Section ①

Euclids $\overset{64\ \ 24}{(m, n)}$

While $n \neq 0$ do

$r \leftarrow m \bmod n$

$m \leftarrow n$

$n \leftarrow r$

return m.

m / n

$\boxed{\text{no.}} \times n$

m − n

rkm saheeh

or

m / n

dec. × n

(dec)

Ex 1.1

Basic op

:=

==, !=, <=, <, >=, >

arthimetic op:

+, −, /, *

6a.

$r \leftarrow 16$

$m \leftarrow 24$

$n \leftarrow 16$

$r \leftarrow 8$

$m \leftarrow 16$

$n \leftarrow 8$

$r \leftarrow 0$

$m \leftarrow 8$

$n \leftarrow 0$

return 8

GCD (31415, 14142)

m = 31415, n = 14142

r = 3131

m = 14142

n = 3131

GCD (14142, 3131)

r = 1618

m = 3131

n = 1618

GCD (3131, 1618)

$\boxed{0.9351 \times 1618}$

app الأكبر

r = 3131/1618

m = 1618

n = 1513

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GCD(1618, 1513)

m = 1513

n = 1618/1513 $\boxed{r}$ → 0.☐ x 1513

n = 105

GCD(1513, 105)

r = 1513/105

m = 105

n = 43

GCD (105, 43)

r = 105/43

m = 43

n = 19

GCD(43, 19)

r = 43/19

m = 19

n = 5

GCD(19, 5)

r = 19/5

m = 5

n = 4

GCD(5, 4)

r = 5/4

m = 4

n = 1

GCD(4, 1)

r = 4/1

m = 1

n = 0

GCD(1, 0) ⟸ ⊗ Stop

return 1

مشي ٧١

يمشوا بسرعة
٧١ نقطة

EX1.2

2.

