Latex math notations and Example R codes with PDF output

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Section 1: Building blocks

Goal	How to get it	Notes
$\alpha, \beta, \omega, \Omega$	`\alpha, \beta, \omega, \Omega`	Spell names of Greek letters.
$\bar{X}, \hat{\beta}, \tilde{\beta}$	`\bar X, \hat\beta, \tilde\beta`	Can't do stats without $\bar{X}$. Can't do econometrics without $\hat{\beta}$!
$\mathbf{X}, \boldsymbol{\beta}$	`\mathbf{X}, \boldsymbol{\beta}`	Bold math symbols. To make Latin-letters bold, you can use `\boldsymbol`from "bm" package: `\usepackage{bm}`
σ^2	`\sigma^2`	Superscripts.
$\sim$	`\sim`	For example, $X \sim N(0,1)$
$\succ, \succsim$	`\succ, \succsim`	Preference relations in micro
$\xrightarrow{p}, \xrightarrow{d}$	`\xrightarrow{p}, \xrightarrow{d}`	Convergence in probability, and convergence in distribution
$\geq, \leq, >, <$	`\ge, \leq, >, <`	Inequality
X_i, σ_{ij}	`X_i, \sigma_{ij}`	Subscripts. When a sub(super)script has more than one symbol, like the ij, braces around it are needed to say where the sub(super)script ends.
$\sum_{i=1}^{n} X_i$	`\sum_{i=1}^n X_i`	Summation.
$\prod_{i=1}^{n} X_i$	`\prod_{i=1}^n X_i`	Products.
$\int_{x=-\infty}^{\infty} x\,dx$	`\int_{x=-\infty}^\infty x\,dx`	Integrals.
$\frac{1}{1-\beta}$	`\frac{1}{1 - \beta}`	Fractions. Braces enclose numerator and denominator.
$\frac{\partial f(x,y)}{\partial x}$	`\frac{\partial f(x,y)}{\partial x}`	Partial derivative.
$\log(x), \exp(x)$	`\log(x), \exp(x)`	Named functions. Looks better if you don't omit the \.
$\sqrt{V+1}$	`\sqrt{V+1}`	Square root.

$\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{pmatrix}$	`\begin{pmatrix}`
	`  1 & 2 & 3 \\`
	`  4 & 5 & 6 \\`
	`\end{pmatrix}`
		Matrices.

$\begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix}$	`\begin{bmatrix}`
	`  \beta_0 \\`
	`  \beta_1 \\`
	`  \beta_2 \\`
	`\end{bmatrix}`
		Matrices.

Section 2: Example math equations

Example 1: Aligning equations with expression after equal sign

Syntax:

```
\begin{align*}
\hat{\beta}
  &= \mathbf{(X^{\prime}X)^{-1} (X^{\prime}Y)} \\
  &= \mathbf{(X^{\prime}X)^{-1} (X^{\prime} (X \beta + \mathbf{e}))} \\
  &= \mathbf{(X^{\prime} X)^{-1} X^{\prime}{X} \beta
   + (X^{\prime} X)^{-1} X^{\prime} e}\\
  &= \beta + \mathbf{(X^{\prime} X)^{-1} X^{\prime} e}
\end{align*}
```

becomes:

$$\begin{aligned}
\hat{\beta} &= \mathbf{(X'X)^{-1}(X'Y)} \\
&= \mathbf{(X'X)^{-1}(X'(X\beta + e))} \\
&= \mathbf{(X'X)^{-1}X'X\beta + (X'X)^{-1}X'e} \\
&= \beta + \mathbf{(X'X)^{-1}X'e}
\end{aligned}$$

Example 2: Writing equations within a curly brace

Syntax:

```
\begin{equation*}
  F(x) =
    \begin{cases}
      0 &  \quad x < 0 \\
      x &  \quad 0 \ge x \ge 1\\
      1 &  \quad x > 1
    \end{cases}
\end{equation*}
```

becomes:

$$F(x) = \begin{cases} 0 & x < 0 \\ x & 0 \ge x \ge 1 \\ 1 & x > 1 \end{cases}$$

Example 3: Including comments within equations

Syntax:

```
\begin{equation*}
  Z_n =
    \begin{cases}
      -n & \text{with probability $1/n$}\\
      0 &  \text{with probability $1-2/n$}\\
      n &  \text{with probability $1/n$}\\
    \end{cases}
\end{equation*}
```

becomes:

$$Z_n = \begin{cases} -n & \text{with probability } 1/n \\ 0 & \text{with probability } 1-2/n \\ n & \text{with probability } 1/n \end{cases}$$

