Modeling Truck Safety Critical Events: Efficient Bayesian Hierarchical Statistical and Reliability Models

(Dissertation defense 2020)

Miao Cai

Department of Epidemiology and Biostatistics,

Saint Louis University

July 20, 2020

SAINT LOUIS UNIVERSITY

COLLEGE FOR PUBLIC HEALTH
AND SOCIAL JUSTICE

Contents

Dissertation Committee

Steven E. Rigdon
Saint Louis University

Committee chair

Hong Xian
Saint Louis University

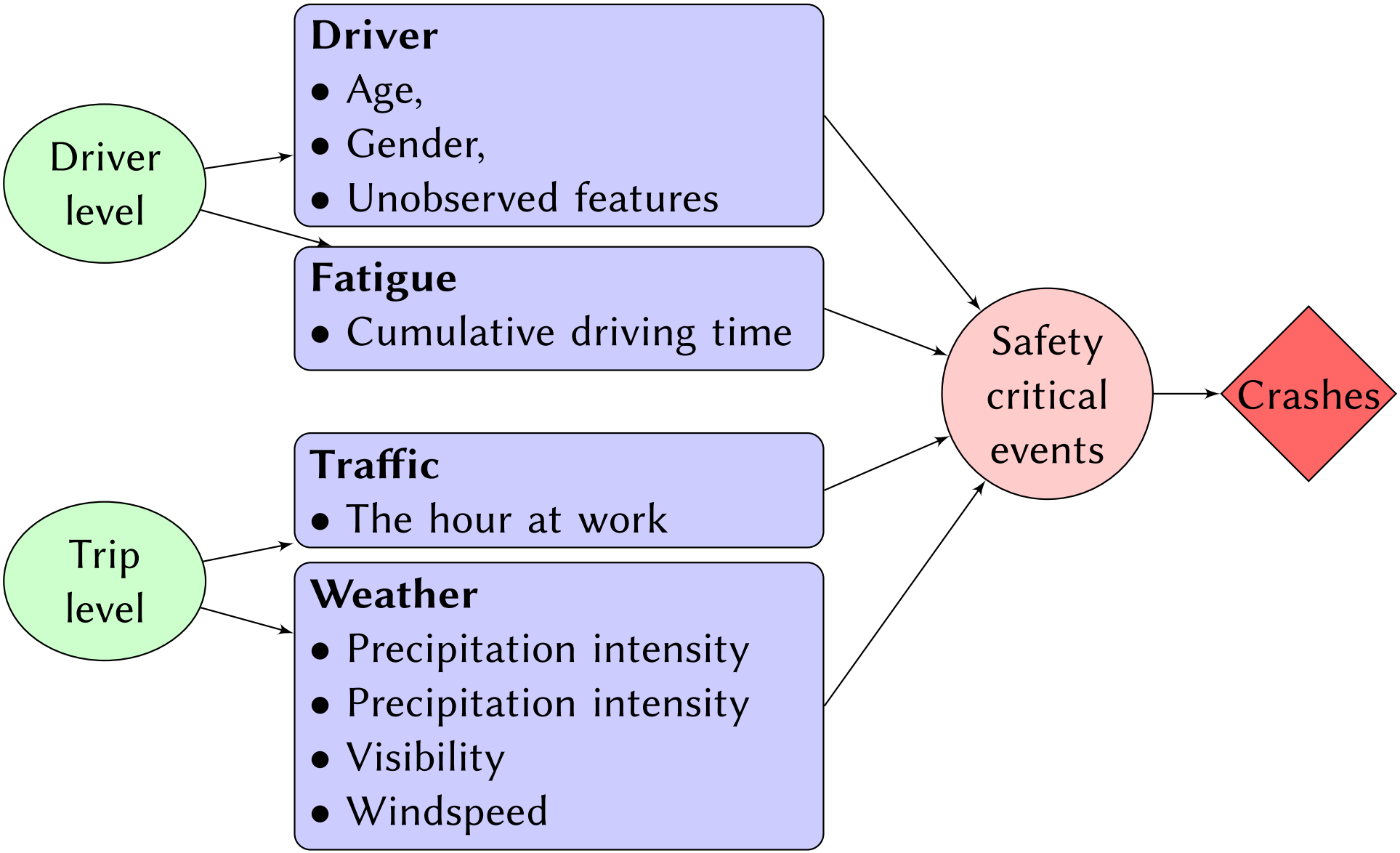
Committee member

Fadel Megahed
Miami University

Committee member

Contents

Conceptual framework



Contents

Hierarchical logistic regression

$$
\begin{aligned}
Y_i &\sim \text{Bernoulli}(p_i) \\
\log \frac{p_i}{1-p_i} &= \beta_{0,d(i)} + \beta_{1,d(i)} \cdot \text{CT}_i + \beta_2 x_2 + \cdots + \beta_k x_k \\
\beta_{0,d(i)} &\sim N(\mu_0, \sigma_0^2) \\
\beta_{1,d(i)} &\sim N(\mu_1, \sigma_1^2),
\end{aligned}
\tag{1}
$$

Hierarchical negative binomial regression

$$
\begin{aligned}
Y_i^\star &\sim \text{Negative Binomial}\left(T_i \times \mu_i,\ \mu_i + \frac{\mu_i^2}{\theta}\right) \\
\log \mu_i &= \beta^\star_{0,d(i)} + \beta^\star_{1,d(i)} \cdot \text{CT}_i + \beta^\star_2 x_2 + \cdots + \beta^\star_k x_k \\
\beta^\star_{0,d(i)} &\sim N(\mu^\star_0, \sigma^{\star 2}_0) \\
\beta^\star_{1,d(i)} &\sim N(\mu^\star_1, \sigma^{\star 2}_1),
\end{aligned}
\tag{2}
$$

Outcomes and predictors

The outcomes in this aim are the time to the SCEs since the start of shifts. The predictors include driver demographics (age, gender, and race), weather (mean visibility, precipitation intensity and probability at shift level), and shift specific variables (mean and standard deviation of speed). The driver-, shift-, trip-, and SCE-level notations are:

- Driver $d : 1, 2, \ldots, D$,
- Shift $s : 1, 2, \ldots, S_d$,
- Trip $r : 1, 2, \ldots, R_{d,s}$,
- SCE $i : 1, 2, \ldots, I_{d,s}$.

The data used in this aim are the same with those in Aim 2, but aggregated on trip- and shift-level for PLP and JPLP estimation. The notations for data in this aim are:

- $t_{d,s,i}$: time to the i-th SCE for driver d measured from the beginning of the s-shift,
- $n_{d,s,r}$: the number of SCEs for trip r within shift s for driver d,
- $a_{d,s,r}$: the end time of trip r within shift s for driver d.

Power law process (PLP)

$$
\begin{aligned}
t_{d,s,1}, t_{d,s,2}, \cdots, t_{d,s,n_{d,s}} &\sim \text{PLP}(\beta, \theta_{d,s}, \tau_{d,s}) \\
\beta &\sim \text{Gamma}(1,1) \\
\log \theta_{d,s} &= \gamma_{0d} + \gamma_1 x_{d,s,1} + \gamma_2 x_{d,s,2} + \cdots + \gamma_k x_{d,s,k} \\
\gamma_{01}, \gamma_{02}, \cdots, \gamma_{0D} &\sim \text{i.i.d. } N(\mu_0, \sigma_0^2) \\
\gamma_1, \gamma_2, \cdots, \gamma_k &\sim \text{i.i.d. } N(0, 10^2) \\
\mu_0 &\sim N(0, 5^2) \\
\sigma_0 &\sim \text{Gamma}(1,1),
\end{aligned} \tag{3}
$$

- $t_{d,s,i}$: time to the i-th event for driver d in shift s,
- $\tau_{d,s} = a_{d,s,R_{d,s}}$: length of time of shift s (truncation time) for driver d,
- $n_{d,s} = \sum_{r=1}^{n_{d,s}}$: number of SCEs in shift s for driver d.

Jump power law process (JPLP)

$$
\begin{aligned}
t_{d,s,1}, t_{d,s,2}, \cdots, t_{d,s,n_{d,s}} &\sim \text{JPLP}(\beta, \theta_{d,s}, \tau_{d,s}, \kappa) \\
\beta &\sim \text{Gamma}(1,1) \\
\log \theta_{d,s} &= \gamma_{0d} + \gamma_1 x_{d,s,1} + \gamma_2 x_{d,s,2} + \cdots + \gamma_k x_{d,s,k} \\
\kappa &\sim \text{Uniform}(0,1) \\
\gamma_{01}, \gamma_{02}, \cdots, \gamma_{0D} &\sim \text{i.i.d. } N(\mu_0, \sigma_0^2) \\
\gamma_1, \gamma_2, \cdots, \gamma_k &\sim \text{i.i.d. } N(0, 10^2) \\
\mu_0 &\sim N(0, 5^2) \\
\sigma_0 &\sim \text{Gamma}(1,1),
\end{aligned}
\tag{4}
$$

- κ: percent of intensity function recovery once the driver takes a break, and we assume κ is constant across drivers and shifts,
- $a_{d,s,r}$: end time of trip r within shift s for driver d.

Contents

What are TEX and LATEX, and Friends?

TEX

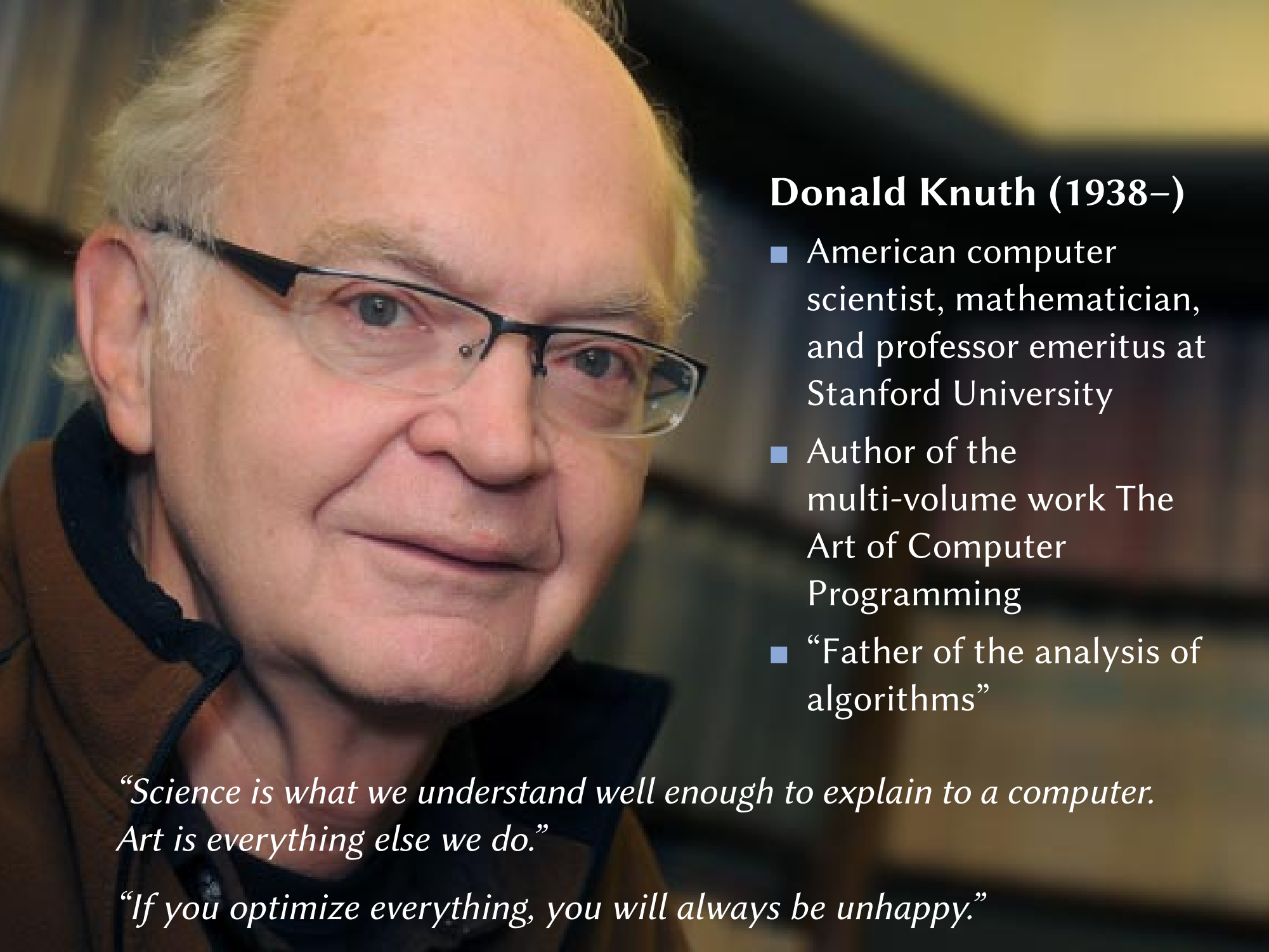
- From Greek τεχ
- ASCII `TeX`, /tɛx/, /tɛk/
- A computer typesetting system created by Donald Knuth
- for 'the creation of beautiful books'

