xabxac 1
abxac 2
bxac 3
xac 4
ac 5
c 6

abxac 2
1
ac 5
1
bxac 3
1
c 6
1
xabxac 1
1
xac 4

SA

ST

1 ... n

(0 .. n-1)

---

abacaba 1
bacaba 2
acaba 3
caba 4
aba 5
ba 6
a 7

a 7
aba 5
abacaba 1
acaba 3
ba 6
bacaba 2
caba 4

0 1 2 3 4 5 6 7

$T = \underbrace{abacaba\$}$

$8 = 2^3$

[a, b, a, c, a, b, a, $]

abacababa$$$$$$$

$10 \to 16 = 2^4$

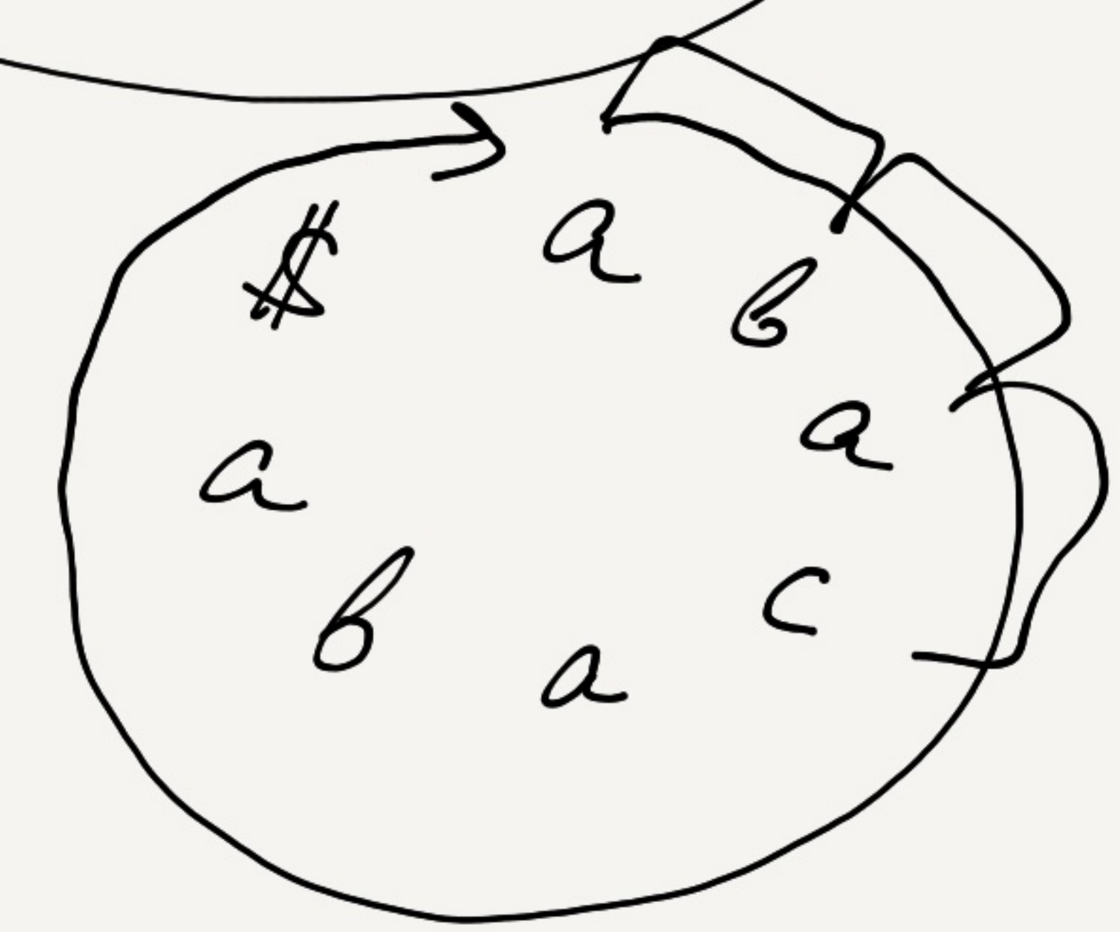
$\$ < a < b < c$

0 1 2 3

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| indices | 7 | 0 | 2 | 4 | 6 | 1 | 5 | 3 |
| text | $ | a | a | a | a | b | b | c |
| c | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |

abacaba$

ab
ba
ac
ca
ab
ba
a$
$a



| | |
|---|---|
| ~~abacaba\$~~ | ~~0~~ |
| ~~bacaba\$a~~ | ~~1~~ |
| ~~acaba\$ab~~ | ~~2~~ |
| ~~caba\$aba~~ | ~~3~~ |
| ~~aba\$abac~~ | ~~4~~ |
| ~~ba\$abaca~~ | ~~5~~ |
| ~~a\$abacab~~ | ~~6~~ |
| ~~\$abacaba~~ | ~~7~~ |

| \$abacaba | 7 | |
|---|---|---|
| a\$abacab | 6 | 7 |
| aba\$abac | 4 | 5 |
| abacaba\$ | 0 | 1 |
| acaba\$ab | 2 | 3 |
| ba\$abaca | 5 | 6 |
| bacaba\$a | 1 | 2 |
| caba\$aba | 3 | 4 |

$\$ < a < b < c$

abac\$

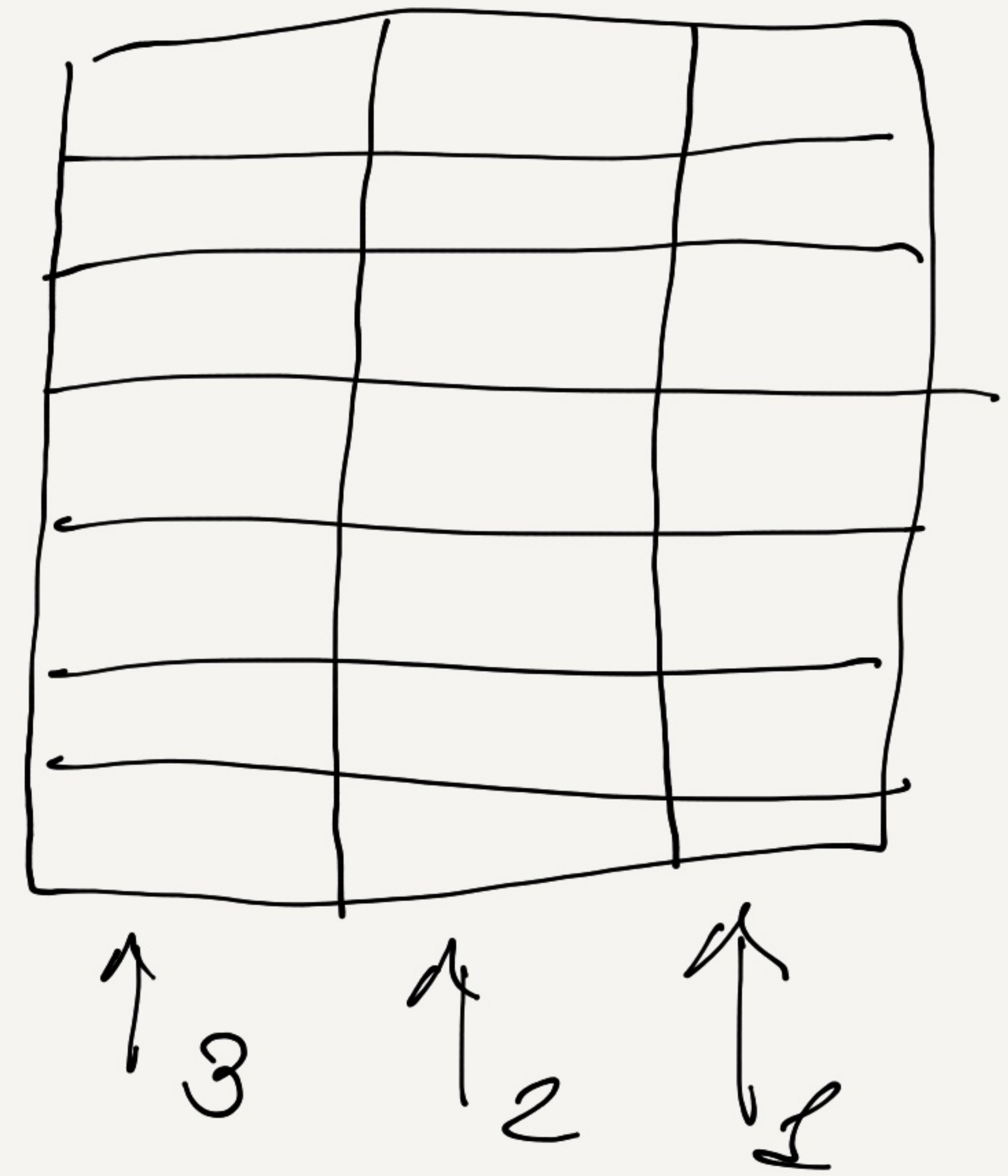
| \$abac | | |
|---|---|---|
| abac\$ | 0 | abac |
| ac\$ab | 2 | ac |
| bac\$a | 1 | bac |
| c\$aba | 3 | c |

