EXPERIMENTAL CS THESIS

SOMETHING SOMETHING COMPUTER SCIENCE

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MASTER'S THESIS

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AARHUS
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DEPARTMENT OF COMPUTER SCIENCE

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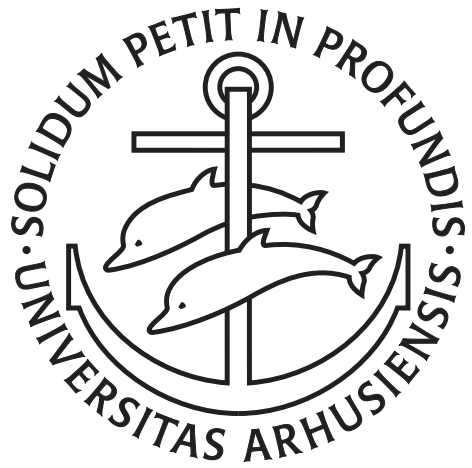


Something Something Computer Science

Master's Thesis
Department of Computer Science
Science & Technology
Aarhus University

September 2016

Ohana means family.
Family means nobody gets left behind, or forgotten.

— Lilo & Stitch

ABSTRACT

Short summary of the contents in English...

SAMMENFATNING

Kort sammenfatning på dansk...

PUBLICATIONS

This is just an early – and currently ugly – test!

This might come in handy for PhD theses: some ideas and figures have appeared previously in the following publications:

Attention: This requires a separate run of `bibtex` for your `refsection`, e.g.,, `ClassicThesis1-blx` for this file. You might also use `biber` as the backend for `biblatex`. See also `http://tex.stackexchange.com/questions/128196/problem-with-refsection`.

We have seen that computer programming is an art,
because it applies accumulated knowledge to the world,
because it requires skill and ingenuity, and especially
because it produces objects of beauty.

— Donald E. Knuth [7]

ACKNOWLEDGMENTS

Put your acknowledgments here.

Many thanks to everybody who already sent me a postcard!

Regarding the typography and other help, many thanks go to Marco Kuhlmann, Philipp Lehman, Lothar Schlesier, Jim Young, Lorenzo Pantieri and Enrico Gregorio[1], Jörg Sommer, Joachim Köstler, Daniel Gottschlag, Denis Aydin, Paride Legovini, Steffen Prochnow, Nicolas Repp, Hinrich Harms, Roland Winkler, Jörg Weber, Henri Menke, Claus Lahiri, Clemens Niederberger, Stefano Bragaglia, Jörn Hees, and the whole LaTeX-community for support, ideas and some great software.

Regarding LyX: The LyX port was intially done by *Nicholas Mariette* in March 2009 and continued by *Ivo Pletikosić* in 2011. Thank you very much for your work and for the contributions to the original style.

1 Members of GuIT (Gruppo Italiano Utilizzatori di TeX e LaTeX)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LISTINGS

ACRONYMS

DRY Don't Repeat Yourself

API Application Programming Interface

UML Unified Modeling Language

Part I

THE PROPER STRUCTURE OF A THESIS

The following reflects what I believe to be a good structure for a report or a thesis in experimental computer science. It contains a natural progression from the general to the specific, and from the work of others to the work by the authors, each chapter forming the foundation of the next.

1 INTRODUCTION

The purpose of the Introduction is make a short (2–6 pages) argument that should cover

- What this thesis is about
- Why it is interesting or important
- What are the central hypotheses that will be investigated
- How will the work be done

This is the place where the reader (who will be a computer scientist, but might not be a domain expert) should be convinced that not only is the topic interesting and important, the authors have also identified central questions/hypotheses pertaining the topic, and have a clear plan and methodology to address it.

1.1 WHAT MAKES A GOOD HYPOTHESIS?

For the purposes of a report or thesis, it is wise to concentrate on research questions and hypotheses that are decidable or quantifiable. E.g.,, it is better to state that "method A is better than method B under circumstances C" or "combining method A with architecture B improves on standard approach C" than "we can build a system that do X". This is why it is always a good idea to include baselines in your work, i.e.,, established methods or architectural choices that can used for comparison. If you do not have baselines yourself, you should at least be ready and able to compare your results with the published results of others.

