Lecture 38

CSE 331

Dec 4, 2017

Quiz 2

1:00-1:10pm

Lecture starts at 1:15pm

Final Reminder

note

stop following 147 views

Actions

Incentive for filling in the course evaluations

You must have received an email (or should be receiving an email shortly) about filling the course evaluation forms. I believe this is the link:

https://www.smartevals.com/login.aspx?s=buffalo

Here is my offer to incentivize you guys filling in the course evaluation form:

- If **at least 85%** of you fill in the course evaluation form, then I will release one T/F (without justification) question on the final exam (which corresponds to Q1(a): see @842 for the format).
- If **at least 95%** of you fill in the course evaluation form, then I will release one T/F (without justification) question and one T/F (with justification) question (corresponding to Q1(a) and Q2(a) respectively: see @842 for the format).

Of course if $< 85\%$ of you fill in the course eval form, then no question gets released. I will post weekly updates on the response rate.

(Also to clarify: the % is only for students who are still registered in the course and have not resigned, which is an even 200.)

Review sessions/extra OH

poll

stop following 19 views

Actions

Review sessions/extra OH

The final exam week will have one (or two-- depending on the response and room availability) review session(s) and Office hours hosted by the TAs. The review session(s) will be during Mon-Wed.

Copies of HW solutions can also be picked at the office hours.

Please choose all time slots that work for you (choose a slot even if it works only for part of the time).

I will use the votes on Wed 8pm to pick the final slots.

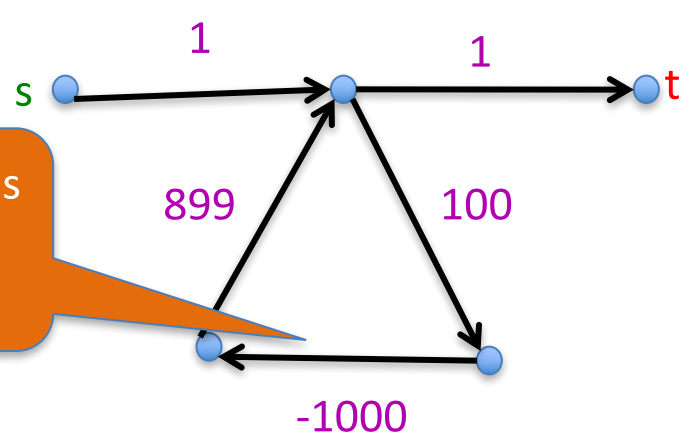
- ☐ Mon, Dec 11, 10-11am
- ☐ Mon, Dec 11, 11am -12pm
- ☐ Mon, Dec 11, 12-1pm
- ☐ Mon, Dec 11, 1-2pm
- ☐ Mon, Dec 11, 2-3pm
- ☐ Mon, Dec 11, 3-4pm
- ☐ Mon, Dec 11, 4-5pm

Shortest Path Problem

Input: (Directed) Graph $G=(V,E)$ and for every edge e has a cost c_e (can be <0)

t in V

Output: Shortest path from every s to t



Shortest path has cost negative infinity

Assume that G has no negative cycle

Longest path problem

Given G, does there exist a simple path of length n-1 ?

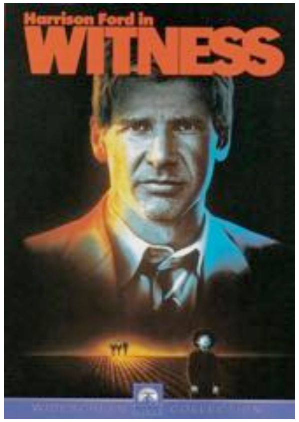
Longest vs Shortest Paths

Two sides of the "same" coin

Shortest Path problem

Can be solved by a polynomial time algorithm

Is there a longest path of length n-1?



Given a path can verify in polynomial time if the answer is yes

Poly time algo for longest path?

P vs NP question

P: problems that can be solved by poly time algorithms

Is P=NP?

NP: problems that have polynomial time verifiable witness to optimal solution

Alternate NP definition: Guess witness and verify!

Proving P ≠ NP

Pick any one problem in NP and show it cannot be solved in poly time

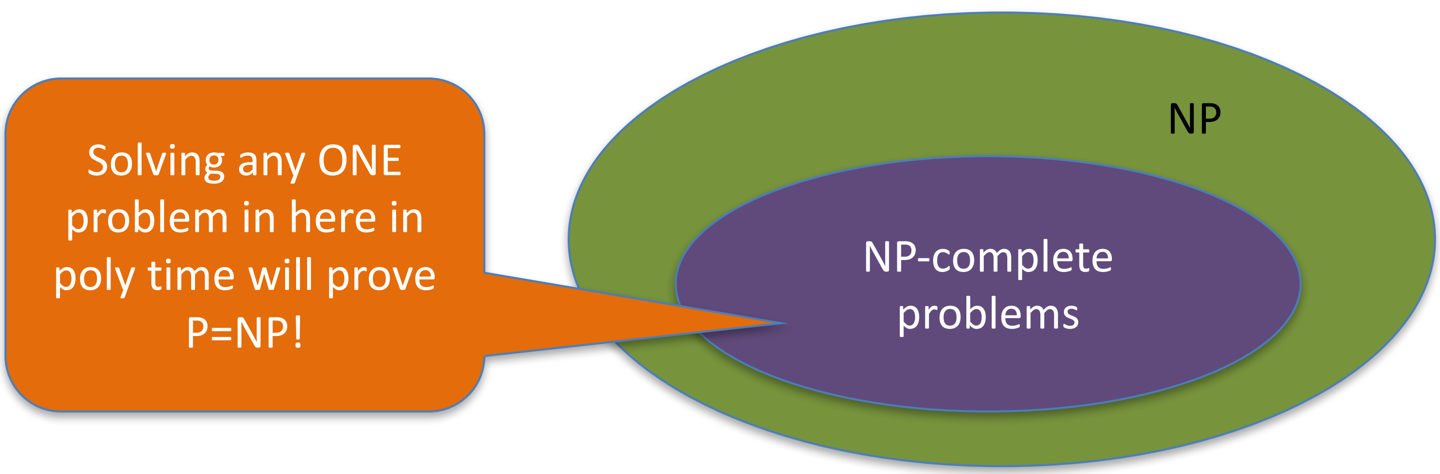
Pretty much all known proof techniques *provably* will not work