$n, n$

$O(n \log n \cdot n) = \underline{O(n^2 \log n)}$

a b a c a b a $

0 1 2 3 4 5 6 7

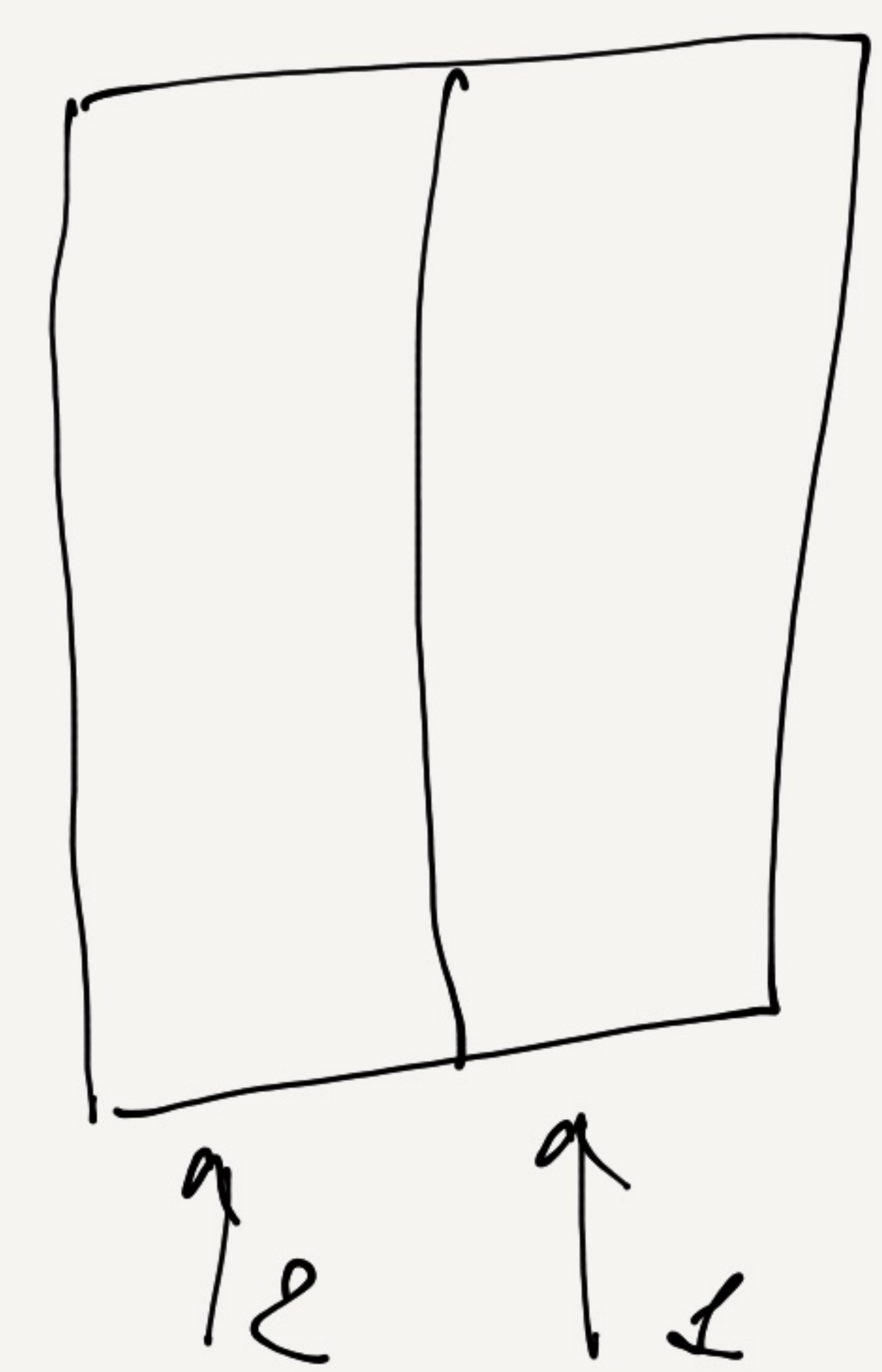



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ind | 7 | 0 | 2 | 4 | 6 | 1 | 5 | 3 |
| text | $ | a | a | a | a | b | b | c |
| c | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |

0 ab
1 ba
2 ac
3 ca
4 ab
5 ba
6 a$
7 $a

| | | |
|---|---|---|
| a$ | | 7 |
| $a | | 0 |
| ba | | 2 |
| ca | | 4 |
| ba | | 6 |
| ab | | 1 |
| ab | | 5 |
| ac | | 3 |

2 1



a b a c a b a $

0 1 2 3 4 5 6 7

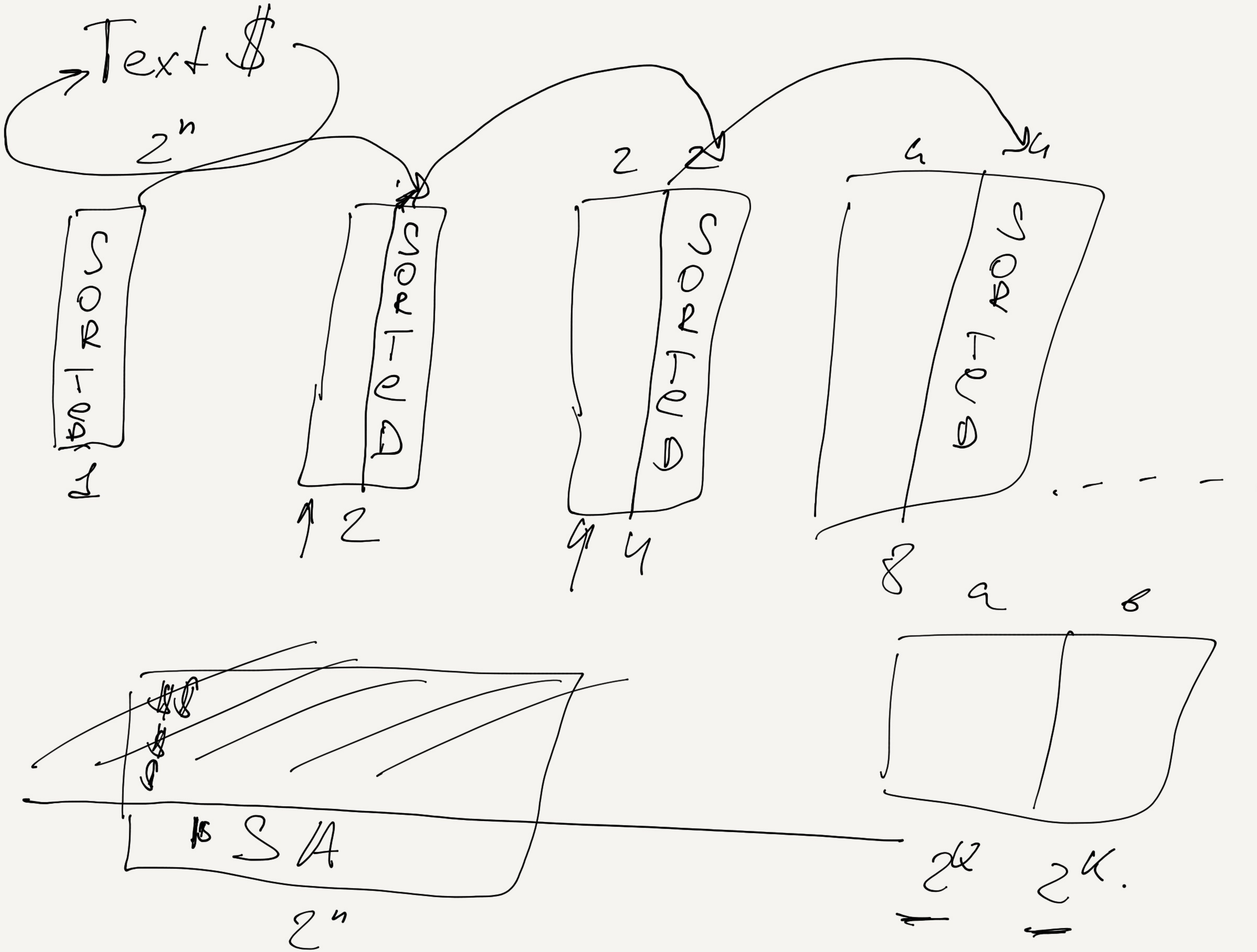
I.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ind | 7 | 0 | 2 | 4 | 6 | 1 | 5 | 3 |
| text | $ | a | a | a | a | b | b | c |
| c | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |

II.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ind | 6 | 7 | 1 | 3 | 5 | 0 | 4 | 2 |
| text | a$ | $a | ba | ca | ba | ab | ab | ac |
| c: | 1 | 0 | 2 | 3 | 2 | 1 | 1 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ind | 7 | 6 | 0 | 4 | 2 | 1 | 5 | 3 |
| | (0 1) | (1 0) | (1 2) | (1 2) | 1 3 | 2 1 | 2 1 | 3 1 |
| text | $a | a$ | ab | ab | ac | ba | ba | ca |
| c: | 0 | 1 | 2 = | 2 | 3 | 4 = | 4 | 5 |


Text $
2^n
SORTED
1
1 2
SORTED
2 2
SORTED
4 4
4 4
SORTED
8
a
b
SA
2^n
2^k
2^k.

a b a c a b a $

0 1 2 3 4 5 6 7

| | | | |
|---|---|---|---|
| 6 | a | $ | 7 |
| 7 | $ | a | 0 |
| 1 | b | a | 2 |
| 3 | c | a | 4 |
| 5 | b | a | 6 |
| 0 | a | b | 1 |
| 4 | a | b | 5 |
| 2 | a | c | 3 |

| c | text | ind |
|---|---|---|
| 0 | $a | 7 |
| 1 | a$ | 6 |
| 2 | ab | 0 |
| 2 | ab | 4 |
| 3 | ac | 2 |
| 4 | ba | 1 |
| 4 | ba | 5 |
| 5 | ca | 3 |

abacaba$
0 1 2 3 4 5 6 7

| | | | |
|---|---|---|---|
| 5 | 4 | ba | $a |
| 4 | 2 | ab | a$ |
| 6 | 1 | a$ | ab |
| 2 | 3 | ac | ab |
| 0 | 2 | ab | ac |
| 7 | 0 | $a | ba |
| 3 | 5 | ca | ba |
| 1 | 4 | ba | ca |

4
~~3n~~

| ind | 7 | 6 | 4 | 0 | 2 | 5 | 1 | 3 |
|---|---|---|---|---|---|---|---|---|
| text | $aba | a$ab | aba$ | abac | acab | ba$a | baca | caba |
| c | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

7

6

4

0

2

5

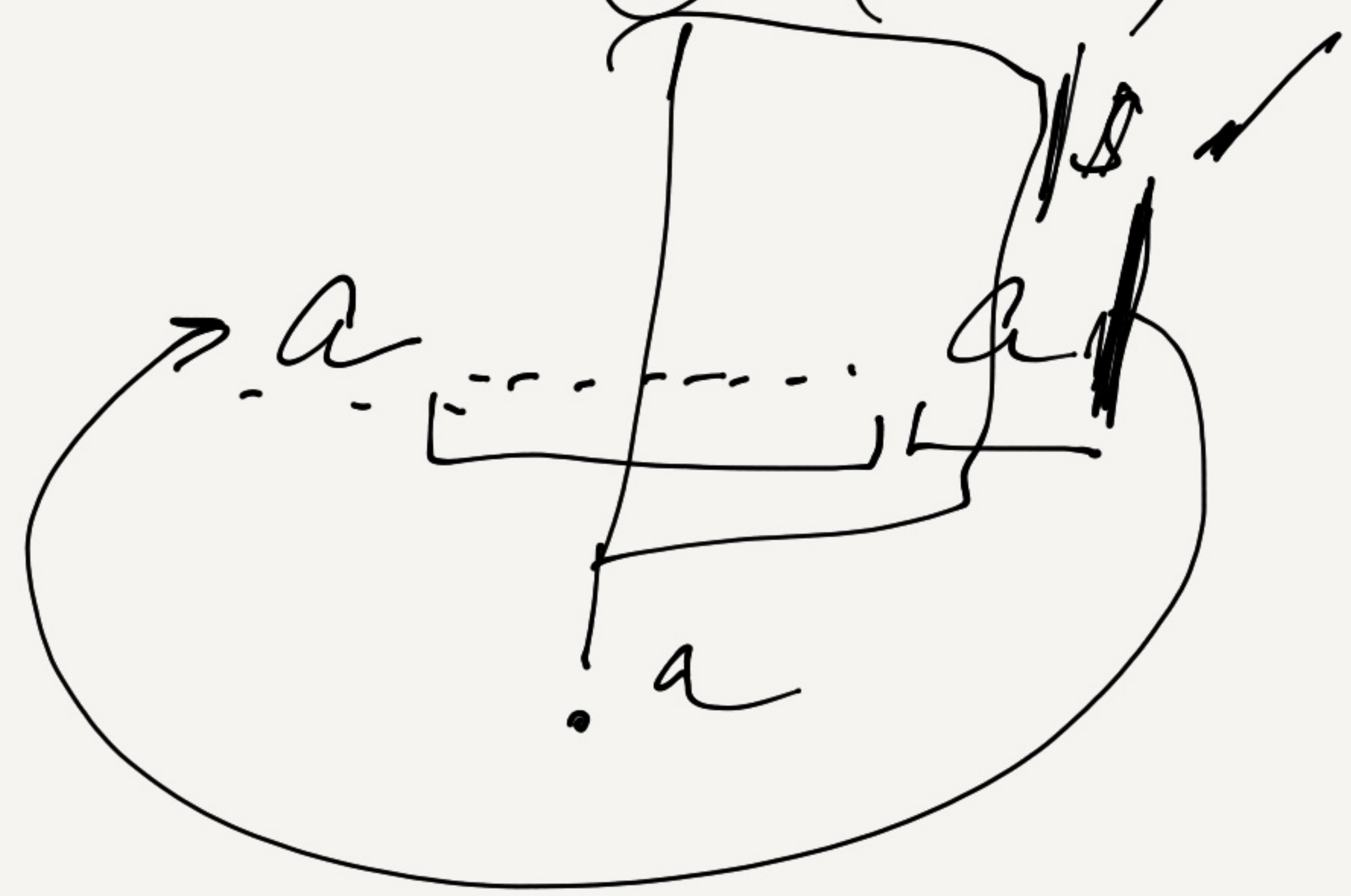
1

3

$1 \to 2 \to 4 \to 8 \ldots \to 2^n$

$O(n \log n)$

$O(n)$




a a . . .