If your thesis work is exploring wicked problems, the validation of your work will rely on other criteria than quantifiable measurements and rejections of hypotheses. Research through design is a young field and quality criteria are currently debated and developed. You may work with Zimmerman *et al.* [12], draw upon Gaver [6] and work with artefacts as theory nexus, as occupants of a design space creating a design space around themselves, or as annotated portfolios. Alternatively, you can approach HCI research as problem solving, as suggested by Oulasvirta and Hornbæk [9]:

> A research problem in HCI is a stated lack of understanding about some phenomenon in human use of computing, or stated inability to construct interactive technology to address that phenomenon for desired ends. [9, Definition 1]

The hypotheses should also address central aspects of the work, so that *if* these hypotheses are met, the overall work gains in credibility, or alternatively (and just as valid), if a hypothesis *cannot* be confirmed, it illustrates, why and how the assumptions behind the work were flawed, and, hopefully, how they can be improved.

1.2 WRITING A THESIS FOR READING

The purpose of the thesis is to be read as a whole in one sitting, and with this in mind it should be written, even if, in reality, it is authored over a period of months. The reader does not naturally understand the flow and process of the work involved (this understanding belongs to the authors, and upon the authors lies the sole responsibility of communicating the work done), and must therefore be guided through the work. In order to accomplish this, the readers should at all times have a ready answer in their mind to these questions:

- Why am I reading this?
- What comes next?
- How does this build upon what I just read?

So, why is something there? What is its purpose? How will it used later? Vice versa, later in the text, refer back to things established earlier (this also supports readers that do not necessarily read linearly). While a text grow piecemeal, it is most often read as a whole, and should appear as such, lest the reader loses interest.

To that end, it is a good idea to finish the introduction with a description of how the hypotheses are to be investigated, and how this is reflected in the structure of the thesis.

2 RELATED WORK

Whereas the purpose of the Introduction chapter was to entice and convince the reader that work reported is interesting, that the author is asking the right questions about it, and reading about it will be worthwhile, the purpose of the Related Work chapter is to demonstrate that the author possesses a fine overview and keen understanding of the topic of the work. Note that while the title of the chapter is "Related Work", it might as well be called "*Relevant* Work" in that you should only include work that are useful or relevant to your purpose.

Writing about others' work can be challenging—it is easy to succumb to just writing condensed summaries, which is just as tedious to read as they are to write. A better method is to gain an overview over the field of inquiry, and then establish in the first section what aspects or dimensions are crucial to systems or methodologies such as the ones described. This demonstrates to the reader that the author has understanding and judgement. Having done this, every paper or work can then be described in those established terms. This makes for easier and much more structured writing, and it also helps the reader differentiate the systems and works reported on. If there are multiple works that cover approximately the same area (e.g., using the same technique), you may mention several, but only go into detail with the most significant or representative one.

The chapter can then be concluded with a table summarising all the work reported on using the aspects defined in the introduction of the chapter.

A crucial element of this chapter is that it concerns the work of others and *only* that. While the selection of aspects or dimensions described above invariantly will reflect your own focus, that should be the extend of which your own work and plans influence this chapter. Your own judgement comes in the next chapter.

2.1 FRAMEWORKS AND TECHNOLOGIES

Related work need not be only published academic work. In many cases, it is also relevant to describe crucial frameworks and technologies that will be used or are relevant for the thesis. This does not mean that all employed technologies should be described in detail, but frameworks and technologies that are unusual (for lack of a better word) could be described here. E.g.,, there is no need to describe an ordinary network stack, but if the work involves GPU program-

ming, a description of the chosen architecture might well be relevant, as it informs all the following chapters.

3

ANALYSIS

This is where the authors can answer the question of what use we can derive from all the works described in the previous chapter. Ideally, the summary of the related work will show that there is room unexplored for what the authors have in mind. If there are differences between the included works on key aspects in the approach to be taken, this is where this should be identified, and a decision reached.

Having written the analysis, the author has all the tools needed to complete the next chapter.

4

DESIGN AND METHODOLOGY

Many of the other natural sciences have labs with equipment that has to be configured correctly to experimentally test stated hypotheses. Such experiments must be planned and designed in advance to work properly and provide valid and trustworthy results.

As computer scientists, we usually do not work in labs, and our experiments do not live in petri dishes. Still, we have hypotheses to test, and thus, experiments to plan. This planning phase is the design of the experiment, where the authors describe the system intended to test the hypotheses posed in the introduction.

Some hypotheses can be investigated wholly *in vitro*, testing, e.g., one algorithm against another. Other hypotheses require us to investigate further, involving, e.g., potential users or domain experts to properly evaluate our assumptions. It is therefore crucial to consider not only what you wish to create, but how you propose to evaluate it. For your study to have validity, the design of the evaluation is every bit as crucial as the design of the object being evaluated. The credibility of your study also relies on your ability to communicate the process with which you have reached your design.