Proving P = NP

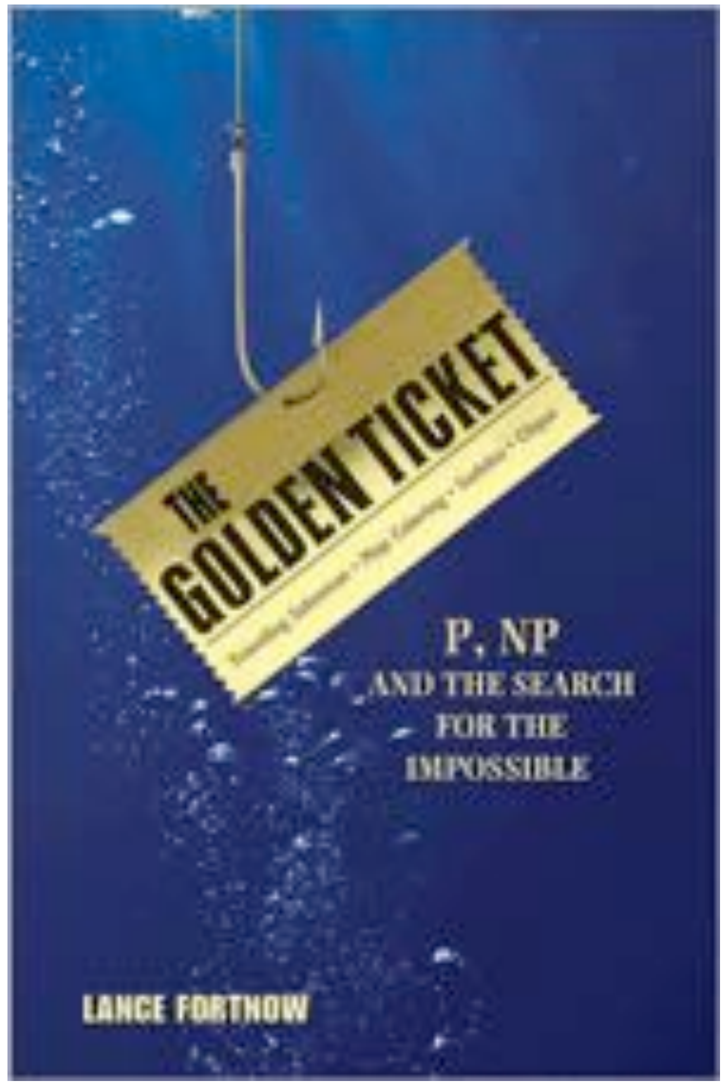
Will make cryptography collapse

Compute the encryption key!

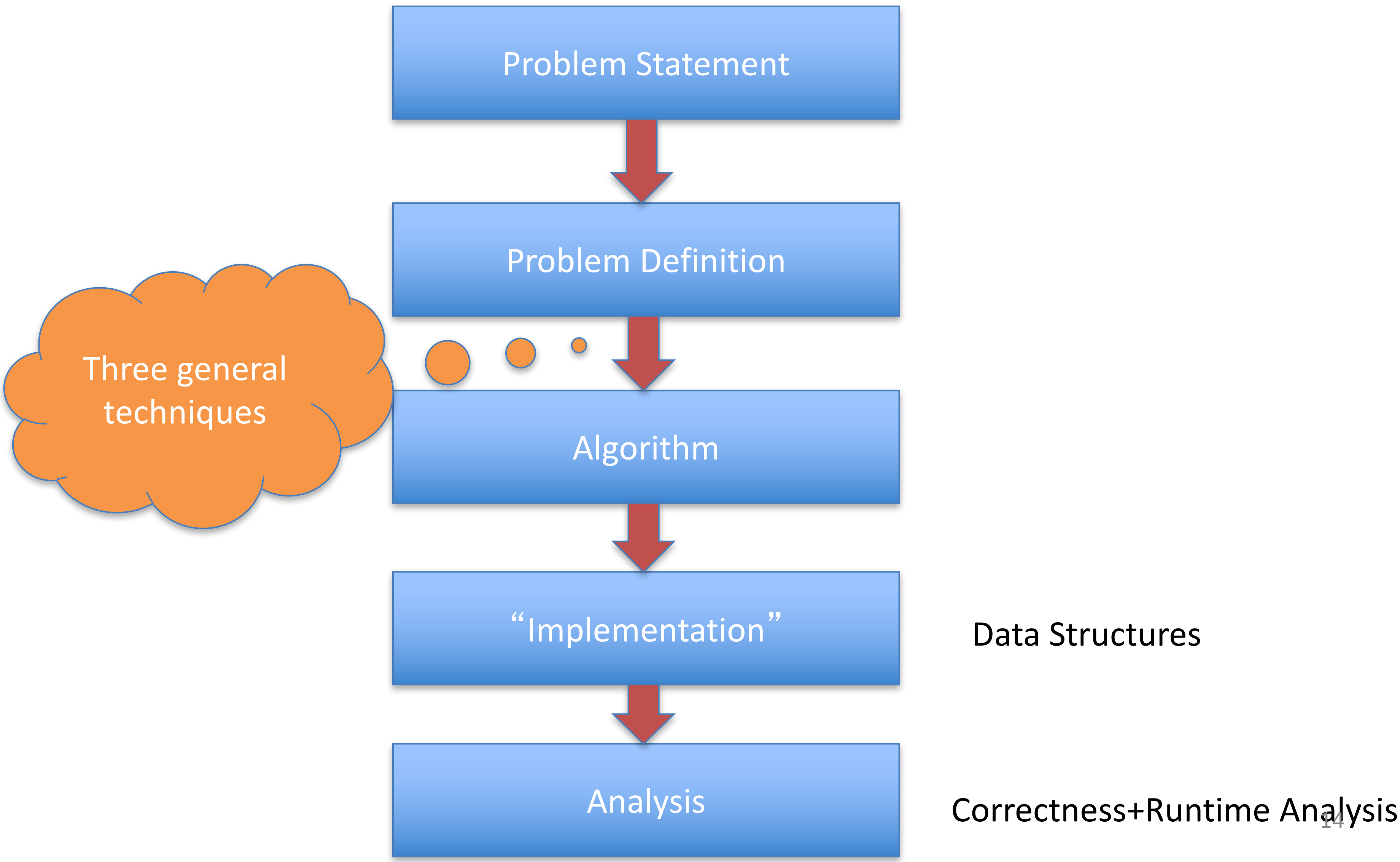
Prove that all problems in NP can be solved by polynomial time algorithms



