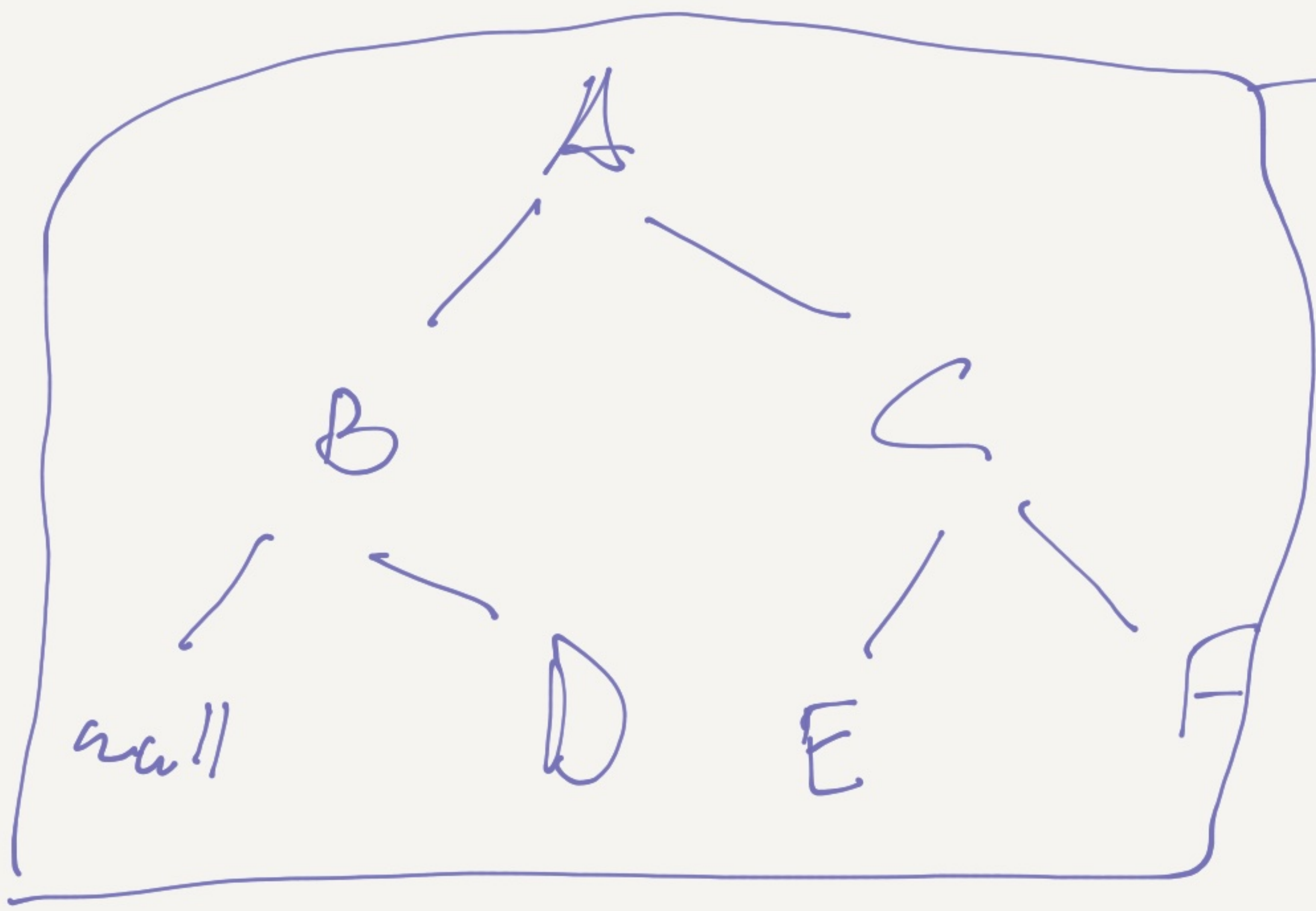
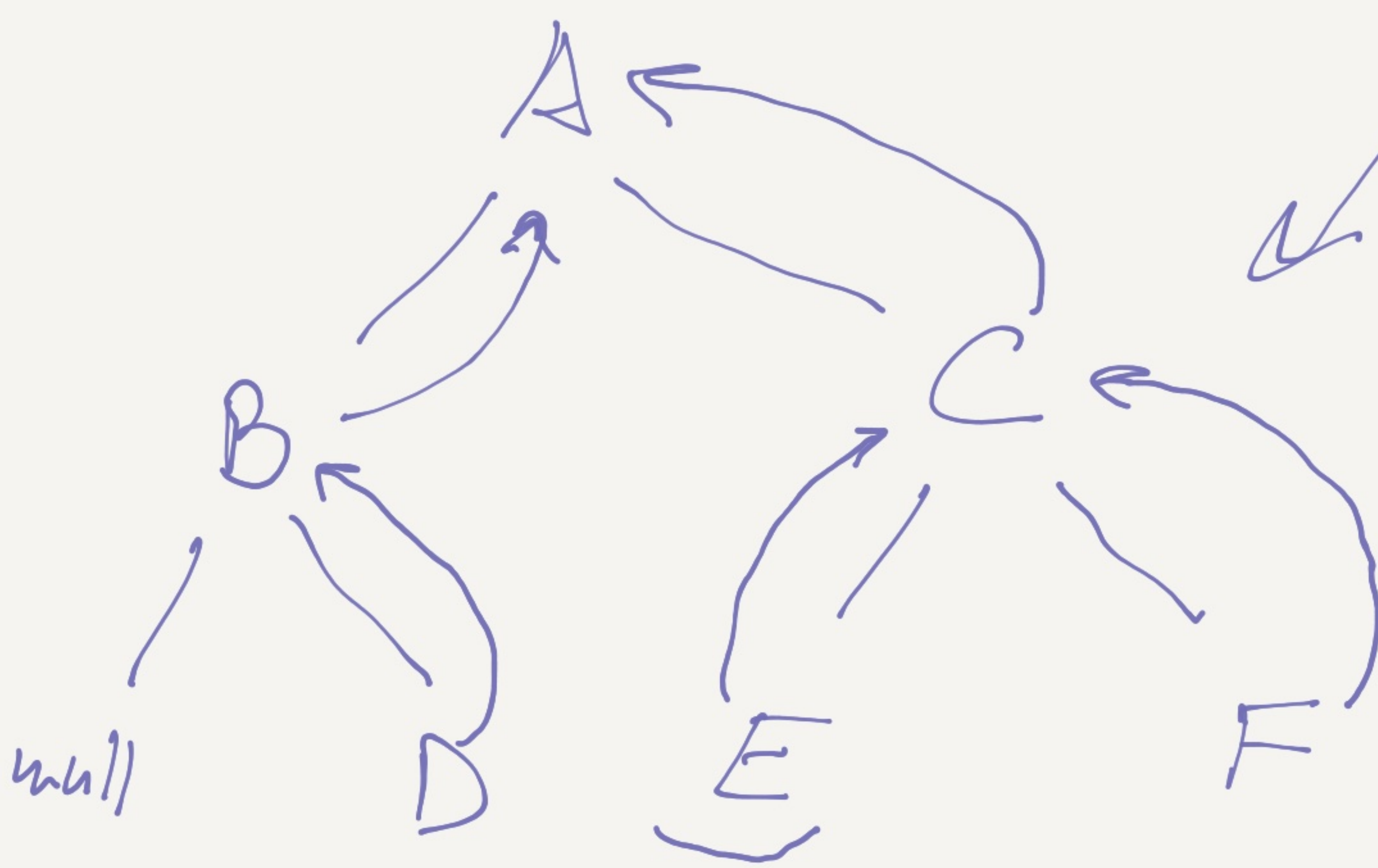


$size_A$ A 0 | $size_B$ B 0, 0

$size_{null}$

$size_D$ D 1 | $size_C$ C 0 $size_E$ E 1

$size_F$ F 1 |



КМП

БМ

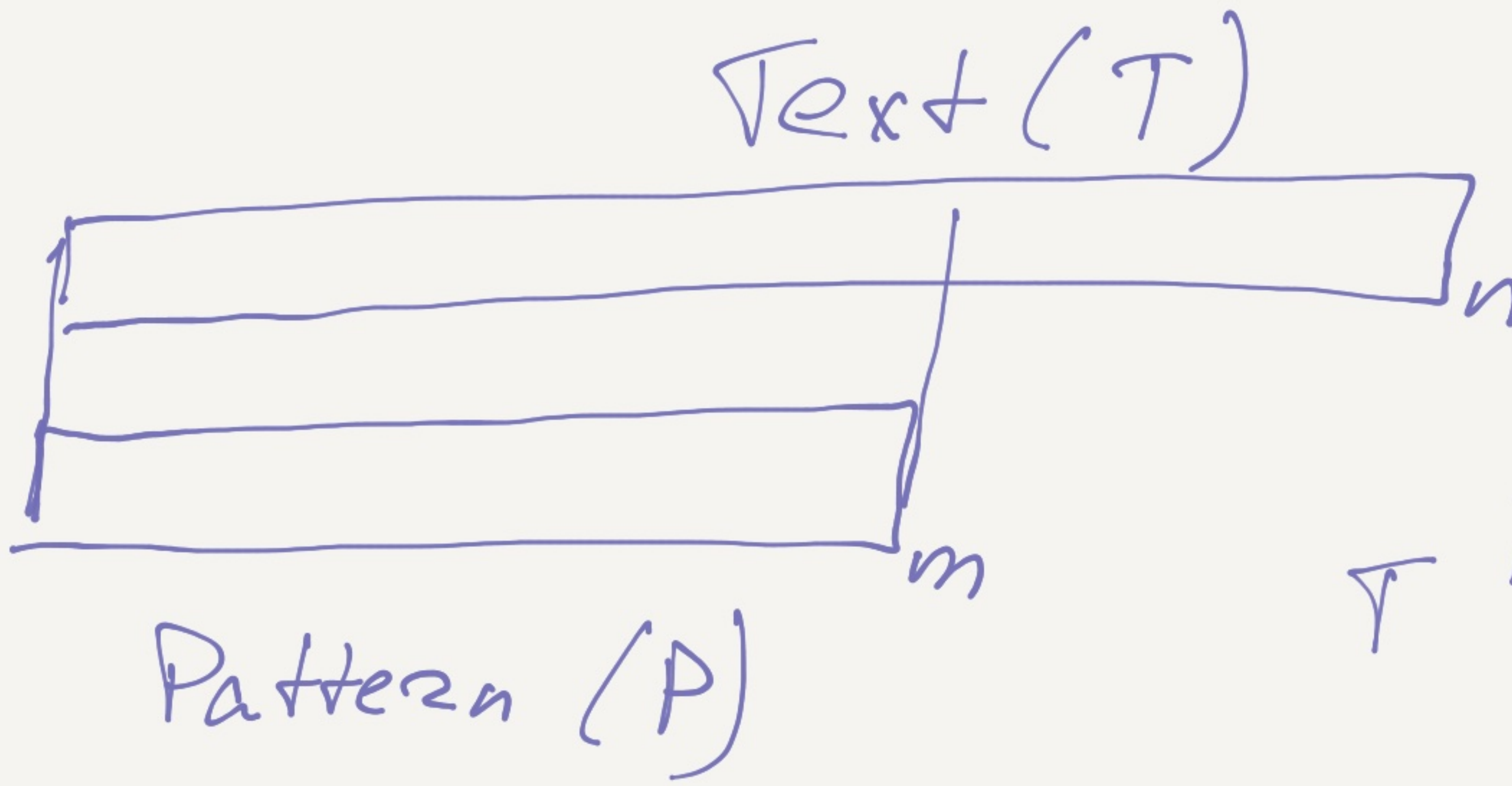
АД

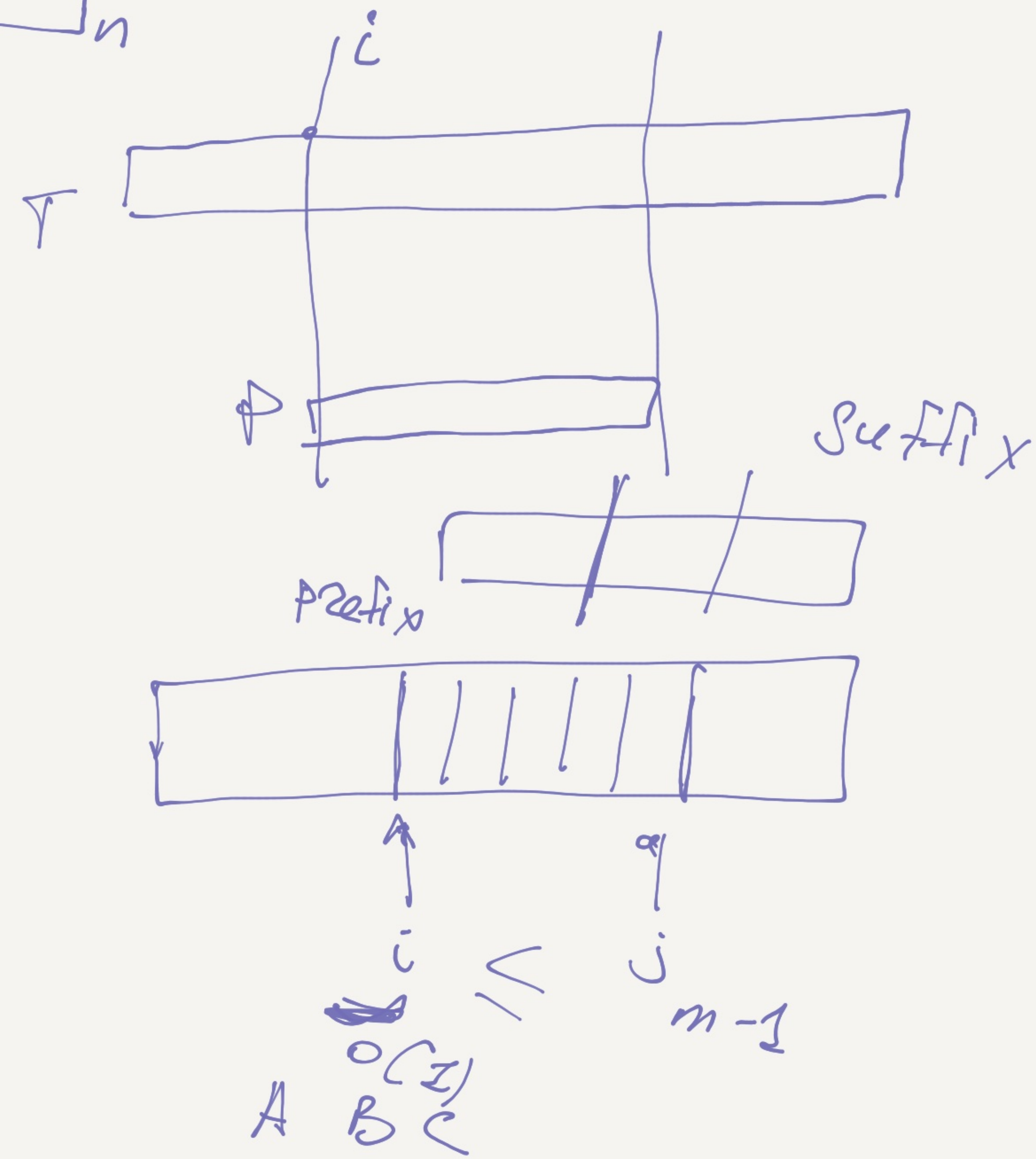
Гасфилд "Строки, деревья и последовательности в алгоритмах".

