

American Computer Science League

2018-2019

Contest #1

INTERMEDIATE DIVISION SOLUTIONS

1. Computer Number Systems

$$\begin{aligned} 23A4B_{16} &= 0010\ 0011\ 1010\ 0100\ 1011\ 2 \\ &= 100\ 011\ 101\ 001\ 001\ 011\ 2 \\ &= 4\ 3\ 5\ 1\ 1\ 3\ 8 \end{aligned}$$

1. 435113_8
or 435113

2. Computer Number Systems

$$1_{10} = 1_2 \text{ and } 32_{10} = 100000_2$$

Number of digits in the binary number: 1 2 3 4 5

Number with more 1's than 0's: 1 1 3 4 11

Total is 20.

2. 20

3. Recursive Functions

$$f(20) = f(f(20-2)) + 1 = f(f(18)) + 1 = f(2) + 1 = 1 + 1 = 2$$

$$f(18) = f(f(18-2)) + 1 = f(f(16)) + 1 = f(2) + 1 = 1 + 1 = 2$$

$$f(16) = f(f(16-2)) + 1 = f(f(14)) + 1 = f(2) + 1 = 1 + 1 = 2$$

$$f(14) = f([14/2]) - 1 = f(7) - 1 = 3 - 1 = 2$$

$$f(7) = [7/2] = 3$$

$$f(2) = [2/2] = 1$$

3. 2

4. Recursive Functions

$$f(1) = 2$$

$$f(2) = -2$$

$$\begin{aligned} f(3) &= 2 * f(3-1) + 3 * f(3-2) - 1 = 2 * f(2) + 3 * f(1) - 1 \\ &= 2 * (-2) + 3 * 2 - 1 = -4 + 6 - 1 = 1 \end{aligned}$$

$$f(4) = 2 * f(3) + 3 * f(2) - 1 = 2 * 1 + 3 * (-2) - 1 = 2 - 6 - 1 = -5$$

$$f(5) = 2 * f(4) + 3 * f(3) - 1 = 2 * (-5) + 3 * 1 - 1 = -10 + 3 - 1 = -8$$

$$f(6) = 2 * f(5) + 3 * f(4) - 1 = 2 * (-8) + 3 * (-5) - 1 = -16 - 15 - 1 = -32$$

$$f(7) = 2 * f(6) + 3 * f(5) - 1 = 2 * (-32) + 3 * (-8) - 1 = -64 - 24 - 1 = -89$$

4. -89

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5. What Does This Program Do?

5. -7

a	b	c	d	e	f
10	2	40	5	100	16
10	2	40	10	100	16
10	2	40	10	0	16
10	2	20	10	0	16
10	2	20	10	0	4
10	2	20	10	0	4
10	2	20	10	0	2

$$g = a * b + c + d + e + f * a$$

$$= 10 * 2 + 20 + 10 + 0 + 2 * 10 = 20 + 20 + 10 + 0 + 20 = 70$$

$$h = g / (c - a) + b * (c \uparrow e + f) / 3 - b \uparrow a / f \uparrow 5 / b$$

$$= 70 / (20 - 10) + 2 * (20 \uparrow 0 + 2) / 3 - 2 \uparrow 10 / 2 \uparrow 5 / 2$$

$$= 70 / 10 + 2 * (1 + 2) / 3 - 1024 / 32 / 2$$

$$= 7 + 2 * 3 / 3 - 32 / 2$$

$$= 7 + 2 - 16$$

$$= -7$$