A book on P vs. NP



High level view of CSE 331



If you are curious for more

CSE 429 or 431: Algorithms

CSE 396: Theory of Computation

Now relax…

Randomized algorithms

http://calculator.mathcaptain.com/coin-toss-probability-calculator.html

What is different?

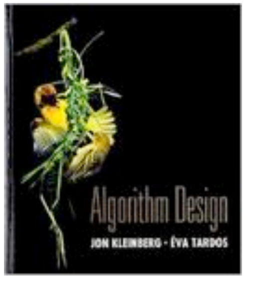
Algorithms can toss coins and make decisions

A Representative Problem

Hashing

Further Reading

Chapter 13 of the textbook

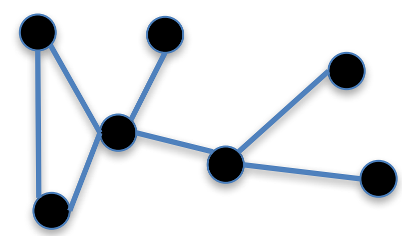


Approximation algorithms

What is different?

Algorithms can output a solution that is say 50% as good as the optimal

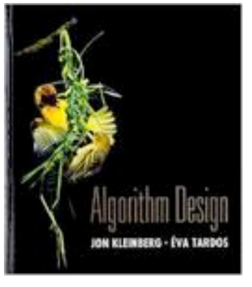
A Representative Problem



Vertex Cover

Further Reading

Chapter 12 of the textbook



Online algorithms

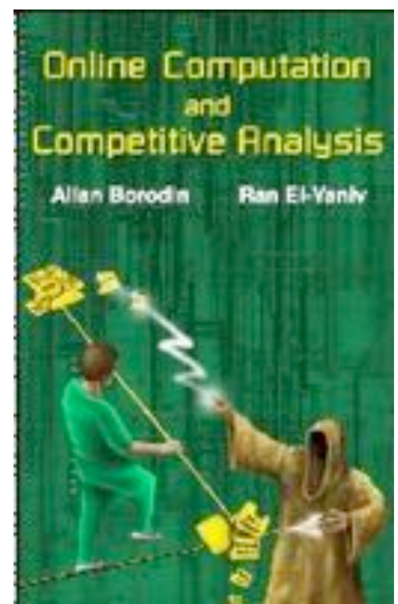
What is different?

Algorithms have to make decisions before they see all the input

A Representative Problem

Secretary Problem

Further Reading



Data streaming algorithms

https://www.flickr.com/photos/midom/2134991985/

What is different?

One pass on the input with severely limited memory

A Representative Problem

Compute the top-10 source IP addresses

Further Reading

Distributed algorithms

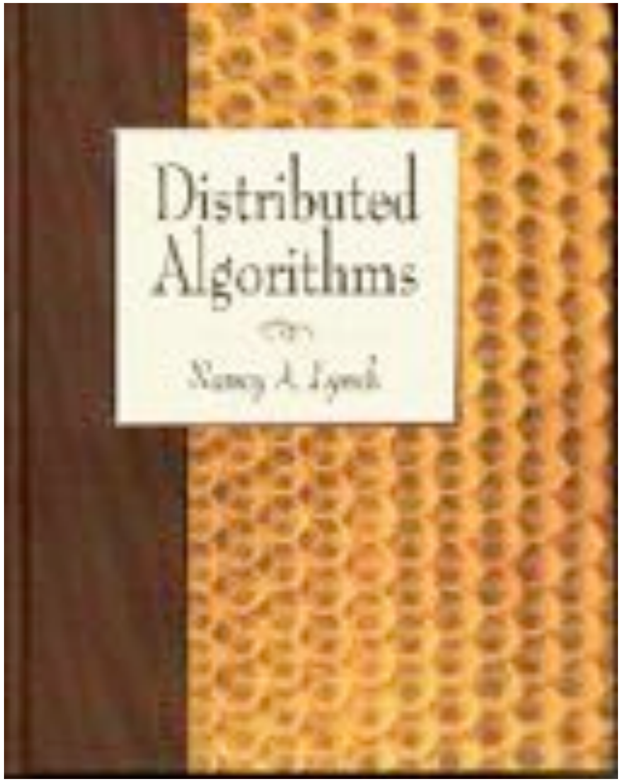
What is different?

Input is distributed over a network

A Representative Problem

Consensus

Further Reading



Beyond-worst case analysis

What is different?