$T = \boxed{AB}C\boxed{ABC}\boxed{AB}$

0 1 2 3 4 5 6 7

4 4 3, 5





$\exists i : \forall k \in [0; m-1] :$

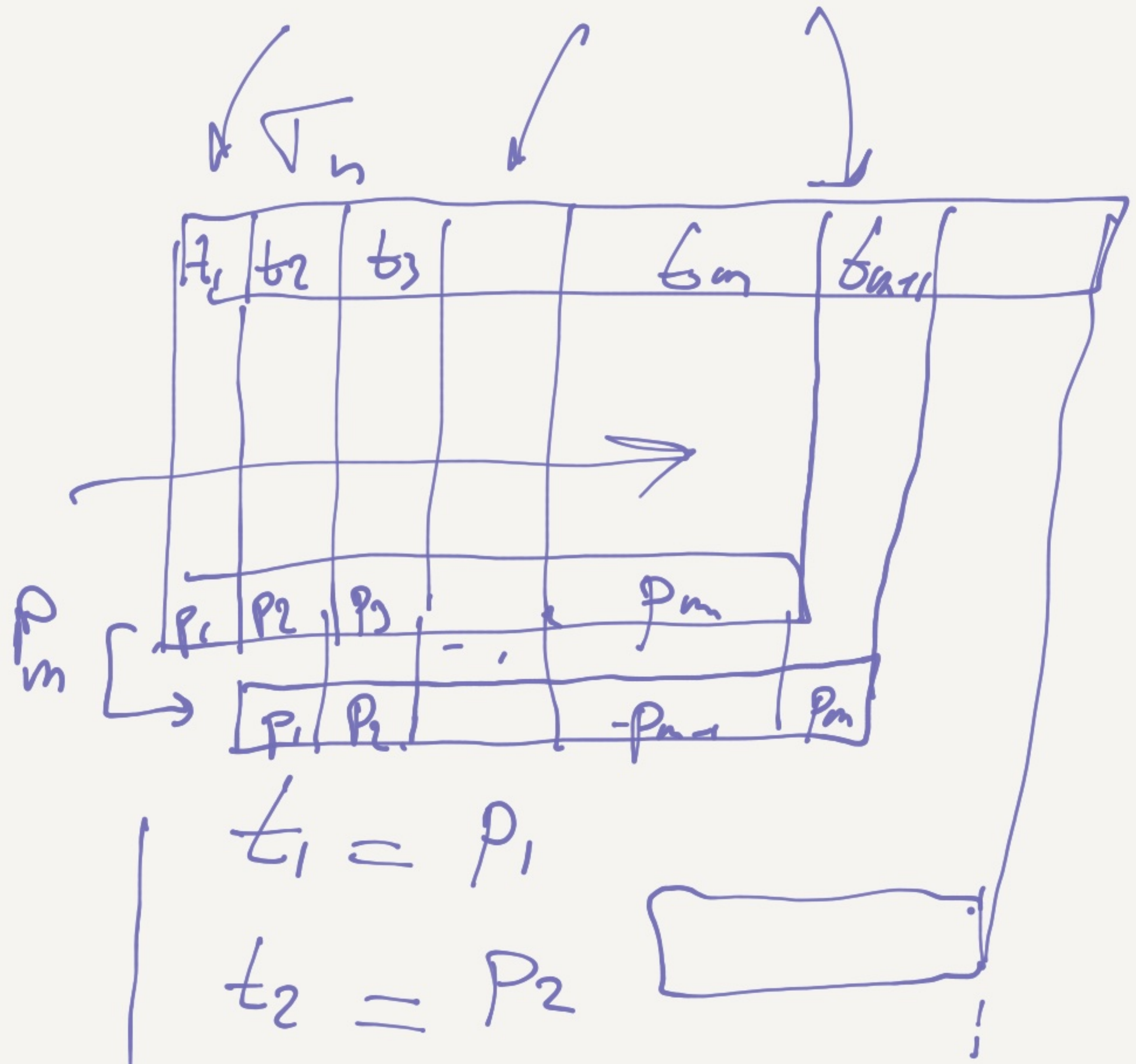
$T[i+k] = P[k]$

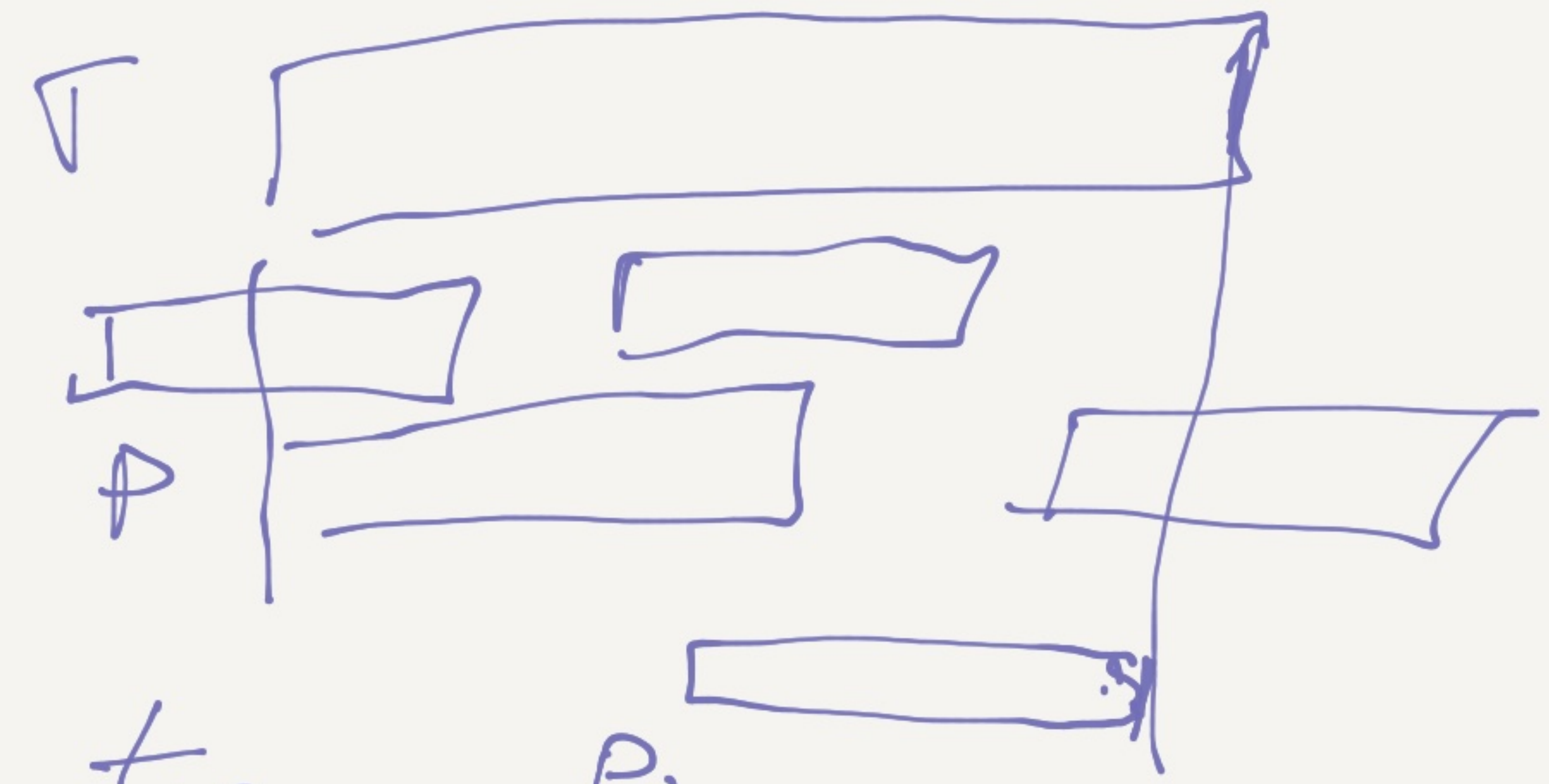
$T[i] = P[0]$

$T[i+1] = P[1]$

. — — —

$T[i+m-1] = P[m-1]$





$t_1 = p_1$

$t_2 = p_2$

$t_3 = p_3$

. . . . .

$t_m = p_m$

t_2 p_1

t_3 p_2

. . . . .

t_m p_{m-1}

t_{m+1} p_m

t_{n-m+1} p_1

m

$k \cdot m$

$k \cdot m^2 - m^2 =$
$= (k-1)m^2$

t_{n-1} p_{m-1}

t_n p_m

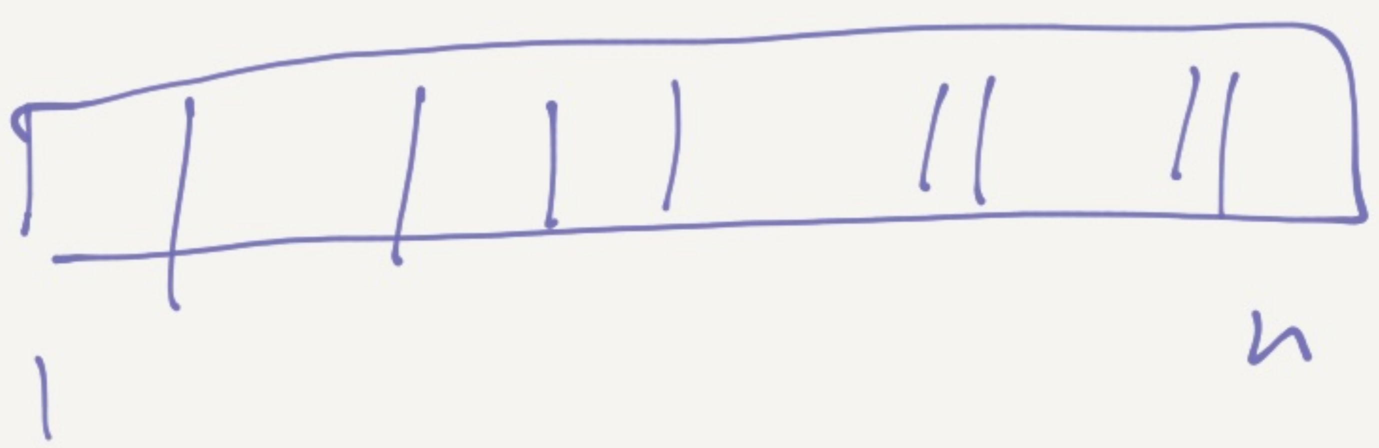
```
for i = 1 to n-m+1:   ← n-m
    for j = 1 to m:   ← m
        if p_j != t_i:
            break
    if j == m && p_j == t_i:
        вхождение.
```

$(n-m)m =$

$= nm - m^2.$

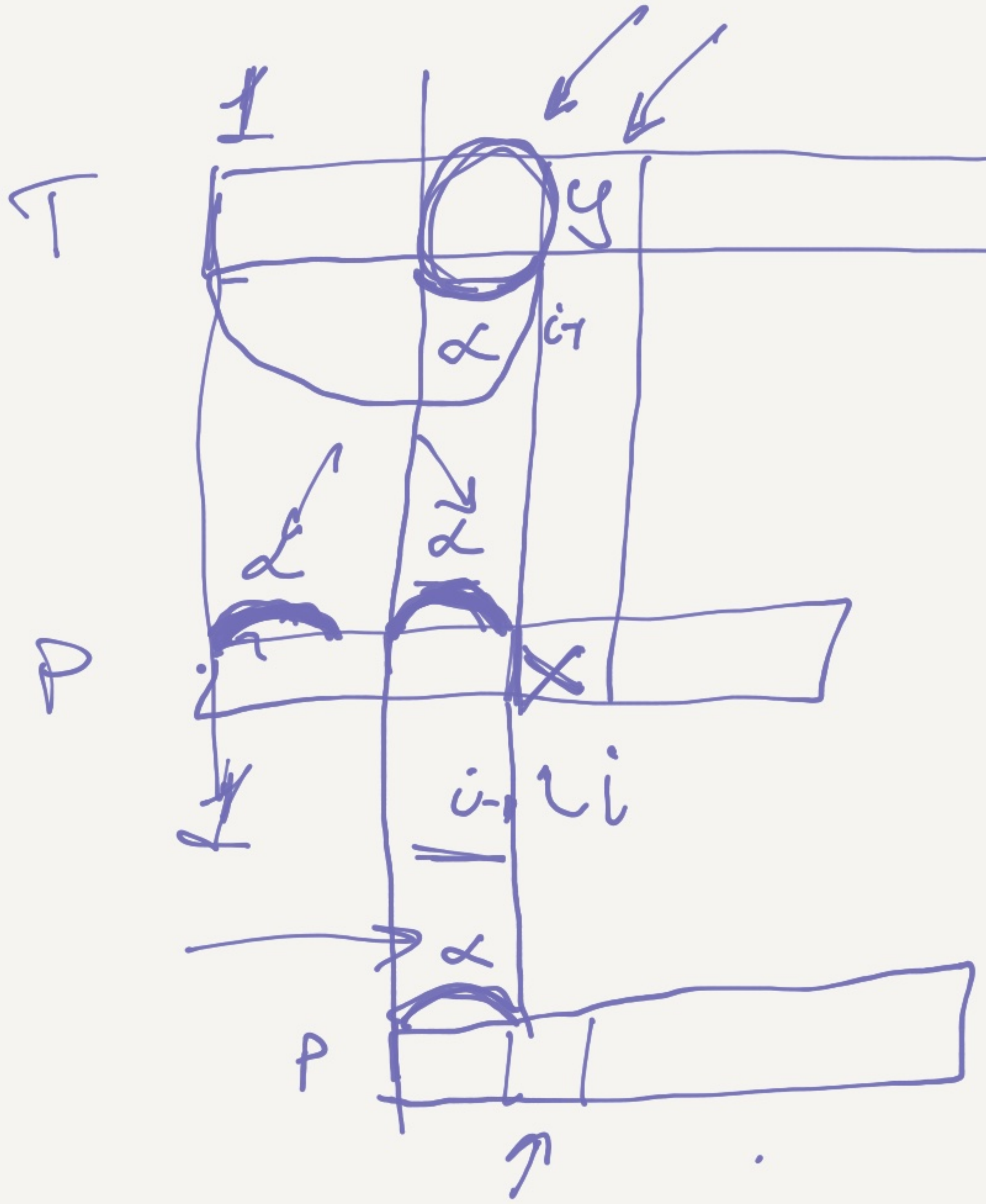
$O(n \cdot m)$

Кнута – Морриса – Пратта



$$\underbrace{\begin{matrix}1-1\\1-2\\1-3\\1-4\\\ldots\\1-n\end{matrix}}_{n}\qquad\underbrace{\begin{matrix}2-2\\2-3\\2-4\\\ldots\\2-n\end{matrix}}_{n-1}\qquad\begin{matrix}3-3\\3-4\\\ldots\\n-2\end{matrix}\qquad\ldots\qquad\underbrace{\begin{matrix}(n-1)-(n-1)\\(n-1)-n\end{matrix}}_{2}\qquad\begin{matrix}n-n\\1\end{matrix}$$