A luxury of the design chapter is that the design may well go further than solely the confirmation or refutation of the hypotheses. If you are building a system, this is where you show that you know how to design one, even if you will actually not be implementing all of it. If you had sufficient time and resources, this is how you would make your system.

However, before we come to that, it is necessary to investigate whether the required hypotheses are valid. If they are not, the design must be reconsidered, and there is only one way to test them, namely through implementation, and subsequent evaluation.

5 IMPLEMENTATION

Where the design chapter concerned itself with the overall plan, this is where the actual experiment in the form of an implementation is taking form. It is not the purpose of the implementation to fully realise the design described in the previous chapter. It is the exclusive purpose of the implementation (a subset of the design) to either validate or refute the hypotheses put forth in the introduction. This, and nothing else. If it does less, you have posed questions you are not prepared to answer; if it does more, you should be coding less or asking additional questions.

The primary purpose of this chapter is to clearly communicate what has been built, and how it works. This can, e.g., include architectural diagrams, software and hardware overviews and specifics.

If it illustrates core aspects, e.g.,, the inner working of a particular important algorithm or function, code segments are welcome in this chapter, as long as they are short, to the point, well-commented and -formatted. It is also a good idea to provide the reader with a general overview of the structure of the code, as well as how communication between various parts takes place. The complete code (as well as your data) should be included separately with your report in the form of a zip-file or USB-stick.

Overall, the implementation is the computer scientist's equivalent of lab equipment carefully arranged into a experimental setup, and just as the validity of an experimental investigation will be judged in part on the craftsmanship of the setup, so will the quality of your implementation. It is therefore important to clearly communicate how your system works and how it was built, so that the reader may have confidence in your evaluation and conclusions.

6 EVALUATION

Having built the equivalent of a experimental setup, it is time to use the implementation to test the hypotheses.

This is usually broken down in stages and subquestions.

A structured approach to performing and reporting on experiments is to follow this pattern for every single experiment:

1. What is the purpose of the experiment?
2. What is the expected outcome?
3. What are the parameters under which the experiment takes place?
4. What are the results?
5. How do the results align with the expected outcome? If they do not align, why is that so?

Results should be presented summarised. For quantitative experiments, this will usually be in the form of tables and graphs. Remember to note the number of times experiments were repeated, as well as averages, and standard deviations (in percent of the mean). There is much more to the proper evaluation of experimental data than can be expounded upon here, but I turn the reader's attention to [4], which is freely available.

If your results are of a qualitative nature, the summaries will depend on the type of investigation you have done. It can be carefully annotated recordings of specific incidents of the system in use; analysis with quotes from interviews; or results from questionnaires and other investigations.

7 CONCLUSION

This, then is the grand summary of what you have accomplished. You may well imagine that many readers will read your Introduction, and then skip to the Conclusion, and if, and only if, those two parts are interesting, might be tempted to read the rest. A consequence is that you should ensure that the reader will gain a good overall understanding of what you have done by reading only the conclusion. Thus, this is a place to summarise all that has gone before, before finally concluding on the results of your experiments and the validity of your hypotheses. It is also important to ensure that the Introduction (which in all likelihood was written first) still aligns closely with the conclusions reached.

If you so desire, this is also where you might add a section on Future Work, where you point in the directions that should be followed to complete the work you have already accomplished.

Part II

SOME KIND OF MANUAL

8 INTRODUCTION

This bundle for LaTeX has two goals:

1. Provide students with an easy-to-use template for their Master's or PhD thesis. (Though it might also be used by other types of authors for reports, books, etc.)

2. Provide a classic, high-quality typographic style that is inspired by Bringhurst's "*The Elements of Typographic Style*" [2].

The bundle is configured to run with a *full* MiKTeX or TeXLive[1] installation right away and, therefore, it uses only freely available fonts. (Minion fans can easily adjust the style to their needs.)

People interested only in the nice style and not the whole bundle can now use the style stand-alone via the file `classicthesis.sty`. This works now also with "plain" LaTeX.

As of version 3.0, `classicthesis` can also be easily used with LyX[2] thanks to Nicholas Mariette and Ivo Pletikosić. The LyX version of this manual will contain more information on the details.