Analyze algorithms in a more instance specific way

A Representative Problem

Intersect two sorted sets

Further Reading

http://theory.stanford.edu/~tim/f14/f14.html

Algorithms for Data Science

What is different?

Algorithms for non-discrete inputs

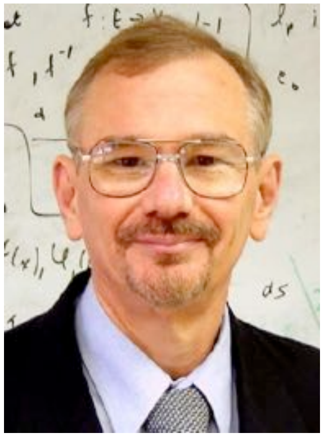
A Representative Problem

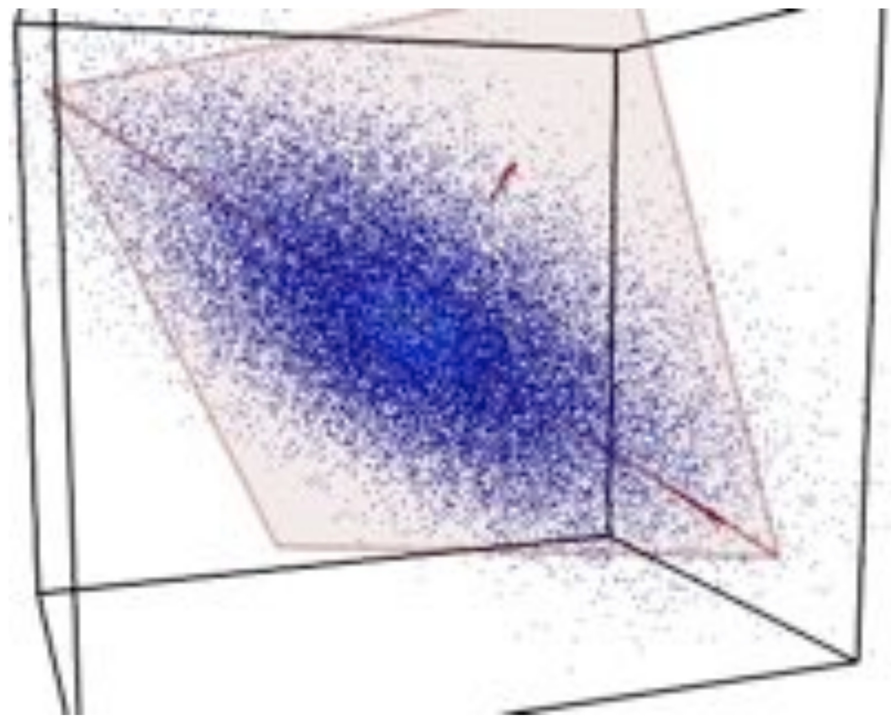
Compute Eigenvalues

Further Reading

http://research.microsoft.com/en-US/people/kannan/book-no-solutions-aug-21-2014.pdf

