



## American Computer Science League

2019-2020

Contest #3

### INTERMEDIATE DIVISION

#### 1. Boolean Algebra

How many ordered triples make the following expression FALSE?

$$A(\bar{B} + C) + B(A + \bar{C}) + \bar{ABC}$$

1.

#### 2. Boolean Algebra

Simplify the following expression:

$$\overline{A(B+C)} + \bar{B}(\bar{A}+C)$$

2.

#### 3. Data Structures

How many nodes have only one child in the binary search tree for:

WINDSORCONNECTICUT

3.

#### 4. Data Structures

Given an initially empty stack and the following commands on the stack, what will the next popped item be?

PUSH(T), PUSH(H), PUSH(E), PUSH(K), POP(X), POP(X),  
PUSH(I), PUSH(N), POP(X), PUSH(G), PUSH(A), PUSH(N),  
POP(X), POP(X), POP(X), PUSH(D), PUSH(I), POP(X), POP(X).

4.



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**5. FSA's and Regular Expressions**

5.

Which of the following strings can be produced by the following regular expression?

a b \* b a a \* b a a

- A. a b a b a a
  - B. a a b b b a a a a b b a a
  - C. a b a a a b b a a
  - D. a b b b b a b a
  - E. a b b b b a a a b a a
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### INTERMEDIATE DIVISION SOLUTIONS

#### 1. Boolean Algebra

$$\begin{aligned} A(\bar{B} + C) + B(A + \bar{C}) + \bar{A}\bar{B}\bar{C} \\ = A\bar{B} + AC + AB + B\bar{C} + \bar{A} + \bar{B} + \bar{C} \\ = \bar{A} + A\bar{B}(A + 1) + \bar{C}(B + 1) + AC + AB \\ = \bar{A} + \bar{B} + \bar{C} + A(B + C) \\ \bar{A} + \bar{B} + \bar{C} + A(B + C) = 0 \\ \rightarrow \bar{A} = 0 \wedge \bar{B} = 0 \wedge \bar{C} = 0 \wedge A(B + C) = 0 \\ \rightarrow A = 1 \wedge B = 1 \wedge C = 1 \wedge 1 * (1 + 1) = 0 \\ \text{which is impossible} \end{aligned}$$

So none make it FALSE

1. 0

#### 2. Boolean Algebra

$$\begin{aligned} \overline{A(B+C)} + \bar{B}(\bar{A}+C) \\ = \bar{A} + \overline{B+C} + \bar{A}\bar{B} + \bar{B}C \\ = \bar{A} + \bar{B}\bar{C} + \bar{A}\bar{B} + \bar{B}C \\ = \bar{A} + \bar{B}(\bar{C} + \bar{A} + C) \\ = \bar{A} + \bar{B} \text{ or } \bar{A}\bar{B} \end{aligned}$$

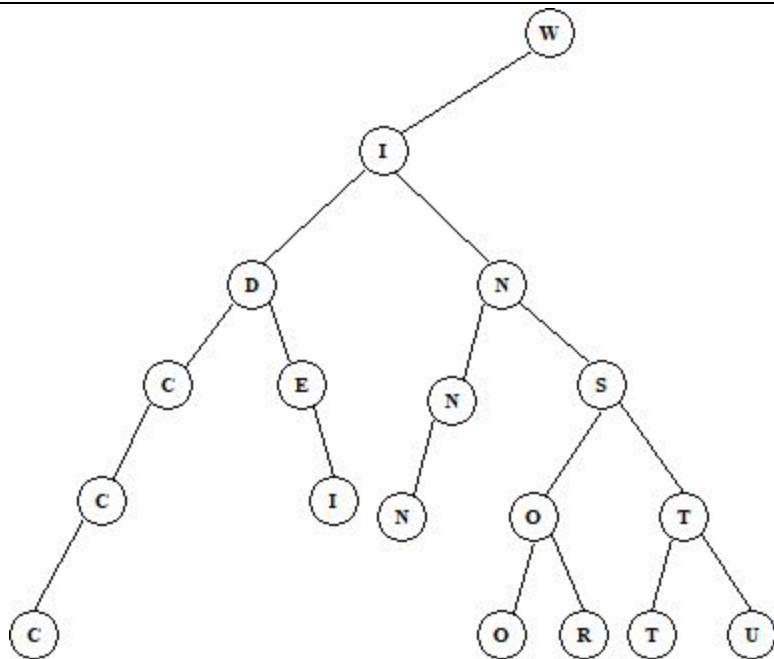
2.  $\bar{A} + \bar{B}$  or  $\bar{A}\bar{B}$

#### 3. Data Structures

There are 5 with only 1 child: W, C, E, N, C.

The following is the binary search tree for:  
WINDSORCONNECTICUT

3. 5

**INTERMEDIATE DIVISION SOLUTIONS****4. Data Structures****4. I**

The stack is constructed using LIFO as follows:

T, TH, THE, THEK, THE, TH, THI, THIN, THI, THIG,  
THIGA, THIGAN, THIGA, THIG, THI, THID, THIDI,  
THID, THI

The next item popped would be I.

**5. FSA's and Regular Expressions****5. A, E**

Regular expression: a b \* b a a \* b a a

The string must start with a single “a” which eliminates B.

It must end with “a b a a” which eliminates C and D.

Both A and E can be formed from the expression.