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CS 331 - Programming Languages
Assignment 1

Exercise A

$\boxed{\text{“BE SURE TO DRINK YOUR OVALTINE”}}$

Exercise B

:)

Exercise C

1. Although the use of `let` allows for more dynamic typing, Swift primarily uses static typing.
2. This means that type checking is done in the static context - before runtime. Errors about invalid typing are thrown before the program ever executes.

Exercise D

The grammar can be also represented with the regular expression $ro*z+$

The grammar contains the strings $\boxed{\text{1, 3, and 5}}$.

Exercise E

This language contains all strings that start with n many pairs of a's (aa), where n is greater than or equal to 0, followed by zero or more c's, and ended by n many pairs of b's (bb).

Exercise F

The regular expression $x*(ab \mid c)*$ contains the strings labeled $\boxed{\text{1, 3, 4, 5, and 7}}$.

Exercise G

This regular expression matches all strings that have any number of a's, b's, and c's and also have one b, by matching the arbitrary set of $[abc]$ on either side of a singular b.

$$\boxed{(a \mid b \mid c)*b(a \mid b \mid c)*}$$

Exercise H

1. No, this grammar contains the rule $S \to SaS$ which is not one of the accepted forms of productions for a regular grammar. We have to track how many S's are generated on both sides of the a.
2. Yes, this grammar is context-free as all of its productions' left sides contain a single non-terminal.

3. Leftmost:

$$\boxed{\begin{array}{l} S \\ SaS \\ baS \\ bab \end{array}}$$

4. Rightmost:

$$\boxed{\begin{array}{l} S \\ SaS \\ Sab \\ bab \end{array}}$$

5. The string $babab$ has two different parse trees.

Parse tree one:

$$\begin{tikzcd}
 & & S \arrow[dl] \arrow[d] \arrow[dr] & \\
 & S \arrow[dl] \arrow[d] \arrow[dr] & a & S \arrow[d] \\
S \arrow[d] & a & S \arrow[d] & X \arrow[d] \\
X \arrow[d] & & X \arrow[d] & b \\
b & & b &
\end{tikzcd}$$

Parse tree two:

$$\begin{tikzcd}
 & S \arrow[dl] \arrow[d] \arrow[dr] & & \\
S \arrow[d] & a & S \arrow[dl] \arrow[d] \arrow[dr] & \\
X \arrow[d] & S \arrow[d] & a & S \arrow[d] \\
b & X \arrow[d] & & X \arrow[d] \\
 & b & & b
\end{tikzcd}$$

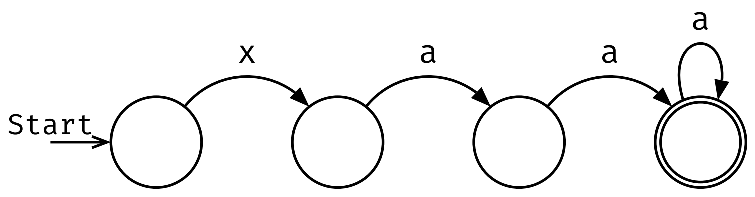
6. $$\boxed{\begin{array}{l} S \to bA \\ A \to aS \mid \varepsilon \end{array}}$$

This is non-ambiguous as all derivations generate right-most derivations.

Exercise E

1. $\boxed{xaa+}$

2.



3. $$\boxed{\begin{array}{l} S \to xaaA \\ A \to a \mid \varepsilon \end{array}}$$

4. No, the grammar is not ambiguous as any derivation will always contain the first step, followed by n many additional of the second steps for any number of a's needed past two a's. Since there are

only two possible productions for A, and one of them is the empty string ε, there are no alternative ways to construct a string in the language from this grammar.

Exercise J

The provided statements are given (NOT IN BNF FORM!!!):

```
<uc-letter> ::= A-Z
<lc-letter> ::= a-z
```

My solution is:

```
       <name> ::= <real-name> <middle-name> <real-name>
  <real-name> ::= <uc-letter> <lc-letter> <lc-tail>
    <lc-tail> ::= <lc-letter> <lc-tail> | ""
<middle-name> ::= " " | " " <uc-letter> ". "
```

Note: " " is a single space character and "" is the empty string.