LATEX

- ASCII `LaTeX`, /ˈlɛɪtɛx/, /ˈlɛɪtɛk/, /ˈlɑːtɛx/, /ˈlɑːtɛk/
- A document preparation system by Leslie Lamport

Friends

- BibTEX, MakeIndex, METAFONT, METAPOST, ...
- `http://www.ctan.org/what_is_tex.html`

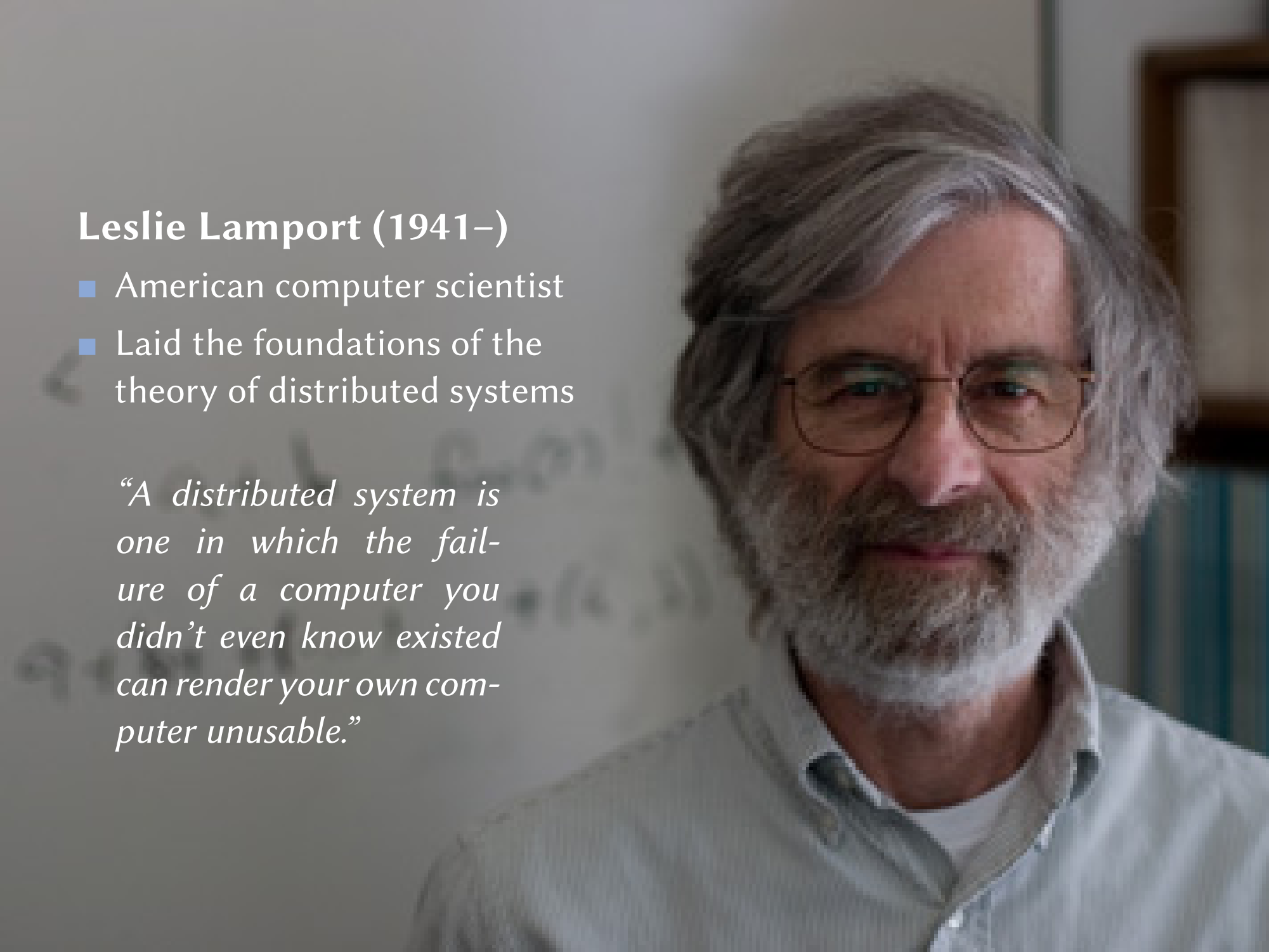


Donald Knuth (1938–)

- American computer scientist, mathematician, and professor emeritus at Stanford University
- Author of the multi-volume work The Art of Computer Programming
- "Father of the analysis of algorithms"

"Science is what we understand well enough to explain to a computer. Art is everything else we do."

"If you optimize everything, you will always be unhappy."



Leslie Lamport (1941–)

- American computer scientist
- Laid the foundations of the theory of distributed systems

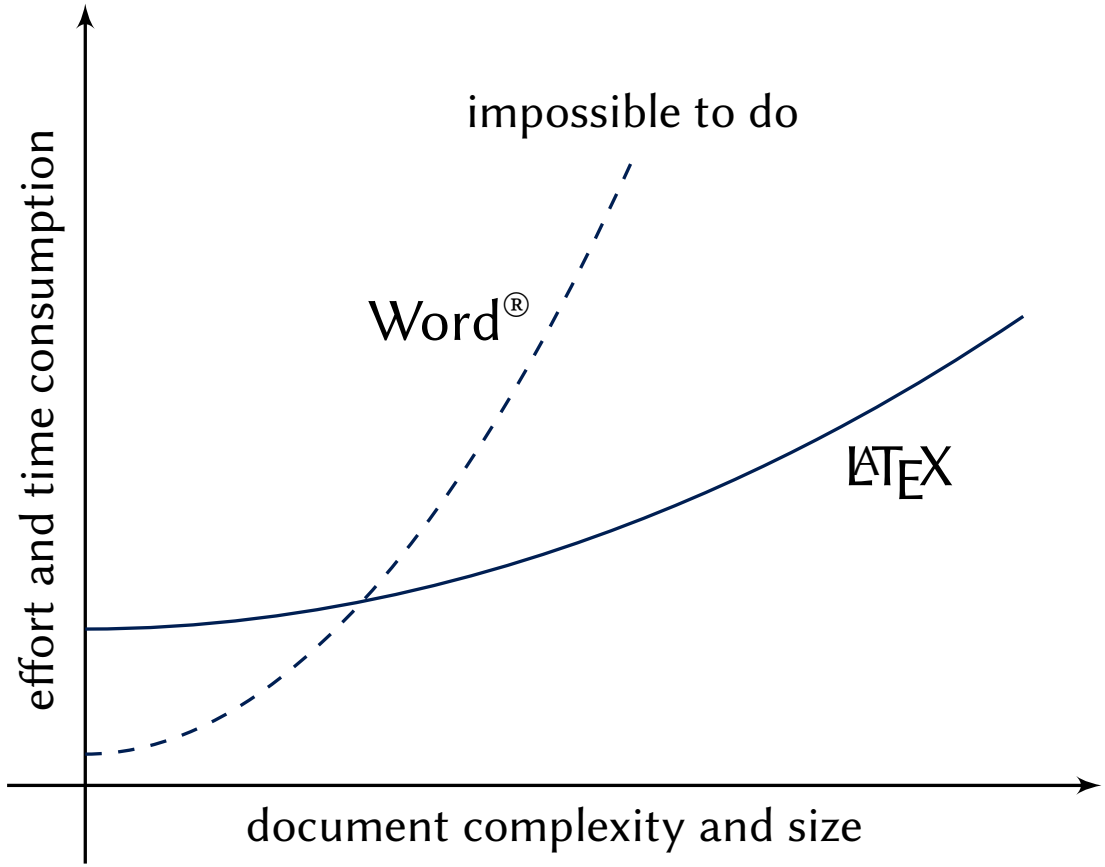
"A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable."

Typesetting and Word Processing

Apples and Oranges

- Word processors
  - Replacement of mechanical typewriters
  - Word, OpenOffice, AbiWord, ...
- Typesetting and Desktop publishing
  - For publication and printing
  - InDesign, QuarkXPress, Scribus...

Scalability



Scalability of LATEX and Microsoft Word® against document size and complexity (redrawn from Marko Pinteric's original at `http://www.pinteric.com/miktex.html`)

Professional Typesetting Quality Output

- Typesetting quality and legibility
  - good kerning hinting and correct ligatures
  - inter-word, line and paragraph spacing
  - context-sensitive hyphenation

Table fiery fluffy

This paper outlines an approach to produce a prototype WordNet system for Malay semi-automatically, by using bilingual dictionary data and resources provided by the original English WordNet system. Senses from an English-Malay bilingual dictionary were first aligned to English WordNet senses, and a set of Malay synsets were then derived. Semantic relations between the English WordNet synsets were extracted and re-applied to the Malay synsets, using the aligned synsets as a guide. A small Malay WordNet prototype with 12429 noun synsets and 5805 verb synsets was thus produced. This prototype is a first step towards building a full-fledged Malay WordNet.

Table fiery fluffy

This paper outlines an approach to produce a prototype WordNet system for Malay semi-automatically, by using bilingual dictionary data and resources provided by the original English WordNet system. Senses from an English-Malay bilingual dictionary were first aligned to English WordNet senses, and a set of Malay synsets were then derived. Semantic relations between the English WordNet synsets were extracted and re-applied to the Malay synsets, using the aligned synsets as a guide. A small Malay WordNet prototype with 12429 noun synsets and 5805 verb synsets was thus produced. This prototype is a first step towards building a full-fledged Malay WordNet.

- Correct mathematical typesetting (spacing etc)

$$W_\psi(f)(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} f(t)\psi\left(\frac{t-b}{a}\right) dt$$

$$W_\psi(f)(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} f(t)\psi\left(\frac{t-b}{a}\right) dt$$

This is not a Word Processors vs LATEX debate.

- It's a 'teaser' preview of an alternative tool.
- Some word processors also provide mechanisms to handle same routine tasks (with varying degrees of ease, consistency and stability)
- Use the best tool for the task at hand.
- **You** are the best judge to decide for yourself.

How Do I Use It?

1. Write a plain text LATEX file (`.tex`)
2. Run it through `pdflatex` or `xelatex` $\longrightarrow$ PDF output
   (or `latex + dvips + ps2pdf` for DVI + PS + PDF)
3. Run `bibtex` and/or `makeindex` to process bibliographies, indices
4. Re-run `pdflatex` to resolve references and pointers

Example .tex File

```
\documentclass[a4paper,11pt]{article}
\author{Lim Lian Tze}
\title{An Introductory Paper}
\date{\today}
\usepackage[english]{babel}

\begin{document}
\maketitle
\tableofcontents

\begin{abstract}
This paper introduces\ldots
\end{abstract}

\section{Introduction}
We consider\ldots

\section{State of the Art}
We look at\ldots

\subsection{Document Formats}
There are many\ldots
\end{document}
```

pdflatex

An Introductory Paper

Lim Lian Tze

June 7, 2011

Contents

Abstract

This paper introduces...

1 Introduction

We consider...

2 State of the Art

We look at...

2.1 Document Formats

There are many...

1

Where Do I Get It?

Online	Overleaf (`www.overleaf.com`)
Windows	MikTEX, TEX Live
Un*x, GNU/Linux	TEX Live
Mac OS X	MacTEX (based on TEX Live)
Installation	Use your OS' package manager (or download manually)
Editors	vi, emacs, Texmaker, TeXworks, Texstudio, TeXshop...
LATEX Packages	Use MikTEX or TEX Live's package manager
Documentation	(Online) `http://texdoc.net/pkg/<packagename>`
	(TEX Live) `$ texdoc <package name>`
	(MikTEX) `$ mthelp <package name>`

Easy to Learn, Hard to Master

- Customising may not be straightforward (vs word processors)
- Intentionally so: Style guidelines should be followed strictly
  - Publisher/organisation provides document class or style files
  - Use these to take care of formatting and styling, focus on the content

So, What Can LATEX Do?