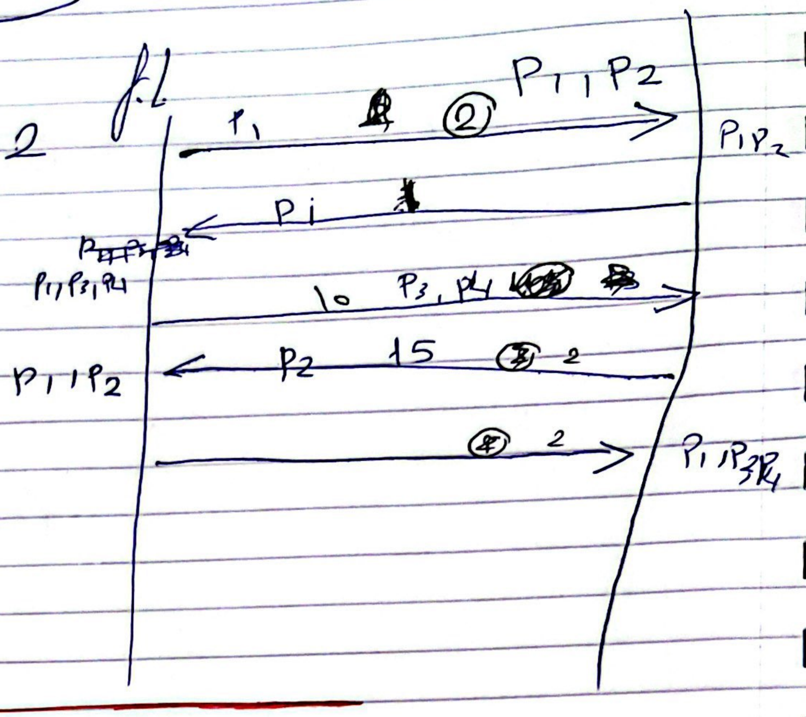
$P_1 \leftarrow 1$

$P_2 \leftarrow 2$

$P_3 \leftarrow 5$

$P_4 \leftarrow 10$

f.L



P1 and P2 go first
→ then P1 return
P_3, P4 goes
P2 return back
P1, P2 go

③ dmin ← ∞

for $i \leftarrow 0$ to $n-2$ do

for $j \leftarrow 0$ to $n-1$ do

if $i \neq j$ $|A[i] - A[j]| < d_{min}$

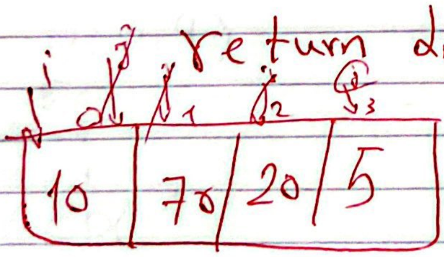
$d_{min} \leftarrow |A[i] - A[j]|$

return dmin.

let this

$j = \boxed{i+1}$

remove this



1.3 (1)

for i ← 0 to n-1 do Count[i] ← 0

for i ← 0 to n-2 do

  for j ← i+1 to n-1 do

    if A[i] < A[j]

      Count[j] ← Count[j]+1

    else

      Count[i] ← Count[i]+1

for i ← 0 to n-1 do S[Count[i]] ← A[i]

return S

not inplace

memory

Variabler

(a)

A

0	1	2	3	4	5
60	35	81	98	14	47

الاجابة

Count متعرف جوا الfunction

وقيمته بـ (0)

S

0	1	2	3	4	5
14	35	47	60	81	98

[redacted]

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

1.3

not in place

Count

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

i

j

j \ i	0	1	2	3	4	5
0	–	–	–	–	–	–
1		–	–	–	–	–
2	✓	✓	–	–	–	–
3	✓	✓	✓	–	–	–
4					–	–
5	✓	✓			✓	–

	0	1	2	3	4	5
A	60	35	81	98	14	47

S						

S [3] = 60

S [1] = 35

S [4] = 81

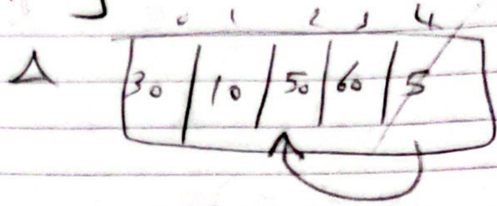
S [5] = 98

S [0] = 14

S [2] = 47

Ex. 1.4

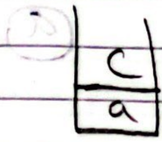
1. ⓐ $A[d] = A[4]$



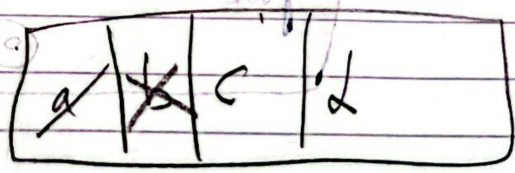
ينقص ال Size بواحد $\boxed{n = n - 1}$

3. ⓐ

LIFO



ⓑ FIFO



Regression : الانحدار (الصعود والهبوط)

Section ②

Algorithm

①

problem

↓

Algo.

↓

input → $\boxed{\text{Comp}}$ → output

Q2 ⓐ $1+2+3+ \sim 70$

$f=1$

$L=70 \quad S=70$

$$\frac{(f+L)S}{2} = \frac{(1+70)70}{2}$$

ⓑ $1+3+5 - - - +999 \quad F=1$ (1 → 1000)

$L=999$ odd no.

