

אלגוריתמי מיון

- מיון הכנסה

$O(n^2)$

- מיון בעזרת עץ חיפוש בינרי מאוזן:

- בנה עץ AVL על-ידי הכנסת האיברים בזה אחר זה.

- סרוק את העץ ב- inorder

$O(n \log n)$

- מיון ערימה:

- בנה ערימת מקסימום.

- הוצא את האיבר המקסימלי ושים בראש הפלט הנוכחי

$O(n \log n)$

משפט

כל אלגוריתם למיון מבוסס השוואות צורך
 $\Omega(n \cdot \log n)$ השוואות במקרה הגרוע

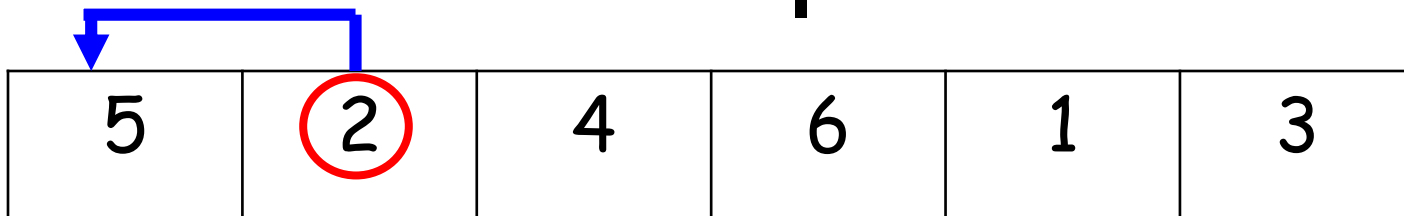


מיון הכנסה

5	2	4	6	1	3
---	---	---	---	---	---



מיון הכנסה



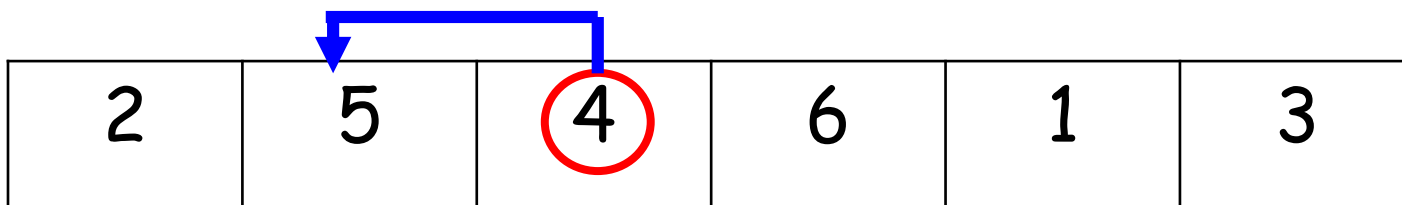


מיון הכנסה

2	5	4	6	1	3
---	---	---	---	---	---



מיון הכנסה



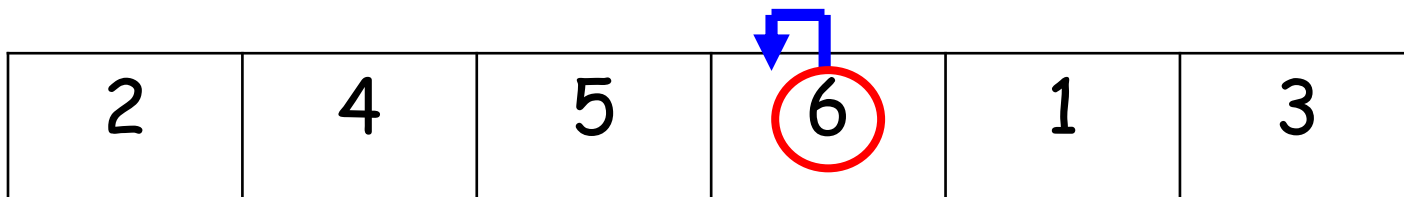


מיון הכנסה

2	4	5	6	1	3
---	---	---	---	---	---



מיון הכנסה



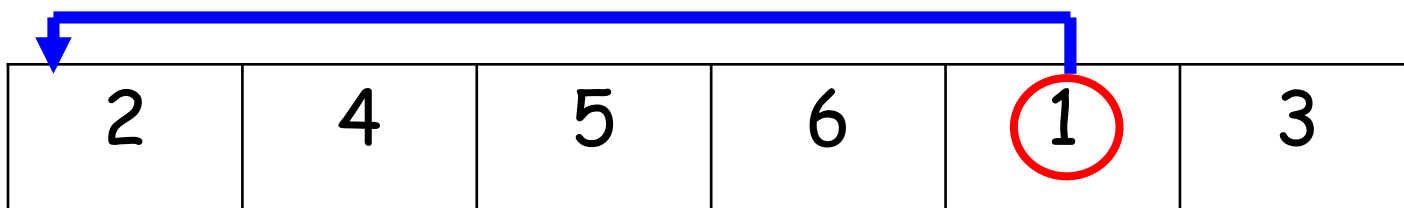


מיון הכנסה

2	4	5	6	1	3
---	---	---	---	---	---



מיון הכנסה



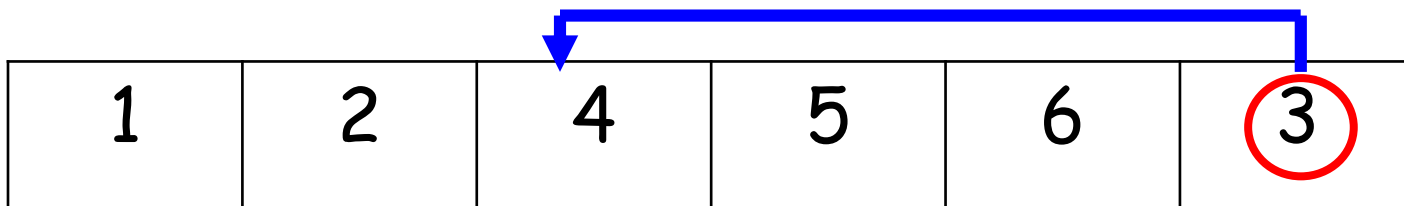


מיון הכנסה

1	2	4	5	6	3
---	---	---	---	---	---



מיון הכנסה





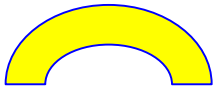
מיון הכנסה

1	2	3	4	5	6
---	---	---	---	---	---




מיון הכנסה

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



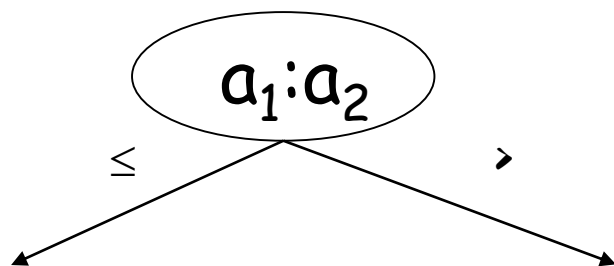
a[1]	a[2]	a[3]
?	?	?


עץ החלטה



$a[1]$	$a[2]$	$a[3]$
?	?	?

