COMPUTERS & TYPESETTING

JUBILEE • 2021 • edition

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COMPUTERS & TYPESETTING / A

The TEXbook

It's usually a good idea to define special control sequences for accented letters that you need frequently. For example, you can put

```
\def\Ahat{{\hat A}}
\def\chat{{\hat c}}
\def\scheck{{\check s}}
\def\xtilde{{\tilde x}}
\def\zbar{{\bar z}}
```

at the beginning of a manuscript that uses the symbols $\hat{A}$, $\hat{c}$, $\check{s}$, $\tilde{x}$, and $\bar{z}$ more than, say, five times. This saves you a lot of keystrokes, and it makes the manuscript easier to read. Chapter 20 explains how to define control sequences.

When the letters i and j are accented in math formulas, dotless symbols $\imath$ and $\jmath$ should be used under the accents. These symbols are called `\imath` and `\jmath` in plain TEX. Thus, for example, a paper that uses '$\hat{\imath}$' and '$\hat{\jmath}$' ought to begin with the following definitions:

```
\def\ihat{{\hat\imath}}
\def\jhat{{\hat\jmath}}
```

You can put accents on top of accents, making symbols like $\hat{\hat{A}}$ that might cause a mathematician to squeal with ecstasy. However, it takes a bit of finesse to get the upper accent into a position that looks right, because the designer of a font for mathematics usually tells TEX to position math accents in special ways for special letters. Plain TEX provides a control sequence called `\skew` that makes it fairly easy to shift superaccents into their proper place. For example, '`\skew6\hat\Ahat`' was used to produce the symbol above. The number '`6`' in this example was chosen by trial and error; '`5`' seems to put the upper accent a bit too far left, while '`7`' makes it a bit too far right, at least in the author's opinion. The idea is to fiddle with the amount of skew until you find what pleases you best.

It's possible, in fact, to put math accents on any subformula, not just on single characters or accented characters. But there's usually not much point in doing so, because TEX just centers the accent over the whole subformula. For example, '`$\hat{I+M}$`' yields '$\hat{I+M}$'. In particular, a `\bar` accent always stays the same size; it's not like `\overline`, which grows with the formula under it. Some people prefer the longer line from `\overline` even when it applies to only a single letter; for example, '`$\bar z+\overline z$`' produces '$\bar{z}+\overline{z}$', and you can take your pick when you define `\zbar`. However, plain TEX does provide two accents that grow; they are called `\widehat` and `\widetilde`:

`$\widehat x,\widetilde x$`	$\widehat{x}, \widetilde{x}$
`$\widehat{xy},\widetilde{xy}$`	$\widehat{xy}, \widetilde{xy}$
`$\widehat{xyz},\widetilde{xyz}$`	$\widehat{xyz}, \widetilde{xyz}$

The third example here shows the maximum size available.

▸ **EXERCISE 16.13**

This has been another long chapter; but cheer up, you have learned a lot! Prove it by explaining what to type in order to get the formulas e^{-x^2}, $D \sim p^\alpha M + l$,

and $\hat{g} \in (H^{\pi_1^{-1}})'$. (In the last example, assume that a control sequence `\ghat` has already been defined, so that `\ghat` produces the accented letter $\hat{g}$.)

Producing Greek letters is as easy as π.
You just type `... as easy as $\pi$.`

— LESLIE LAMPORT, *The LaTeX Document Preparation System* (1983)

TeX has no regard for the glories of the Greek tongue—
as far as it is concerned, Greek letters are just additional weird symbols,
and they are allowed only *in math mode.*
In a pinch you can get the output $\tau\epsilon\chi$ by typing `$\tau\epsilon\chi$`,
but if you're actually setting Greek text, you will be using
a different version of TeX, designed for a keyboard with Greek letters on it,
and you shouldn't even be reading this manual,
which is undoubtedly all English to you.