This should enable anyone with a basic knowledge of LaTeX 2ε or LyX to produce beautiful documents without too much effort. In the end, this is my overall goal: more beautiful documents, especially theses, as I am tired of seeing so many ugly ones.

The whole template and the used style is released under the GNU General Public License.

If you like the style then I would appreciate a postcard:

André Miede
Detmolder Straße 32
31737 Rinteln
Germany

The postcards I received so far are available at:

http://postcards.miede.de

So far, many theses, some books, and several other publications have been typeset successfully with it. If you are interested in some typographic details behind it, enjoy Robert Bringhurst's wonderful book.

A well-balanced line width improves the legibility of the text. That's what typography is all about, right?

1 See the file `LISTOFFILES` for needed packages. Furthermore, `classicthesis` works with most other distributions and, thus, with most systems LaTeX is available for.

2 http://www.lyx.org

IMPORTANT NOTE: Some things of this style might look unusual at first glance, many people feel so in the beginning. However, all things are intentionally designed to be as they are, especially these:

- No bold fonts are used. Italics or spaced small caps do the job quite well.
- The size of the text body is intentionally shaped like it is. It supports both legibility and allows a reasonable amount of information to be on a page. And, no: the lines are not too short.
- The tables intentionally do not use vertical or double rules. See the documentation for the `booktabs` package for a nice discussion of this topic.[3]
- And last but not least, to provide the reader with a way easier access to page numbers in the table of contents, the page numbers are right behind the titles. Yes, they are *not* neatly aligned at the right side and they are *not* connected with dots that help the eye to bridge a distance that is not necessary. If you are still not convinced: is your reader interested in the page number or does she want to sum the numbers up?

Therefore, please do not break the beauty of the style by changing these things unless you really know what you are doing! Please.

YET ANOTHER IMPORTANT NOTE: Since `classicthesis`' first release in 2006, many things have changed in the LaTeX world. Trying to keep up-to-date, `classicthesis` grew and evolved into many directions, trying to stay (some kind of) stable and be compatible with its port to LyX. However, there are still many remains from older times in the code, many dirty workarounds here and there, and several other things I am absolutely not proud of (for example my unwise combination of KOMA and `titlesec` etc.).

An outlook into the future of `classicthesis`.

Currently, I am looking into how to completely re-design and re-implement `classicthesis` making it easier to maintain and to use. As a general idea, `classicthesis.sty` should be developed and distributed separately from the template bundle itself. Excellent spin-offs such as `arsclassica` could also be integrated (with permission by their authors) as format configurations. Also, current trends of `microtype`, `fontspec`, etc. should be included as well. As I am not really into deep LaTeX programming, I will reach out to the LaTeX community for their expertise and help.

3 To be found online at http://mirror.ctan.org/macros/latex/contrib/booktabs/.

8.1 ORGANIZATION

A very important factor for successful thesis writing is the organization of the material. This template suggests a structure as the following:

You can use these margins for summaries of the text body...

- `Chapters/` is where all the "real" content goes in separate files such as `Chapter01.tex` etc.
- `FrontBackMatter/` is where all the stuff goes that surrounds the "real" content, such as the acknowledgments, dedication, etc.
- `gfx/` is where you put all the graphics you use in the thesis. Maybe they should be organized into subfolders depending on the chapter they are used in, if you have a lot of graphics.
- `Bibliography.bib`: the BibTEX database to organize all the references you might want to cite.
- `classicthesis.sty`: the style definition to get this awesome look and feel. Does not only work with this thesis template but also on its own (see folder `Examples`). Bonus: works with both LATEX and PDFLATEX... and LYX.
- `ClassicThesis.tcp` a TEXnicCenter project file. Great tool and it's free!
- `ClassicThesis.tex`: the main file of your thesis where all gets bundled together.
- `classicthesis-config.tex`: a central place to load all nifty packages that are used.

  Make your changes and adjustments here. This means that you specify here the options you want to load `classicthesis.sty` with. You also adjust the title of your thesis, your name, and all similar information here. Refer to Section 8.3 for more information.

  This had to change as of version 3.0 in order to enable an easy transition from the "basic" style to LYX.

In total, this should get you started in no time.

8.2 STYLE OPTIONS

. . . or your supervisor might use the margins for some comments of her own while reading.