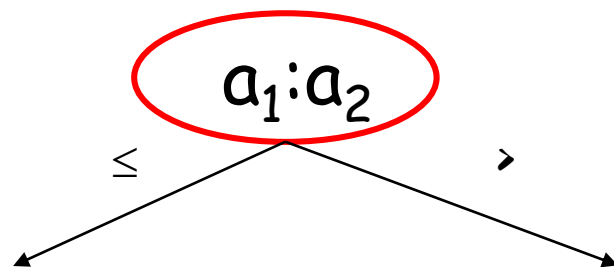
עץ החלטה

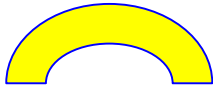




$a[1]$	$a[2]$	$a[3]$
1	2	3

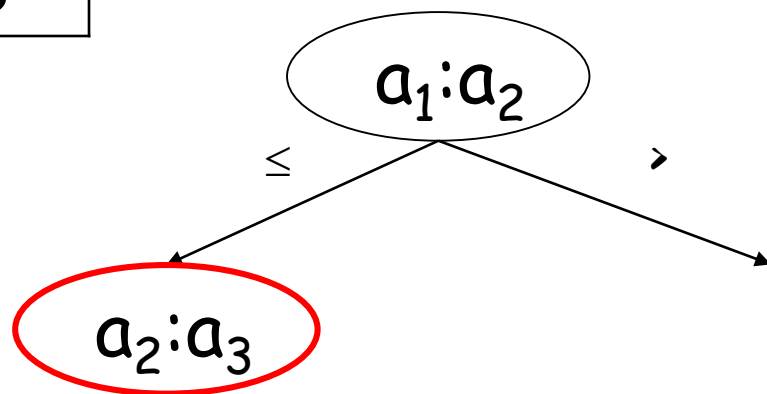
עץ החלטה





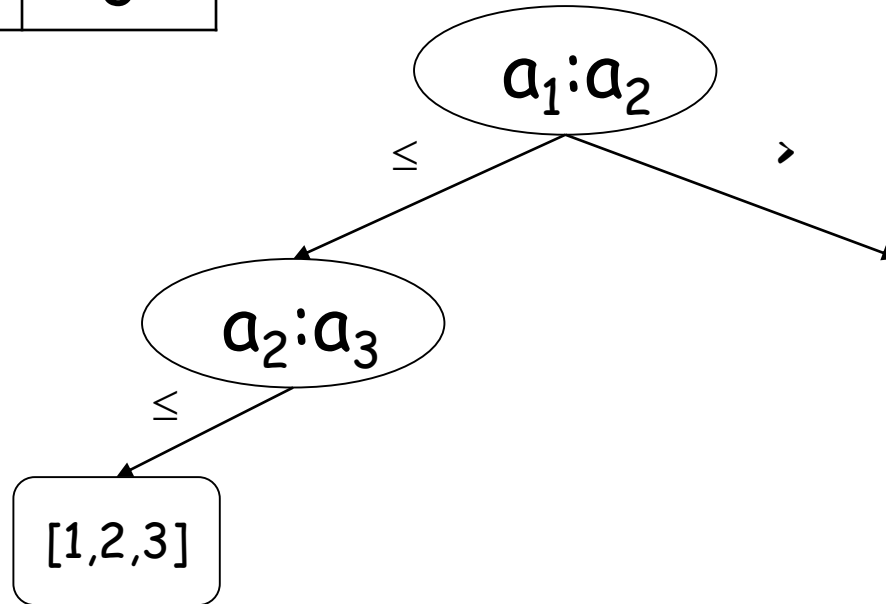
$a[1]$	$a[2]$	$a[3]$
1	2	3


עץ החלטה



$a[1]$	$a[2]$	$a[3]$
1	2	3

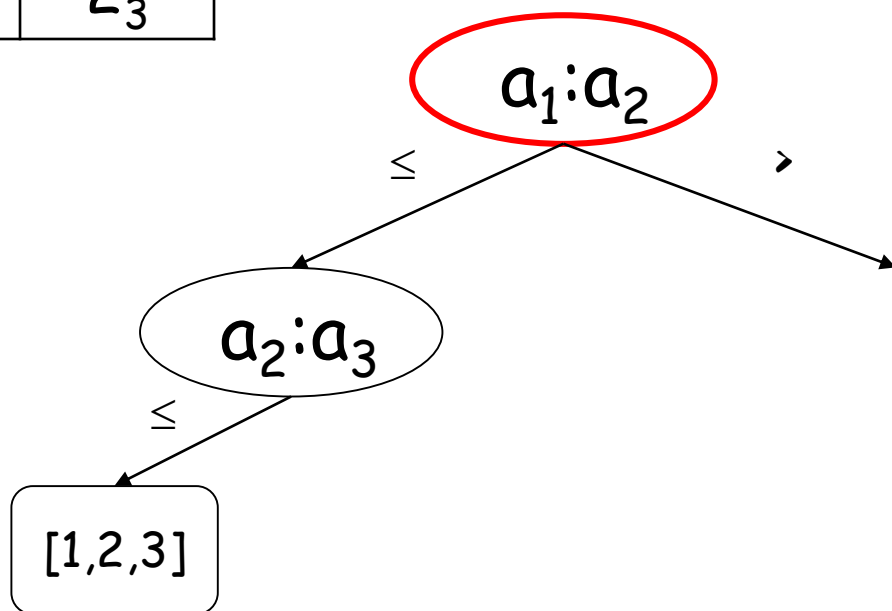
עץ החלטה

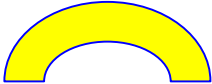




$a[1]$	$a[2]$	$a[3]$
1_1	3_2	2_3

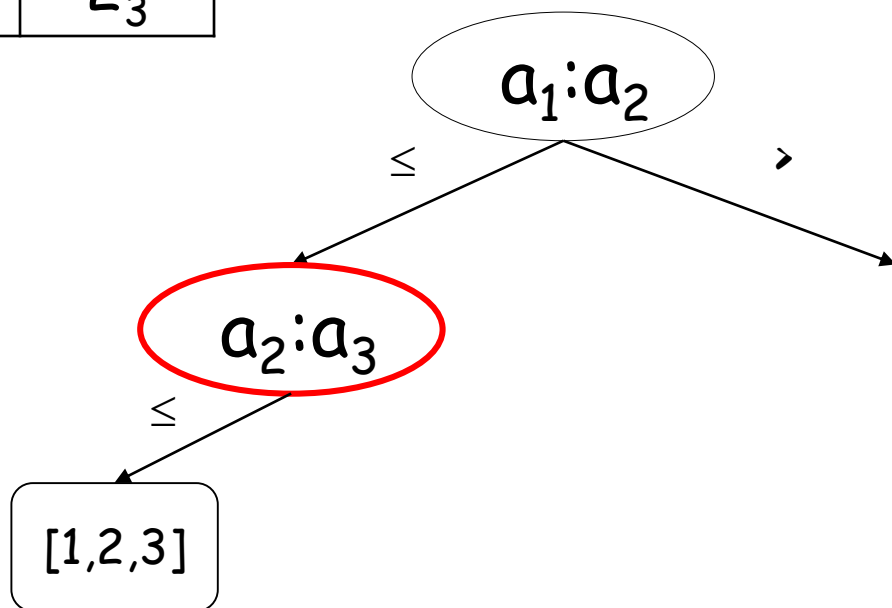
עץ החלטה

