

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

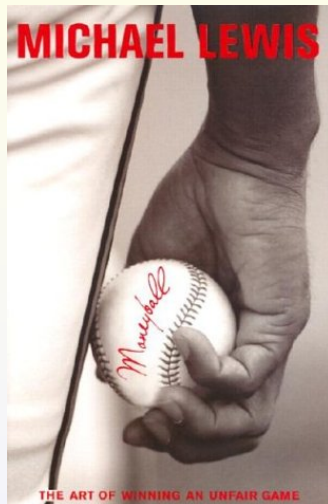
Graphical Methods

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/

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

Jan 8, 2009



[The Trillion Dollar Bet - YouTube](#)

youtube.com

Sep 15, 2007



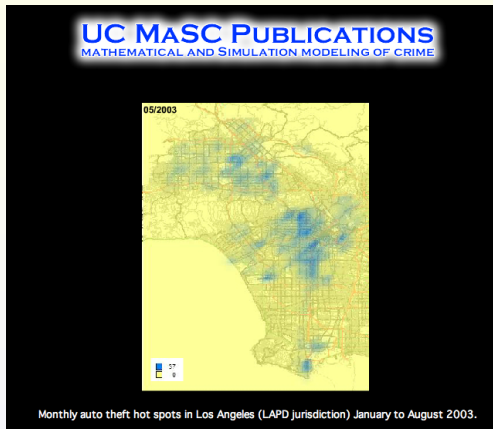
[The Midas Formula Stockmarket ...](#)

youtube.com

Aug 23, 2011

Trillion Dollar Bet

What is Mathematical Modeling?



LAPD Fighting Crime with Math

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.

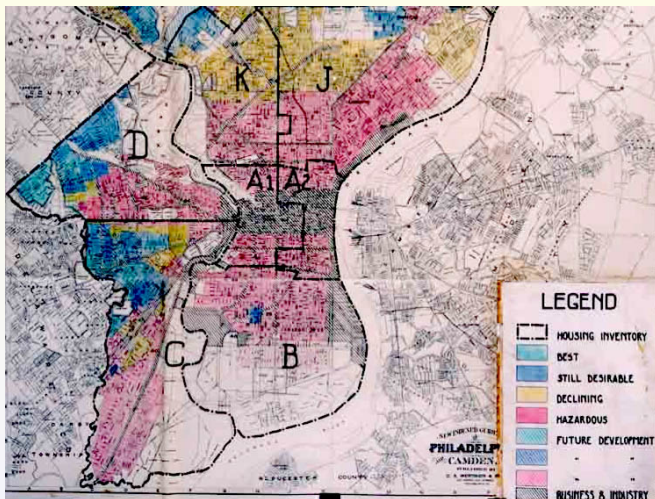
What is Work Statement?

- 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

Example: Insurance Redlining



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



Programmings in this class

- \LaTeX :
 - `moderncv`
 - `beamer`
 - `report`
 - `tikz`
- Git
 - `git gui`
- R:
 - `tikzDevice`
 - `lm`

Tutorial: \LaTeX

\LaTeX is a computer language for writing a scholarly paper:

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

Table: HTML vs \LaTeX

Tutorial: \LaTeX

- Demo on preparing a resume using \LaTeX `moderncv` package:
 - Install \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 \LaTeX editor,
 - Look at the resulting PDF file.

Tutorial: Git

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



An alternative: `git gui`

Tutorial: Git

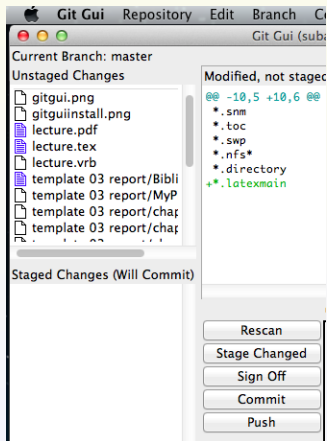
```
cd ~/
git clone http://cis.jhu.edu/~nhlee/550400.git
```



