CSP203: Software Tools & Technologies Lab

Lab-10: Practice Problems (LaTeX)

Date: 1-Oct-2024

Instructions:

1. Try to complete lab problems during the lab hour and submit it through canvas.
2. Prepare all your solution files in a zip file and name it as <ROLLNO.zip> and submit on canvas.

Setting up LaTeX:

Please follow the below instructions to set up LaTeX in your laptop.

1. sudo apt update
2. sudo apt install texlive-latex-extra -y
3. sudo apt install texstudio

Question-1: Use Latex to generate the following content in the pdf format.

Exercise 3.2. What is an example of a proof with mathematical content?

Solution:

Proof. If you want to include math in a sentence, you use $. For example (see latex file), $\int x = \frac{1}{2}x^2 + C$. If you want to display math (centered on a new line), use $$. For example (see latex file),

$$\sum_{i=1}^{100} i = 5050.$$

Next is an example of the `align` environment:

$$\begin{aligned}
\sum_{i=1}^{k+1} i &= \left(\sum_{i=1}^{k} i\right) + (k+1) \\
&= \frac{k(k+1)}{2} + k + 1 && \text{(by inductive hypothesis)} \\
&= \frac{k(k+1) + 2(k+1)}{2} \\
&= \frac{(k+1)(k+2)}{2} \\
&= \frac{(k+1)((k+1)+1)}{2}.
\end{aligned}$$

Question-2: Use latex to generate the following text in the pdf format.

Each of the exercises below involves a choice among the master theorem templates discussed in lecture. For each, indicate which case applies and specify the asymptotic growth class of the function. If no case applies, simply state that fact; you are not required to attempt a solution when no master theorem case applies.

1. $T(n) = 2T(\lfloor n/4 \rfloor) + n^{1/2}$.
2. $T(n) = 3T(\lfloor n/2 \rfloor) + n \lg n$.
3. $T(n) = 5T(\lfloor n/5 \rfloor) + \frac{n}{\lg n}$.
4. $T(n) = 4T(\lfloor n/2 \rfloor) + n^2\sqrt{n}$.
5. $T(n) = 2T(\lfloor n/2 \rfloor) + n \lg n$.

Solutions.

$a = 3, b = 2$ implies a reference function $g(n) = n^{\log_2 3}$. Converting as follows,

$$\begin{aligned} y &= \log_2 3 \\ 2^y &= 3 \\ y \ln 2 &= \ln 3 \\ y &= \frac{\ln 3}{\ln 2} = 1.585, \end{aligned}$$

we have $g(n) = n^{1.585}$. The "glue" function is $f(n) = n \lg n$. Let $g_\epsilon(n) = n^{1.585-\epsilon}$, for $0 < \epsilon < 0.5$. Since

$$\begin{aligned} \frac{f(n)}{g_\epsilon(n)} &= \frac{n \lg n}{n^{1.585-\epsilon}} = \frac{\lg n}{n^{0.585-\epsilon}} \\ &\leq \frac{\lg n}{n^{0.085}} \to 0 \end{aligned}$$

as $n \to \infty$, we have $f(n) = o(g_\epsilon(n))$, which implies $f(n) = O(g_\epsilon(n))$ and allows case (1) of the master template. Therefore $T(n) = \Theta(g(n)) = \Theta(n^{1.585})$.