\overset{a}{=}B\left(\frac{BW}{\omega_o}\right)\overset{\mu_1=\mu_2}{\overbrace{=}}B\left(\frac{BW}{\omega_o}\right)\underset{=}{\underbrace{\mu_1=\mu_2}}B\left(\frac{BW}{\omega_o}\right)$$

Boxed equation: `\begin{equation}\boxed{...} \end{equation}`

$$\boxed{x^2+y^2=z^2} \tag{3.15}$$

3.6. *Extensible arrows*

`\xleftarrow` and `\xrightarrow` produce arrows that extend automatically to accommodate unusually wide subscripts or superscripts. These commands take one optional argument (the subscript) and one mandatory argument (the superscript, possibly empty):

$$\xleftarrow[a+c]{x^2+2xy+y^2} \qquad \xrightarrow[a+c]{x^2+2xy+y^2} \qquad \xleftarrow[x+y^2]{\text{maps to}} \qquad \xrightarrow[x+y^2]{\text{maps to}} \qquad \xleftarrow[a+c]{\text{maps to}}$$

3.7. *Math accents*

`\hat{a}`	$\hat{a}$	`\bar{a}`	$\bar{a}$
`\grave{a}`	$\grave{a}$	`\acute{a}`	$\acute{a}$
`\dot{a}`	$\dot{a}$	`\ddot{a}`	$\ddot{a}$
`\breve{a}`	$\breve{a}$	`\mathring{a}`	$\mathring{a}$
`\stackrel\frown{a}`	$\stackrel{\frown}{a}$	`\check{a}`	$\check{a}$
`\vec{a}`	$\vec{a}$	`\tilde{a}`	$\tilde{a}$

Revision history

Revision State	Revision Date	Version Number	Revision History
00	16 December, 2021	Version 1.0	