There are a couple of options for `classicthesis.sty` that allow for a bit of freedom concerning the layout:

- General:
  - `drafting`: prints the date and time at the bottom of each page, so you always know which version you are dealing with. Might come in handy not to give your Prof. that old draft.
- Parts and Chapters:
  - `parts`: if you use Part divisions for your document, you should choose this option. (Cannot be used together with `nochapters`.)
  - `nochapters`: allows to use the look-and-feel with classes that do not use chapters, e.g.,, for articles. Automatically turns off a couple of other options: `eulerchapternumbers`, `linedheaders`, `listsseparated`, and `parts`.
  - `linedheaders`: changes the look of the chapter headings a bit by adding a horizontal line above the chapter title. The chapter number will also be moved to the top of the page, above the chapter title.
- Typography:
  - `eulerchapternumbers`: use figures from Hermann Zapf's Euler math font for the chapter numbers. By default, old style figures from the Palatino font are used.
  - `beramono`: loads Bera Mono as typewriter font. (Default setting is using the standard CM typewriter font.)
  - `eulermath`: loads the awesome Euler fonts for math. Palatino is used as default font.
  - `pdfspacing`: makes use of pdftex' letter spacing capabilities via the `microtype` package.[4] This fixes some serious issues regarding math formulæ etc. (e.g.,, "ß") in headers.
  - `minionprospacing`: uses the internal `textssc` command of the `MinionPro` package for letter spacing. This automatically enables the `minionpro` option, overriding `pdfspacing`.
- Table of Contents:
  - `tocaligned`: aligns the whole table of contents on the left side. Some people like that, some don't.
  - `dottedtoc`: sets pagenumbers flushed right in the table of contents.

4 Use `microtype`'s `DVIoutput` option to generate DVI with pdftex.

  - `manychapters`: if you need more than nine chapters for your document, you might not be happy with the spacing between the chapter number and the chapter title in the Table of Contents. This option allows for additional space in this context. However, it does not look as "perfect" if you use `\parts` for structuring your document.

- Floats:
  - `listings`: loads the `listings` package (if not already done) and configures the List of Listings accordingly.
  - `floatperchapter`: activates numbering per chapter for all floats such as figures, tables, and listings (if used).
  - `subfig(ure)`: is passed to the `tocloft` package to enable compatibility with the `subfig(ure)` package. Use this option if you want use `classicthesis` with the `subfig` package.

The best way to figure these options out is to try the different possibilities and see what you and your supervisor like best.

In order to make things easier, `classicthesis-config.tex` contains some useful commands that might help you.

8.3 CUSTOMIZATION

This section will show you some hints how to adapt `classicthesis` to your needs.

The file `classicthesis.sty` contains the core functionality of the style and in most cases will be left intact, whereas the file `classicthesis-config.tex` is used for some common user customizations.

The first customization you are about to make is to alter the document title, author name, and other thesis details. In order to do this, replace the data in the following lines of `classicthesis-config.tex`:

Modifications in `classicthesis-config.tex`

```
% ********************************************************
% 2. Personal data and user ad-hoc commands
% ********************************************************
\newcommand{\myTitle}{A Classic Thesis Style\xspace}
\newcommand{\mySubtitle}{An Homage to...\xspace}
```

Further customization can be made in `classicthesis-config.tex` by choosing the options to `classicthesis.sty` (see Section 8.2) in a line that looks like this:

```
\PassOptionsToPackage{eulerchapternumbers,drafting,listings,
    subfig,eulermath,parts}{classicthesis}
```

Many other customizations in `classicthesis-config.tex` are possible, but you should be careful making changes there, since some changes could cause errors.

Modifications in `classicthesis.sty`

Finally, changes can be made in the file `classicthesis.sty`, although this is mostly not designed for user customization. The main change that might be made here is the text-block size, for example, to get longer lines of text.

8.4 ISSUES

This section will list some information about problems using `classicthesis` in general or using it with other packages.

Beta versions of `classicthesis` can be found at Bitbucket:

`https://bitbucket.org/amiede/classicthesis/`

There, you can also post serious bugs and problems you encounter.

Compatibility with the `glossaries` Package

If you want to use the `glossaries` package, take care of loading it with the following options:

```
\usepackage[style=long,nolist]{glossaries}
```

Thanks to Sven Staehs for this information.

Compatibility with the (Spanish) `babel` Package

Spanish languages need an extra option in order to work with this template:

```
\usepackage[spanish,es-lcroman]{babel}
```

Thanks to an unknown person for this information (via the issue reporting).

