

7wona

$$x=0$$

$$a=5$$

$$n=3$$

$$m=3$$

$$1$$

$$5$$

$$5$$

$$-3$$

$$-3$$

$$-3$$

$$2$$

$$10$$

$$5$$

$$i > 0$$

$$-3$$

$$-3$$

$$-3$$

$$1$$

$$15$$

$$5$$

$$-3$$

$$-3$$

$$-3$$

$$0$$

$$30$$

$$x = 0 + 5 = 5$$

$$i = 2$$

$$x = 10$$

$$i = 1$$

$$x = 15$$

$$i = 0$$

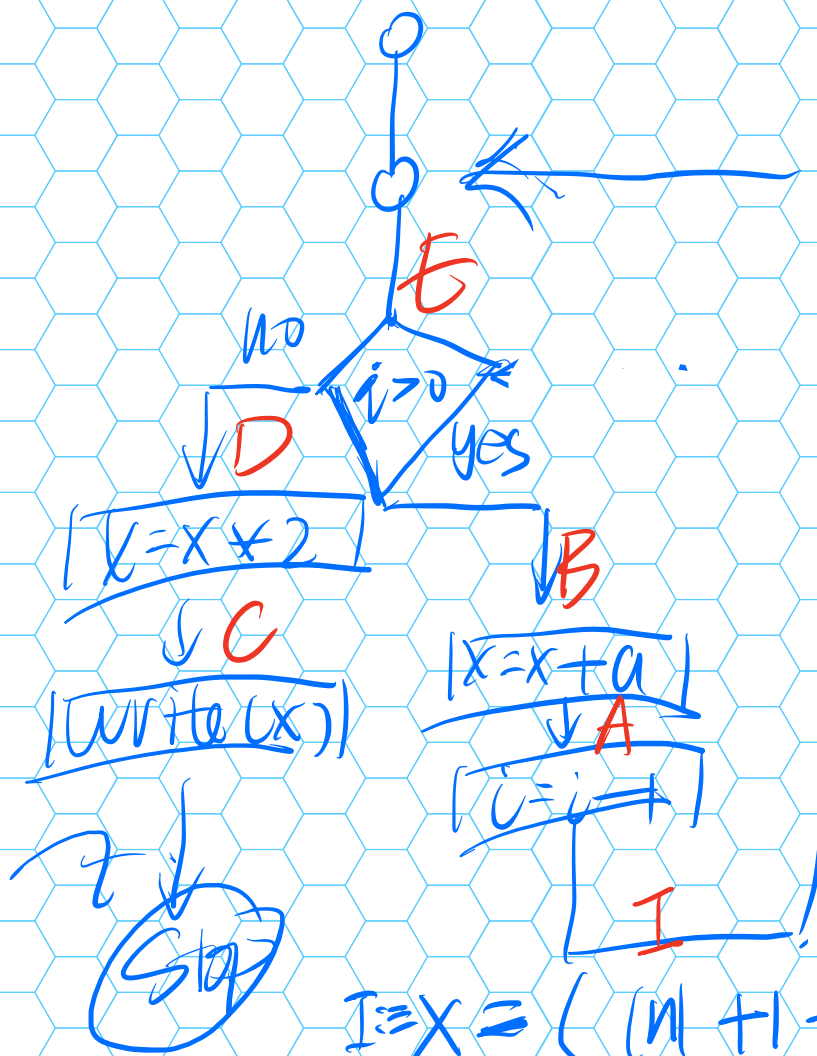
$$\Downarrow$$

$$x = 15 \times 2 = 30$$

$$x = 2 \times 3 \times 5 = 30$$

$$I \equiv x =$$

$$x = (n+1-i) \times a$$



$$I \equiv x = (n + 1 - i) * a$$

$$\text{WP } I \equiv i - 1 \mid I$$

$$\equiv x = i - 1 / i$$

$$\equiv x = (n + 2 - i) * a \equiv A$$

$$\text{wp}[x = x + a] A$$

$$\equiv A(x + a/x)$$

$$\equiv x + a = (|n| + 2 - i) * a$$

$\vdash B$

$$\text{wp}[\text{write}(x)] Z$$

$$\equiv \forall x, x = 2 * |n| * a$$

$$\vdash C$$

$$\text{wp}[x = x * 2] C$$

$$\equiv C(x * 2/x)$$

$$\equiv \forall x, x = 2 * |n| * a$$

7. 精分

$$\text{WPI } i \geq 0 \text{ II } (D, B) \\ = (\neg(i \geq 0) \wedge D) \quad \#$$

