

# 550.400: Mathematical Modeling and Consulting

## Lecture Notes

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# Outline

Preliminaries

Principles

Tools

Arguments from Scale

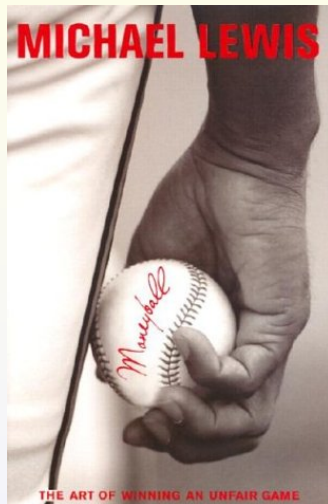
Graphical Methods

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



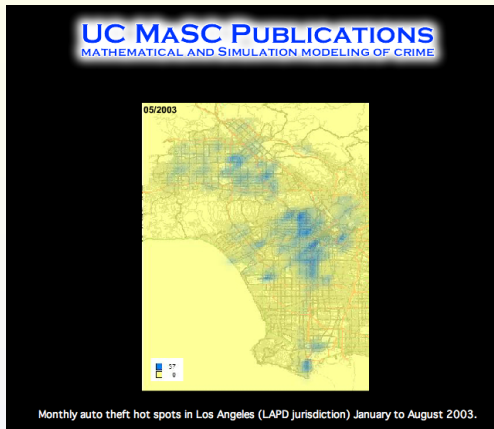
#### [The Midas Formula Stockmarket ...](#)

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

Aug 23, 2011

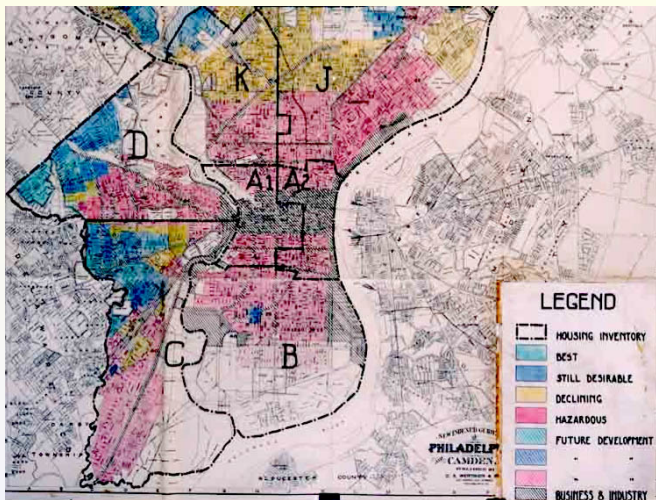
Trillion Dollar Bet

# 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.

# 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

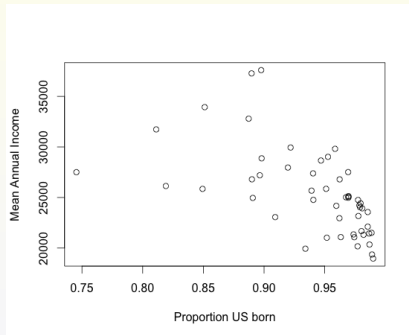
- R:
  - `tikzDevice`
  - `lm`
- $\text{\LaTeX}$  :
  - `moderncv`
  - `beamer`
  - `report`
  - `tikz`
- Git
  - `git gui`



# Demo: R

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

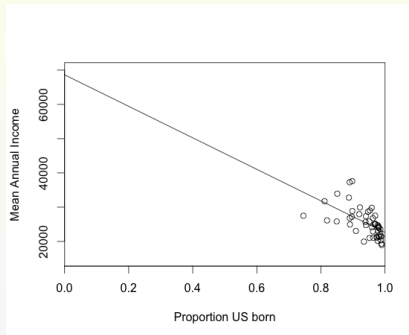
---



# 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	Webpage	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
```

---

A screenshot of the Git website homepage. The top section features the Git logo (a red diamond with a white branching diagram) 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 with links: "About", "Documentation", "Downloads", "GUI Clients", "Logos", and "Community". The "Downloads" link is highlighted in red. The "GUI Clients" link is also highlighted in red. 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 the heading, there is a paragraph of text: "Git comes with built-in GUI tools for comr" (likely "common") and "third-party tools for users looking for plat" (likely "platforms"). At the bottom of the white box, there is a button labeled "Show GUIs for all OSes" and a red text link "7 Mac GUIs a" (likely "are available").

An alternative: `git gui`

# Tutorial: Git

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

---

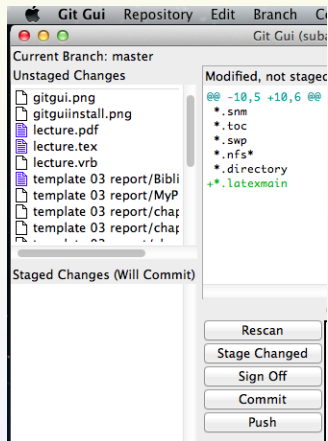


An alternative: `git gui`

# 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



# 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