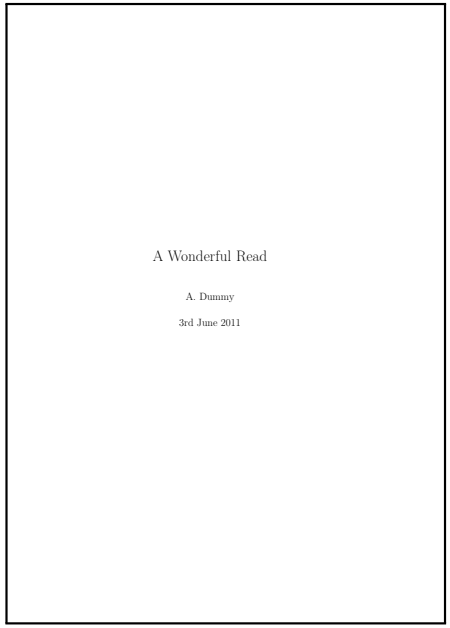
Contents

Basic Types

Books

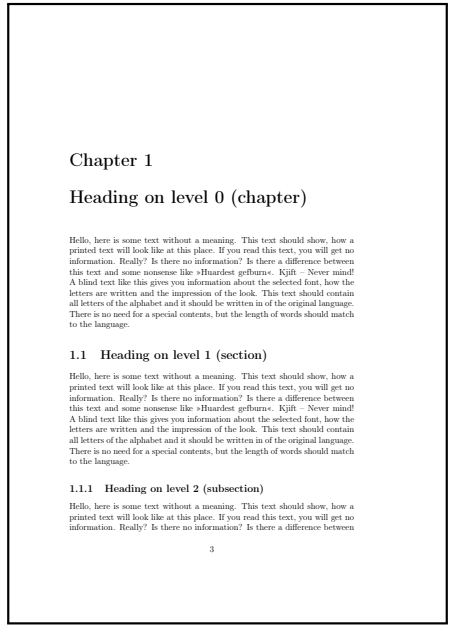
```
\documentclass{book}
\author{...}
\title{...}

\begin{document}
\maketitle
\chapter{...}
\section{...}
...
\subsection{...}
\end{document}
```


A Wonderful Read

A. Dummy

3rd June 2011


Chapter 1

Heading on level 0 (chapter)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

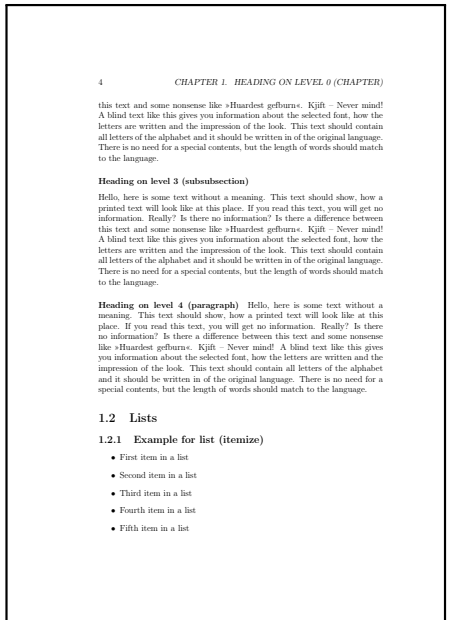
1.1 Heading on level 1 (section)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1.1.1 Heading on level 2 (subsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between

3


4 CHAPTER 1. HEADING ON LEVEL 0 (CHAPTER)

this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

Heading on level 3 (subsubsection)

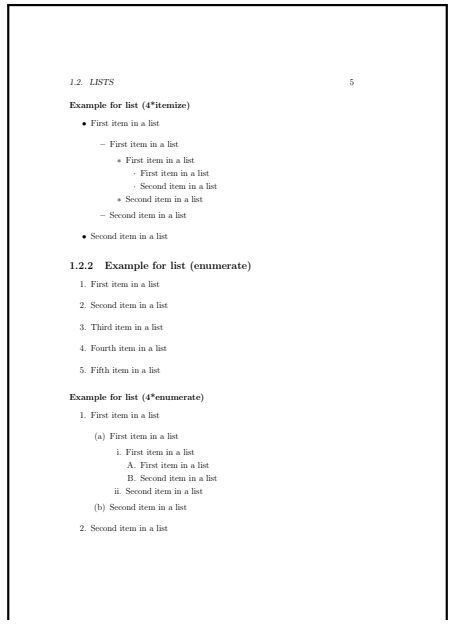
Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

Heading on level 4 (paragraph) Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1.2 Lists

1.2.1 Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list


1.2. LISTS 5

Example for list (4*itemize)

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list
      - Second item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

1.2.2 Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list
4. Fourth item in a list
5. Fifth item in a list

Example for list (4*enumerate)

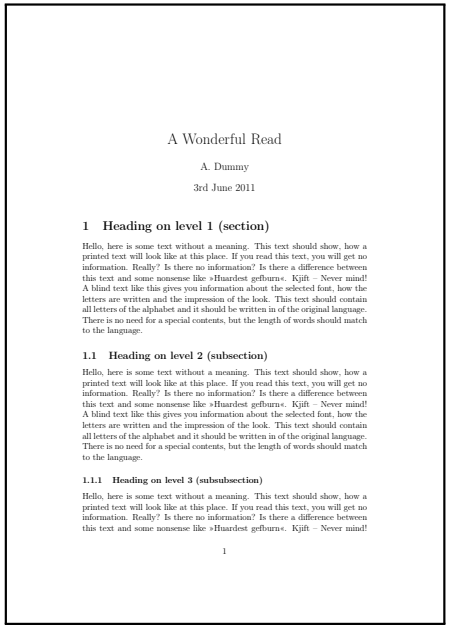
1. First item in a list
   (a) First item in a list
      i. First item in a list
         A. First item in a list
         B. Second item in a list
      ii. Second item in a list
   (b) Second item in a list
2. Second item in a list

Basic Types (cont'd)

Articles

```
\documentclass{article}
\author{...}
\title{...}

\begin{document}
\maketitle
\section{...}
...
\subsection{...}
\end{document}
```



A Wonderful Read

A. Dummy

3rd June 2011

1 Heading on level 1 (section)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

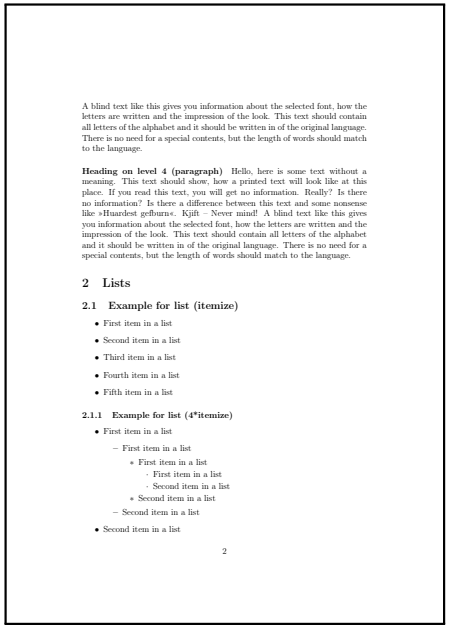
1.1 Heading on level 2 (subsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1.1.1 Heading on level 3 (subsubsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind!

1



A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

Heading on level 4 (paragraph) Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

2 Lists

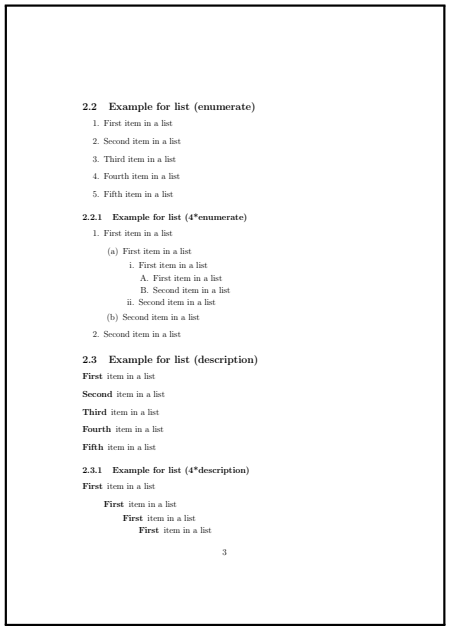
2.1 Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list

2.1.1 Example for list (4*itemize)

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list
      - Second item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

2



2.2 Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list
4. Fourth item in a list
5. Fifth item in a list

2.2.1 Example for list (4*enumerate)

1. First item in a list
   (a) First item in a list
      i. First item in a list
         A. First item in a list
         B. Second item in a list
      ii. Second item in a list
   (b) Second item in a list
2. Second item in a list

2.3 Example for list (description)

First item in a list

Second item in a list

Third item in a list

Fourth item in a list

Fifth item in a list

2.3.1 Example for list (4*description)

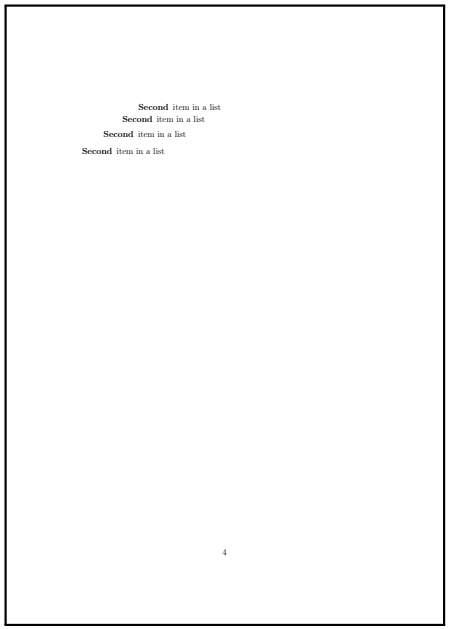
First item in a list

First item in a list

First item in a list

First item in a list

3



Second item in a list

Second item in a list

Second item in a list

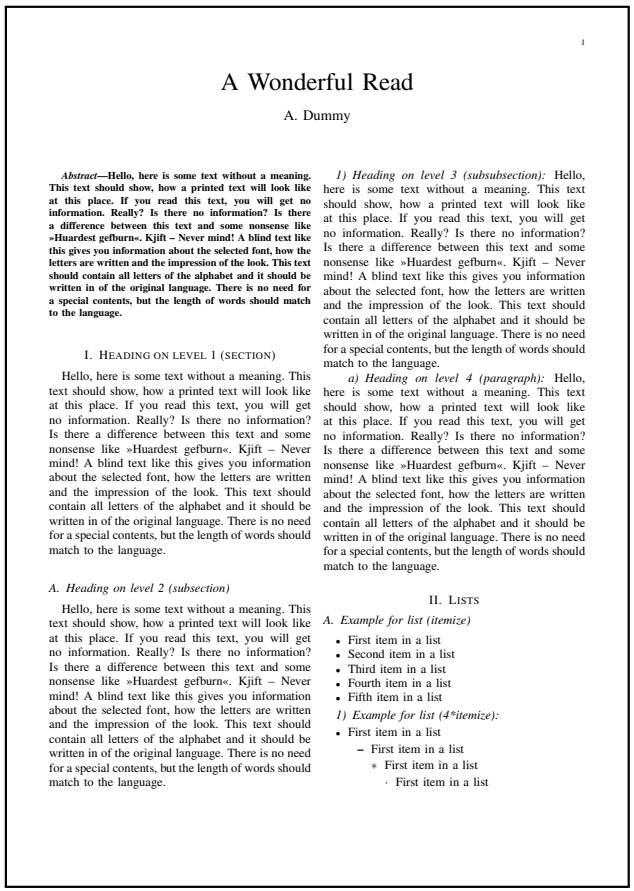
Second item in a list

4

Journal and Conference Proceedings Articles

IEEE

`\documentclass{IEEEtran}`



A Wonderful Read

A. Dummy

***Abstract*—Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.**

I. Heading on level 1 (section)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

A. Heading on level 2 (subsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1) Heading on level 3 (subsubsection): Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

a) Heading on level 4 (paragraph): Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

II. Lists

A. Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list

*1) Example for list (4*itemize):*

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list

ACM

`\documentclass{sig-alternate}`

A Wonderful Read

A. Dummy

ABSTRACT

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1. Heading on level 1 (SECTION)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1.1 Heading on level 2 (subsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1.1.1 Heading on level 3 (subsubsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

Heading on level 4 (paragraph).
Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

2. Lists

2.1 Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list

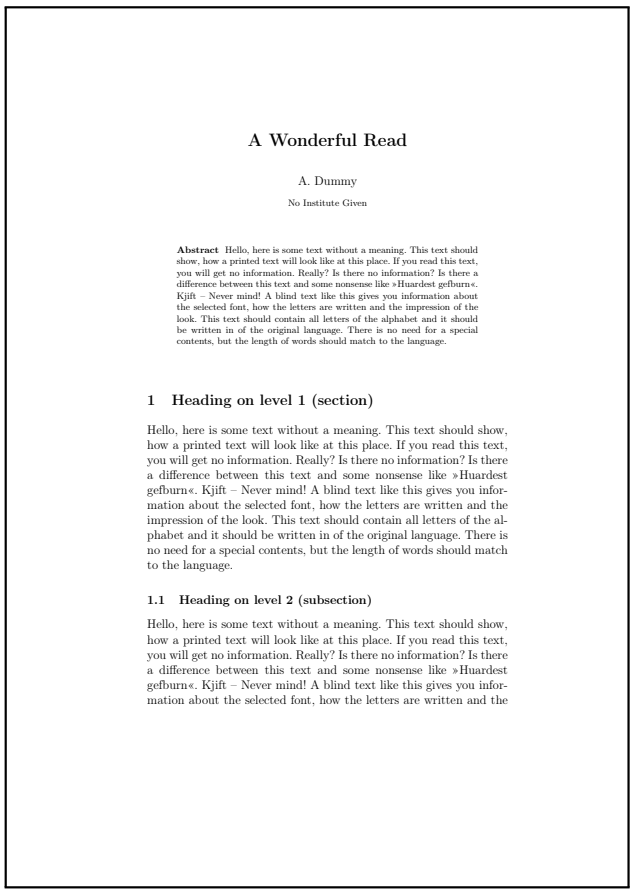
*2.1.1 Example for list (4*itemize)*

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list
      - Second item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

MOSC 2011, July 3–5, 2011, Penang, Malaysia.

