Bachelor/Master's Thesis

Your title goes here

Your Name

Examiner: Prof. Dr. Bugs Bunny
Advisers: Terence Hill, Bud Spencer

Albert-Ludwigs-University Freiburg
Faculty of Engineering
Department of Computer Science
Chair for Thesis Templates

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Writing period

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Examiner

Prof. Dr. Bugs Bunny

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Albert-Ludwigs-Universität Freiburg
Technische Fakultät
Institut für Informatik
Lehrstuhl für Thesis-Templates

3. April 2017

Bearbeitungszeit

05. 07. 2016 – 05. 10. 2016

Gutachter

Prof. Dr. Bugs Bunny

Betreuer

Terence Hill, Bud Spencer

Declaration

I hereby declare that I am the sole author and composer of my thesis and that no other sources or learning aids, other than those listed, have been used. Furthermore, I declare that I have acknowledged the work of others by providing detailed references of said work.
I hereby also declare that my Thesis has not been prepared for another examination or assignment, either wholly or excerpts thereof.

Place, Date	Signature

Abstract

foo bar

Zusammenfassung

German version is only needed for an undergraduate thesis.

Inhaltsverzeichnis

1 Introduction

This is a template for an undergraduate or master's thesis. The first sections are concerned with the template itself. If this is your first thesis, consider reading Section 1.3.

The structure of this document is only an example. Discuss with your advisor what structure fits best for your thesis.

1.1 Template Structure

- To compile the document either run the `Makefile` or run your LaTeX compiler on the file 'thesis_main.tex'. The included `Makefile` requires `latexmk` which automatically runs `bibtex` and recompiles your document as often as needed. Moreover, it automatically places all output files (`aux`, `bbl`, ...) in the folder '`out`'. As the pdf file also goes in there, the `Makefile` copies the pdf file to the parent folder. There is also a `Makefile` in the `chapters` folder, to ensure you can also compile from this directory.

- The file '`setup.tex`' includes some useful packages and defines commands. For more details see Section 1.2.

- The source for each chapter is in a separate file the folder `chapters`.

- The folder `bib` contains `.bib` files that contain entries for the references in a structured form called bibtex entry. For a thesis it is usually

sufficient to have a single `.bib` file, but you might obtain files from your advisor or from the internet. If you add some or rename the existing ones, these changes must be reflected in the argument of the `bibliography` command in `thesis_main.tex`. The `cite` command refers to bibtex entries by their key Kingma and Ba [2014], Bromley et al. [1993], Muja and Lowe [2009].

- The template is written in a way that eases the switch from the `scrbook` to the `book` class. If you are not a fan of KOMA you can just replace the documentclass in the main file. The only thing that needs to be changed in `setup.tex` is the caption styling, see the comments there.

1.2 setup.tex

Edit `setup.tex` according to your needs. The file contains two sections, one for package includes and one for defining commands. At the end of the includes and commands there is a section that can safely be removed if you do not need algorithms or tikz. Do not forget to adapt the pdf hypersetup!! `setup.tex` defines:

- some new commands for remembering to do stuff:
  - `\todo{Do this!}`: **(TODO: Do this!)**
  - `\extend{Write more when new results are out!}`: **(EXTEND: Write more when new results are out!)**
  - `\draft{Hacky text!}`: **(DRAFT: Hacky text!)**
- some commands for referencing, 'in `\chapref{chap:introduction}`' produces 'in Chapter 1'
  - `\chapref{}`
  - `\secref{sec:XY}`

  - `\eqref{}`
  - `\figref{}`
  - `\tabref{}`

- the colors of the univerty's corporate design, accessible with `{\color{UniX} Colored Text}`
  - UniBlue
  - UniRed
  - UniGrey

- a command for naming matrices `\mat{G}`, $\mathbf{G}$, and naming vectors `\vec{a}`, $\mathbf{a}$. This command overwrites the default behavior of having an arrow over vectors, sticking to the naming conventions normal font for scalars, bold-lowercase for vectors, and bold-uppercase for matrices.