$$\frac{(f+L)S}{2} = \frac{1+999(500)}{2} \quad S = 500 \leftarrow \boxed{500}$$

$\boxed{\text{Size} = \underset{up}{f} - \underset{down}{\cancel{S}} + 1}$

(c) $\sum_{i=3}^{5} 2$

$2+2+2 = 6$

$\sum_{i=5}^{1000} 5 \quad (1000-5+1)5$

(d) $\sum_{i=3}^{10} C = (10-3+1)C = 8C$

(e) $\sum_{i=3}^{n} 2 = (n-3+1)2 = 2n-4$

(f) $\sum_{i=0}^{n-1} i$

$i=0,\ i=1,\ i=2 - i=n-1$

$0+1+2+3 - - + n-1.$

$f=0$

$L=n-1$

$S=n$

$\sum_{i=0}^{n-1} i+1$

$i=0 \Rightarrow i+1=1, \quad i=n-1+1$

$f=1$

$L=n$

$S=\cancel{n-1+1}-0$

(g) $\sum_{i=0}^{n-1} n = \cancel{n-1-0+1}\, n = n^2$

(h) $\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} 1 = \sum_{i=0}^{n-1} \cancel{n-1-0+1} = \cancel{n-1-0+1}\, n$

$\boxed{= n^2}$

① $\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} j$

$f = 0$
$L = n-1$
$S = n$

$\sum_{i=0}^{n-1} \frac{(n-1+0)n}{2} = \sum_{i=0}^{n-1} \frac{n^2-n}{2}$

$= \frac{(n \cancel{-1} - 0 \cancel{+1})\, n^2 - n}{2}$

$\boxed{= \frac{n^3 - n^2}{2}}$

(j) $\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} i = \sum_{i=0}^{n-1} \cancel{n i - 0 + 1}$

$= \sum_{i=0}^{n-1} n i$

$f = 0, \quad L = n(n-1)$

$S = \cancel{n-1+0+1}$

$= \frac{(0 + n^2 - n)n}{2}$

$\boxed{= \frac{n^3 - n^2}{2}}$

or

$n \sum_{i=0}^{n-1} i$

$f = 0$
$L = n-1$
$S = n$

$\cancel{f = 0,}$
$\cancel{L = n-1}$
$\cancel{S = n}$

$= n \cancel{(0+1+ \quad n-1)}$

$\frac{n(n-1) \cdot n}{2}$

$= \frac{(n^2 - n)n}{2}$

(k) $$\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \sum_{k=0}^{n-1} k$$

$f=0$
$L=n-1$
$S=n\cancel{-1-0+1}$
$$\frac{((n-1)\cancel{+0})\,n}{2}$$

$$\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \frac{n^2-n}{2}$$

$$\sum_{i=0}^{n-1} (n\cancel{-1-0+1}) \frac{n^2-n}{2}$$

$$\sum_{i=0}^{n-1} \frac{n^3-n^2}{2}$$

$$\frac{n\cancel{-1-0+1}\,(n^3-n^2)}{2} = \boxed{\frac{n^4-n^3}{2}}$$

(r) $$\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} i \cdot j$$

$f=0$
$L=n-1$
$S=n\cancel{-1-0+1}$

$$\sum_{i=0}^{n-1} \frac{n^2-n}{2}\, i$$

$$\frac{n^2-n}{2} \sum_{i=0}^{n-1} i$$

$f=0$
$L=n-1$
$S=n\cancel{-1-0+1}$

$$\frac{n^2-n}{2} \cdot \frac{(\cancel{0+}n-1)n}{2}$$

$$\left(\frac{n^2-n}{2}\right)\left(\frac{n^2-n}{2}\right) = \left(\frac{n^2-n}{2}\right)^2$$

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m. $\sum_{i=0}^{n-1} \sum_{j=0}^{i} 1$

$\sum_{i=0}^{n-1} (i \cancel{-0} + 1)1$

$\sum_{i=0}^{n-1} i + 1$

$f = 1$

$L = n$

$S = n \cancel{-1-0+1}$

$= \frac{(1+n)n}{2} = \boxed{\frac{n+n^2}{2}}$

(n) $\sum_{i=0}^{n-1} \sum_{j=0}^{i} j$

$f = 0$
$L = i$
$S = \cancel{i-0}+1$

$\sum_{i=0}^{n-1} \frac{(\cancel{0+}i)(i+1)}{2}$

$\sum_{i=0}^{n-1} \frac{i^2+i}{2}$

$F = 0$
$L = \frac{(n-1)^2+(n-1)}{2}$
$S = n \cancel{-1-0+1}$

$\left(\cancel{0+}\left[\frac{(n-1)^2+n-1}{2}\right]\right) n / 2$

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Q3

basic op

*, / → more time

+, - → less time

>, <=, <, >=, ==, != → lessen

:= → less time

Q3 (a) $x \leftarrow 0$

for $i \leftarrow 1$ to n

$x \leftarrow x + 1$

end.