$T = d\ c\ a\ b\ a\ c\ a\ d\ \$\ \$\ \$\ \$\ \$\ \$\ \$\ \$$

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

dc

d$

1

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ind | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 2 | 4 | 6 | 3 | 1 | 5 | 0 | 7 |
| text | $ | $ | $ | $ | $ | $ | $ | $ | a | a | a | b | c | c | d | d |
| $\boxed{c}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 3 | 3 | 4 | 4 |

2

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ind | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 1 | 3 | 5 | 2 | 0 | 4 | 15 | 6 |
| text | d$ | $$ | $$ | $$ | $$ | $$ | $$ | $$ | ca | ba | ca | ab | dc | ac | $d | ad |
| c' | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 3 | 1 | 4 | 1 | 0 | 1 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ind | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 2 | 4 | 6 | 3 | 1 | 5 | 7 | 0 |
| text | $$ | $$ | $$ | $$ | $$ | $$ | $$ | $d | ab | ac | ad | ba | ca | ca | d$ | dc |
| C_old | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,4 | 1,2 | 1,3 | 1,4 | 2,1 | 3,1 | 3,1 | 4,0 | 4,3 |
| c | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 |

| | | |
|---|---|---|
| 8 | \$\$ | 0 |
| 9 | \$\$ | 0 |
| 10 | \$\$ | 0 |
| 11 | \$\$ | 0 |
| 12 | \$\$ | 0 |
| 13 | \$\$ | 0 |
| 14 | \$\$ | 0 |
| 15 | \$d | 1 |
| 2 | ab | 2 |
| 4 | ac | 3 |
| 6 | ad | 4 |
| 3 | ba | 5 |
| 1 | ca | 6 |
| 5 | ca | 6 |
| 7 | d\$ | 7 |
| 0 | dc | 8 |
| ind | text | c |

4

| | | |
|---|---|---|
| 6 | ad\$\$ | 4 |
| 7 | d\$\$\$ | 7 |
| 8 | \$\$\$\$ | 0 |
| 9 | \$\$\$\$ | 0 |
| 10 | \$\$\$\$ | 0 |
| 11 | \$\$\$\$ | 0 |
| 12 | \$\$\$\$ | 0 |
| 13 | \$\$\$d | 0 |
| 0 | dcab | 8 |
| 2 | abac | 2 |
| 4 | acad | 3 |
| 1 | caba | 6 |
| 15 | \$dca | 1 |
| 3 | baca | 5 |
| 5 | cad\$ | 6 |
| 14 | \$\$dc | 0 |
| ind | text | c |

| | | | |
|---|---|---|---|
| 8 | \$\$\$\$ | 0, 0 | 0 |
| 9 | \$\$\$\$ | 0, 0 | 0 |
| 10 | \$\$\$\$ | 0, 0 | 0 |
| 11 | \$\$\$\$ | 0, 0 | 0 |
| 12 | \$\$\$\$ | 0, 0 | 0 |
| 13 | \$\$\$d | 0, 1 | 1 |
| 14 | \$\$dc | 0, 8 | 2 |
| 15 | \$dca | 1, 6 | 3 |
| 2 | abac | 2, 3 | 4 |
| 4 | acad | 3, 4 | 5 |
| 6 | ad\$\$ | 4, 0 | 6 |
| 3 | baca | 5, 6 | 7 |
| 1 | caba | 6, 5 | 8 |
| 5 | cad\$ | 6, 7 | 9 |
| 7 | d\$\$\$ | 7, 0 | 10 |
| 0 | dcab | 8, 2 | 11 |
| ind | text | c_old | c |

| d | c | a | b | a | c | a | d | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

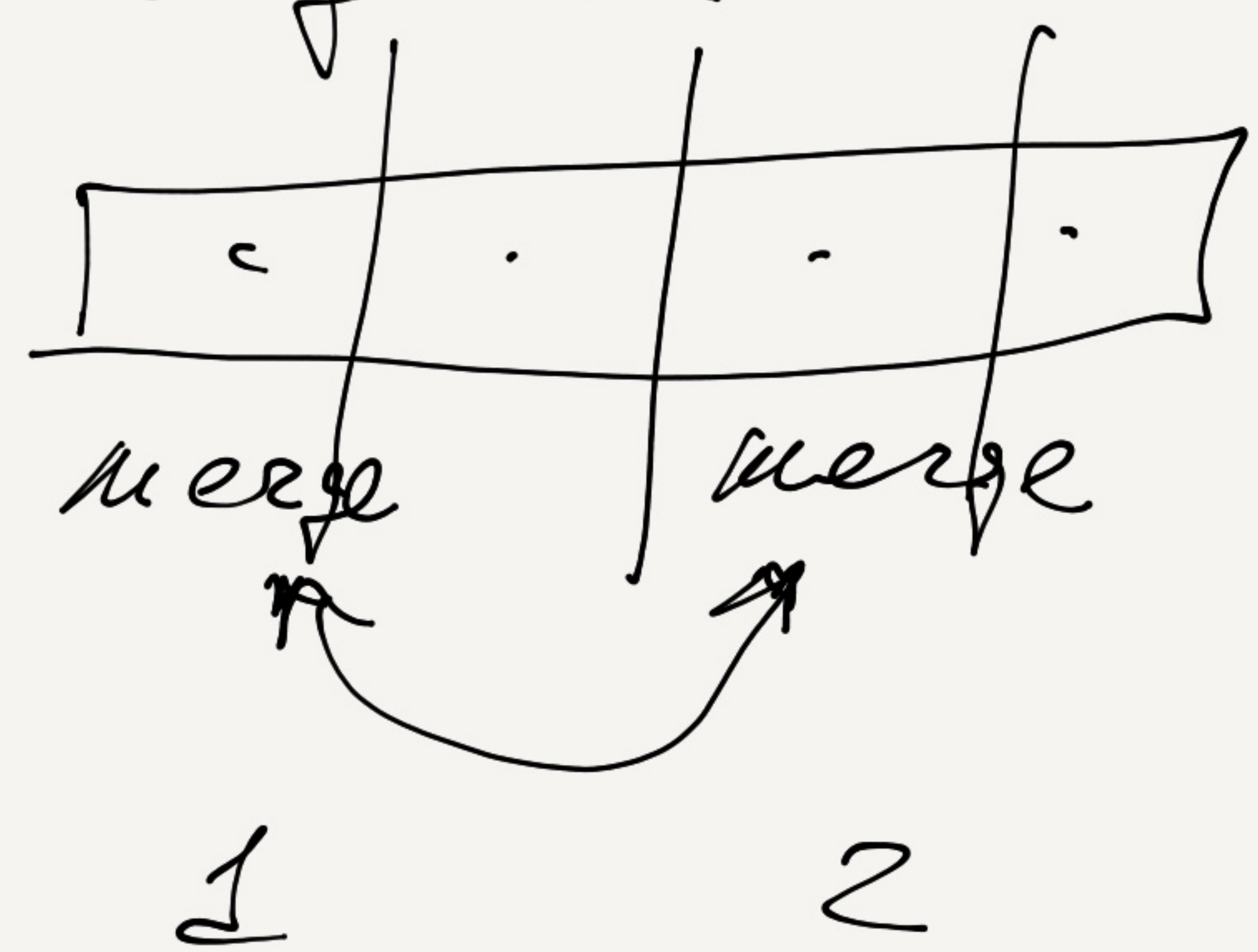
e-maxx.ru

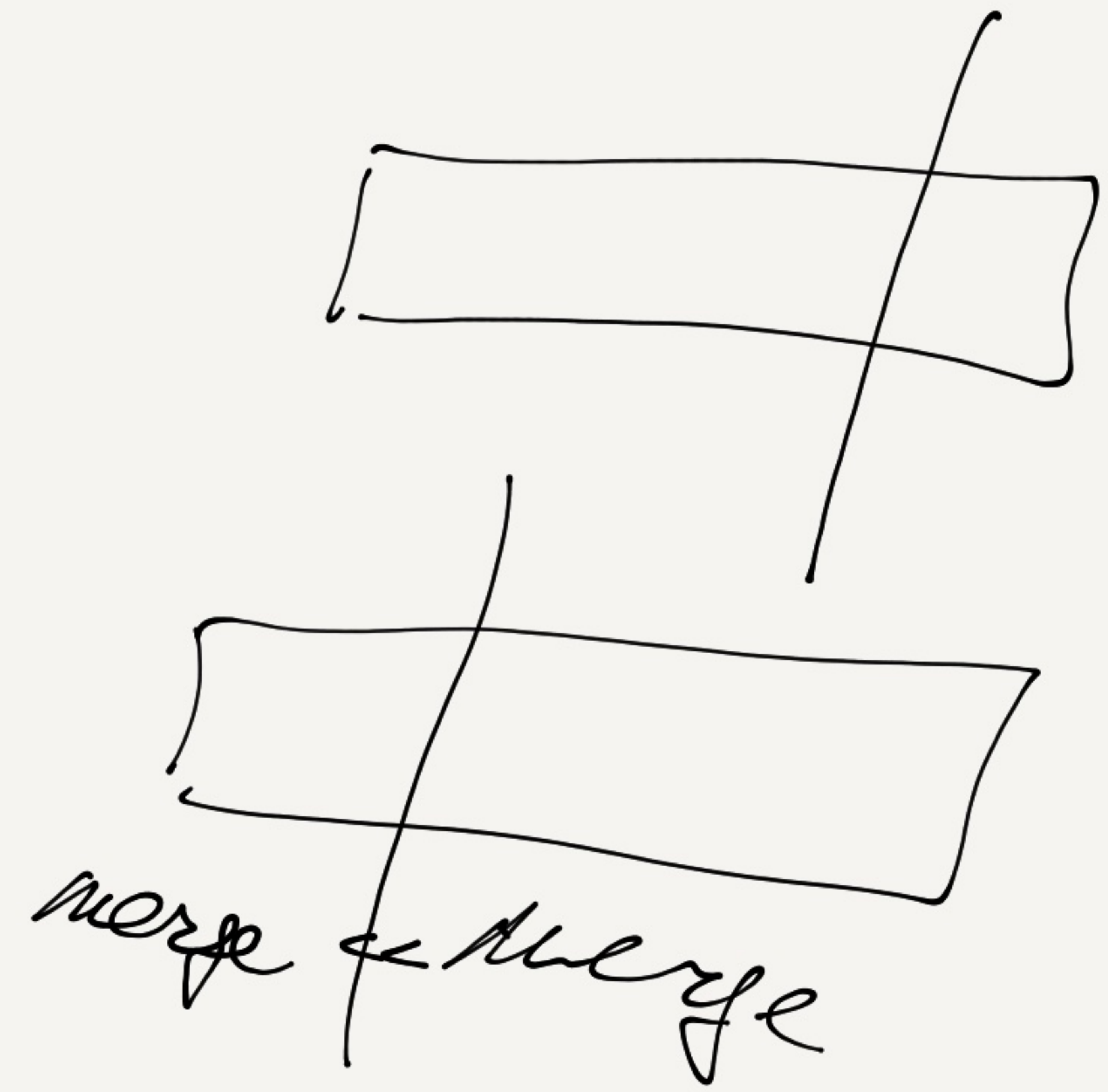
$O(n \log n)$.

