

$$(A \cdot B) \% C = (A \% C \cdot B \% C) \% C$$

$$(A \cdot B \cdot C) \% D = [(A \cdot B) \% D \cdot C \% D] \% D$$

$$= [(A \% D \cdot B \% D) \% D \cdot C \% D] \% D$$

$$\frac{1}{2} + \frac{1}{4} = \frac{1}{8}$$

$$a \left(\frac{1-b^4}{1-b} \right)$$

=

$$d_i^T = d_{(a-ib) \% N}^{T-1} = d_{[a-(a-ib) \% N] b}^{T-2} \% N$$

~~ca-1~~

~~ca-1~~

$$d_{ca-1}^T = d_{a+ib}^{T-1} = d_{a+(a+ib)b}^{T-2} = d_{a+(a+(a+ib)b)b}^{T-3}$$

$$= d_{a+(ab+ib^2)}^{T-2} = a+(a+(ab+ib^2))b$$

$$= d_{a+ab+ib^2}^{T-2} = a+(a+ab+ib^2)b$$

$$= a+(ab+ab^2+ib^3)$$

$$= a+ab+ab^2+ib^3 + ab^3 - ab^3$$

$$= a(1+b+b^2) + ib^3$$

$$= a(1+b+b^2+b^3) + ib^3 - ab^3$$

$$= a(1+b+b^2+b^3) + (i-a)b^3$$

$$= a \sum_{j=0}^3 b^j + (i-a)b^3$$

$$\frac{a}{1-b} \cdot \frac{b}{1-b} = \frac{ab}{1-b^2} = \frac{a-ab^2+b^2-b^3}{1-b}$$

$$a \left(\frac{1-b^2}{1-b} \right) + \frac{(1-b)ib^2}{(1-b)}$$

$$\frac{a(1-b^2) + (1-b)ib^2}{1-b}$$

$$t=1$$

$$a+ib$$

$$\frac{a}{1-b} \cdot \frac{b}{1-b} = \frac{ab}{1-b^2} = a \left(\frac{1-b^2}{1-b} \right) + ib^2$$

$$a \sum_{j=0}^{t-1} b^j + ib^t$$

$$a \frac{1-b^t}{1-b} + ib^t$$

12/26/20
15:10:40

03.py

```
1: import math
2:
3: import utils
4:
5: hill = []
6: for line in utils.iterstrip('input-03.txt'):
7:     hill.append(line)
8:
9: def n_trees(hill, n_right, n_down):
10:     x = 0
11:     s = 0
12:     for y in range(0, len(hill), n_down):
13:         line = hill[y]
14:         if line[x % len(line)] == '#':
15:             s += 1
16:             x += n_right
17:
18:     return s
19:
20: print(n_trees(hill, 3, 1))
21:
22: print(math.prod([
23:     n_trees(hill, 1, 1),
24:     n_trees(hill, 3, 1),
25:     n_trees(hill, 5, 1),
26:     n_trees(hill, 7, 1),
27:     n_trees(hill, 1, 2),
28: ]))
29:
30:
31:
```

0 1 2 3 4 5 6 7 8 9
2 3 4 5 6 7 8 9 0 1
1 0 9 8 7 6 5 4 3 2
1 4 7 0 3 6 9 2 5 8

cut 3
cut 4
inc 3 (new(cut 2(d)))

cut 2

new
inc 3

$$d_i^T = inc_3(new(cut_2(d_x^{T-1})))$$

2020

$$d_{2020}^T = d_{j-1}^{T-1}$$

$$d_{j-1}^{T-1} = d_{j-2}^{T-2}$$

cut 2(d^{T-1})

new(e) = f

inc 3(f) = g = d^T

$$a \cdot a^{p-1}$$

$$(2020 \cdot N^T) \cdot N$$

M(N, incn)

M(incn, N)

$$= f.$$

$$L \cdot M(N, incn=3)$$

$$= e(N-1-iM)$$

$$= d(N-1-iM + incn \cdot n)$$

$$d_{2020}^1 = d_{95893}^0 =$$

$$a - b(2020) = 95893$$

$$a - b_i =$$

20

$$d_i^T = d_{i+n}^{T-1} \cdot N$$

$$d_i^T = d_{i \cdot A}^{T-1} \cdot N$$

$$d_{i \cdot A}^{T-1} = d_{i \cdot A^2}^{T-2} = d_{i \cdot A^2}^{T-2}$$

$$d_{i+n}^{T-1} \cdot N = d_{([i+n] \cdot N) + n}^{T-2} \cdot N$$

$$= d$$

$$= (i + 2n) \cdot N$$

$$d_{i \cdot A}^{T-1}$$

$$d_i^T = (i + Tn) \cdot N$$

$$d_{i \cdot A}^0$$

$$d_{11-7i}^{T-1} = d_{11-7(11-7i)}^{T-2}$$

$$= d_{11-77+49i} = d_{4-66+49i}$$

$$d_{2020}^3 = d_{(2020+n) \cdot N}^2$$

$$d_{(2020+n) \cdot N}^2 = d_{(2020+2n) \cdot N}^1$$

$$d_{11-7(11-7i)}^{T-2}$$

$$d_{(2020+2n) \cdot N}^1 = d_{(2020+3n) \cdot N}^0$$

$$= d_{11-7[11-7(11-7i)]}^{T-3}$$

$$d_i^T = (2020+3n) \cdot N$$

$$d_i^T = (i + Tn) \cdot N$$

$$d_i^T = d_{11-7i}^{T-1} = \sum_{j=0}^{T-1} d_{11-7i}^{T-1-j}$$

$$= d_{(10-1-7i+2)} = d_{(11-7i) \cdot N}$$

0 1 2 3 4 5 6
 0 5 3 1 6 4 2
~~0 4 1 5 2 3 6~~

0 5 10 15 20 25 30
 0 5 3 1 6 4 2

7, 3 → 5
 7, 3 = 1

0 1 2 3 4 5 6 7 8 9
 0 7 4 1 8 5 2 9 6 3
 0 7 14 21 10, 3 → 7
 10, 3 = 1

0 1 2 3 4 5 6 7 8 9 10
 0 7 4 1 8 5 2 9 6 3 10
 0 4 8 1 5 9 2 6 10 3 7
 1 1 1 1 1 1