$$\vee ((i \geq 0) \wedge B)$$

$$= \underline{\underline{(i \leq 0 \wedge D)}}$$

$$\vee (\underline{\underline{i \geq 0 \wedge B}}) \quad \text{EEE}$$

$$X = (M + 1 - i) \times A$$

Or

$$\exists i (i \leq 0) \wedge (\exists x, x = 2x) \quad (n \neq a)$$

$$\forall (i > 0) \wedge (x + a \neq (n + 2 - i) * a)$$

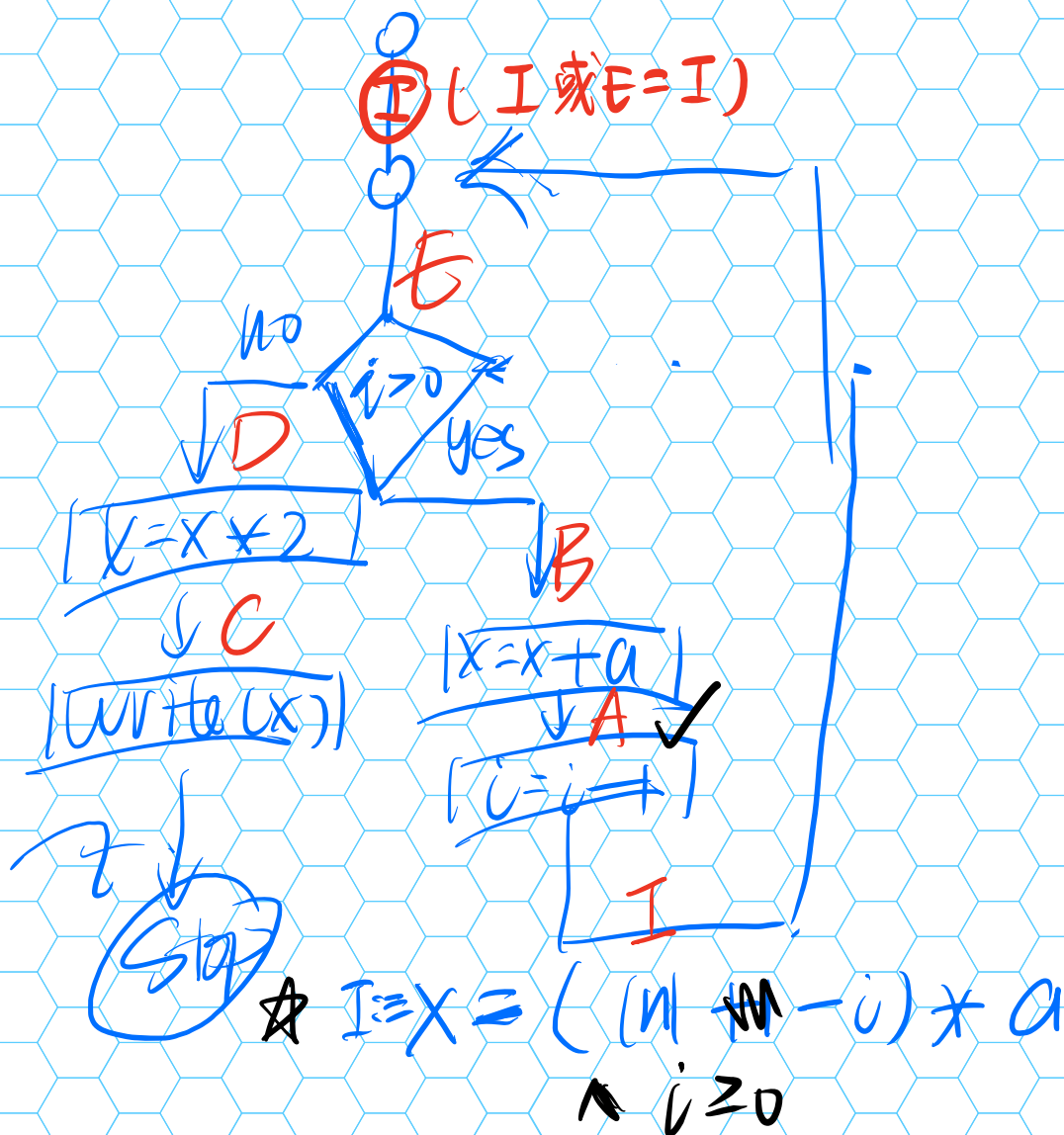
x	a	n	i
0	3	-3	3 ✓
3	3	-3	2
6	3	-3	1

~~2~~

① 规律 $x = (|n| - i) * a$.

② 范围 $i \geq 0$

Loop Invariant: $I \equiv x = (N-i) \times a$



WP $I \wedge i = i - 1 \mid I$

$\equiv I(i-1 / i)$

$$= \overline{x} = (|n| - i + 1) * a \wedge i \geq 1 \equiv A$$

$$\text{wp} \parallel x = x + a \parallel (A)$$

$$\equiv x + a = (|n| - i + 1) * a \wedge i \geq 1 \equiv B$$

$$\text{wp} \parallel \text{write}(x) \parallel (Z)$$

$$\equiv \cancel{Z} \quad x = 2 * |n| * a \equiv C$$

$i \in Z$
对于 $i \geq 1$
就是
 $i > 0$

$$\text{wp} \parallel x = x * 2 \parallel (C)$$

$$\equiv 2x = 2|n|a$$

$$\equiv x = a|n| \equiv D$$

$$\text{wp} \parallel i > 0 \parallel (D, B)$$

$$\equiv (i \leq 0 \wedge x = a|n|) \vee$$

$$(i > 0 \wedge x = (|n| - i) * a \wedge i \geq 1)$$

$$\equiv (i \leq 0 \wedge x = a[n])$$

$$\vee (i > 0 \wedge x = a[n-i])$$

我们的I是

$$x = (n-i)a \wedge i \geq 0$$

↓
当 $i=0$ 时
 $a[n]$

↓
当 $i>0$ 时
 $x = a[n-i]$

$$\Leftarrow (i=0) \wedge x = a[n]$$

$$\vee (i > 0 \wedge x = a[n-i])$$

$$\equiv I$$

Counter Time C)