Johnson Lindenstrauss Lemma

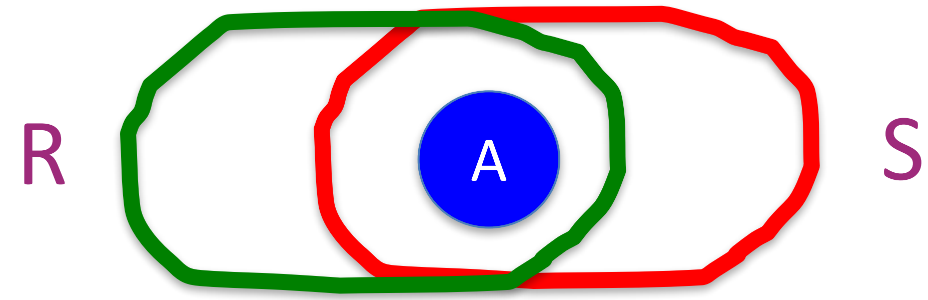




http://www.scipy-lectures.org/_images/pca_3d_axis.jpg

The simplest non-trivial join query

Intersection of R and S

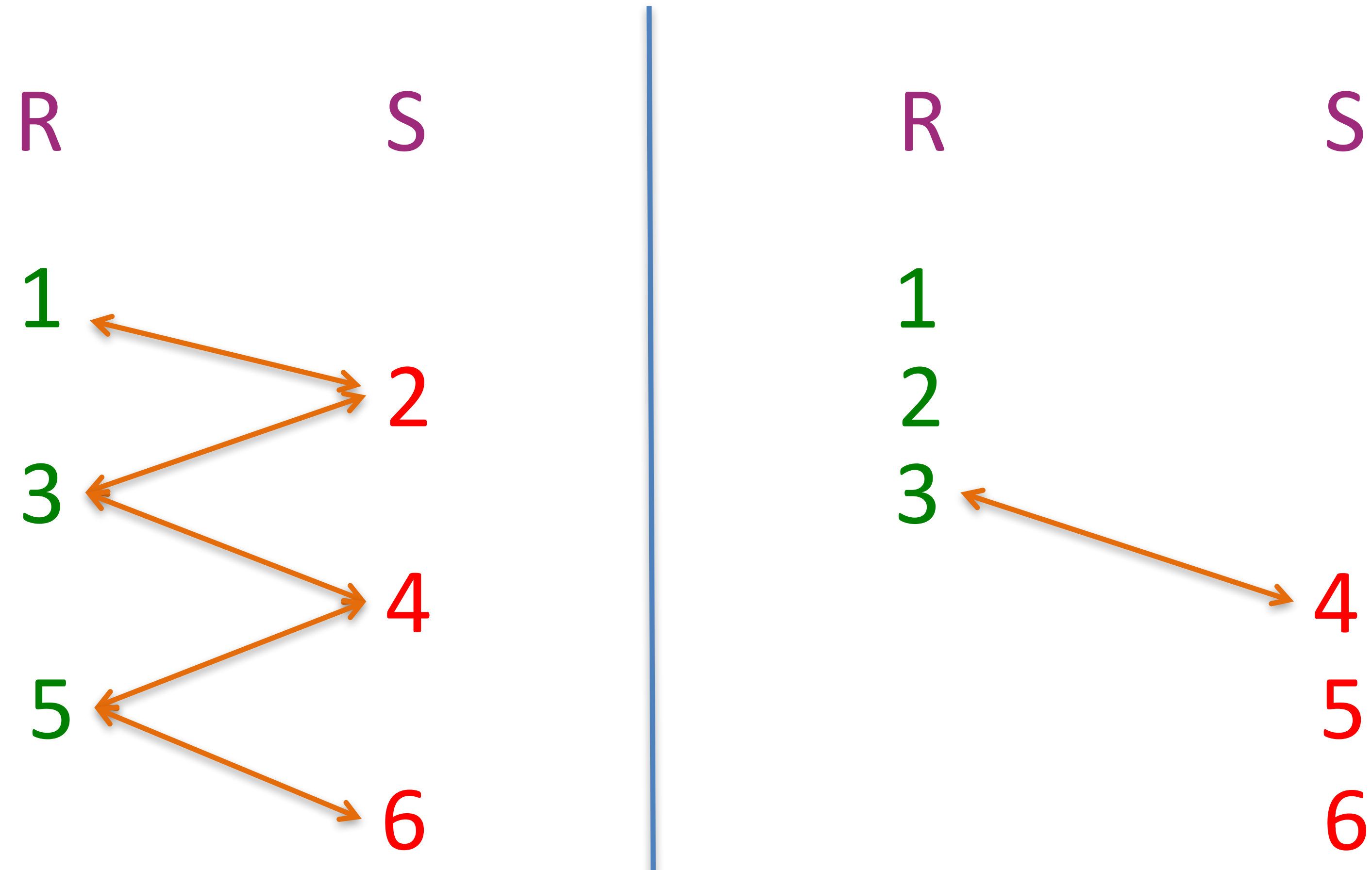


Assume R and S are sorted

Let us concentrate on comparison based algorithms

Assume $|R| = |S| = N$

Not all inputs are created equal

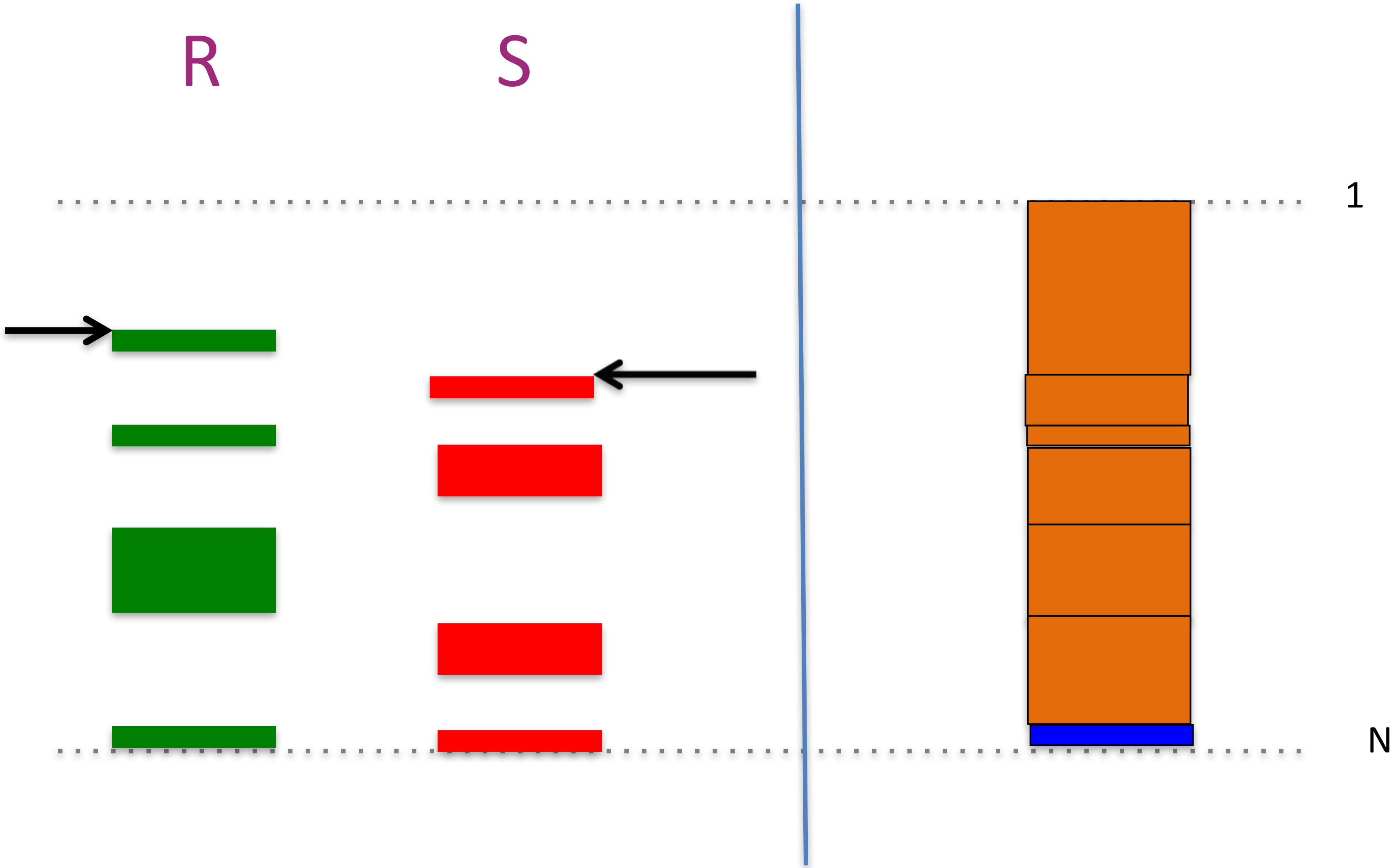


$\Omega(N)$ comparisons

1 comparison!

