Matrix Representation of Graphs

Group 3

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Abstract

By representing graphs in a matrix adjancy matrix it is possible to observe special patterns and reveal dependencies which might not be seen in the graph per se. By combining the benefits of both the matraix representation and the graph it self, a very powerfull approach of graph analysing may be achieved.

In this survey we present some powerfull techniques applyable to adjancy matrices to analyze graphs. furthermore, we present some tools utilizing these techniques.

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Chapter 1

Basics

This chapter explains the different types of graphs and their corresponding matrices, which techniques are basically used on matrices and how to interpret the resulting patterns

Definitions

Every node in the graph has its distinctive unique id, which never changes. In this paper, the terms "nodes" and "edges" are used.

TODO: some more stuff here

Types of Graphs

We distinguish between two types of edges (directed and undirected) and two types of cost calculations (weighted and unweighted) between the nodes, which leads to 4 different graphs

directed/undirected

As can be seen in figure **??** undirected edges may be traversed in any direction, whereas directed edges may just be traversed in one direction.

TODO: some more stuff here

weighted/unweighted

A graph without weights has uniform costs on all edges, which leads to equal costs by traversing the edges in any order. When adding weights or costs to the edges, this fact changes. The order or selection of traversing the edges does matter as it creates different costs.

TODO: some more stuff here

Use cases

Some use cases of the different graph types are (to name just a few examples):

- Navigation system (weighted directed)

    - Nodes: Cities/POIs
    - Edges: Routes directed (one way streets)
        * weights
            · length of street (find shortest way)

· time to traverse the street (find fastest way)

- Subway map (undirected unweighted)

  – Nodes: stations
  – edges: connection between stations

- Relations of tweets (directed unweighted)

  – nodes: single tweet entry
  – edges: references to other tweets

Matrix representation of graphs

When representing graphs in a matrix, an adjacency matrix is used. Adjacency matrices are structured with every row and every column represents one node. This leads to a N x N square matrix, where N is the number of nodes.

These matrices show some patterns according to their corresponding graph but most times these patterns are not immediately visible. There are some techniques to reveal these patterns, all of them involving the reordering of the matrix.

Reordering

The main goal of reordering the matrix is to cluster the edges and thus reveal certain patterns. An example of this behaviour can be seen in figure 1.1.

Figure 1.1: Reordering a matrix

When reordering the matrix, the indices of the single rows and columns stay with the rows, otherwise the graph would change by this workstep. In this example, at first the rows 1 and 4 get swapped and as a second step columns 2 and 4. In this way the full connection pattern of the two subgraphs may be observed.

Patterns

There are 4 main patterns which may be revealed by reordering the matrix. These patterns may be combined in such a way, that for example a subgraph creates a circle, but one node if it is connected to every other node. This results in a combination of the star and the circle pattern. The four different patterns can be seen in the corresponding figures 1.2.

Figure 1.2: 4 differnet patterns: star, full, circle and line

Chapter 2

Scalability

Graph visuaisations are always limited by the number of nodes, aswell as the number of edges.

The simple geometrie of Adjacenzy matrxes allows an esimation of those upper limits. May edgtes is always nodes**2.

On a typical sreen with 25" alows to about

table

The most simple aproach is zooming, unfortunatly this brings new problems, and doeas not solve

Simple zooming bring problems: Zoomed in:Invisible edges in hidden zoom area, tasks wie mit allen verbunden geht nimma

Simple zooming dows not solve problems: Zoomed out: to small cols/rows with unreadable labels

Improvments in a spezific kontext, Clustering, recursive clustering: relations beteen nodes, clusters (ham). depends on clustering, this is dataproprocessing from my point of view.

Hybrid: dens clusters (nodetrix) is usefull if dense subclusters a present. Shows them as adjm in traditional graph

Matrix subdivision

clusteralgo

algo -> sort, multible sorts (within cluser, clusters)

minimizes unseed edges. sugest marks for unseedn edges

Transformations

Header

Cell

Recursive Matrix subdivision

additional header stuff

Hybrid Representation

shows adjm in tratitionsl graph best for dense clustes in graph

Chapter 3

Academic Writing

Writing in an academic context is different to other types of writing. Care must be taken to follow the conventions of academic writing.

Academic Criteria

An academic survey must demonstrate the following components:

- Motivation. What problem you are addressing and why.

- Survey. A thorough review of related work in the field.

- An extensive bibliography. To demonstrate knowledge of the major works in the field, even if they have not all been read in their entirety.

Academic Integrity

It is very easy to find helpful material on the web. Resist the temptation to copy such material verbatim, even with minor changes in phrasing and word order. It is just as easy for a supervisor or advisor (or anyone else for that matter) to check the originality of a piece of text by copying a passage into Google or services such as [**PlagiarismOrg**].

Work submitted for academic assessment must be original and created by the stated author(s). Care must be taken to avoid both *plagiarism* and *breach of copyright*:

- *Plagiarism*: Using the work of others *without acknowledgement*.

- *Breach of copyright*: Using the work of others *without permission*.

Plagiarism

Plagiarism is a violation of intellectual honesty. This means copying other people's work or ideas without due acknowledgement, thus giving the reader the impression that these are original (your own) work and ideas. The Concise Oxford Dictionary, 8th Edition, defines plagiarism as:

> "**plagiarise 1** take and use (the thoughts, writings, inventions, etc. of another person) as one's own.
> **2** pass off the thoughts etc. of (another person) as one's own."

Plagiarism is the most serious violation of academic integrity and can have dire consequences, including suspension and expulsion [**Reisman2005**].