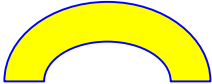




$a[1]$	$a[2]$	$a[3]$
1_1	3_2	2_3

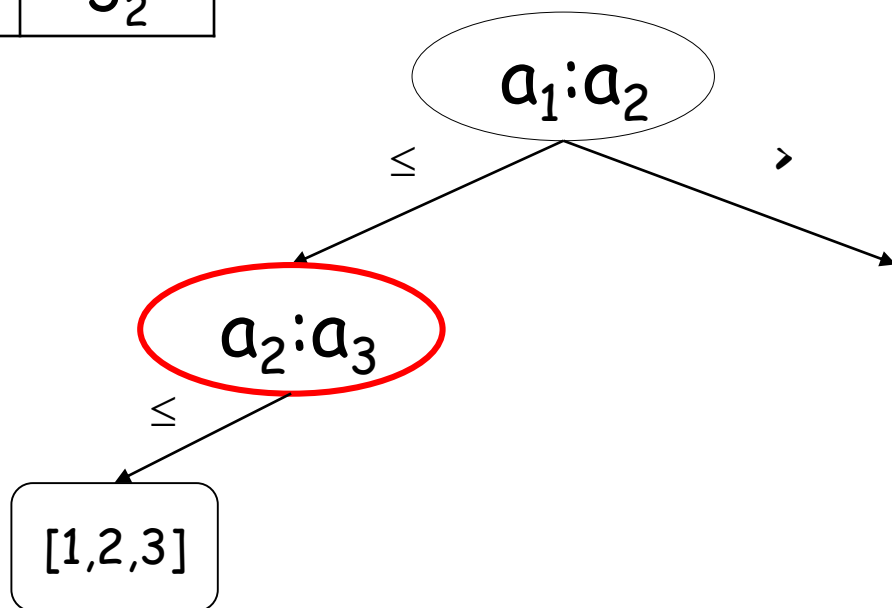
עץ החלטה

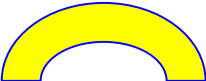




$a[1]$	$a[2]$	$a[3]$
1_1	2_3	3_2

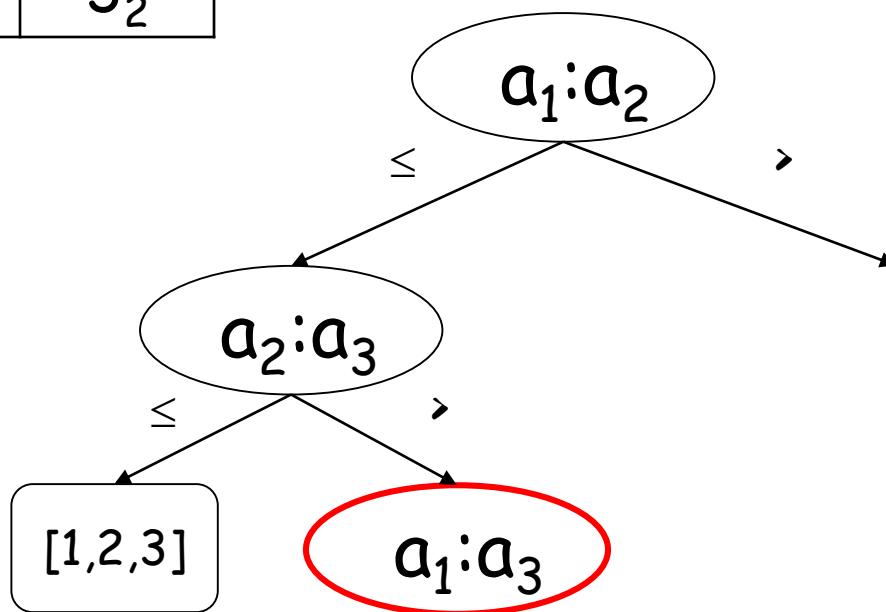
עץ החלטה





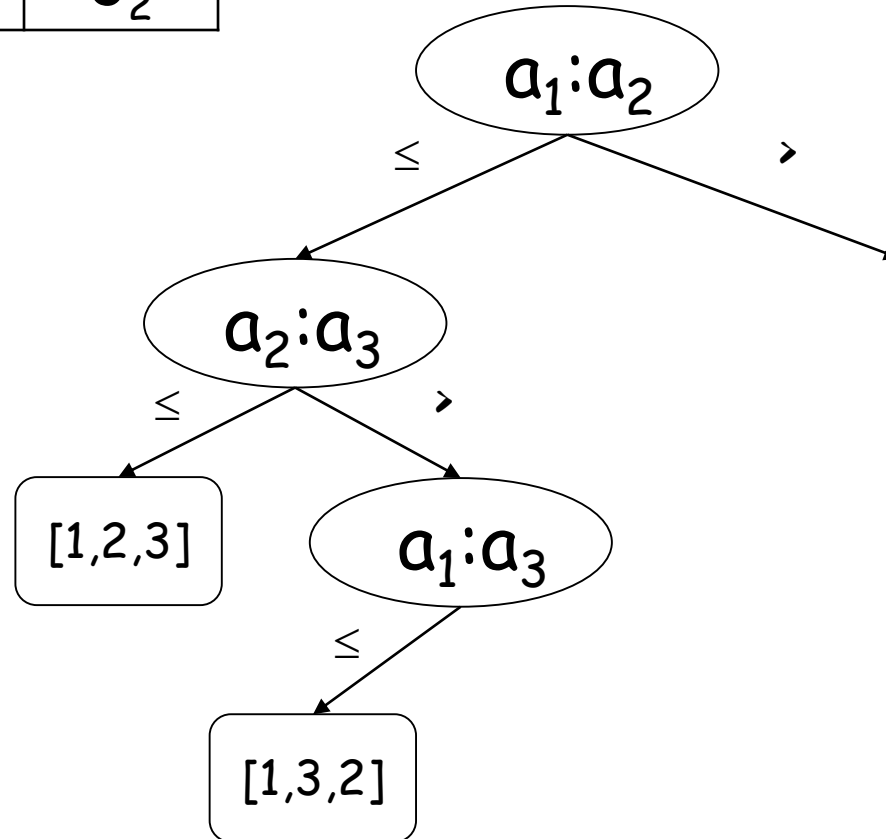
$a[1]$	$a[2]$	$a[3]$
1_1	2_3	3_2

עץ החלטה



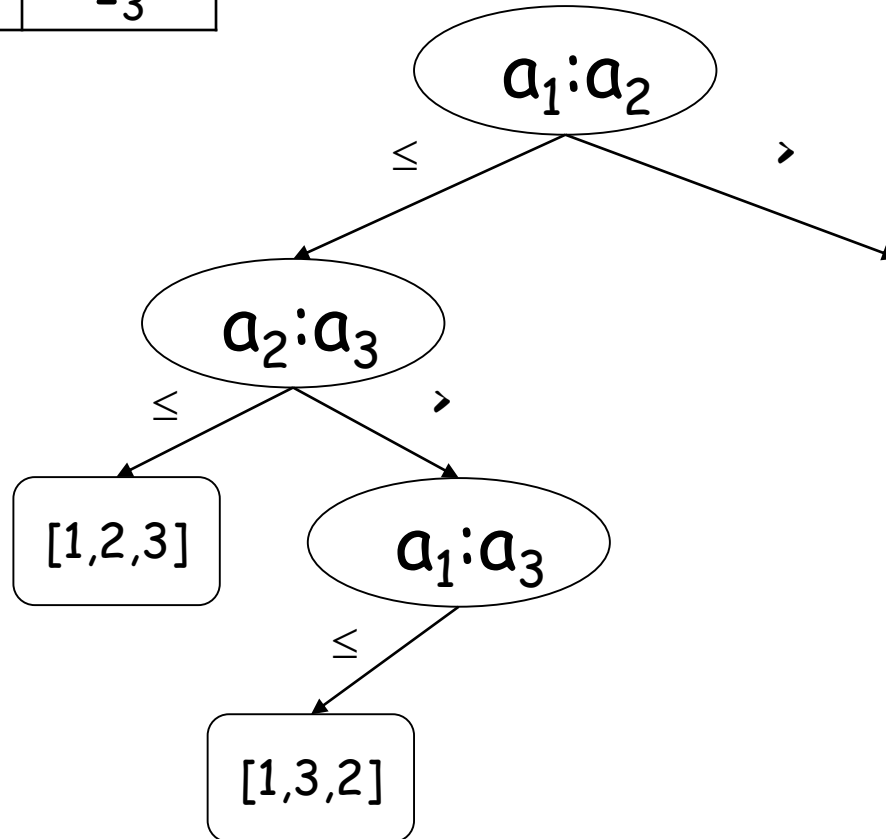
$a[1]$	$a[2]$	$a[3]$
1_1	2_3	3_2

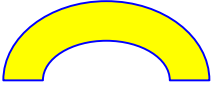
עץ החלטה