LLNCS

`\documentclass{llncs}`



A Wonderful Read

A. Dummy

No Institute Given

Abstract Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for a special contents, but the length of words should match to the language.

1 Heading on level 1 (section)

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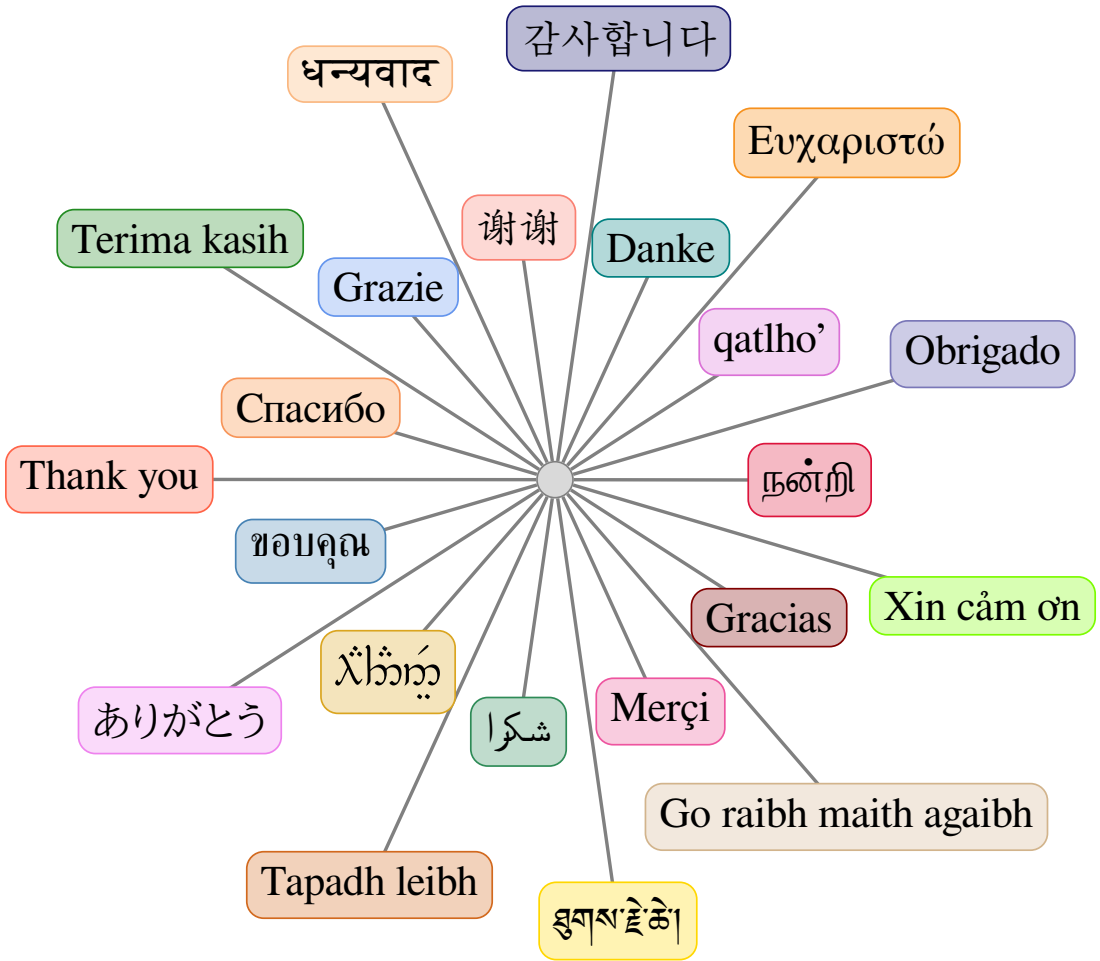
1.1 Heading on level 2 (subsection)

Hello, here is some text without a meaning. This text should show, how a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like »Huardest gefburn«. Kjift – Never mind! A blind text like this gives you information about the selected font, how the letters are written and the

Multilingual LaTeX

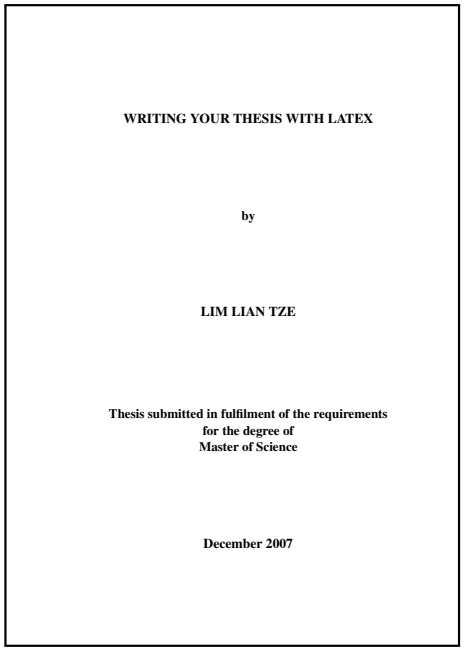


XeLaTeX, LuaLaTeX Unicode input

LaTeX Various packages (sometimes with transcriptions: `nan^ri`, `salAm`)

University Theses

Universiti Sains Malaysia `\documentclass{usmthesis}`



WRITING YOUR THESIS WITH LATEX

by

LIM LIAN TZE

Thesis submitted in fulfilment of the requirements
for the degree of
Master of Science

December 2007

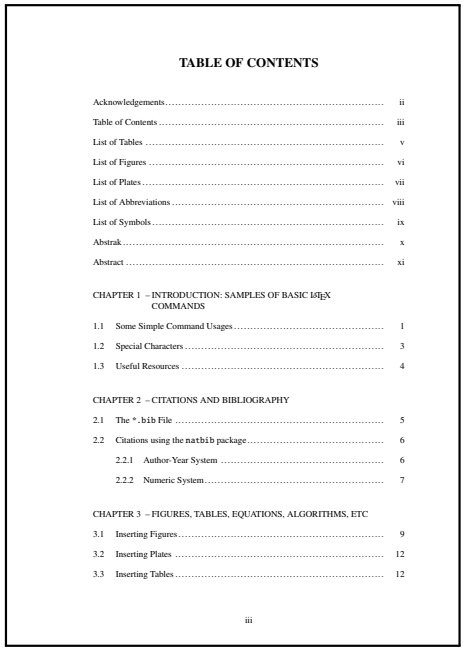
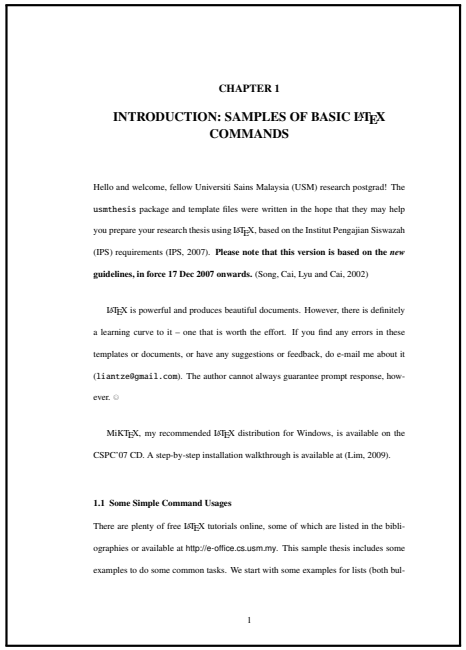


TABLE OF CONTENTS

iii



CHAPTER 1

INTRODUCTION: SAMPLES OF BASIC LaTeX COMMANDS

Hello and welcome, fellow Universiti Sains Malaysia (USM) research postgrad! The `usmthesis` package and template files were written in the hope that they may help you prepare your research thesis using LaTeX, based on the Institut Pengajian Siswazah (IPS) requirements (IPS, 2007). **Please note that this version is based on the *new* guidelines, in force 17 Dec 2007 onwards.** (Song, Cai, Lyu and Cai, 2002)

LaTeX is powerful and produces beautiful documents. However, there is definitely a learning curve to it – one that is worth the effort. If you find any errors in these templates or documents, or have any suggestions or feedback, do e-mail me about it (`liantze@gmail.com`). The author cannot always guarantee prompt response, however. ☺

MiKTeX, my recommended LaTeX distribution for Windows, is available on the CSPC 07 CD. A step-by-step installation walkthrough is available at (Lim, 2009).

1.1 Some Simple Command Usages

There are plenty of free LaTeX tutorials online, some of which are listed in the bibliographies or available at http://e-office.cs.usm.my. This sample thesis includes some examples to do some common tasks. We start with some examples for lists (both bul-

1

REFERENCES

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URL: *http://www.sciencedirect.com/science/article/B6WCX-4S50K9H-1/2/fe82b213b3ec28e07aef15882eb37538*

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Oetiker, T., Partl, H., Hyna, I. and Schlegl, E. (2006). *The Not So Short Introduction to LaTeX 2ε*, 4.2 edn.

Roberts, A. (2005). Getting to grips with LaTeX, [Online]. [Accessed January 22, 2011]. Available from World Wide Web: http://www.andy-roberts.net/misc/latex/index.html.

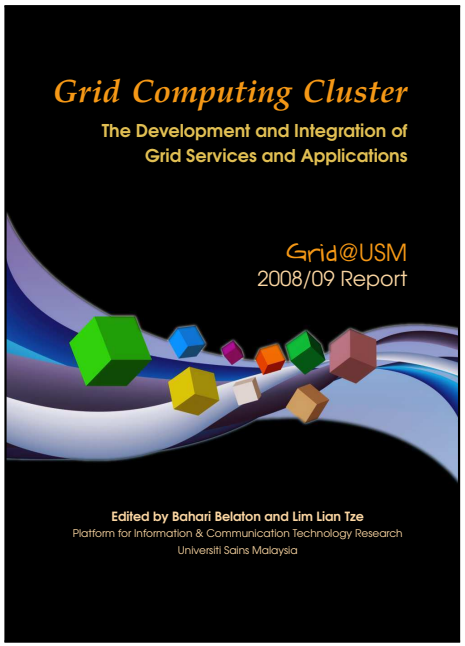
Song, J. Q., Cai, M., Lyu, M. R. and Cai, S. J. (2002). A new approach for line recognition in large-size images using hough transform, *Proceedings of the 16th International Conference on Pattern Recognition.*, Vol. 1, pp. 33–36.

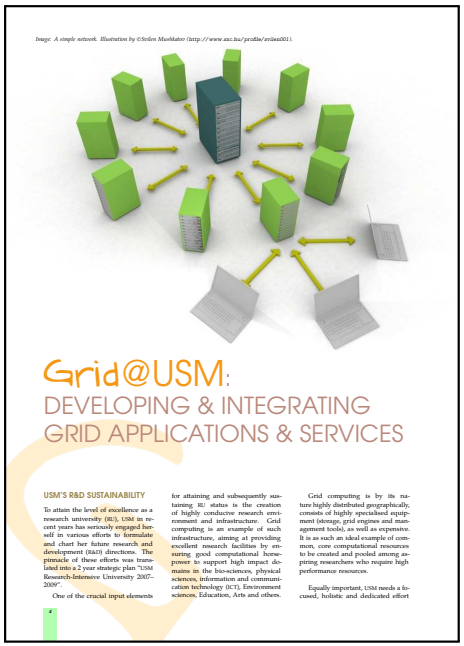
24

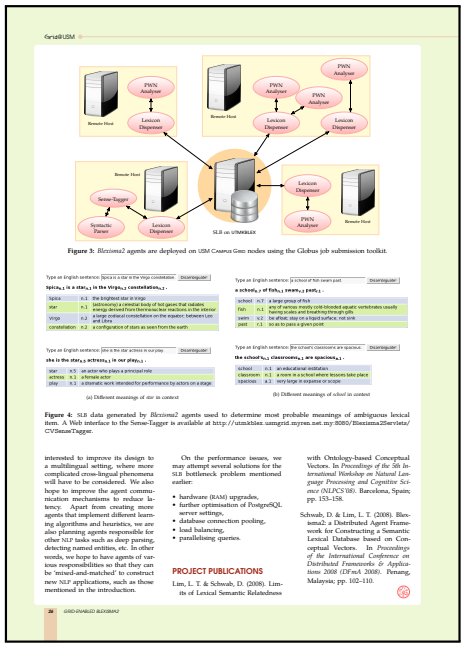
Highly Configurable Documents

`memoir` and KOMA-Script Classes

- Sectional headings
- Running headers and footers
- Good font, colour and illustration choices
- `http://latex-my.blogspot.com/search/label/bookdesign`







Presentation Slides

- This presentation was made with LaTeX!
- Many possible classes: powerdot, beamer