Breach of Copyright

Copyright law[1] varies in detail from country to country, but certain aspects are internationally widely accepted. In general, the creator of a work, say a piece of writing, a diagram, a photograph, or a screenshot, automatically has copyright of that work. Copyright usually expires 70 years after the creator's death. The copyright holder can grant the right for others to use or publish their work on an exclusive or non-exclusive basis.

The copyright laws of most countries have provisions for *fair use*, which generally means it is allowable to quote small parts of a work. Austrian copyright law [**UrhG**] allows for reasonable quotes from published works or works made publicly available with permission of the copyright holder. Austrian copyright law [**UrhG**] also makes certain exemptions for materials used for teaching in universities and schools. Note that significant changes to Austrian copyright law [**UrhG-Novelle-2015**] came into effect on 01 Oct 2015.

Acceptable Use

Academic work almost always builds upon the work of others, and it is appropriate, indeed essential, that related and previous work by others be discussed in an academic thesis. However, this must be done according to the rules of acceptable use. There are two forms of acceptable use:

- *Paraphrasing (Indirect Quotation)*: Summarising the ideas of someone else using original words and with attribution.

- *Quoting (Direct Quotation)*: Including an exact verbatim copy inside quotation marks and with attribution.

Attribution means that the original source is cited. For further information on acceptable and non-acceptable academic practice see [**FremdeFedern**; **Wikipedia-Zitat**].

Paraphrasing (Indirect Quotation)

Paraphrasing means closely summarising and restating the ideas of another person, but in (your own) original words. When writing a literature survey, the relevant parts of each paper or source are generally *paraphrasd*.

One good technique for paraphrasing is:

1. Read the original source.

2. Put it down away from view.

3. *Without refering to the original*, summarise it in your own words.

When paraphrasing someone else's ideas, the original source must always be cited!

Since paraphrased text is not enclosed in quotation marks, it is not always obvious how to indicate the extent of the text which corresponds to a particular citation. If the paraphrased text only covers a single paragraph, include the citation either within or at the end of the first sentence of the paragraph, or at the end of the paragraph. Otherwise, describe the extent of the citation in words at the beginning, for example: This section is based on the work of **InfoSkyIVS**

Quoting Text (Direct Quotation)

In some circumstances, it makes sense to directly *quote* small parts of text (typically a few sentences or paragraphs) from a relevant source. When quoting directly, the *exact* words, spelling, and punctuation of the original are copied verbatim and enclosed in quotation marks.

---

[1]Disclaimer: I am not a lawyer. The comments here reflect the situation to the best of my knowledge at the time of writing, but do not constitute legal advice. Laws sometimes change and I make no guarantees.

Most of an academic paper or thesis must be in words written by the author(s) themselves. However, when an exact phrase or specific wording from another source is important, then a direct quotation should be used. In any case, the original source must be cited!

Quoting Images

It is common to want to include photographs, diagrams, or screenshots taken from the internet or from another work, particularly when surveying related work. Austrian copyright law [**UrhG**] allows images from published works to be included in scientific works for the purposes of discussion. However, it is not entirely clear what constitutes a scientific work and what not. The safest policy is always to ask permission from the owner.

For diagrams, an alternative strategy is to redraw and possibly adapt the diagram in a drawing editor such as Adobe Illustrator [**Adobe-Illustrator**] or Inkscape [**Inkscape**]. The original source should be cited with wording like "Redrawn from [. . .]" or "Adapted from [. . .]".

For graphs and plots, it is often possible to reconstruct the graphic from the original data using tools such as gnuplot [**gnuplot**] or R [**R-Project**]. The original source should be cited with wording similar to "Created from the original data [. . .] using[. . .]".

For screenshots, it is sometimes possible to obtain the original software, install it, and make new screenshots. The source software should be cited with wording similar to "Screenshot created using [. . .]".

Always State Both Source and Permission

Regardless of whether permission has been obtained from the copyright owner or material is being used under the provisions of a specific country's copyright law: whenever someone else's work is being used, academic integrity dictates that the original source must be cited! In addition, it is also good practice to state the terms (permission) under which the material is being used.

For each piece of included material, make two things absolutely clear:

1. *Source*: Cite the original source of the material. Use a standard LATEX 2$_\varepsilon$citation.

2. *Permission*: Explain the legal basis for using the material. For example, give the *exact* Creative Commons licence, state the *exact* legal exemption, or state that permission has kindly been given by the named original author.

These two things should be stated in two places:

- *Caption*: At the end of the caption of the figure or listing.

- *Credits section*: In the Credits section at the front of the thesis.

All this means, of course, that if a thesis is based upon this skeleton [**KeithThesis**], then the source and permission should be stated at the appropriate place (in this case, in the Credits section).

References

Bib Files

Typically, one or more `.bib` files are prepared, containing various original sources and references. Listing 3.1 shows four typical entries from a `.bib` file for use with biblatex and biber. The `inproceedings` entry describes a paper published in conference proceedings, the `article` entry describes a paper published in a journal, and the `booklet` entry is being used for internet resources and web sites (`booklet` has the advantage over `online` that it has a `howpublished` field.).

