Evolution of a Computational Thinking Course

Anna Ritz

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Virginia Tech
annaritz@vt.edu

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The Main Players

Steve Reiss  |  Tom Doeppner  |  Krishnamurthi  |  John F. Hughes
Software Engineering  |  Operating Systems  |  Programming Languages  |  Computer Graphics
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.”
Applied Computer Science for the Humanities and Social Sciences
(#0829533; Awarded in 2008)

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

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.”
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*
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1. Course Description

2. Course Evolution

3. Last Thoughts

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

- **Claim (Bernard Goldberg, 2001):** In the media, conservatives are labeled as “conservative” more often than liberals are labeled as “liberal”
The First Lecture: Liberal Media Bias

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- By the end of this course, students will be able to write a program to perform this task on the New York Times in milliseconds.

- **Minds are blown.**
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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.
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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

- Find out what CSV is
- Use a terminal
- Run a Java program
- Find a problem with the program
- Figure out a solution
- Import the data we want into Excel
- Format the table to get what we want

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

Unit 2: Textual Analysis

The Wizard of OZ

- About 40 Books, written by 7 different authors

Lyman Frank Baum (1856-1919)

Ruth Plumly Thompson

Published in 1921

http://www.ssc.wisc.edu/~zzeng/soc357/OZ.pdf
How are we going to analyze texts?

First python program: count the number of words in *Moby Dick*
- Learn expressions, assignments, types, functions, File I/O
- Learn this in **one day**
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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
- Mini-Unit: Google Earth & Twitter
Final Project

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Project Areas

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

- Limited class size
- In-class labs (all examples were done by students)
- Lots of skeleton code

How Did This All Get Done?
How Did This All Get Done?

- Lab-Oriented Class
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- Lots of Help
  - Four TAs for a class size of 25
  - TAs attended class and had extensive office hours
  - Four faculty available to help look at proposals
  - In class, students could ask each other for help on their projects
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- Lots of feedback (both to students and from students)
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CS0931 Evolution

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

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<th>Semester</th>
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Anna Ritz (Virginia Tech)  Computational Thinking  October 20, 2013
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Deborah Lai
Brown Alum 2012
Economics & East Asian Studies Major

- 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)
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- 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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- Didn’t know a lick of Python
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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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- Last grant-funded course

...
Another Look at CS0931 Evolution

Fall 2009

Class
- Frosh (3)
- Soph (2)
- Jun (3)
- Sen (12)
- Grad (0)

Fall 2010

Class
- Frosh (0)
- Soph (2)
- Jun (3)
- Sen (2)
- Grad (0)

Fall 2011

Class
- Frosh (4)
- Soph (6)
- Jun (6)
- Sen (8)
- Grad (1)

Spring 2012

Class
- Frosh (2)
- Soph (6)
- Jun (7)
- Sen (15)
- Grad (0)
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- Amount of work
- The more help, the better (TAs, instructor, other faculty)
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- Instructor doesn’t always know the answer
- 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