LaTeX Tricks

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Abstract

How to use LaTeX in a fancy way.

1 Equation

1.1 Multi-line Formula

When writing about PDEs, we usually need to write the equations and their initial and/or boundary conditions in one equation, i.e., use only one number for the equation and IC/BC. We will show how to write multi-line formula with the example of heat equation and its solution. The main idea of writing multi-line formula are using `eqnarray` and `array` environment. Heat Equation.

$$\begin{cases} \dfrac{\partial u}{\partial t} = a^2 \dfrac{\partial^2 u}{\partial t^2}, t > 0, -\infty < x < +\infty \\ u|_{t=0} = \varphi(x)| \end{cases} \tag{1}$$

Solution

$$\begin{aligned} u(t,x) &= \mathcal{F}^{-1}\left[\hat{\varphi}(\lambda) e^{-a^2\lambda^2 t}\right] \\ &= \mathcal{F}^{-1}[\hat{\varphi}(\lambda)] * \mathcal{F}^{-1}\left[e^{-a^2\lambda^2 t}\right] \\ &= \varphi(x) * \frac{1}{2a\sqrt{\pi t}} \exp\left(-\frac{x^2}{4a^2 t}\right) \\ &= \frac{1}{2a\sqrt{\pi t}} \int_{-\infty}^{+\infty} \varphi(\xi) \exp\left(-\frac{(x-\xi)^2}{4a^2 t}\right) \mathrm{d}\xi \end{aligned} \tag{2}$$

1.2 Matrix and determinant

Matrix and determinant are common in dynamics and continuum mechanics. Here we use the relationship of coordinates vector as an example. The main idea of writing matrix and determinant is `array` and `&` symbol.

$$\mathbf{e}_i = \sum_{i=1}^{n} \frac{1}{H_i} \frac{\partial r_i}{\partial x_i} \mathbf{i}_i \tag{3}$$

Denote $\mathbf{e} = \{\mathbf{e}_1, \mathbf{e}_2, \ldots, \mathbf{e}_n\}$, $\mathbf{i} = \{\mathbf{i}_1, \mathbf{i}_2, \ldots, \mathbf{i}_n\}$, then

$$\mathbf{e} = A\mathbf{i} \tag{4}$$

where

$$A = \begin{pmatrix} \frac{1}{H_1}\frac{\partial r_1}{\partial x_1} & \frac{1}{H_1}\frac{\partial r_2}{\partial x_1} & \cdots & \frac{1}{H_1}\frac{\partial r_n}{\partial x_1} \\ \frac{1}{H_2}\frac{\partial r_1}{\partial x_2} & \frac{1}{H_2}\frac{\partial r_2}{\partial x_2} & & \\ \vdots & & \ddots & \\ \frac{1}{H_n}\frac{\partial r_1}{\partial x_n} & & & \frac{1}{H_n}\frac{\partial r_n}{\partial x_n} \end{pmatrix} \tag{5}$$

and

$$\det A = \begin{vmatrix} \frac{1}{H_1}\frac{\partial r_1}{\partial x_1} & \frac{1}{H_1}\frac{\partial r_2}{\partial x_1} & \cdots & \frac{1}{H_1}\frac{\partial r_n}{\partial x_1} \\ \frac{1}{H_2}\frac{\partial r_1}{\partial x_2} & \frac{1}{H_2}\frac{\partial r_2}{\partial x_2} & & \\ \vdots & & \ddots & \\ \frac{1}{H_n}\frac{\partial r_1}{\partial x_n} & & & \frac{1}{H_n}\frac{\partial r_n}{\partial x_n} \end{vmatrix} \tag{6}$$

1.3 Differential Symbol

Integral is common in equations and formula. The `d` symbol is very tricky. It should not be italic and should be separated from the integrand by a space. We can use the command `\dif` in package `commath` to write `d` correctly.

$$\int_0^1 x dx = \frac{1}{2}x^2\Big|_0^1 = \frac{1}{2} \tag{7}$$

$$\int_0^1 x \mathrm{d}x = \frac{1}{2}x^2\Big|_0^1 = \frac{1}{2} \tag{8}$$

$$\int_0^1 x\,\mathrm{d}x = \frac{1}{2}x^2\Big|_0^1 = \frac{1}{2} \tag{9}$$

1.4 Tensor Scripts

Here are two different approach to write subscript and superscript for a tensor or operator symbol. For general purpose