Of particular note is the `doi` field, which gives the DOI (digital object identifier) of a paper. DOIs are for academic papers what ISBNs are for books; a unique handle with which one can easily find the original. Most

```
 1  @book{SpenceBook,
 2    author       = "Robert Spence",
 3    title        = "Information Visualization: Design for Interaction",
 4    edition      = "2",
 5    publisher    = "Prentice Hall",
 6    date         = "2006-12-18"
 7    isbn         = "0132065509",
 8  }
 9
10  @article{InfoSkyIVS,
11    author       = "Keith Andrews and Wolfgang Kienreich and Vedran Sabol and
12                     Jutta Becker and Georg Droschl and Frank Kappe and
13                     Michael Granitzer and Peter Auer and Klaus Tochtermann",
14    title        = "The InfoSky Visual Explorer: Exploiting Hierarchical
15                     Structure and Document Similarities",
16    journal      = "Information Visualization",
17    publisher    = "Palgrave-Macmillan",
18    volume       = 1,
19    number       = "3/4",
20    date         = "2002-12",
21    pages        = "166--181",
22    doi          = "10.1057/palgrave.ivs.9500023",
23  }
24  % This is a comment containing a UTF8 character ü
25
26  @inproceedings{Andrews-VRwave,
27    author       = "Keith Andrews and Andreas Pesendorfer and
28                     Michael Pichler and Karl Heinz Wagenbrunn
29                     and Josef Wolte",
30    title        = "Looking Inside {VRwave}: The Architecture and
31                     Interface of the {VRwave} {VRML97} Browser",
32    booktitle    = "Proc.\ Third Symposium on the Virtual Reality
33                     Modeling Language (VRML '98)",
34    venue        = "Monterey, California, USA",
35    publisher    = "ACM Press",
36    date         = "1998-02",
37    pages        = "77--82",
38    doi          = "10.1145/271897.274374",
39    url          = "http://ftp.iicm.tugraz.at/pub/papers/vrml98.pdf",
40  }
41
42  @booklet{InfoVisNotes,
43    author       = "Keith Andrews",
44    title        = "Information Visualisation: Lecture Notes",
45    date         = "2016-03-17",
46    url          = "http://courses.iicm.tugraz.at/ivis/ivis.pdf",
47    urldate      = "2016-09-14",
48  }
49
50  @booklet{XML,
51    author       = "{W3C}",
52    title        = "Extensible Markup Language {(XML)}",
53    howpublished = "World-Wide Web Consortium",
54    date         = "2016-03-01",
55    url          = "https://w3.org/XML/",
56    urldate      = "2016-03-01",
57  }
```

Listing 3.1: Four typical entries from a `.bib` file for use with biblatex and biber. An `inproceedings` entry describes a paper published in conference proceedings, an `article` entry describes a paper published in a journal, and a `booklet` entry is used for internet resources and web sites. The `doi` field gives the DOI (digital object identifier) of the paper.

publishers are now assigning DOIs to new conference and journal papers and are working back in time to assign them to previously published papers. Always give the DOI of a paper where one is available. If a DOI exists but points to a subscription site, and the paper is also freely available on the web (say at the home page of an author), then use the `url` field to give the free URL as well. Do not redundantly give the same URL in the `url` field which the DOI itself resolves to.

Downloading Bib Entries

When `.bib` entries are downloaded or copied from the ACM Digital Library, the IEEE Digital Library, or other onlibne sources, they should *not* be used as is. They generally need to be cleaned up first and made consistent with biblatex. Listing 3.2 shows typical BibTeX entries provided by the ACM Digital Library and the IEEE Computer Society Digital Library.

To bring bib entries into line with biblatex and the examples shown in Listing 3.1, the following should be addressed:

- The title of the paper should use capitalised main words.

- Capitalisations in the title which need to be preserved (such as the R in VRwave) should be enclosed in curly brackets (VRwave).

- The `title` and `booktitle` should use capitalised main words (not all lower case).

- The `edition` field is usually be a number in inverted commas, such as `"2"`, instead of a word such as `"Second"`.

- The name of a conference should be rephrased, with the short form of the conference name in parentheses at the end (VRML'98).

- Any `year`, `month`, and `day` fields should be combined into a `date` field.

- For a conference paper, the first day of the conference should be used as the date of publication.

- The location of a conference should be in the `venue` field, not in the `address` or `location` field. The `address` field is for the address of the publisher.

- Any minus signs must be removed from the ISBN number. Otherwise, the macro used in this skeleton for handling ISBNs and linking to Amazon will break.

- Any initial `http://doi.acm.org/` or `http://doi.ieeecomputersociety.org/` must be removed from the DOI. They are *not* part of the DOI.

- If a free, unofficial version of a paper with a DOI is available at the web site of one of the authors, give this in the `url` field.

- Manually shorten any URL as much as possible: try selectively removing parameters after a question mark and try removing `www` from the domain. Do *not* use a URL shortening service like `bit.ly`, since there is no guarantee the service will be around long term. It is acceptable to use a URL shortening service maintained by the original site themselves, such as `youtu.be` for YouTube URLs.

What to Reference

The set of references should be balanced:

- Do not have largely web sites as references. A few web sites as references is fine, most references being web sites is (usually) not so good.

```
 1  % From the IEEE Computer Society DL:
 2
 3  @article{10.1109/INFOVIS.2005.7,
 4  author = {Martin Wattenberg},
 5  title = {Baby Names, Visualization, and Social Data Analysis},
 6  journal = {infovis},
 7  volume = {0},
 8  year = {2005},
 9  issn = {1522-404x},
10  pages = {1},
11  doi = {http://doi.ieeecomputersociety.org/10.1109/INFOVIS.2005.7},
12  publisher = {IEEE Computer Society},
13  address = {Los Alamitos, CA, USA},
14  }
15
16
17  % From the ACM DL:
18
19  @inproceedings{1106568,
20   author = {Martin Wattenberg},
21   title = {Baby Names, Visualization, and Social Data Analysis},
22   booktitle = {INFOVIS '05: Proceedings of the Proceedings of the 2005 IEEE Symposium on
           Information Visualization},
23   year = {2005},
24   isbn = {0-7803-9464-x},
25   pages = {1},
26   doi = {http://dx.doi.org/10.1109/INFOVIS.2005.7},
27   publisher = {IEEE Computer Society},
28   address = {Washington, DC, USA},
29   }
30
31
32  % Clean, edited version for Keith:
33
34  @inproceedings{WattenbergNames,
35    author       = "Martin Wattenberg",
36    title        = "Baby Names, Visualization, and Social Data Analysis",
37    booktitle    = "Proc.\ {IEEE} Symposium on Information Visualization
38                    (InfoVis 2005)",
39    location     = "Minneapolis, Minnesota, USA",
40    organization = "{IEEE} Computer Society",
41    isbn         = "078039464X",
42    date         = "2005-10",
43    pages        = "1--8",
44    doi          = "10.1109/INFOVIS.2005.7",
45    url          = "http://www.research.ibm.com/visual/papers/final-baby-margin-nocomments.
           pdf",
46  }
```