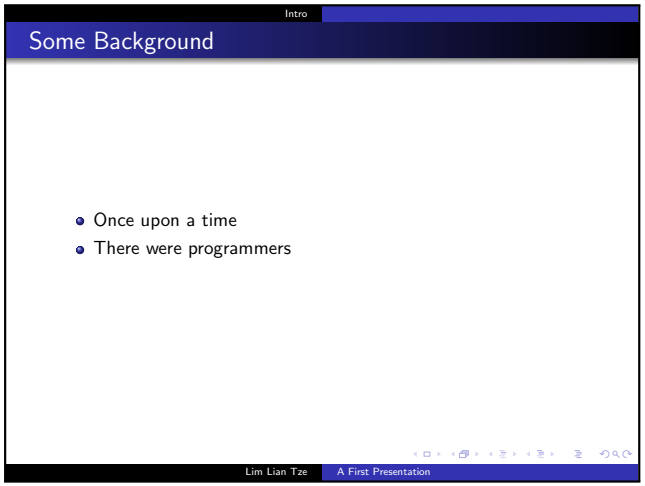
```
\documentclass{beamer}
\usetheme{Warsaw}

\author ...

\begin{document}
\titleframe

\section{Intro}

\begin{frame}
\frametitle{Some Background}
...
\end{frame}
\end{document}
```



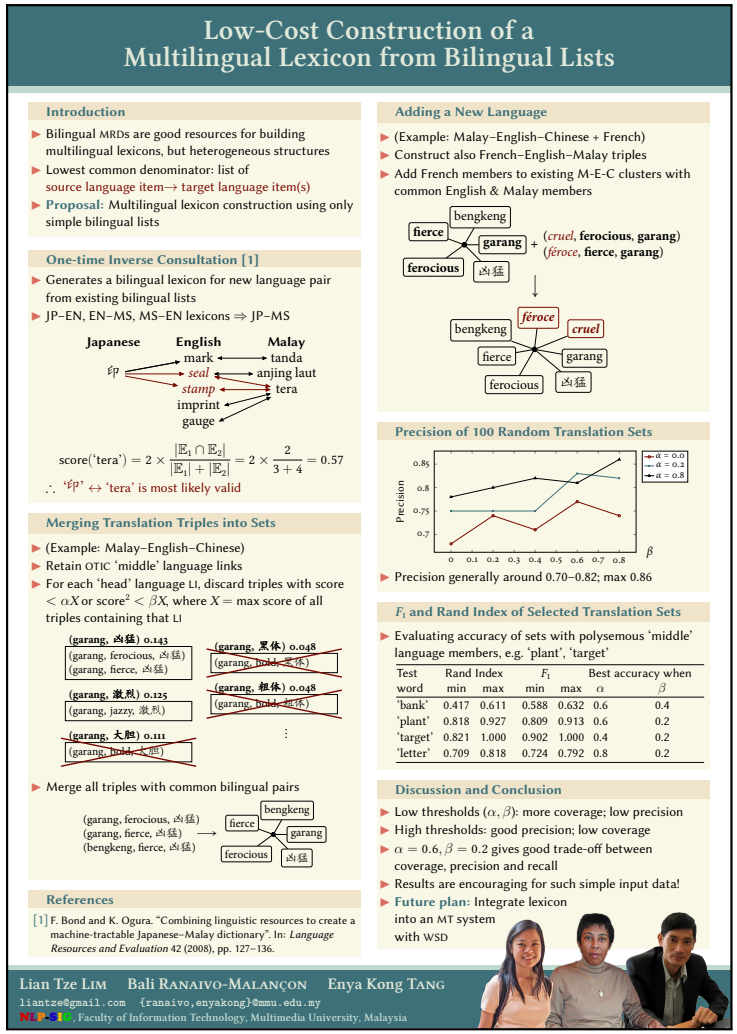
Oversized Posters

- Many possible solutions:

  sciposter, flowfram, beamerposter, tikzposter

```
\documentclass{beamer}
\usepackage[orientation=portrait,size=a0]
  {beamerposter}
\usetheme{...}
\author ...  % Meta-information

\begin{document}
\begin{frame}
...  % Poster contents goes here
\end{frame}
\end{document}
```

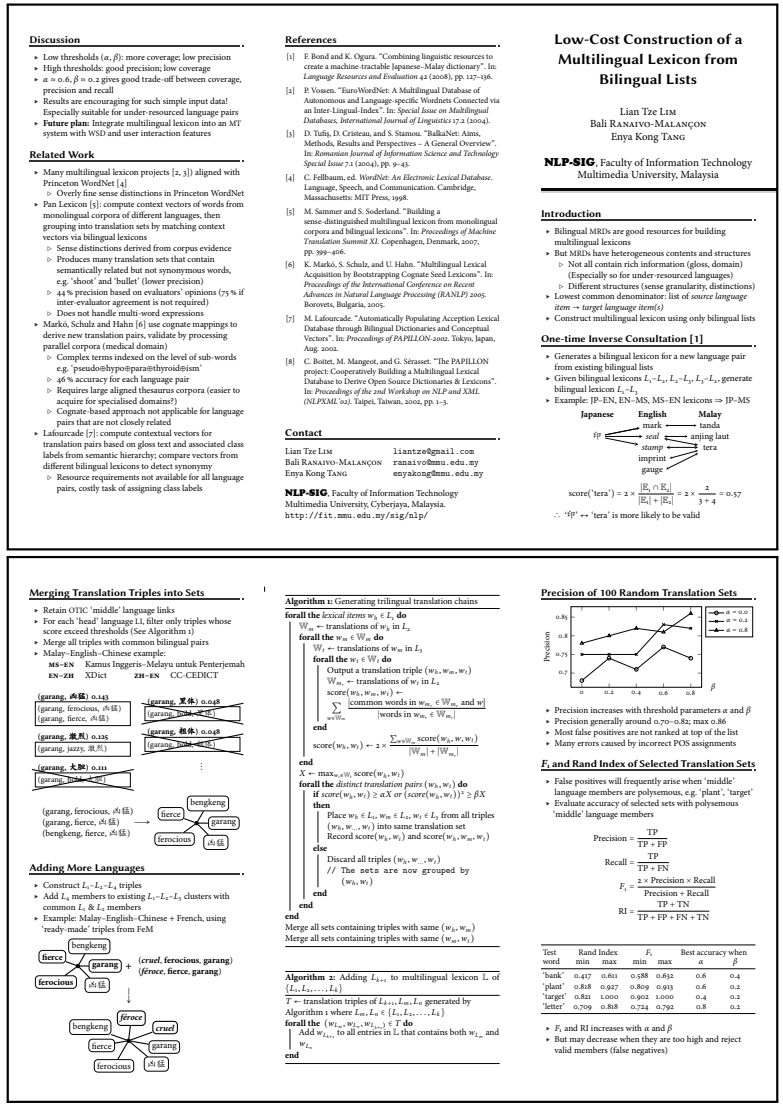


Leaflets

- `leaflet`: arrange contents into 6 pages on a foldable double-sided sheet

```
\documentclass[foldmark,a4paper]
{leaflet}
\author ... % Meta-information

\begin{document}
\maketitle
\section ...
... % Leaflet contents
\end{document}
```



Discussion

- Low thresholds (α, β): more coverage; low precision
- High thresholds: good precision; low coverage
- $\alpha \approx 0.6$, $\beta \approx 0.2$ gives good trade-off between coverage, precision and recall
- Results are encouraging for such simple input data! Especially suitable for under-resourced language pairs
- **Future plan:** Integrate multilingual lexicon into an MT system with WSD and user interaction features

Related Work

- Many multilingual lexicon projects [2, 3]) aligned with Princeton WordNet [4]
  - Overly fine sense distinctions in Princeton WordNet
- Pan Lexicon [5]: compute context vectors of words from monolingual corpora of different languages, then grouping into translation sets by matching context vectors via bilingual lexicons
  - Sense distinctions derived from corpus evidence
  - Produces many translation sets that contain semantically related but not synonymous words, e.g. 'shoot' and 'bullet' (lower precision)
  - 44 % precision based on evaluators' opinions (75 % if inter-evaluator agreement is not required)
  - Does not handle multi-word expressions
- Markó, Schulz and Hahn [6] use cognate mappings to derive new translation pairs, validate by processing parallel corpora (medical domain)
  - Complex terms indexed on the level of sub-words e.g. 'pseudo@hypo@para@thyroid@ism'
  - 46 % accuracy for each language pair
  - Requires large aligned thesaurus corpora (easier to acquire for specialised domains?)
  - Cognate-based approach not applicable for language pairs that are not closely related
- Lafourcade [7]: compute contextual vectors for translation pairs based on gloss text and associated class labels from semantic hierarchy; compare vectors from different bilingual lexicons to detect synonymy
  - Resource requirements not available for all language pairs, costly task of assigning class labels

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[8] C. Boitet, M. Mangeot, and G. Sérasset. "The PAPILLON project: Cooperatively Building a Multilingual Lexical Database to Derive Open Source Dictionaries & Lexicons". In: *Proceedings of the 2nd Workshop on NLP and XML (NLPXML'02)*. Taipei, Taiwan, 2002, pp. 1–3.

Contact

Lian Tze Lim — liantze@gmail.com
Bali Ranaivo-Malançon — ranaivo@mmu.edu.my
Enya Kong Tang — enyakong@mmu.edu.my

NLP-SIG, Faculty of Information Technology
Multimedia University, Cyberjaya, Malaysia.
http://fit.mmu.edu.my/sig/nlp/

Low-Cost Construction of a Multilingual Lexicon from Bilingual Lists

Lian Tze Lim
Bali Ranaivo-Malançon
Enya Kong Tang

NLP-SIG, Faculty of Information Technology
Multimedia University, Malaysia

Introduction

- Bilingual MRDs are good resources for building multilingual lexicons
- But MRDs have heterogeneous contents and structures
  - Not all contain rich information (gloss, domain) (Especially so for under-resourced languages)
  - Different structures (sense granularity, distinctions)
- Lowest common denominator: list of *source language item* ↔ *target language item(s)*
- Construct multilingual lexicon using only bilingual lists

One-time Inverse Consultation [1]

- Generates a bilingual lexicon for a new language pair from existing bilingual lists
- Given bilingual lexicons L_1–L_2, L_2–L_3, L_3–L_4, generate bilingual lexicon L_1–L_3
- Example: JP–EN, EN–MS, MS–EN lexicons ⇒ JP–MS

$$\text{score}(\text{'tera'}) = 2 \times \frac{|\mathbb{E}_1 \cap \mathbb{E}_3|}{|\mathbb{E}_1| + |\mathbb{E}_3|} = 2 \times \frac{2}{3+4} = 0.57$$

$\therefore$ 'ﾀﾝﾎﾟ' ↔ 'tera' is more likely to be valid

Merging Translation Triples into Sets

- Retain OTIC 'middle' language links
- For each 'head' language LI, filter only triples whose score exceed thresholds (See Algorithm 1)
- Merge all triples with common bilingual pairs
- Malay–English–Chinese example:
  - MS–EN Kamus Inggeris–Melayu untuk Penterjemah
  - EN–ZH XDict
  - ZH–EN CC-CEDICT

Adding More Languages

- Construct L_1–L_2–L_4 triples
- Add L_4 members to existing L_1–L_2–L_3 clusters with common L_1 & L_2 members
- Example: Malay–English–Chinese + French, using 'ready-made' triples from FeM

Algorithm 1: Generating trilingual translation chains

forall the *lexical items* $w_k \in L_k$ **do**
  $\mathbb{W}_m \leftarrow$ translations of w_k in L_2
  forall the $w_m \in \mathbb{W}_m$ **do**
    $\mathbb{W}_l \leftarrow$ translations of w_m in L_3
    forall the $w_l \in \mathbb{W}_l$ **do**
      Output a translation triple (w_k, w_m, w_l)
      $\mathbb{W}_{m_s} \leftarrow$ translations of w_l in L_2
      $\text{score}(w_k, w_m, w_l) \leftarrow \sum_{w \in \mathbb{W}_m} \frac{|\text{common words in } w_m \in \mathbb{W}_m \text{ and } w|}{|\text{words in } w_m \in \mathbb{W}_m|}$
    end
    $\text{score}(w_k, w_l) \leftarrow 2 \times \frac{\sum_{w \in \mathbb{W}_l} \text{score}(w_k, w, w_l)}{|\mathbb{W}_m| + |\mathbb{W}_{m_s}|}$
  end
end
$X \leftarrow \max_{w \in \mathbb{W}} \text{score}(w_k, w_l)$
forall the *distinct translation pairs* (w_k, w_l) **do**
  if $\text{score}(w_k, w_l) \geq \alpha X$ *or* $(\text{score}(w_k, w_l))^2 \geq \beta X$ **then**
    Place $w_k \in L_1$, $w_m \in L_2$, $w_l \in L_3$ from all triples $(w_k, w_{\_}, w_{\_})$ into same translation set
    Record $\text{score}(w_k, w_l)$ and $\text{score}(w_k, w_m, w_l)$
  else
    Discard all triples $(w_k, w_{\_}, w_l)$
    // The sets are now grouped by (w_k, w_l)
  end
end
Merge all sets containing triples with same (w_k, w_m)
Merge all sets containing triples with same (w_m, w_l)

Algorithm 2: Adding L_{k+1} to multilingual lexicon $\mathbb{L}$ of $\{L_1, L_2, \ldots, L_k\}$

