

Writing for computer science: Chapter 5: Mathematics

YU Le
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Introduction

Mathematics gives solidity to abstract concepts.

Mathematical notation can be used to describe algorithms, data structures, or just about any of the objects that computer scientists study.

Clarity: Mathematical writing is essential to be precise

Tip 1: Many discussions can be clarified through the use of mathematical notation.

Bad example:

An inverted list for a given term is a sequence of pairs, where the first element in each pair is a document identifier and the second is the frequency of the term in the document to which the identifier corresponds.

Good example:

An inverted list for a term t is a sequence of pairs of the form $\langle d, f \rangle$, where each d is a document identifier and f is the frequency of t in d .

Clarity: Mathematical writing is essential to be precise

Tip 2: Many terms are confusing and should be used carefully.

Example:

normal	⇒	usual
formula	⇒	equation
equivalent	⇒	similar
element	⇒	partition
average	⇒	mean
metric	⇒	measure

Theorems

Tip 3: Steps in the logic of a proof should be simple, the gaps can be completed by a reader mechanically.

Tip 4: Theorems, definitions, lemmas, and propositions should be numbered, even if there are only two or three of each in the paper.

Tip 5: Some presentation problems are not easily resolved. One approach is to state the main theorem first, then state and prove the lemmas before giving the main proof.

Readability

Tip 6: Mathematics is usually presented in italics. For example: “of length n ”

Tip 7: Use the same font for the same variable.

Tip 8: Parentheses should stand out from the expression they enclose:

✘ $(p \cdot (\sum_{i=0}^n A_i))$

✔ $(p \cdot (\sum_{i=0}^n A_i))$

Tip 9: Mathematics should not be used at the start of a sentence:

✘ $p \leftarrow q_1 \wedge \dots \wedge q_n$ is a conditional dependency.

✔ The dependency $p \leftarrow q_1 \wedge \dots \wedge q_n$ is conditional.

Readability

Tip 10: Give the type of each variable every time it is used. Watch out the misplaced types of variables:

× The values are represented as a list of numbers L .

✓ The values are represented as a list L of numbers.

Tip 11: Mathematics should not take the place of text, readers may get lost.

× Let $\langle S \rangle = \{ \sum_{i=1}^n \alpha_i x_i \mid \alpha_i \in F, 1 \leq i \leq n \}$. For $x = \sum_{i=1}^n \alpha_i x_i$ and $y = \sum_{i=1}^n \beta_i x_i$, so that $x, y \in \langle S \rangle$, we have $\alpha x + \beta y = \alpha \left(\sum_{i=1}^n \alpha_i x_i \right) + \beta \left(\sum_{i=1}^n \beta_i x_i \right) = \sum_{i=1}^n \left(\alpha \alpha_i + \beta \beta_i \right) x_i \in \langle S \rangle$.

Readability

Tip 11: Mathematics should not take the place of text, readers may get lost.

✓ Let $\langle S \rangle$ be a vector space defined by

$$\langle S \rangle = \left\{ \sum_{i=1}^n \alpha_i x_i \mid \alpha_i \in F, 1 \leq i \leq n \right\}.$$

We now show that $\langle S \rangle$ is closed under addition. Consider any two vectors $x, y \in \langle S \rangle$. Then $x = \sum_{i=1}^n \alpha_i x_i$ and $y = \sum_{i=1}^n \beta_i x_i$. For any constants $\alpha, \beta \in F$, we have

$$\begin{aligned} \alpha x + \beta y &= \alpha \left(\sum_{i=1}^n \alpha_i x_i \right) + \beta \left(\sum_{i=1}^n \beta_i x_i \right) \\ &= \sum_{i=1}^n \left(\alpha \alpha_i + \beta \beta_i \right) x_i, \end{aligned}$$

so that $\alpha x + \beta y \in \langle S \rangle$.

Readability

Tip 12: Mathematical expressions should not run together.

✗ For each x_i , $1 \leq i \leq n$, x_i is positive.

✓ Each x_i , where $1 \leq i \leq n$, is positive.

Tip 13: Consider breaking down expressions to make them more readable, especially if doing so enlarges small symbols.

✗ $f(x) = e^{2^{-\frac{b}{a}x\sqrt{1-\frac{a^2}{x^2}}}}$

✓ $f(x) = e^{2^{g(x)}}$ where $g(x) = -\frac{b}{a}x\sqrt{1-\frac{a^2}{x^2}}$

Ranges

Tip 14:

The closed range of real numbers r , where $a \leq r \leq b$ is represented by “[a, b]”

The open range $a < r < b$ is represented by “(a,b)”

The expression $1 \leq i \leq 6$ should be replaced by $i = 1, 2, \dots, 6$ if it is not clear that i should be integer.

Alphabets

Tip 15: Most readers are familiar with only a few Greek letters, so use of unfamiliar letters should be minimized.

Tip 16: Some alphabets can cause confusion.

Symbol	Confused with
ϵ epsilon	<i>e</i>
η eta	<i>n</i>
ι iota	<i>i</i>
μ mu	<i>u</i>
ρ rho	<i>p</i>
υ upsilon	<i>v</i>
ω omega	<i>w</i>
\vee or	<i>v</i>
\propto proportional	α alpha
\emptyset empty set	ϕ phi

Line breaks

Tip 17: Avoid letting a number, symbol appear at the start of the line, particularly if it the end of a sentence.

- ✗ We have therefore introduced an additional variable, denoted by x . It allows ...
- ✓ We therefore introduce an additional variable, denoted by x . It allows ...
- ✗ Accesses to the new kind of disk typically require about 12 ms using our techniques.
- ✓ Accesses to the new kind of disk typically require about 12 ms using our techniques.

Percentage

Tip 18: Percentages should always be in figures.

Bad Example:

The increase was over 5 per cent.

Good Example:

The increase was over 5%.

Tip 19: Do not mix modes.

✗ There were between four and 32 processors in each machine.

✓ There were between 4 and 32 processors in each machine.

✗ The sizes were 7.31 Kb and 181 Kb, respectively.

✓ The sizes were 7.3 Kb and 181.4 Kb, respectively.

Units of measurement

Tip 20: Units should be typeset in the font used in the paper for text, even when they are part of a mathematical expression.

✗ The volume is r^p *Kb* in total.

✓ The volume is r^p Kb in total.