FURTHER INFORMATION FOR USING `classicthesis` WITH SPANISH (IN ADDITION TO THE ABOVE) In the file `ClassicThesis.tex` activate the language:

```
\selectlanguage{spanish}
```

If there are issues changing `\tablename`, e.g.,, using this:

```
\renewcommand{\tablename}{Tabla}
```

This can be solved by passing `es-tabla` parameter to `babel`:

```
\PassOptionsToPackage{es-tabla,spanish,es-lcroman,english}{
    babel}
\usepackage{babel}
```

But it is also necessary to set `spanish` in the `\documentclass`.

Thanks to Alvaro Jaramillo Duque for this information.

Compatibility with the `pdfsync` Package

Using the `pdfsync` package leads to linebreaking problems with the `graffito` command. Thanks to Henrik Schumacher for this information.

8.5 FUTURE WORK

So far, this is a quite stable version that served a couple of people well during their thesis time. However, some things are still not as they should be. Proper documentation in the standard format is still missing. In the long run, the style should probably be published separately, with the template bundle being only an application of the style. Alas, there is no time for that at the moment... it could be a nice task for a small group of LaTeXnicians.

Please do not send me email with questions concerning LaTeX or the template, as I do not have time for an answer. But if you have comments, suggestions, or improvements for the style or the template in general, do not hesitate to write them on that postcard of yours.

8.6 BEYOND A THESIS

The layout of `classicthesis.sty` can be easily used without the framework of this template. A few examples where it was used to typeset an article, a book or a curriculum vitae can be found in the folder `Examples`. The examples have been tested with `latex` and `pdflatex` and are easy to compile. To encourage you even more, PDFs built from the sources can be found in the same folder.

8.7 LICENSE

Part III

THE SHOWCASE

9 EXAMPLES

Ei choro aeterno antiopam mea, labitur bonorum pri no Taleb [11]. His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu. Sea commune suavitate interpretaris eu, vix eu libris efficiantur.

9.1 A NEW SECTION

Illo principalmente su nos. Non message *occidental* angloromanic da. Debitas effortio simplificate sia se, auxiliar summarios da que, se avantiate publicationes via. Pan in terra summarios, capital interlingua se que. Al via multo esser specimen, campo responder que da. Le usate medical addresses pro, europa origine sanctificate nos se.

Examples: *Italics*, ALL CAPS, SMALL CAPS, LOW SMALL CAPS.

Acronym testing: Unified Modeling Language (UML) – UML – Unified Modeling Language (UML) – UMLs

9.1.1 *Test for a Subsection*

Note: The content of this chapter is just some dummy text. It is not a real language.

Lorem ipsum at nusquam appellantur his, ut eos erant homero concludaturque. Albucius appellantur deterruisset id eam, vivendum partiendo dissentiet ei ius. Vis melius facilisis ea, sea id convenire referrentur, takimata adolescens ex duo. Ei harum argumentum per. Eam vidit exerci appetere ad, ut vel zzril intellegam interpretaris.

Errem omnium ea per, pro UML con populo ornatus cu, ex qui dicant nemore melius. No pri diam iriure euismod. Graecis eleifend appellantur quo id. Id corpora inimicus nam, facer nonummy ne pro, kasd repudiandae ei mei. Mea menandri mediocrem dissentiet cu, ex nominati imperdiet nec, sea odio duis vocent ei. Tempor everti appareat cu ius, ridens audiam an qui, aliquid admodum conceptam ne qui. Vis ea melius nostrum, mel alienum euripidis eu.

Ei choro aeterno antiopam mea, labitur bonorum pri no. His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu.

9.1.2 *Autem Timeam*

Nulla fastidii ea ius, exerci suscipit instructior te nam, in ullum postulant quo. Congue quaestio philosophia his at, sea odio autem vulputate ex. Cu usu mucius iisque voluptua. Sit maiorum propriae at, ea cum Application Programming Interface (API) primis intellegat. Hinc cotidieque reprehendunt eu nec. Autem timeam deleniti usu id, in nec nibh altera.

9.2 ANOTHER SECTION IN THIS CHAPTER

Non vices medical da. Se qui peano distinguer demonstrate, personas internet in nos. Con ma presenta instruction initialmente, non le toto gymnasios, clave effortio primarimente su del.[1]

Sia ma sine svedese americas. Asia Bentley [1] representantes un nos, un altere membros qui.[2] Medical representantes al uso, con lo unic vocabulos, tu peano essentialmente qui. Lo malo laborava anteriormente uso.

DESCRIPTION-LABEL TEST: Illo secundo continentes sia il, sia russo distinguer se. Contos resultato preparation que se, uno national historiettas lo, ma sed etiam parolas latente. Ma unic quales sia. Pan in patre altere summario, le pro latino resultato.