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/`

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

```
library(ggplot2)
library(dplyr)
library(foreign)
library(rattle)
library(RColorBrewer)
library(RCurl)
library(RJSONIO)
library(Rshiny)
library(RSQLite)
library(RUnit)
library(RWeb)
library(RWeb2)
library(RWeb3)
library(RWeb4)
library(RWeb5)
library(RWeb6)
library(RWeb7)
library(RWeb8)
library(RWeb9)
library(RWeb10)
library(RWeb11)
library(RWeb12)
library(RWeb13)
library(RWeb14)
library(RWeb15)
library(RWeb16)
library(RWeb17)
library(RWeb18)
library(RWeb19)
library(RWeb20)
library(RWeb21)
library(RWeb22)
library(RWeb23)
library(RWeb24)
library(RWeb25)
library(RWeb26)
library(RWeb27)
library(RWeb28)
library(RWeb29)
library(RWeb30)
library(RWeb31)
library(RWeb32)
library(RWeb33)
library(RWeb34)
library(RWeb35)
library(RWeb36)
library(RWeb37)
library(RWeb38)
library(RWeb39)
library(RWeb40)
library(RWeb41)
library(RWeb42)
library(RWeb43)
library(RWeb44)
library(RWeb45)
library(RWeb46)
library(RWeb47)
library(RWeb48)
library(RWeb49)
library(RWeb50)
library(RWeb51)
library(RWeb52)
library(RWeb53)
library(RWeb54)
library(RWeb55)
library(RWeb56)
library(RWeb57)
library(RWeb58)
library(RWeb59)
library(RWeb60)
library(RWeb61)
library(RWeb62)
library(RWeb63)
library(RWeb64)
library(RWeb65)
library(RWeb66)
library(RWeb67)
library(RWeb68)
library(RWeb69)
library(RWeb70)
library(RWeb71)
library(RWeb72)
library(RWeb73)
library(RWeb74)
library(RWeb75)
library(RWeb76)
library(RWeb77)
library(RWeb78)
library(RWeb79)
library(RWeb80)
library(RWeb81)
library(RWeb82)
library(RWeb83)
library(RWeb84)
library(RWeb85)
library(RWeb86)
library(RWeb87)
library(RWeb88)
library(RWeb89)
library(RWeb90)
library(RWeb91)
library(RWeb92)
library(RWeb93)
library(RWeb94)
library(RWeb95)
library(RWeb96)
library(RWeb97)
library(RWeb98)
library(RWeb99)
library(RWeb100)
```

Diamond Pricing

R Studio

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

The R Project for Statistical Computing

About R
What is R?
Contributions
Screenshots
What's new?

Download, Packages
CRAN

R Project
Foundation
Members & Donors
Mailing Lists
Bug Tracking
Developer Page
Conferences
Search

Documentation
Manuals
FAQs
The R Journal
Wiki
Books
Certification
Other

Getting Started:

- R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To [download R](#), please choose your preferred [CRAN mirror](#).
- If you have questions about R like how to download and install the software, or what the license terms are, please read our [answers to frequently asked questions](#) before you send an email.

News:

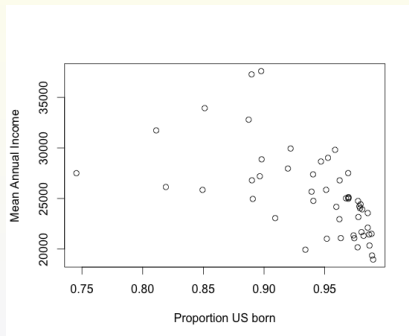
- R version 2.15.1 (Roasted Marshmallows) has been released on 2012-06-22.
- The R Journal Vol.4(1) is available.
- useR! 2012, took place at Vanderbilt University, Nashville Tennessee, USA, June 12-15, 2012.

Use R

R

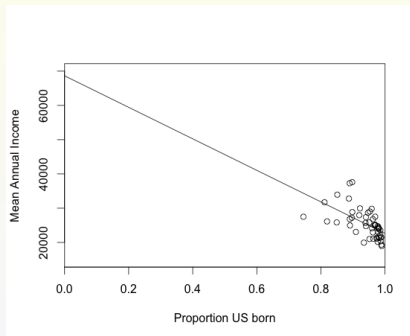
Demo: R

```
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))
```



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