$a[1]$	$a[2]$	$a[3]$
2_1	3_2	1_3

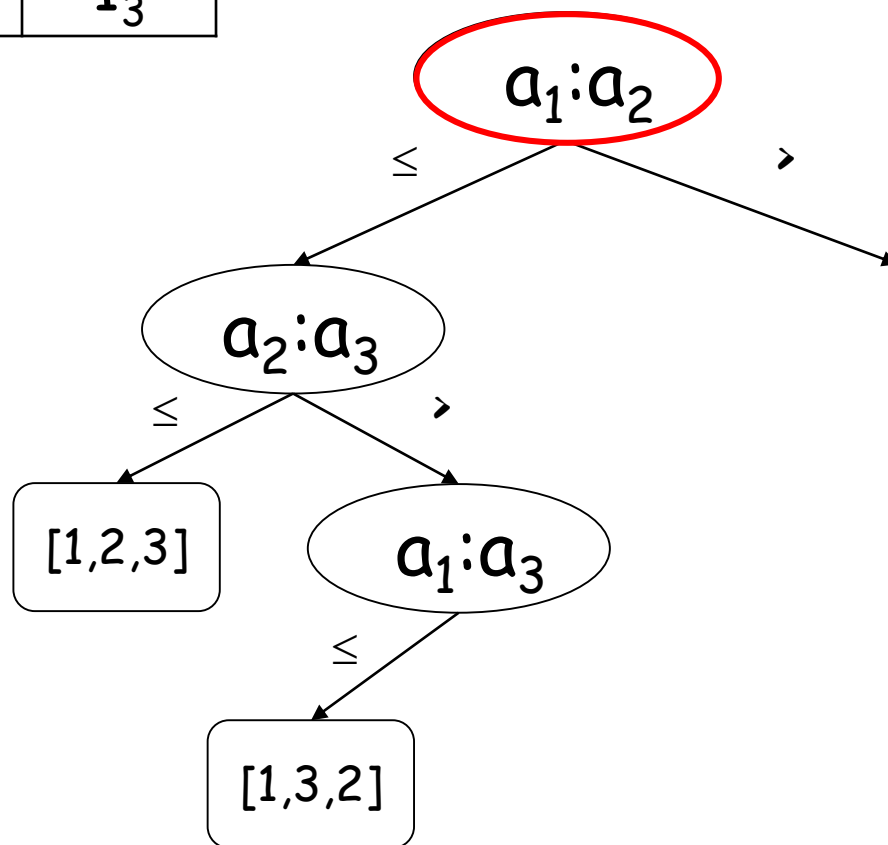
עץ החלטה






$a[1]$	$a[2]$	$a[3]$
2_1	3_2	1_3

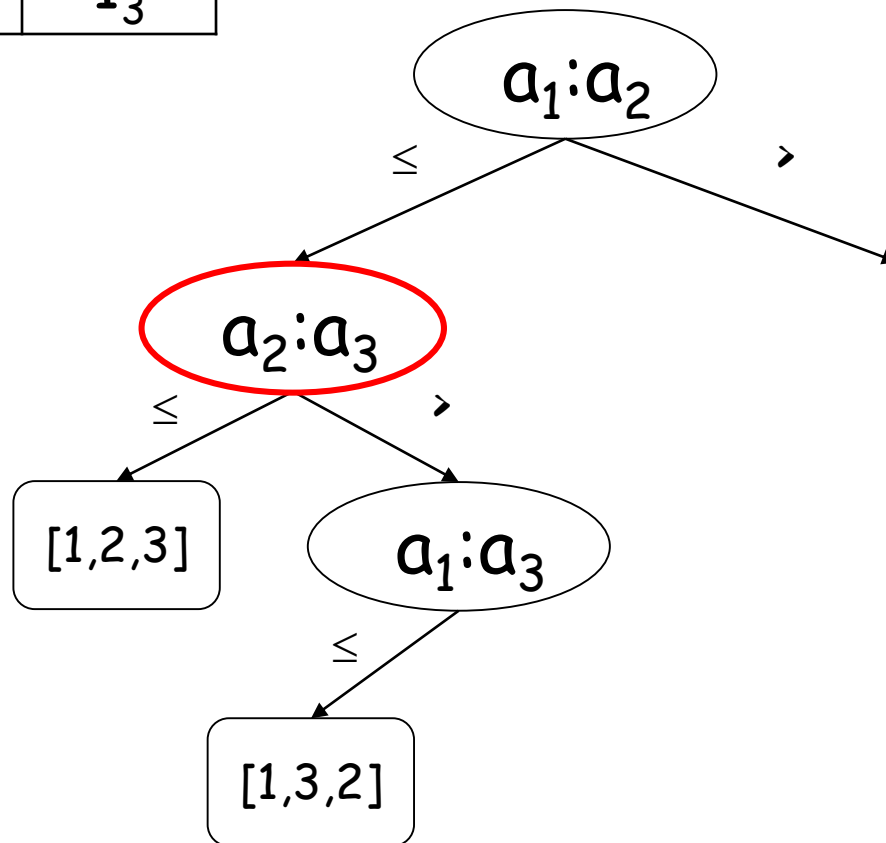
עץ החלטה






$a[1]$	$a[2]$	$a[3]$
2_1	3_2	1_3

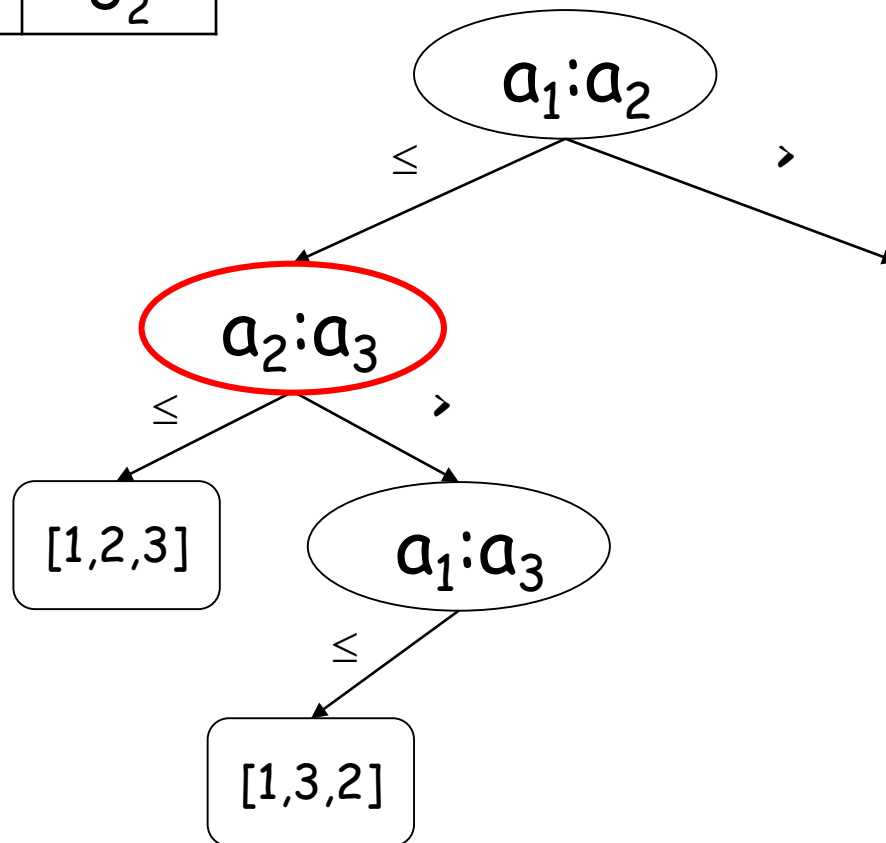
עץ החלטה

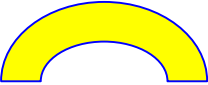




$a[1]$	$a[2]$	$a[3]$
2_1	1_3	3_2

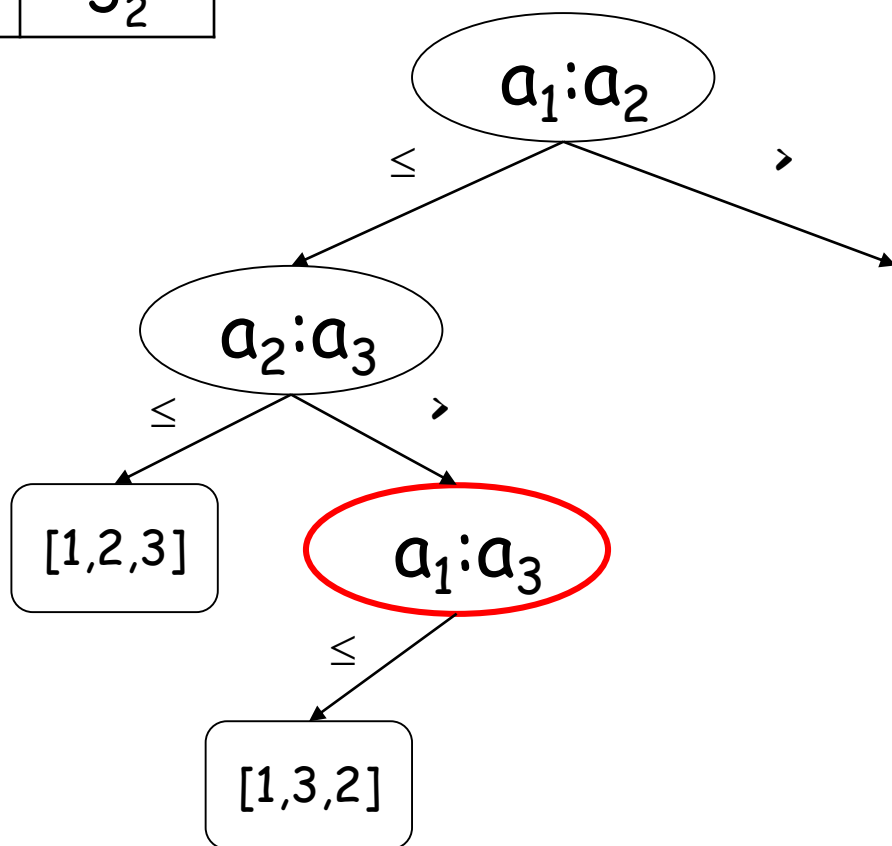
עץ החלטה

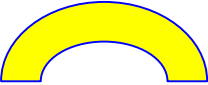




$a[1]$	$a[2]$	$a[3]$
2_1	1_3	3_2

