Introduction to \LaTeX

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When the first volume of Donald Knuth’s *The Art of Computer Programming* was published in 1969, it was typeset using hot metal type set by a Monotype Corporation typecaster with a hot metal typesetting machine from the 19th century which produced a “good classic style” appreciated by Knuth. When the second edition of the second volume was published, in 1976, the whole book had to be typeset again because the Monotype technology had been largely replaced by photographic techniques, and the original fonts were no longer available. When Knuth received the galley proofs of the new book on 30 March 1977, he found them awful. Around that time, Knuth saw for the first time the output of a high-quality digital typesetting system, and became interested in digital typography. The disappointing galley proofs gave him the final motivation to solve the problem at hand once and for all by designing his own typesetting system. On 13 May 1977, he wrote a memo to himself describing the basic features of TeX.

from Wikipedia, 17.IX.2013
the value of \( f \) at any point on the 2-interval \( I_{(0,0),(1,\frac{1}{2})} = [0, 1] \times [0, \frac{1}{2}] \). Indeed, the image of this 2-interval is \([0, \frac{1}{2}] \cup [1, \frac{3}{2}]\), which is not an interval in \( \mathbb{R} \). \( \diamond \)

As indicated by the example in Remark 1.24, a simple modification of the result in Proposition 1.23 yields a characterization of the IVP.

**Proposition 1.25.** Let \( D \subseteq \mathbb{R}^2 \) and let \( f : D \to \mathbb{R} \) be a function. Then for any 2-interval \( I \times J \subseteq D \),

\[
f \text{has the IVP on } I \times J \iff f(E) \text{ is an interval in } \mathbb{R}
\]

for every 2-interval \( E \subseteq I \times J \).

**Proof.** The implication “\( \implies \)” follows from Proposition 1.23. To prove the converse, let \((x_1, y_1), (x_2, y_2) \in I \times J\) and let \( r \) be a real number that lies between \( f(x_1, y_1) \) and \( f(x_2, y_2) \). Let \( E \) denote the 2-interval \( I_{(x_1,y_1),(x_2,y_2)} \). Since \( f(E) \) is an interval in \( \mathbb{R} \), it follows that \( r = f(x_0, y_0) \) for some \((x_0, y_0) \in E\). Since \( E \subseteq I \times J \), it follows that \( f \) has the IVP on \( I \times J \). \( \Box \)

### 1.3 Cylindrical and Spherical Coordinates

For points in \( \mathbb{R}^2 \), one has the familiar notion of polar coordinates. These provide an alternative and useful way to represent points in the plane other than the origin. Recall that the polar coordinates of \((x, y) \in \mathbb{R}^2 \setminus \{(0,0)\}\) are given by \((r, \theta)\), where \( r \) and \( \theta \) are real numbers determined by the equations \( x = r \cos \theta \) and \( y = r \sin \theta \) and the conditions \( r > 0 \) and \( \theta \in (-\pi, \pi] \). The precise relationship is stated below. For a proof of this, one may refer to Proposition 7.20 of ACICARA.

**Fact 1.26.** If \( x, y \in \mathbb{R} \) are such that \((x, y) \neq (0,0)\), then \( r \) and \( \theta \) defined by

\[
 r := \sqrt{x^2 + y^2} \quad \text{and} \quad \theta := \begin{cases} 
 \cos^{-1} \left( \frac{x}{r} \right) & \text{if } y \geq 0, \\
 -\cos^{-1} \left( \frac{x}{r} \right) & \text{if } y < 0,
\end{cases}
\]

satisfy the following properties:

\[
 r, \theta \in \mathbb{R}, \quad r > 0, \quad \theta \in (-\pi, \pi], \quad x = r \cos \theta, \quad \text{and} \quad y = r \sin \theta.
\]

Conversely, if \( r, \theta \in \mathbb{R} \) are such that \( r > 0 \) and \( \theta \in (-\pi, \pi] \), then \( x := r \cos \theta \) and \( y := r \sin \theta \) are real numbers such that \((x, y) \neq (0,0), r = \sqrt{x^2 + y^2}\), and \( \theta \) equals \( \cos^{-1}(x/r) \) or \( -\cos^{-1}(x/r) \) according as \( y \geq 0 \) or \( y < 0 \).
TEX is a programming language.
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A TEX file is a program, that is, it is a series of commands that is compiled by the TEX engine which delivers output.
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\LaTeX\ requires a preface declaring certain styles and initiating packages of commands that have been designed by others.
A typical setup

\documentclass{article}
\usepackage{amsmath}
\usepackage{amssym}
\usepackage{amsfonts}

*You can put many useful things here.*

\begin{document}

*Your text here.*

\end{document}
A \textit{binomial} is an algebraic expression of the form $a + b$, on which we can carry out some operation. Most often the expressions are monomials and a binomial is a kind of polynomial.

If we raise the monomial $a + b$ to a power, we obtain new terms: Of course, $(a + b)^1 = a + b$, and most of us know that

$$(a+b)^2 = a^2 + 2ab + b^2.$$  

If one is willing, we can extend this further:

\begin{align*}
(a+b)^3 &= a^3 + 3a^2 b + 3a b^2 + b^3 \\
(a+b)^4 &= a^4 + 4a^3 b + 6 a^2 b^2 + 4 a b^3 + b^4,
\end{align*}

and so on. The coefficients appearing in these expressions are called \textit{binomial coefficients} and they are defined in general by the notation:

$$(a + b)^n = a^n + \binom{n}{1} a^{n-1} b + \binom{n}{2} a^{n-2} b^2 + \cdots + \binom{n}{k} a^{n-k} b^k + \cdots + \binom{n}{n-1} a b^{n-1} + b^n.$$  

Thus, $\displaystyle \binom{4}{2} = 6$.
A binomial is an algebraic expression of the form $a + b$, on which we can carry out some operation. Most often the expressions are monomials and a binomial is a kind of polynomial. If we raise the monomial $a + b$ to a power, we obtain new terms: Of course, $(a + b)^1 = a + b$, and most of us know that
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\[
(a + b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4,
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\]
Thus, $\binom{4}{2} = 6$. 