We need a faster/adaptive algorithm

The MERGE algorithm works

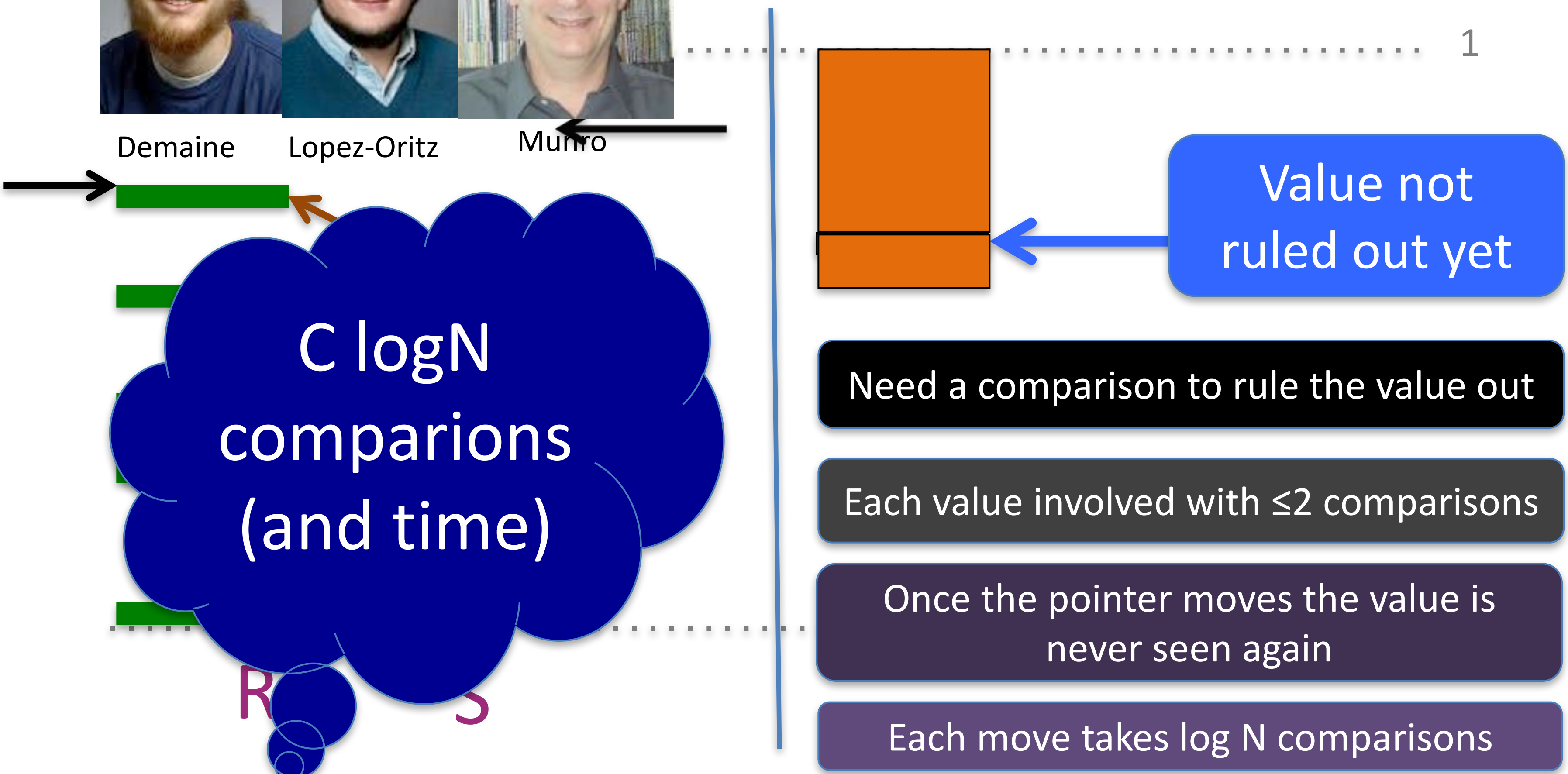


An assumption

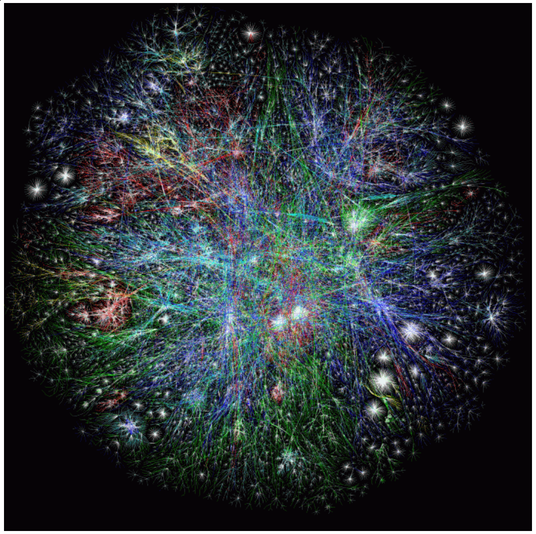
Output of the join is empty

MERGE is (near) instance optimal

Benchmark: Minimum number of comparisons (C) to “certify” output



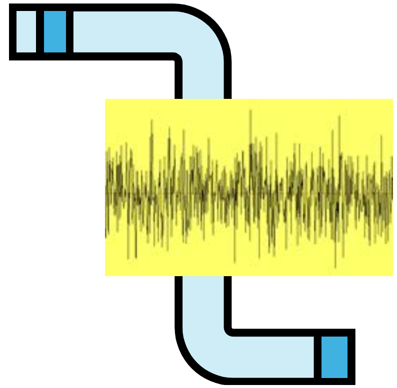
Coding Theory



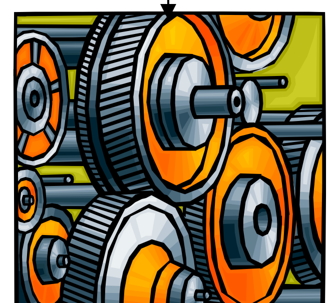
Communicating with my 3 year old

x

C(x)



