

# Lab 3

Due Monday, February 26 by 10:00pm

Handout 7  
CSCI 334: Spring 2024

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## Coding Guidelines

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Each question in this assignment must be written using  $\LaTeX$ . I provide a  $\LaTeX$  template in your repository for you to use to get started.

It is likely that you have not used  $\LaTeX$  before. Treat this homework as you would with any other new programming language: make small changes and compile frequently using `pdflatex`. The template I provide compiles without error as-is. For full credit, you must submit both your `.tex` source file as well as the rendered `.pdf` file. (5 points) Your source file should be called `lab-3.tex` and your PDF should be called `lab-3.pdf`. (5 points) Your source file should compile without error. (5 points)

To draw trees, please use the `forest` package. The supplied  $\LaTeX$  template includes an example for you to start with and modify.

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## Turn-In Instructions

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Turn in your work using the `git` repository assigned to you. The name of the `git` repository will have the form `https://aslan.barowy.net/cs334-s24/cs334-lab03-<USERNAME>.git`. For example, if your CS username is `abc1`, the repository would be `https://aslan.barowy.net/cs334-s24/cs334-lab03-abc1.git`.

You should have received an invite to commit to the repository via email. If you did not receive an email, please contact me right away!

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## Single-Author Programming Assignment

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This is a solo lab. You may work with another classmate to understand what the problems ask, but you are not permitted to develop solutions together. Submitted solutions must be exclusively your own. Please refer to the section “single author programming assignments” in the honor code handout for additional information. You do not need to submit a `collaborators.txt` file for this assignment. You are always welcome to ask me for clarification if the above is unclear in some circumstance.

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## Reading

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1. (Required) “Syntax”
2. (Required) “Introduction to the Lambda Calculus, Part 1”
3. (Optional) “Introduction to  $\LaTeX$ ”

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## Problems

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**Q1.** (25 points) ..... Parse Tree

Draw the derivation tree for the expression “ $1 - 5 + 24$ ”. Is there another derivation for “ $1 - 5 + 24$ ”? If so, draw the other tree. Refer to the grammar at the top of the section titled Ambiguity in the reading “Syntax.”

**Q2.** (30 points) ..... Handling Ambiguity

Draw derivation trees for the following expressions, assuming the precedence and associativity rules shown in Table 2 of the reading, “Syntax.”

(a)  $1 + 1 * 1$

(b)  $1 + 1 - 1$

(c)  $1 - 1 + 1 - 1 * 1$ , but give  $+$  higher precedence than  $-$ .

**Q3.** (30 points) ..... Parsing Lambda Expressions

Given the following grammar for the lambda calculus,

```
<expression> ::= <variable>
               | <abstraction>
               | <application>
               | <parens>

<variable>    ::= x | y
<abstraction> ::=  $\lambda$ <variable>.<expression>
<application> ::= <expression><expression>
<parens>      ::= (<expression>)
```

draw derivation trees for the following expressions. You may need to refer to the reading for additional parsing rules.

(a)  $\lambda x.xy$

(b)  $\lambda x.x\lambda y.xx$

(c)  $(\lambda x.\lambda y.xy)(\lambda x.xy)$

**Q4.** ( $\frac{1}{10}$ <sup>th</sup> bonus point) ..... Optional: Feedback

I always appreciate hearing back about how easy or difficult an assignment is.

For  $\frac{1}{10}$ <sup>th</sup> of a bonus to your final grade, please fill out the following Google Form.