Basic op: add

$$T(N) = \sum_{i=1}^{n} 1 \rightarrow$$ اول رقم بعد Sigma.

$$= (n - \cancel{1 + 1}) 1 = n$$

(b) $$T(N) = \sum_{i=1}^{n} 1$$

basic op: multiplic

$$= (n - \cancel{1 + 1}) 1 = n$$

Basic op: Addit

(c) $$T(N) = \sum_{i=1}^{n} 2 = 2n$$

$n - \cancel{1 + 1}\, 2$

(d) $$\sum_{i=1}^{n} 2 = 2n$$

Basic op: add, subtraction

(e) $T(N) = \sum_{i=1}^{n} \sum_{i=1}^{n} 2$ B.op.: add.

$= \sum_{i=1}^{n} 2n$

$= (n \cancel{-1+1}) \, 2n$

$\boxed{= 2n^2}$

(f) $\sum_{i=1}^{n} \sum_{i=1}^{i} 2$ B.op: div, mulitiply

$(i \cancel{-1+1}) \, 2$

$\sum_{i=1}^{n} 2i$

$2 \cdot \sum_{i=1}^{n} i \rightarrow \cancel{2} \frac{(n+1)n}{\cancel{2}} = \boxed{n^2 + n}$

$f = 1$

$L = n$

$S = n \cancel{-1+1}$

[redacted]

Section (B)

$$Q1: (a) \quad \boxed{A} \quad i \rightarrow \overbrace{\begin{array}{c} j \downarrow \quad n\times n \quad 2\times 2 \\ \begin{bmatrix} \square & \times \\ 0 & \Delta \end{bmatrix} \end{array} + \begin{array}{c} n\times n \\ \begin{bmatrix} \square & \times \\ 0 & \Delta \end{bmatrix} \end{array}}^{2\times 2} \rightarrow \boxed{B}$$

for $i \leftarrow 0$ to $n-1$

for $\leftarrow 0$ to $n-1$

$C[i,j] = A[i,j] + B[i,j]$

$$\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} 1$$

$$\sum_{i=0}^{n-1} (n-1-0+1) 1$$

$$T(N) = \sum_{i=0}^{n-1} n = (n-1-0+1) n = \boxed{n^2}$$

$\boxed{\text{input} = 2n^2}$, $\boxed{n^2 + n^2}$

(b) A $\begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}$ B $\begin{bmatrix} 3 & 2 \\ 3 & 1 \end{bmatrix}$

C $\begin{bmatrix} 1\times3+1\times3 & 1\times2+1\times1 \\ 2\times3+1\times3 & 2\times2+1\times2 \end{bmatrix}$

2 multiplication → n times

$$T(n) = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} n = \sum_{i=0}^{n-1} n^2$$

$$\boxed{T(n) = n^3}$$

$\boxed{\text{inputs} = 2n^2}$ inputs ⇒ + بعض

Q2

best case: $\boxed{\begin{array}{l} 1 \text{ L red} \\ 1 \text{ R red} \end{array} \boxed{2}}$ 11 left 11 Right