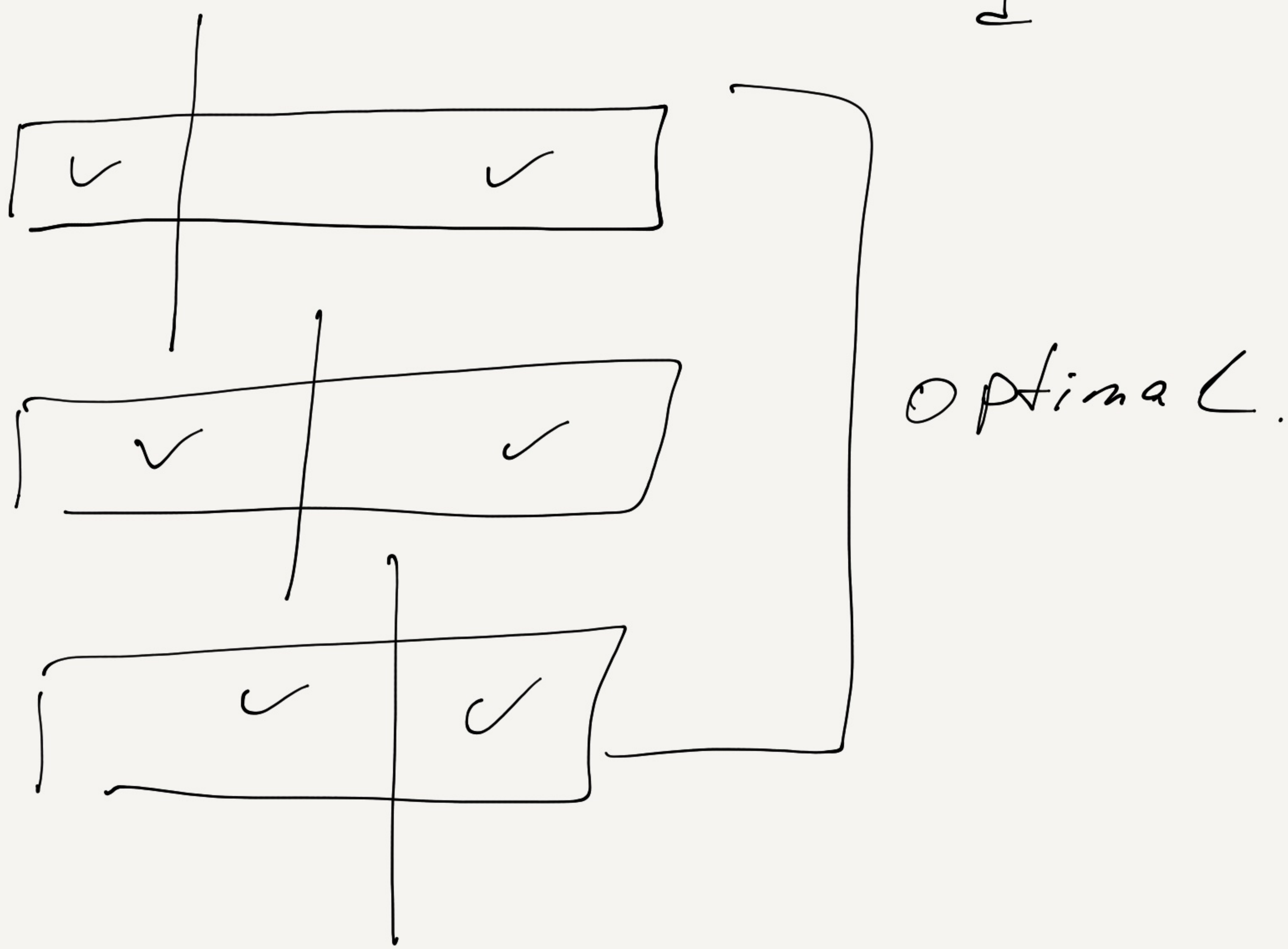
ДП

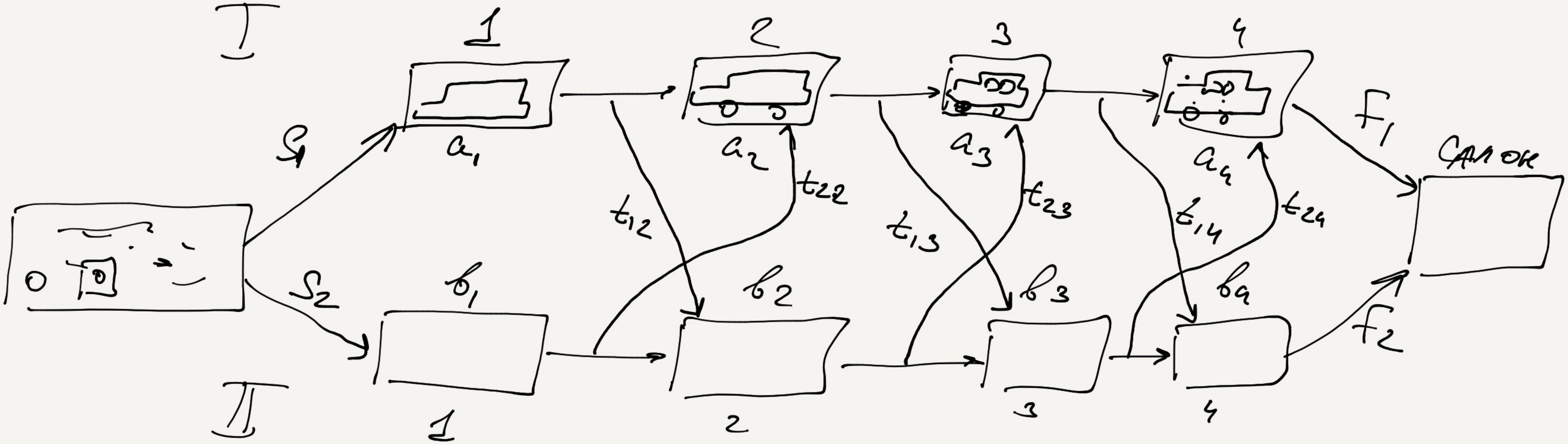
Кормен, гл. 15.