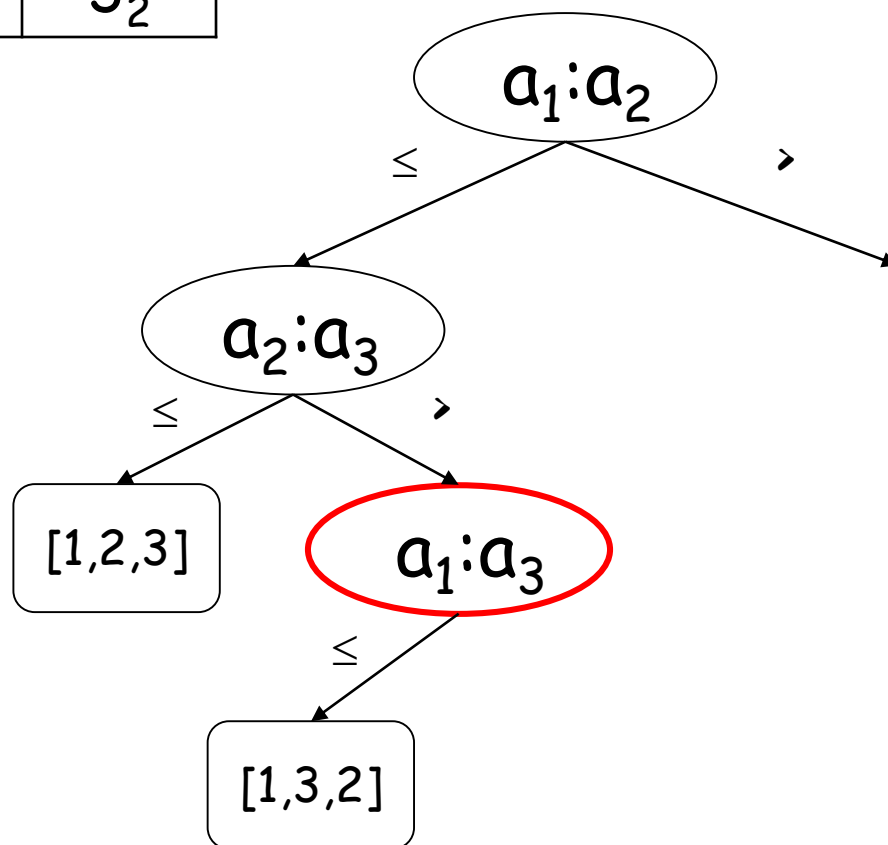
עץ החלטה





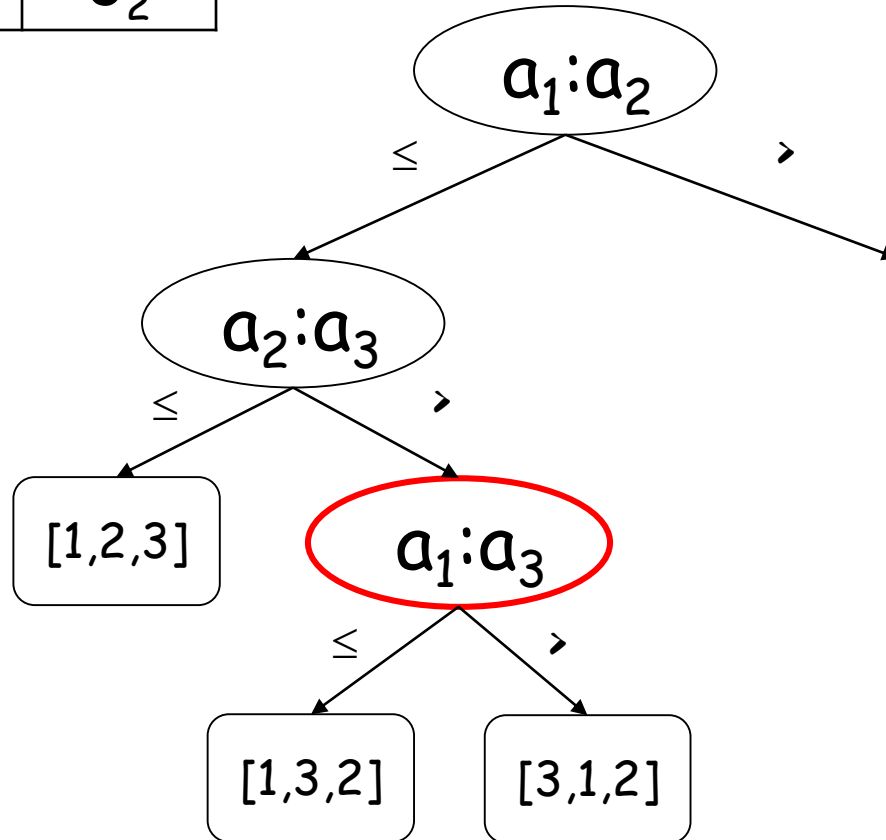
$a[1]$	$a[2]$	$a[3]$
1_3	2_1	3_2

עץ החלטה



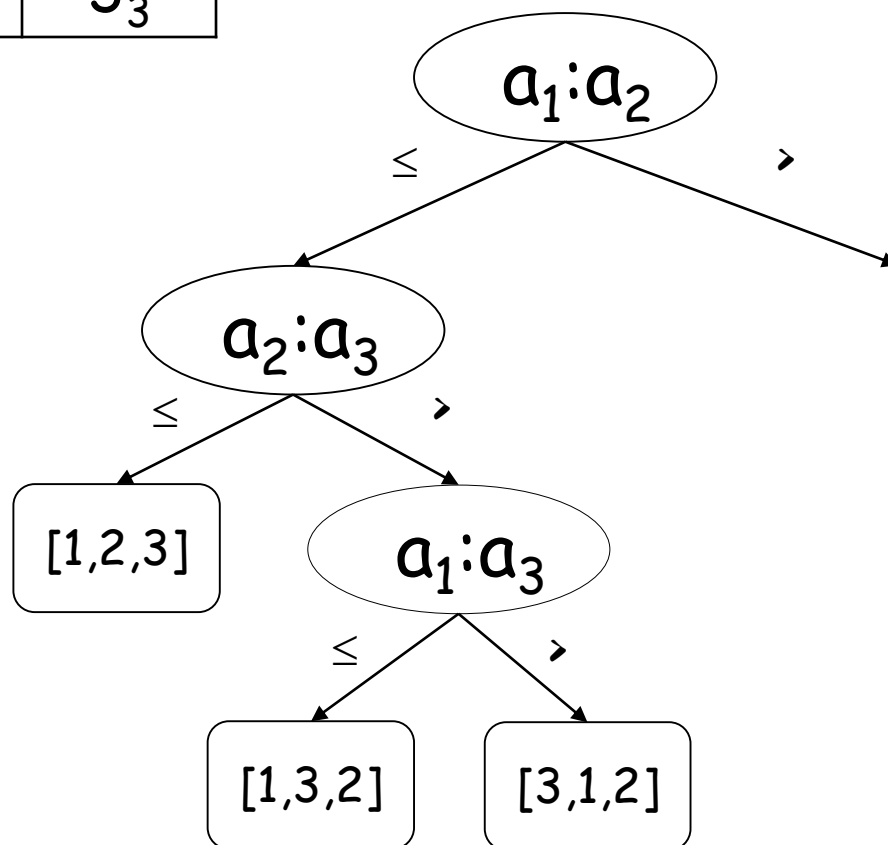
$a[1]$	$a[2]$	$a[3]$
1_3	2_1	3_2

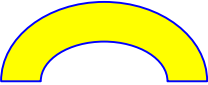
עץ החלטה



$a[1]$	$a[2]$	$a[3]$
2_1	1_2	3_3

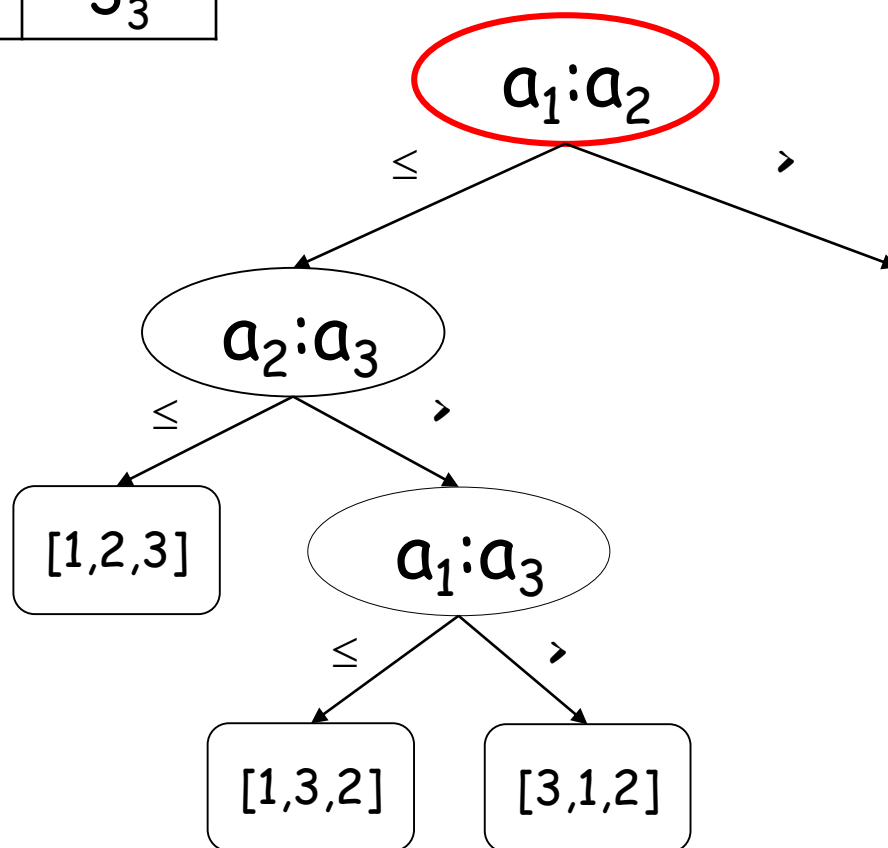
עץ החלטה

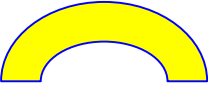




$a[1]$	$a[2]$	$a[3]$
2_1	1_2	3_3

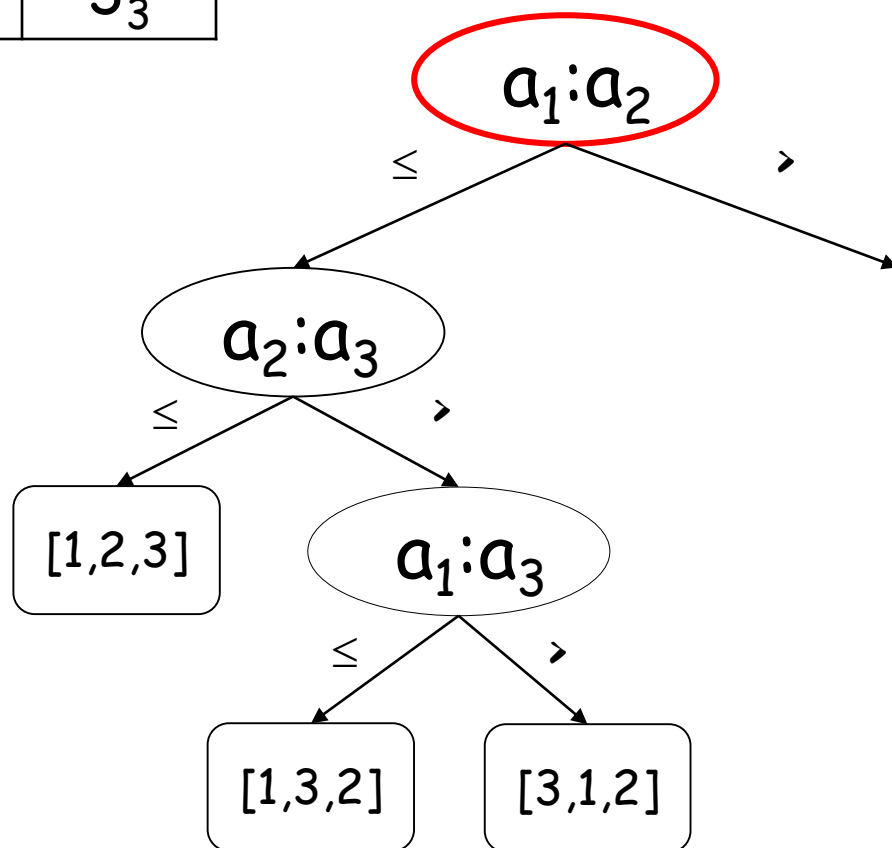
עץ החלטה

