PROJECT 3 REPORT (REPLACE WITH YOUR OWN REAL TITLE)

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Abstract. The Project 3 Report is due Wednesday, May 10 at 4:00pm. Your project report will be the main item I will use to evaluate your project (though I will also take into account class attendance participation). The goal of the project report is to share the problem you explored, the methods you tried, the results you found, your explanations for these results, the new questions you uncovered, and the ideas you want to try next. If your Project 3 is on the same topic as your Project 1 or 2, then your report can be a continuation of your Project 1 or 2 report!

To submit your report, email Henry at `henry.adams@colostate.edu`. Attach your project report and any code that you wrote. You don't need to attach data or code that you didn't write (though you're welcome to if they're small), but do include links to this data and code in your report. Make clear which code you wrote, which code you didn't write, and which parts of code you may have modified.

Several pieces of advice:

(1) Make sure you keep me up-to-date with your plan for the project, and that I approve of the level of mathematics that you're using.
(2) I'm a big fan of great exposition. Spend time explaining the basics of your project very clearly (with pictures or examples if possible), else otherwise your reader won't make it to the more complicated sections. Typically, an idea should be explained first in english words and in math notation. Only afterwards should you consider explaining the implementation of that idea in pseudocode.
(3) Feel free to include hand-drawn figures in your report (take a picture with your phone or computer and then include the picture as a figure in LaTeX). Professional figures are nice, but a hand drawn figure is a fine substitute when a professional figure takes too long to make.

Do include an abstract in your report. The abstract can repeat information from your introduction and conclusion sections. Whereas the introduction section will be a gentle introduction to your topic of study, the abstract can be written for an expert, with the goal of tersely describing the main ideas of what you did in your project.

1. Information on LaTeX

This project report must be written in LaTeX. ShareLaTeX[1] and Overleaf[2] are relatively easy ways to write LaTeX files online. On my Mac I use TeXShop[3]. On the Weber 205 linux machines you can use Texmaker[4], TeXworks[5], or TeXnicCenter[6], and you can also download

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[1] `https://www.sharelatex.com`
[2] `https://www.overleaf.com`
[3] `http://pages.uoregon.edu/koch/texshop`
[4] `http://www.xm1math.net/texmaker`
[5] `https://www.tug.org/texworks/`
[6] `http://www.texniccenter.org`

these or similar programs for free on your own machine. A list of common LaTeXsymbols is available at ([7]), and you can also search for symbols using Detexify[8].

2. Introduction

This document is a description of what I expect for the project report, as well as a template that you may edit in order to write your project report in LaTeX. There is no length requirement for the project report. Instead, you will be evaluated on the quality of your ideas and the clarity of your exposition. Feel free to show me drafts of your report prior to the due date and I will give you feedback.

What follows is a list of sections or subsections that you may choose to include in your project report. This organization is only a very loose guide — change the section titles and organization as you best see fit for your particular project.

In the introduction section, briefly state the problem your project addresses, the main ideas of your analysis, and perhaps a sneak-peak into some of your findings. End the introduction with a brief description of what is contained in the report, such as:

"In Section 3 we state the problem, in Section 4 we overview related work, and in Section 5 we describe our method. We share our results in Section 6, evaluate the strengths and weaknesses of our method in Section 7, and conclude in Section 8."

3. Problem formulation

In this section, state precisely the problem you are addressing. Why is this problem interesting?

4. Related work

Have other people worked on similar things? Here is an example citation [1]. Here is another [2]. You can cite both at once [1, 2]. Feel free to try something on your own first and then only later look into what others have done later — in this class it's fine if you reinvent the wheel.

5. Our method

What approach are you taking to address this problem? What assumptions are you making? What are some of the justifications for your method?

6. Results

What results did you find? What are your explanations (or best guesses at explanations) for these findings? If your method depends on the choice of parameters, how sensitive are your results to those parameters?

The rest of this section contains LaTeXexamples of bullet points, numbered lists, math equations, figures, tables, theorems and definitions, and common LaTeXerrors.

[7] `https://www.artofproblemsolving.com/wiki/index.php/LaTeX:Symbols`

[8] `http://detexify.kirelabs.org/classify.html`

6.1. **Bullet points and lists.** Here is how you create bullet points in LaTeX.

- First point.
- Second point.

Here is how you create a numbered list in LaTeX.

(1) First point.
(2) Second point.

6.2. **Example math equations.** Here are example math equations: $ax^2 + bx + c = \frac{1}{2}e^{\pi i}$ or $\int_{K_i} e^{-\|u\|_1} du = \frac{1}{2^{2i+1}} C_i$ or $f(x) = \log(x) + 5$. You can also write math equations on their own line, such as

$$\int_{-3}^{5} \sin(x) dx \leq \int_{-3}^{5} |\sin(x)| dx < \infty$$

or

$$\sum_{i=0}^{\infty} \Big(\frac{1}{2^{2i+1}} C_i \Big) x^i = \frac{1}{2} \sum_{i=0}^{\infty} C_i \Big(\frac{x}{4} \Big)^i = \frac{1}{1 + \sqrt{1-x}}.$$