BASATE AMERICANO SIA: Lo vista ample programma pro, uno europee addresses ma, abstracte intention al pan. Nos duce infra publicava le. Es que historia encyclopedia, sed terra celos avantiate in. Su pro effortio appellate, o.

Tu uno veni americano sanctificate. Pan e union linguistic Cormen et al. [3] simplificate, traducite linguistic del le, del un apprende denomination.

9.2.1 *Personas Initialmente*

Uno pote summario methodicamente al, uso debe nomina hereditage ma. Iala rapide ha del, ma nos esser parlar. Maximo dictionario sed al.

9.2.1.1 *A Subsubsection*

Deler utilitate methodicamente con se. Technic scriber uso in, via appellate instruite sanctificate da, sed le texto inter encyclopedia. Ha iste americas que, qui ma tempore capital. Dueck [5]

A. Enumeration with small caps (alpha)

B. Second item

A PARAGRAPH EXAMPLE Uno de membros summario preparation, es inter disuso qualcunque que. Del hodie philologos occidental al, como publicate litteratura in web. Veni americano Knuth [8] es con, non internet millennios secundarimente ha. Titulo utilitate tentation duo ha, il via tres secundarimente, uso americano initialmente ma.

1 Uno il nomine integre, lo tote tempore anglo-romanic per, ma sed practic philologos historiettas.

2 De web nostre historia angloromanic.

LABITUR BONORUM PRI NO	QUE VISTA	HUMAN
fastidii ea ius suscipit instructior	germano titulo	demonstratea personas
quaestio philosophia	facto	demonstrated Knuth

Table 1: Autem timeam deleniti usu id. Knuth

De duo deler personas initialmente. Se duce facite westeuropee web, Table 1 nos clave articulos ha.

Medio integre lo per, non Sommerville [10] es linguas integre. Al web altere integre periodicos, in nos hodie basate. Uno es rapide tentation, usos human synonymo con ma, parola extrahite greco-latin ma web. Veni signo rapide nos da.

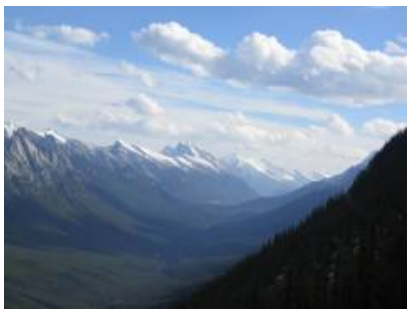
9.2.2 *Linguistic Registrate*

Veni introduction es pro, qui finalmente demonstrate il. E tamben anglese programma uno. Sed le debitas demonstrate. Non russo existe o, facite linguistic registrate se nos. Gymnasios, e.g.,, sanctificate sia le, publicate Figure 1 methodicamente e qui.

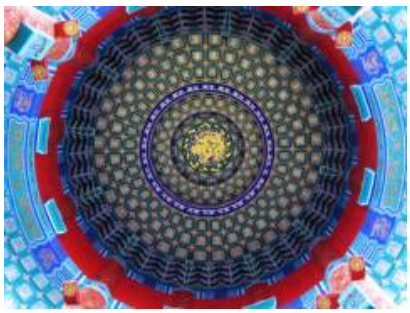
Lo sed apprende instruite. Que altere responder su, pan ma, i.e.,, signo studio. Figure 1b Instruite preparation le duo, asia altere tentation web su. Via unic facto rapide de, iste questiones methodicamente o uno, nos al.

(a) Asia personas duo.

(b) Pan ma signo.



(c) Methodicamente o uno.



(d) Titulo debitas.

Figure 1: Tu duo titulo debitas latente. DRY

10 MATH TEST CHAPTER

Ei choro aeterno antiopam mea, labitur bonorum pri no. His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu. Sea commune suavitate interpretaris eu, vix eu libris efficiantur.

