American Computer Science League

2017-2018 **Contest #3**

SENIOR DIVISION SOLUTIONS

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1. Boolean Algebra

$$\overline{\overline{A}(B+\overline{C})} + \overline{B}\overline{\overline{C}} + \overline{\overline{A}}\overline{B}\overline{\overline{C}} = \overline{\overline{A}} + \overline{B+\overline{C}} + \overline{B} + \overline{\overline{C}} + \overline{\overline{A}} + \overline{B} + \overline{\overline{C}}$$
$$= A + \overline{B}\overline{\overline{C}} + \overline{B} + C + A + \overline{B} + C$$
$$= A + \overline{B}(C+1) + C = A + \overline{B} + C$$

1. $A + \overline{B} + C$

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2. Boolean Algebra

$$\overline{A(\overline{B}C + A\overline{C})(\overline{A}\overline{B} + BC)} + \overline{\overline{A}\overline{B}(A + \overline{A}B)}\,\overline{(\overline{B} + \overline{C})}$$
$$= \overline{A} + \overline{\overline{B}C + A\overline{C}} + \overline{\overline{A}\overline{B} + BC} + (\overline{\overline{A}} + \overline{\overline{B}} + \overline{A + \overline{A}B})(\overline{\overline{B}}\,\overline{\overline{C}})$$
$$= \overline{A} + \overline{\overline{B}C}\,\overline{A\overline{C}} + \overline{\overline{A}\overline{B}}\,\overline{BC} + ABC + BC + \overline{A}\,\overline{A\overline{B}}BC$$
$$= \overline{A} + (\overline{\overline{B}} + \overline{C})(\overline{A} + \overline{\overline{C}}) + (\overline{\overline{A}} + \overline{\overline{B}})(\overline{B} + \overline{C}) + ABC + BC + \overline{A}BC(\overline{\overline{A}} + \overline{B}) =$$
$$\overline{A} + \overline{A}B + BC + \overline{A}\,\overline{C} + C\overline{C} + A\overline{B} + A\overline{C} + B\overline{B} + B\overline{C} + ABC + BC + A\overline{A}BC + \overline{A}B\overline{B}C$$
$$= \overline{A} + \overline{A}B + BC + \overline{A}\,\overline{C} + A\overline{B} + A\overline{C} + B\overline{C} + ABC$$
$$= \overline{A}(1 + B + \overline{C}) + BC(1 + A) + A\overline{B} + A\overline{C} + B\overline{C}$$
$$= \overline{A} + B(C + \overline{C}) + A\overline{B} + A\overline{C} = \overline{A} + B + A\overline{B} + A\overline{C}$$

If FALSE, then $\overline{A} = 0 \wedge B = 0 \wedge A\overline{B} = 0 \wedge A\overline{C} = 0$. But if $A = 1 \wedge B = 0$, then $A\overline{B} = 1$ which results in a contradiction. Therefore 0 make it FALSE.

2. 8

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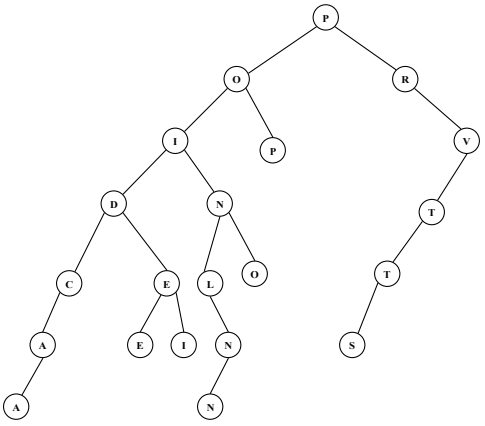
3. Data Structures



The binary search tree is at the left. The internal path length is calculated as follows: 2*1 + 3*2 + 3*3 + 5*4 + 5*5 + 2*6 = 74. The official name of the state is The State of Rhode Island and Providence Plantations. The longest name is for the smallest state.

3. 74

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4. Data Structures

The queue is constructed using FIFO as follows: R, RO, O, OG, GO, GOE, GOER, OER, REO, REOW, REOWI, REOWIL, LIWOER, IWOER, IWOERL,WOERL,WOERLI, ILREOW, ILREOWA, ILREOWAM, LREOWAM, REOWAM, REOWAMS, SMAWOER .

The next item popped in the queue is S.

The stack is constructed using LIFO as follows: R, RO, R, RG, GR, GRE, GRER, GRE, ERG, ERGW, ERGWI, ERGWIL, LIWGRE, LIWGR, LIWGRL, LIWGR, LIWGRI, IRGWIL, IRGWILA, IRGWILAM, IRGWILA, IRGWIL, IRGWILS, SLIWGRI.

The next item popped in the stack is I.

Roger Williams founded the colony of Rhode Island in 1636.

4. Queue: S

Stack: I

5. Regular Expressions

[1-9]*[a-j][k-z]*.[o,c]*[!o,u]

A. 18csl.ooo - no match since last character cannot be o or u
B. 1718acsl.com - no match since c is not valid in [a-j]
C. 40thyr.cov - no match since 0 is not in [1-9]
D. allst.or - matches
E. 1978ricsl.m - no match since r is not valid in [a-j] and c is not valid in [k-z]*

5. D