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



I ? II

$$\begin{cases} p_1 = t_1 \\ p_2 = t_2 \\ \dots \\ p_{i-1} = t_{i-1} \end{cases}$$

$\rightarrow p_i \neq t_i$

$x \quad y$

$p_1 \neq t_2$

$p_2 = t_3$

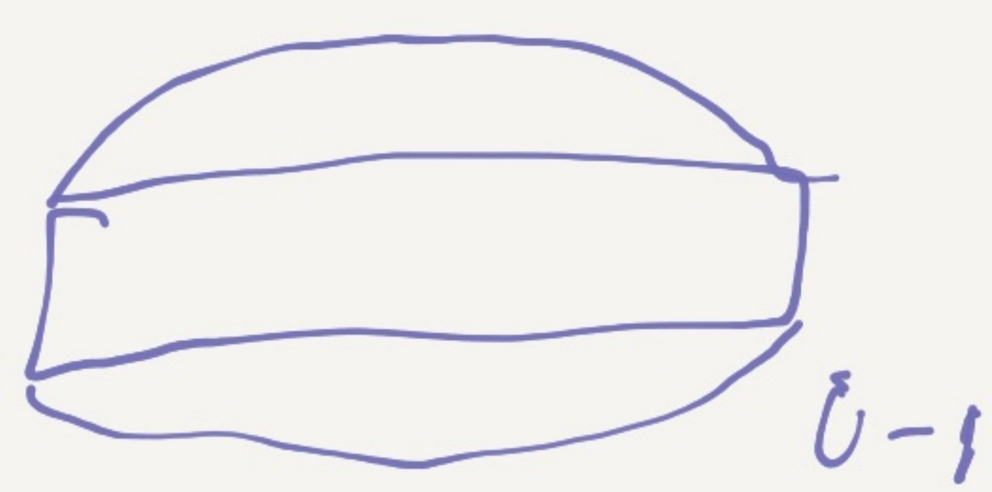
$\dots$

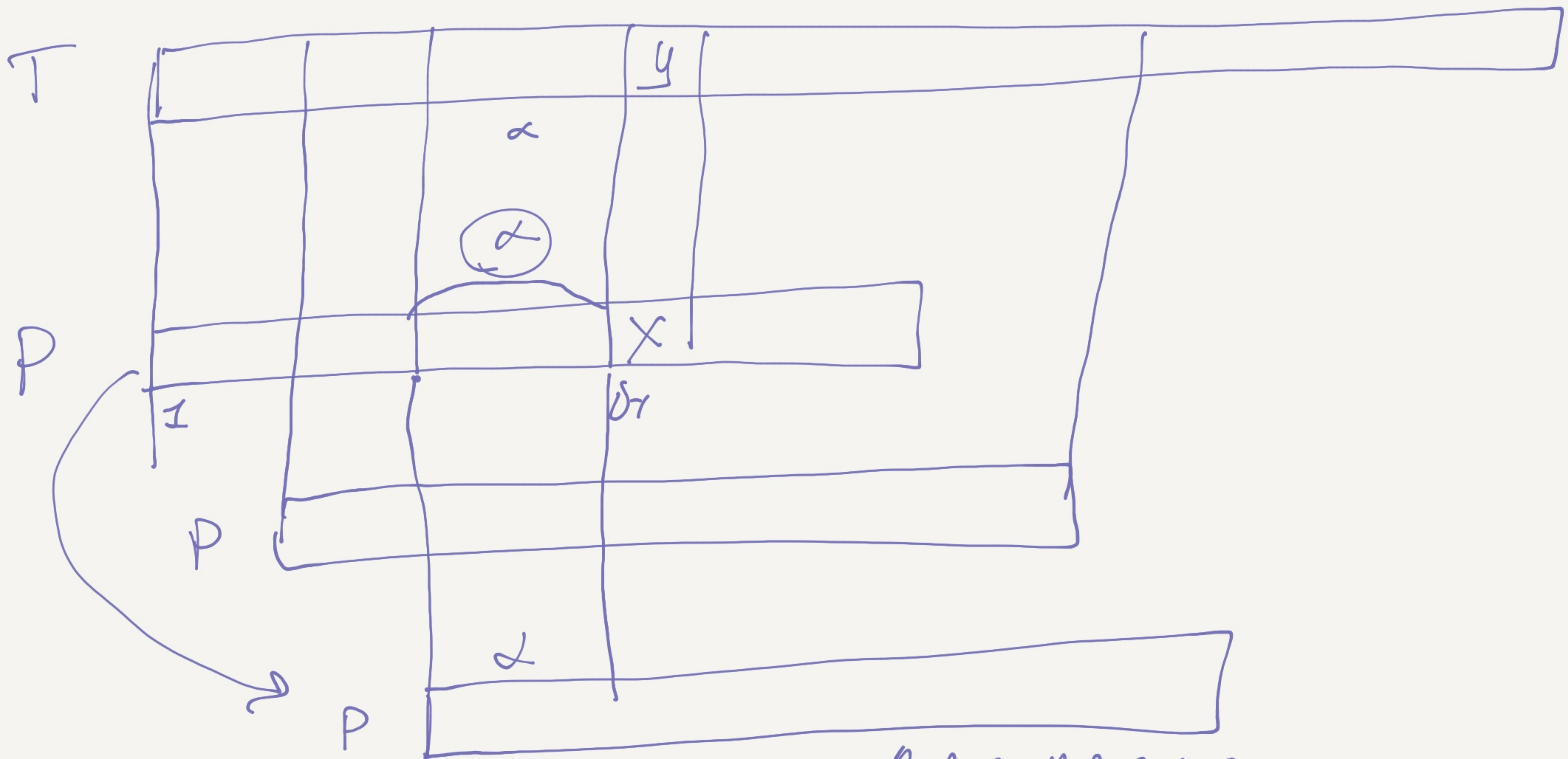
$p_1 \neq t_3$

$p_1 \neq t_4$

$p_1 = t_5$

$P_{|\alpha|+1} \quad t_i$





ABCABCAB

P = ABCABCAB

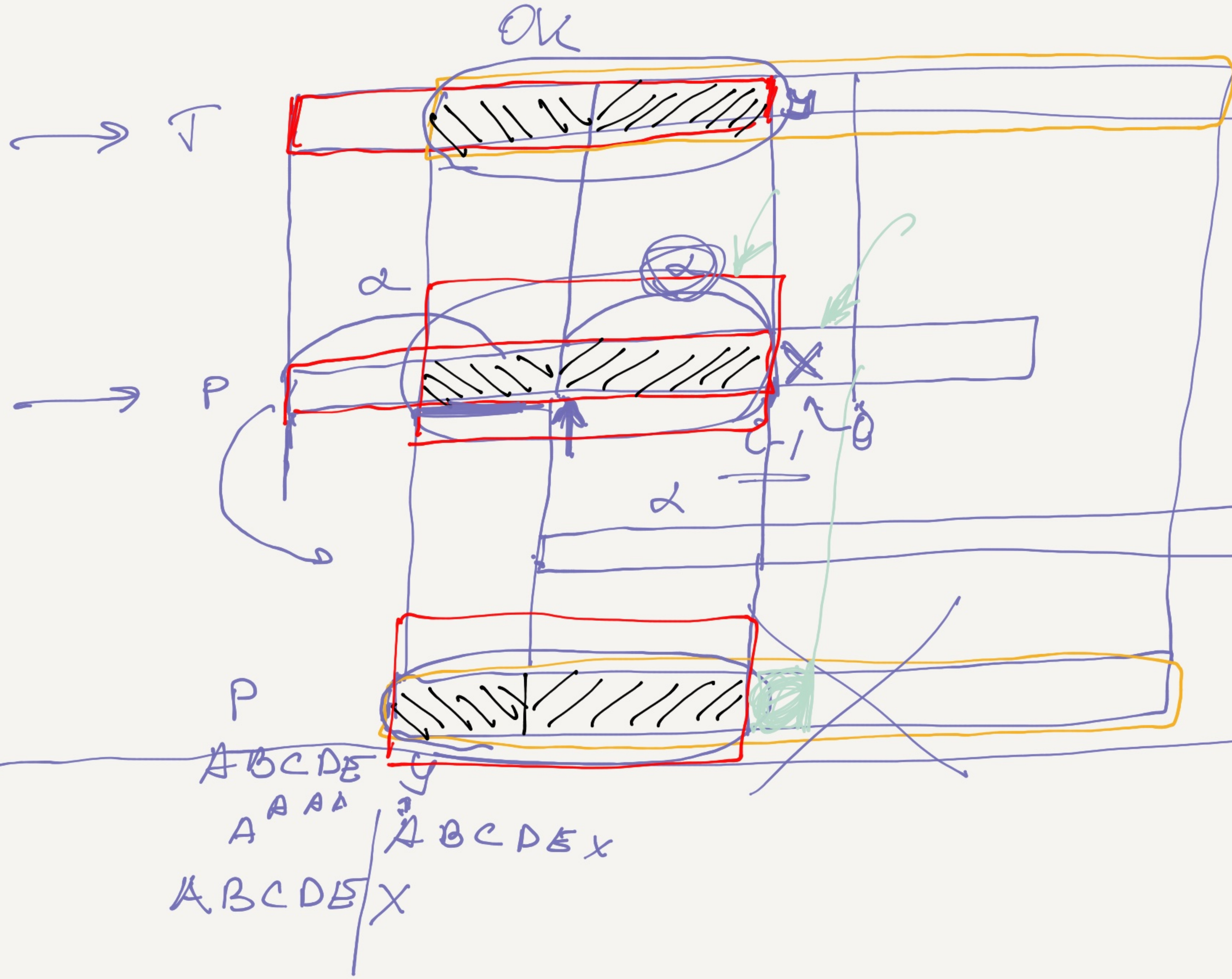
ABCABCAB

α

$P[1..|\alpha|] == P[i-|\alpha|; i-1]$

$\alpha = max.$

$\alpha < i-1$



$P[1 \dots i-1]$

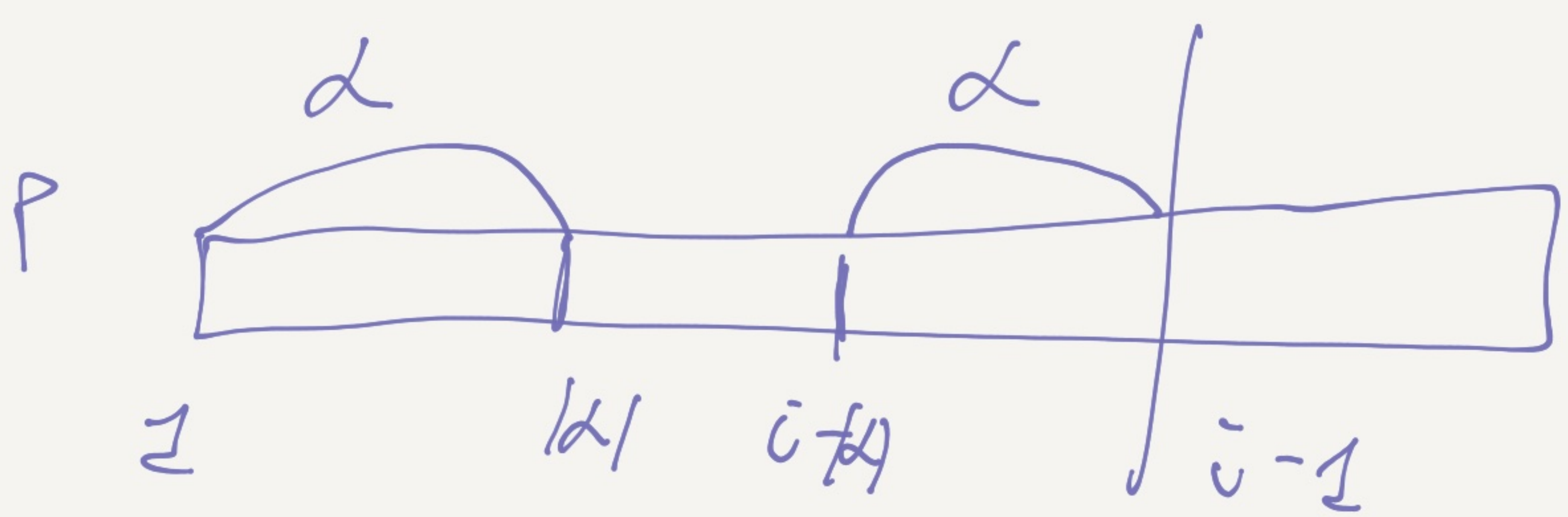
$P_1 = P_{i-|\alpha|}$

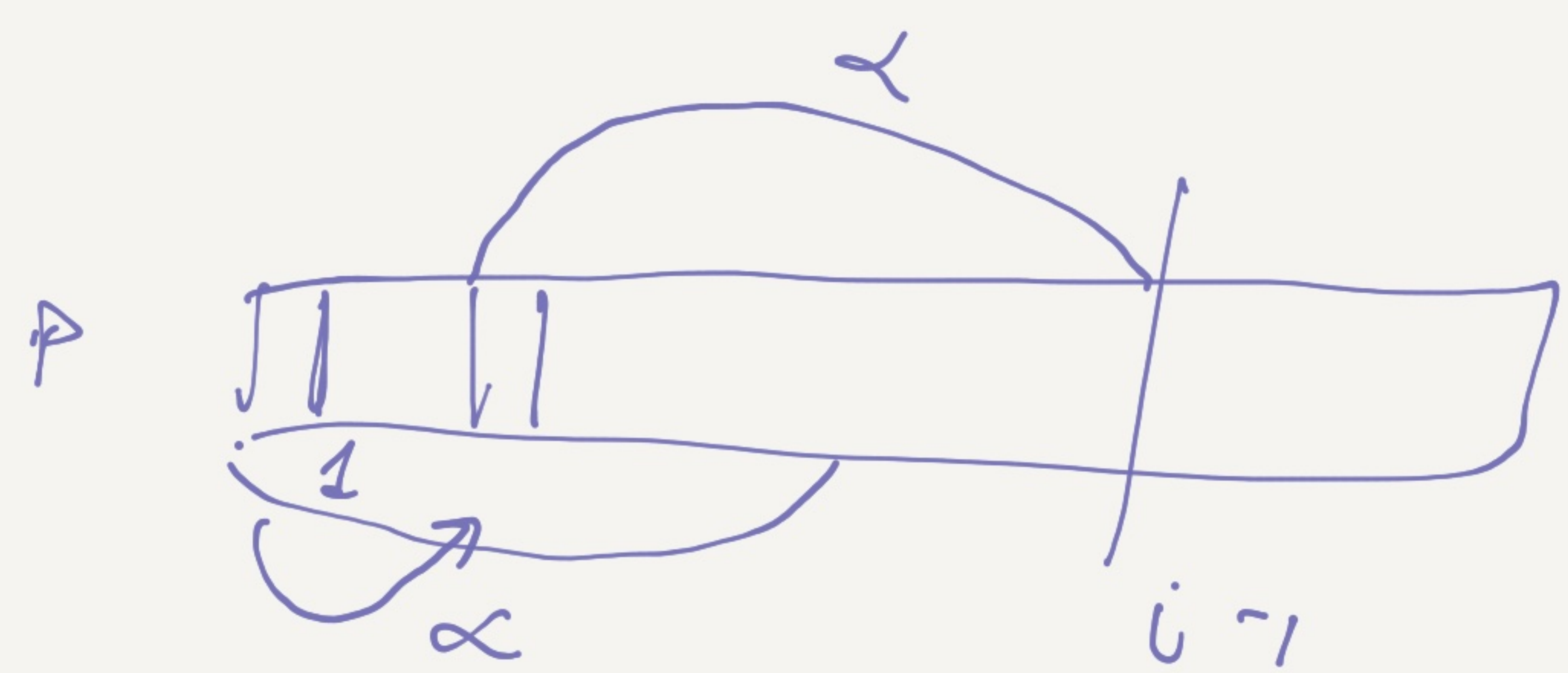
$P_2 = P_{i-|\alpha|+1}$

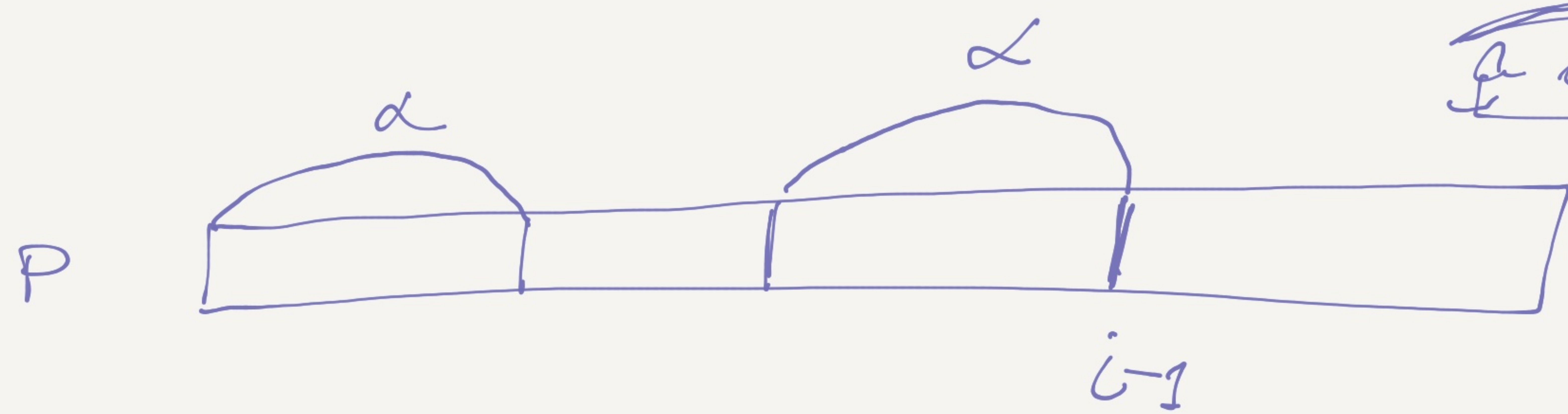
$\dots$