11 / 3 11, 3 → 4
 11, 3 = 2

0 1 2 3 4 5 6 7 8 9 10
 0 4 1 2 3

deck_i⁰ = i * n
 deck_i¹ = deck_i⁰
 0 1 2 3 4 5 6
 0 1 2 3 4 5 6
 4 5 6 N // n

0 1 2 3 4 5 6 0 1 2 3 4 5 6 0 1 2 3 4
 0 1 2 3 4 5 6 0 1 2 3 4 5 6 0 1 2 3 4
 0 1 2 3 4 5 6 0 1 2 3 4 5 6 0 1 2 3 4

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

9 8 7 6 5 4 3 2 1 0

4 3 2 1 0 9 8 7 6 5

7 6 5 4 3 2 1 0 9 8

7 0 3 6 9 2 5 8 1 4

0 1 2 3 4 5 6 7 8 9

7 0 3 6 9 2 5 8 1 4

4 1 8 5 2 9 6 3 0 7

9 6 3 0 7 4 1 8 5 2

8 5 2 9 6 3 0 7 4 1

8 7 6 5 4 3 2 1 0 9

deal into new

cut 5

cut -3

deal w/ increment 3

$$d_i^{T-2} = d_{N-1-i}^{T-3}$$

deal into new

cut 5

cut -3

deal w/ increment 3

$$new(d_i) = d_{10-i-2}$$

$$new(d_i) = d_{(N-1-i)} \quad N-1-NH+i$$

$$d_i^T = d_{(N-1-i)}^{T-1}$$

$$d_{(N-1-i)}^{T-1} = d_{(N-1-(N-1-i))}^{T-2} = d_i^{T-2}$$

$$d_{2020}^{t+1} = d_{(N-1-2020)}^t$$

$$d_{(N-1-2020)}^t = d_{(N-1-[N-1-2020])}^{t+1}$$

$$cut(d_i, n) = d_{(i+n) \% N}$$

$$cut(d_2, 5) = d_{(2+5) \% 10} = d_7 = 2$$

$$cut(d_2, -3) = d_{(2-3) \% 10} = d_9 = 5$$

$$inc(d_i, n) = d_{(i+n) \% 10}$$

$$inc(d_2, 3) = d_{(2+3) \% 10} = d_5 = 7$$

$$inc(d_0, n) = d_0 \quad 0(10) \% 10 = 0$$

$$inc(d_1, n) = d_7 + 3 \% 10 = 2$$

$$inc(d_2, 3) = d_4 + 6 \% 10 = 4$$

$$inc(d_3, 3) = d_2 + 6 \% 10 = 2$$

$$inc(d_6, 3) = d_2 + 12$$

$$inc(d_9, 3) = d_3$$

$$inc(d_{10}, n) = d_i$$

- in 1-10

$$deck_2^0 = 2$$

$$deck_2^1 = deck_2^0 = j$$

$$deck_{2020}^1 = deck_i^0 = j \quad (N+1) /$$

$$d_{2020}^{t+1} = deck_j^t$$

0 1 2 3 4 5 6 7 8 9

0 7 4 1 8 5 2 9 6 3

6 1 2 3 4 5 6 7 8 9

0 . . 1 . . 2 . . 3 . . 4 . . 5 . . 6 . . 7 . . 8 . . 9 . .
 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
 . . 4 . . 5 . . 6 . .
 . 7 . . 8 . . 9 . .

$N=10$
 $q=3$

$N=7, q=2$

0 1 2 3 4 5 6
 0 4 8 12 16 20 24
 0 . 1 . 2 . 3 .
 . 4 . 5 . 6 .

$N=13, q=5$

0 1 2 3 4 5 6 7 8 9 10 11 12
 0 6 16 24 32 40
 0 1 2
 13 . 14 3 4 5
 26 . 47 . . 6 7
 39 . 80 9 10
 . . . 11 12

$N=11, q=3$

0 1 2 3 4 5 6 7 8 9 10
 0 . . 1 . . 2 . . 3 . .
 . 4 . . 5 . . 6 . . 7
 . . 8 . . 9 . . 10 . .

$N=12, q=6$

0 1 2 3 4 5 6 7 8 9 10 11 12
 0 12 24 36 48 60 72
 0 1 2
 3 4
 5 6
 7 8
 . . 9 10
 . 11 12

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
 0 1 2
 3 4
 . 5

N/n

0 1 2

1414 955

INDEX	012	...	2014	2014	2020	2021	9414	...	955	11 9 315 7175	...	-1
START	012	...	2018	2019	2020	2021	9414	...	98...	1. n		-1
1	???	...	?	?	955 9414 9414	?	a	...	9414	?		
2	???	...	?	?	9414	?		...	y			
3	???	...	?	?	y	?		...	z	?		