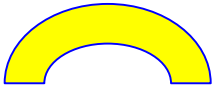




$a[1]$	$a[2]$	$a[3]$
1_2	2_1	3_3

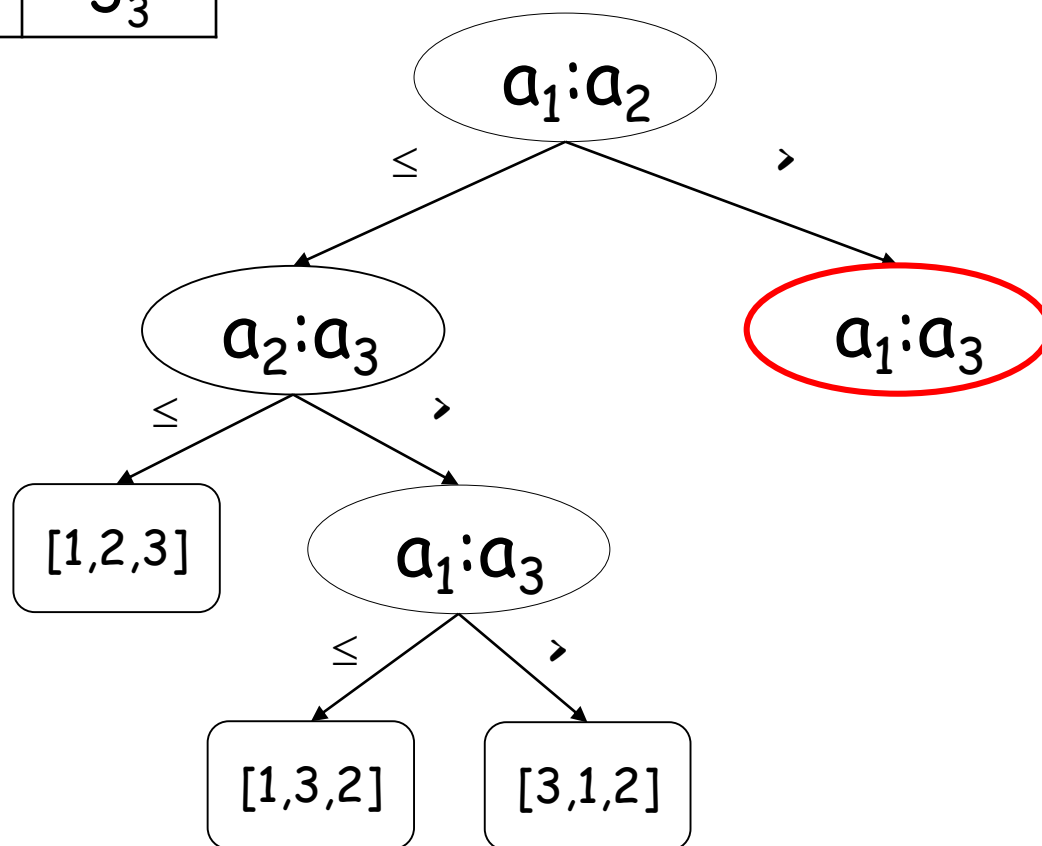
עץ החלטה

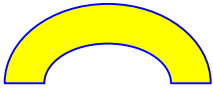




$a[1]$	$a[2]$	$a[3]$
1_2	2_1	3_3

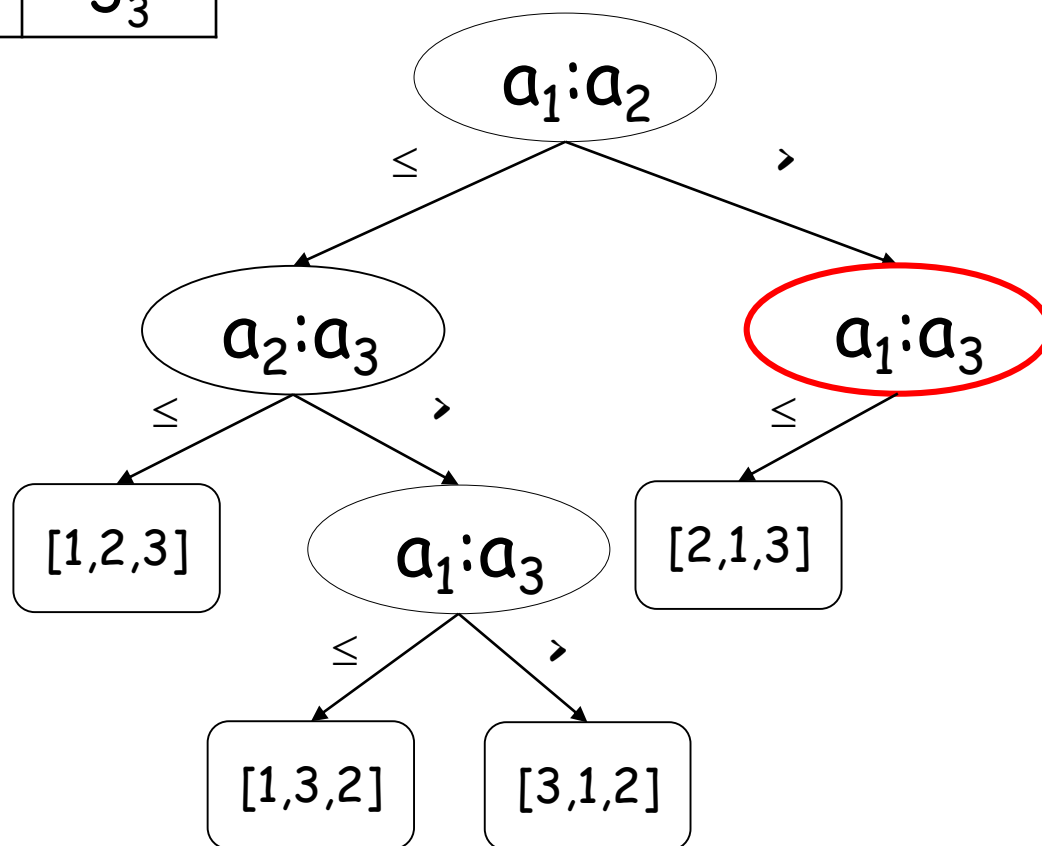
עץ החלטה





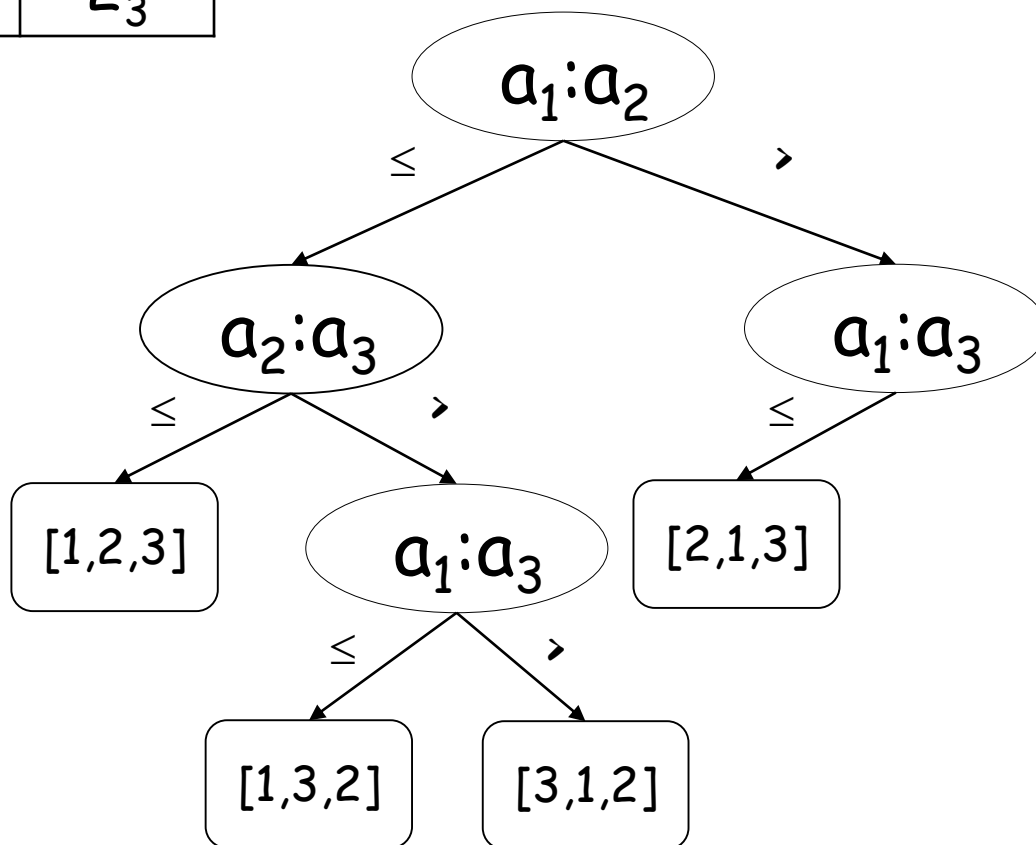
$a[1]$	$a[2]$	$a[3]$
1_2	2_1	3_3

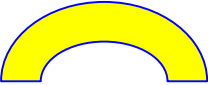
עץ החלטה



$a[1]$	$a[2]$	$a[3]$
3_1	1_2	2_3

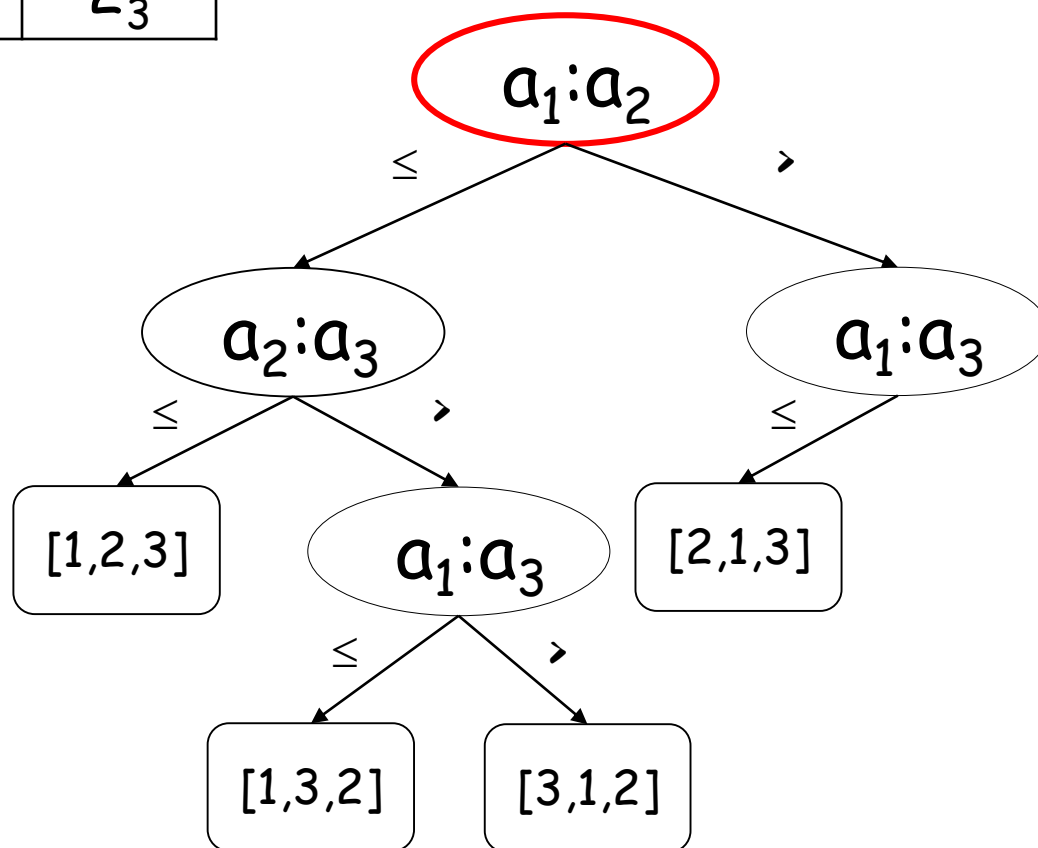
עץ החלטה

