American Computer Science League

2017-2018 **Contest #1**

SENIOR DIVISION SOLUTIONS

1. Computer Number Systems

There is only 1 single bit that works: 1. There is only 1 2-bit number that works: 11. There are 3 3-bit numbers: 101, 110, and 111. There are 4 4-bit numbers: 1011, 1101, 1110, 1111. There are 11 5-bit numbers: 10011, 10101, 10110, 10111, 11001, 11010, 11011, 11100, 11101, 11110, 11111. This makes a total of 20.

1. 20

2. Computer Number Systems

$201718 = 6 * 8^5 + 1 * 8^4 + 1 * 8^3 + 7 * 8^2 + 6 * 8 + 6$
$= 611766_8$

2. 611766_8 or 611766

3. Recursive Functions

The initial stage is a single triangle. On each side a new one is constructed. Now there are 4 triangles. Six new ones can be added to each of six perimeter segments. Now there are 10. Six new triangles are added with 2 new perimeter segments each and 3 with only one segment. This makes a total of 19. The sequence formed is: 1, 4, 10, 19, 31,… So the 7^{th} term is 64.

3. 64

4. Recursive Functions

$f(7, 5) = f(6, 4) + f(6, 5) = 10 + 5 = 15$
$f(6, 5) = 5$
$f(6, 4) = f(5, 3) + f(5, 4) = 6 + 4 = 10$
$f(5, 4) = 4$
$f(5, 3) = f(4, 2) + f(4, 3) = 3 + 3 = 6$
$f(4, 3) = 3$
$f(4, 2) = f(3, 1) + f(3, 2) = 2 + 1 = 3$
$f(3, 2) = 2$
$f(3, 1) = 1$
Now substitute backwards.

4. 15

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5. What Does This Program Do?

The table contains the values of a, b, c, d, e, and f after each line.

a	b	c	d	e	f
0	2	2	-1	4	
0	2	2	-1	4	2
0	4	2	-1	4	2
16	4	2	-1	4	2
4	4	2	-1	4	2
4	4	2	-1	24	2
6	4	2	-1	24	2
6	20	2	-1	24	2
6	10	2	-1	24	2
36	10	2	-1	24	2
36	10	4	-1	24	2

a / (b + f) - e / (d * c) - (10 * b) / (a / f + c / f)
= 36 / (10 + 2) – 24 / (-1 * 4) - (10 * 10) / (36 / 2 + 4 / 2)
= 36 / 12 - 24 / (-4) - (100 / 20)
= 3 + 6 - 5 = 4

5. 4