

# Evolution of a Computational Thinking Course

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# The Main Players



BROWN

Steve Reiss



Software  
Engineering

Tom Doeppner



Operating  
Systems

Shriram  
Krishnamurthi



Programming  
Languages

John F. Hughes



Computer  
Graphics

# The NSF Award

**CPATH:** CISE pathways to revitalized undergraduate computing education

**CISE:** Computer & Information Science & Engineering

*Applied Computer Science for the Humanities and Social Sciences*  
(#0829533; Awarded in 2008)

Motivation:

- “Researchers in the **social sciences** rely on the availability of large data repositories and the general availability of data over the Web.”
- “Researchers in the **humanities** are increasingly looking to analyze the growing number of electronic corpora. ”

# The NSF Award

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Motivation, cont'd.:

- “More and more jobs and companies are relying on the **understanding and processing of information.** ”
- “Modern companies as diverse as Google, WalMart, Amazon, and Goldman Sachs all owe their success in large part to their ability to **evaluate and act on available information.**”
- “It is estimated that in the next ten years, over **twelve million people** in the U.S. workforce will consider programming their primary job, which is **far more** than the current or near-term number of computer science majors.”

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Proposed Actions:

- Focus on disciplines “that have **traditionally been neglected** by computer scientists, harnessing the growing revolution in applying computing to social artifacts.”
- Present material in a “**novel, application-driven, on-demand**” manner, “coming to topics like machine-learning and data-mining very early, rather than late, in the curriculum.”

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## Anticipated Outcomes:

- Provide students “with the tools to make their own **non-trivial contributions** to cyberinfrastructure\*.”
- “It will result in more women and minorities, groups **traditionally underrepresented** in computing, working with and using computation and cyberinfrastructure. ”
- “Finally, it will enable students to wed their deep **social and humanistic insights** to tools that can enable them to build wonderful inventions that have the power to **greatly enrich society**.”

\*United States federal research funders use the term cyberinfrastructure to describe research environments that support advanced data acquisition, data storage, data management, data integration, data mining, data visualization and other computing and information processing services distributed over the Internet beyond the scope of a single institution. - *Wikipedia*

# Evolution of a Computational Thinking Course

1 Course Description

2 Course Evolution

3 Last Thoughts

4 Projects

# The First Lecture: Liberal Media Bias

Liberal bias in the media occurs when liberal ideas have undue influence on the coverage or selection of news stories. - *Wikipedia*

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- *On the Bias* by Geoffrey Nunberg (2002):  
“In fact, I did find a big disparity in the way the press labels liberals and conservatives, but not in the direction that Goldberg claims. On the contrary: the average liberal legislator has a thirty percent greater likelihood of being identified with a partisan label than the average conservative does.”

- **Unit 1: Voting Patterns**

- Rank senators on a liberal-to-conservative spectrum by analyzing their voting patterns.
- Use Excel and learn about some Excel functionality.
- *Secret Goal: get students comfortable with computational thinking.*

- **Unit 2: Textual Analysis**

- Compute statistics on texts such as average word length, vocabulary size, and word frequencies.
- Introduce python.
- *Secret Goal: get students to understand what questions can be answered using their programming knowledge.*

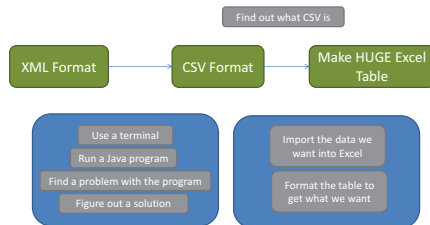
- Weekly homeworks, projects for Units 1 & 2, and a final project.

# Unit 1: Voting Patterns

Collect voting information for all senators for a set of bills.

- Understand XML format
- Use a command-line script to convert XML to CSV
- Import CSV into Excel.

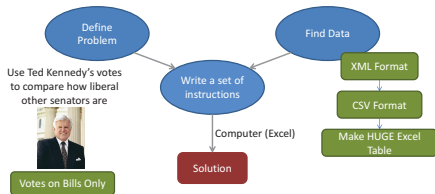
By the end of the day, you will have done these things



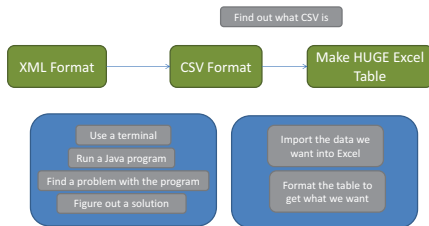
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CS0931 - Intro. to Comp. for the Humanities and Social Sciences

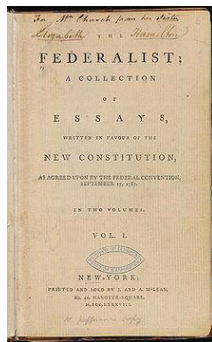
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Rank senators by their similarity with other senators' voting patterns.

