

American Computer Science League

2018-2019

Intermediate Division Short Round Solutions

All-Star Contest

1. Boolean Algebra

$$\begin{aligned}
 & (\bar{A}B + C)(\overline{AB + C})(\bar{A}\bar{B} + C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= (\bar{A}B + C)(\bar{A}\bar{B}\bar{C})(\bar{A}\bar{B} + C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= (\bar{A}B + C)((\bar{A} + \bar{B})\bar{C})(\bar{A}\bar{B} + C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= (\bar{A}B + C)(\bar{A}\bar{C} + \bar{B}\bar{C})(\bar{A}\bar{B} + C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= (\bar{A}BC + \bar{A}B\bar{B}\bar{C} + \bar{A}C + \bar{B}C\bar{C})(\bar{A}\bar{B} + C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= (\bar{A}BC + \bar{A}C)(\bar{A}\bar{B} + C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= (\bar{A}\bar{B}C + \bar{A}C)(A\bar{B} + C)(AB + \bar{C}) \\
 &= \bar{A}C(AB + \bar{C}) = 0
 \end{aligned}$$

Since this is always 0, no ordered triple makes it TRUE. Therefore D.

D. 0

2. Bit-String Flicking

$$(\text{LCIRC-1 } x) \text{ AND } (\text{RSHIFT-2 } x) = 001101$$

Let $x = abcdef$

$$\text{LHS} = (\text{LCIRC-1 } abcdef) \text{ AND } (\text{RSHIFT-2 } abcdef)$$

$$= bcdefa \text{ AND } 00abcd$$

$$= 00adbe cf ad$$

$$\text{LHS} = \text{RHS} \Rightarrow 00adbe cf ad = 001101$$

$$\Rightarrow ad = 1 \quad \text{So } a = 1, d = 1$$

$$be = 1 \quad \text{So } b = 1, e = 1$$

$$cf = 0 \quad \text{If } c = 0, \text{ then } f = *.$$

$$\text{If } c = 1, \text{ then } f = 0.$$

Therefore 11011*, 111110 make it TRUE.

B. 3

3. Recursive Functions

$$\begin{aligned}f(3, -1) &= f(3-2, -1+3) - [-1/3] = f(1, 2) - (-1) = 11 + 1 = 12 \\f(1, 2) &= f(1+1, 2-1) + 1 * 2 = f(2, 1) + 2 = 9 + 2 = 11 \\f(2, 1) &= f(2+1, 1-1) + 2 * 1 = f(3, 0) + 2 = 7 + 2 = 9 \\f(3, 0) &= f(3-2, 0+3) - [0/3] = f(1, 3) - 0 = 7 - 0 = 7 \\f(1, 3) &= f(1+1, 3-1) + 1 * 3 = f(2, 2) + 3 = 4 + 3 = 7 \\f(2, 2) &= 2 * 2 = 4\end{aligned}$$

D. 12

4. Digital Electronics

The digital circuit translates to:

$$\begin{aligned}&\overline{A((AB) + (B+C)) + (B+C)(\overline{C+D}) + \overline{D}} \\&= \overline{A} + \overline{((AB) + (B+C)) + (B+C)(\overline{C+D})} \\&= \overline{A} + \overline{(AB)(B+C) + ((B+C) + (C+D))} D \\&= \overline{A} + ((\overline{A} + \overline{B})(\overline{B}\overline{C})) + (\overline{B}\overline{C} + C + D) D \\&= \overline{A} + \overline{A}\overline{B}\overline{C} + \overline{B}\overline{C} + \overline{B}\overline{C}D + CD + D \\&= \overline{A} + \overline{B}\overline{C} + D\end{aligned}$$

If $\overline{A} + \overline{B}\overline{C} + D = 0$, then $\overline{A} = 0 \wedge \overline{B}\overline{C} = 0 \wedge D = 0$.

So $A = 1 \wedge D = 0$. If $(B=0 \rightarrow C=0) \vee (C=1 \rightarrow B=*)$.

