CS4102 Algorithms

Spring 2020

Today's Keywords

- Differential Privacy
- NP-Completeness
- Review

CLRS Readings

Homeworks

- HW9 due tonight at 11pm
  - Reductions, Graphs
  - Written (LaTeX)
- HW10C due tonight at 11pm

Final Exam

- Take-home exam
  - Open book, open notes, open course material **only**
  - NO collaboration, NO internet (i.e. no “googling”)
  - It will be on Collab under “Tests and Quizzes”
    - Variety of question formats
    - You may want to write pseudocode in a text editor and copy/paste into Collab
  - Must take between 6pm Thursday (4/30) and 1pm Sunday (5/3)
    - 2 hours to submit once started

Final Exam

- Review
  - Practice Exam out by tomorrow
    - We are releasing last semester's final, which will give some new problems but our final will be different!
  - Practice Exam solutions out on Wednesday
  - Review sessions Wednesday (Hott) and Thursday (Horton)
- SDAC: please send us an email so that we can coordinate

President Trump Expected to Shrink Bears Ears by as Much as 90 Percent

Ministers Look to Revive Martin Luther King's 1968 Poverty Campaign

Alabama's Disdain for Democrats Looms Over Its Senate Race

ABC Suspends Reporter Brian Ross Over Erroneous Report About Trump

As Computer Coding Classes Swell, So Does Cheating

By JESS BIDGOOD and JEREMY B. MERRILL MAY 29, 2017

A Computer Science 50 course at Harvard in 2013. Last fall, more than 60 computer science students were referred to the university's honor council, which investigates cheating allegations. Joseph Ong

SECTIONS HOME SEARCH

The New York Times

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RYAN PAUL - 2/12/2010, 5:11 PM

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THE DAILY ILLINI

The independent student newspaper at the University of Illinois

NEWS SPORTS OPINIONS LIFE & CULTURE SPECIAL SECTIONS LONGFORM BUZZ CLASSIFIEDS

College of Engineering piloting program to combat cheating

Top Stories

What are some reasons students cheat?

Our In-Person Academic Integrity Policy

You are encouraged to collaborate with up to 4 other students, but all work submitted must be your own independently written solution. List the computing ids of all of your collaborators in the comments at the top of each submitted file. Do not share written notes, documents (including Google docs, Overleaf docs, discussion notes, PDFs), or code. Do not seek published or online solutions, including pseudocode, for this assignment. If you use any published or online resources (which may not include solutions) when completing this assignment, be sure to cite them. Do not submit a solution that you are unable to explain orally to a member of the course staff. Any solutions that share similar text/code will be considered in breach of this policy. Please refer to the syllabus for a complete description of the collaboration policy.

Our Online Academic Integrity Policy

You are encouraged to collaborate with up to 4 other students, but all work submitted must be your own *independently* written solution. List the computing ids of all of your collaborators in the comments at the top of the tex file. You **are** permitted to collaborate through online tools such as Google Docs, interactive whiteboards, Google Meet, Google Hangouts, Zoom, Skype, etc, however you **must** limit written/typed details to high-level algorithm design. Each person is responsible for taking those ideas and turning them into pesudocode and a writeup. Do **NOT** copy and paste from shared documents, which includes re-typing verbatim or trying to disguise text that you are essentially copying. Over-collaboration of that form is fairly easy to detect with plagiarism tools. **Do not seek published or online solutions, including pseudocode, for this assignment.** If you use any published or online resources (which may not include solutions) when completing this assignment, be sure to cite them. Do not submit a solution that you are unable to explain orally to a member of the course staff. Any solutions that share similar text/code will be considered in breach of this policy. Please refer to the syllabus for a complete description of the collaboration policy.

Our Collaboration Policy and Transition

- What worked in our transition to an online course?
- What could we have improved upon?
- What did other instructors do that you found helpful?
- What is a ”good” collaboration policy?
- How do collaboration policies and academic integrity policies change when transitioning online?

