

# 550.400: Mathematical Modeling and Consulting

## Lecture Notes

**Instructor:**

Dr. N. H. Lee

JHU AMS 2012 FALL

Last Compiled on September 5, 2012

# Outline

Preliminaries

Principles

Tools

Arguments from Scale

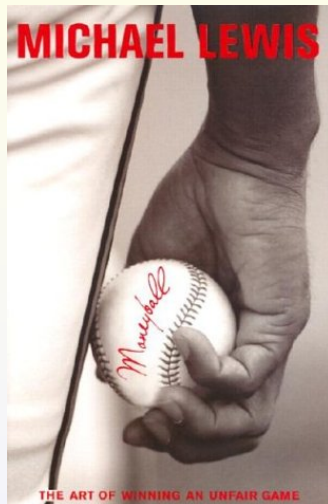
Graphical Methods

Basic Optimization

# Syllabus

- Grade Policy
- Attendance
- *Tentative* Schedule
- Blackboard
- Misc.

# What is Mathematical Modeling?



Money Ball

# What is Mathematical Modeling?

## [NOVA Online | Trillion Dollar Bet](#)

[www.pbs.org/wgbh/nova/stockmarket/](http://www.pbs.org/wgbh/nova/stockmarket/)

Welcome to the companion Web site to "**Trillion Dollar Bet**," originally broadcast on February 8, 2000. The film tells the fascinating story of the invention of the ...

[The Formula that Shook The ...](#) - [Transcripts](#) - [A Trader's Lexicon](#) - [Resources](#)

## [Videos for trillion dollar bet](#) - Report videos



### [Trillion Dollar Bet 1 - YouTube](#)

[youtube.com](http://youtube.com)

Jan 8, 2009



### [The Trillion Dollar Bet - YouTube](#)

[youtube.com](http://youtube.com)

Sep 15, 2007



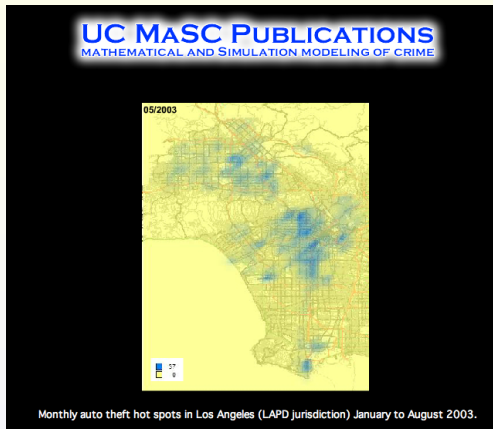
### [The Midas Formula Stockmarket ...](#)

[youtube.com](http://youtube.com)

Aug 23, 2011

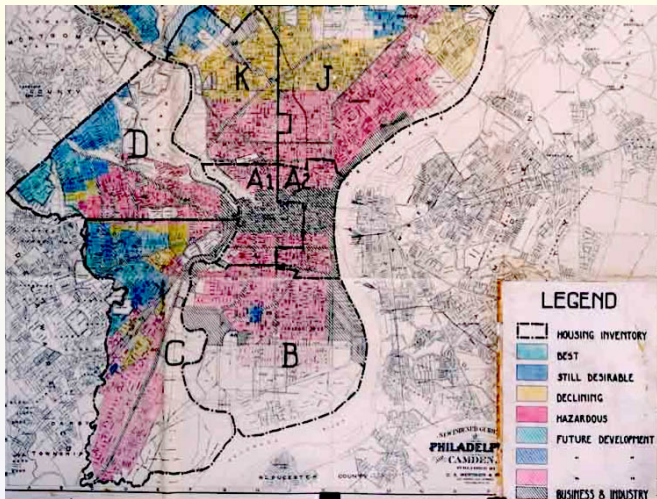
Trillion Dollar Bet

# What is Mathematical Modeling?



LAPD Fighting Crime with Math

# What is Mathematical Modeling?



Insurance Redlining

# Example: Insurance Redlining

## Insurance Redlining

*Insurance redlining* refers to the practice of refusing to issue insurance to certain types of people or within some geographic area.

## FAIR

The **FAIR** plan was offered by the city of Chicago as a default policy to homeowner who had been rejected by the voluntary market.