Sintax:

```
\begin{align*}
\overline{X}_n =
  \frac{1}{n}\sum{i=1}^{n}X_i \xrightarrow{p} E[X]
  \quad \text{ as } n \rightarrow \infty
\end{align*}
```

becomes:

$$\overline{X}_n = \frac{1}{n}\sum_{i=1}^{n} X_i \xrightarrow{p} E[X] \quad \text{as } n \rightarrow \infty$$

Example 4: Maximization problem

Syntax:

```
\begin{equation*}
\begin{aligned}
\max_{x_1, x_2} \quad & u(x_1, x_2) = \frac{1}{2}log x_1 + \frac{1}{2} log x_2 \\
\textrm{s.t.} \quad & w=p_1 x_1 + p_2 x_2 \\
\end{aligned}
\end{equation*}
```

becomes:

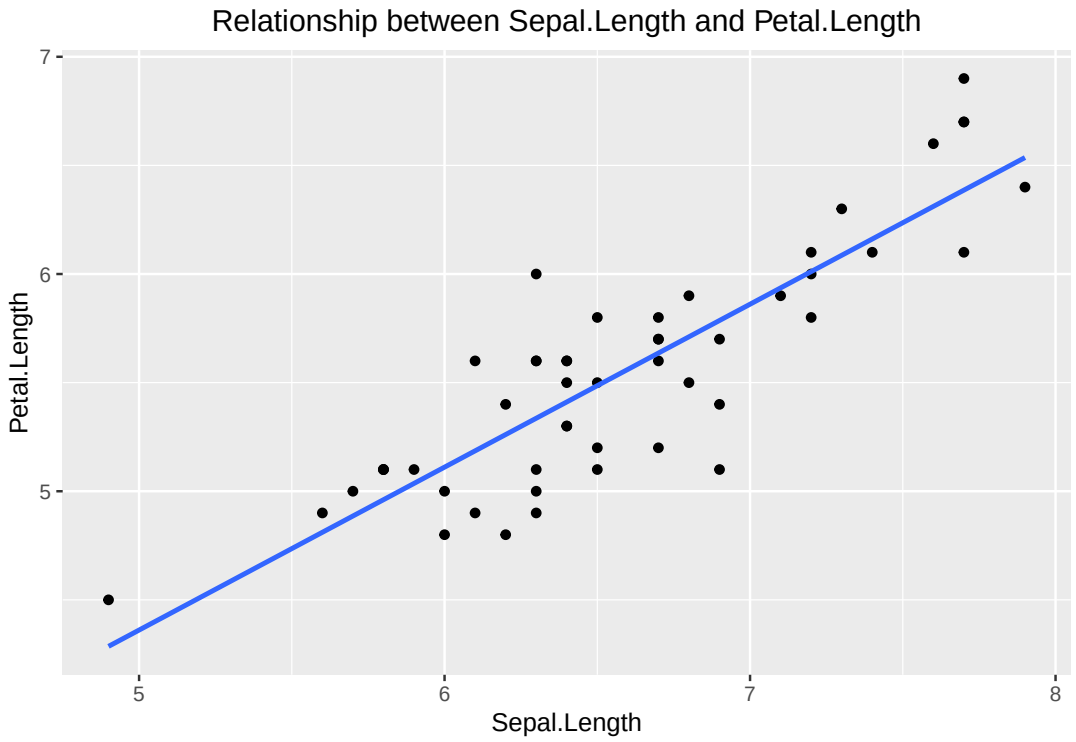
$$\begin{aligned} \max_{x_1, x_2} \quad & u(x_1, x_2) = \frac{1}{2} log x_1 + \frac{1}{2} log x_2 \\ \text{s.t.} \quad & w = p_1 x_1 + p_2 x_2 \end{aligned}$$

Section 3: Write R codes

```
# === Load Packages === #
library(data.table)
library(ggplot2)

# === Data === #
#built-in dataset in R
data(iris)
# Convert the data into data.table
setDT(iris)
# Filter for the species "setosa"
virginica <- iris[Species == "virginica",]
```

```
# === Visualization === #
ggplot(virginica, aes(x=Sepal.Length, y=Petal.Length))+
  geom_point()+
  geom_smooth(method = lm, se = FALSE)+
  labs(title = "Relationship between Sepal.Length and Petal.Length")+
  theme(plot.title = element_text(hjust = 0.5))
```



Section 4: Insert a picture to a document

Below is an example R chunk code to insert a picture.

```
```{r, fig.cap='A caption', out.width = '80%'}
knitr::include_graphics("path to the file")
```
```