Fonts

\textit{italic} gives italic.
\textbf{bold} gives bold.
\textsl{slanted} gives slanted.
\textsc{small caps} gives SMALL CAPS.
\texttt{typewriter} gives typewriter.
Choices

align versus align*

\[(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3 \] \hspace{1cm} (1)
\[(a + b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4, \] \hspace{1cm} (2)

text style versus \( \text{\textbackslash displaystyle} \)

\[\binom{n}{5} \text{ versus } \binom{n}{5}\]
A matrix

$$\begin{pmatrix}
7 & 8 & -1 & 0 \\
4 & -2 & 0 & 9 \\
-1 & 0 & 6 & 12 \\
0 & 3 & -7 & 1
\end{pmatrix}$$
Cases

$$\int_1^x t^p \, dt = \begin{cases} 
\displaystyle \frac{x^{p+1}}{p+1} - \frac{1}{p+1} & \text{if } p \neq -1, \\
\ln(x) & \text{if } p = -1. \end{cases}$$

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A commutative diagram

\[
\begin{array}{ccc}
0 & \rightarrow & C'_{n+1} \\
\downarrow & & \downarrow \\
C'_{n} & \rightarrow & C_{n} \\
\downarrow & & \downarrow \\
C'_{n-1} & \rightarrow & C_{n-1} \\
\downarrow & & \downarrow \\
0 & \rightarrow & C_{n+1} \\
& \rightarrow & \rightarrow \\
\end{array}
\]

\[
\beta \quad \beta \quad \beta
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\[
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**Greek Letters**
\pm \mp \cap \diamond \oplus \cap \bigtriangleup \ominus \times \uplus \bigtriangledown \otimes \div \sqcap \triangleleft \oslash \ast \uplus \bigcirc \circ \vee \lhd \ddagger \cdot \downarrow \wr \bigcirc \bullet \setminus \unrhd \amalg

\textsuperscript{b} Not predefined in a format based on \texttt{basefont.tex}. Use one of the style options \texttt{oldlfont}, \texttt{newlfont}, \texttt{amsfonts} or \texttt{amssymb}.

\textbf{Binary Operation Symbols}
\leq \preceq \ll \subset \subseteq \vdash
\geq \succeq \gg \supset \supseteq \dashv
\equiv \models
\sim \asymp \parallel \perp \bowtie
\| \right相关内容的符号

^b Not predefined in a format based on basefont.tex. Use one of the style options oldlfont, newlfont, amsfonts or amssymb.

Relation Symbols
Arrow Symbols

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<table>
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<th>Symbols</th>
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<td>\imath \nabla \neg \Diamond b</td>
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**Miscellaneous Symbols**
Variable-sized Symbols

\texttt{\textbackslash arccos} \texttt{\textbackslash cos} \texttt{\textbackslash csc} \texttt{\textbackslash exp} \texttt{\textbackslash ker} \texttt{\textbackslash limsup} \texttt{\textbackslash min} \texttt{\textbackslash sinh}
\texttt{\textbackslash arcsin} \texttt{\textbackslash cosh} \texttt{\textbackslash deg} \texttt{\textbackslash gcd} \texttt{\textbackslash lg} \texttt{\textbackslash ln} \texttt{\textbackslash Pr} \texttt{\textbackslash sup}
\texttt{\textbackslash arctan} \texttt{\textbackslash cot} \texttt{\textbackslash det} \texttt{\textbackslash hom} \texttt{\textbackslash lim} \texttt{\textbackslash log} \texttt{\textbackslash sec} \texttt{\textbackslash tan}
\texttt{\textbackslash arg} \texttt{\textbackslash coth} \texttt{\textbackslash dim} \texttt{\textbackslash inf} \texttt{\textbackslash liminf} \texttt{\textbackslash max} \texttt{\textbackslash sin} \texttt{\textbackslash tanh}

Log-like Symbols
Top ten reasons to learn \TeX

1. \TeX\ has the best output.
Top ten reasons to learn TeX

1. TeX has the best output.
2. TeX knows typsetting.
Top ten reasons to learn $\TeX$

1. $\TeX$ has the best output.
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3. $\TeX$ is fast.
Top ten reasons to learn \TeX

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3. \TeX\ is fast.
4. \TeX\ is stable.
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5. \TeX is stable, but not rigid.
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6. \TeX\ input is plain text. (Therefore, small!)
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6. \TeX input is plain text. (Therefore, small!)
7. \TeX output can be anything.
8. \TeX is free.
Top ten reasons to learn \TeX

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4. \TeX{} is stable.
5. \TeX{} is stable, but not rigid.
6. \TeX{} input is plain text. (Therefore, small!)
7. \TeX{} output can be anything.
8. \TeX{} is free.
9. \TeX{} runs anywhere.
Top ten reasons to learn \TeX

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6. \TeX\ input is plain text. (Therefore, small!)
7. \TeX\ output can be anything.
8. \TeX\ is free.
9. \TeX\ runs anywhere.
10. \TeX\ is the standard.