CS30 (Discrete Math in CS), Summer 2021 : Problem Set 0

Topic: Welcome!

Please Start Early!

Instructions

- ***Credit Statement:*** This is important! At the top of your answer-sheet, you **must** write a credit statement citing ***all*** the outside help you obtained for solving these problems. This includes : (a) The Instructor/TA Office Hours you used, (b) Classmates you talked to, (c) the "hints" provided to you on Canvas. **If this statement is missing, you will be docked 1 point.** And this 1 may become 2 the second time you miss, and then 3, and so on

  Why this statement you ask? This statement is more for **you** than for me. Acknowledging people who helped you is one of the gestures that will make you happier and it promotes a sense of collaboration. And let this become a habit in general and not just this course.

- *Presentation*: Your answers should satisfy the following three C's: they should be *Correct, Clear, Concise*.

  Don't *ramble*. Ideally, a grader should be able to read and completely understand any your answer to a single problem in *less than five minutes*. If they are not able to do so, then you risk getting a *straight zero*.

- *Submission:* Please submit all homework electronically in PDF format ***ideally*** typeset using LaTeX. Please try to be concise – as a rule of thumb do not take more than 1 (LaTeX-ed) page for a solution.

- *Collaboration Policy:* You are allowed to discuss with other students but are *not allowed* to exchange full solutions. At the beginning of each problem you must write who you discussed with, and what way did that person help you or you help them. This is important. If you did not talk with anyone about any of the problems, mention this at the beginning of the homework. You may not consult any solutions on the Internet or from previous years' assignments, whether they are student- or faculty-generated.

- *The Coffee Cups:* They show my very gross interpretation of how hard the problems are. A single ☕problem should be do-able under an hour (akin to a drill question). A two ☕☕, may be a couple of hours (either it is long or a trick involved). A ☕☕☕question may take four hours (a trick or two involved). Of course, this assumes you have followed the material and done the drills, etc. And these are just rules of thumb. If you find spending much more time than this, seek one of us out!

- **There are no late days available. So please start early!**

  As an incentive : if you submit more than 24 hours before the deadline, you get a **bonus** of +1 point (but one never gets more than 100%).

Problem 1. (**8 points**)
Below are four problems which you should be able to solve by the conclusion of this course. Some of them will be in your future problem sets or your tests. For now, read the problems below and write down your *current thoughts* on the problems. For example, you can write whether you understand the questions, any ideas how to tackle them, etc. You should not have to spend more than 10 minutes per problem. It is very hard *not* to get full points on this one.

a. Fatima works in an integrated chip company. One day, she gets a circular chip with 100 pins on it. All pairs of pins must be connected by straight line wires. Any time two wires are about to intersect, she needs to put in a plastic micro-clip to prevent them from contacting. The pins are such that no three wires intersect at the same point. How many such clips does she need to order from the factory?

b. Upon inspecting the spam folder of his email, Ganesh finds that 7 emails out of the 100 emails there are actually not spam. He researches a bit and finds that his email server's spam filter claims a false positive of less than 1%. That is, given any random email, if it is not spam then there is less than 1% chance the server puts it in the spam folder. Is Ganesh's email server lying? If not, how can you help Ganesh reconcile with the fact that he is seeing around 7% non-spam (significantly higher than 1%) in his spam folder?

c. Heather manages the centralized system which assigns medical residents with hospitals in the New England region. Every hospital declares their capacity, that is, the maximum number of residents they can intake, while every resident gives their preference of which hospitals they are willing to go to. Heather wonders if *every* resident can be matched to one of their preferred hospitals taking care not to overshoot the capacities of any hospital. Is this always possible? Can you figure out when or when not?

d. Irene wonders what the remainder is when 10^{1000} is divided by 31? Can you figure this out? Also, can you think how such questions may be relevent in computer science?

Problem 2. (**2 points**) ☕
Go an fill up the anonymous Google form at `https://forms.gle/LF2LKWLpvBMJxTrSA` After doing so, please reply "I have filled the Google Form" to obtain your 2 points.