## Example: Insurance Redlining

### Sponsor

*The **U.S. Commission on Civil Rights** examined charges by several Chicago community organizations that insurance companies were redlining their neighborhoods.*

### Data

*The **number of FAIR plan policies** written and renewed in Chicago by zip code for the number of months of December 1977 through May 1978.*

## Example: Insurance Redlining

Variables to consider:

- `race` Racial composition in percentage of minority,
- `fire` Fire per 100 housing units,
- `theft` Theft per 100 housing units,
- `age` Theft per 1000 population,
- `involact` New FAIR plan policies and renewal per 100 housing units,
- `income` Median family income in thousands of dollars,
- `side` North or South side of Chicago.

## Example: Insurance Redlining

Frequently Recurring Elements of doing a Project in Industry:

1. Work Statement,
2. Midterm Presentation,
3. Progress Report,
4. Final Presentation,
5. Final Report.

# Acknowledgement



# What is Work Statement?

- The written proposal and definition of the project
- Your consulting team's "contract" with the sponsor
- It is ultimately given to the sponsor for review and signature

# What is Work Statement?

It sets forth:

- the nature of the project,
- the specific objectives of the project,
- the result expected,
- the “deliverable” for the project.

# What is Work Statement?

- The scope of the project must be within the time table for the course
- The deliverables are reasonable and appropriate

# What is Work Statement?

- Given the nature of research, it should not include promises that your consulting team cannot be certain to achieve
- It may be necessary after discussion and agreements among various parties to modify and renegotiate the work statement as the project progresses



# Programmings in this class

- R:
  - `tikzDevice`
  - `lm`
- $\text{\LaTeX}$  :
  - `moderncv`
  - `beamer`
  - `report`
  - `tikz`
- Git
  - `git gui`

# Demo: R

RStudio  
rstudio.org

Welcome to RStudio

RStudio™ is a free and open source integrated development environment (IDE) for R. You can run it on your desktop (Windows, Mac, or Linux) or even over the web using RStudio Server.

Download RStudio  
for Windows, Mac or Linux

Screencast  
RStudio in 2 minutes

The screenshot shows the RStudio interface. The top bar includes the RStudio logo and the URL rstudio.org. Below this is a 'Welcome to RStudio' message. The main area is divided into several panes: a script editor on the left containing R code for loading data, summarizing it, and plotting it; a console at the bottom left showing the execution of the code; a plot window on the bottom right displaying a scatter plot titled 'Diamond Pricing'; and a sidebar on the right with tabs for 'Workspace', 'History', 'Files', 'Packages', and 'Help'. The 'Workspace' tab is active, showing a list of objects in the environment.

R Studio

The R Project for Statistical Computing  
www.r-project.org

The R Project for Statistical Computing

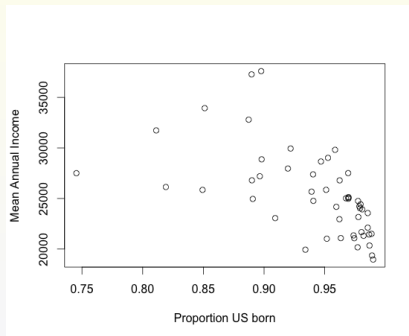
The screenshot shows the R Project for Statistical Computing website. The top bar includes the R logo and the URL www.r-project.org. Below this is a 'The R Project for Statistical Computing' header. The main area features a large PCA plot titled 'PCA 5 vars' showing the first three principal components. To the left of the plot is a sidebar with links to 'About R', 'What is R?', 'Contribution', 'Screenshots', and 'What's new?'. Below these links are sections for 'Download, Packages', 'CRAN', 'R Project', 'Foundation', 'Members & Donors', 'Mailing Lists', 'Bug Tracking', 'Developer Page', 'Conferences', and 'Search'. The 'Getting Started' section provides instructions on how to download and install R, and links to the 'Manuals', 'FAQs', 'The R Journal', 'Wiki', 'Books', 'Certification', and 'Other' resources. The 'News' section lists recent releases, including R version 2.15.1 and The R Journal Vol.4(1).

R

## Demo: R

```
install.packages(faraway)
require(faraway)
data(eco)
plot(income ~ usborn,
     data=eco,
     xlab='Proportion US born',
     ylab='Mean Annual Income'
)
```

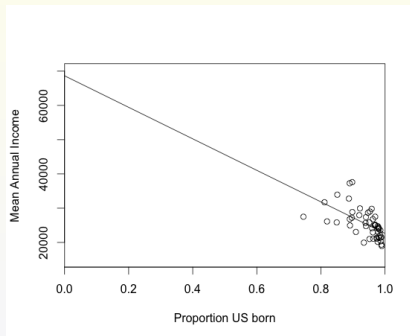
---



# Demo: R

```
g <- lm(income ~ usborn, eco)
summary(g)
plot(income ~ usborn,
     data = eco,
     xlab='Proportion US born',
     ylab='Mean Annual Income',
     xlim=c(0,1),
     ylim=c(15000,70000),
     xaxs='i')
abline(coef(g))
```