Our Collaboration Policy and Transition

Our Collaboration Policy and Transition

Differential Privacy

- Gives a way to probabilistically answer questions about data without giving away its content
- You can get statistical certainty on the answer
- We’re going to use a simple example

Scheme – Embarrassing Questions

- Flip a coin:
  - If Heads, respond “yes”
  - If Tails, truthfully answer an embarrassing question
- Questions

How does it work

- Assume everyone participates honestly
- We know 50% of “yes” answers were from the coin landing **heads**
  - If 100 people participate, eliminate 50 “yes” responses
  - Proportion of “yes” answers given by remaining “yes” answers
- Consider a person who answers “no”
  - We know this person didn’t cheat
- Consider a person who answers “yes”
  - Most people ($\geq 50\%$) who answered “yes” only did so because the coin landed **heads**
  - It’s still **more** likely that this person **did not cheat**

An Example – Your Turn!

- Flip a coin: (on Google, search “flip a coin”)
  - If Heads, respond “yes”
  - If Tails, truthfully answer an embarrassing question

Have you ever streaked the lawn?

Impagliazzo's 5 Worlds

Describes what computer science might look like depending on how certain open questions are answered.

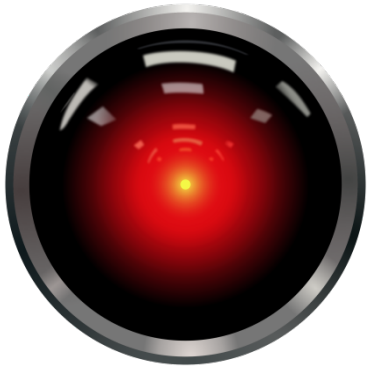
- Algorithmica
- Heuristica
- Pessiland
- Minicrypt
- Cryptomania

Gauss vs. Büttner

Büttner's goal: embarrass Gauss

- Come up with a problem which Gauss finds difficult but Büttner can solve quickly
  1. Come up with a graph and a Vertex Cover together
  2. Give the graph to Gauss
  3. When Gauss is stumped show the Vertex Cover

Algorithmica



$P = NP$

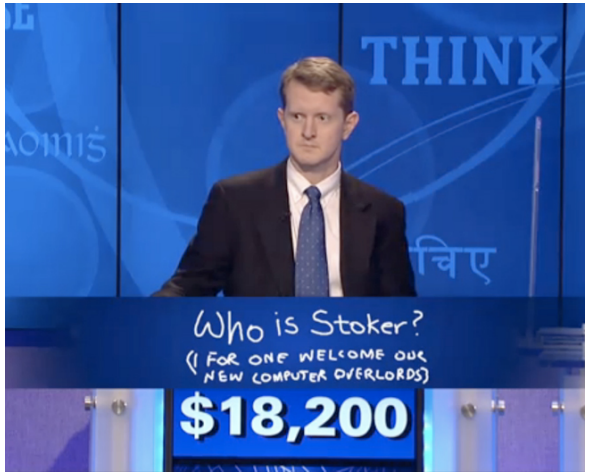
- NP problems solvable efficiently
- Gauss can quickly find the solution to Büttner's problem
- Gauss is not embarrassed

Advantages:

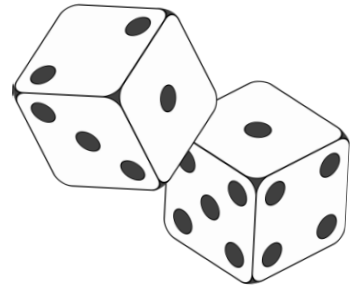
- VLSI Design
- Strong AI
- Cure for cancer?