- named equations:

```
\begin{align}
    d(a,b) &= d(b,a)\\ \eqname{symmetry}
\end{align}
```

$$d(a,b) = d(b,a) \tag{1}$$

symmetry

1.3 Advice

This section gives some advice how to write a thesis ranging from writing style to formatting. To be sure, ask your advisor about his/her preferences.

For a more complete list we recommend to read Donald Knuth's paper on mathematical writing. (At least the first paragraph). `http://jmlr.csail.mit.edu/reviewing-papers/knuth_mathematical_writing.pdf`

- If you use formulae pay close attention to be consistent throughout the thesis!
- In a thesis you never write 'In [24] the data is..'. You have more space than in a paper, so write 'AuthorXY et al. prepare the data... [24]'. The rule is that the text should remain grammatically correct even if the reference is erased. For that reason, the template uses `natbib` with style `plainnat`, which makes it much easier to stick to the rule. Most of the time the citation should be at the end of the sentence before the full stop with a no-break space. `... last word~\cite{XY}`. With `natbib` you can use the `citet` command to refer to the authors' name and cite at the same time. See `https://www.sharelatex.com/learn/Bibliography_management_with_natbib` for more information.
- Get your bibtex entries from `https://dblp.org/`.
- Pay attention to comma usage, there is a big difference between English and German. '...the fact that bla...' etc.
- Do not write contractions like 'don't ', 'can't', and so on. Instead write 'do not', 'cannot', and so on.
- If an equation is at the end of a sentence, add a full stop. If it is not the end, add a comma: $a = b + c \quad (1)$,
- Avoid footnotes if possible.
- Use ``'' for citing, not "".
- Captions of tables and figures do not end with a period, unless the

caption is a full sentence.

- Titles and headings ought to be capitalized properly. Here is a tool to help: `https://capitalizemytitle.com/`

- Check the spelling of your thesis before submitting. There are tools like `aspell` that help you find such mistakes. As a spell checker cannot find grammatical errors, it does not relieve you from properly reading your thesis again and from getting comments from somebody else. You can find an introduction under `https://git.fachschaft.tf/fachschaft/aspell`.

- If the thesis contains graphs or other drawings consider using `tikz`. Do not waste you time studying its manual except for the introduction and some examples, instead go for some of the examples available on the net and adapt. For function graphs or diagrams consider using `pgfplots` or `gnuplot`. Using latex-related tools has the advantage that the style is more consistent (same font, formatting options etc.) than with some external program.

- Discuss with your advisor whether to use passive voice or not. In most computer science papers passive voice is avoided. It is harder to read, more likely to produce errors, and most of the times less precise. Of course, there are situations where passive voice fits but in scientific papers they are rare. Compare the sentence: 'We created the wheel to solve this.' to 'The wheel was created to solve this'. You don't know who did it, making it harder to understand what is your contribution and what is not.

  The thesis should not be written in first person singular. First person plural is generally accepted, but it is good practice to avoid the pronouns 'we', 'our' etc as much as possible.

2 Background

Explain the general context of your work. Explain mathematical background required and introduce notation.

Abbildung 1: Use tikz to draw nice graphs!