$P_{|\alpha|} = P_{i-1}$

ABCDEA







abcabcab

abcabc

1 .... i-1

SP_1

SP_2

⋮

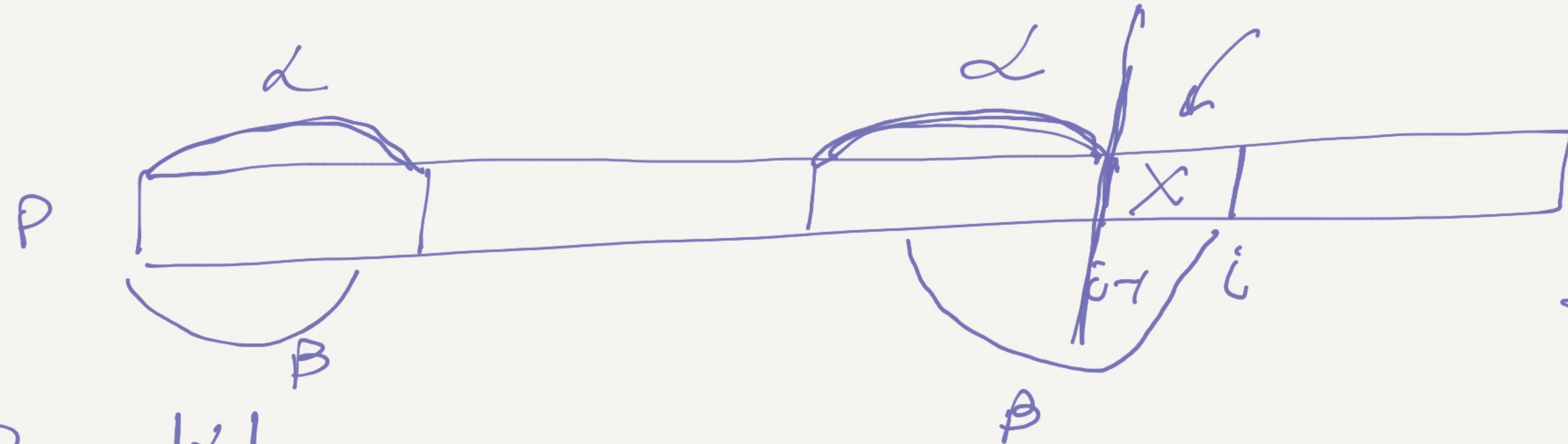
	a	b	c	a	b	c	a	b	a	b	c
SP_i	0	0	0	1	2	3	4	5	1	2	3

$O(m^2)$

abcabcababc

abcabcab

abcabcaba



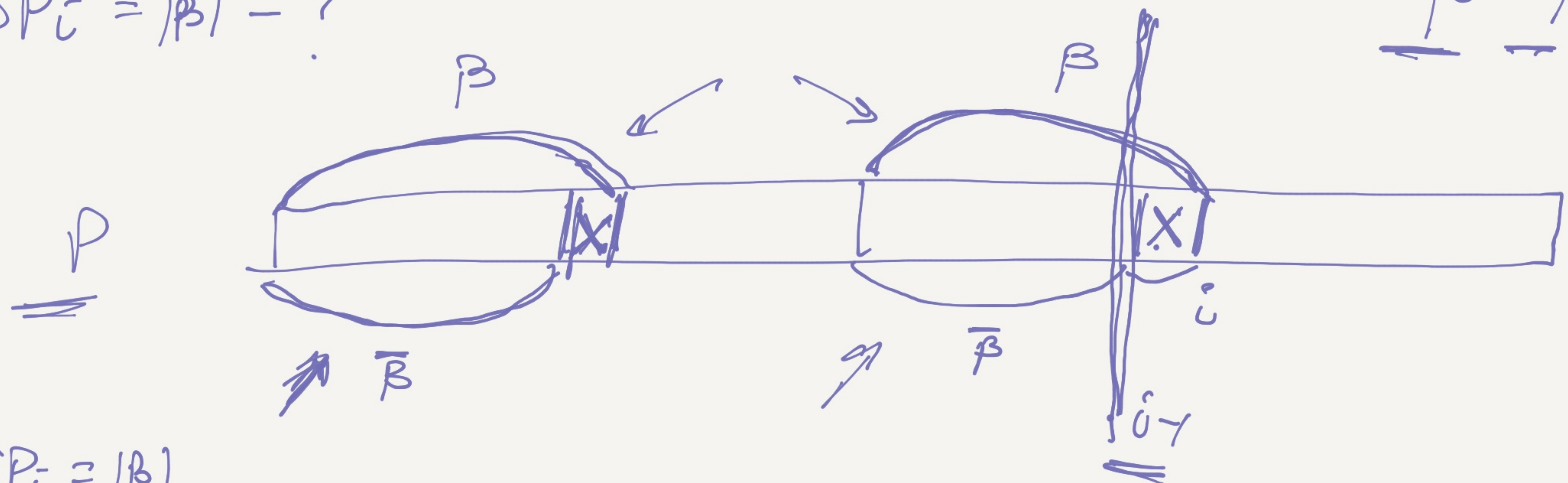
$SP_{i-1} = |\alpha|$

$SP_{i-1} = |\alpha|$

$SP_i = |\beta| - ?$

$$\boxed{SP_i \leq SP_{i-1} + 1.}$$

$\beta = \bar{\beta} X$

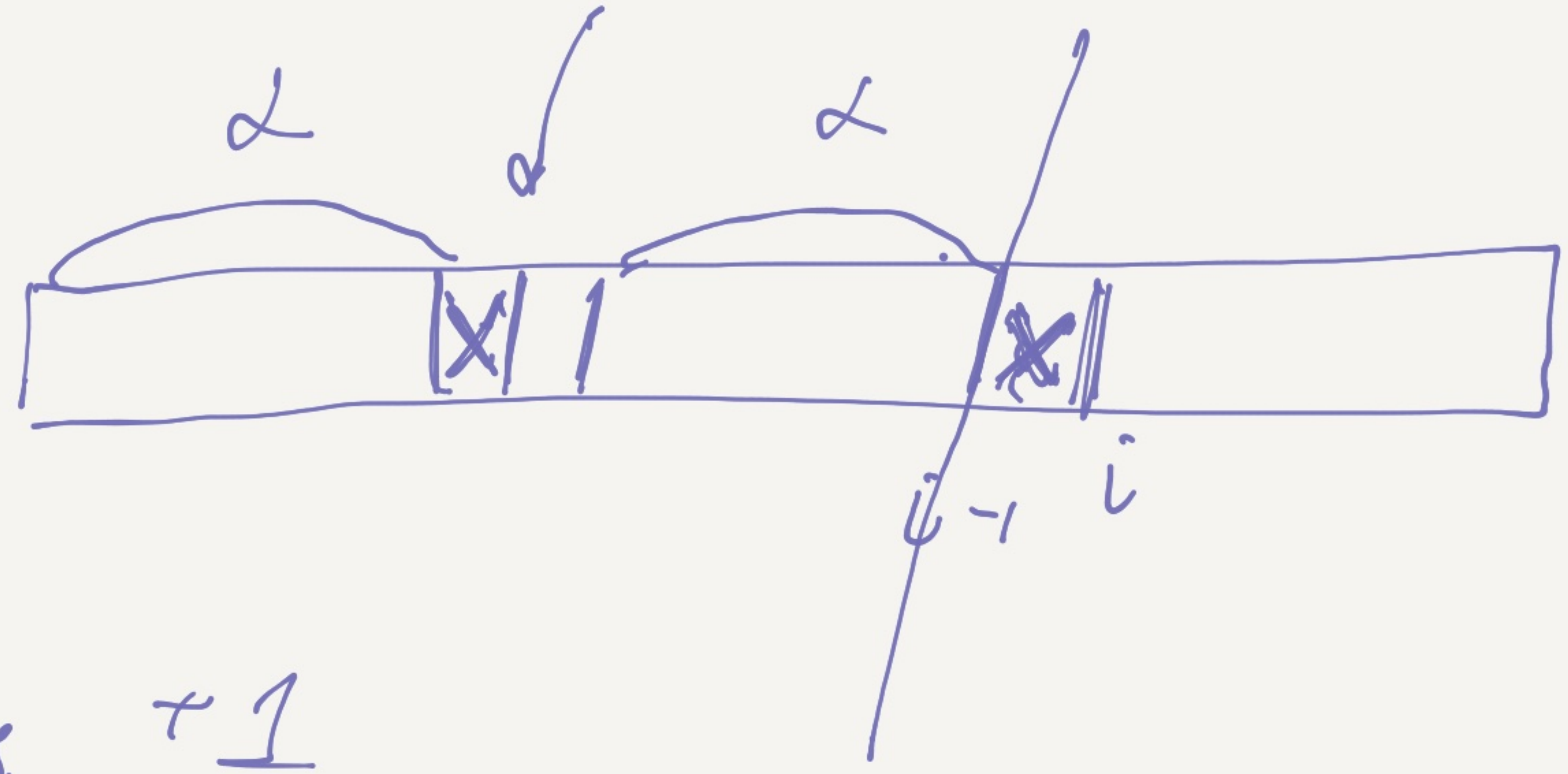


$SP_i = |\beta|$

$|\bar{\beta}| \leq |\alpha|$

$|\bar{\beta}| > |\alpha|$

$SP_1 = 0$

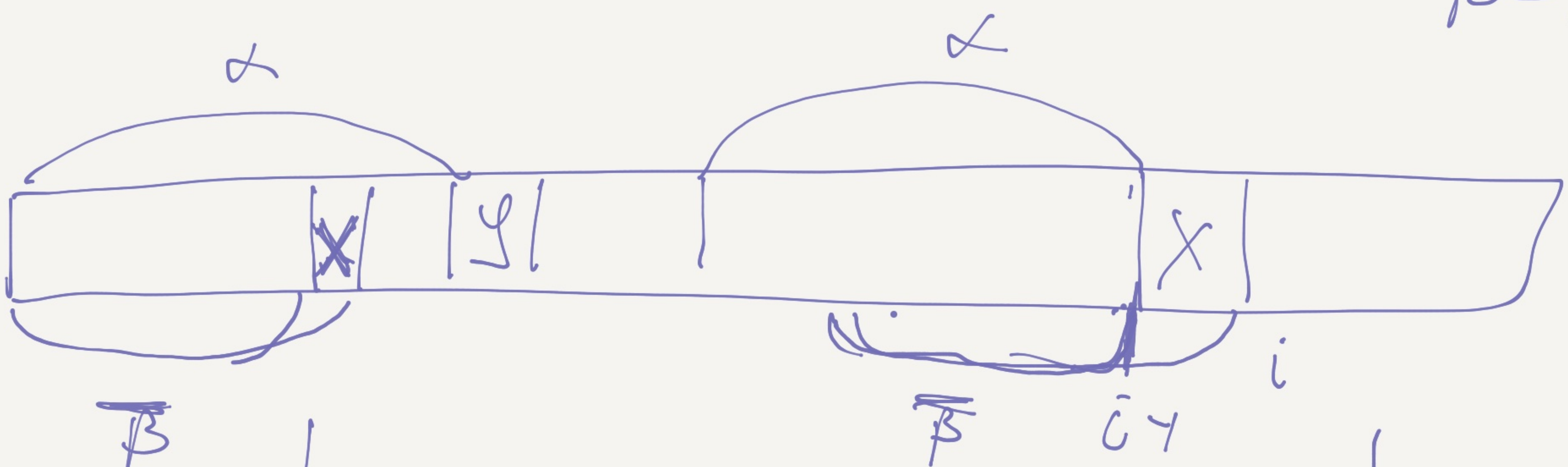


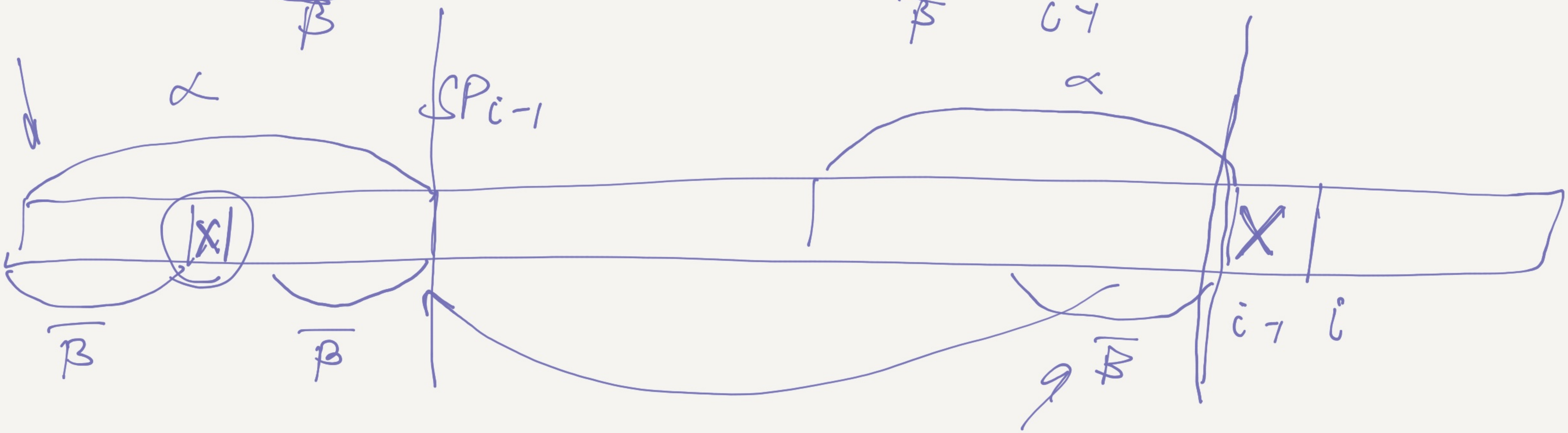
$\cancel{\alpha X}$

$SP_i = SP_{i-1} + 1$

$SP_i = |\beta|$

$\beta = \bar{\beta} X$





$SP_1 = 0$

For $i = 2$ to m :