— MICHAEL SPIVAK, *The Joy of TeX* (1982)

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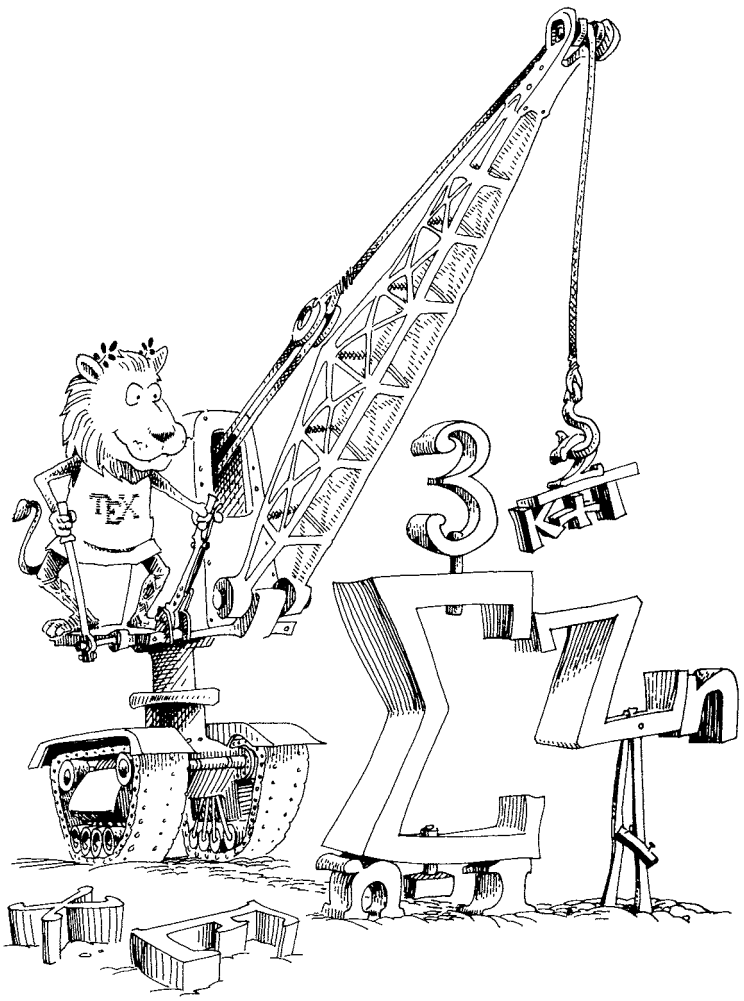
More about Math



Another thing mathematicians like to do is make fractions—and they like to build symbols up on top of each other in a variety of different ways:

$$\frac{1}{2} \quad \text{and} \quad \frac{n+1}{3} \quad \text{and} \quad \binom{n+1}{3} \quad \text{and} \quad \sum_{n=1}^{3} Z_n^2 .$$

You can get these four formulas as displayed equations by typing '`$$1\over2$$`' and '`$$n+1\over3$$`' and '`$$n+1\choose3$$`' and '`$$\sum_{n=1}^3 Z_n^2$$`'; we shall study the simple rules for such constructions in this chapter.

First let's look at fractions, which use the '`\over`' notation. The control sequence `\over` applies to everything in the formula unless you use braces to enclose it in a specific subformula; in the latter case, `\over` applies to everything in that subformula.

Input	*Output*
`$$x+y^2\over k+1$$`	$$x+y^2\over k+1$$
`$${x+y^2\over k}+1$$`	$${x+y^2\over k}+1$$
`$$x+{y^2\over k}+1$$`	$$x+{y^2\over k}+1$$
`$$x+{y^2\over k+1}$$`	$$x+{y^2\over k+1}$$
`$$x+y^{2\over k+1}$$`	$$x+y^{2\over k+1}$$

You aren't allowed to use `\over` twice in the same subformula; instead of typing something like '`a \over b \over 2`', you must specify what goes over what:

`$${a\over b}\over 2$$`	$${a\over b}\over 2$$
`$$a\over{b\over 2}$$`	$$a\over{b\over 2}$$

Unfortunately, both of these alternatives look pretty awful. Mathematicians tend to "overuse" `\over` when they first begin to typeset their own work on a system like TEX. A good typist or copy editor will convert fractions to a "slashed form," whenever a built-up construction would be too small or too crowded. For example, the last two cases should be treated as follows:

`$$a/b \over 2$$`	$$a/b \over 2$$
`$$a \over b/2$$`	$$a \over b/2$$

Conversion to slashed form takes a little bit of mathematical knowhow, since parentheses sometimes need to be inserted in order to preserve the meaning of

the formula. Besides substituting '`/`' for '`\over`', the two parts of the fraction should be put in parentheses unless they are single symbols; for example, $\frac{a}{b}$ becomes simply a/b, but $\frac{a+1}{b}$ becomes $(a+1)/b$, and $\frac{a+1}{b+1}$ becomes $(a+1)/(b+1)$. Furthermore, the entire fraction should generally be enclosed in parentheses if it appears next to something else; for example, $\frac{a}{b}x$ becomes $(a/b)x$. If you are a typist without mathematical training, it's best to ask the author of the manuscript for help, in doubtful cases; you might also tactfully suggest that unsightly fractions be avoided altogether in future manuscripts.

