CSCI 3104 Spring 2023
Instructor: Prof. Ryan Layer and Chandra Kanth Nagesh

Quiz 5 Standard 5 - Exchange Arguments

Due Date ..... TODO
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Quiz Code (enter in Canvas to get access to the LaTeX template) ..... **JUHGD**

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Instructions

- You may either type your work using this template, or you may handwrite your work and embed it as an image in this template. **If you choose to handwrite your work, the image must be legible, and oriented so that we do not have to rotate our screens to grade your work.** We have included some helpful LaTeX commands for including and rotating images commented out near the end of the LaTeX template.
- You should submit your work through the **class Gradescope page** only. Please submit one PDF file, compiled using this LaTeX template.
- You may not need a full page for your solutions; pagebreaks are there to help Gradescope automatically find where each problem is. Even if you do not attempt every problem, please submit this document with no fewer pages than the blank template (or Gradescope has issues with it).
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Problem HC.

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- Any collaborations and external sources have been clearly cited in this document.
- I have not posted to external services including, but not limited to Chegg, Reddit, StackExchange, etc.
- I have neither copied nor provided others solutions they can copy.

Agreed (I agree to the above, Blake Raphael). □

5 Standard 5 - Exchange Arguments (4 points)

Problem 5. Consider the interval scheduling problem from class. You are given a set of intervals $\mathcal{I}$, where each interval has a start and finish time $[s_i, f_i]$. Your goal is to select a subset S of the given intervals such that (i) no two intervals in S overlap, and (ii) S contains as many intervals as possible subject to condition (i).

Suppose we have two intervals with the same start time but different finish times. That is, let $I_1 = [s, f_1]$ and $I_2 = [s, f_2]$ with $f_2 > f_1$.

(a) Let overlap($[s, f]$) denote the number of intervals of $\mathcal{I}$ (other than $[s, f]$) with which $[s, f]$ overlaps. Explain carefully why overlap(I_1) $\leq$ overlap(I_2).

Answer. overlap(I_1) has, by definition, less time in it's interval to overlap (as $f_2 > f_1$).
So with this information, we know that $I_2 > I_1$, so overlap(I_1) would be less than or equal to overlap(I_2) since there is less interval of I_1 to overlap with.

□

(b) Suppose that overlap(I_1) $<$ overlap(I_2). Suppose $S \subseteq \mathcal{I}$ is a non-overlapping set of intervals containing I_2. Explain carefully why $(S \backslash \{I_2\}) \cup \{I_1\}$ is another set of non-overlapping intervals, no smaller than S.

Answer. We know that $S \subseteq \mathcal{I}$ contains I_2.
We also know that overlap(I_1) $<$ overlap(I_2).
Since set S is a non-overlapping set, and the overlap of I_1 is less than that of I_2, when we union the two sets, there are less overlaps, meaning more intervals that can be added without overlap. This means that $(S \backslash \{I_2\}) \cup \{I_1\}$ is no smaller than S, even with the exclusion of I_2.

□