My First Document

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1 Introduction

1.1 Lines of Text

this is text. but entering a new line does not create a new line
this creates a new line

this creates a new line 5.75 millimetres from the previous

this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph, this creates a new paragraph

1.2 Some Text Formatting

Let's list out a few methods of formatting This is normal text. **This is bold-faced text.** *This is italicised text. This is also italicised.* This is underlined text.

This is centralised text. **This is bold, underlined and centralised text.**

1.3 Some Special Characters

Take note of the following special characters:

$ % ˆ & { } \

Take note of accents:

L'Hôpital's Rule, Hölder's Inequality, . . . , for more accents just Google

Quotation Marks: ”this is a bad quote”, “this is a good quote”... in general never use ”, always use ‘ and ’.

2 Mathematics

In this section, we will cover the essential features of the LaTeX mathematical environment.

2.1 Basic Mathematics

The most basic mathematical environment: $x + y - z = 0$... note the difference from x + y - z = 0.

1. Simple Mathematical Symbols.
   (a) One useful reference in general is Detexify (Google it).
   (b) Greek: $\alpha, \beta, \gamma, \delta, \sigma, \Sigma, \Gamma$... compare $\epsilon > 0$ with $\varepsilon > 0$... also $\phi = \varphi$
   (c) Common Symbols: $\{1, 2, 3\} \subseteq \{1, 2, 3, 4\}$, $\infty \notin R$ a function $f(x) = x + 2$... $\sin x, \cos x, \log x$... by the way, please do not write $sin(x), cos(x), log(x)$...
   (d) More Symbols: $f : A \to B, g : B \to X \implies g \circ f : A \to C$
2. Subscripts, Superscripts & Fractions.
   (a) Subcripts: $x_1, x_2, x_3, \dots, x_{n+1}$
   (b) Superscripts: $x^1, 2^{31}, 100^x$
   (c) Fractions: $\frac{1}{2}$, $\frac{1}{1+\frac{1}{n}}$, $\frac{22}{7} \approx \pi$
   (d) Compositions: e is the limit of the sequence $x_n = (1 + \frac{1}{n})^n$ as $n \to \infty$... $\omega_{1_{2_3}}^{4^{5^6}}$... always remember subscripts first, then superscripts ... α_1^ε.
3. Mathematical Fonts
   (a) Default: a, b, c, d, e
   (b) BlackboardBold: $x \in \mathbb{R}$... $\mathbb{N} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R} \subset \mathbb{C} \subset \mathbb{H}$
   (c) Bold-faced: $\mathbf{P}(X \le a) = \frac{1}{3}$, $\mathbf{E}[X] = 0$ whereas $\mathbf{Var}[X] = 1$
   (d) Caligraphy: $(\Omega, \mathcal{A}, \mu)$ and $A \in \mathcal{A}$... (σ-algebra)
   (e) Fraktur: $\mathfrak{ABCDEFG}$... Cardinality of the continuum is $\mathfrak{c}$. $\mathfrak{Re}[x + iy] = x$

2.2 Equations

The first thing we need to know is how to write an "equation".

This is a numbered equation:

$$e^{i\pi} + 1 = 0. \tag{1}$$

This is an unnumbered equation:

$$\bar{X} = \frac{1}{n}(X_1 + X_2 + \cdots + X_n).$$

Let's learn how to write split equations

$$\begin{aligned} |x - z| &= |x - y + y - z| \\ &\le |x - y| + |y - z| \\ &< |x - y| + |y - z| + \varepsilon. \end{aligned} \tag{2}$$

2.3 Integrals, Limits, Summations

Integrals, limits, summations...

$$\int_a^b f(x)\,\mathrm{d}x = F(b) - F(a). \tag{3}$$

$$\iint f(x_1, x_2)\,\mathrm{d}x_1\mathrm{d}x_2. \tag{4}$$

$$\iiint f(x_1, x_2, x_3)\,\mathrm{d}x_1\mathrm{d}x_2\mathrm{d}x_3. \tag{5}$$

$$\iiiint f(x_1, x_2, x_3, x_4)\,\mathrm{d}x_1\mathrm{d}x_2\mathrm{d}x_3\mathrm{d}x_4. \tag{6}$$

$$\int\cdots\int f(x_1, \ldots, x_n)\,\mathrm{d}x_1\cdots\mathrm{d}x_n. \tag{7}$$