$x = P_i$ q

$v = SP_{i-1}$ 2

while $v \neq 0$ && $P_{v+1} \neq x$:

$\boxed{v = SP_v}$

if $P_{v+1} == x$:

$SP_i = v + 1.$

else :

$SP_i = 0$

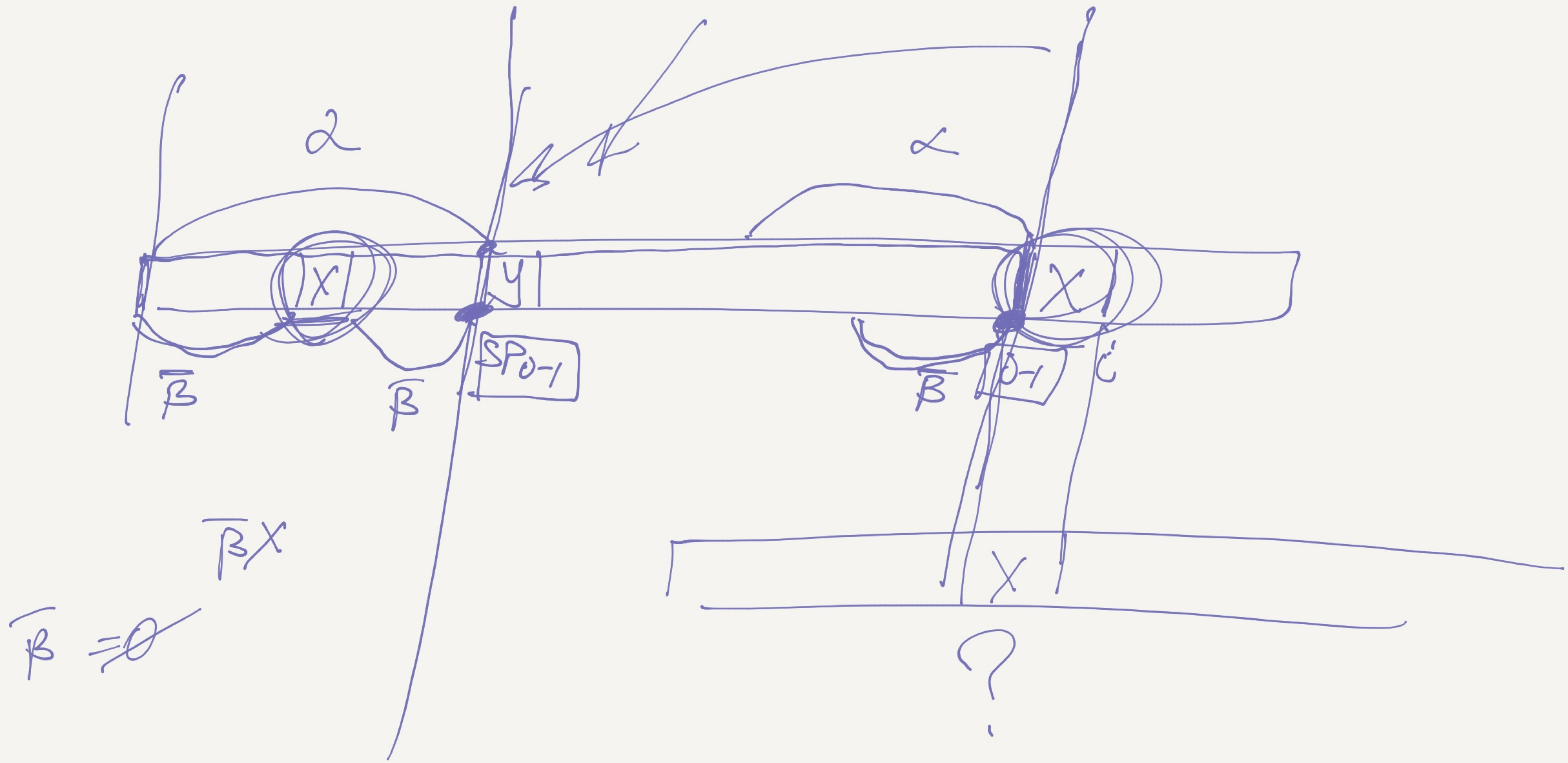
abxabq

$v = 4$

abxabqabxabz

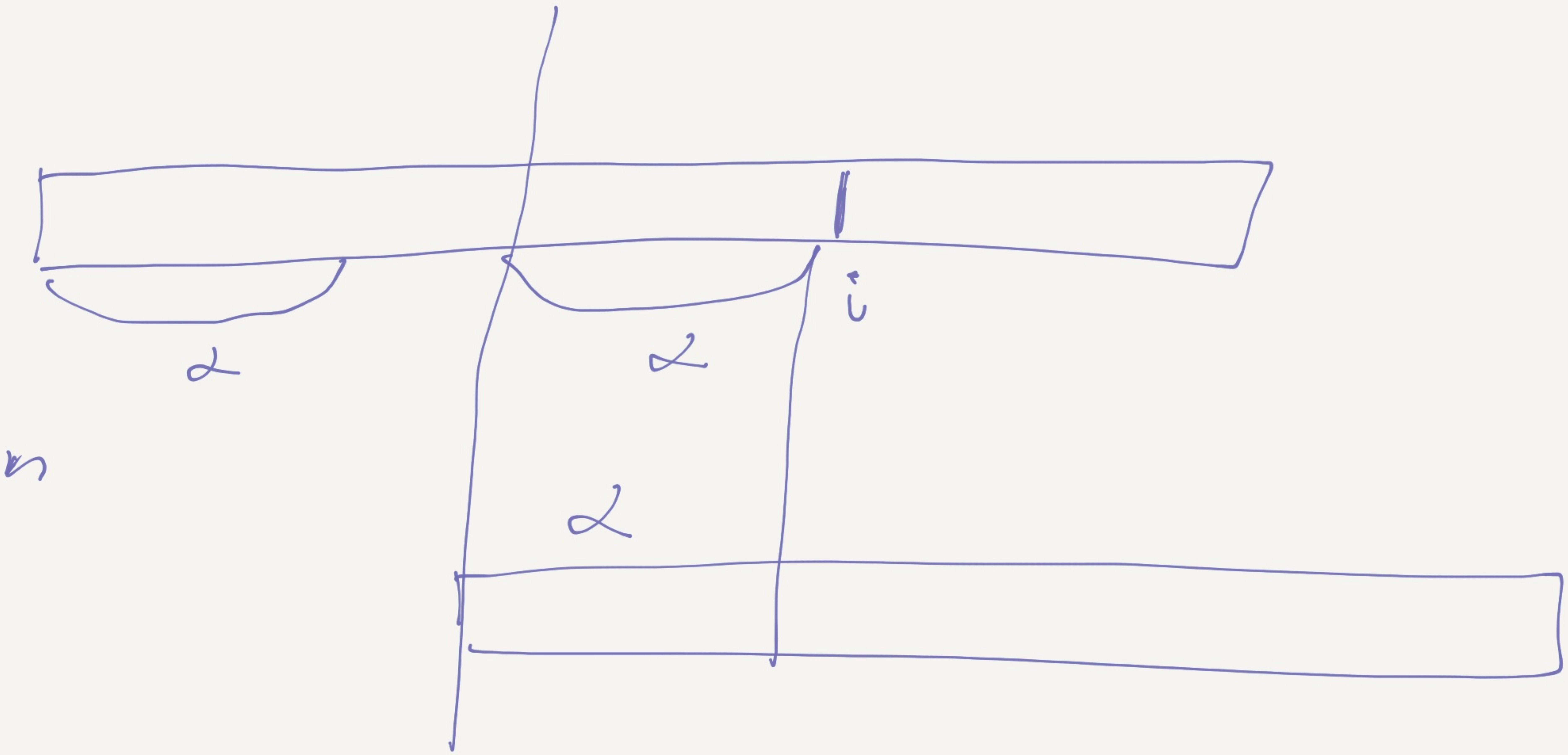
SP_i 0 0 0 1 2 0

$m + m = 2m$


α
X
Y
SP_{i-1}
$\bar{\beta}$
β
α
X
$i-1$
i
β
X
?
$\bar{\beta}X$
$\bar{\beta} = \cancel{0}$

$SP_{i-1} = |\alpha|$

P



$\forall i: 1 \dots n$

$SP_1 = 0$

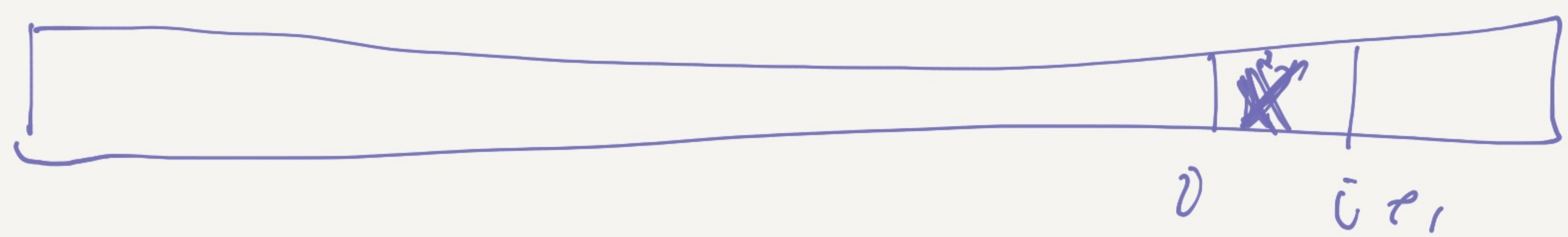
SP_{i+1}

SP_2

SP_3

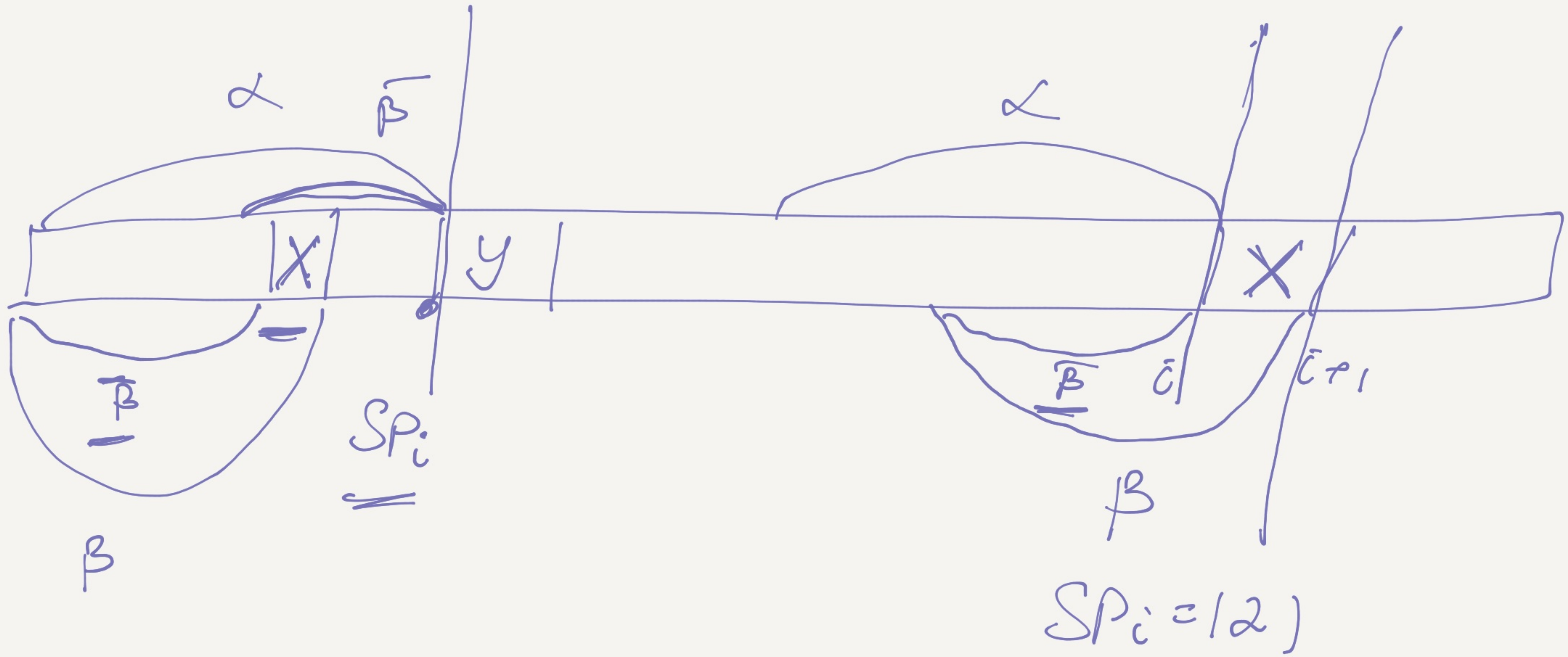
$\vdots$

SP_i



	a	b	c	a	b	c
SP_i	0	0	0	1	2	3

SP_j



$SP_{\boxed{SP_i}} < i$ $\qquad$ $\beta = \overline{\beta} X$

Продолжение

в

13:05

KMP(T, P):

$\boxed{\text{prefix}(P)}$

$i = 1$

$j = 1$

while $i \le n - (m - j)$:

→ while $j \le m$ && $P_j == T_i$

 ++i

 ++j

 if $j == m+1$:

  // вхождение в $i-m$

 if $j == 1$

  ++i

 $j = SP_{j-1} + 1$

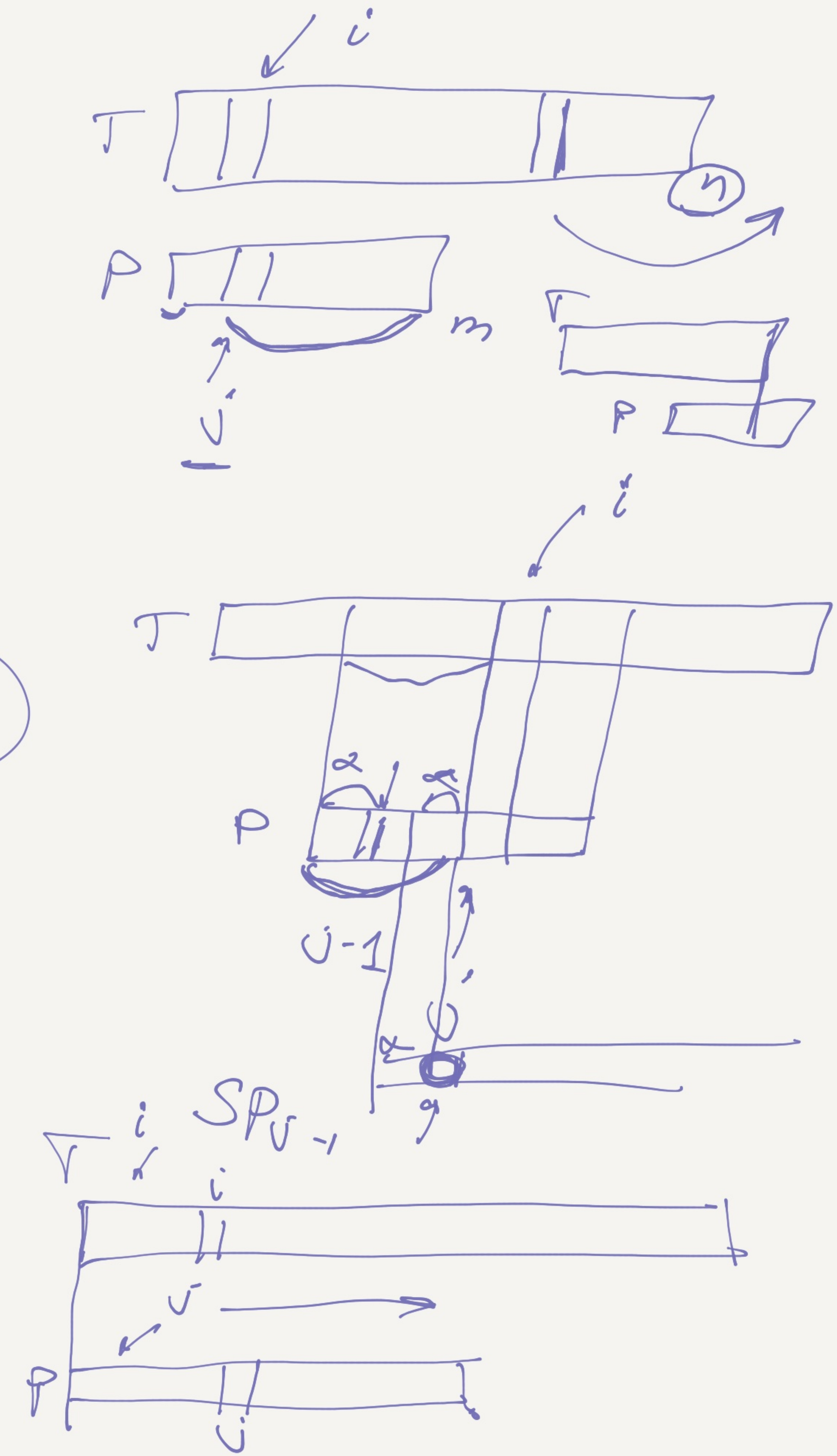
SP_i

q

$2n$

$SP_1 = 0$

$O(m+n)$

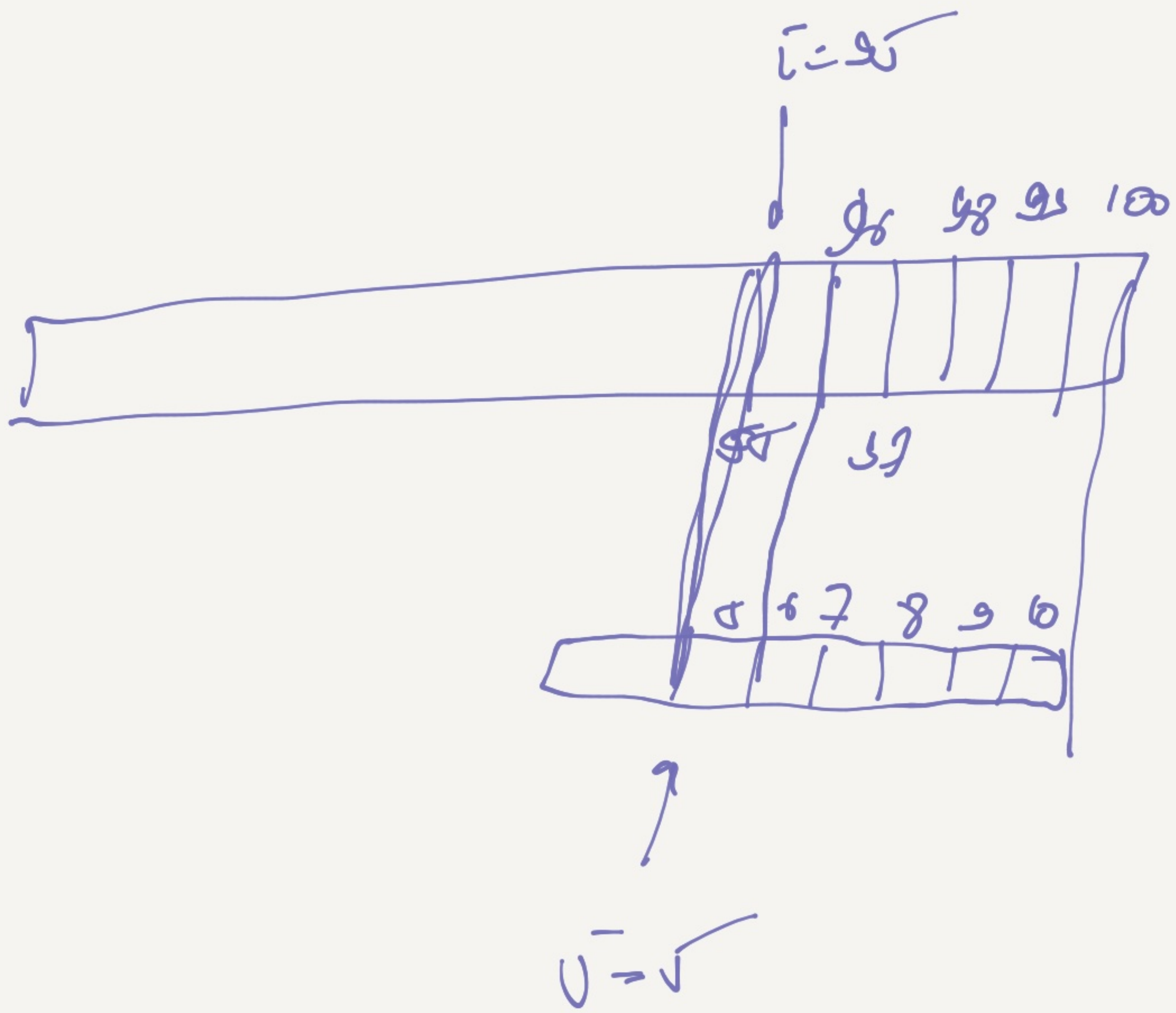


T : $n = 100$

P : $m = 10$

$i = 95$

$j = 5$



$95 \leq 100 - (10-5)$

$i \leq n - (m - j)$

$95 \leq 100 - 5$

$95 \leq 95$

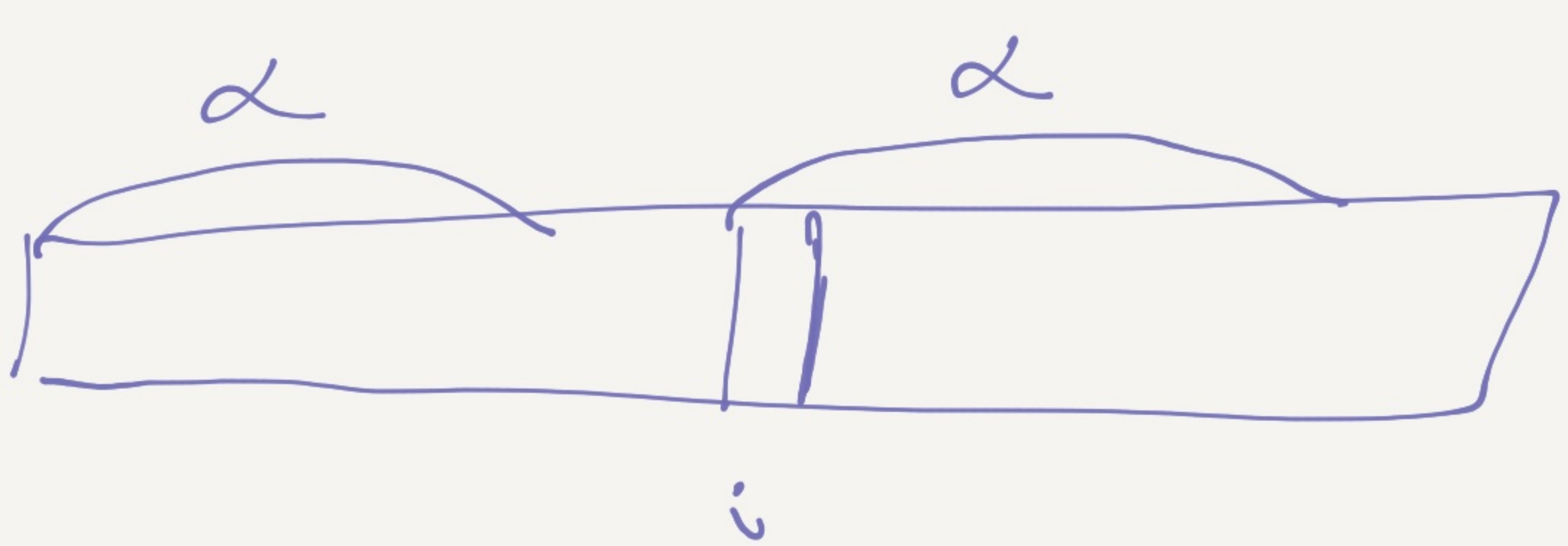
$i = 96$

$j = 5$

Гасфилд, гл. 1-3.

Z-функция

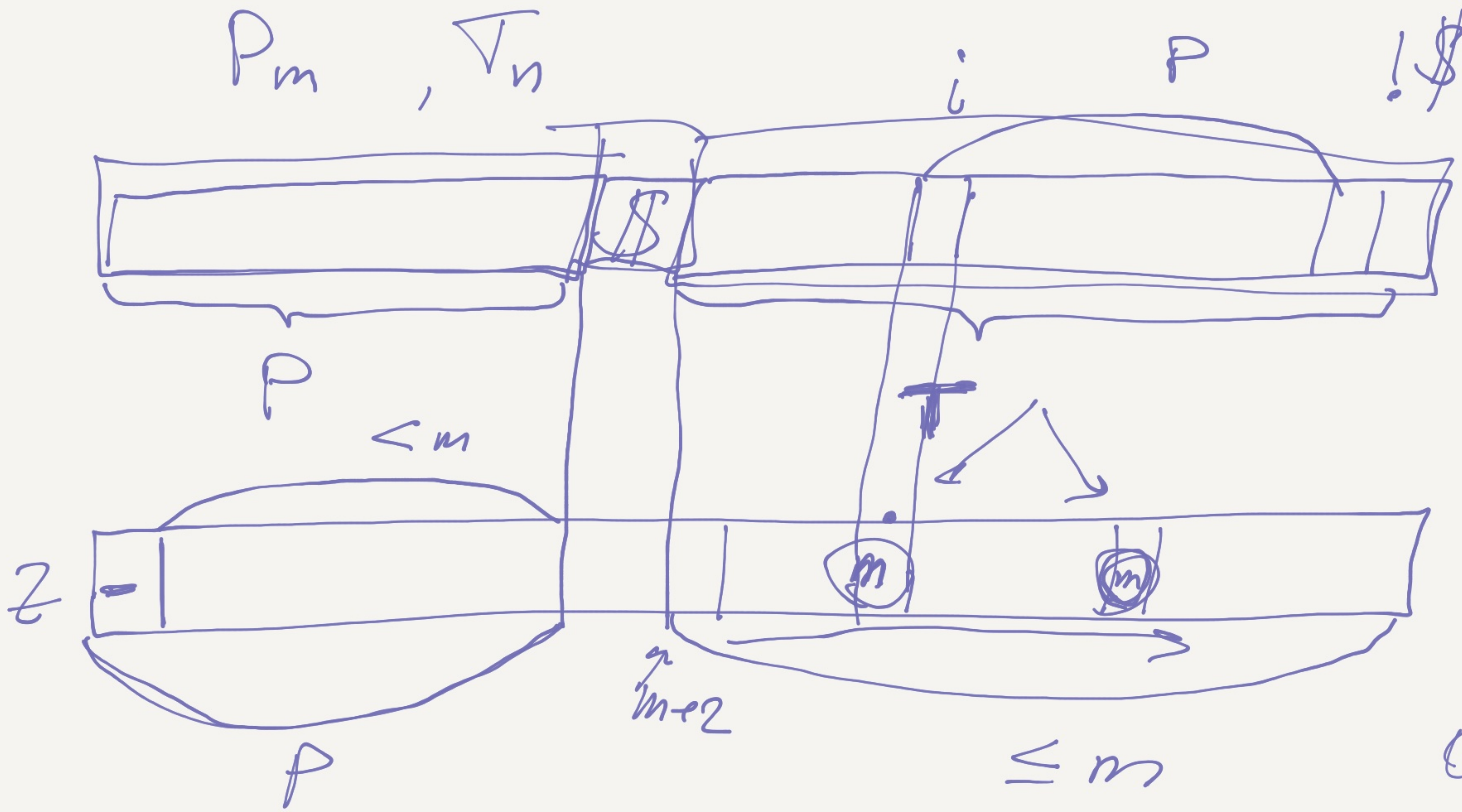
	a	a	b	c	a	a	b	x	a	a	z
Z_i	–	1	0	0	3	1	0	0	2	1	0