Therefore 3 ordered triples make the circuit FALSE

B. 3

5. Prefix-Infix-Postfix

$$\begin{aligned}&6\ 2\ \&\ 4\ 2\ \$\ +\ 2\ ^\ 4\ 1\ +\ /\ 2\ 3\ ^\ 3\ 2\ ^\ \&\ - \\&= (6\ 2\ \&)(4\ 2\ \$) + 2\ ^\ (4\ 1\ +) /\ (2\ 3\ ^\)(3\ 2\ ^\)\ \&\ - \\&= (2\ 3\ +)\ 2\ ^\ 5 /\ (8\ 9\ \&)\ - \\&= (5\ 2\ ^\)\ 5 /\ 8\ - \\&= (25\ 5 /\)\ 8\ - \\&= 5\ 8\ - \\&= -3\end{aligned}$$

D. -3

6. Computer Number Systems

$2019_{10} = 3743_8$
In descending order: $7433_8 = 3867_{10}$
Therefore: $3867 - 2019 = 1848$

C. 1848

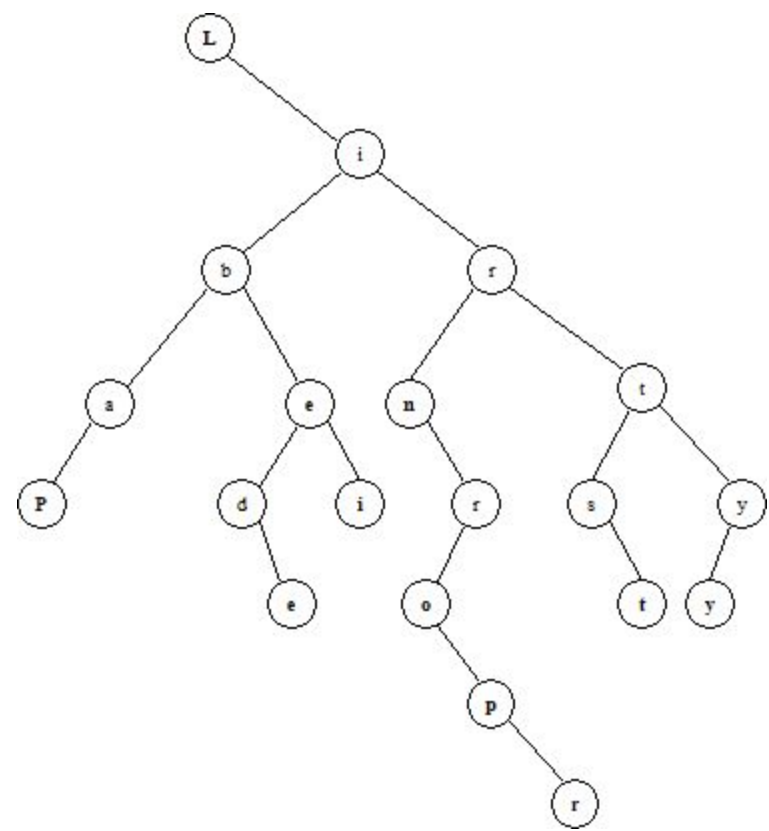
7. What Does This Program Do?

The program adds the digits of the number and divides that sum by 3 to see if the original number is divisible by 3. The input values before 0 that are divisible by 3 are: 93, 18, 982, 321, 84, 156, 99, and 732. There are 7 of them.

B. 7

8. Data Structures

The binary search tree is:



D. 74

The internal path length is: $1*1 + 2*2 + 3*4 + 4*6 + 5*4 + 1*6 + 1*7 = 74$

<p>9. LISP</p> <pre> (CDR (CAR (REVERSE (CDADDR '(a (b e) (a (b (c d)) (e f (g h))) f (d a)))))) = (CDR (CAR (REVERSE (CDADR '((b e) (a (b (c d)) (e f (g h))) f (d a)))))) = (CDR (CAR (REVERSE (CDAR '((a (b (c d)) (e f (g h))) f (d a)))))) = (CDR (CAR (REVERSE (CDR '(a (b (c d)) (e f (g h))))))) = (CDR (CAR (REVERSE '((b (c d)) (e f (g h)))))) = (CDR (CAR '((e f (g h)) (b (c d))))) = (CDR '(e f (g h))) = (f (g h)) </pre>	<p>C. (f (g h))</p>
<p>10. Graph Theory</p> <p>The round trips from A with just ACSL Air are: ADA, ABA, ABCDA, ABDA, ACDA, ACBA, and ACBDA. After merging with CompSci Air 5 new round trips were added: ABGFCDA, ACGFBA, ACFBA, ACFBDA, and ACGFBDA.</p>	<p>B. 5</p>

11. FSAs and Regular Expressions

- a) 2018KCSLwaseestablished. MATCHES
- b) AllStar@WayneHS Does not match. Fails
at the S in Star and at the e in Wayne
- c) 41Consecutive/yr MATCHES
- d) 12Categories@shorts Does not match.
Fails at the t in shorts
- e) Programmingischallenging&fun MATCHES
- f) ACSL.org MATCHES

D. a, c, e, f

12. Assembly Language

This program counts the number of even factors of the numbers from 1 to 10, inclusive. There are 10 of them.

A. 10
