Mathematical Writing Tips

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November 24, 2020

You will learn

1. The usage of Latex commands for conventional mathematical expressions.
2. Some notices for improving your mathematical writing.

I Mathematical Notations and Symbols

1. Using typographic conventions can be helpful to your readers.
   "Lower case italic type" denotes scalars (e.g., a, x, p, i, n).
   "Boldface Symbols" or "Arrows" over vectors (e.g., $\mathbf{v}$, $\mathbf{u}$, $\vec{a}$).
   "Blackboard bold typeface" denotes the basic number systems (e.g., $\mathbb{N}$ denoting the set of natural numbers).
   "The Greek alphabet" (e.g., α, β, γ) denotes some special parameters.
   You can use more changeable typeface such as $\mathcal{N}$, $\mathcal{L}$, $\mathcal{G}$.

```
a, x, p, i, n
\mathbf{v}, \mathbf{u}, \vec{a}
\alpha, \beta, \gamma
\mathcal{N}, \mathcal{L}, \mathcal{G}
```

a, x, p, i, n
$\mathbf{v}$, $\mathbf{u}$, $\vec{a}$
α, β, γ
$\mathcal{N}$, $\mathcal{L}$, $\mathcal{G}$

2. Use the latex commands to input log-like functions.

```
\cos, \sin, \exp, \log
\inf, \Pr, \lim, \max
```

cos, sin, exp, log
inf, Pr, lim, max

3. Use "\textrm{}" to input the text in math environment.

```
10\textrm{km}, 1^{\textrm{rt}}
```

10km, 1^{rt}

4. Symbols in different formulas must be separated by words. For example, "Consider S_q, where $q \leq p$".
5. Do not start a sentence with a symbol. Add a word such as "The term/The polynomial" before the symbol.
6. Be careful to define symbolds before you use them (or at least to define them very near where you use them).
   E.g., "The term x denotes the 'blah'". "The 'blah' is denoted by x". "Let x denote the 'blah'".
   E.g., "Let $f(x)$ be the function of 'blah', it is given by $f(x) = ax + b$, where x is 'blah'".
7. Do not use the same notation for two different things.

8. Be careful to distinguish between mathematical notation and programming language notation.
   E.g., the term "p[r]" in programming language turns to the mathematical notaion p_r in a formal paper.
   E.g., a star (*) $\rightarrow \times$.
   E.g., the matrix multiplication $N * M \rightarrow N \times M$.

9. Be careful to use too many subscripts when dealing with a set that doesn't need to be indexed.
   E.g., "Let $X = \{x_1, \ldots, x_n\}$". Such a definition of X is troublesome.
   If you're going to need subsets of X, since the subset will have to defined as $\{x_{i_1}, \ldots, x_{i_m}\}$, say.
   Also, you'll need to be speaking of elements x_i and x_j all the time.

10. *Do not name the elements of X unless necessary.* Set element notation can be used to avoid subscripted subscripts.
    For simplicity, you can omit subscripts when the subscript is no need to be stressed.
    Bad: "p_i is an element of P."
    Good: "p is an element of P."
    You can also refer to elements x_1 and x_2 as specified elements of X in your subsequent discussion.

11. The form $1/R$ is used for inline math expression and

$$\frac{1}{R}$$

    is used for displayed math expression.

12. You can overdo the use of any good tool.
    For instance, you could overuse typographic tools by having 20 different fonts in one paper.

II Mathematical Formulas and Expressions

1. Latex supports many math environments (e.g., `$$...$$`, `\begin{displaymath}...\end{displaymath}`, and `\begin{equation}...\end{equation}`) for different formats when displaying math expressions. Here are two math environments for your convenient usage.

   Display a formula in single line:

```
\begin{equation}
f(x)=\frac{1}{\pia^2}
\end{equation}
```

$$f(x) = \frac{1}{\pi a^2} \tag{1}$$

   Format the vertical alignment formula:

```
\begin{align}{ll}
g(x)&=f(x) \\
y&=x\\
\end{align}
```

$$\begin{aligned} g(x) &= f(x) \\ y &= x \end{aligned} \tag{2}$$

2. Put the period "." inside the math expression when the sentence is ending with the math expression.
   Bad: The velocity formula is given by

$$v(t) = x(t) - x(0)$$

   .
   Good: The velocity formula is given by

$$v(t) = x(t) - x(0).$$

3. Do not add a colon before displayed expressions when the expressions are already part of the sentence.
   Bad: The velocity formula is given by:

$$v(t) = x(t) - x(0).$$

   Good: The velocity formula is given by

$$v(t) = x(t) - x(0).$$

4. If you need to refer to some of these formulas from remote parts of the text, give reference numbers to all of the most important ones, even if they aren't referenced.
   Numbering all displayed formulas is usually a bad idea; number the important ones only.
   Learn to use "`\label{eq1}`" and "`\ref{eq1}`" to cite some formulas.
   E.g., "`\begin{equation}\label{eq1}...\end`", "As shown in `Eq.~(\ref{eq1})`".
   Mention that the citation of the certain "Theorem/Lemma/Table" can also use "`\label{eq1}`" and "`\ref{eq1}`".

5. Put words between adjacent formulas.

6. Display important formulas on a line by themselves.

7. It's natural in mathematics to hold off some aspects of your definition - to "place action before definition".
   E.g., "$p(x) < p(y)$ for some $x < y$".
   But it is possible to carry this too far, if too much is being held back. The best location for certain definitions is a subjective matter.

8. The usage of ellipses. When placig ellipses between commas the three dots belong on the same level as the commas, but when the ellipses is bracketed by symbols such as "+" or "<" the dots should be at mid-level.

```
{x_{1},\ldots,x_{n}}
x_{1}+\cdots+x_{n}
```

$\{x_1, \ldots, x_n\}$
$x_1 + \cdots + x_n$

9. Linebreaks in the middle of formulas are undesirable. You can catch many such awkward breaks by not letting the final symbol lie on a line separate from the rest of its sentence.
   In Latex, a tilde ~ in place of space will cause the two symbols on either side of the tilde to be tied together.
   We also use the tilde ~ to tie the citation labels with a word, such as "`Eq.~(\ref{eq1})`", "`Section~(\ref{sec2})`", "`Fig.~(\ref{fig3})`", "`Tab.~(\ref{tab4})`".

III Theorems, Lemmas, and Proofs

1. Generally speaking, "Lemma" helps to derive the formulas of "Theorem/Proposition" later.
   "Proof" is used to demonstrate the detailed derivation process for "Lemma/Theorem/Proposition".
   The long "Proof" can be displayed in the appendix, leaving reference at the end of "Lemma/Theorem/Proposition".

2. Capitalize names like "Theorem 1", "Lemma 2", "Algorithm 3", "Method 4".

3. The statement just preceding a theorem, algorithm, etc., should be a complete sentence or should end with a colon.
   Bad: We now have the following
   Theorem. "Blahblahblah".
   Good: We now can prove the following results.
   Theorem. "Blahblahblah".

VI Transition between sentences and formulas

Donald E. Knuth: Many readers will skim over formulas on their first reading of your exposition. Therefore, your sentences should flow smoothly when all but the simplest formulas are replaced by "blah" or some other grunting noise.
Donald E. Knuth: Ask yourself what the reader knows and expects to see next at some point in the text.

1. Do not omit "that" when it helps the reader to parse the sentence.
   Bad: We assume A is a group.
   Good: We assume that A is a group.

2. Small numbers should be spelled out when used as adjectives, but not when used as names (i.e., when talking about numbers as numbers).
   E.g., "Method 2 is illustrated in Fig. 1; it requires 17 passes."

3. Comments such as, "We demonstrate the second conclusion by contradiction," and "There must be a witness to the unsortedness of P," are useful because they tell the reader what is going on or bring in new and helpful vocabulary.

4. Try to make sentences easily comprehensible from left to right.
   Bad: "We prove that 'blah1' and 'blah2' implies 'blah'".
   Good: "We prove that the two conditions 'blah1' and 'blah2' imply 'blah'.".
   It seems at first that 'blah1' and 'blah2' are being proved.

5. Be precise in your wording. If you mean "not nonincreasing," Do not say "increasing".

References

[1] Learn more Math notations: `https://en.wikipedia.org/wiki/List_of_mathematical_symbols`
[2] Quickly build your math expressions: `https://latex.codecogs.com/eqneditor/editor.php`
[3] Find more fonts: `https://wiki.contextgarden.net/Math_fonts`
[4] Books: Mathematical Writing by Donald E. Knuth , Tracy Larrabee, and Paul M. Roberts.
[5] Learn to be skilled at using Latex: 《一份不太简短的LATEX2" 介绍》