CS 170 Homework 0

Due **1/24/2022, at 10:00 pm (grace period until 11:59pm)**

1 Study Group

List the names and SIDs of the members in your study group. If you have no collaborators, you must explicitly write none.

In addition, we would like to share correct student solutions that are well-written with the class after each homework. Are you okay with your correct solutions being used for this purpose? Answer “Yes”, “Yes but anonymously”, or “No”

2 Course Policies

(a) What dates and times are the exams for CS170 this semester? Are there planned alternate exams?

Note: We will make accommodations for students in faraway timezones.

Solution:

(a) **Midterm 1**: Wednesday 2/23, 8:00pm - 10:00pm PST
(b) **Midterm 2**: Tuesday 4/5, 8:00pm - 10:00pm PST
(c) **Final**: Wednesday 5/11, 11:30am - 2:30pm PST

We do not plan on offering alternate exams.

(b) Homework is due Mondays at 10:00pm, with a late deadline at 11:59pm. At what time do we recommend you have your homework finished?

Solution: 10:00pm

(c) We provide 2 homework drops for cases of emergency or technical issues that may arise due to homework submission. If you miss the Gradescope late deadline (even by a few minutes) and need to submit the homework, what should you do?

Solution: The 2 homework drops are provided in case you have last minute issues and miss the Gradescope deadline. Homework extensions are not granted because solutions need to be released soon after the deadline, and so you do nothing.

(d) What is the primary source of communication for CS170 to reach students? We will email out all important deadlines through this medium, and you are responsible for checking your emails and reading each announcement fully.

Solution: The primary source of communication is Piazza.

(e) Please read all of the following:

(i) **Syllabus and Policies:** `https://cs170.org/syllabus/`

(ii) **Homework Guidelines:** `https://cs170.org/resources/homework-guidelines/`

(iii) **Regrade Etiquette:** `https://cs170.org/resources/regrade-etiquette/`

(iv) **Piazza Etiquette:** `https://cs170.org/resources/piazza-etiquette/`

Once you have read them, copy and sign the following sentence on your homework submission.

"I have read and understood the course syllabus and policies."

Solution: I have read and understood the course syllabus and policies. -Alan Turing

3 Understanding Academic Dishonesty

Before you answer any of the following questions, make sure you have read over the syllabus and course policies (`https://cs170.org/syllabus/`) carefully. For each statement below, write *OK* if it is allowed by the course policies and *Not OK* otherwise.

(a) You ask a friend who took CS 170 previously for their homework solutions, some of which overlap with this semester's problem sets. You look at their solutions, then later write them down in your own words.

Solution: Not OK

(b) You had 5 midterms on the same day and are behind on your homework. You decide to ask your classmate, who's already done the homework, for help. They tell you how to do the first three problems.

Solution: Not OK.

(c) You look up a homework problem online and find the exact solution. You then write it in your words and cite the source.

Solution: Not OK. As a general rule of thumb, you should never be in possession of any exact homework solutions other than your own.

(d) You were looking up Dijkstra's on the internet, and run into a website with a problem very similar to one on your homework. You read it, including the solution, and then you close the website, write up your solution, and cite the website URL in your homework writeup.

Solution: OK. Given that you'd inadvertently found a resource online, clearly cite it and make sure you write your answer from scratch.

4 In Between Functions

Find a function $f(n) \geq 0$ such that:

- For all $c > 0$, $f = \Omega(n^c)$

- For all $\alpha > 1$, $f = \mathcal{O}(\alpha^n)$

Give a proof for why it satisfies both these properties.

Solution: Let $f(n) = 2^{(\log n)^2}$.

- For any $n^c = 2^{c \log n}$, this is eventually dominated by $2^{(\log n)\cdot(\log n)}$. So $f(n) = \Omega(n^c)$ for any $c > 0$.
- For any $\alpha^n = \left(2^{\log \alpha}\right)^n = 2^{n \cdot \log \alpha}$, this will dominate $2^{(\log n)^2}$ (so long as $\log \alpha$ is positive). So $f(n) = \mathcal{O}(\alpha^n)$ for any $\alpha > 1$.

This shows that there can be algorithms whose running time grows faster than any polynomial but slower than any exponential.

In other words, there exists a region between polynomial-time and exponential-time.

5 Asymptotic Bound Practice

Prove that for any $\epsilon > 0$ we have $\log x \in O(x^\epsilon)$.

Solution:

Observe that $x > \log x \forall x > 0$. We can see this by taking finding the minimum of the function $x - \log x$ over the range $(0, \inf)$ using some calculs (find the critical points, then check concavity). The minimizing x is 1, with value 1.

If $x > \log x$, then we have that $\log x^\epsilon < x^\epsilon$, and therefore $\epsilon \log x < x^\epsilon$. It follows that a constant factor times x^ϵ is always larger than $\log x$ for $x > 0$. This proves $\log x \in O(x^\epsilon)$.

Here is an alternate argument, using l'Hopital's rule:

$$\begin{aligned}
\lim_{x\to\infty} \frac{\log x}{x^\epsilon} &= \lim_{x\to\infty} \frac{\frac{d}{dx}\log x}{\frac{d}{dx}x^\epsilon} \\
&= \lim_{x\to\infty} \frac{\frac{1}{x}}{\epsilon x^{\epsilon-1}} \\
&= \lim_{x\to\infty} \frac{1}{\epsilon x^\epsilon} = 0
\end{aligned}$$

And so therefore $\log x \in O(x^\epsilon)$.