

CSCE 222  
Discrete Structures for Computing

LaTeX

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Based on slides by Andreas Klappenecker



# Tripitaka Koreana

- Palman Daejanggyeong (“Eighty-Thousand Tripitaka”)
- South Korean collection of Buddhist scriptures
- Carved onto 81,258 wooden printing blocks in the 13th century
- The world’s most comprehensive and oldest intact version of Buddhist canon in Hanja script, with no known errors or errata in the 52,382,960 characters





# Haeinsa – UNESCO World Heritage Site



般若波羅蜜多心經

唐三藏法師玄奘譯

觀自在菩薩行深般若波羅蜜多時  
照見五蘊皆空度一切苦厄舍利子  
色不異空空不異色色即是空空即  
是色受想行識亦復如是舍利子是  
諸法空相不生不滅不垢不淨不增  
不減是故空中無色无受想行識無  
眼耳鼻舌身意无色聲香味觸法无  
眼界乃至無意識界无無明亦无無  
明盡乃至无老死亦無老死盡無苦  
集滅道無智亦无得以無所得故苦  
提薩埵依般若波羅蜜多故心無罣  
碍无罣碍故無有恐怖遠離顛倒夢  
想究竟涅槃三世諸佛依般若波羅  
蜜多故得阿耨多羅三藐三菩提故  
知般若波羅蜜多是大神呪是大明  
呪是無上呪是无等等呪能除一切  
苦真實不虛故說般若波羅蜜多呪  
即說呪曰

揭帝揭帝 般羅揭帝 般羅僧揭  
帝 菩提僧莎訶

般若波羅蜜多心經

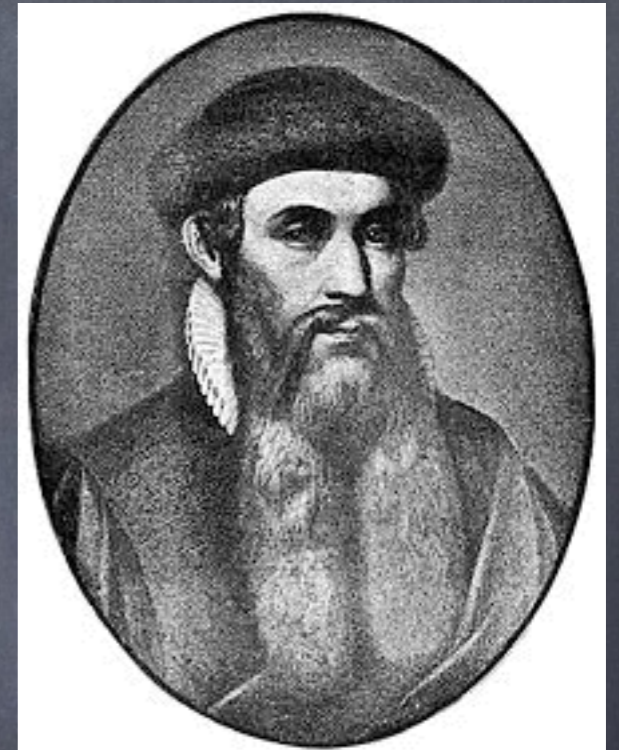
戊戌歲高麗國大藏都監奉

勅彫造



# Gutenberg

- Johannes Gutenberg
- Introduced **movable** metal type to Europe (in around 1439)
- Invented the printing press
- Started a revolution in printing in Europe





# Gutenberg Bible

- Gutenberg demonstrated his printing technology by printing a complete bible.
- The Gutenberg bible was produced at a significantly lower cost than hand copying.
- Still, cost: about 3 years salary of a clerk per bible.
- 1978: Copy sold for \$2.2million