y = C(x)+error



x

Give up

"Code" **C**

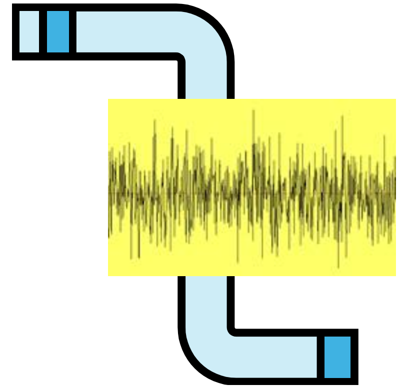
"Kiran English"

C(x) is a "codeword"

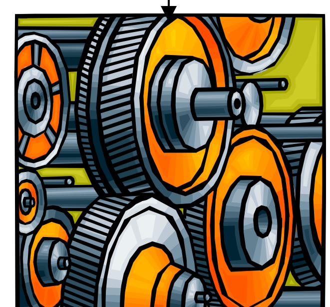
The setup

x

C(x)



y = C(x)+error



x

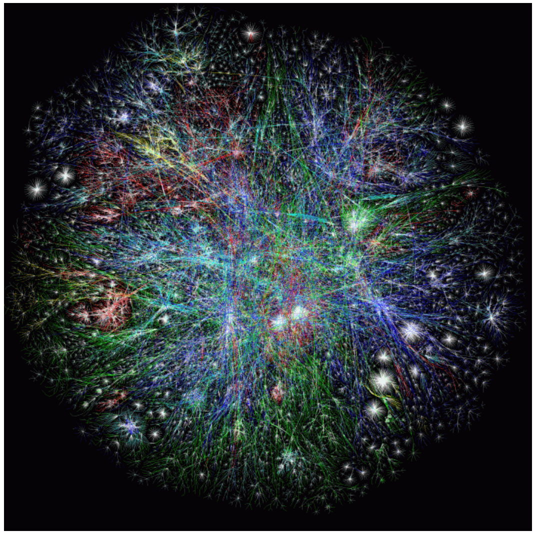
Give up

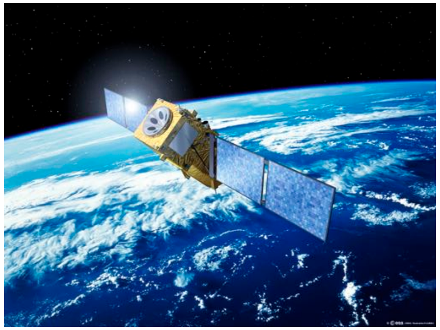
Mapping **C**

- Error-correcting code or just code
- Encoding: x → C(x)
- Decoding: y → x
- C(x) is a codeword

Different Channels and Codes

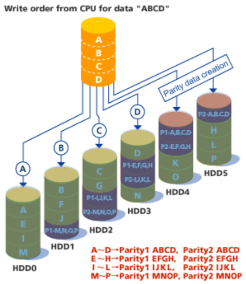
- Internet
  - Checksum used in mult layers of TCP/IP stack
- Cell phones
- Satellite broadcast
  - TV
- Deep space telecommunications
  - Mars Rover



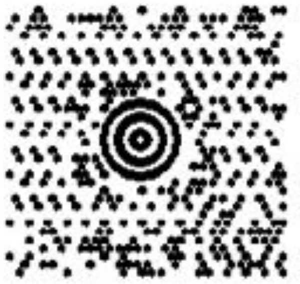


“Unusual” Channels

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



- Paper bar codes
  - UPS (MaxiCode)



Codes are all around us

Redundancy vs. Error-correction

- Repetition code: Repeat every bit say 100 times
  - Good error correcting properties
  - Too much redundancy
- Parity code: Add a parity bit
  - Minimum amount of redundancy
  - Bad error correcting properties
    - Two errors go completely undetected
- Neither of these codes are satisfactory

1 1 1 0 0 | 1

1 0 0 0 0 | 1

Two main challenges in coding theory

- Problem with parity example
  - Messages mapped to codewords which do not differ in many places
- Need to pick a lot of codewords that differ a lot from each other