- Excel Pivot Tables
- Decision Trees
- Excel functions
- Matrix Multiplication

# The Federalist Papers

- 85 articles written in 1787 to promote the ratification of the US Constitution
- In 1944, Douglass Adair guessed authorship
  - Alexander Hamilton (51)
  - James Madison (26)
  - John Jay (5)
  - 3 were a collaboration
- Corroborated in 1964 by a computer analysis



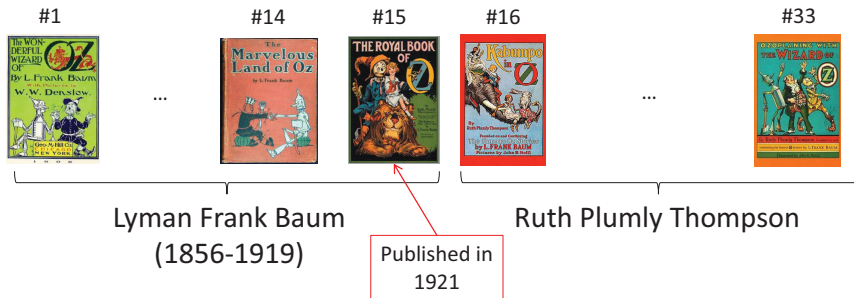
Wikipedia

<http://pages.cs.wisc.edu/~gfung/federalist.pdf>



# The Wizard of Oz

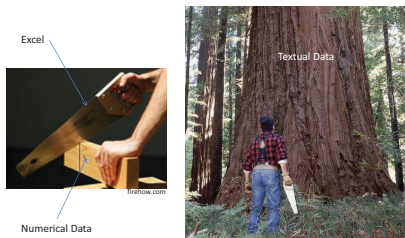
- About 40 Books, written by 7 different authors



<http://www.ssc.wisc.edu/~zzeng/soc357/OZ.pdf>

# Unit 2: Textual Analysis

How are we going to analyze texts?



CS0931 - Intro. to Comp. for the Humanities and Social Sciences

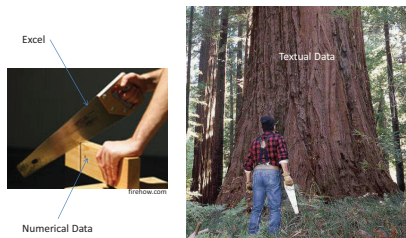
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First python program: count the number of words in *Moby Dick*

- Learn expressions, assignments, types, functions, File I/O
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Summary Statistics: word count, average word length, longest word, word frequencies. . .

- for loops, conditional statements, dictionaries
- Regular expressions
- Learn this over the course of **3-4 weeks**

# Final Project

- Over **five weeks** with no weekly assignments to work on this.
- Mini-Unit: Hypothesis Testing
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## Project Areas

- |  |                          |
|--|--------------------------|
| • Politics                                     | • Education              |
| • Population Growth                            | • Twitter                |
| • Literature, Writing Styles, & Writing Awards | • Biology                |
| • Brown & Providence                           | • Health                 |
| • Economics & Business                         | • Sports & Entertainment |

# How Did This All Get Done?

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- Lots of feedback (both to students and from students)



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From *The Critical Review*, Brown's independent, student-run review process.

Semester	Class	Weekly Hours		Comments
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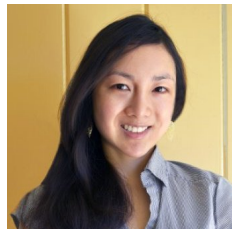
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Deborah Lai

Brown Alum 2012

Economics & East Asian Studies Major



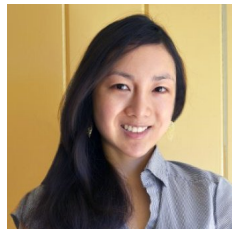
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- Took CS0931 in the Fall of 2010 and **loved it**
- Offered to be a TA for Fall 2011 (only TA to have taken the class)
- Continued to take CS courses
- Now works in Emerging Markets at Google: “Grow Internet literacy and Google product engagement in emerging markets through education”

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## The Catalyst:

Maria (Gabby) Suarez

Brown Alum 2013

Applied Math & Economics

- TA in the Fall of 2012
- *"Make the weekly assignments harder!"*
- Head TA in the Spring of 2012





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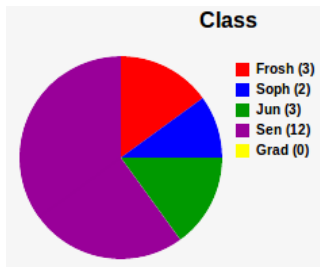
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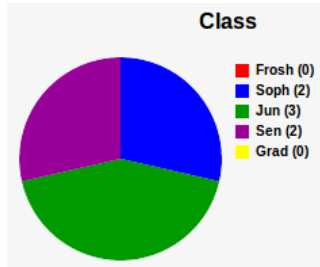
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Spring 2014				
...				

# Another Look at CS0931 Evolution

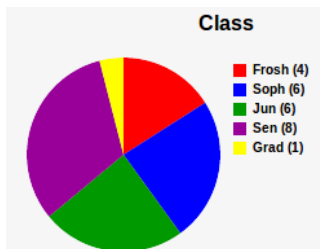
Fall 2009



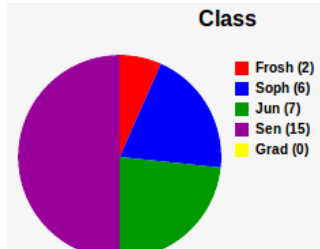
Fall 2010



Fall 2011



Spring 2012



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- Amount of work
- The more help, the better (TAs, instructor, other faculty)

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- Plagiarism

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# Projects

## Unit 1: Excel

- Partisanship in the Senate
- Are shorter songs more successful?

## Unit 2: Python

- Dickens Start to Finish
- The “decline of language” in the State of the Union speeches
- Rhymes & Warfare

## Final Project:

- Population change in Australia
- Visualizing LDS Growth
- Protein Alignment
- Grocery Stores and Income