Listing 3.2: Bib entries copied from the ACM Digital Library or the IEEE Computer Society Digital Library contain useful information, but cannot be used "as-is". They must be edited to conform to biblatex and to these thesis guidelines.

- Do not have too many Wikipedia references. A few Wikipedia references is OK; more than a few is not. Wikipedia is a good *starting* point for (further) academic research, it is not a good ending point for academic research.

- Have plenty of academic conference and journal papers (with a DOI). Sometimes, both an academic paper and a project web site will be avilable – reference both as separate entries.

- Include some books (with an ISBN) if at all possible. Books still count in academic circles.

- If you know or suspect who will be reviewing or marking your thesis or paper, make sure to include some of their references. The first thing many reviewers do is check to see if they appear in the bibliography.

- No ghost references. Every reference in the bibliography should be cited somewhere in the text.

Citing

When a citation is included within flowing text:

- Distinguish between *textual* citations and *parenthetical* citations. Textual citations are used to embed the authors' names in the current sentence. Parenthetical citations are used at the end of a sentence.

    `\citet{Jones1990}` → Jones et al. [1990]
    `\citep{Jones1990}` → [Jones et al., 1990]

- If one specific part in a very long paper or book is being cited, always state the page number or range in the citation:

    `As \citet[pages 22--23]{Jones1990} say` → As Jones et al. [1990, pages 22–23] say

Guides to Scientific Writing

CraftScientificWriting is one of the classic guides to scientific writing. Other good ones include **BoothCraft** and **BoothCommunicating**

Chapter 4

Language and Writing Style

The classic reference for English writing style and grammar is **StrunkWhite** The original text is now available for free online [**Strunk**], so there is no excuse at all for writing poor English. Readers should consult it first, then continue reading this chapter. Another good free guide is **NASAGuide**

Zobel-WritingCompSci and **BugsInWriting** are guides specifically aimed at computer science students. **Phillips-HowGetPhD** gives practical advice for PhD students. Sections 4.4 and 4.5 are adapted from the ACM CHI'94 conference language and writing style guidelines.

Paragraphs

Sentences should be grouped into paragraphs by topic. A new paragraph introduces a (slight) variation in topic. Paragraphs should generally consist of *several* sentences. Short paragraphs of only one or two sentences should be merged topically with neighbouring paragraphs.

Some Basic Rules of English

There are a few basic rules of English for academic writing, which are broken regularly by my students, particularly if they are non-native speakers of English. Here are some classic and often encountered examples:

- *Never* use I, we, or you.

  Write in the passive voice (third person).

Bad:	You can do this in two ways.
Good:	There are two ways this can be done.

- *Never* use he or she, his or her.

  Write in the passive voice (third person).

Bad:	The user speaks his thoughts out loud.
Good:	The thoughts of the user are spoken out loud.

  See Section 4.5 for many more examples.

- Stick to a consistent dialect of English. Choose either British or American English and keep to it throughout the whole of your thesis.

- Do *not* use slang abbreviations such as "it's", "doesn't", or "don't".

  Write the words out in full: "it is", "does not", and "do not".

Bad:	It's very simple to...
Good:	It is very simple to...

- Do *not* use abbreviations such as "e.g." or "i.e.".

  Write the words out in full: "for example" and "that is".
  Bad: ...in a tree, e.g. the items...
  Good: ...in a tree, for example the items...

- Do *not* use slang such as "a lot of".
  Bad: There are a lot of features...
  Good: There are many features...

- Do *not* use slang such as "OK" or "big".
  Bad: ...are represented by big areas.
  Good: ...are represented by large areas.

- Do *not* use slang such as "gets" or "got".

  Use "becomes" or "obtains", or use the passive voice (third person).
  Bad: The radius gets increased...
  Good: The radius is increased...

  Bad: The user gets disoriented...
  Good: The user becomes disoriented...

- *Never* start a sentence with "But".

  Use "However," or "Nevertheless,". Or consider joining the sentence to the previous sentence with a comma.
  Bad: But there are numerous possibilities...
  Good: However, there are numerous possibilities...

- *Never* start a sentence with "Because".

  Use "Since", "Owing to", or "Due to". Or turn the two halves of the sentence around.

- *Never* start a sentence with "Also". Also should be placed in the middle of the sentence.
  Bad: Also the target users are considered.
  Good: The target users are also considered.

- Do *not* use "that" as a connecting word.

  Use "which".
  Bad: ...a good solution that can be computed easily.
  Good: ...a good solution which can be computed easily.

- Do *not* write single-sentence paragraphs.

  Avoid writing two-sentence paragraphs. A paragraph should contain at least three, if not more, sentences.

Avoid Austrianisms

I see these mistakes time and time again. Please do not let me read one of them in your work.

