Thesis template title

by
Your Name

Master of Science Thesis in
Applied and Computational Mathematics

Department of Mathematics
University of Bergen

November 2017

Abstract

The abstract goes here. It should contain information about why the work was done, which problem that was solved, what was done, what is new, and how it was done.

If you are curious about how to write mathematics, perhaps this is of help.

- `http://web.cs.ucdavis.edu/~amenta/w10/writingman.pdf`
- `https://www.math.uh.edu/~tomforde/Books/Halmos-How-To-Write.pdf`

Acknowledgements

Write acknowledgements here.

Contents

Notation

- **Groups**

  $\mathbb{Z}$: Additive integers

  $\mathbb{Z}_n = \mathbb{Z}/n\mathbb{Z}$: Additive integers mod n

  $\mathbb{R}$: Additive reals

  $T = \mathbb{R}/\mathbb{Z}$: Additive reals mod 1

  $GL(n, \mathbb{Z})$: Invertible matrices over $\mathbb{Z}$

- **Objects**

  G, H : Abelian groups

  U, V : Unimodular matrices

  I_n : Identity matrix of size n

- **Binary operators**

  $+$: Addition

  $*$: Convolution

  $\oplus$: Direct sum

- **Relations**

  $\cong$: Isomorphic

  $>$: Greater than

  $\geq$: Greater than or equal to

Abbreviations

ML - Maximum likelihood

MAP - Maximum a posteriori

Chapter 1

Introduction

1.1 Introduction

The introduction goes here.

1.2 Chapter overview

An overview of each chapter goes here.

Chapter 1 – Introduction This chapter.

Chapter 2 – Basic LaTeX Some latex basics here.

Chapter 3 – More LaTeX Even more latex stuff here.

Appendices There is only one appendix, namely Appendix A, which contains an example of how Python code can be included in a thesis.

Chapter 2

Basic LaTeX

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.1 A section with a definition and a theorem

The above is a section. Here's a definition.

Definition 2.1 (Conditional probability). *The conditional probability of A given B is defined as*

$$P(A|B) = \frac{P(A \cap B)}{P(B)},$$

where $A \cap B$ denotes the intersection of A and B. ⌟

Theorem 2.2 (Bayes theorem). *Given $P(A|B)$, $P(A)$ and $P(B)$, we can compute $P(B|A)$ using*

$$P(B|A) = \frac{P(A|B)P(B)}{P(A)}. \tag{2.1}$$

Proof. Write $P(A \cap B)$ in two ways using the Definition 2.1 of conditional probability

as follows.

$$P(A \cap B) = P(A|B)P(B) \qquad P(B \cap A) = P(B|A)P(A)$$

The intersection is symmetric, meaning that $B \cap A = B \cap A$. Thus we can compare terms and write $P(A|B)P(B) = P(B|A)P(A)$, rearranging this gives Bayes theorem. □

Bayes theorem has many applications, such as the *Naive Bayes Classifier*, which is a machine learning algorithm. The classifier assigns a label to a piece of data, e.g. classifying an email as spam or not. It's called "naive" since it assumes conditional independence. Equation (2.1) has extensions when more variables are used.

2.2 A section with an example

In Section 2.1 we gave a theorem, here's an example with a real world application.

Example 2.3 (An example with numbers). Here's a little example with some numbers.

$$\begin{aligned} P(B|A) &= \frac{P(A|B)P(B)}{P(A)} \\ &= \frac{(0.3)(0.4)}{0.24} = \frac{0.12}{0.24} = \frac{1}{2} \end{aligned}$$

As you see, applications are everywhere. ⌟

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2.3 A section with a figure

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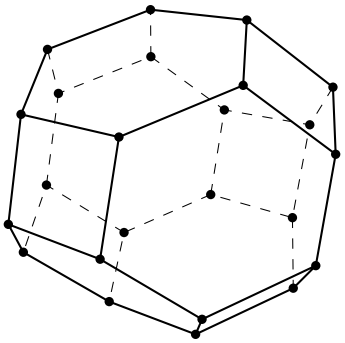

Figure 2.1: A pretty figure.

text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Chapter 3

Some more LaTeX

3.1 References and lists

Although [Strang, 1976] is a great introduction to linear algebra, [Roman, 2005] presents the material in a more abstract way.

Here's a list of some linear algebra concepts.

1. Linear algebra is about matrices and vectors.
   (i) The elements are usually numbers from $\mathbb{R}$ or $\mathbb{C}$.
   (ii) Matrices are given by two indices, vectors by one.
2. Matrix multiplication is given by $y_i = \sum_j A_{ij} x_j$.
3. If $A = a_{ij}$, then the tranpose flips across the diagonal so that $A^T = a_{ji}$. The transpose is the adjoint, i.e. $\langle Ax, y \rangle = \langle x, A^T y \rangle$.

Here's a different type of list.

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3.2 Algorithms

Here's an algorithm.

Algorithm 1: Algorithm for a thesis.

Input : Student s.
Output : Inverse s^{-1} such that $s \circ s^{-1} = s^{-1} \circ s = \mathrm{Id}$.

```
// Morning.
```
1 Grab coffee;
2 **while** *thesis not finished* **do**
3 | Read mathematics;
4 | Write thesis;
5 **end**
6 Relax for an hour;

```
// Evening.
```
7 **for** *every friend* $f \in F$ **do**
8 | Call f; `// Give your friends a call.`
9 **end**
10 Sleep;

Notice in Algorithm 1 above that the student does in fact call his friends in line 8.

Here's some Python code.

```python
def square(x):
    return x*x

def add(x):
    return x + 2

def compose(f, g):
    """Composition of functions. A higher order function.
    """
    def composed_function(*args, **kwargs):
        return f(g(*args, **kwargs))
    return composed_function

f, g = square, add

composed_f_g = compose(f, g)
composed_g_f = compose(g, f)

print(composed_f_g(2)) # 16
print(composed_g_f(2)) # 6
```

3.3 title

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Bibliography

[Roman, 2005] Roman, S. (2005). *Advanced linear algebra*, volume 135 of *Graduate texts in mathematics*. Springer, New York, 2nd ed. edition.

[Strang, 1976] Strang, G. (1976). *Linear algebra and its applications*. Academic Press, San Diego, 3nd ed. edition.

Appendices

Appendix A

Example code

sdf