▸**EXERCISE 17.1**
What's a better way to render the formula $x + y^{\frac{2}{k+1}}$?

▸**EXERCISE 17.2**
Convert '$\frac{a+1}{b+1}x$' to slashed form.

▸**EXERCISE 17.3**
What surprise did B. L. User get when he typed '`$$x = (y^2\over k+1)$$`'?

▸**EXERCISE 17.4**
How can you make '$7\frac{1}{2}¢$'? (Assume that the control sequence `\cents` yields '$¢$'.)

The examples above show that letters and other symbols sometimes get smaller when they appear in fractions, just as they get smaller when they are used as exponents. It's about time that we studied TEX's method for choosing the sizes of things. TEX actually has eight different styles in which it can treat formulas, namely

display style	(for formulas displayed on lines by themselves)
text style	(for formulas embedded in the text)
script style	(for formulas used as superscripts or subscripts)
scriptscript style	(for second-order superscripts or subscripts)

and four other "cramped" styles that are almost the same except that exponents aren't raised quite so much. For brevity we shall refer to the eight styles as

$$D,\ D',\ T,\ T',\ S,\ S',\ SS,\ SS',$$

where D is display style, D' is cramped display style, T is text style, etc. TEX also uses three different sizes of type for mathematics; they are called text size, script size, and scriptscript size.

The normal way to typeset a formula with TEX is to enclose it in dollar signs `$`...`$`; this yields the formula in text style (style T). Or you can enclose it in double dollar signs `$$`...`$$`; this displays the formula in display style (style D). The subformulas of a formula might, of course, be in different styles. Once you know the style, you can determine the size of type that TEX will use:

If a letter is in style	then it will be set in	
D, D', T, T'	text size	(like this)
S, S'	script size	(like this)
SS, SS'	scriptscript size	(like this)

There is no "*SSS*" style or "scriptscriptscript" size; such tiny symbols would be even less readable than the scriptscript ones. Therefore TEX stays with scriptscript size as the minimum:

In a formula of style	the superscript style is	and the subscript style is
D, T	S	S'
D', T'	S'	S'
S, SS	SS	SS'
S', SS'	SS'	SS'

For example, if `x^{a_b}` is to be typeset in style D, then `a_b` will be set in style S, and `b` in style SS'; the result is 'x^{a_b}'.

So far we haven't seen any difference between styles D and T. Actually there is a slight difference in the positioning of exponents, although script size is used in each case: You get x^2 in D style and x^2 in T style and x^2 in D' or T' style—do you see the difference? But there is a big distinction between D style and T style when it comes to fractions:

In a formula α`\over`β of style	the style of the numerator α is	and the style of the denominator β is
D	T	T'
D'	T'	T'
T	S	S'
T'	S'	S'
S, SS	SS	SS'
S', SS'	SS'	SS'

Thus if you type '`$1\over2$`' (in a text) you get $\frac{1}{2}$, namely style S over style S'; but if you type '`$$1\over2$$`' you get

$$\frac{1}{2}$$

(a displayed formula), which is style T over style T'.

While we're at it, we might as well finish the style rules: `\underline` does not change the style. Math accents, and the operations `\sqrt` and `\overline`, change uncramped styles to their cramped counterparts; for example, D changes to D', but D' stays as it was.

▸**EXERCISE 17.5**

State the style and size of each part of the formula $\sqrt{p_2^{e'}}$, assuming that the formula itself is in style D.

Suppose you don't like the style that TEX selects by its automatic style rules. Then you can specify the style you want by typing `\displaystyle` or `\textstyle` or `\scriptstyle` or `\scriptscriptstyle`; the style that you select will apply until the end of the formula or subformula, or until you select