

Programming Language Concepts Homework 3

Due Wednesday Oct 2; Joseph Sepich (jps6444)

1 Problem 1

1.1 Part 1

$L(R) = (a|b)(a|b)(a|b)$

1. "aaa"
2. "aab"
3. "aba"
4. "abb"
5. "baa"
6. "bab"
7. "bba"
8. "bbb"

1.2 Part 2

$L(R) = a(aa|bb)^*b$

This set will be infinite, so I will write down the 7 shortest.

1. "ab"
2. "aaab"
3. "abbb"
4. "aaaaab"
5. "aaabbb"
6. "abbbbb"
7. "aaaaaaab"

2 Problem 2

2.1 Part 1

Write a regular expression with non empty binaries that start and end with the same digit.

$L(R) = ((1(1|0)^*1)|(0(1|0)^*0))$

2.2 Part 2

Write a regular expression for declarations of variables of type int.

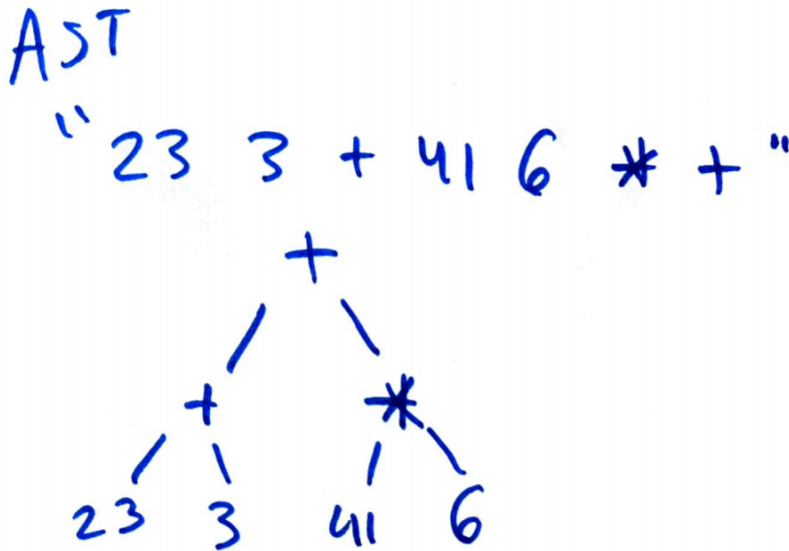
$L(R) = \text{int} \backslash sID(, ID)^*(ID|N)(, (ID|N))^* ;$

3 Problem 3

3.1 Part a

$\text{Expr} \rightarrow \text{Expr Expr} - \mid \text{Expr Expr} + \mid \text{Expr Expr} * \mid \text{Expr Expr} / \mid N$

3.2 Part b



3.3 Part c

$\text{Expr} \rightarrow \text{Expr Expr} + \rightarrow \text{Expr Expr Expr} * + \rightarrow \text{Expr Expr N} * + \rightarrow$
 $\text{Expr N N} * + \rightarrow \text{Expr Expr} + \text{N N} * + \rightarrow \text{Expr N} + \text{N N} * + \rightarrow$
 $\text{N N} + \text{N N} * + \rightarrow \text{N N} + \text{N 6} * + \rightarrow \text{N N} + 41 6 * + \rightarrow$
 $\text{N 3} + 41 6 * + \rightarrow 23 3 + 41 6 * +$

4 Problem 4

$\text{Paren} \rightarrow \epsilon \mid \text{Paren } () \mid () \text{Paren} \mid (\text{Paren})$

5 Paroblem 5

5.1 Part a

This language is ambiguous. The definition of F has it on either side of an operator. A revised unambiguous grammar would be:

```
E -> E + F | F
F -> F * G
G -> Id | (E)
```

This creates a left associativity in the grammar for both the $+$ and $*$ multipliers, and the $+$ multiplier has a lower precedence.

5.2 Part 2

This language is unambiguous. The union operator has a lower precedence than the intersection operator. The union operator has right associativity and the intersection operator has a left associativity.