**I**n capitulo huius bresithi que nos genesi dicimus

**I**n principio creauit deus celum. **cap. pr<sup>m</sup>**  
 et terram. Terra autem erat inanis et  
 vacua: et tenebre erant super faciem abyssi:  
 et spiritus dei ferebatur super aquas.  
 Dixitque deus. **fiat lux.** Et facta est lux.  
 Et vidit deus lucem quod esset bona: et  
 diuisit lucem a tenebris. appellauitque  
 lucem diem et tenebras noctem. **factum**  
 est vespere et mane dies unus. Dixit  
 quoque deus. **fiat firmamentum** in me-  
 dio aquarum: et diuidat aquas ab a-  
 quis. **Et fecit deus firmamentum:** diui-  
 sitque aquas que erant sub firmamen-  
 to ab hijs que erant super firmamen-  
 tum: et factum est ita. **Vocauitque deus**  
**firmamentum celum:** et factum est vespere  
 et mane dies secundus. **Dixit vero de-**  
**us.** Congregentur aque que sub celo  
 sunt in locum unum. et appareat arida.  
**Et factum est ita.** **Et vocauit deus** ari-  
 dam terram: congregationesque aquarum  
 appellauit maria. **Et vidit deus** quod es-  
 set bonum. et ait. **Germinet terra** herbam  
 viuentem et facientem sementem: et lignum  
 pomiferum faciens fructum iuxta genus  
 suum: cuius sementem in semetipso sit super  
 terram. **Et factum est ita.** **Et proculit**

pellent diei ac nocti: et diuiderent lucem  
 ac tenebras. **Et vidit deus** quod esset bonum:  
 et factum est vespere et mane dies quartus.  
**Dixit etiam deus.** Producant aque  
 reptile anime viuentis et volatile super  
 terram: sub firmamento celi. **Creauitque**  
**deus** cete grandia. et omnem animam vi-  
 uentem atque motabilem quam produxe-  
 rant aque in species suas: et omne vo-  
 latile secundum genus suum. **Et vidit de-**  
**us** quod esset bonum: benedixitque ei dicens.  
**Crescite et multiplicamini.** et replete a-  
 quas maris: auesque multiplicentur  
 super terram. **Et factum est vespere et mane**  
**dies quintus.** **Dixit quoque deus.** Pro-  
 ducat terra animam viuentem in gene-  
 re suo: iumenta et reptilia. et bestias ter-  
 re. secundum species suas. **factum est ita.** **Et**  
**fecit deus bestias terre iuxta species su-**  
**as:** iumenta et omne reptile terre in ge-  
 nere suo. **Et vidit deus** quod esset bonum:  
 et ait. **faciamus hominem** ad ymaginem et  
 similitudinem nostram. et pluit piscibus maris.  
 et volatilibus celi. et bestiis uniuersisque terre:  
 omnique reptili quod mouetur in terra. **Et crea-**  
**uit deus hominem** ad ymaginem et simi-  
 litudinem suam: ad ymaginem dei crea-  
 uit illum: masculum et feminam creauit eos.



# Fast Forward to 1974

|                             |  |    |
|-----------------------------|--|----|
| 5.                          | <i>Vertical Fragmentation</i>                              | 20 |
| 5.1.                        | <i>The Transformation <math>PT \rightarrow AST</math></i>  | 22 |
| 5.2.                        | <i>The Transformation <math>AST \rightarrow ST</math></i>  | 24 |
| 5.3.                        | <i>The Transformation <math>ST \rightarrow ACT</math></i>  | 24 |
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| 5.5.                        | <i>The Transformation <math>ADT \rightarrow SET</math></i> | 27 |
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| 8.                          | <i>Evaluation</i>  | 34 |
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| <u>CHAPTER 2.: ANALYSIS</u> |  |    |
| F. L. DeRemer               | REVIEW OF FORMALISMS AND NOTATION                          | 37 |
|                             | 1. <i>Terminology and Definitions of Grammars</i>          | 37 |
|                             | 1.1. <i>Unrestricted Rewriting Systems</i>                 | 37 |

- Academic books often a mix of handwritten symbols (e.g. formulas) and typeset symbols.
- Note the arrows...



# Fast Forward to 2011

## (Homework Submission)

4. Can we get exponential growth  
 by repeatedly printing the output to the  
 tape, getting it back, and then printing  
 polynomially many more times?

5.  $L_1 \cup L_2 \in P$  since  $x \in L_1 \cup L_2$  is decidable by  $x \in L_1$  &  
 $L_1 \cap L_2 \in P$  since if  $x \in L_1, x \in L_2$  then  $x \in L_1 \cap L_2$   
 $L \in P$  since  $x \in L \iff x \in L_1$   
 $L \in P$  (proof?)

The scan is a faithful reproduction of the submission! It remains a mystery how the TA was able to read it.



# Late 70's: Don Knuth invents TeX



## 2 Features

Both  $\text{T}_{\text{E}}\text{X}$  and  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$  allow for accents, and excel at typesetting mathematical equations, in-line or displayed on a line by itself. For instance, an article on quadratics may need

$$ax^2 + bx + c = 0 \implies x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a},$$

or an article on complex analysis may include  $e^{i\theta} = \cos \theta + i \sin \theta$ .