Worst case: $\boxed{11}$ left R
$\boxed{1}$ Right R $\boxed{12}$

$T(n) = \cancel{4}n^3 + \cancel{n^2} + \cancel{n}$

$T(1000) = 4(1000\ldots) + (1000000\ldots) + (1000)$

- We ignore constants
- & ~~ignore~~ take highest power

to bring → $O(n^3)$

Q3

(c) $n \rightarrow 4n$

$\frac{4\cancel{n}}{\cancel{n}} = 4$ timer

(d) $n^2 \rightarrow (4n)^2$

$\frac{(4n)^2}{n^2} = \frac{16\cancel{n^2}}{\cancel{n^2}} = 16$

(e) $n^3 \longrightarrow (4n^3)$

$\frac{4^3 n^3}{n^3} = 64$ time

(f) $2^n \longrightarrow 2^{4n}$

$\frac{2^{4n}}{2^n} = 2^{3n} = \boxed{8^n}$

(a) $\log_2 n \rightarrow \log_2 4n$

$\frac{\log_2(4n)}{\log_2(n)} =$

$\log_2 4 \cancel{+ \log_2 n - \log_2 n}$

$\boxed{= 2}$

(b) $\sqrt{n} \rightarrow \sqrt{4n}$

$\frac{\sqrt{4n}}{\sqrt{n}} = 2$

Q7 (a) $\frac{n(n+1)}{2} \in \Theta(n^3)$

$\frac{n^2 + n}{2}$ if belongs to

(b) ~~Not belong~~ True, $\in o(n^2)$

(c) ~~belong~~ false not belong $\Rightarrow$ $\boxed{\text{not exact}}$

(d) True

Q4 (a) $T(n) = (n^2+1)^{10} = \boxed{n^{20}}$

$\Theta(n^{20})$

(b) $\sqrt{10n^2+7n+3}$

$\sqrt{10}\, n + \sqrt{7n} + \sqrt{3}$ $\quad \Theta(n)$

(c) $2n\log(n+2)^2 + (n+2)^2 \log\frac{n}{2}$

$= \cancel{4}n\left[\log(n\cancel{+2})\right] + (n\cancel{+2})^2 \cdot \log n - \cancel{\log 2}$

$\Theta(n\log n) + \Theta(n^2\log n)$

$\boxed{\Theta(n^2\log n)}$

نفك ال log لو multiply أو divide

(d) $2^{n+1} + 3^{n-1}$

$2^n \cdot 2^1 + \frac{3^n}{3^1}$

$\Theta(2^n) + \Theta(3^n)$ $\quad \Theta(3^n)$

(c) $\lfloor \log_2 n \rfloor$ $\theta(\log_2 n)$.

Q5

(1) $\theta(n!)$

(2) $5 \log(n+100)^{10}$ $\theta(\log n)$

(3) $2^{2n} \rightarrow 4^n \rightarrow \theta(4^n)$

(4) $0.001 n^4 + 3n^3 + 1 \Rightarrow \theta(n^4)$

* (5) $\ln^2 n = \log^2 n$ $\theta(\log^2 n)$

(6) $\sqrt[3]{n} \Rightarrow \theta(n^{2/3})$

(7) $3^n = \theta(3^n)$.

(2), (5), (6), (4), (7), (3), (1)

Q6

(i)
```
x <- 0   min <- ∞
for i <- 0 to n-1
    ~~for j <- 0 to n-1~~
    if A[i] > max
        max <- A[i]
    if [Ai] < min
        min <- A[i]
```

$T(n) = n$.

$\theta(n)$

(ii) $T(n) = 1$

$\Theta(1)$

(iii) $T(n) = N$

$\Theta(N)$

(iv) $T(n) = T(\log n)$

$\Theta(\log n)$.

Section (4)

(i) (a) $X(n) = X(n-1) + 5$, $X(1) = 0$

no of Basic op.

$X(n-1) = \boxed{X(n-2) + 5}$

$X(n-2) = X(n-3) + 5$

$X(n) = X(n-2) + 5 + 5$

$\boxed{X(n) = X(n-3) + 15}$

$\boxed{X(n) = X(n-k) + 5k.}$

assume $X(n-k) = X(1) = 0$

$n-k = 1$

$k = 1-n$

$\boxed{k = n-1}$

$X(n) = \cancel{X(n-k)} + 5k$

$X(n) = 5(n-1) = 5n-5$

$\boxed{\Theta(n)}$

(b) $X(n) = 3X(n-1)$ $\boxed{X(1) = 4}$

$X(n-1) = 3X(n-2)$

$X(n-2) = 3X(n-3)$

$X(n) = 3 \times 3 X(n-2)$

$X(n) = \cancel{3} \times 9 \cancel{3} \times 3 X(n-3)$

$X(n) = 27 X(n-3)$.

$$\boxed{X(n) = 3^{k} X(n-k)}$$

$X(n-k) = X(1) = 4$

$\Theta(3^n)$.