merge sort

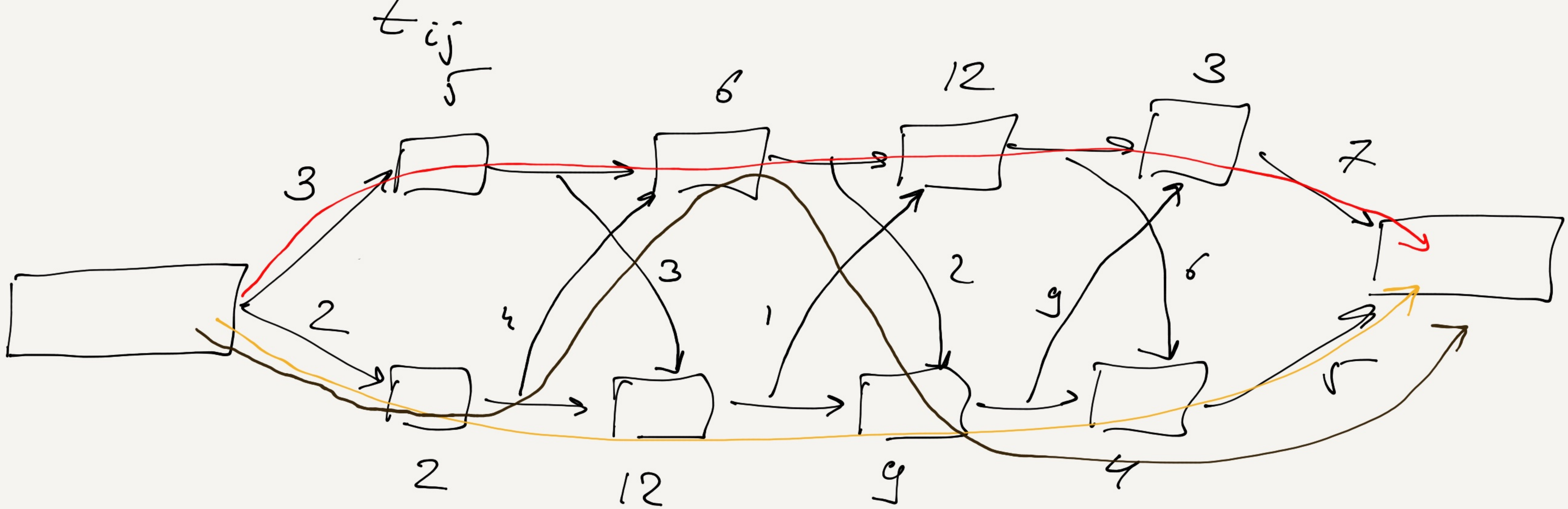





$3+5+6+12+3+7=36$



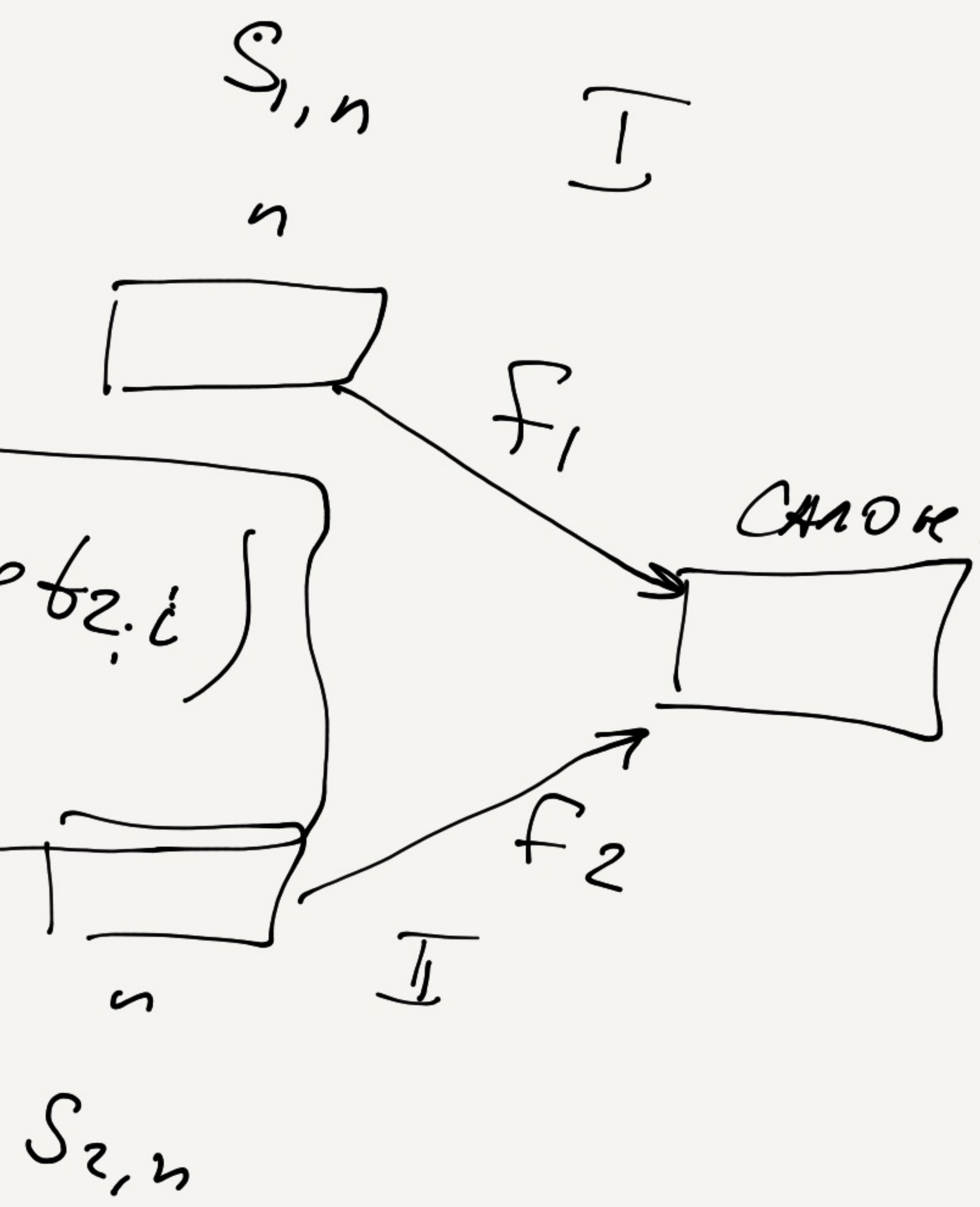

$2+2+12+9+4+5=34.$

$2+2+4+6+2+9+4+5=34.$

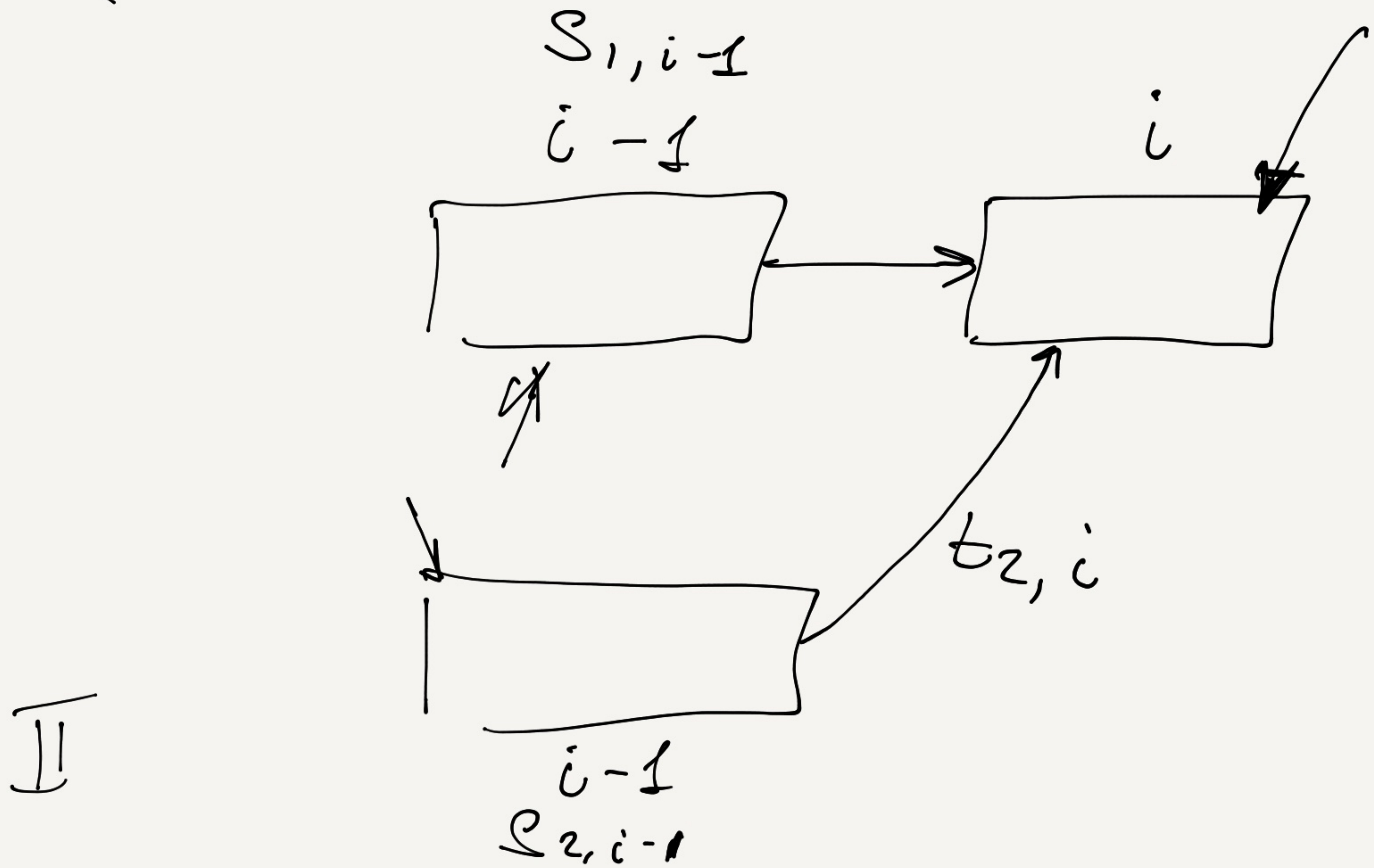
$n$ 0 1

$O(n \cdot 2^n)$

$$\boxed{S_{1,i} = a_i + \min(S_{1,i-1},\ S_{2,i-1} + t_{2,i})}$$