Disadvantages:

- No privacy
- Computers take over



Heuristica



$P \neq NP$ in worst case, $P = NP$ on average

- Time to come up with a problem ≈ time to solve it
- Büttner can give hard problems, but it's hard to find them
- Gauss is not embarrassed

Advantages:

- Maybe similar to Algorithmica
- Depends on real-world distributions

Disadvantages:

- Bad real world distributions could make things hard to solve

Pessiland

$P \neq NP$ on average, one-way functions don't exist

- Hard problems easy to find, but *solved* hard problems difficult to find
- Gauss can be stumped, but Büttner does no better

Advantages:

- Universal Compression
- Reverse Engineering
- Derandomization

Disadvantages:

- No crypto
- No algorithmic advantages
- Progress is slow

Minicrypt

One-way functions exist, no public key cryptography

- Büttner can give hard problems to Gauss and also know their solutions
- Gauss is embarrassed

Advantages:

- Private key crypto
- Can prove identity

Disadvantages:

- No electronic currencies

Cryptomania

Public Key Crypto Exists

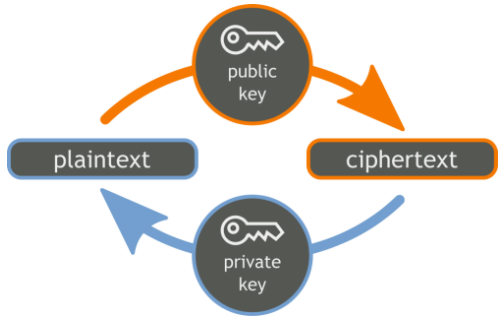
- Büttner can come up with problems and solutions, then share the solution with all other students
- Gauss is very embarrassed

Advantages:

- Secure computation
- Signatures
- Bitcoin, etc.

Disadvantages:

- Algorithmic progress will be slow



Does P=NP?

	$P \neq NP$	$P = NP$	Ind	DC	DK	DK and DC	other
2002	61(61%)	9(9%)	4(4%)	1(1%)	22(22%)	0(0%)	3(3%)
2012	126 (83%)	12 (9%)	5 (3%)	5 (3%)	1(0.6%)	1 (0.6%)	1 (0.6%)

When Will P=NP be resolved?

	02–09	10–19	20–29	30–39	40–49	50–59	60–69	70–79
2002	5(5%)	12(12%)	13(13%)	10(10%)	5(5%)	12 (12%)	4(4%)	0(0%)
2012	0(0%)	2(.01%)	17(11%)	18(12%)	5(3%)	10 (6.5%)	10 (6.5%)	9(6%)

	80–89	90–99	100–109	110–119	150–159	2200–3000	4000–4100
2002	1(1%)	0(0%)	0(0%)	0(0%)	0(0%)	5(5%)	0(0%)
2012	4(3%)	5(3%)	2(1.2%)	5(3%)	2(1.2%)	3(2%)	3(2%)

	Long Time	Never	Don't Know	Sooner than 2100	Later than 2100
2002	0(0%)	5(5%)	21(21%)	62(62%)	17 (17%)
2012	22(14%)	5(3%)	8(5%)	81(53%)	63 (41%)

Notable Statements on P vs NP

Scott Aaronson I believe P $\neq$ NP on basically the same grounds that I think I won't be devoured tomorrow by a 500-foot-tall robotic marmoset from Venus, despite my lack of proof in both cases.

Suggested rephrased question:

will humans manage to prove P $\neq$ NP *before they either kill themselves out or are transcended by superintelligent cyborgs? And if the latter, will the cyborgs be able to prove* P $\neq$ NP*?*

Neil Immerman P $\neq$ NP will be resolved somewhere between 2017 and 2034, using some combination of logic, algebra, and combinatorics.

Donald Knuth: (Retired from Stanford) It will be solved by either 2048 or 4096. I am currently somewhat pessimistic. The outcome will be the truly worst case scenario: namely that someone will prove "P=NP because there are only finitely many obstructions to the opposite hypothesis"; hence there will exists a polynomial time solution to SAT but we will never know its complexity!