$n - k = 1$

$\boxed{k = n-1}$ $X(n) = 3^{n-1} \cdot 4$

(c) $X(n) = X(n-1) + n$. $X(0) = 0$

$X(n-1) = X(n-2) + (n-1)$

$X(n-2) = X(n-3) + (n-2)$

$X(n) = X(n-2) + n - 1 + n$

$X(n)$ $X(n-3) + (n-2) + (n-1) + n$ Σ

$f \leftarrow 0 \longrightarrow n \rightarrow \angle$

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$S = n + 1$

$$\frac{(0 + n)\, n+1}{2} = \frac{n^2 + n}{2} \quad \boxed{\Theta(n^2)}$$

ⓔ $X(n) = x(n/3) + 1 \qquad x(1) = 1$

$X(n/3) = X\left(\frac{n}{3^1}\right) + 1$ ... $X(n/3) = X(n/9) + 1$

$X(n/9) = X(n/27) + 1$

$X(n) = \underline{x\left(\frac{n}{9}\right)} + 1 + 1$ ($9 = 3^2$)

$X(n) = X\left(\frac{n}{27}\right) + 1 + 1 + 1$ ($27 = 3^3$)

$X(n) = X\left(n/3^K\right) + K$

$\frac{n}{3^K} = 1$

assume $X\left(\frac{n}{3^K}\right) = X(1) = 1$

$\frac{n}{3^K} = 1$

$n = 3^K$

$\boxed{K = \log_3 n}$

$X(n) = \cancel{X\left(\frac{n}{3^K}\right)} + K$

$1 + \log_3 n$

$\boxed{\Theta(\log n)}$

$\rightarrow 2^1 x(\frac{n}{2^1}) + (1n)$

(d) $x(n) = 2x(n/2) + n$ $\qquad x(1) = 1$

$x(n/2) = 2x(\frac{n}{4}) + (\frac{n}{2})$

$x(\frac{n}{4}) = 2x(\frac{n}{8}) + (\frac{n}{4})$

[redacted]

[redacted] $\rightarrow 2^2 x(\frac{n}{2^2}) + 2n$

$x(n) = 4x(\frac{n}{4}) + n + n$

[redacted] $x(n) = 4[2x(n/8) + \frac{n}{4}] + n$

$x(n) = 8x(n/8) + n + n + n$

[redacted]

$\boxed{x(n) = 2^k x(n/2^k) + n.k}$

assume

$2^3 x(\frac{n}{2^3}) + 3n$

$x(n/2^k) = x(1) = 1$

$\frac{n}{2^k} = 1$

$n = 2^k$

$\boxed{k = \log_2 n}$

$\cancel{x}$ $x(n) = \cancel{2^{\log_2 n}} \cancel{x(\frac{n}{2^{\log_2 n}})} + n.\log_2 n$

1

$\cancel{n} + n \log_2 n$

$$\boxed{\Theta(n \log n)}$$

---

9) $X(n) = X(n/2) + 5$, $X(1) = 1$.

$X(n/2) = X(n/4) + 5$

$X(n/4) = X(n/8) + 5$

$X(n) = X(n/4) + \underbrace{5 + 5}_{2}$

$X(n) = X(n/8) + \underbrace{5 + 5 + 5}_{3}$ $\quad \boxed{X(n) = X(n/2^k) + 5k}$

2^3

assume $X(n/2^k) = X(1) = 1$

$$\boxed{k = \log_2 n}$$

$X(n) = 1 + 5\log_2 n$

$\Theta(\log n)$.

