

G-TEAMS Research Presentation: Error Correcting Codes

Sarah Edge Mann

University of Arizona, Program in Applied Mathematics

October 24, 2011

Introduction

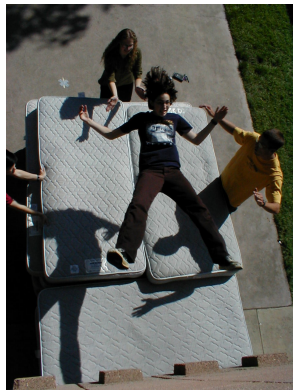
- I grew up in Washington, DC
- Attended The Field School, a small private high school near Dupont Circle



Harvey Mudd College

I attended Harvey Mudd College where I earned a B.S. in Mathematics.

- Small, private, liberal arts college
- Located in Claremont, California on the Eastern edge of LA County
- A member of the Claremont Consortium with Pitzer, Claremont-McKenna, Scripps, and Pomona
- Focuses on Math, Science, and Engineering with an extensive core curriculum in these areas
- I majored in Math, but also studied Physics and Computer Science

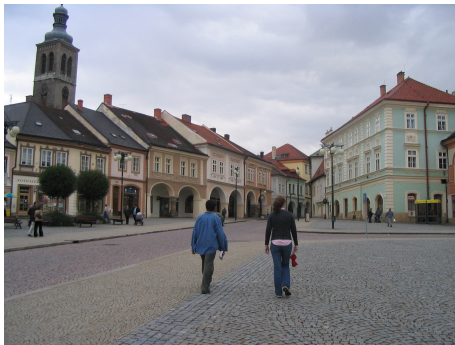


Budapest Semesters in Mathematics



- Fall semester of my Junior year at HMC (2004) I spent in Budapest with Budapest Semesters in Mathematics (BSM).
- BSM is a study abroad program run by St. Olaf's college.
- Students spend a semester (or a year) studying in Budapest, Hungary.
- Hungary has long history of excellence in mathematics. Courses are taught in English by Hungarian mathematicians.

Budapest Semesters in Mathematics



- Located in central Europe, Budapest is both a fascinating city and an excellent starting point from which to explore central and Eastern Europe.
- I visited 10 countries that semester: Hungary, Croatia, Bosnia and Herzegovina, Bulgaria, Romania, Serbia, Austria, Slovakia, Poland, and The Czech Republic

The Lewin Group

After graduating from HMC in 2006, I took a break from school and worked for The Lewin Group for two years.

- Lewin is a public health policy consulting firm. They advise the state, local, and federal governments, as well as private organization on topics related to public health.
- I worked on building economic models:
 - Cost of Diabetes
 - Physician Supply and Demand Model
- I did data analysis to generate the base data for these models, and also built the user interfaces for the models.
- This required both mathematics, and computer programming.

University of Arizona

- In 2008 I came to Tucson to study in the Program in Applied Mathematics at the University of Arizona.
- I earned my Masters of Science in Applied Math in December, 2009.
- I am working on a PhD in Applied Math with a minor in Computer Science

G-TEAMS

- This year, I am participating in the G-TEAMS program (Graduate Students and Teachers Engaging in Mathematical Sciences).
- G-TEAMS is funded by the National Science Foundation through their GK-12 program.
- “The program provides an innovative and dynamic opportunity for graduate students and teacher partners to collaborate on the development of novel, rigorous and relevant material for K-12 mathematics courses.”

Research?

To earn a PhD, one must complete original research in their field. So, what is original research in Applied Math?

Right now, I am working on Error Correcting Codes.

Motivation

- When data is stored on a hard drive, sometimes there is a mechanical error and the hard drive fails
- If we are storing data on a group of hard drives, we can use one or a few extra drives to store additional information that allows us to reconstruct data on a failed disk

Example

Disk 1:	1	0	1	1	0	0	0	0	1	1	1	0	1	0
Disk 2:	1	1	0	0	0	1	1	0	0	1	1	0	1	1
Disk 3:	1	0	1	1	0	0	1	0	0	1	1	0	0	1
Disk 4:	1	1	1	1	0	1	1	1	0	0	0	0	0	1
Check Drive:	0	0	1	1	0	0	1	1	1	1	1	0	0	1

Example

Disk 1: 1 0 1 1 0 0 0 0 1 1 1 0 1 0

Disk 2: 1 1 0 0 0 1 1 0 0 1 1 0 1 1

Disk 3: ? ? ? ? ? ? ? ? ? ? ? ? ?

Disk 4: 1 1 1 1 0 1 1 1 0 0 0 0 0 1

Check Drive: 0 0 1 1 0 0 1 1 1 1 1 0 0 1

Example

Disk 1: 1 0 1 1 0 0 0 0 1 1 1 0 1 0

Disk 2: 1 1 0 0 0 1 1 0 0 1 1 0 1 1

Disk 3: 1 ? ? ? ? ? ? ? ? ? ? ? ? ?

Disk 4: 1 1 1 1 0 1 1 1 0 0 0 0 0 1

Check Drive: 0 0 1 1 0 0 1 1 1 1 1 0 0 1

Example

Disk 1: 1 0 1 1 0 0 0 0 1 1 1 0 1 0

Disk 2: 1 1 0 0 0 1 1 0 0 1 1 0 1 1

Disk 3: 1 0 ? ? ? ? ? ? ? ? ? ? ? ?

Disk 4: 1 1 1 1 0 1 1 1 0 0 0 0 0 1

Check Drive: 0 0 1 1 0 0 1 1 1 1 1 0 0 1

Example

Disk 1: 1 0 1 1 0 0 0 0 1 1 1 0 1 0

Disk 2: 1 1 0 0 0 1 1 0 0 1 1 0 1 1

Disk 3: 1 0 1 ? ? ? ? ? ? ? ? ? ? ?

Disk 4: 1 1 1 1 0 1 1 1 0 0 0 0 0 1

Check Drive: 0 0 1 1 0 0 1 1 1 1 1 0 0 1

Example

Disk 1: 1 0 1 1 0 0 0 0 1 1 1 0 1 0

Disk 2: 1 1 0 0 0 1 1 0 0 1 1 0 1 1

Disk 3: 1 0 1 1 ? ? ? ? ? ? ? ? ? ?

Disk 4: 1 1 1 1 0 1 1 1 0 0 0 0 0 1

Check Drive: 0 0 1 1 0 0 1 1 1 1 1 0 0 1

Example

Disk 1: 1 0 1 1 0 0 0 0 1 1 1 0 1 0

Disk 2: 1 1 0 0 0 1 1 0 0 1 1 0 1 1

Disk 3: 1 0 1 1 0 0 1 0 0 1 1 0 0 1

Disk 4: 1 1 1 1 0 1 1 1 0 0 0 0 0 1

Check Drive: 0 0 1 1 0 0 1 1 1 1 1 0 0 1

Generalization

- This is a RAID scheme
 - *Redundant Array of Inexpensive Disks*
 - *Redundant Array of Independent Disks*

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- If there are more disks, we might expect two or more disks to fail simultaneously
- We can correct simultaneous disk failures by using more check drives computed in different ways

Applications

- UPC codes
- Hard drives
- Internet communications
- Deep space communications
- Cell phones
- Compact Disks and DVDs