- "actual" ≠ "current"

  If you mean "aktuell" in German, you probably mean "current" in English.
  Bad: The actual selection is cancelled.
  Good: The current selection is cancelled.

- "allows to" is not English.

  Bad: The prototype allows to arrange components...
  Good: The prototype supports the arrangement of components...

- "enables to" is not English.

  Bad: it enables to recognise meanings...
  Good: it enables the recognition of meanings...

- "according" ≠ "corresponding"

  Bad: For each browser, an according package is created.
  Good: For each browser, a corresponding package is created.

- "per default" is not English.

  Use "by default".

  Bad: Per default, the cursor is red.
  Good: By default, the cursor is red.

- "As opposed to" is not English.

  Use "In contrast to".

  Bad: As opposed to C, Java is object-oriented.
  Good: In contrast to C, Java is object-oriented.

- "sensible" ≠ "sensitive"

  If you mean "sensibel" in German, you probably mean "sensitive" in English.

  Bad: Store sensible data securely.
  Good: Store sensitive data securely.

- "*anything*-dimensional" is spelt with a hyphen.

  For example: two-dimensional, three-dimensional.

- "*anything*-based" is spelt with a hyphen.

  For example: tree-based, location-based.

- "*anything*-oriented" is spelt with a hyphen.

  For example: object-oriented, display-oriented.

- "*anything*-side" is spelt with a hyphen.

  For example: client-side, server-side.

- "*anything*-friendly" is spelt with a hyphen.

  For example: user-friendly, customer-friendly.

- "*anything*-to-use" is spelt with hyphens.

  For example: hard-to-use, easy-to-use.

- "*anything*-level" is spelt with hyphens.

  For example: low-level, high-level.

- "realtime" is spelt with a hyphen if used as an adjective, or as two separate words if used as a noun.

  Bad: ...display the object in realtime.
  Bad: ...using realtime shadow casting.
  Good: ...display the object in real time.
  Good: ...using real-time shadow casting.

Clear Writing

An academic paper written in English should use simple and clear language appropriate for an international audience. In particular:

- Write simple, straightforward sentences. Do not use long, convoluted sentences with many nested clauses, purely for the whim of it, because, as is sometimes the case, it may seem like a good idea at the time, even though it is not really.

- Use common and basic vocabulary. For example:

    - "unusual" instead of "arcane"
    - "specialised" instead of "erudite".
    - "guideline" instead of "rule of thumb".

- Define or explain any necessary technical vocabulary the first time it is mentioned.

- Explain any acronyms the first time they are used, by writing out the full phrase followed by the acronym in parentheses.

    Bad: When using SVG, the figure scales freely.
    Good: When using Scalable Vector Graphics (SVG), the figure scales freely.

- Avoid local references. International readers will probably not recognise the names of the provincial capitals of Austria, for example. If local context is necessary for understanding, then describe it fully.

- Avoid "insider" jargon. Do not assume knowledge of a particular context. For example, do not assume the reader is familiar with a particular operating system or application.

- Express culturally localised things such as times, dates, currencies, and numbers in an unambiguous form. For example, 9/11 is the 9th of November in much of the world. In English, a period "." is used as the decimal point character and a comma "," is used as the thousands separator (in German, it is the other way round).

- Do not use "word plays" or puns. Phrases such as "red herring", "taking the mickey", and "like watching paint dry" require cultural knowledge of English to understand.

- Be careful with humour. Irony and sarcasm are sometimes hard to detect for non-native speakers.

- If you find yourself repeating the same word or phrase too often, look in a thesaurus such as **Roget**; **RogetInt** for an alternative word with the same meaning.

Part of writing usable documents is understanding and then addressing the characteristics of the intended audience.

Avoiding Gender Bias

Two issues should be considered with regard to avoiding gender bias: avoiding characterisations or stereotypes about men or women, and avoiding biases inherent in the English language. Here are some suggestions for handling the second issue:

- Refer to people generically using a gender-neutral term:

    | man | the human race |
    | mankind | humankind, people |
    | manpower | workforce, personnel |
    | man on the street | average person |

- Use gender-neutral terms for job titles or roles, where possible:

chairman	chairperson
spokesman	spokesperson, representative
policeman	police officer
stewardess	flight attendant

- When refering to the holder of a specific position and their gender is known, use the correct gender pronoun. For example, assuming the chairperson is known to be a man:

  Bad: The chairperson announced her resignation.
  Good: The chairperson announced his resignation.

- Avoid using a gender pronoun by repeating the job title or role if possible:

  Bad: Interview the user first and then ask him to fill out a questionnaire.
  Good: Interview the user first and then ask the user to fill out a questionnaire.

- Avoid using his or her by using the plural form:

  Bad: Each student should bring his text to class.
  Good: All students should bring their texts to class.

- Replace his or her with the article (the):

  Bad: Every student must hand his report in on Friday.
  Good: Every student must hand the report in on Friday.

- Avoid using his or her by rewriting in the passive voice:

  Bad: Each department head should do his own projections.
  Good: Projections should be done by each department head.

- Avoid awkward formulations such as "s/he," "he/she," or "his/her." As a last resort, use the less awkward "he or she," or "his or hers."

When to use Capitalisation

Capitalisation means using a capital (upper case) initial letter for a word. *Lowercasing* means writing the entire word in lower case. In many common writing styles, headings and titles are partially capitalised: the first and the principal (main) words are capitalised and other words are lowercased.

Proper names, such as the names of people, towns, and countries, are always capitalised (Keith Andrews, the United Kingdom). The first word in a heading or title is always capitalised.