$T \leftarrow$ translation triples of L_{k+1}–L_m–L_n generated by Algorithm 1 where $L_m, L_n \in \{L_1, L_2, \ldots, L_k\}$
forall the $(w_{1_m}, w_{1_n}, w_{2_{1_n}}) \in T$ **do**
  Add $w_{1_{k+1}}$ to all entries in $\mathbb{L}$ that contains both w_{1_m} and w_{1_n}
end

Precision of 100 Random Translation Sets

- Precision increases with threshold parameters α and β
- Precision generally around 0.70–0.82; max 0.86
- Most false positives are not ranked at top of the list
- Many errors caused by incorrect POS assignments

F_i and Rand Index of Selected Translation Sets

- False positives will frequently arise when 'middle' language members are polysemous, e.g. 'plant', 'target'
- Evaluate accuracy of selected sets with polysemous 'middle' language members

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$F_i = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

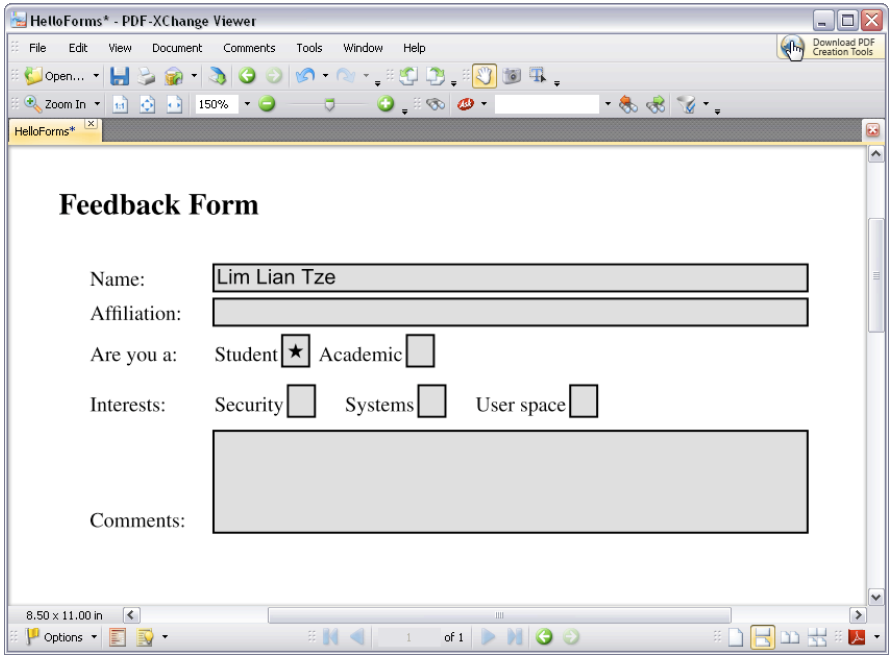
$$\text{RI} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{FP} + \text{FN} + \text{TN}}$$

Test word	Rand Index min	Rand Index max	F_i min	F_i max	Best accuracy when α	Best accuracy when β
'bank'	0.417	0.611	0.588	0.632	0.6	0.4
'plant'	0.818	0.927	0.809	0.913	0.6	0.2
'target'	0.821	1.000	0.902	1.000	0.4	0.2
'letter'	0.709	0.818	0.724	0.792	0.8	0.2

- F_i and RI increases with α and β
- But may decrease when they are too high and reject valid members (false negatives)

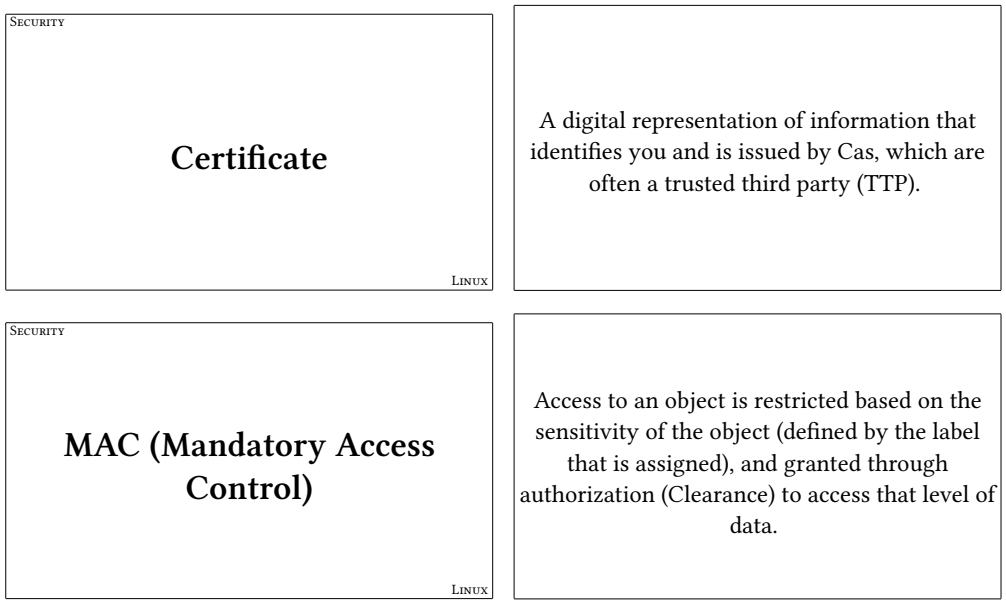
Fillable PDF Forms

```
\usepackage{hyperref}
... % various settings  skipped
\TextField{Name:}\\
\TextField{Affiliation:}\\
\ChoiceMenu[radio=true]
{Are you a:}{Student, Academic}\\
Interest:
\CheckBox{Security}
\CheckBox{Systems}
\CheckBox{User space}\\
\TextField[multiline=true]
{Comments:}\\
```



Flash Cards

```
\documentclass[avery5388,frame]
{flashcards}
\cardfrontstyle{headings}
\cardfrontfoot{Linux}

\begin{document}
\begin{flashcard}[Security]
{Certificate}
...
\end{flashcard}

\begin{flashcard}[Security]
{MAC ...}
...
\end{flashcard}
\end{document}
```



Examination Paper

```
\documentclass{exam}
...
\begin{questions}\printanswers
\question[5]
What is Paul McCartney's middle name?
\begin{oneparchoices}
\choice John \CorrectChoice Paul
\choice Ringo \choice James
\end{oneparchoices}

\question[10] What was the Beatles' first single
  in 1962?
\begin{solution}Love Me Do\end{solution}

\question
\begin{parts}
\part[5] What was George's inspiration for
  `While My Guitar Gently Weeps'?
\begin{solution}
He opened a random book and saw the words
  ``gently weep''.
\end{solution}
...
\end{questions}
```

1. What is Paul McCartney's middle name? (5)

   A. John **B. Paul** C. Ringo D. James

2. What was the Beatles' first single in 1962? (10)

   Solution: Love Me Do

3. (a) What was George's inspiration for 'While My Guitar Gently Weeps'? (5)

   Solution: He opened a random book and saw the words "gently weep".

   (b) Who guest-performed for the song and why? (5)

   Solution: Eric Clapton; he wanted a spiffy guitar solo.

Contents

Mathematics

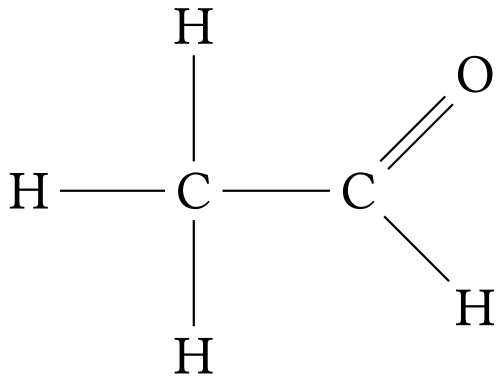
(5) relates the golden ratio and the Fibonacci series. Recall that the golden ratio, $\varphi = \frac{1}{2}(1 + \sqrt{5})$.

$$\varphi = 1 + \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{F_n F_{n+1}} \tag{5}$$

```
\eqref{eq:gratio} relates the golden ratio and the Fibonacci series.
Recall that the golden ratio, $\phi = \frac{1}{2} (1 + \sqrt{5})$.

\begin{equation}\label{eq:gratio}
\phi = 1 + \sum^{\infty} _{n=1}
                \frac{ (-1)^{n+1} }{ F_n F_{n+1} }
\end{equation}
```

Chemical Equations and Molecules

$$\mathrm{Zn^{2+}} \underset{+2\,\mathrm{H^+}}{\overset{+2\,\mathrm{OH^-}}{\rightleftharpoons}} \underset{\text{amphoteres Hydroxid}}{\mathrm{Zn(OH)_2}\downarrow} \underset{+2H+}{\overset{+2\,\mathrm{OH^-}}{\rightleftharpoons}} \underset{\text{Hydroxozikat}}{\mathrm{[Zn(OH)_4]^{2-}}}$$



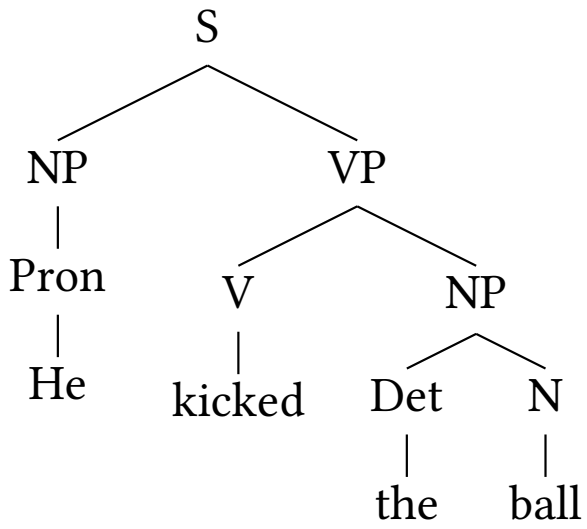

```
\usepackage[version=3]{mhchem}    % sufficient for chemical equations
\usepackage{chemfig}    % for 2-D molecule drawings
...
\ce{Zn^2+ <=>[\ce{+ 2OH-}][\ce{+ 2H+}]
$\underset{\text{amphoteres Hydroxid}}{\ce{Zn(OH)2 v}}$
<=> C[+2OH-][{+ 2H+}]
$\underset{\text{Hydroxozikat}}{\cf{[Zn(OH)4]^2-}}$ }

\chemfig{H-C(-[2]H)(-[6]H)-C(-[7]H)=[1]O}
```

Linguistics

(1)

*%*Wen*	*liebt*	*seine*	*Mutter?*
Whom	loves	his	mother
'Who	does	his	mother

```
\usepackage{linguex,qtree}
...
\ex
\begingl
\gla \%*Wen liebt seine Mutter?//
\glb Whom loves his mother//
\glc `Who does his mother love?'//
\endgl
\xe
```




```
\usepackage{qtree}
...
\Tree [ .S [.NP [.Pron He ] ] [.VP [.V
kicked ] [.NP [.Det the ] [.N ball ] ]
] ]
```

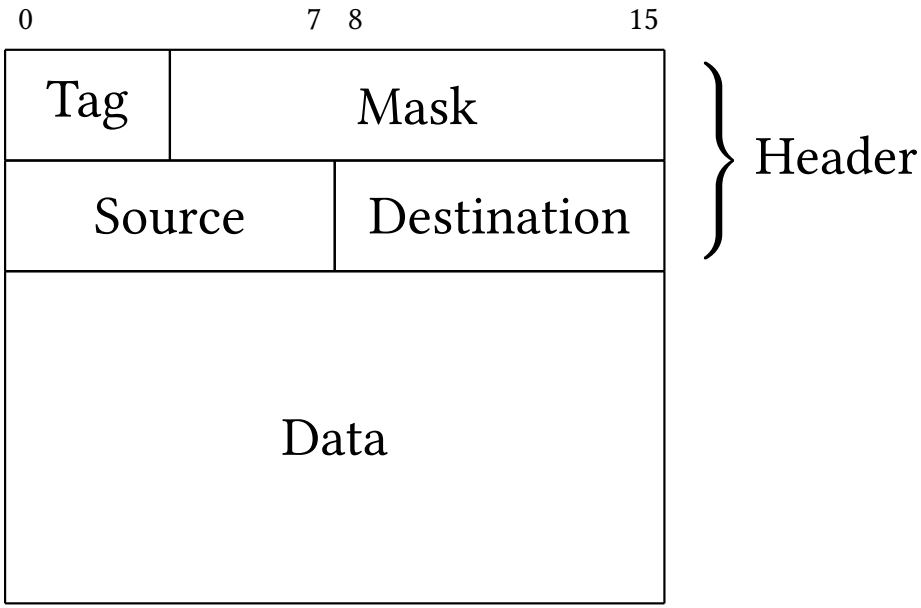
Program Listings

```
\usepackage{listings,xcolor}
...
\begin{lstlisting}
[language=C,columns=fullflexible,
basicstyle=\ttfamily,
keywordstyle=\bfseries\color{red},
commentstyle=\sffamily\color{green},
stringstyle=\rmfamily\color{orange}]
#include <stdio.h>
/*
 | Prints "hello world"
 */
int main(void)
{
    printf("hello, world\n");
    return 0;
}
\end{lstlisting}
```

