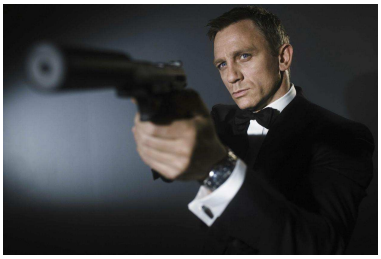
Error Correcting Codes: Combinatorics, Algorithms and Applications

CSE 510C

August 27, 2006

Let's do some introductions



The name is Bond… James Bond

Let's do some introductions

- Atri Rudra
  - 123 Bell Hall
  - atri@cse.buffalo.edu
  - 645-3180 x 117
  - Office hours: TBA

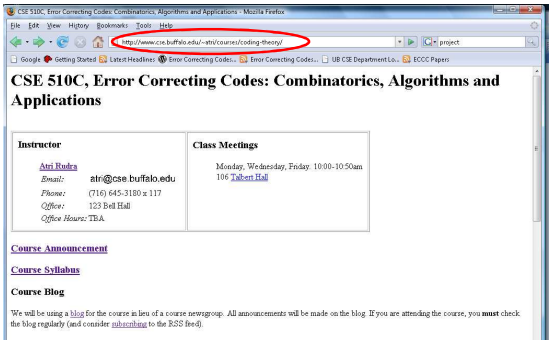
Handouts for today

- Syllabus
- Feedback form
  - Also fill in the sheet being passed around with your name/email
- List of project topics

Plug for feedback forms

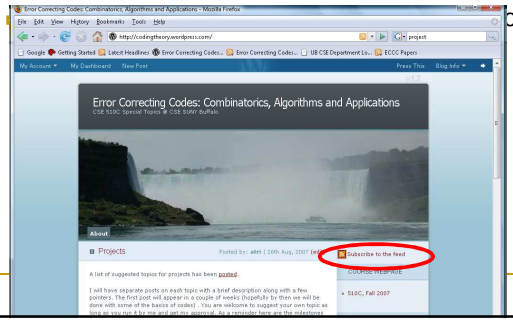
- Completing the form is voluntary
- Purpose of the form
  - Fix office hours
  - For me to get an idea of your technical background
- Last 5 minutes of the lecture to complete it

Course webpage



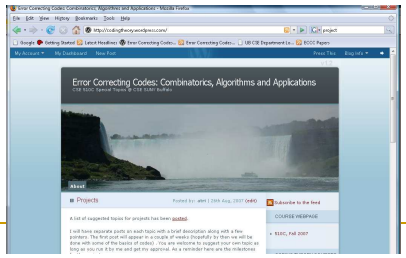
Course blog (codingtheory.wordpress.com)

- Used for announcements



Why use a blog?

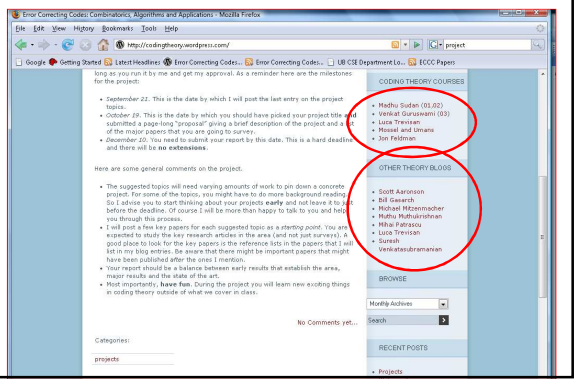
- Easy access
- Easier to link to URLs and displaying math



What will appear on the blog?

- Change in office hours
- An entry for each lecture/homework
  - Comments section to ask questions or post comments
- An entry for each project topic
- A post on some interesting side story/comment

Other stuff on the blog



Questions/Comments?