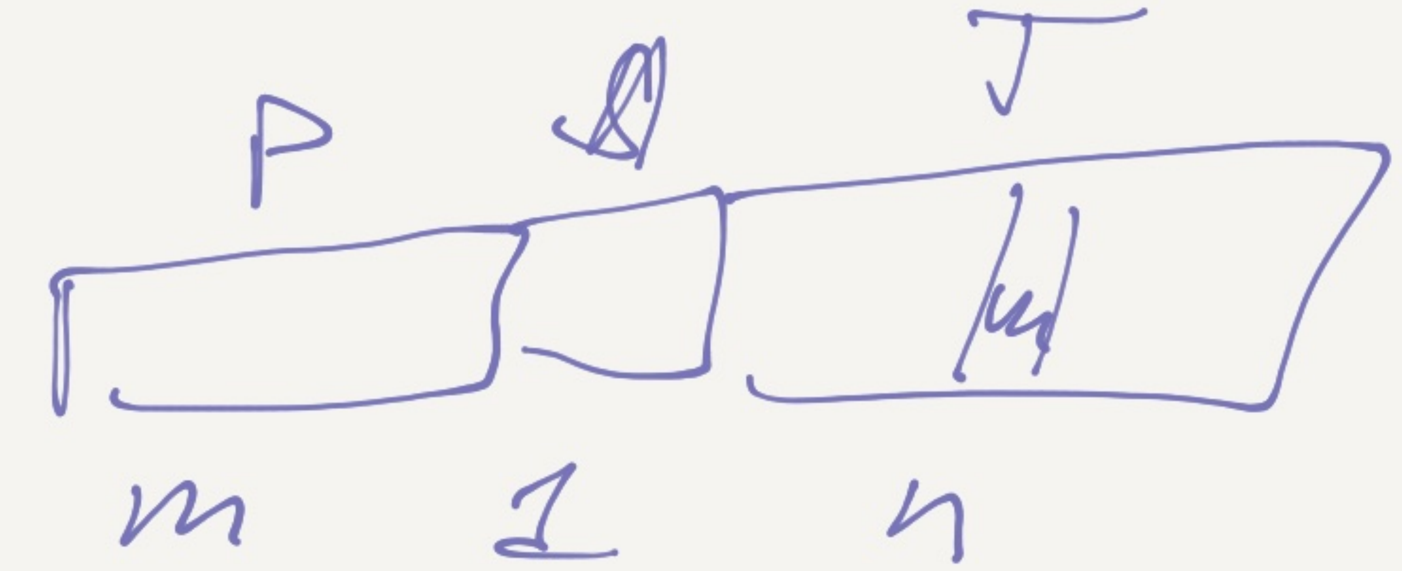
a z

aabcaabxaa z

P_m , T_n



$= S$



$O(m+n)$

$O(m+n) \to Z$

$O(m \cdot n)$

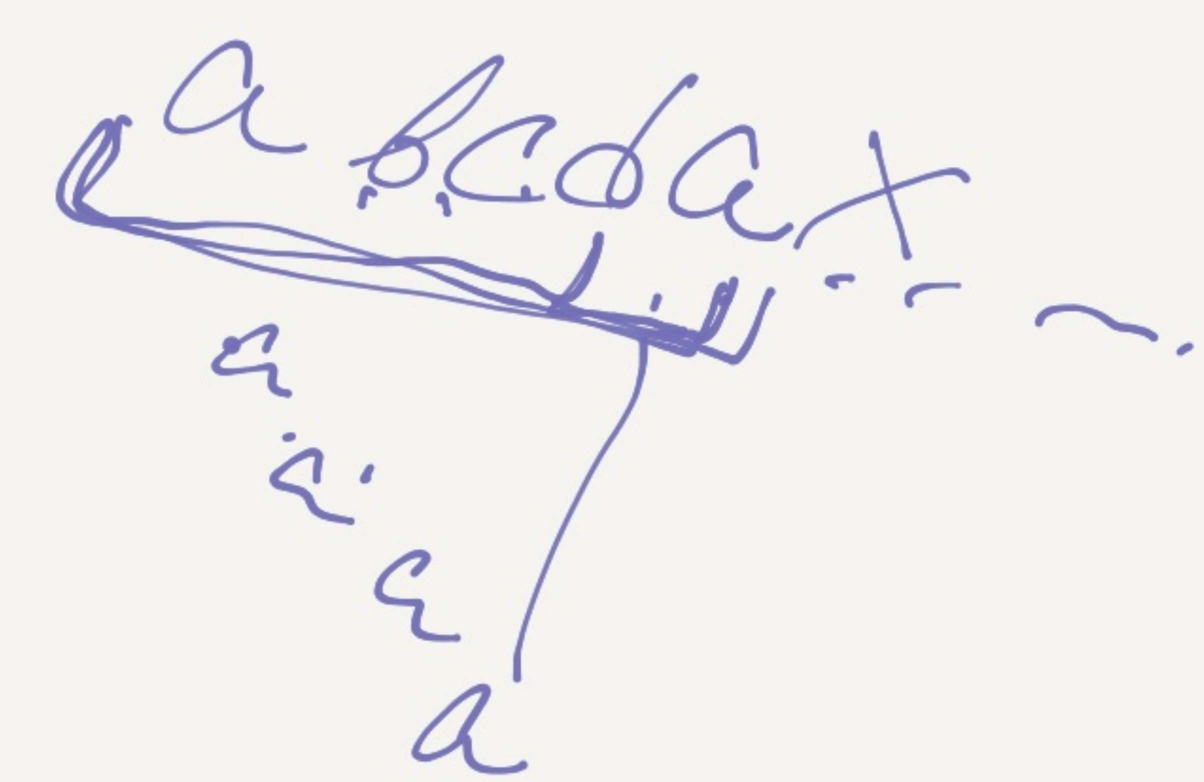
$n+m+1$

$P = abcab$

$O(n+m)$

$T = ababcabcabx$

	a	b	c	a	b	$	a	b	a	b	c	a	b	c	a	b	x
Z	−	0	0	2	0	0	2	0	5	0	0	5	0	0	2	0	0



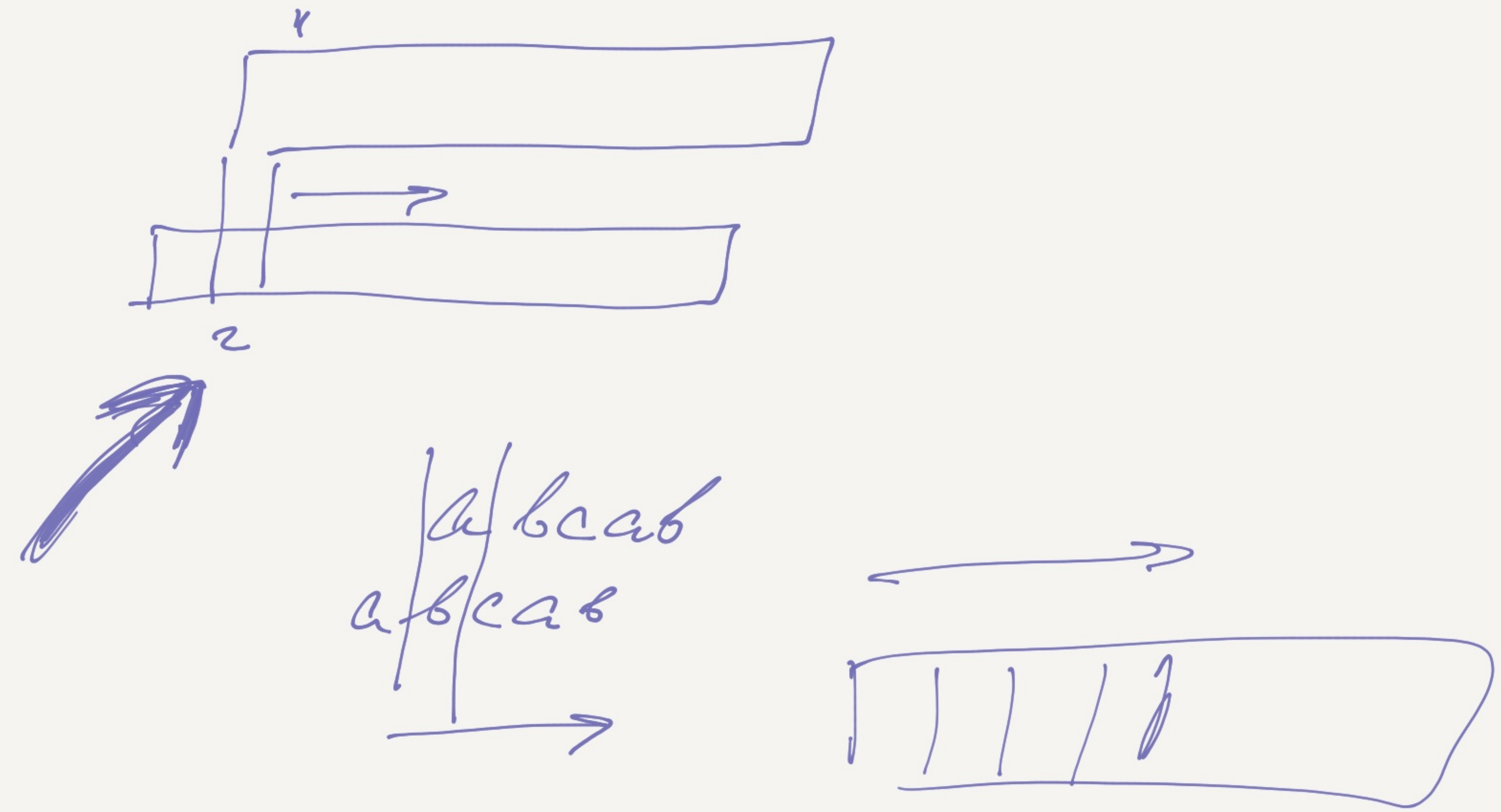
$z_1 \to$

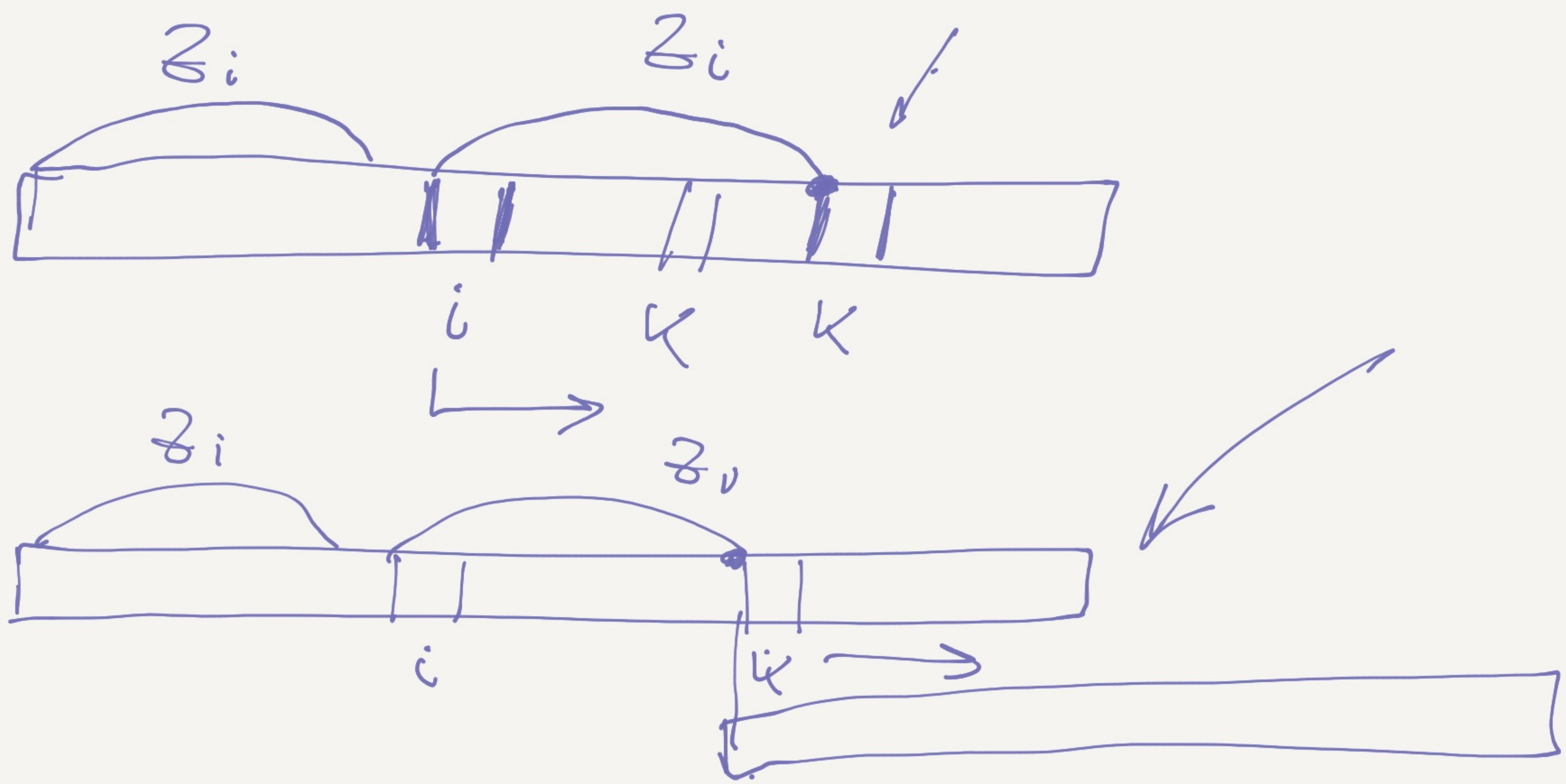
$z_2 \to$

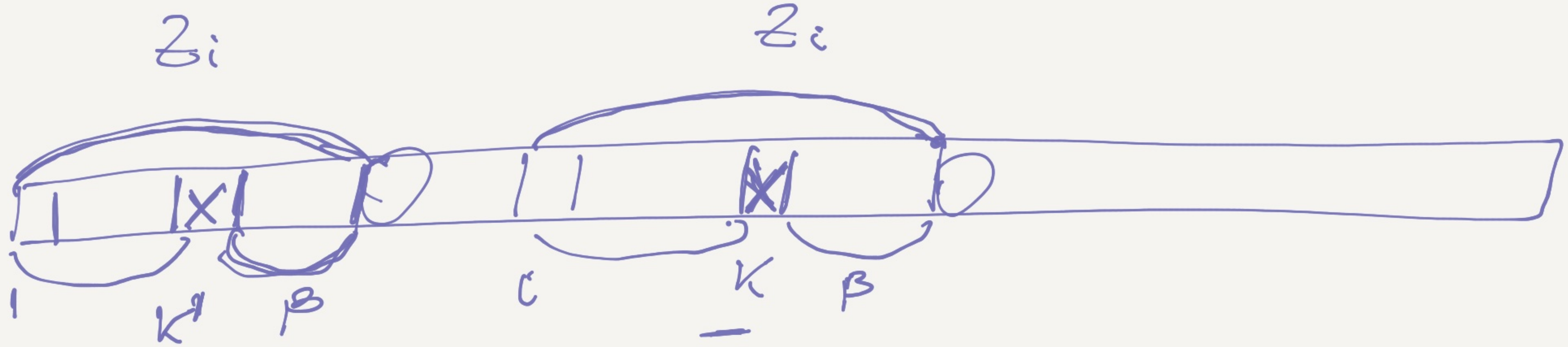
i

z_k

z_{k+1}





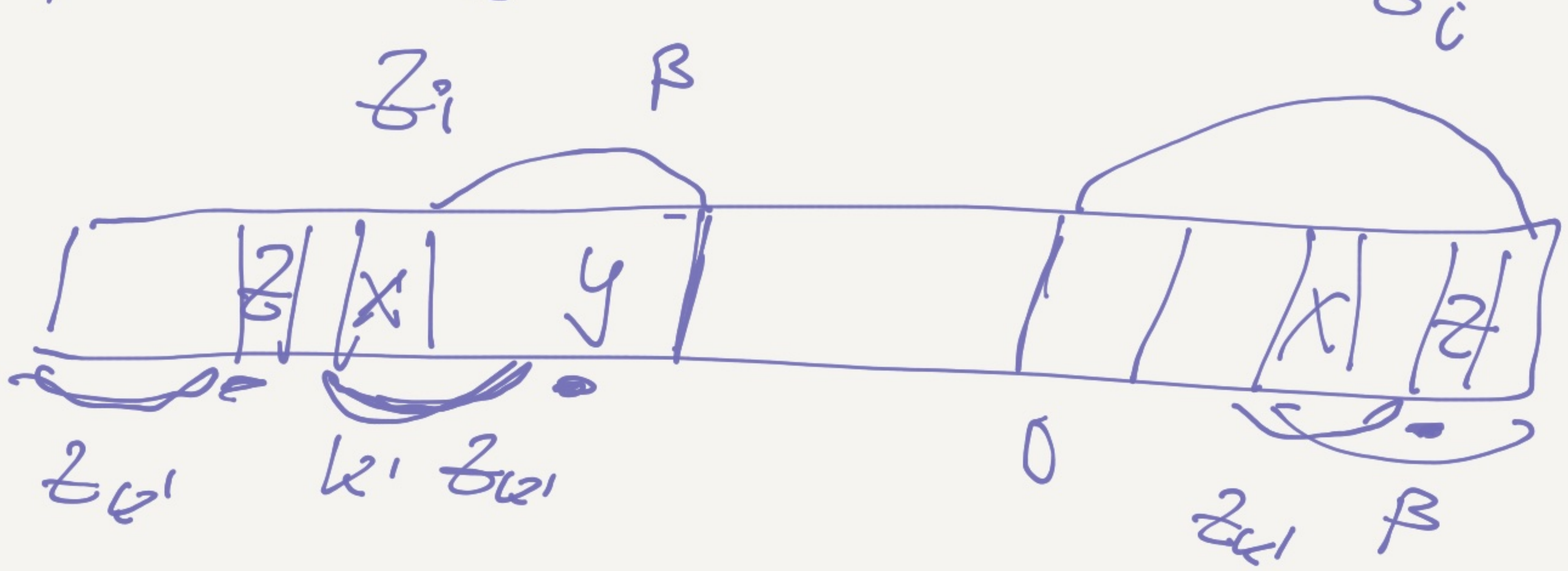


$z_{k'}$ $\qquad$ $z_k - ?$ $\qquad$ $z_k = z_{k'}$

$k' < k$ $\qquad$ $|\beta|$ $\qquad$ $z_{k'}$ $\qquad$ z_i

$z_{k'}$

$|\beta| > z_{k'}$



$|\beta| \le z_{k'}$

P	a	a	b	c	a	a	b	x	a	a	z
Z_i	–	1	0	0	3	1	0	0	2	1	0
idx	1	2	3	4	5	6	7	8	9	10	11

K

$|\beta| = Z_{k'}$

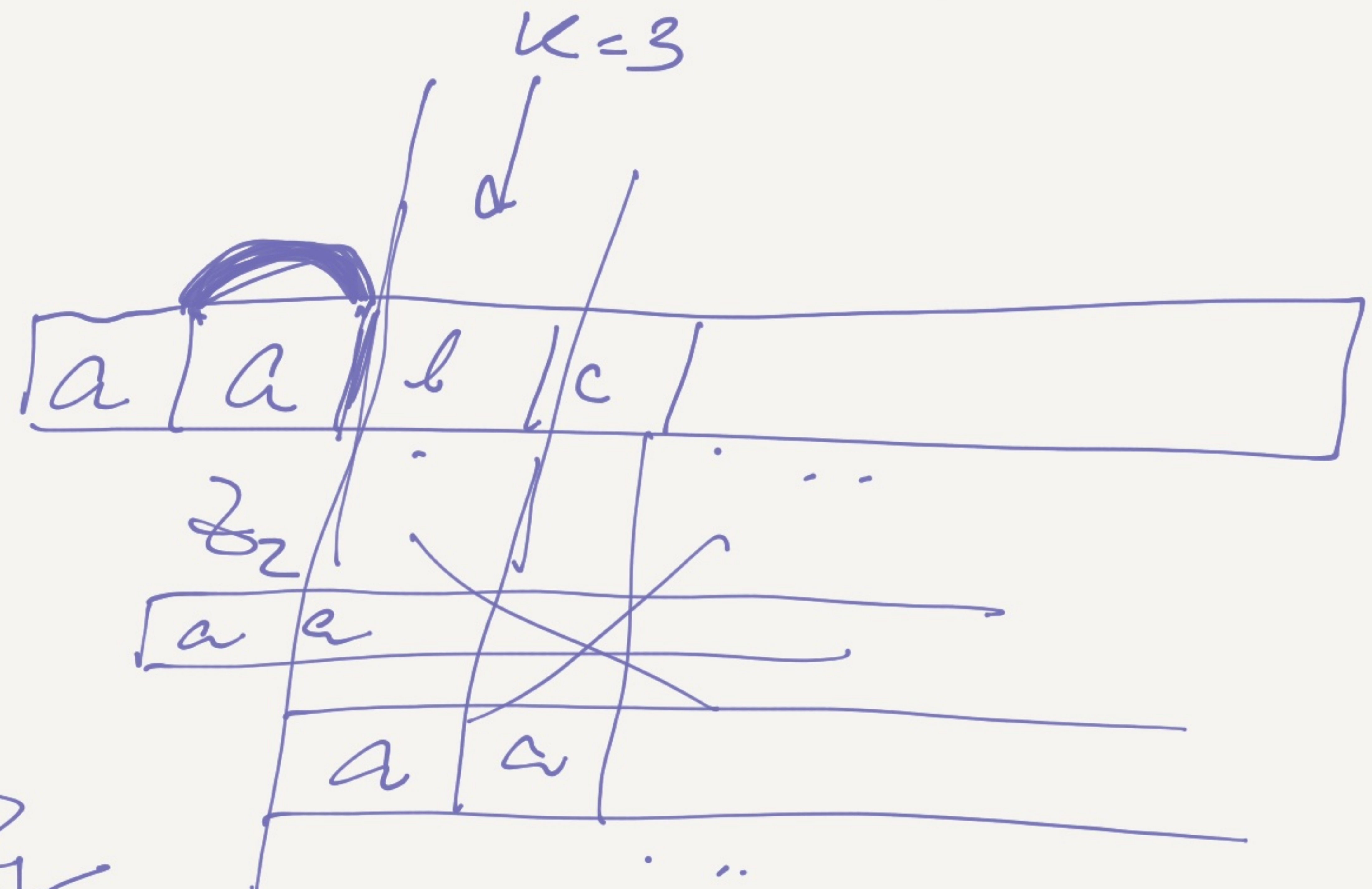
$|\beta| = 1$

$q = 0$

q

$|\beta| + q = Z_k$

1



a a

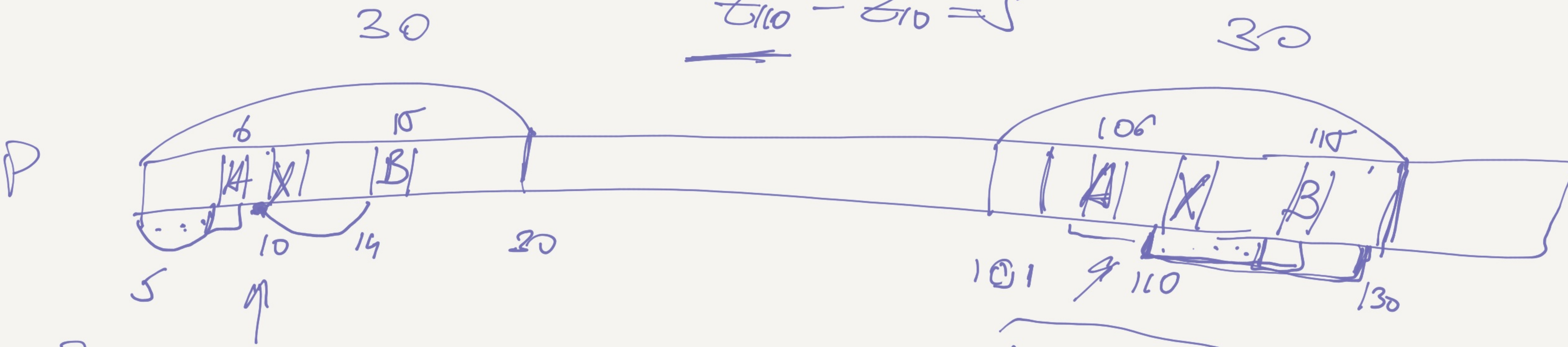
5 6 2

a a b

a a b

1 2 3

$Z_{110} = Z_{10} = 5$



Z_2

Z_3

$\vdots$

Z_{100}

Z_{10}

$\boxed{Z_{100} = 30}$