Algorithm 1 Stochastic Gradient Descent: Neural Network

Create a mini batch of m samples $\mathbf{x}_0 \dots \mathbf{x}_{m-1}$
foreach sample $\mathbf{x}$ **do**
  $\mathbf{a}^{\mathbf{x},0} \leftarrow \mathbf{x}$ ▷ Set input activation
  foreach Layer $l \in \{1 \dots L-1\}$ **do** ▷ Forward pass
    $\mathbf{z}^{\mathbf{x},l} \leftarrow \mathbf{W}^l \mathbf{a}^{\mathbf{x},l-1} + \mathbf{b}^l$
    $\mathbf{a}^{\mathbf{x},l} \leftarrow \varphi(\mathbf{z}^{\mathbf{x},l})$
  end for
  $\boldsymbol{\delta}^{\mathbf{x},L} \leftarrow \nabla_{\mathbf{a}} C_{\mathbf{x}} \odot \varphi'(\mathbf{z}^{\mathbf{x},L})$ ▷ Compute error
  foreach Layer $l \in L-1, L-2 \dots 2$ **do** ▷ Backpropagate error
    $\boldsymbol{\delta}^{\mathbf{x},l} \leftarrow ((\mathbf{W}^{l+1})^T \boldsymbol{\delta}^{\mathbf{x},l+1}) \odot \varphi'(\mathbf{z}^{\mathbf{x},l})$
  end for
end for
foreach $l \in L, L-1 \dots 2$ **do** ▷ ▷ Gradient descent
  $\mathbf{W}^l \leftarrow \mathbf{W}^l - \frac{\eta}{m} \sum_{\mathbf{x}} \boldsymbol{\delta}^{\mathbf{x},l} (\mathbf{a}^{\mathbf{x},l-1})^T$
  $\mathbf{b}^l \leftarrow \mathbf{b}^l - \frac{\eta}{m} \sum_{\mathbf{x}} \boldsymbol{\delta}^{\mathbf{x},l}$
end for

3 Approach

The approach starts with the problem definition and continues with what you have done. Try to give an intuition first and describe everything with words and then be more formal like 'Let g be ...'.

Strive to make the following items crystal clear to your readers.

- What is the problem you are treating?
- What are the research questions you want to answer in this work?
- What are your own contributions and what is work of others? If you are working in a team, it is important to demarcate against the contributions of others in your team.

Describe each major technical problem and how it was solved.

3.1 Problem Definition

Start with a very short motivation why this is important. Then, as stated above, describe the problem with words before getting formal.

3.2 First Part of the Approach

3.3 N-th Part of the Approach

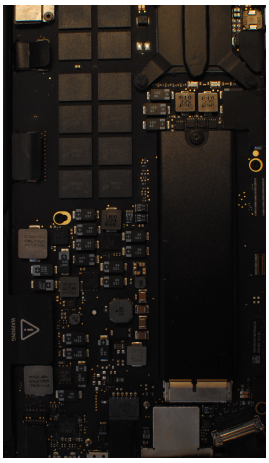
4 Experiments

Experiments often include benchmarks. You need to describe you benchmarking setup: parameters of the machine used (architecture, memory, etc), parameters of the software used (OS version, libraries used and their version), the benchmark programs. The programs need not be part of the thesis, but they should be described and available separately.

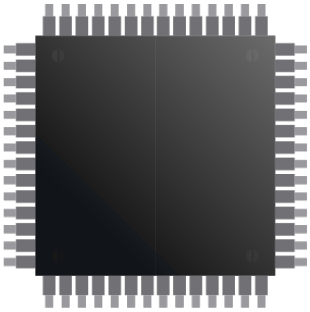
If you measure run times and evaluate your findings statistically, then there is great potential for errors. Consult SIGPLAN's checklist for empirical evaluations `http://www.sigplan.org/Resources/EmpiricalEvaluation/` for advice.

Type	Accuracy
A	82.47 ± 3.21
B	78.47 ± 2.43
C	84.30 ± 2.35
D	86.81 ± 3.01

Tabelle 1: Table caption. foo bar...



(a) Some cool graphic



(b) Some cool related graphic

Abbildung 2: Caption that appears under the fig Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

5 Related Work

Give a brief overview of the work relevant for your thesis. Closely related work should be compared in depth: what are the pros and cons of their work compared to yours?

6 Conclusion

Brief wrapup of the achievements of this thesis.

Directions for future work (if applicable).

Literaturverzeichnis

Jane Bromley, James W Bentz, Léon Bottou, Isabelle Guyon, Yann LeCun, Cliff Moore, Eduard Säckinger, and Roopak Shah. Signature verification using a "siamese" time delay neural network. *International Journal of Pattern Recognition and Artificial Intelligence*, 7(04):669–688, 1993.

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