When I write a displayed math equation in a sentence, I punctuate it as

$$\sum_{i=0}^{\infty} \Big(\frac{1}{2^{2i+1}} C_i \Big) x^i = \frac{1}{2} \sum_{i=0}^{\infty} C_i \Big(\frac{x}{4} \Big)^i = \frac{1}{1 + \sqrt{1-x}}$$

or

$$\sum_{i=0}^{\infty} \Big(\frac{1}{2^{2i+1}} C_i \Big) x^i = \frac{1}{2} \sum_{i=0}^{\infty} C_i \Big(\frac{x}{4} \Big)^i = \frac{1}{1 + \sqrt{1-x}},$$

where a comma at the end is allowed. When I end a sentence with a displayed math equation, I punctuate it as

$$\sum_{i=0}^{\infty} \Big(\frac{1}{2^{2i+1}} C_i \Big) x^i = \frac{1}{2} \sum_{i=0}^{\infty} C_i \Big(\frac{x}{4} \Big)^i = \frac{1}{1 + \sqrt{1-x}}.$$

When text appears in an equation, such as $coeff = 5c$, the spacing gets ugly. To fix this, use either the command `\mathrm{ }` or `\mbox{ }`, as shown here: $\mathrm{coeff} = 5c$ or $\mbox{coeff} = 5c$.

LaTeXhas several built-in math commands, such as $\lim_{x \to 0} x^2$, $\cos(x)$, and $\min_{x \geq 3} f(x)$.

Sometimes you get tired of writing a command over and over again, such as `\mathbb{R}` in order to produce $\mathbb{R}$. You can define new commands in LaTeX, for example on line 8 of this source file which says `\newcommand{\R}{\mathbb{R}}`. We can now write `\R` in order to produce $\R$. As another example, the new command on defined on line 9 of this source file allows us to write $\coeff = 5c$ more easily.

6.3. **Example figure.** Here is an example figure (see Figure 1). LaTeXwill sometimes move figures from where you place them, typically to the top or to the bottom of an adjacent page. This is standard when publishing papers—typically the author needs to allow the publisher to move the figure to where the publisher best sees fit. My recommendation is to not try too hard to force the exact location of your figures; mitigate this issue by citing the figure in your text (Figure 1). If you really need to force a figure location, talk to Henry for how to do this.

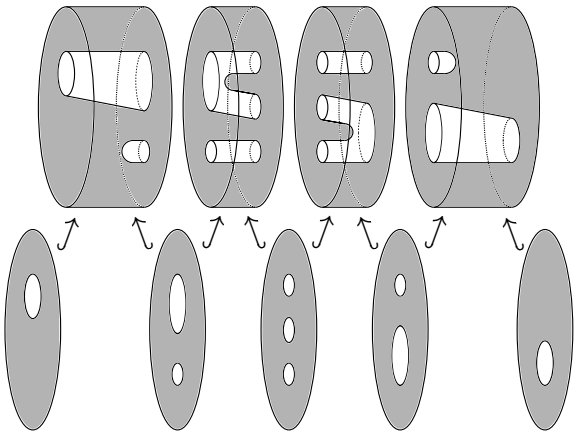

FIGURE 1. Here is an example caption.

6.4. **Example table.** Here is an example table:

title1	title2	title3
15	cell	π
9	$ax - y$	test
42	∞	$\sqrt{2}$

6.5. **Definitions, lemmas, theorems, proofs.**

Definition 6.1. Here's how you emphasize a definition.

Lemma 6.2. Here's how you state a lemma.

Proof. Here's how you write a proof. □

Theorem 6.3. Here's how you state a theorem.

Proof. Here's how you write a proof. □

Question 1. Here's how you emphasize a question.

Here's how you refer to Definition 6.1, Lemma 6.2, Theorem 6.3, or Question 1.

6.6. **Common questions.**

- Here's how you cite a reference [1].
- Here's how you write a webpage: `http://www.math.colostate.edu/~adams/`.
- Here's how you write a percentage sign: 95%.
- Here's how you write an underscore: image_3.

6.7. **Common errors.**

- The first time you use any math symbol, be sure you define or explain it. For example, instead of saying "$x \sim N(\mu, \sigma^2)$", say "random variable x is normally distributed with mean μ and variance σ^2, which we denote by $x \sim N(\mu, \sigma^2)$".
- The first time you use any acronym (PCA), be sure you define it (Principal Component Analysis).
- Don't write "inside quotes". Instead, write "inside quotes".

- Don't write i.e. or e.g. or et al. since the spacing is poor. Instead, write i.e. or e.g. or et al. with the correct spacing.

7. Discussion and future work

What are some of the pros and cons of your method? What extensions could be added? Do you have any predictions, guesses, or wild conjectures that you'd like to make? What are some avenues for future work, or questions that could be considered next?

8. Conclusion

Summarize the main ideas and key points of your project.

9. Acknowledgements

Acknowledge people (besides me or your project group) who helped you with various aspects of your project — for example other students in Math 435 or other faculty at CSU you may have gotten advice from. Acknowledge places where you borrowed code.

References

[1] Karl Pearson. On lines and planes of closest fit to systems of points in space. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 2(11):559–572, 1901.

[2] Ingo Steinwart and Andreas Christmann. *Support vector machines*. Springer Science & Business Media, 2008.