$$\min(S_{1,n} + f_1,\ S_{2,n} + f_2)$$




I

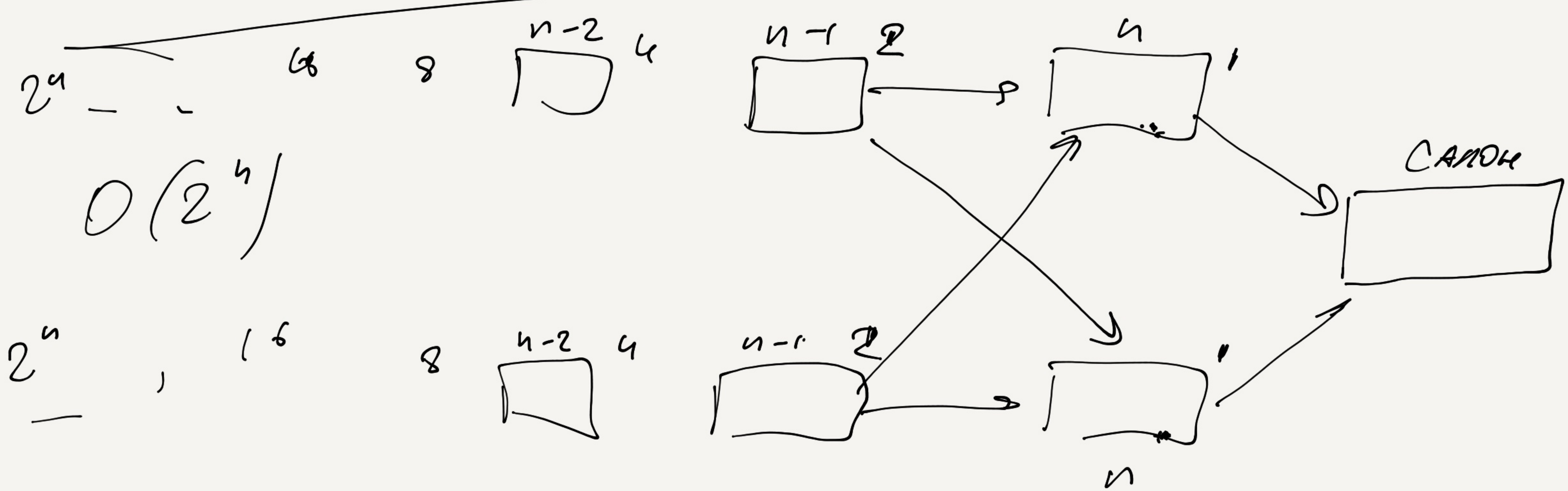
$$S_{1,i} = S_{1,i-1} + a_i$$

$$S_{1,i} = S_{2,i-1} + t_{2,i} + a_i$$

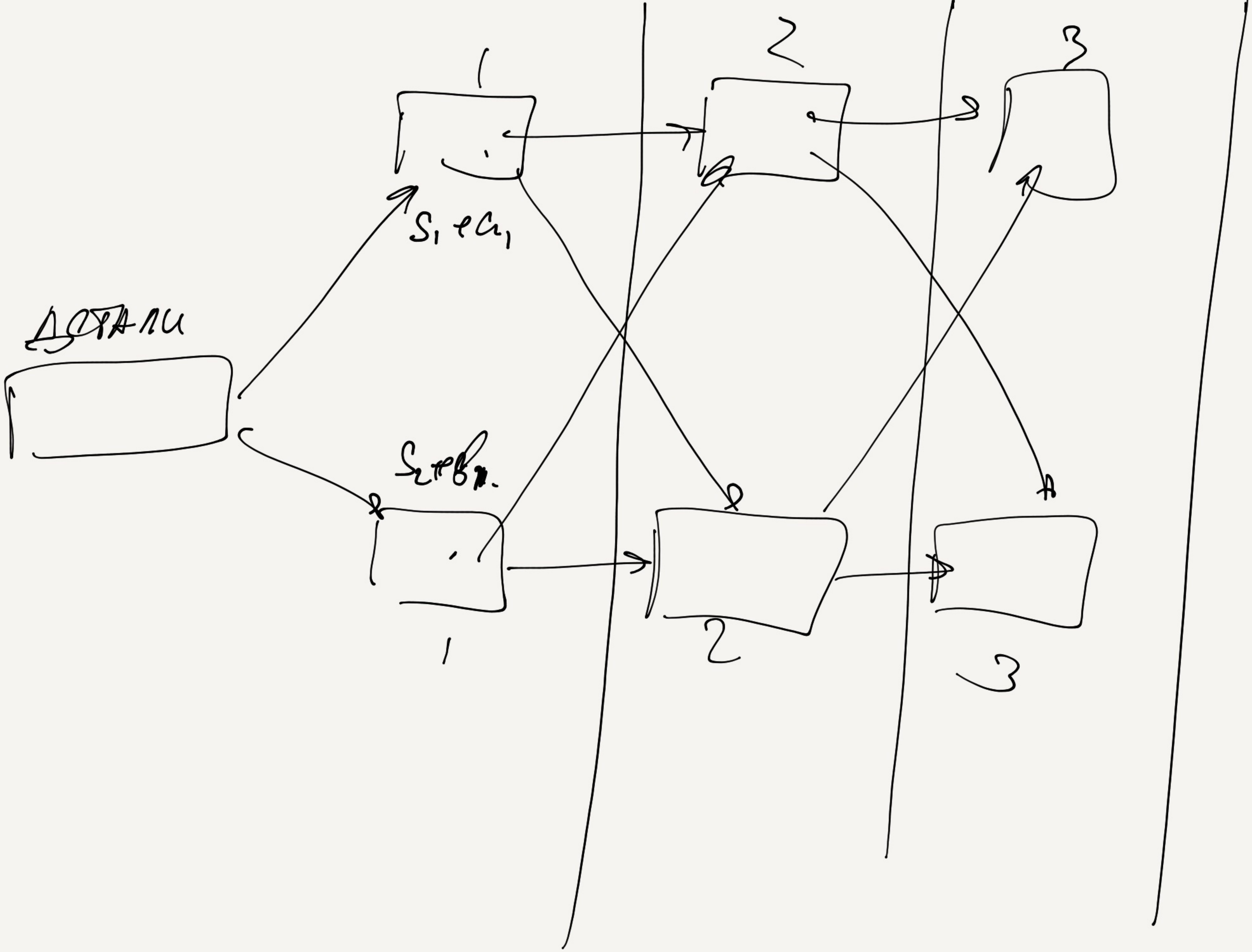
$$\begin{cases} S_{1,i} = a_i + \min(S_{1,i-1},\ S_{2,i-1} + t_{2,i}) \\ S_{2,i} = b_i + \min(S_{2,i-1},\ S_{1,i-1} + t_{1,i}) \end{cases}$$

