

# 550.400: Mathematical Modeling and Consulting

## Lecture Notes

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## Outline

FAQ

Git

L<sup>A</sup>T<sub>E</sub>X

R & Matlab

Vim for efficient editing

Causality & Spurious Correlation & Math Modeling

## What is that on the slide?

<http://connect.johnshopkins.edu/welcome/>

## Quiz

- Create a github repository with your favorite quote as a text file `main.txt`,
- Post your github location in the designated Discussion forum by creating a thread just for yourself,
- Collect all of your classmates' quote only using git,
- You should have at least four commits, each adding new materials to the file `main.txt`,
- You have twenty minutes to complete the quiz.

## FAQ

- How to start Vim?
- How to quit Vim?

## How to add a figure in your work statement?

Note that <+> denotes a thing that you need to fill in. See the `lecture.tex` for (many) examples.

```
\begin{figure}
  \caption{<+caption text+>}
  \begin{center}
    \includegraphics[width=<+>\textwidth]{<+>}
  \end{center}
\end{figure}
```

---

## Commit? Add? What is the difference?

### An imperfect analogy

- Just like doing your HW with many questions
- For each question, first you do some work
- `git add` is like you being satisfied with your current version of your answer
- `git commit` is like you transcribing your solution to your paper that you will actually submit
- `git push` is like submitting your solution to the instructor so that they can see

## Sorry ... but still confused about git ...

<http://gitref.org/index.html>

## Class Exercise I

### Exercise 1

This is called a *commit* graph

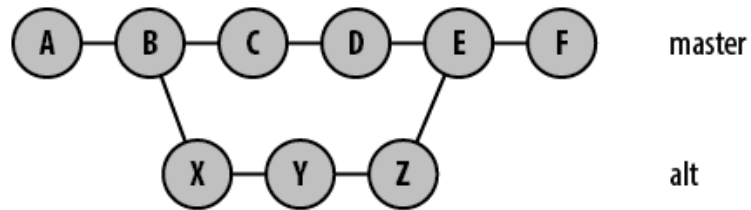


Figure 14-3. History of two branches

## Class Exercise II

Create a git folder with the following history

- Each node's label signifies the commit
- The folder contains only one single file `main.txt` throughout the history
- Keep “the story” simple
- Push it to your github (remote) repository

### Exercise 2

Collect all 8 stanzas of the “Elephant” poem from the course github remote repositories and then push the resulting one to *your* github repository.

You will need the following addresses:

## Class Exercise III

```

git://github.com/nhlee/550400.stanza1.git
git://github.com/nhlee/550400.stanza2.git
git://github.com/nhlee/550400.stanza3.git
git://github.com/nhlee/550400.stanza4.git
git://github.com/nhlee/550400.stanza5.git
git://github.com/nhlee/550400.stanza6.git
git://github.com/nhlee/550400.stanza7.git
git://github.com/nhlee/550400.stanza8.git
  
```

## Intro. to work-statement template I

```

\documentclass[12pt,letterpaper][article]
\usepackage{amsmath,amsthm,amssymb,amsfonts} # for popular math add-on
\usepackage{graphicx} # for inserting png, jpeg, pdf files as figure
\usepackage{bm} # for bold math
# some preamble stuff omitted (see the actual template)
\begin{document}
\section{A}
\section{a}
\paragraph{Hello World}
\begin{align*}
&f(x) = \int_0^1 \sin(u+x) \, du, \quad \backslash\backslash \\
&f(\bm{x}) = \int_0^1 \sin(u+\bm{x}) \, du.
\end{align*}
\end{document}
  
```

## Introduction to beamer I

### Basic Body Layer

```
\begin{document}
\section{Hello World}
\section{hello world}
\begin{frame}
\frametitle{hi world}
\begin{columns}
\begin{column}{0.5\textwidth}
\begin{itemize}
\item Alice!
\end{itemize}
\end{column}
\begin{column}{0.5\textwidth}
\begin{block}{hey world}
Bob!
\end{block}
\end{column}
\end{columns}
\end{frame}
\end{document}
```