Titles and Headings

Capitalise all principal words: nouns, pronouns, adjectives, verbs, and adverbs, and the first word. Lowercase all articles, coordinating conjunctions ("for", "and", "nor", "but", "or", "yet", "so"), and prepositions.

For example:

- Here, "it" is a pronoun, which should always be capitalised.

  Bad: Saying it Directly
  Good: Saying It Directly

- Here, "is" is a verb, which should always be capitalised.

  Bad: When is Enough Enough?
  Good: When Is Enough Enough?

- Here, "in" is being used as a preposition and should be lowercased.

  Bad: The Elephant In the Room.
  Good: The Elephant in the Room.

- Here, "in" is being used as an adverb and should be capitalised.

  Bad: Handing in Your Work.
  Good: Handing In Your Work.

See **WB-Capitalisation** for some slightly different rules and some more examples.

Captions

The short version (the optional parameter in square brackets) of a caption for a figure, table, or listing appears in the List of Figures, List of Tables, or List of Listings. The short caption is used like a heading and should be capitalised like a heading. The long version of a caption for a figure, table, or listing should be written as full sentences: only the first word of each sentence and any proper names are capitalised and (each sentence in) the caption ends with a full stop.

Chapters, Sections, Figures and Tables

A specific, named or numbered entity, such as a particular chapter, appendix, section, figure, table, or listing is considered to be a proper name and thus *should be capitalised*. For example, Chapter 4, Section 4.5, Figure 5.2, Table 6.2, or Listing 3.1. However, if an entity is not specifically named or numbered, then it should *not* be capitalised. For example, when refering to the first chapter or the next section, without giving a name or number.

Use a Spelling Checker

In these days of high technology, spelling mistakes and typos are inexcusable. It is *very* irritating for your supervisor to have to read through and correct spelling mistake after spelling mistake which could have been caught by an automated spelling checker. Believe me, irritating your supervisor is not a good idea.

So, use a spelling checker *before* you hand in *any* version, whether it is a draft or a final version. Since this is apparently often forgotten, and sometimes even wilfully ignored, let me make it absolutely clear:

Use a spelling checker, please.
Use a spelling checker!
Use a spelling checker, you moron.

Use a Dictionary

If you are not quite sure of the meaning of a word, then use a dictionary. **DictionaryCom** is a free English dictionary, **DictChemnitz** and **DictLeoOrg** are two very good English-German dictionaries.

Use a Thesaurus

If a word has been used several times already, and using another equivalent word might improve the readability of the text, then consult a thesaurus. **Roget** and **RogetInt** are free English thesauri.

Chapter 5

Technical Realisation

Use LaTeX 2ε to produce your thesis. Do *not* even entertain the idea of writing your thesis with Microsoft Word. Ever.

LaTeX

LaTeX 2ε provides very comfortable features for structuring and reorganising your work. In particular, figure and section numbers are symbolic references and are automatically kept consistent. Even more importantly, when material is added or changed, LaTeX 2ε reformats your work *automatically*.

Furthermore, the Biblatex package lets you maintain a database of bibliographic entries; citations are then also made by symbolic reference. The exact appearance of citations and the bibliography is controlled by setting a particular bibliographic style. See **WordProcessors** for plenty more reasons to use LaTeX 2ε rather than Word.

Literature and Online Resources

The best reference book for LaTeX 2ε is **KopkaDaly** – buy it! Your advisor can become very irritated by students repeatedly asking the same basic questions instead of consulting the book. Good online resources for LaTeX 2ε include the Wikibook LaTeX [**Wikibooks-latex**], **NotShortIntroLaTeX FormattingInformation** the TeX Users Group [**TUG**] (see Figure 5.1), and the Deutschsprachige Anwendervereinigung DANTE [**DANTE**] (in German). LaTeX 2ε information in German is available on the local LaTeX@TUG web site [**LatexTUGraz**]. Questions can be asked in the local TU Graz newsgroup `tu-graz.latex` .

Installing LaTeX 2ε

For information about availability, versions, installation, etc. of LaTeX 2ε consult the online *TeX Frequently Asked Questions* [**TeXfaq**]. The best way to install LaTeX 2ε under Windows is to get the TeXLive 2016 [**texlive**] DVD distribution. You can download an ISO image from CTAN TeXLive [**ctan-texlive**]. Under Windows 10, you can mount an ISO image by double-clicking, it is no longer necessary to actually burn the image to a DVD.

Installing Extra LaTeX 2ε Packages

Depending on the LaTeX 2ε package you install, you may need to install additional or more recent versions of LaTeX 2ε packages. For example, this thesis makes use of the LaTeX 2ε `titlesec` package. You can find a list of packages at your local CTAN site [**CTAN**]. To install a package, read the advice at `http://www.ctan.org/installationadvice/`
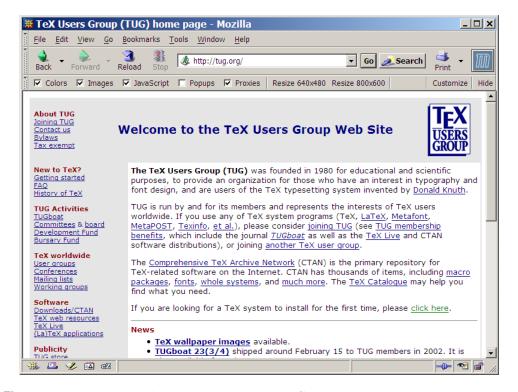
Figure 5.1: The web site of the TeX Users Group [**TUG**]. [Screenshot taken by the author of this thesis.]