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(b) $x(n) = x(n-3) + 3$ $\quad x(1) = 0$

$x(n-3) = x(n-6) + 3$

$x(n-6) = x(n-9) + 3$

$x(n) = x(n-6) + 3 + 3$

$x(n) = x(n-9) + 3 + 3 + 3$

$$\boxed{x(n) = x(n-3k) + 3k}$$

assume $x(n-3k) = x(1) = 0$

$n - 3k = 1$

$-3k = 1 - n$

$\boxed{3k = n - 1}$

$\boxed{k = \frac{n-1}{3}}$

$x(n) = 0 + \cancel{3}\left(\frac{n-1}{\cancel{3}}\right)$

$x(n) = n - 1$

$\boxed{\theta(n)}$

Sheet 3 (Ch 2 2.3 → 2.5)

1 b $2 + 4 + 8 + 16 + \dots 1024$

$2^1 + 2^2 + 2^3 \dots + 2^{10}$

first → $a \left(\frac{1 - r^m}{1 - r} \right)$ → multiply → size.

$$\boxed{2 \left(\frac{1 - 2^{10}}{1 - 2} \right)}$$

f $\sum_{j=1}^{n} 3^{j+1}$ n X

j=1 — j=2 — j=3

$3^2 + 3^4 + 3^4 \dots 3^{n+1}$

$$\boxed{3^2 \left(\frac{1 - 3^n}{1 - 3} \right)}$$

Sheet 3

1 $x(n) = 2x(n-2) + 2$ $x(1) = 0$

$x(n-2) = 2x(n-4) + 2$

$x(n-4) = 2x(n-6) + 2$

$x(n) = 2[2x(n-4) + 2] + 2$

$$x(n) = 2\left[\underset{2\times}{2x(n-4)} + 2\right] + 2$$

$$= \underset{2^2}{4}\, x\underset{(n-4)}{(n-4)} + \underset{2^2}{4} + \underset{2^1}{2}$$

$$x(n) = 4\left[2x(n-6) + 2\right] + 4 + 2$$

$$\underset{2^3}{8}\, x\underset{(3\times2)}{(n-6)} + \underset{2^3}{8} + \underset{2^2}{4} + \underset{2^1}{2}$$

$$x(n) = \cancel{2^k\, x(n-2k)} + 2^k + 2^{k-1} + 2^{k-2} + \cdots 2^1$$

assume $x(n-2k) = x(1) = 0$

$$n-2k = 1$$

$$\cancel{n-2k}\quad n = 1-2k$$

$$\boxed{k = \frac{n-1}{2}}$$

$$\boxed{\theta(2^n)}$$

$$\boxed{x(n) = 2^{\frac{n-1}{2}} + \cdots 2^1}$$

$$\cancel{2^{n-1}}\; 2^1\left(\frac{1-2^{\frac{n-1}{2}}}{1-2}\right) \simeq 2^n$$

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Sheet 3 (ch 2.3 → 2.5)

Q3

(b) $Q(n) = Q(n-1) + 1$

$Q(1) = 0 \longrightarrow$ no multiplication solved.

not multiplication

$Q(n-1) = Q(n-2) + 1$

$\boxed{Q(n) = Q(n-K) + K}$

$Q(n) = Q(n-\underbrace{2}_{2}) + \underbrace{1+1}_{2}$

assume $Q(n-K) = Q(1) = 0$

$Q(n) = 0 + K$

$\boxed{\theta(n)}$

$n - K = 1$

$\boxed{K = n - 1}$

(c) $Q(n) = Q(n-1) + 2$

$Q(1) = 0 \longrightarrow$

مفيش

⊕ or ⊖

$Q(n-1) = Q(n-\underbrace{2}_{2}) + \underbrace{2+2}_{2^2}$

$Q(n-2) = Q(n-\underbrace{3}_{3}) + \underbrace{2+2+2}_{2^3}$