- If something is broken on the blog (e.g. you cannot post a comment), let me know

Makeup classes

- Some classes will be canceled
  - I will be traveling
  - 3-4 classes
- Need two 90 mins makeup lectures
  - Indicate your preferences in the feedback form
- September 17 class is cancelled

References

- No text book
- Best online resource: Madhu Sudan's lecture notes @ MIT
  - Links on the course blog/webpage
- Standard coding theory texts
  - MacWilliams and Sloane
  - van Lint
  - Blahut
  - Handbook of coding theory

Grades and such like

- Scribing notes
  - 30-40%
- Homework(s)
  - 30-15%
- Project report
  - 40-45%

Scribing notes

- Every lecture notes will be scribed by a student (maybe give some extra details)
- 3-4 times during the course
  - Depends on the class strength
- Use LaTeX
  - Style file on the webpage
- They are due in a week
- Notes will be graded on timeliness & quality

Homework

- 1-2 depending on other course load
- Collaboration generally allowed
  - Work in groups of size at most 3
  - Write up your own solutions
  - Acknowledge your collaborators
  - Breaking these rules will be considered as cheating
- More details when they are handed out

Project report

- Individual survey reports
- Handed out a list of suggested topics
  - Also linked from the course webpage/blog
  - Topics we will not cover in class (or will just briefly mention it)
  - You can also suggest your own topic
- An entry/topic on the blog
  - A brief description
  - Point out one/two key papers as a *starting point*

Project time line

- September 21
  - Last blog entry on a project topic
- October 19
  - Pick your topic
  - Submit a one page proposal
    - Short description of the survey
    - List of important papers that you are going to survey
- December 10
  - Final submission: **hard** deadline

Some comments

- See the post on projects on the blog
- Decide on a project topic **early**
  - Different topics might need different prep. Work
  - Come talk to me
- Report should be a balance of
  - Classical work
  - Major results
  - State of the art

Some of my teaching "quirks"

- Neighbor talk time
- Periodic feedback forms
- Catch the instructor

Questions/Comments?

Let the fun begin!

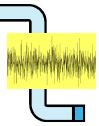
What does this say?

- W*lcome to the cl*ss. I h*pe you w*ll h*ve as mu*h f*n as I wi*l hav* t*ach*ng it!
- Welcome to the class. I hope you will have as much fun as I will have teaching it!

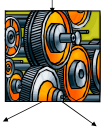
Why did the example work?

- English has in built redundancy
- Can tolerate "errors"

The setup

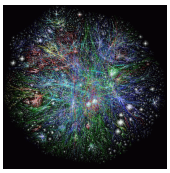
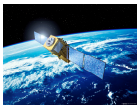


- Mapping **C**
  - Error-correcting code or just code
  - Encoding: $x \rightarrow C(x)$
  - Decoding: $y \rightarrow x$
  - $C(x)$ is a codeword



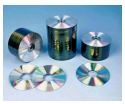
Communication

- Internet
  - Checksum used in multiple layers of TCP stack
- Cell phones
- Satellite broadcast
  - TV
- Deep space telecommunications
  - Mars Rover

"Unusual" applications

- Data Storage
  - CDs and DVDs
  - RAID
  - ECC memory



- Paper bar codes
  - UPS (MaxiCode)

Codes are all around us

Other applications of codes

- Outside communication/storage domain
- Tons of applications in theory
  - Complexity Theory
  - Cryptography
  - Algorithms

The birth of coding theory

- Claude E. Shannon
  - "A Mathematical Theory of Communication"
  - 1948
  - Gave birth to Information theory

- Richard W. Hamming
  - "Error Detecting and Error Correcting Codes"
  - 1950

Structure of the course

- Part I: Combinatorics
  - What can and cannot be done with codes
- Part II: Algorithms
  - How to use codes efficiently
- Part III: Applications
  - Applications in theoretical Computer Science

The fundamental tradeoff

- Correct as many errors as possible while using as little redundancy as possible
  - Intuitively, contradictory goals