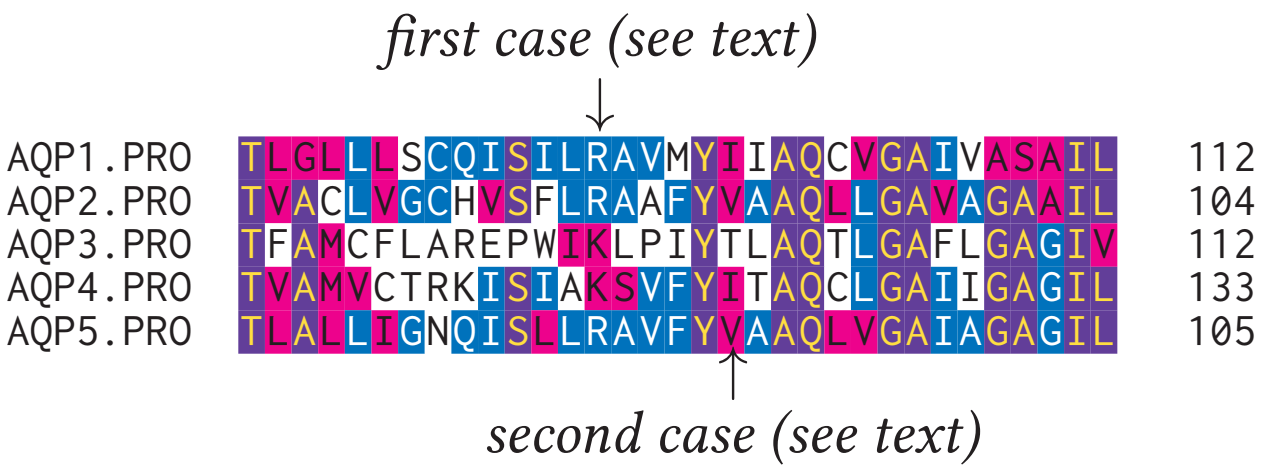
```c
#include <stdio.h>

/*
 | Prints "hello world"
 */
int main(void)
{
    printf("hello, world\n");
    return 0;
}
```

Network Protocols

```
\usepackage{bytefield}
...
\begin{bytefield}{16}
\bitheader{0,7,8,15} \\
\begin{rightwordgroup}{Header}
\bitbox{4}{Tag} & \bitbox{12}{Mask} \\
\bitbox{8}{Source} &
\bitbox{8}{Destination}
\end{rightwordgroup} \\
\wordbox{3}{Data}
\end{bytefield}
```

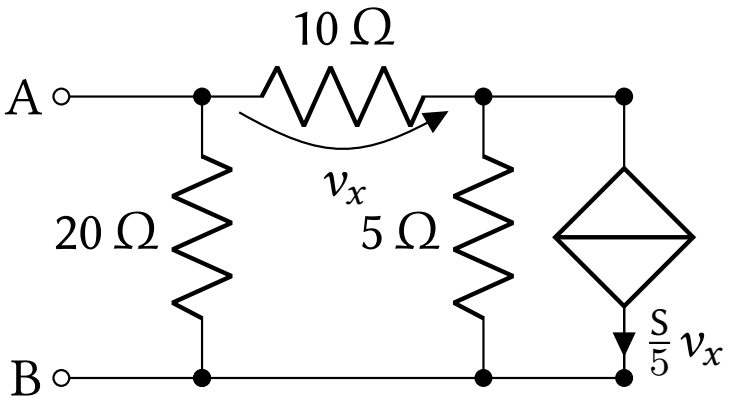


Life Sciences




```
\usepackage{texshade}   % for nucleotide and peptide alignments
...
\begin{texshade}{AQPpro.MSF.txt}
\shadingmode{similar}
\threshold[80]{50}
\setends{1}{80..112}
\hideconsensus
\feature{top}{1}{93..93}{fill:$\downarrow$}{first case (see text)}
\feature{bottom}{1}{98..98}{fill:$\uparrow$}{second case (see text)}
\end{texshade}
```

Circuits and SI Units



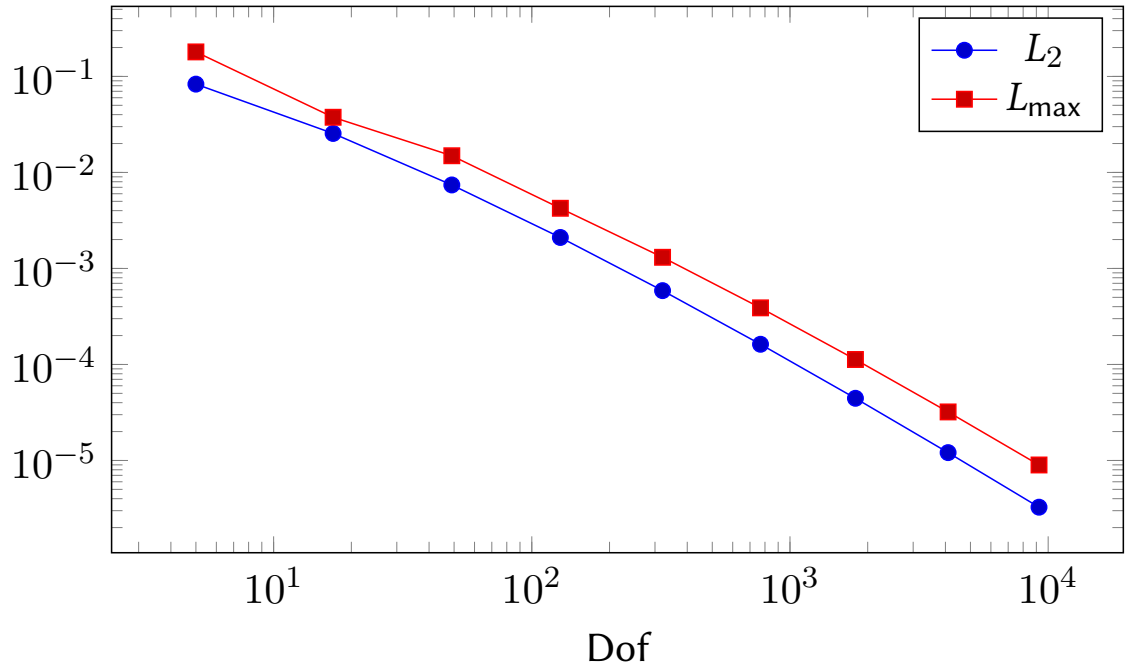
- $3.45 \times 10^4\ \mathrm{V^2\,lm^3\,F^{-1}}$
- 40 km/h, 85 km/h and 103 km/h

```
\usepackage{siunitx}
\usepackage[siunitx]{circuitikz}
...
\begin{circuitikz}
\draw (0,0) node[anchor=east] {B}
  to[short, o-*] (1,0)    to[R=20<\ohm>, *-*] (1,2)
  to[R=10<\ohm>, v=$v_x$] (3,2) -- (4,2)
  to[ cI=$\frac{\si{\siemens}}{5} v_x$, *-*] (4,0) -- (3,0)
  to[R=5<\ohm>, *-*] (3,2)
  (3,0) -- (1,0)   (1,2) to[short, -o] (0,2) node[anchor=east]{A}
;\end{circuitikz}

\SI{3.45d4}{\square\volt\cubic\lumen\per\farad}
\SIlist[per-mode=symbol]{40;85;103}{\kilo\metre\per\hour}
```

Bar Codes

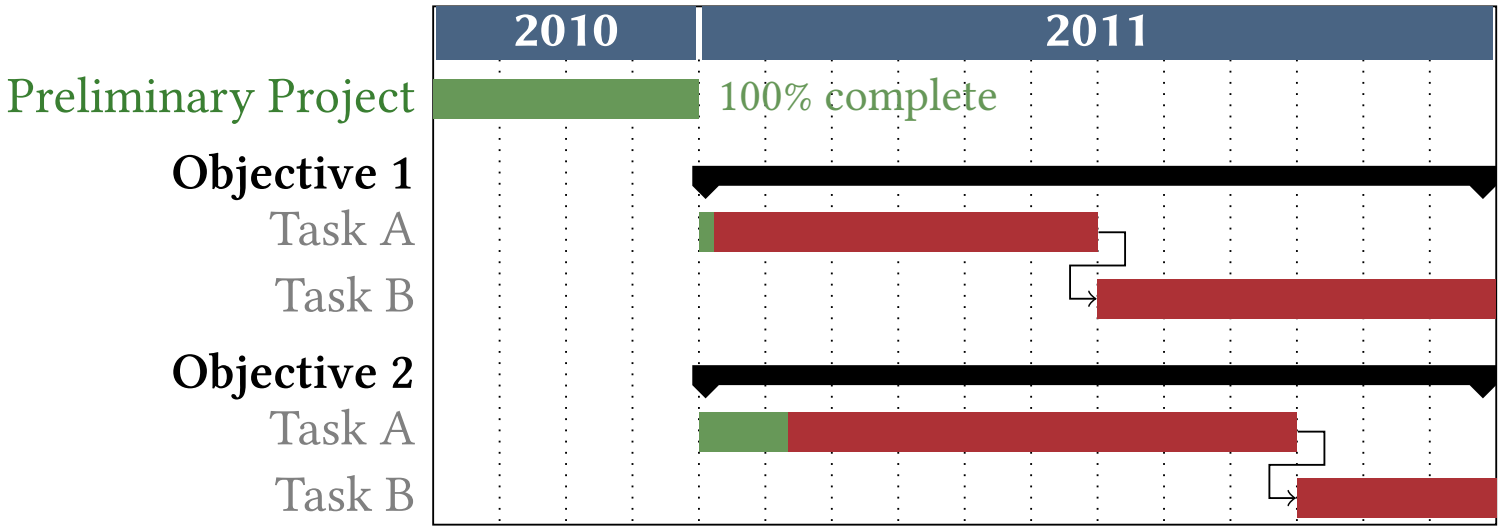
```
\usepackage{auto-pst-pdf}   % Needed if running pdflatex; must use option -shell-escape
\usepackage{pstricks,pst-barcode}
...
\begin{pspicture}
\psbarcode{MECARD:N:Malaysia Open Source Conference...}{eclevel=L}{qrcode}
\psbarcode{9781860742712}{includetext guardwhitespace}{ean13}
\psbarcode{978-3-86541-114}{includetext guardwhitespace}{isbn}
\psbarcode{LE28HS9Z}{includetext}{royalmail}
\psbarcode{^453^178^121^239}{columns=2 rows=10}{pdf417}
\end{pspicture}
```

Graph Plots



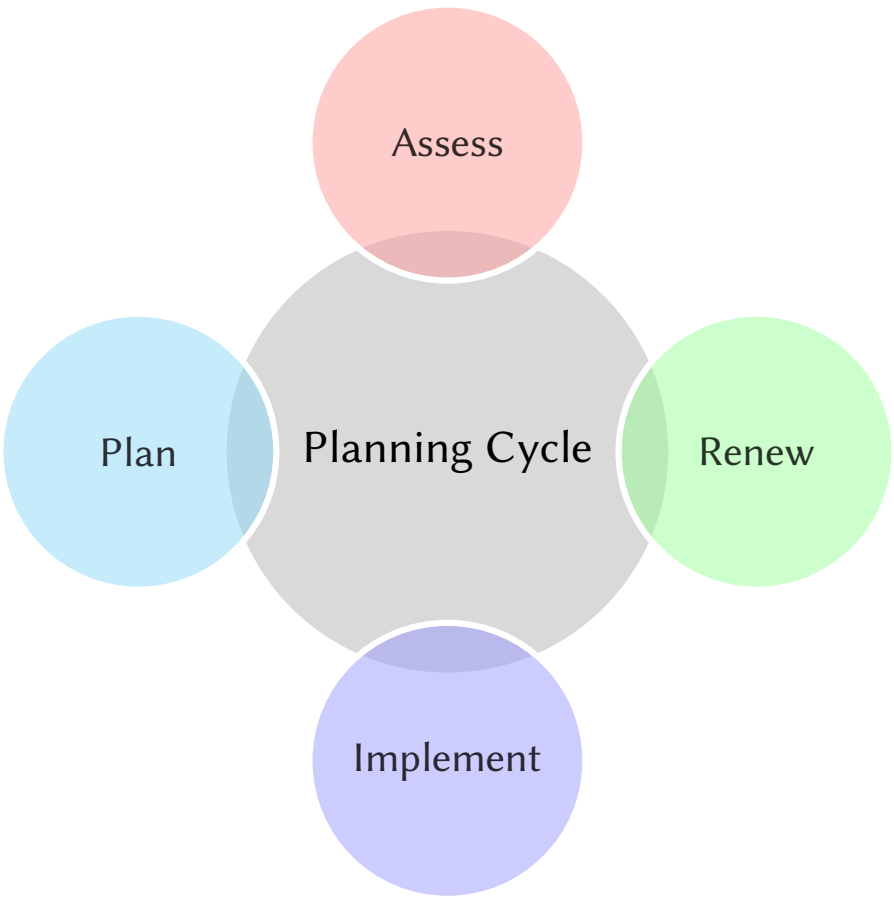

```
\usepackage{pgfplots}
...
\begin{tikzpicture}
\begin{loglogaxis}[xlabel=Dof]
\addplot table[x=dof,y=L2]{datafile.dat}; \addlegendentry{$L_2$};
\addplot table[x=dof,y=Lmax]{datafile.dat};  \addlegendentry{$L_\text{max}$};
\end{loglogaxis}
\end{tikzpicture}
```