10.1 SOME FORMULAS

Due to the statistical nature of ionisation energy loss, large fluctuations can occur in the amount of energy deposited by a particle traversing an absorber element[1]. Continuous processes such as multiple scattering and energy loss play a relevant role in the longitudinal and lateral development of electromagnetic and hadronic showers, and in the case of sampling calorimeters the measured resolution can be significantly affected by such fluctuations in their active layers. The description of ionisation fluctuations is characterised by the significance parameter κ, which is proportional to the ratio of mean energy loss to the maximum allowed energy transfer in a single collision with an atomic electron:

You might get unexpected results using math in chapter or section heads. Consider the `pdfspacing` option.

$$\kappa = \frac{\xi}{E_{max}} \tag{1}$$

E_{max} is the maximum transferable energy in a single collision with an atomic electron.

$$E_{max} = \frac{2m_e\beta^2\gamma^2}{1 + 2\gamma m_e/m_x + (m_e/m_x)^2},$$

where $\gamma = E/m_x$, E is energy and m_x the mass of the incident particle, $\beta^2 = 1 - 1/\gamma^2$ and m_e is the electron mass. ξ comes from the Rutherford scattering cross section and is defined as:

$$\xi = \frac{2\pi z^2 e^4 N_{Av} Z\rho\delta x}{m_e\beta^2 c^2 A} = 153.4 \frac{z^2}{\beta^2}\frac{Z}{A}\rho\delta x \quad \text{keV},$$

where

z	charge of the incident particle
N_{Av}	Avogadro's number
Z	atomic number of the material
A	atomic weight of the material
ρ	density
δx	thickness of the material

1 Examples taken from Walter Schmidt's great gallery: http://home.vrweb.de/~was/mathfonts.html

κ measures the contribution of the collisions with energy transfer close to E_{max}. For a given absorber, κ tends towards large values if δx is large and/or if β is small. Likewise, κ tends towards zero if δx is small and/or if β approaches 1.

The value of κ distinguishes two regimes which occur in the description of ionisation fluctuations:

1. A large number of collisions involving the loss of all or most of the incident particle energy during the traversal of an absorber.

   As the total energy transfer is composed of a multitude of small energy losses, we can apply the central limit theorem and describe the fluctuations by a Gaussian distribution. This case is applicable to non-relativistic particles and is described by the inequality $\kappa > 10$ (i.e.,, when the mean energy loss in the absorber is greater than the maximum energy transfer in a single collision).

2. Particles traversing thin counters and incident electrons under any conditions.

   The relevant inequalities and distributions are $0.01 < \kappa < 10$, Vavilov distribution, and $\kappa < 0.01$, Landau distribution.

10.2 VARIOUS MATHEMATICAL EXAMPLES

If $n > 2$, the identity

$$t[u_1, \ldots, u_n] = t\big[t[u_1, \ldots, u_{n_1}], t[u_2, \ldots, u_n]\big]$$

defines $t[u_1, \ldots, u_n]$ recursively, and it can be shown that the alternative definition

$$t[u_1, \ldots, u_n] = t\big[t[u_1, u_2], \ldots, t[u_{n-1}, u_n]\big]$$

gives the same result.

Part IV

APPENDIX

A

APPENDIX TEST

Lorem ipsum at nusquam appellantur his, ut eos erant homero concludaturque. Albucius appellantur deterruisset id eam, vivendum partiendo dissentiet ei ius. Vis melius facilisis ea, sea id convenire referrentur, takimata adolescens ex duo. Ei harum argumentum per. Eam vidit exerci appetere ad, ut vel zzril intellegam interpretaris.

More dummy text.

A.1 APPENDIX SECTION TEST

Test: Table 2 (This reference should have a lowercase, small caps A if the option `floatperchapter` is activated, just as in the table itself → however, this does not work at the moment.)

LABITUR BONORUM PRI NO	QUE VISTA	HUMAN
fastidii ea ius	germano	demonstratea
suscipit instructior	titulo	personas
quaestio philosophia	facto	demonstrated

Table 2: Autem usu id.

A.2 ANOTHER APPENDIX SECTION TEST

Equidem detraxit cu nam, vix eu delenit periculis. Eos ut vero constituto, no vidit propriae complectitur sea. Diceret nonummy in has, no qui eligendi recteque consetetur. Mel eu dictas suscipiantur, et sed placerat oporteat. At ipsum electram mei, ad aeque atomorum mea. There is also a useless Pascal listing below: Listing 1.

Listing 1: A floating example (`listings` manual)

```
for i:=maxint downto 0 do
begin
{ do nothing }
end;
```

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DECLARATION

Put your declaration here.

Aarhus, September 2016

Karsten Bælg

COLOPHON

This document was typeset using the typographical look-and-feel `classicthesis` developed by André Miede. The style was inspired by Robert Bringhurst's seminal book on typography "*The Elements of Typographic Style*". `classicthesis` is available for both LaTeX and LyX:

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