- Efficient decoding
  - Naive algorithm: check received word with all codewords

The fundamental tradeoff

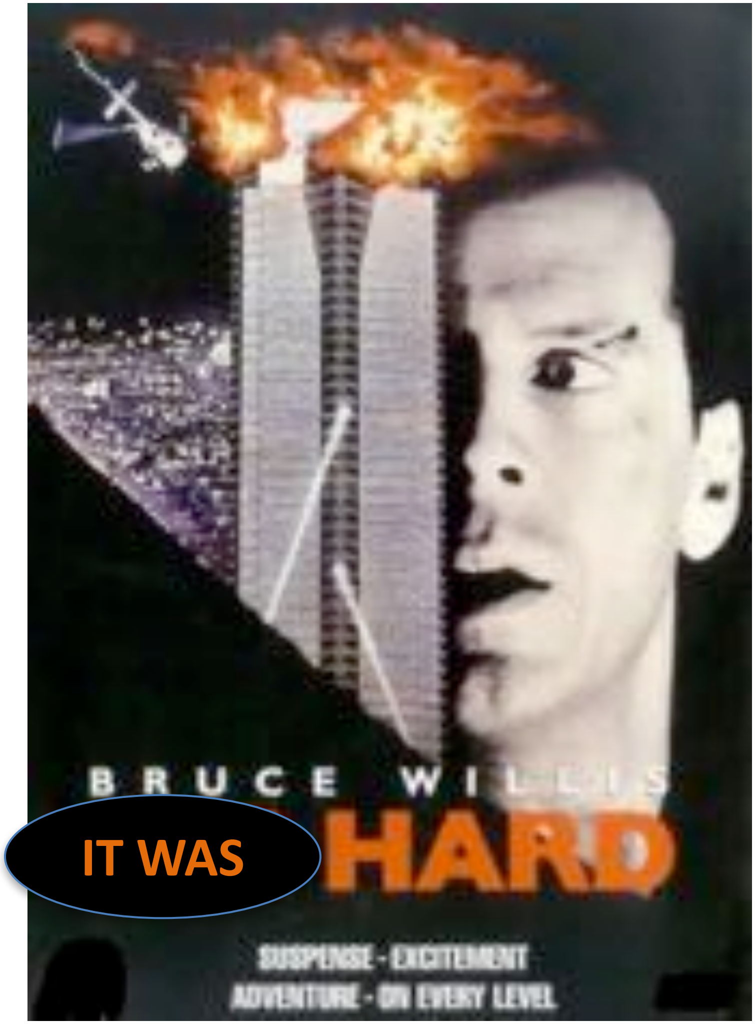
- Correct as many errors as possible with as little redundancy as possible

Can one achieve the "optimal" tradeoff with *efficient* encoding and decoding ?

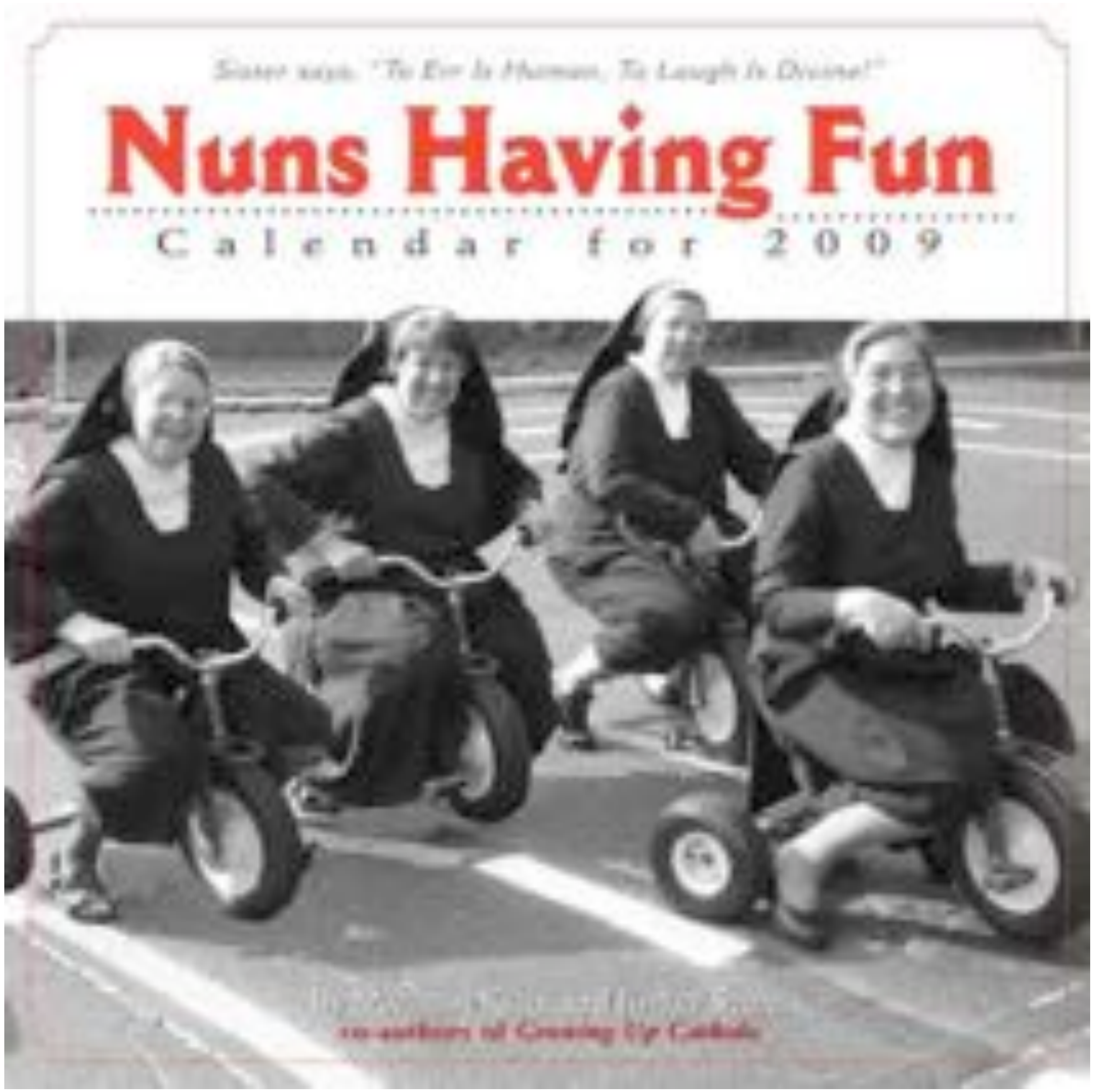
Interested in more?

CSE 545, Spring 2019

Whatever your impression of the 331



Hopefully it was fun!



Thanks!

Except of course, HW 10, presentations and the final exam