LaTeX Tutorial: Exercise Handout

Department of Statistics, Chiang Mai University

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This document contains the exercises for the "Introduction to LaTeX" workshop. Please complete each exercise as directed by the instructor.

Exercise 1: Your First Document

Task: Write the following document. Replace bracketed text with your own information and pay close attention to the special characters and quotes.

Exercise 1

My Research Profile
Authored by: [Your Name]

1. Motivation

My work focuses on the 68% of statistical problems involving high-dimensional data. As of 2025, the "data explosion" requires new methods. My goal is to develop new models that are both theoretically sound & practically applicable. The cost of failure is at least $1 million in some fields.

2. Core Areas

My research interests include:

- Bayesian Inference
- High-Dimensional Data Analysis

Exercise 2: Basic Equations

Task: Add a new section and typeset the following formulae:

Exercise 2

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}.$$

$$f(x \mid \mu, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right).$$

$$1^2 + 2^2 + \ldots + n^2 = \sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}.$$

$$\int_{-\infty}^{\infty} f(x)g(x)\,\mathrm{d}x \leq \left(\int_{-\infty}^{\infty} f(x)^2\,\mathrm{d}x\right)^{1/2} \left(\int_{-\infty}^{\infty} g(x)^2\,\mathrm{d}x\right)^{1/2}.$$

$$Y = \beta_0 + \beta_1 X + \epsilon, \quad \text{where} \quad \epsilon \sim \mathcal{N}(0, \sigma^2).$$

Exercise 3: Cross-Referencing Equations

Task: Add a new section and typeset the following derivation of the Chebyshev's inequality:

Exercise 3

Recall the Markov's inequality:

$$\mathbb{P}(Y \geq a) \leq \frac{\mathbb{E}[Y]}{a}, \tag{1}$$

and the definition of the variance:

$$\mathbb{E}[(X-\mu)^2] = \sigma^2. \tag{2}$$

Letting $Y = (X-\mu)^2$, it follows from (1) and (2) respectively that

$$\begin{aligned}
\mathbb{P}\left(|X-\mu| \geq a\right) &= \mathbb{P}\left((X-\mu)^2 \geq a^2\right) \\
&\leq \frac{\mathbb{E}[(X-\mu)^2]}{a^2} \\
&= \frac{\sigma^2}{a^2}.
\end{aligned}$$

This final line is the *Chebyshev's inequality.*

Exercise 4: Alignment and Macro

Task: Add a new section. Add a `\newcommand` to your preamble for the expectation operator, `\mathbb{E}`. Then, typeset the following derivation using the `align*` environment.

Exercise 4

The variance of a random variable X can be derived from the definition of variance and the linearity of expectation:

$$\begin{aligned}\operatorname{Var}(X) &= \mathbb{E}[(X - \mathbb{E}[X])^2] \\ &= \mathbb{E}[X^2 - 2X\mathbb{E}[X] + (\mathbb{E}[X])^2] \\ &= \mathbb{E}[X^2] - 2\mathbb{E}[X]\mathbb{E}[X] + (\mathbb{E}[X])^2 \\ &= \mathbb{E}[X^2] - (\mathbb{E}[X])^2.\end{aligned}$$

Exercise 5: Matrices and Cases

Task: Add the following mathematical definitions to your document. Use the `bmatrix` environment for the matrix and the `cases` environment for the piecewise function. Use display math `\[...\]` for these unnumbered equations.

Exercise 5

The covariance matrix for two random variables X and Y is given by:

$$\Sigma = \begin{bmatrix} \operatorname{Var}(X) & \operatorname{Cov}(X,Y) \\ \operatorname{Cov}(Y,X) & \operatorname{Var}(Y) \end{bmatrix}.$$

The probability density function of the exponential distribution is:

$$f(x) = \begin{cases} \lambda e^{-\lambda x} & \text{if } x \geq 0 \\ 0 & \text{otherwise,} \end{cases} \qquad \text{for any } x \in \mathbb{R}.$$

Exercise 6: Figures and Tables

Task: Create the table and figure below and refer to them in a sentence.

1. Create the table using the `booktabs` package commands (`\toprule`, etc.). Add the caption and label.

Item	Qty	Unit $
Widget	1	199.99
Gadget	2	399.99
Cable	3	19.99

Table 1: Prices of stuff.

2. Add a figure of Moo Deng. Add the caption and label.

Figure 1: Moo Deng.

3. Write the sentence: "The prices of stuff are summarized in Table 1 and the picture of Moo Deng is shown in Figure 1."

Exercise 7: Managing a Bibliography

Task: Add a bibliography to your document.

1. In Overleaf, create a new file named `my_references.bib`.
2. Go to Reference 1 and Reference 2 and copy the BibTeX entries from the websites to `my_references.bib`.
3. In your main `.tex` file, add `\bibliographystyle{plain}` and `\bibliography{my_references}` before the `\end{document}` command.
4. Add the following sentence to your document: "For variable selection in high dimensions, a popular method is the Lasso [1, 2]."

Exercise 8: Your First Beamer Presentation

Task: Create a **new Beamer project** in Overleaf. Reproduce the following slides.

- **Slide 1 (Title):** Use either the `SimplePlus` or `metropolis` theme. Title the presentation "A Quick Summary".
- **Slide 2 (List):** Create a frame titled "How to Present Your Work". Add the following bullet points so they appear one-by-one (e.g., using `\begin{itemize}[<+->]`).
  - **Start with your audience in mind.** Think about what the audience will want to know, what might confuse them, what might potentially interest them.
  - **Craft a story.** Don't present the whole paper. Let your main idea and your most critical result drive the story of your presentation.
  - **Guide audience's attention.** Use visual cues (e.g, highlighting, arrows, animations, or step-by-step reveals) to direct your audience's focus to exactly what matters most on each slide.
- **Slide 3 (Columns):** Create a frame titled "The Core Model". Use a `columns` environment. In the left column, show the linear model equation from Exercise 2. In the right column, add an `alertblock` titled "Important" with the text "The error term ϵ_i is assumed normal.", which shows up one frame after the left column.

References

[1] Robert Tibshirani. Regression shrinkage and selection via the lasso. *Journal of the Royal Statistical Society. Series B (Methodological)*, 58(1):267–288, 1996.

[2] Hui Zou. The adaptive lasso and its oracle properties. *Journal of the American Statistical Association*, 101(476):1418–1429, 2006.