

16/04/2024

Midterm Exam

Duration: 90 minutes

Name: Solutions

Student No:

P1 [20 points]

1. Which of the following is NOT a criterion for evaluating programming languages? (a) Efficiency (b) Reliability (c) Documentation (d) Orthogonality

2. Which of the following is a major benefit of readability? (a) Reduced debugging time (b) Increased program size (c) Faster execution speed (d) Improved programmer morale

3. Which of the following languages was designed with orthogonality as a primary criterion? (a) COBOL (b) PL/I (c) ALGOL 68 (d) C++

4. Which of the following is a common programming statement that is bad for readability? (a) if-then-else (b) for loop (c) while loop (d) switch statement
5. Which of the following is a major disadvantage of having too many features in a language? (a) Increased complexity (b) Reduced efficiency (c) Difficulty in learning (d) All of the above

6. Which language was designed specifically for the development of artificial intelligence applications? (a) Lisp (b) Prolog (c) SQL (d) Haskell

7. Which of the following is NOT a common extension to EBNF? (a) Repetition (b) Optional parts (c) Multiple-choice options (d) Inheritance

8. Which of the following is a purpose of predicates in attribute grammars? (a) To define attributes (b) To evaluate attributes (c) To constrain attribute values (d) To generate code
9. Which of the following tasks is NOT performed by a lexical analyzer? (a) Character classification (b) Tokenization (c) Parsing (d) Symbol table management

10. Which of the following is a major advantage of dynamic scoping? (a) Flexibility in program design (b) Improved readability (c) Reduced debugging time (d) All of the above

1. ☐ A ☐ B ☒ C ☐ D

2. ☒ A ☐ B ☐ C ☐ D

3. ☐ A ☐ B ☒ C ☐ D

4. ☐ A ☐ B ☐ C ☒ D

5. ☐ A ☐ B ☐ C ☒ D

6. ☒ A ☐ B ☐ C ☐ D

7. ☐ A ☐ B ☐ C ☒ D

8. ☐ A ☐ B ☒ C ☐ D

9. ☐ A ☐ B ☒ C ☐ D

10. ☒ A ☐ B ☐ C ☐ D

P2 [10 points] Compute the weakest precondition for each of the following sequences of assignment statements and their postconditions:

(a)  $a = 2 * b + 3;$   
 $b = a + 3 * b$   
 $\{b > 13\}$

$2b + 3 + 3b = 5b + 3 > 13$   
 $b > 2$

(b)  $a = 2 * (b + a);$   
 $b = 5 * a - 1$   
 $\{b < 9\}$

$5(2b + 2a) - 1 < 9$   
 $10a + 10b < 10$   
 $a + b < 1$

P3 [10 points] Write a regular expression that matches the pattern of a valid email address. Assume that an email must look like a@a.a or a@a.a.a (you can assume a can be any alphanumeric string)

Assuming  $S = (a-zA-Z)(a-zA-Z0-9)^*$ ,  $\backslash S @ \backslash S . \backslash S (\backslash S)?$   
alphanumeric string  
(\ is just character)

P4 [10 points] Consider the following grammar and find out which of the following strings are in the language generated by this grammar? (Circle correct options.)

- $\langle S \rangle \rightarrow a \langle S \rangle b \mid b \langle S \rangle a \mid \langle S \rangle \langle S \rangle \mid \epsilon$

(equal # of as & bs)
- baaab ☐ Yes ☒ No

abba ☒ Yes ☐ No

baaaabb ☐ Yes ☒ No

aababbab ☒ Yes ☐ No

P5 [30 points] Consider the following grammar:

$\langle \text{Expr} \rangle \rightarrow \langle \text{Expr} \rangle ? \langle \text{Expr} \rangle : \langle \text{Expr} \rangle \mid \langle \text{id} \rangle$

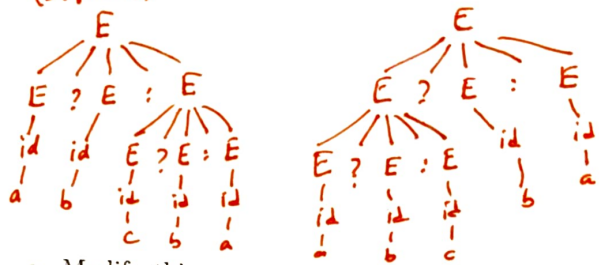
$\langle \text{id} \rangle \rightarrow a \mid b \mid c$

a. Write a leftmost derivation for the string  $a?b:c$

$\langle \text{Expr} \rangle \rightarrow \langle \text{Expr} \rangle ? \langle \text{Expr} \rangle : \langle \text{Expr} \rangle$   
 $\rightarrow \langle \text{id} \rangle ? \langle \text{Expr} \rangle : \langle \text{Expr} \rangle$   
 $\rightarrow a ? \langle \text{Expr} \rangle : \langle \text{Expr} \rangle$   
 $\rightarrow a ? \langle \text{id} \rangle : \langle \text{Expr} \rangle$   
 $\rightarrow a ? b : \langle \text{Expr} \rangle$   
 $\rightarrow a ? b : \langle \text{id} \rangle$   
 $\rightarrow a ? b : c$

b. Prove that the grammar is ambiguous.

Parse tree for  $a?b:c?b:a$  can be both:  
( $\text{Expr} = E$ )



c. Modify this grammar so that it is no longer ambiguous.

$\langle \text{Expr} \rangle \rightarrow \langle \text{id} \rangle ? \langle \text{Expr} \rangle : \langle \text{Expr} \rangle \mid \langle \text{id} \rangle$   
 $\langle \text{id} \rangle \rightarrow a \mid b \mid c.$

OR

$\langle \text{Expr} \rangle \rightarrow \langle \text{Expr} \rangle ? \langle \text{Expr} \rangle : \langle \text{id} \rangle \mid \langle \text{id} \rangle$   
 $\langle \text{id} \rangle \rightarrow a \mid b \mid c.$

P6 [20 points] Consider the grammar and the corresponding LR parsing table from the textbook. Write the trace of a parse of the string  $(id+id+id)$

1.  $E \rightarrow E + T$
2.  $E \rightarrow T$
3.  $T \rightarrow (E)$
4.  $T \rightarrow id$

State	Action					GoTo	
	id	+	(	)	\$	E	T
0	S4		S3			1	2
1		S5			accept		
2	R2	R2	R2	R2	R2		
3	S4		S3			6	2
4	R4	R4	R4	R4	R4		
5	S4		S3				8
6		S5		S7			
7	R3	R3	R3	R3	R3		
8	R1	R1	R1	R1	R1		

Stack	Input	Action
0	(id+id+id)\$	S3
0(3	id+id+id)\$	S4
0(3 id 4	+id+id)\$	R4
0(3 T 2	+id+id)\$	R2
0(3 E 6	+id+id)\$	S5
0(3 E 6 + 5	id+id)\$	S4
0(3 E 6 + 5 id 4	+id)\$	R4
0(3 E 6 + 5 T 8	+id)\$	R1
0(3 E 6	+id)\$	S5
0(3 E 6 + 5	id)\$	S4
0(3 E 6 + 5 id 4	)\$	R4
0(3 E 6 + 5 T 8	)\$	R1
0(3 E 6	)\$	S7
0(3 E 6 ) 7	\$	R3
0 T 2	\$	R2
0 E 1	\$	accept.