Gantt Charts

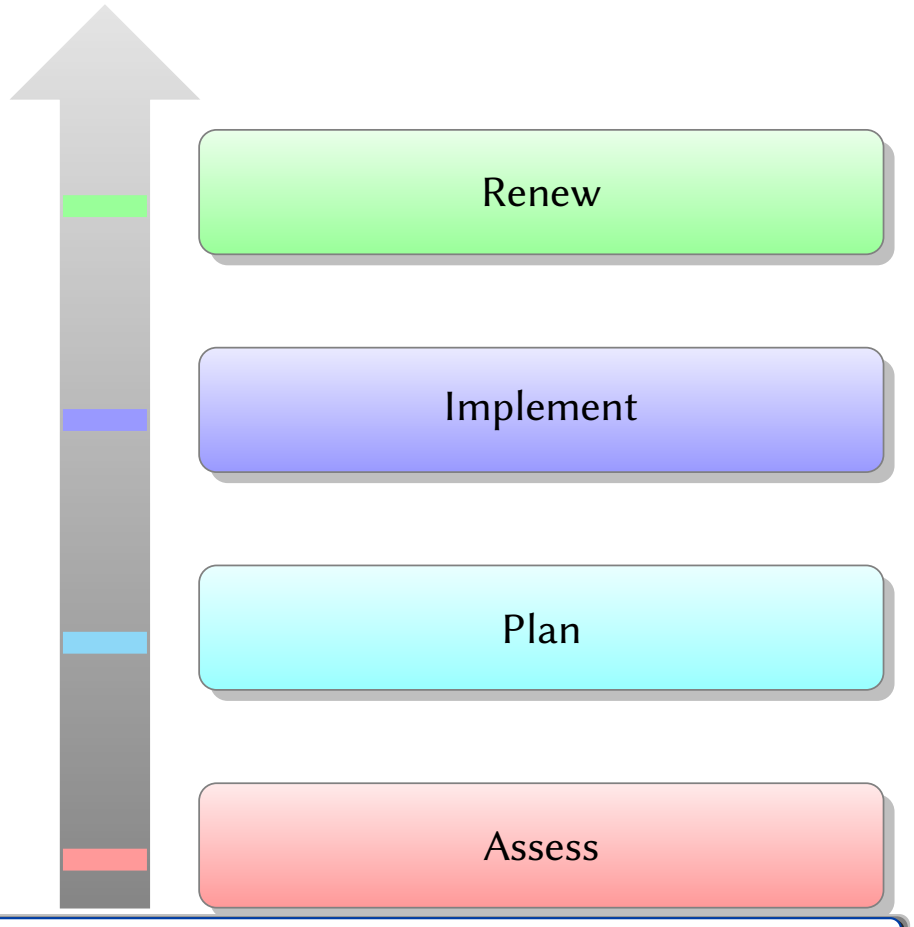



```
\usepackage{pgfgantt}
...
\begin{ganttchart}[...settings...]{1}{16}
\ganttitle{2010}{4} \ganttitle{2011}{12} \\
\ganttbar[progress=100]{Preliminary Project}{1}{4} \\
\ganttgroup{Objective 1}{5}{16} \\
\ganttbar[progress=4, name=T1A]{Task A}{5}{10} \\
\ganttlinkedbar[progress=0]{Task B}{11}{16} \\
...
\end{ganttchart}
```

'Smart Diagrams'




```
\usepackage{smartdiagram}
\smartdiagram[bubble diagram]{
  Planning Cycle,Assess,Plan,
  Implement,Renew}
```

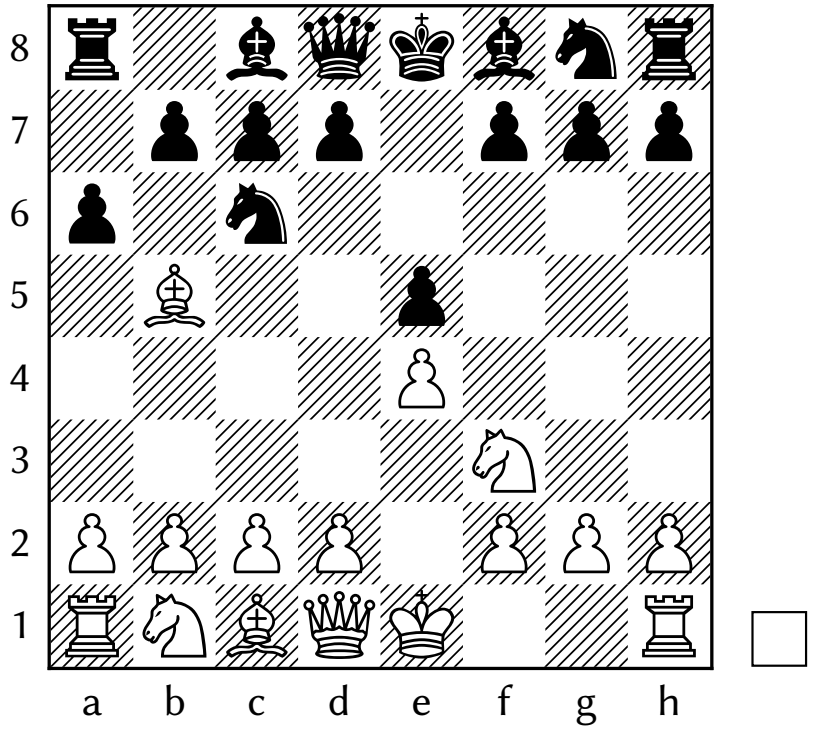



```
\usepackage{smartdiagram}
\smartdiagram
  [priority descriptive diagram]{
  Assess,Plan,Implement,Renew}
```

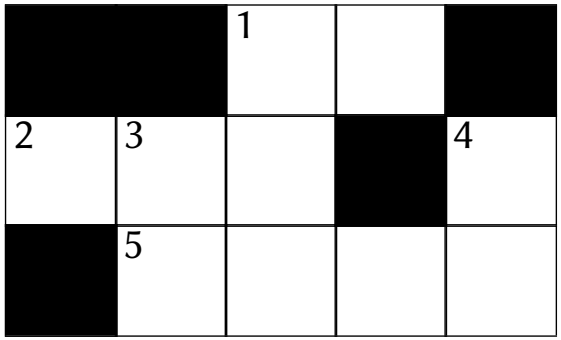
Chess games

```
\usepackage[skaknew]%
{skak,chessboard}
...
\newgame
\mainline{1. e4 e5 2. Nf3 Nc6 3. Bb5 a6}
\chessboard[smallboard]
```

1 e4 e5 2 ♘f3 ♘c6 3 ♗b5 a6



Crossword Puzzles

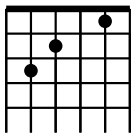


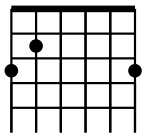
Across: 1 unit of measure
$2 *$ 5 sectioning unit

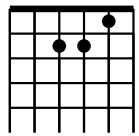
Down: 1 η 3 unit of measure 4 nonproportional font

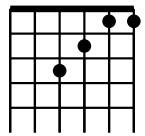
```
\usepackage{cwpuzzle}
...
\begin{Puzzle}{5}{3}
|* |* |[1]E|X |* |.
|[2]A|[3]S|T |* |[4]T|.
|* |[5]P|A |R |T |.
\end{Puzzle}
\begin{PuzzleClues}{
\textbf{Across:} }
  \Clue{1}{EX}{unit of measure}
  \Clue{2}{AST}{\(\ast\)}
  \Clue{5}{PART}{sectioning unit}
\end{PuzzleClues}
\begin{PuzzleClues}{
\textbf{Down:} }
  \Clue{1}{ETA}{\(\eta\)}
  \Clue{3}{SP}{unit of measure}
  \Clue{4}{TT}{nonproportional font}
\end{PuzzleClues}
```

Song Books with Guitar Tabs

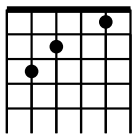

C

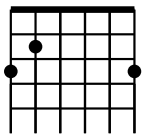

G

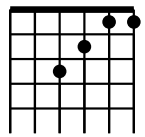

Am

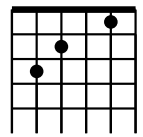

F

Country road, take me home, to the place I belong.


C


G


F


C

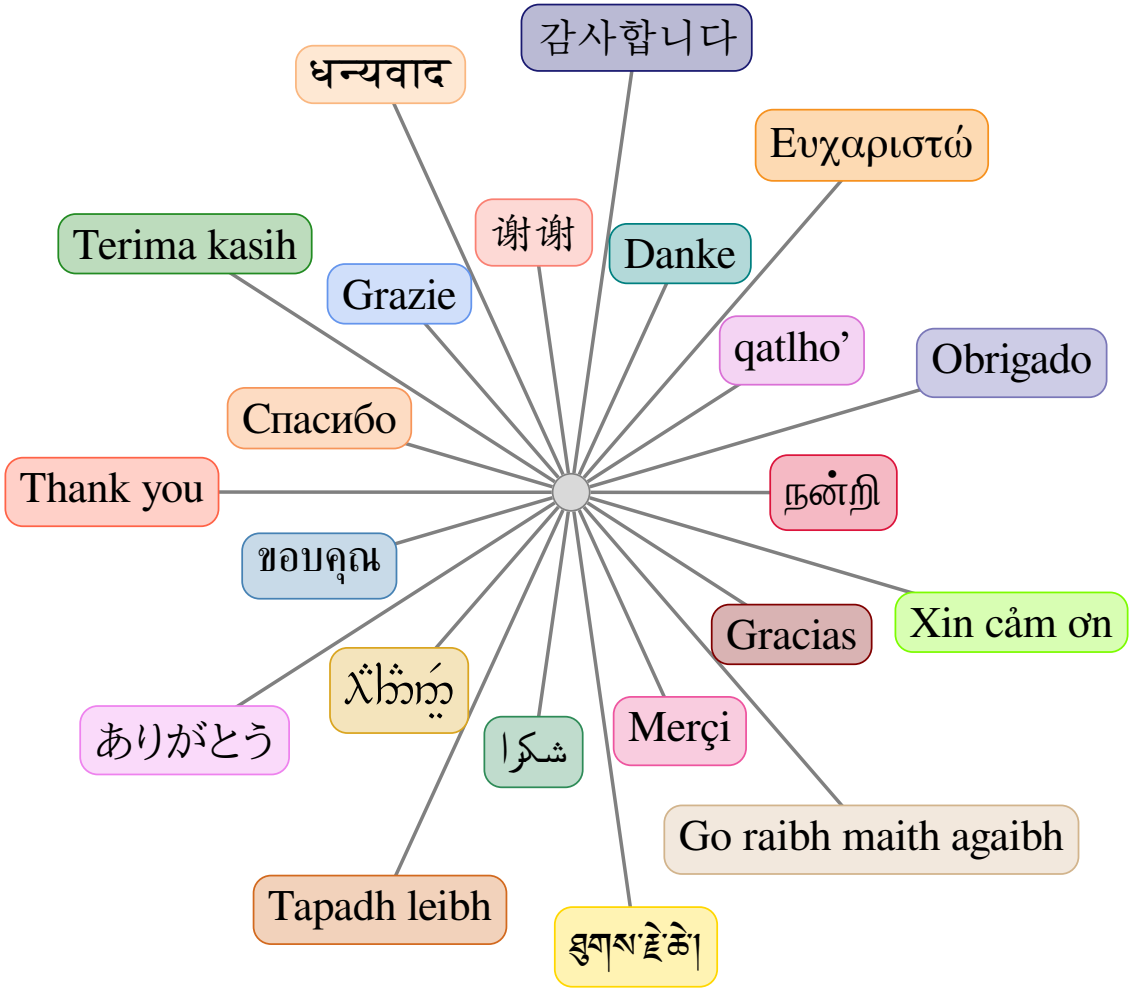
West Virginia, mountain momma, take me home, country road.

```
\usepackage{gchords,guitar}
...
\begin{guitar}
\newcommand{\CMaj}{\chord{t}{n,p3,p2,n,p1,n}{C}}
\newcommand{\Amin}...
Country [\CMaj]road, take me [\GMaj]home, ...
\end{guitar}
```

Contents

Summary

- LaTeX
  - a document preparation system
  - professional quality typesetting output
- Output artefacts
  - Academic: papers, theses, books
  - Dedicated document types
  - Domain-specific material
- Usage scenario
  - Direct authoring
  - Automatic generation (via scripts etc)
  - As back-end of other applications



Questions?

miao.cai@outlook.com