1996–97 American Computer Science League — Contest #2

Intermediate Division — SHORT PROBLEMS

1. What Does This Program Do? (BASIC)

Variable x is a 5x5 array, initially set to all zeros. How many elements of the array will be non-zero after the following program runs?

```
for r = 2 to 4
  for c = 2 to 4
    x(r-1,c-1) = 1
    x(r,c-1) = 1
    x(r+1,c+1) = 1
    x(r,c+1) = 1
  next c
next r
```

2. Boolean Algebra

How many ordered triples make the following expression true?

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

3. Boolean Algebra

Complete the label of the rightmost column in the following truth table.

A	B	C	$B\square C$	$A\square(B\square C)$
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	1	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$A\square(B\square C)$

4. Bit String Flicking

Evaluate the following:

```
(RSHIFT-1 (LCIRC-2 01101))
```

5. Bit String Flicking

Evaluate the following:

```
01011 OR 10110 AND 11010
```

1. The following table shows which new elements of `x` are set to 1 each time through the inner loop:

r	c	
2	2	(1,1) (2,1) (3,3) (2,3)
2	3	(1,2) (2,2) (3,4) (2,4)
2	4	(1,3) (3,5) (2,5)
3	2	(3,1) (4,3)
3	3	(3,2) (4,4)
3	4	(4,5)
4	2	(4,1) (5,3)
4	3	(4,2) (5,4)
4	4	(5,5)

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2. The expression simplifies as follows:

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

The following truth table shows the inputs that make the expression true:

A	B	C	ABC	$\overline{A}B$	$\overline{A}C$	$ABC+\overline{A}B+\overline{A}C$
0	0	0	0	0	0	0
0	0	1	0	0	1	1
0	1	0	0	1	0	1
0	1	1	0	1	1	1
1	0	0	0	0	0	0
1	0	1	0	0	0	0
1	1	0	0	0	0	0
1	1	1	1	0	0	1

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3. From the fourth column, the expression $B\boxed{\ \ }C$ is true only when both are true, so the operator must be AND. From the last column, the epression $A\boxed{\ \ }(B*C)$ is false only when both are false, so the missing operator must be OR.

$A\boxed{+}+(B\boxed{*}C)$

4. The evaluation starts at the inner parentheses and continues outward:

`(LCIRC-2 01101)` = `10101`

`(RSHIFT-1 10101)` = `01010`

`01010`

5. The AND must be evaluated before the OR; the evaluation is as follows:

`01011 OR 10110 AND 11010` = `01011 OR 10010`

= `11011`

`11011`