13 / 27

## Introduction to beamer II

### Basic Preambles

```
\documentclass[hyperref={colorlinks=false},handout,10pt]{beamer}
\usetheme{Singapore}
\usecolortheme{lily}
\usefonttheme[onlymath]{serif} % What does this do?
```

---

### OR

```
\documentclass[hyperref={colorlinks=false},handout,10pt]{beamer}
\usetheme{Berlin}
\usecolortheme{wolverine}
\usefonttheme[onlymath]{serif} % What does this do?
```

---

For a more complete array of themes, go to:

<http://www.hartwork.org/beamer-theme-matrix/>

14 / 27

## Introduction to beamer III

SO, how to put a code in the slide? and it looks like codes?

```
\begin{lstlisting}
require(tikzDevice)
x = rnorm(100)
plot.ts(x)
dev.off()
\end{lstlisting}
```

```
require(tikzDevice)
x = rnorm(100)
plot.ts(x)
dev.off()
```

---

But, this requires the following in the preamble portion of your tex file:

```
\usepackage{listings}
\lstset{
basicstyle=\footnotesize\ttfamily,
numbers=left,
frame=bottomline,
frametopmargin=50pt,
}
```

15 / 27

## Introduction to beamer IV

Where to get more help:

<http://en.wikibooks.org/wiki/LaTeX/Presentations>

16 / 27

## How to do software documentation (via R)

```
myfun <- function(x) {x^2}
package.skeleton(name='MYPAC',
  list='myfun',
  path='~/')
#Do the documentation
system('R CMD check ~/MYPAC')
system('R CMD build ~/MYPAC')
system('R CMD install MYPAC')
```

---

17 / 27

## Using R to do Bash Stuff I

```
for(itr in 1:8) {
  stanzaname = paste("stanza",itr,sep="")
  gitaddress = paste("git://github.com/nhlee/550400.",
    stanzaname,".git",sep="")
  bashcommand = paste("git remote add ",
    stanzaname," ",gitaddress,sep="")
  system(bashcommand)
}
```

---

- 1:8 creates a vector that ...
- X = 1 assigns 1 to X
- X <- 1 also assigns 1 to X
- lots of things are done through function
- paste and system are functions that ...
- functions has none or more arguments

18 / 27

## Using R to do Bash Stuff II

- arguments are implicitly ordered but the order can be overridden

```
system(`ls -ld .*)
system(`cat .Rprofile')
system(`cat .bashrc')
system(`cat .gitignore')
system(`cat .vimrc')
```

---

- .xxx files are hidden
- ls -ld .\* show the hidden files
- .Rprofile set up your R behavior
- .bashrc set up your bash behavior
- .gitignore set up your git behavior
- .vimrc set up you vim behavior
- these files are equivalent to Preference part of your GUI software

19 / 27

## Vim for efficient editing

Vim is a *highly customizable* text editor

1. L<sup>A</sup>T<sub>E</sub>X, R, C/C++, Java, Python, Git and etc.
2. Regular expression, syntax coloring, auto-completion
3. <ESC>-mode
  - :-mode, aka., the last line mode
  - i-mode, aka., the insert mode

20 / 27

## Vim for efficient editing

- Download & Install GVim or MacVim
- Download & Install tetris.vim
- Download & Install minibufexpl.vim
- Download & Install Gundo
- Download & Install Vim-LaTeX

21 / 27

## Vim for efficient editing

version 1.1  
April 1st, 06

vi/vim lesson 1 - basic editing

**motion** moves the cursor, or defines the range for an operator  
**command** direct action command, if red, it enters insert mode