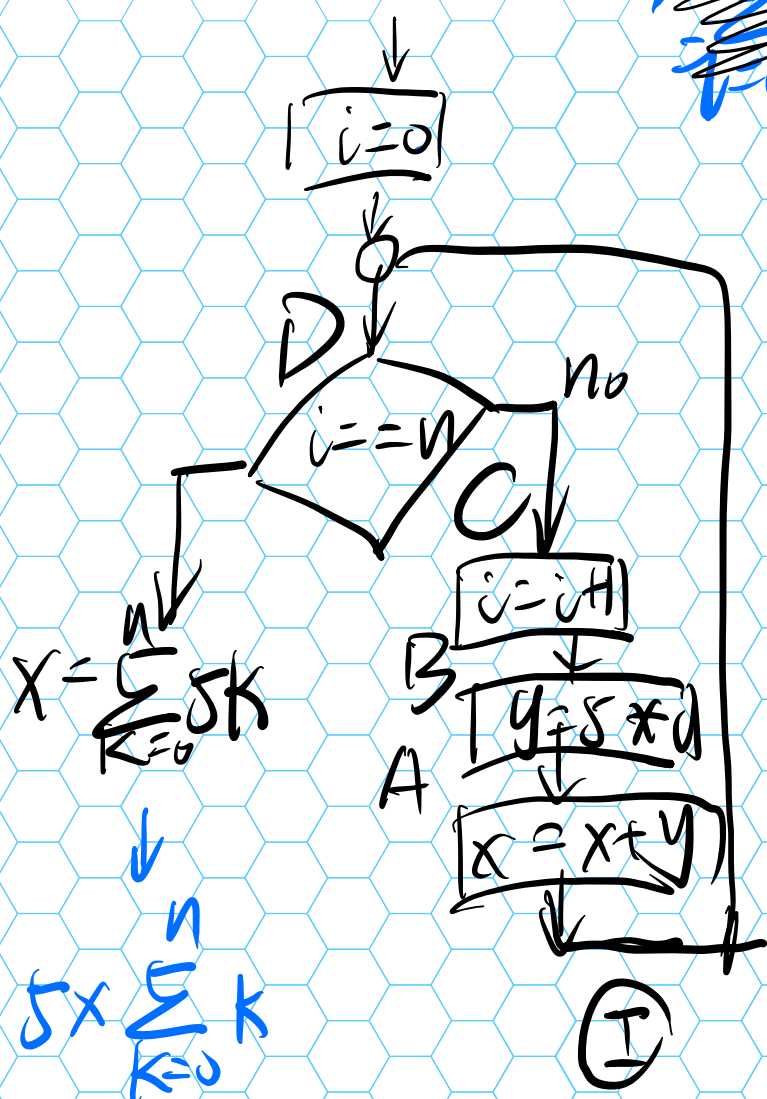
	n	i	k
之前	3	0	0
	3	0	1
		"	5
	3	1	0
			5
	n	1	5

Y?

i	y	x	n
0	0	0 ⁰	5
1	5	5 ¹	5
2	10 ²	15 ³	5
3	15 ³	30 ⁶	5
4	20	50 ¹⁰	5
5	25	75 ⁴	5

I 归纳

$$I \equiv y = 5i \wedge x = \frac{i(i+1)}{2} \wedge i \leq n$$



$$X = \sum_{k=0}^n 5k$$

$$\downarrow$$

$$5 \times \sum_{k=0}^n k$$

$$= 5 \times \frac{n \times (n+1)}{2}$$

~~$\sum_{k=0}^i$~~ 等不代 平一般 $\sum_{k=0}^n$

含退出条件

$$WP [x = x + y] (I)$$

$$A \equiv I(x + y / x)$$

$$\equiv y = 5i \wedge x + y = \sum_{i=0}^n a_i \wedge i \leq n$$

B $\text{wp } \Pi y = 5 * i \mid (A)$

$$\equiv x + 5i = \sum_{i=0}^n a_i \wedge i \leq n$$

C $\text{wp } \Pi i = i + 1 \mid (B)$

$$\equiv x + 5(i+1) = \sum_{i=0}^n a_i \wedge (i+1) \leq n$$

\Downarrow

$$i+1 \leq n$$

D: $(i \leq n \wedge x = \sum_{k=0}^n 5k)$

$\forall (i \leq n \wedge i+1 \leq n \wedge \dots)$

~~$t+1=0$~~



$$y = \delta u \quad \wedge \quad x = \frac{i(i+1)}{2} \times n \quad \wedge \quad i \in n$$

$$n \neq \Sigma$$

$$x = \frac{(i+1)(i+2)}{2} \times n$$