# Knuth

- Don Knuth illustrates the mathematical typesetting with TeX by writing the bible of computer programming:
- Four volumes published so far:





# 1984: LaTeX

- In 1984, Leslie Lamport writes the markup language LaTeX that makes TeX particularly easy to use.
- Key feature: The document is organized according to its structure (e.g. Title, Chapter, Sections, etc.)
- The language is easy to learn
- Available on virtually all computing platforms



# LaTeX

- Computer programmers will feel right at home: The document is produced by a program.
- The language can be customized with macros
- Typesetting of formulas is easy: Once you understand the main features, most formulas are quickly written in LaTeX
- Much faster than any formula editor



# Structure of a LaTeX Document

```
\documentclass{article}  
% macro definitions  
\begin{document}  
% text comes here  
\end{document}
```

Comments  
begin with %

Commands start  
with \



# LaTeX Example

```
\documentclass[12pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\date{}
\begin{document}
  \maketitle
  \LaTeX{} is a document preparation system for the \TeX{}
  typesetting program. It offers programmable desktop publishing
  features and extensive facilities for automating most aspects of
  typesetting and desktop publishing, including numbering and
  cross-referencing, tables and figures, page layout, bibliographies,
  and much more. \LaTeX{} was originally written in 1984 by Leslie
  Lamport and has become the dominant method for using \TeX; few
  people write in plain \TeX{} anymore. The current version is
  \LaTeXe.

  % This is a comment; it will not be shown in the final output.
  % The following shows a little of the typesetting power of LaTeX:
  \begin{align}
    E &= mc^2 && \\\
    m &= \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}
  \end{align}
\end{document}
```

ℒℒℒℒ

ℒℒℒℒ is a document preparation system for the ℒℒℒℒ typesetting program. It offers programmable desktop publishing features and extensive facilities for automating most aspects of typesetting and desktop publishing, including numbering and cross-referencing, tables and figures, page layout, bibliographies, and much more. ℒℒℒℒ was originally written in 1984 by Leslie Lamport and has become the dominant method for using ℒℒℒℒ; few people write in plain ℒℒℒℒ anymore. The current version is ℒℒℒℒ 2<sub>ε</sub>.

$$E = mc^2 \tag{1}$$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2}$$



# Emphasizing Text

This is a `\textbf{bold}` text \\

This is a `\textit{text}` in italics \\

This is a `\textsl{slanted}` text

This is a **bold** text

This is a *text* in italics

This is a *slanted* text



# Inline Mathematics

You can write a text and within the text you can have inline mathematical formulas, such as  $\sqrt{x^2+1}$ , that are simply enclosed in single dollar signs.

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# Displayed Mathematics

Important equations can be set in double dollar signs, for example

$$y = \sqrt{x^2 + 1},$$

and will be displayed as a centered equation.

Important equations can be set in double dollar signs, for example

$$y = \sqrt{x^2 + 1},$$

and will be displayed as a centered equation.



# Numbering Equations

A numbered equation

```
\begin{equation}\label{eqn}
```

$$z^2 = x^2 + y^2.$$

```
\end{equation}
```

It follows from equation (`\ref{eqn}`)  
that ...

A numbered equation

$$z^2 = x^2 + y^2.$$

(1)

It follows from equation (??) that ...

Run LaTeX twice to  
resolve references



# Compiling LaTeX Documents

- Suppose you have written a LaTeX document, say `homework.tex`
- Compiling the document, typesetting, and creating a pdf file:  
`pdflatex homework.tex`
- View your document `homework.pdf` with some pdf viewer (e.g., `ghostview homework.pdf`, `preview homework.pdf`, ...)



# LaTeX Distributions

- Windows: MikTeX
- Mac: MacTeX
- Unix: Tex Live
- Further information: <http://www.ctan.org/>
- Already installed on `unix.cs.tamu.edu`



# Homework

- Our problem sets will be assigned using a LaTeX file, say `hw1.tex`
- The file will typically contain 10 problems
- You add the solutions, your name, and all the resources that you have used.
- Submit your homework solution to e-campus: `hw1.tex` and `hw1.pdf` (BOTH!!!)
- Submit a hardcopy version of your `hw1.pdf` in class (no need to print out `hw1.tex`).