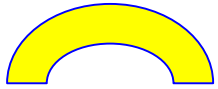




$a[1]$	$a[2]$	$a[3]$
3_1	1_2	2_3

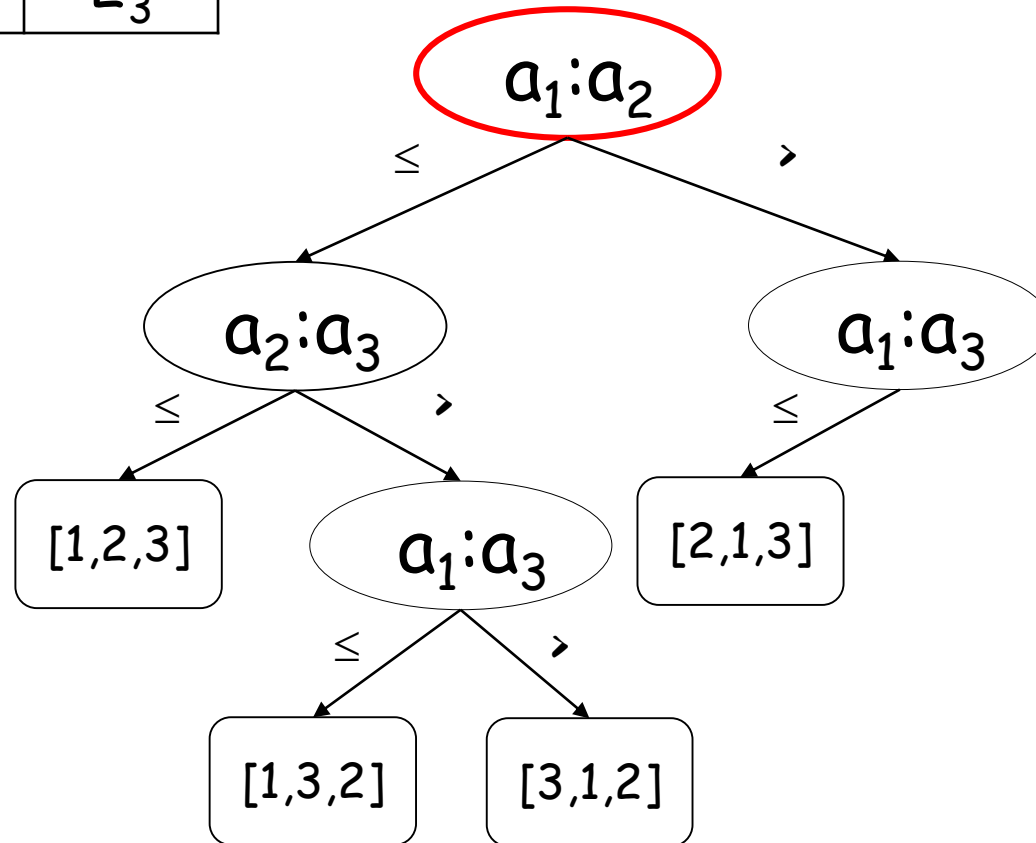
עץ החלטה

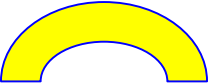




$a[1]$	$a[2]$	$a[3]$
1_2	3_1	2_3

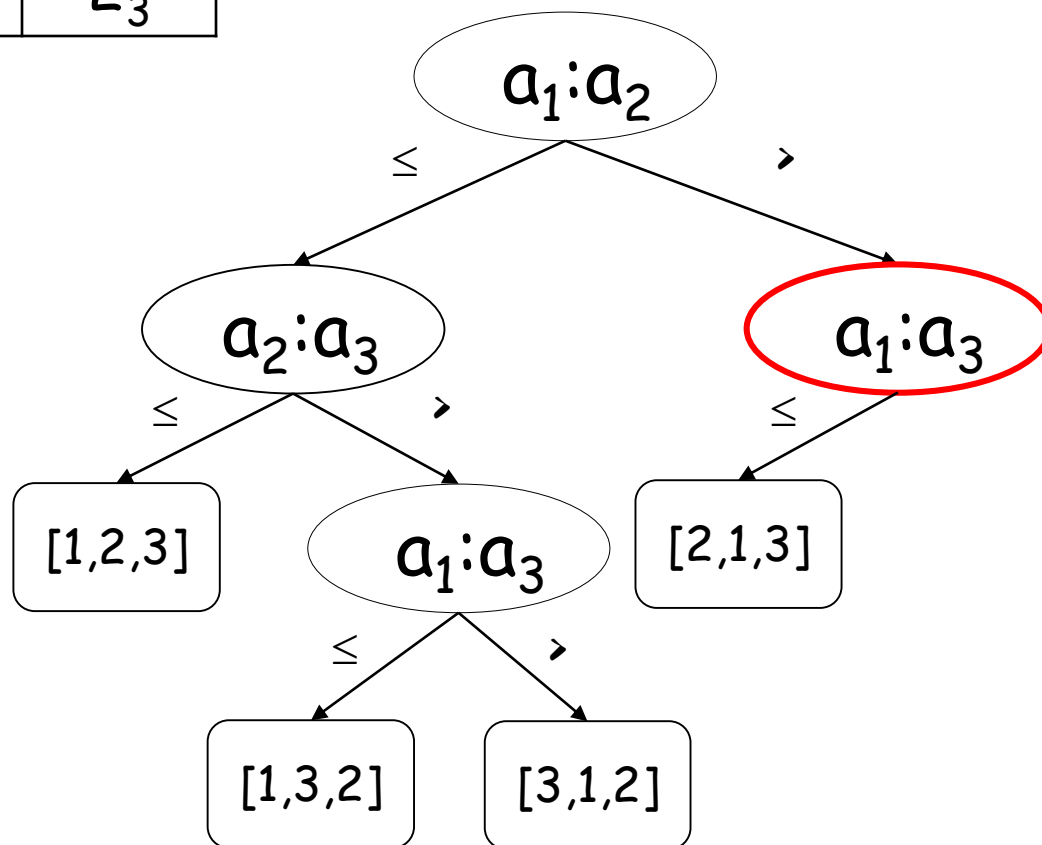
עץ החלטה

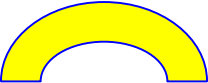




$a[1]$	$a[2]$	$a[3]$
1_2	3_1	2_3

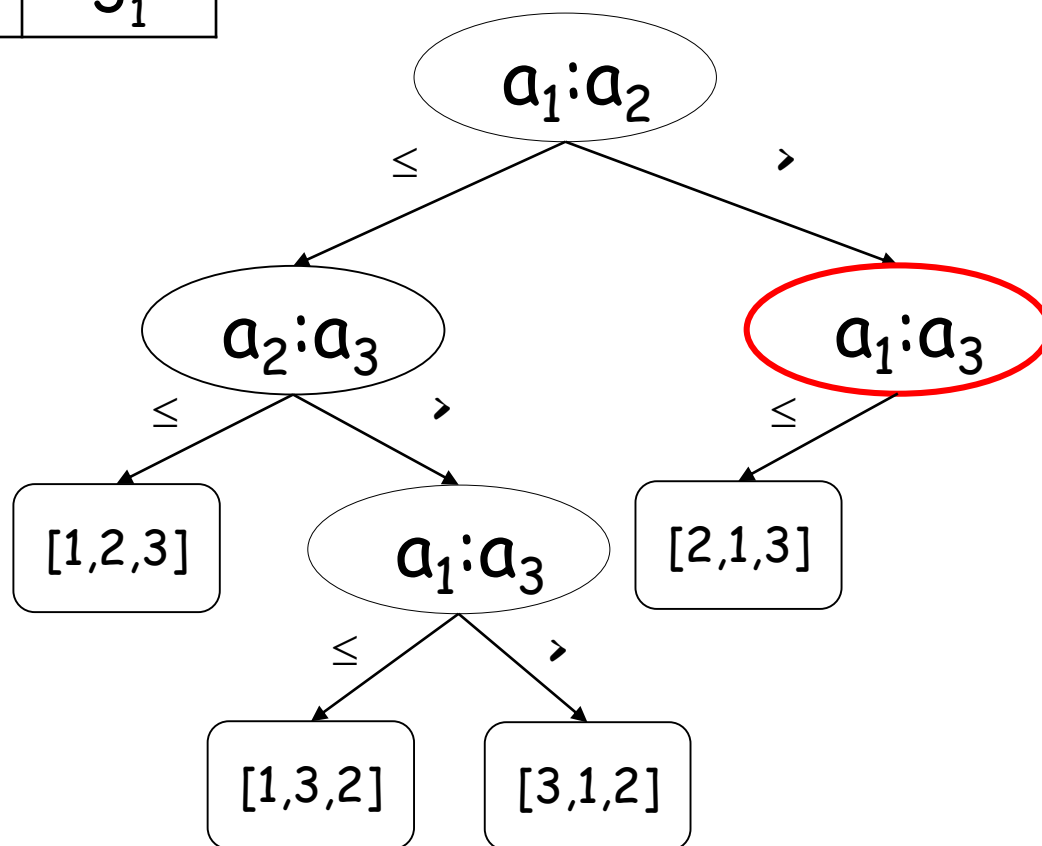
עץ החלטה

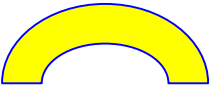




$a[1]$	$a[2]$	$a[3]$
1_2	2_3	3_1