$$\prescript{a}{b}{C}^{c}_{d} \tag{10}$$

, or use package `Tensor`

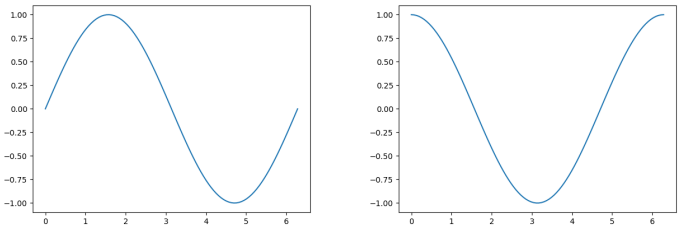
$$M^{a\ cd}_{\ b\ \ e} \tag{11}$$

$$\prescript{a\ c}{b\ d}{M}^{a\ c}_{\ b\ d} \tag{12}$$

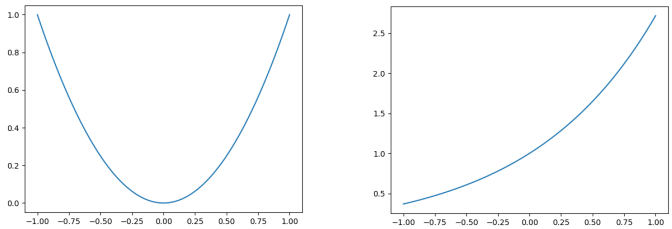
2 Figure

2.1 Subfigures

Subfigure is a common techniques for showing images. In LaTeX, there are several different packages for subfigures. Here we use the package `subcaption` for an example, which is shown in Figure 1.



(a) $y = \sin x, x \in [0, 2\pi]$ **(b)** $y = \cos x, x \in [0, 2\pi]$



(c) $y = x^2, x \in [-1, 1]$ **(d)** $y = \mathrm{e}^x, x \in [-1, 1]$

Figure 1. Illustration of subfigures.

2.2 Vertical and Horizontal Label

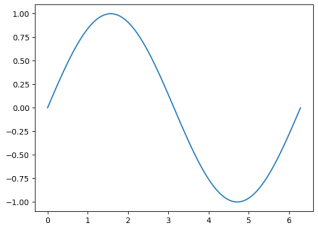
Sometimes we need to write row name and column name for subfigures grid. It is possible with command `rotatebox`, `phantom` and `hspace`, but it's also very complicated. The effect is shown in

2.3 Combination of Figures and Tables

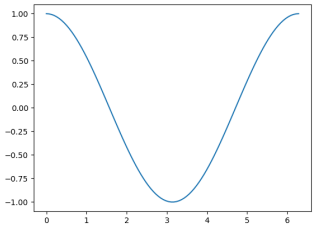
We can insert tabular in a subfigure, so that figures and tables can be combined in a single image, which is shown in Figure 3. In Figure 3d, we merged several lines of the row names. This can be used for merging cells. Package `multirow` is required for such operation.

Col 1 Col 2

Row 1

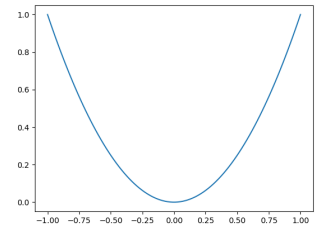


(a) $y = \sin x, x \in [0, 2\pi]$

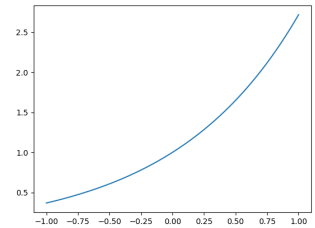


(b) $y = \cos x, x \in [0, 2\pi]$

Row 2

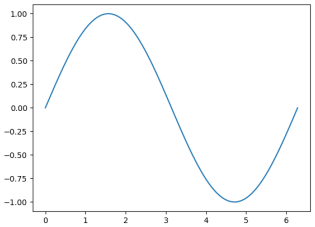


(c) $y = x^2, x \in [-1, 1]$

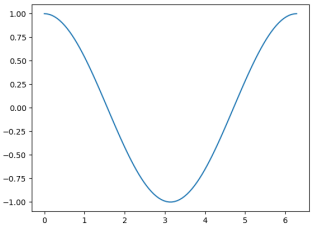


(d) $y = \mathrm{e}^x, x \in [-1, 1]$

Figure 2. Illustration of vertical and horizontal labels.



(a) $y = \sin x, x \in [0, 2\pi]$



(b) $y = \cos x, x \in [0, 2\pi]$

name	x	y	z	w
a	1	2	3	4
b	1	2	3	4
c	1	2	3	4

(c) First Table

name	x	y	z	w
	1	2	3	4
merged a	1	2	3	4
	1	2	3	4

(d) Second Table

Figure 3. Illustration of figures and tables combination.