**Esc** normal mode

**\$** col **^** "soft" hol **0** "hard" hol

**W** next WORD **E** end WORD **R** replace mode **u** undo **i** insert mode

**A** append at col **h** ← **j** ↓ **k** ↑ **l** → **.** ex end line

**X** back-space **X** delete char **B** prev WORD **b** prev word

**Basics:**  
**H** **J** **K** **I** are vi/vim cursor keys – use them as they are much closer than regular cursor keys!  
 Use **I** to enter insert mode, cursor turns from a block into a vertical line, and you can type in text. Use **Esc** to return to normal mode.  
 Use **X** to delete the current character, or **X** to delete the one to the left.  
 Use **A** to go insert text at the end of the line (wherever you are in the line!)  
 (Note: insert mode is actually very similar to a regular editor; you can use cursor/navigation keys, backspace, delete...)

**Extras:**  
**u** to undo the last action – traditional vi has a single level, while vim supports unlimited undo (CTRL - **R** to redo)  
**O** jumps directly to the beginning of the line, **S** to the end, and **A** to the first non-blank  
 Use **w** **b** **e** to move along 'words'. A 'word' is a sequence of all alphanumeric or punctuation signs: `quux(foo) bar, baz`  
 Use **W** **B** **E** to move along WORDS. A 'WORD' is a sequence of any non-blank characters: `quux(foo) bar, baz`  
 Use **R** to enter insert mode with an overstrike cursor, which types over existing characters.  
**q** **w** and press enter to save, **:q** and enter to quit.

For the rest of the tutorial & a full cheat sheet, go to [www.viemu.com](http://www.viemu.com) - home of ViEmu, vi/vim emulation for Microsoft Visual Studio

22 / 27

## Assessing Causality (WMA, 527)

- Consistency of association:  
*The association is observed in several different populations using different types of study design.*
- Strength of association  
*A bigger difference in outcomes between cases with and without the purported causal factor indicates a stronger association.*
- Temporal relationship  
*The cause preceded the effect. A correlation between two variables measured at the same time gives weaker evidence than one measuring the relationship between changes in the supposed cause and subsequent responses in the outcome.*
- Mechanism  
*There is a plausible means by which the alleged cause could affect the outcome.*

23 / 27

## Spurious Causality I

```
cbe.loc<-'http://www.massey.ac.nz/~pscowper/ts/cbe.dat';
cbe <- read.table(cbe.loc,header=T);
plot(cbe[,1],cbe[,3]);
```

```
set.seed(10);
x <- rnorm(100);
y <- rnorm(100);
for(i in 2:100) {
  x[i] <- x[i-1] + rnorm(1);
  y[i] <- y[i-1] + rnorm(1);
}
plot(x,y);
```

24 / 27

## Spurious Causality II

```
x <- y <- mu <- rep(0,1000);
for(i in 2:1000) mu[i] <- mu[i-1] + rnorm(1);
x <- mu + rnorm(1000);
y <- mu + rnorm(1000);

xrate.loc <- 'http://www.massey.ac.nz/~pscowper/ts/us_rates.dat';
xrates <- read.table(xrate.loc,header=T);
plot(xrates$UK,xrates$EU,pch=4);
```

---

Then, how to detect the underlying factors?

## Spurious Causality III

```
require(tseries)
adf.test(x)$p.value
adf.test(y)$p.value
po.test(cbind(x,y))

pp.test(xrates$UK)
pp.test(xrates$EU)
po.test(cbind(xrates$UK,xrates$EU))
ukeu.lm <- lm(xrates$UK ~ xrates$EU)
ukeu.res <- resid(ukeu.lm)
```

---

## A Word Problem

*To encourage Elmer's promising tennis career, his father offers him a prize if he wins (at least) two tennis sets in a row in a three-set series to be played with his father and the club champion alternately: father-champion-father or champion-father-champion, according to Elmer's choice. The champion is a better player than Elmer's father. Which series should Elmer choose?*

- What is that you wish to know?
- unimportant, exogenous, and endogenous?
- if the model fits the situation, will we be able to use it?
- Test the model