Running LaTeX 2ε

When running LaTeX 2ε under Unix, check that the environment variables are set to something like the values shown here:

```
setenv TEXINPUTS .:~/tex/inputs:./inputs::
setenv BSTINPUTS .:~/tex/inputs::
setenv BIBINPUTS .:~/tex/bib:./bib::
```

LaTeX 2ε updates certain auxiliary files during translation (for example with figure numbers or captions) and makes use of them in subsequent runs. To be absolutely certain that all references are resolved correctly, run pdflatex, biber, pdflatex, and pdflatex in sequence, as shown below for this thesis:

```
pdflatex thesis
biber thesis
pdflatex thesis
pdflatex thesis
```

An alternative is to use the latexmk perl script:

```
latexmk --pdf thesis
```

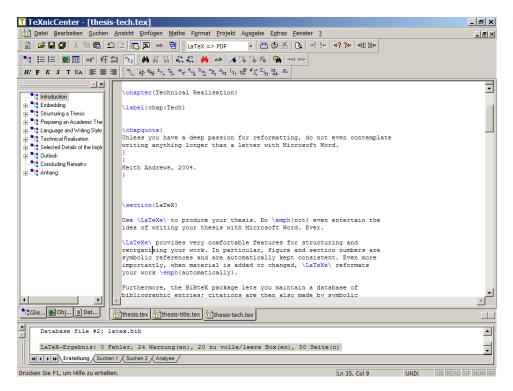latexmk can also be configured using a config file such as $HOME/.latexmkrc in the user's home directory:

Figure 5.2: The TeXnicCenter [**TeXnicCenter**] integrated development environment (IDE) for LaTeX 2$_\varepsilon$.
[Screenshot taken by the author of this thesis.]

```
$pdf_mode = 1;   # force use of pdflatex
```

Spell Checking

GNU Aspell [**Aspell**] is a free open source spell checker. It can automatically ignore LaTeX 2$_\varepsilon$ commands. Aspell can either be run from the command line or integrated into other packages such as Emacs.

Integrated Development Environments (IDEs) for LaTeX 2$_\varepsilon$

Under Windows you might want to use an integrated development environment (a fancy editor) for LaTeX 2$_\varepsilon$, which have built-in support for editing LaTeX 2$_\varepsilon$, spell checking, compiling, and so forth. The IDEs assume that you have a working LaTeX 2$_\varepsilon$ installation, so install LaTeX 2$_\varepsilon$ first. The best are Texmaker [**texmaker**], TeXnicCenter [**TeXnicCenter**] (shown in Figure 5.2), and LEd [**LEd**], all of which are free. The shareware WinEdt [**WinEdt**] is also very good.

Including Images

Use the `graphicx` package to include images:

```
\usepackage{graphicx}
```

Screenshots

Screenshots should be made using software such as IrfanView or Gimp and *saved as PNG*. PNG is a lossless image format which preserves every pixel of the original image. Sometimes, novices save screenshots as JPEG (`.jpg`), which is an inherently lossy image format. Screenshots saved as JPEG invariably introduce artefacts such as smudged lines and text, due to the way that JPEG achieves its high compression rates.

Diagrams

Diagrams and illustrations should be drawn using a *vector* graphics editor such as Adobe Illustrator or Inkscape[**Inkscape**]. Archive (and hand-in) the respective source files (`.ai` or `.svg`). Convert or export the diagram to PDF for inclusion into LaTeX 2$_\varepsilon$.

Vector graphics are based on objects such as lines, circles, polygons, and text strings and as such are freely scalable without loss of quality. In contrast, *raster* graphics are based on pixels and do not scale without loss of quality. Saving diagrams in a raster format such as PNG, GIF, or JPEG means they cannot be resized without considerable loss of quality.

Graphs and Plots

Tabular data can be plotted as, say, a line chart or bar chart, using the free packages gnuplot [**gnuplot**] or R [**R-Project**]. The plots should be created as SVG (vector graphics), which can then be touched up, cropped, and converted to PDF using Adobe Illustrator or Inkscape[**Inkscape**].

Including Listings

Use the listings package to include source code listings. There are three types of listing:

- *Inline*: A small snippet of code can be contained within the flow of a paragraph using `\lstinline`, for example `\lstinline!var i:integer;!` produces `var i:integer;`.

- *In-Place displayed*: An in-place displayed listing is a block of code listed at the place where it occurs. Use in-place displayed listings for short blocks of source code upto max n lines (I use $n = 3$). Create an in-place displayed listing with the `lstlisting` environment, but without using the `float` parameter.

- *Floating displayed*: A floating displayed listing is a block of code treated like other LaTeX 2$_\varepsilon$ floats (such as figures or tables). Use floating displayed listings for longer blocks of code. LaTeX 2$_\varepsilon$ places the Listing at some point later on. Create a floating displayed listing with the `lstlisting` environment, but specify the `float` and `caption` parameters. A floating displayed listing is given a number (Listing 2.1) and is listed in the List of Listings.

The listings package is currently not designed for use with UTF8 characters. To use UTF8 characters inside listings, you have to specify the parameter `inputencoding=utf8` and specify each character inside the `literate=` parameter to the `\lstset` command.

Biblatex and Biber

Biblatex [**Biblatex**] is a companion system to LaTeX 2$_\varepsilon$, which allows you to manage sets of references in plain text files (called `.bib` files) and cite references from within your LaTeX 2$_\varepsilon$ documents. Biber [**Biber**] is a program which takes `.bib` files and manages the formatting of citations and of the bibliography itself. Biblatex and Biber have replaced the now obsolete BibTex.

Chapter 6

Selected Examples of Doing Things with LaTeX 2_ε (and Test of Extremely Long Chapter Titles to See How They Work Or Not)

This chapter contains some examples of typical LaTeX 2_ε usage.