$$\oint_\Gamma f(z)\,\mathrm{d}z. \tag{8}$$

$$\lim_{n\to\infty} \frac{1}{n^2+n+1} = 0. \tag{9}$$

$$\sum_{k=1}^{n} k = \frac{n}{2}(n+1). \tag{10}$$

$$\sum_{i=1}^{\infty}\sum_{j=1}^{\infty} \alpha_{ij}. \tag{11}$$

$$F(x) = f(x) + \left(\int_0^x g(t)\,\mathrm{d}t + \cdots + C\right) \tag{12}$$

$$\pi = \sqrt{6\sum_{n=1}^{\infty}\frac{1}{n^2}} \tag{13}$$

2.4 Matrices, Vectors

$$A = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}. \tag{14}$$

$$B = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}. \tag{15}$$

Let $\vec{v} \in \mathbb{R}^n$, we may write this vector as

$$\vec{v} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}. \tag{16}$$

3 Theorems, Lemmas, Definitions & Corollaries

This section is mainly for Mathematics majors.

Definition 3.1 (Convergent Sequences)**.** *Let $(x_n)_{n=1}^{\infty}$ be a sequence in $\mathbb{R}$. A sequence is said to converge to a limit ℓ if, for any given $\varepsilon > 0$ there exists $N \in \mathbb{N}$ such that $n \geq N$ implies $|x_n - \ell| < \epsilon$. We denote this by $x_n \to \ell$, or*

$$\lim_{n\to\infty} x_n = \ell \tag{17}$$

Based on Definition 3.1 alone, we can prove the following Lemma.

Lemma 3.2. *If $\lim_{n\to\infty} x_n = \ell$, then $\lim_{n\to\infty} |x_n| = |\ell|$.*

Proof. The proof is left as an exercise. □

Remark 3.3. *The converse of Lemma 3.2 is not true in general!*

Theorem 3.4 (Central Limit Theorem)**.** *Let $X_1, X_2, X_3, \ldots$ be a sequence of IID random variables with finite mean μ and variance σ^2. Then, as $n \to \infty$*

$$\frac{\bar{X} - \mu}{\sigma/\sqrt{n}} \xrightarrow{d} \mathcal{N}(0, 1). \tag{18}$$

Theorem 3.4 was proved by Pierre-Simon Laplace (see [2]) a long time ago.

Corollary 3.5. *Let $X \sim$ Binomial(n, p) and set $q = 1 - p$. Then for sufficiently large values of $n \in \mathbb{N}$, the distribution of X can be approximated by*

$$Y \sim \mathcal{N}(np, npq). \tag{19}$$

4 Other Stuff

4.1 Tables

This is a table:

Name	Favourite Food
Mark	Cookies
Einstein	Sandwiches

4.2 Figures

This is a figure:

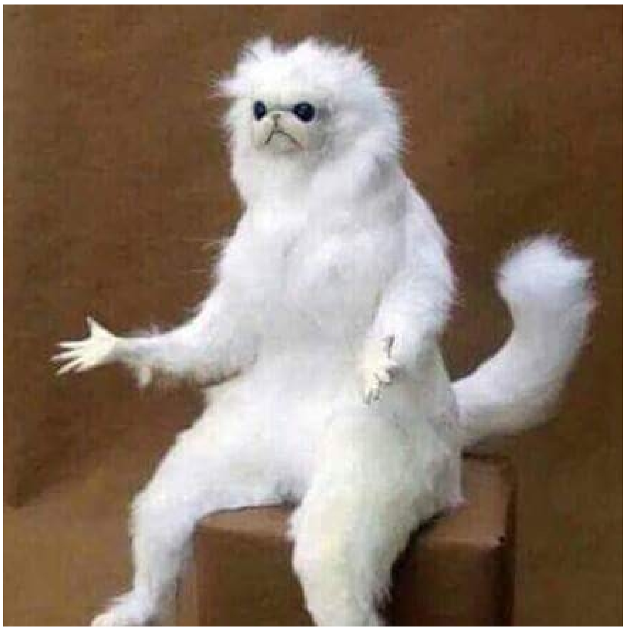

Figure 1: What?!?!?

References

[1] Mark Ng (2017), "*A First Course in LaTeX*". NUS Mathematics Society.

[2] Pierre-Simon Laplace (1812), "*Théorie analytique des probabilités*". Paris, Ve. Courcier.