

**University of Waterloo**  
**CS240 Spring 2022**  
**Tutorial 00**

## **1 Mathematics**

Write a proof showing that  $\log(n!) \in O(n \log n)$ .

The definition of  $n!$  tells us that:

$$\log(n!) = \log(n * (n - 1) * (n - 2) \dots (2) * (1))$$

We can also make the observation that for some integer  $k > 1$ :

$$(n - k) \leq n \quad \forall n \geq 1$$

Therefore we get that:

$$\log(n!) \leq \log(n * (n) * (n) \dots (n) * (n)) \quad \forall n \geq 1$$

$$\log(n!) \leq \log(n^n) \quad \forall n \geq 1$$

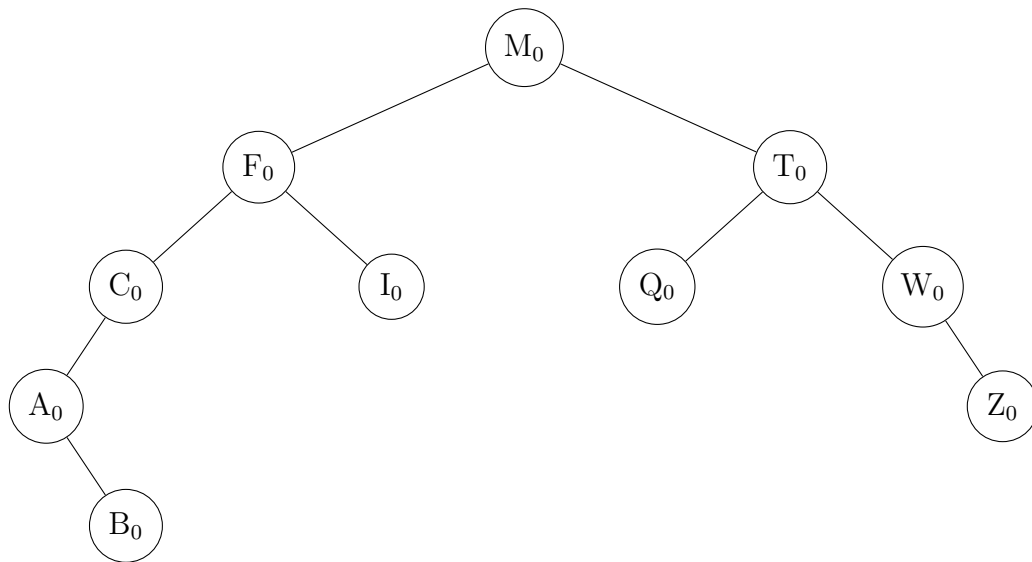
By our log rules this simplifies to:

$$\log(n!) \leq n \log(n) \quad \forall n \geq 1$$

Thus  $n_0 = 1$ , which proves that  $\log(n!) \in O(n \log n)$ .

## 2 Trees

We will add the letters Z, A, and B to the BST below.

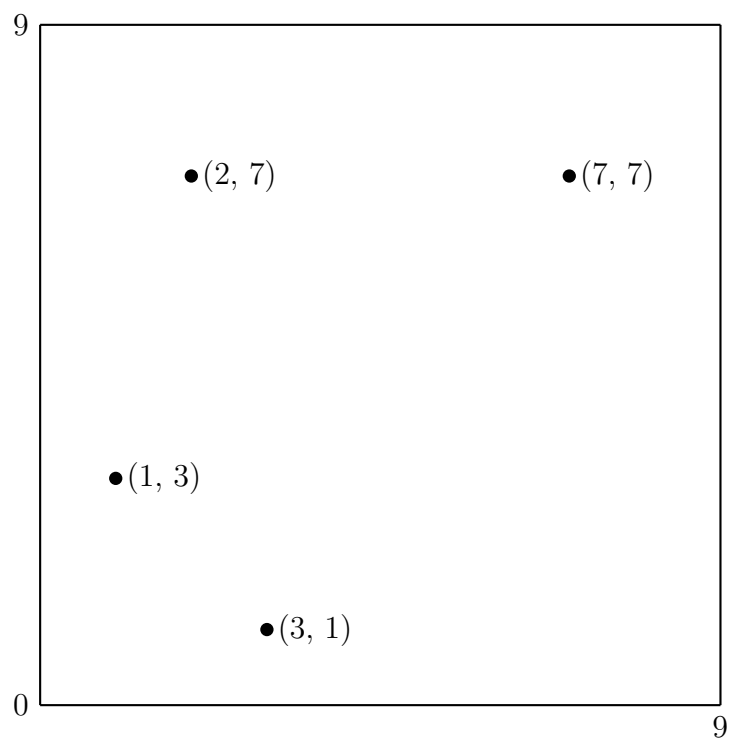


*Hint: For nodes with only one child, you may wish to use “child[missing]” for the non-existent child.*

### 3 Plots

Plot the following points below. Only show the resulting plot.

Points:  $(2,7)$ ,  $(1,3)$ ,  $(3,1)$ ,  $(7,7)$



### 4 Latex Resources

L<sup>A</sup>T<sub>E</sub>X Editors

- a) TeX Live: <https://www.tug.org/texlive/>
- b) TeXstudio: <https://www.texstudio.org/>
- c) Overleaf: <https://www.overleaf.com/>
- d) pdflatex: on the student environment

Miscellaneous Resources

- <http://detexify.kirelabs.org/classify.html>
- [https://oeis.org/wiki/List\\_of\\_LaTeX\\_mathematical\\_symbols](https://oeis.org/wiki/List_of_LaTeX_mathematical_symbols)
- <https://en.wikibooks.org/wiki/LaTeX>
- <https://tex.stackexchange.com/>