First Selected Example

An example of using a table can be seen in Table 6.1.

Second Selected Example

This example shows how to inculde vector graphics in the form of PDF files. It also shows how to use subfigures within a figure.

An example of using the subfig package can be seen in Figure 6.1. Figure 6.1a shows the polygons before transformation, while Figure 6.1b shows them afterwards.

Third Selected Example

This example shows how to include a screen shot (or other raster graphic) into a LaTeX 2_ε figure.

An example of how to correctly cite the source when using an image from someone else. In their 1998 paper, **Andrews-VRwave** discuss the VRwave VRML browser. Figure 6.2 shows a VRML model of a cavalry pistol from the Armoury in Graz displayed in the VRwave VRML browser.
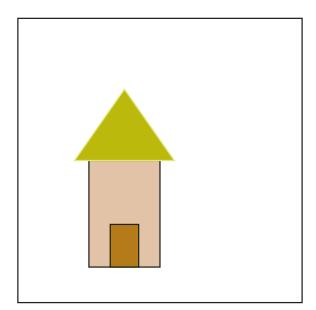
Fourth Selected Example

You can use many (but not all) of the thousands of characters available in the UTF-8 [**Wikipedia-UTF8**; **Unicode-Charts**] character encoding. For example, the German umlauts (äüö), the German sharp s (ß), or the yen symbol (¥).

You can also try some of the ≈ 100 symbols available in the textcomp package, such as the yen symbol (¥) and a circled letter A (Ⓐ).
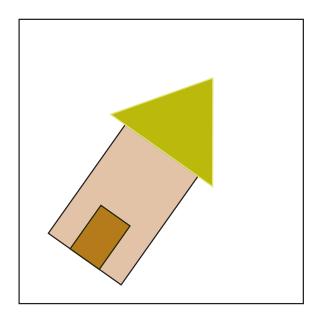
Use the vname, cname, and fname macros to define the style for variable names, class names, and file names. You can also define your own macros. The is a very long file name `/usr/data/keith/travel/austria/vienna.txt` to see how they are broken at a line end. A typical class name is HVSInformationPyramidsInputFactory.

Name	Type	Rating	Description
The Office	English	*****	The best pub in Graz. Hidden in the narrow streets of the old town. A wonderful hideout for ex-pats. A pint of Guinness for only € 3.90.
Flann O'Brien	Irish	****	In the centre of town and easy to find for marauding tourists.
O'Carolans	Irish	****	In the centre of town in a small side street next to Flann's. Small, cosy Irish pub.
O'Riginal	pseudo Irish		Austrian dive pretending to be an Irish pub. Definitely not my cup of tea.

Table 6.1: The best pubs in Graz.

(a) A object has been composed to represent an abstract version of the clock tower in Graz. Here, the object is in its initial state.

(b) The object has been scaled and rotated, and now resembles a leaning tower.

Figure 6.1: The leaning tower of Graz. An abstract model of the clock tower in Graz leaning over time. (a) shows the initial state. (b) shows the final state.
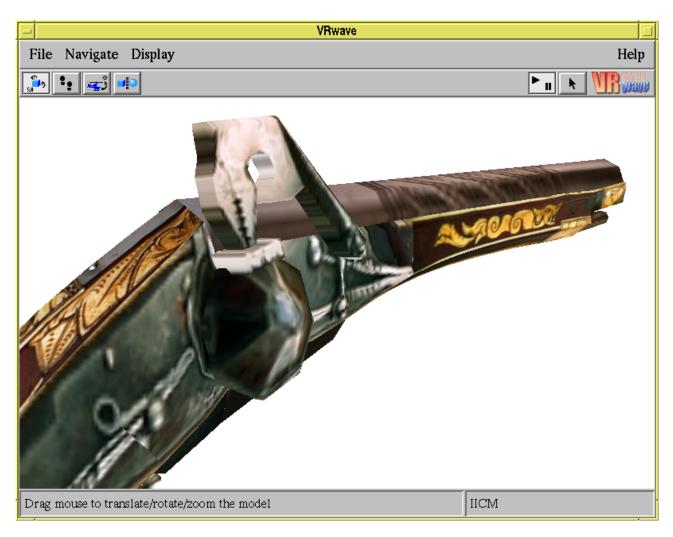
Figure 6.2: VRwave in Flip mode displaying a textured model of a cavalry pistol from the world-renowned Zeughaus (armoury) in Graz. [Image extracted from **Andrews-VRwave** under the terms of the ACM copyright. Copyright © by the Association for Computing Machinery, Inc.]

Fifth Selected Example

Sometimes, a macro (new command definition) can be useful to define the contents of table cells, particularly if these contain images. For example, Table 6.2 uses the macro called `iibox`, which takes a single parameter, the name of the particular image.

Textual Citations

DataAnalysisChallenges define visual analytics as:

> "iterative process that involves collecting information, data preprocessing, knowledge representation, interaction, and decision making".

InteractiveDataVisualisation categorise visualisation techniques for multi-variate data according to the graphical primitive used in the rendering: points, lines, and regions.

Elementary Symbols	
Document	
Assistant	
Template	
Document Types	
Text document	
Spreadsheet document	
Presentation document	
Database document	
Applications	
Word	
Excel	
Powerpoint	
Access	
Generated Icons	
Word text document	
Excel spreadsheet document	
Powerpoint presentation document	
Access database document	
Word template	
Powerpoint template	
Access template	
Word template assistant	
Powerpoint template assistant	
Access template assistant	

Table 6.2: Iconic language for Windows NT 4.0 documents.

Chapter 7

Concluding Remarks