$$\begin{cases} S_{1,1} = S_1 + a_1 \\ S_{2,1} = S_2 + b_1 \end{cases}$$

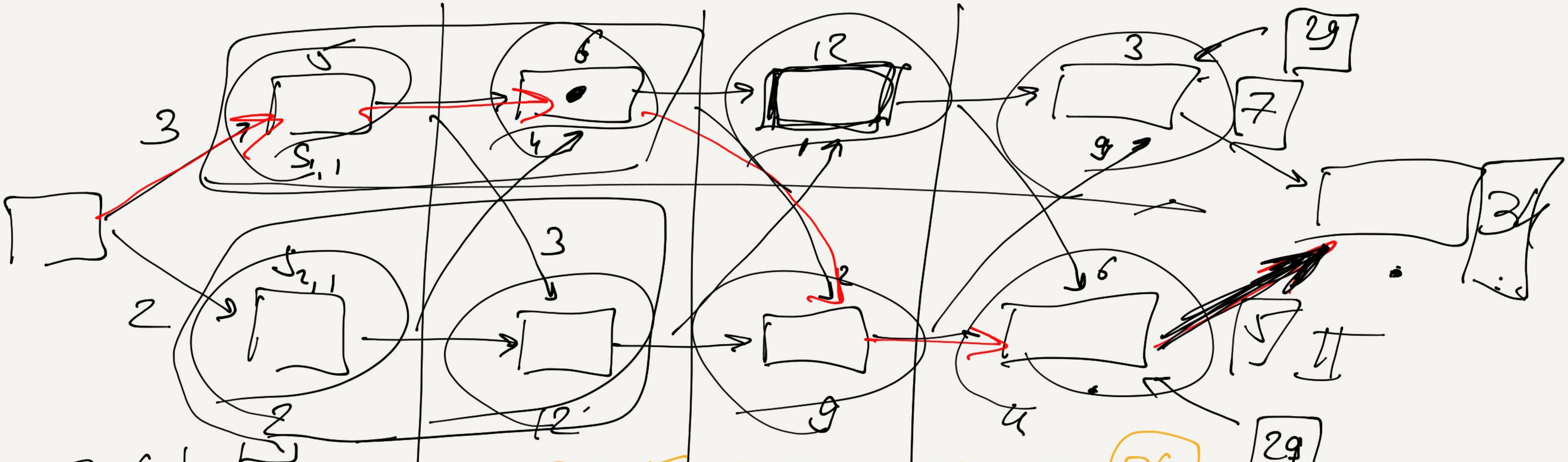
$$\text{Result} = \min(S_{1,n} + f_1,\ S_{2,n} + f_2)$$




$O(2^n)$



Детали
1
2
3
$S_1$ еа,
$S_2$ ев.
1
2
3




$3+5+6+2+9+4+5 = 34$

$O(n)$

$S_{1,1} = 3+5 = 8$

$S_{2,1} = 2+2 = 4$

$S_{1,2} = \min(S_{1,1}, S_{2,1} + t_{2,2}) + a_2 =$

$= \min(8, 4+4) + 6 = 14$

$\min(29+7, 29+5) = 34$

$S_{2,2} = \min(4, 11) + 12 = 16$

$S_{1,3} = \min(14, 16+1) + 12 = 26$

$S_{2,3} = \min(16, 14+2) + 9 = 25$

$S_{1,4} = \min(26, 25+9) + 3 = 29$

$S_{2,4} = \min(25, 26+6) + 4 = 29$

$l_{1,2} = 1$

$l_{2,2} = 2$

$l_{1,3} = 1$

$l_{2,3} = 1$

$l_{1,4} = 1$

$l_{2,4} = 2$.

$\boxed{1} \rightarrow \boxed{1} \rightarrow \boxed{2} \rightarrow \boxed{2}$

$A_1 \quad A_2 \quad A_3 \quad \dots \quad A_n.$

$p_0 \times p_1 \quad p_1 \times p_2 \quad p_2 \times p_3 \dots \quad p_{n-1} \times p_n$

$A_i \cdot A_{i+1}$

$p_{i-1} \times p_i \quad p_i \times p_{i+1}.$

$A_1 \quad A_2 \quad A_3$

$100 \times 10 \quad 10 \times 50 \quad 50 \times 5$

$(A_1 \; A_2) A_3$

$100 \times 50 \quad 50 \times 5$

$$\left.\begin{array}{l} 100 \cdot 10 \cdot 50 = 50000 \\ 100 \cdot 50 \cdot 5 = 25000 \end{array}\right] \underline{\underline{75000}}$$

$A_1 A_2 \dots A_{i-1} (A_i A_{i+1}) A_{i+2} \dots A_n$

$A_1 A_2 \dots A_{i-1} \bar{A} A_{i+2} \dots A_n.$

$p_{i-1} \times p_{i+1}$

$p_{i-1} \cdot p_0 \cdot p_{i+1}$

$n \longrightarrow n-1$

$A_{1 \dots i} \; A_{i+1 \dots n}.$

$p_0 \cdot p_i \cdot p_n + C_{1 \dots i} + C_{i+1 \dots n}.$

$A_1 (A_2 \; A_3)$

$100 \times 10 \quad 10 \times 5$

$$\left.\begin{array}{l} 10 \cdot 50 \cdot 5 = 2500 \\ 100 \cdot 10 \cdot 5 = 5000 \end{array}\right] \underline{\underline{7500}}$$

$A_{1 \dots i} \; A_{i+1 \dots n}$

$C_{1,i} + C_{i+1,n} + p_0 \cdot p_i \cdot p_n$

$A_1 (A_2 \dots A_n)$

$(A_1 A_2)(A_3 \dots A_n)$

$(A_1 A_2 A_3)(A_4 \dots A_n)$

Result = min $\left( \boxed{C_{1,k}} + \boxed{C_{k+1,n}} + p_0 \cdot p_k \cdot p_n \right)$

$\boxed{k}$

$4^n$

$(A_{1 \dots n-1}) A_n$.

$(A_i A_{i+1}) A_{i+2}$

$A_1 A_2$ , $A_2, A_3$ , $A_3, A_4 \dots$ $A_{n-1}, A_n$

$A_1 A_3$ , $A_2, A_4$ , ... , $A_{n-2}, A_n$

$A_1 A_4$ _ $A_2$ $A_5$ _ _ $A_1 A_n$

$A_1 A_{n-1}$ $A_2 A_n$

$A_1 A_2 A_3 A_4$

$((A_1 A_2) A_3) A_4$ I

$((A_1 A_2)(A_3 A_4))$ 0

$(A_1 (A_2 (A_3 A_4)))$ II

$((A_1 (A_2 A_3)) A_4)$ I

$(A_1 ((A_2 A_3) A_4))$ II

$\underline{A_1 A_2}$, $A_2 A_3$, $\underline{A_3 A_4}$

$\underline{A_1 A_2 A_3}$, $A_2, A_3, A_4$

$A_1 A_2 A_3 A_4$.

5

min( - - - ) opt

opt

$(A_1 \dots A_i)(A_{i+1} \dots A_n)$

$\boxed{p_0 \cdot p_i \cdot p_n} + \underline{C_{1,i}} + \underline{C_{i+1,n}}$

$(A_1 A_2)(A_3 A_4)$

$((A_1 A_2) A_3) A_4$ $\quad$ $(A_1 (A_2 A_3)) A_4$

$\underline{(A_{1 \dots 3})} A_4$.

for $m = 2$ to $n$:

for $i = 1$ to $n - m + 1$:

for $j = i$ to $i + m - 1$:

if $C_{ij} + C_{j,i+m-1} + P_{i-1} \cdot P_j \cdot P_{i+m-1} < opt$:

$opt = C_{ij} + C_{j,i+m-1} + P_{i-1} \cdot P_j \cdot P_{i+m-1}$.