$\boxed{\begin{array}{l} P_1 = P_{101} \\ P_2 = P_{102} \\ \dots \\ P_{30} = P_{130} \end{array}}$

$P_6 = P_{106}$

$P_{15} = P_{115}$

$\boxed{Z_{10} = 5}$

$P_{10} = P_1$

$P_{11} = P_2$

$P_{12} = P_3$

$P_{13} = P_4$

$P_{14} = P_5$

$P_{15} \neq P_6$

$P_{110} = P_{10} = P_1$

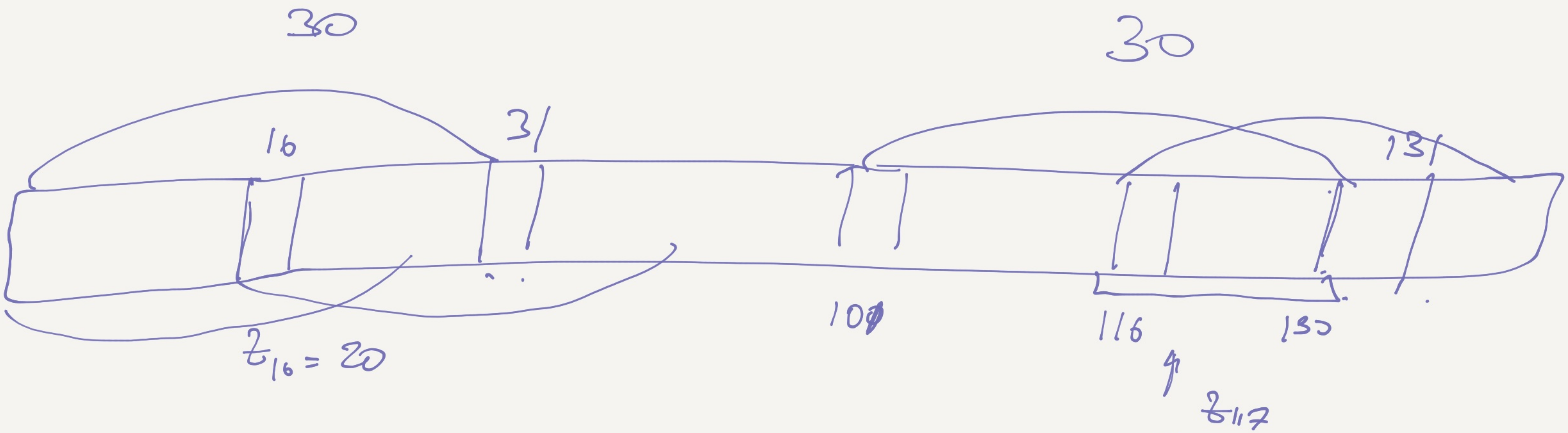
$P_{111} = P_{11} = P_2$

$P_{112} = P_{12} = P_3$

$P_{113} = P_{13} = P_4$

$P_{114} = P_{14} = P_5$

$P_{115} = P_{15} \neq P_6$



z_{116} - ?

$P_{16} = P_1$

$P_{17} = P_2$

$P_{30} = P_{20}$

$z_{101} = 30$

$P_{101} = P_1$

$P_{102} = P_2$

$P_{130} = P_{30}$

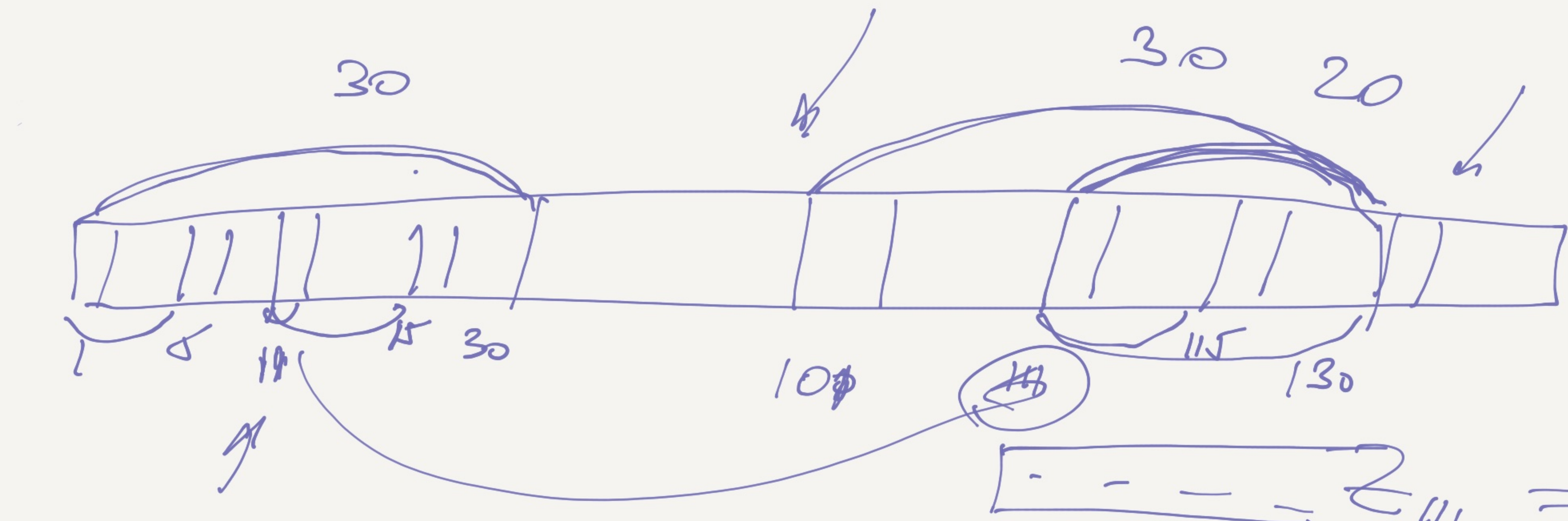
$z_{116} = 15 + 4$

$P_{116} = P_{16} = P_1$

$P_{117} = P_{17} = P_2$

$P_{130} = P_{30} = P_{15}$

P_{131} ? $P_{31} = P_{16}$



$Z_{111} = Z_{11} = 4$

$Z_{11} = 4$

$P_1 = P_{11} = P_{111}$

$P_2 = P_{12} = P_{112}$

$P_3 = P_{13} = P_{113}$

$P_4 = P_{14} = P_{114}$

$P_5 \neq P_{15} = P_{115}$

$P_5 \neq P_{115}$

$4 < 20$

$(n+m)$

$O(n+m)$

$O(n \cdot m)$

$O(n^2)$

$O(n)$