What’s an algorithm?

“ A procedure for solving a mathematical problem (as of finding the greatest common divisor) in a finite number of steps that frequently involves repetition of an operation. ” — webster.com

“ An algorithm is a finite, definite, effective procedure, with some input and some output. ” — Donald Knuth
What is this course about?

• In CS230, you learnt how to:
  • Abstract functionality from design
  • Design efficient data structures
  • Design modular applications

• You used to,
  • Code all of that
  • Test it to see if it works
  • Then, the fun starts 😊

What is this course about?

• In CS231, you learn the design and analysis of algorithms to solve problems.

• We’ll always focus on three things:
  • How to understand and define a problem
  • How to implement an algorithm that “correctly” solves that problem
  • How to analyze the performance of that algorithm

• The goal is to define correct and efficient algorithms without having to implement and test them.

Remember: You cannot prove correctness by example!
Why take CS231?

Because ... It’s a major requirement!

Really, why?

- Understanding and Remembering:
  - Recognize algorithmic techniques used to solve a problem.
  - Identify the correctness, or lack thereof, of an algorithm.
- Critical Thinking:
  - Dissect new problems to identify their input and corresponding output.
- Practical Thinking:
  - Determine appropriate algorithmic techniques to solve new problems, by relating new problems to ones in their foundation knowledge.
  - Define correct algorithms to solve new problems and prove their correctness.
  - Critique existing algorithms.
  - Calculate the asymptotic run time complexity of new algorithms.
- Projects and Research:
  - Coordinate tasks and collaborate on writing a final paper.
  - Identify high quality scholarly articles, and their contributions.
  - Summarize existing algorithmic research on a topic of their choice.
  - Present summary of research to peers, as part of a team.
- Interpersonal Relationships:
  - Collaborate with peers on dissecting new problems.
  - Give feedback to peers on their proofs.
  - Take responsibility for work performed as part of a group.
Textbook


Class readings

• Your textbook is amazing, and it’s a great resource.

• In almost every lecture, there is required reading to be done before class.

• How should you do that reading before class?
  • First pass (no longer than 15 minutes)
    • Skim the required reading by reading the section and subsection titles, with the first paragraph or 2 of these sections
    • Goal: Know what we’ll talk about in class
  • Second pass (no longer than 45 minutes)
    • If you feel comfortable, read all English description paragraphs
    • Goal: Be familiar with the content, to identify points that you need to focus on in the lecture
  • Third pass (no longer than 1 hour)
    • Read the proofs
    • Goal: Good practice for more advanced parts of the course
Assignments

- **Schedule**
  - Posted on Thursday / Friday
  - Due the following Friday (at midnight)

- **Submission**
  - Write your assignments in latex, try overleaf.com
  - You will be provided with a Latex template every assignment
    - Template must be used as is
  - Upload pdf on your CS231 assignment link in Gradescope

- **Proof modules**
  - In some assignments, you will find a problem marked with [Proof-problem]
  - For these problems, you need to carefully formulate and write your arguments for the correctness of your solutions.

More on proof modules ...

- Your proofs will be reviewed by your peers through a two-step review process.

- This review process allows you to:
  - See other styles of proof writing
  - Critically read proofs
  - Clearly express your thoughts through your review

- The process is as follows:
  - On Friday, when the assignment is due, you will submit a hard copy of your proof
  - Don’t write your name, you will write a random number that will be picked in class
  - Each of you will be randomly assigned one of your peers proofs
  - The first round of reviews must be completed before the following class on Tuesday
  - On Tuesday, the submissions will be randomly distributed (again)
  - The second round of reviews must be completed before the next class on Friday

- Finally, after each of you gets your doubly peer-reviewed proof, you get a chance to edit your proof (if needed), and submit it to me the following Tuesday.
- I’ll grade it and return it to you the following Friday.
More on proof modules ...

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Assignment is due – Submit proof as hardcopy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Round 1 complete</td>
<td>Round 2 complete</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Submit final version</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How should I review a proof?

- We will practice how to read and write good proofs in the first 2 weeks of classes.

- Then, when reading a peer’s proof, you are asked to do the following:
  - Mark at least one thing that you liked
  - Mark at least one thing that needs improvement

- What does mark mean?
  - You will highlight at least one sentence in the proof
  - You will write a comment on that highlighted section
  - You will sign that comment with your random number
More ...

- All other assignment submissions will be done using Gradescope.
  - You’ll get an email this week.

- Assignments must be in PDF format, using Latex.
  - You can use overleaf.com

- Late submissions are not allowed, but you get (4) free passes to use throughout the semester.

- All communication will be done using Piazza.
  - You should have received an email this week.

Exams

- You’ll have two exams during the semester,
  - 1st exam on March 10th
  - 2nd exam on April 24th

- All exams are in-class and open book

- There will be no final exam.
  - Instead, there will be a final short paper and presentation.
CS231 course webpage

- It contains all course info
  - The schedule for the semester
  - Office hours discussion sections and help room
  - The course syllabus

- Make sure you check it often

- Let’s take a quick look

Now, let’s review some data structures

Remember arrays and linked lists? 😊