---



# Tutorial: $\text{\LaTeX}$

$\text{\LaTeX}$  is a computer language for writing a scholarly paper:

	HTML	$\text{\LaTeX}$
Code	<pre>&lt;html&gt; . . . &lt;/html&gt;</pre>	<pre>\begin{document} . . . \end{document}</pre>
Compiler	Firefox and etc.	pdflatex and etc.
Output	Web-page	PDF file

Table: HTML vs  $\text{\LaTeX}$

# Tutorial: $\text{\LaTeX}$

- Demo on preparing a resume using  $\text{\LaTeX}$  `moderncv` package:
  - Install  $\text{\LaTeX}$  (MikTeX in Windows and MacTeX in OSX),
  - Download `moderncv` package files from the course folder,
  - Change file names to reflect you,
  - Edit the TeX file,
  - Compile using your favorite  $\text{\LaTeX}$  editor,
  - Look at the resulting PDF file.

# Tutorial: Git

```
sudo apt-get install git
```

---



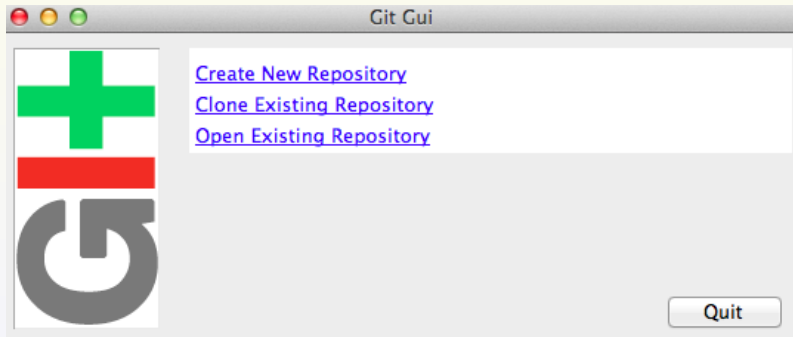
The screenshot shows the Git website homepage. At the top, the Git logo (a red diamond with a white branching diagram) is followed by the word "git" in a large, bold, black font. To the right of the logo, the tagline "--distributed-is-the-new-centralized" is written in a smaller, grey font. Below the logo and tagline, there is a navigation menu on the left with the following items: "About", "Documentation", "Downloads" (in red), "GUI Clients" (in red), "Logos", and "Community". To the right of the navigation menu, there is a large white box with the heading "GUI Clients" in a large, bold, black font. Below this heading, the text "Git comes with built-in GUI tools for com" and "third-party tools for users looking for plat" is visible. At the bottom of this white box, there is a button that says "Show GUIs for all OSes" and a red text link that says "7 Mac GUIs a".

An alternative: `git gui`

# Tutorial: Git

```
cd ~/
git clone http://cis.jhu.edu/~nhlee/550400.git
```

---



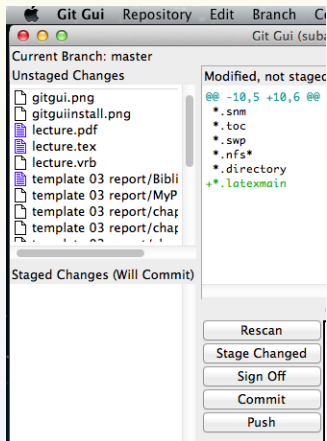
An alternative: `git gui`



# Tutorial: Git

```
cd ~/550400.git  
git reset --hard HEAD  
git pull origin master
```

---



An alternative: git gui

# Tutorial: Git

- Demo I: build a *personal* Git folder
  - Create some files
  - Stage the files
  - Commit the files
- Demo II: build the *course* Git folder

# Unofficial Way to Access the Course Folder

`http://cis.jhu.edu/~nhlee/550400.html/`

# Seven Basic Principles

1. Set the context
2. Choose effective examples and analogies
3. Choose vocabulary to suit your readers
4. Decide whether to present #s in text, tables, or figures
5. Report and interpret #s in the text
6. Specify the direction *and* size of an association between variables
7. For many #s, summarize overall pattern

# Creating Effective Tables

# Example: Cost of Packaging

# Example: The Nuclear Mission Arms Race

# Example: Maintaining Inventory