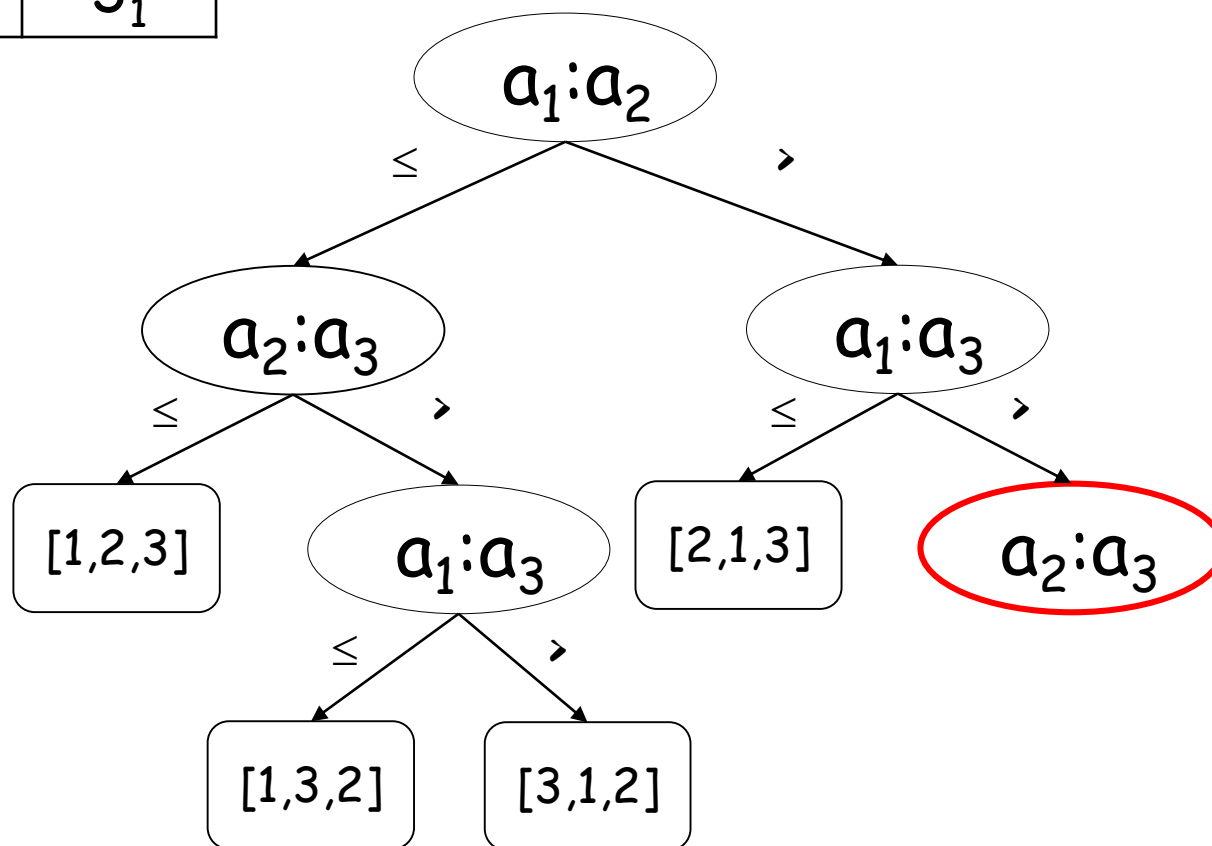
עץ החלטה





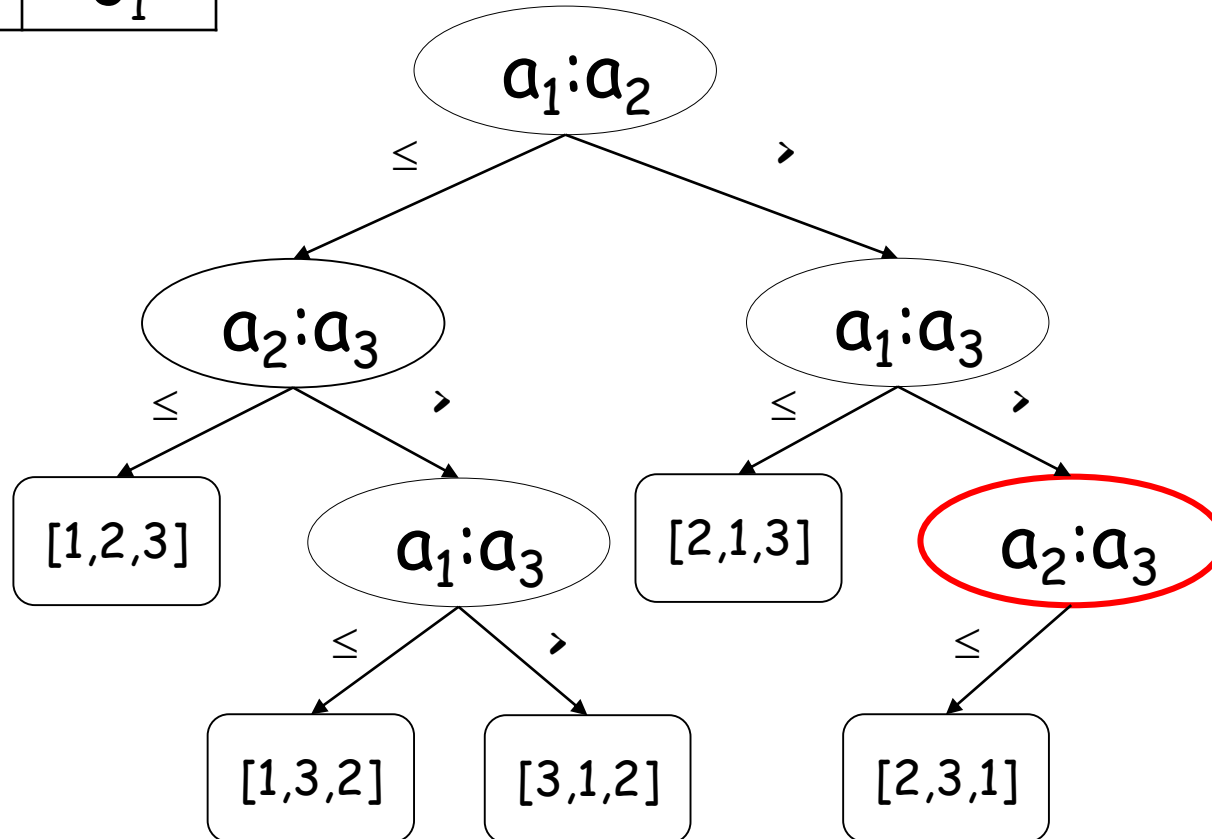
$a[1]$	$a[2]$	$a[3]$
1_2	2_3	3_1

עץ החלטה



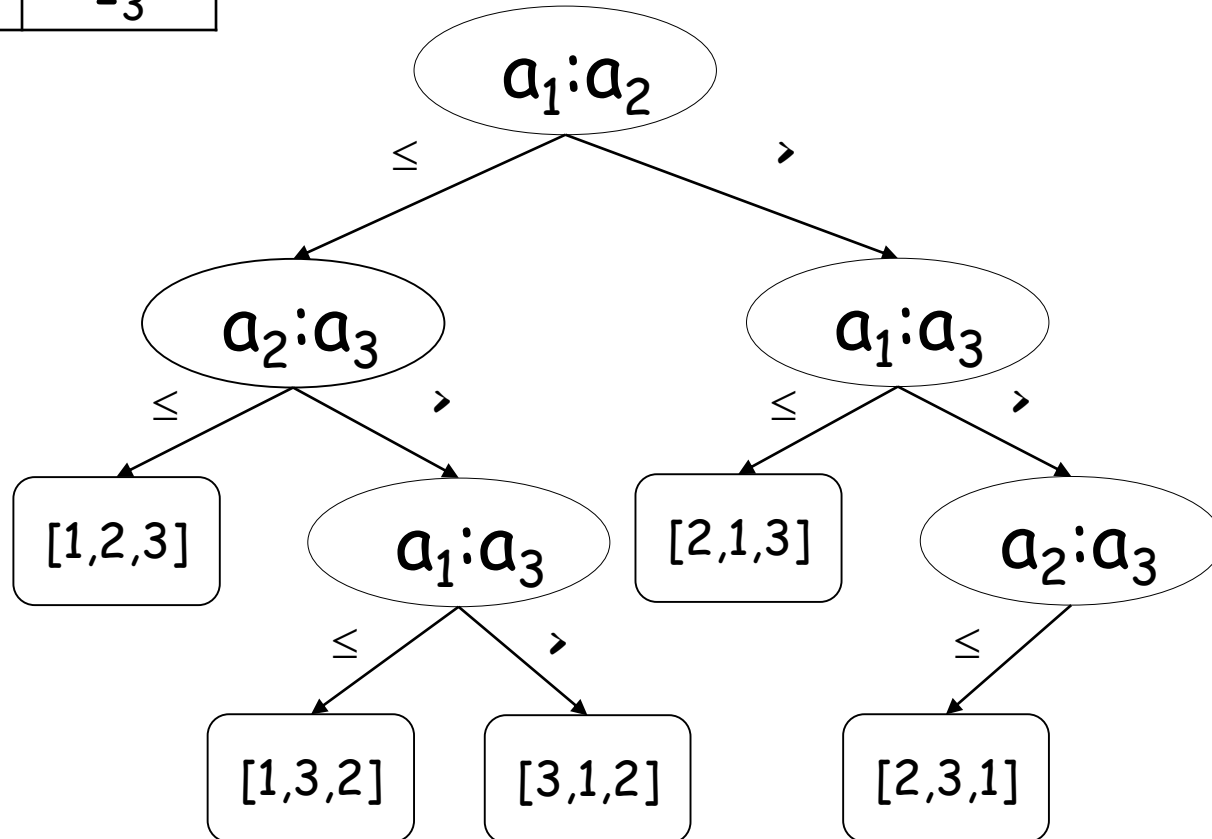
$a[1]$	$a[2]$	$a[3]$
1_2	2_3	3_1

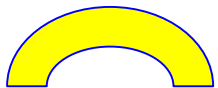
עץ החלטה



$a[1]$	$a[2]$	$a[3]$
3_1	2_2	1_3

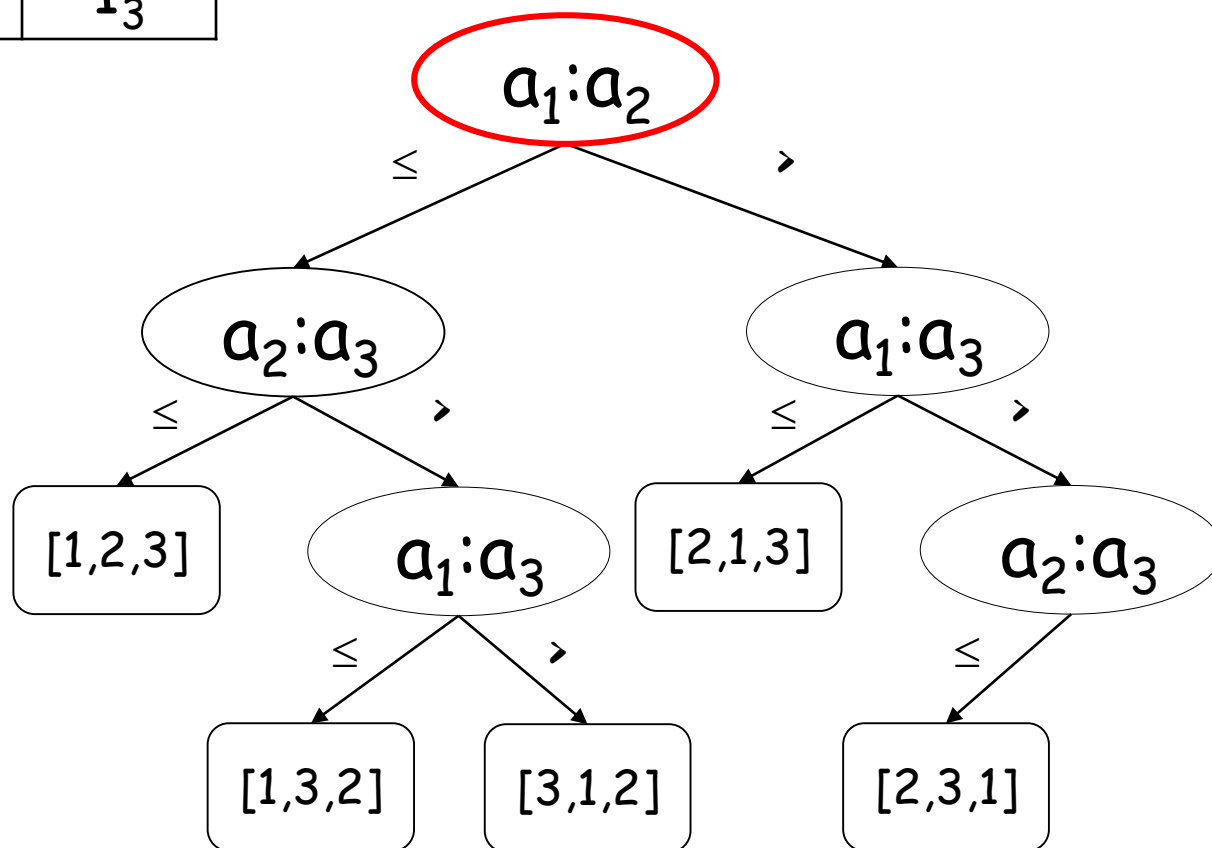
עץ החלטה





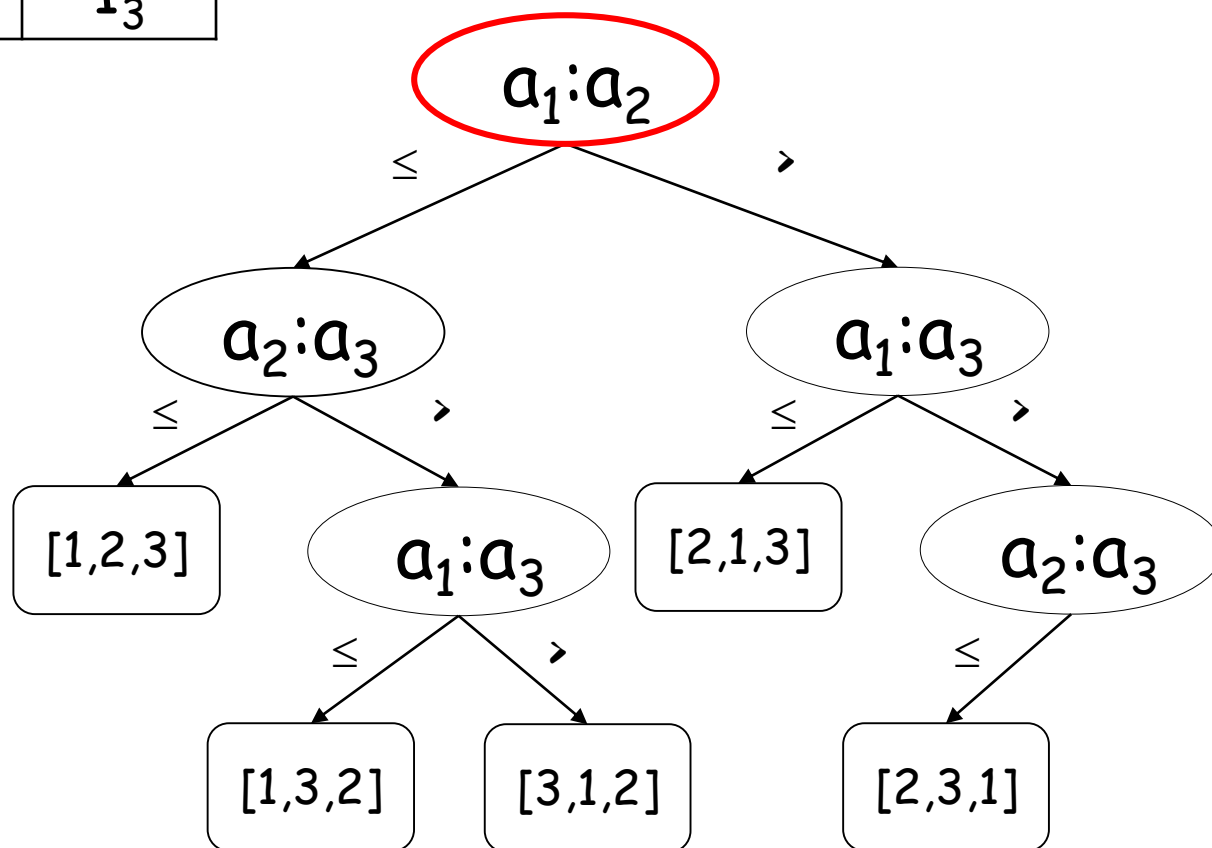
$a[1]$	$a[2]$	$a[3]$
3_1	2_2	1_3

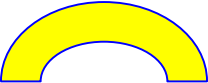
עץ החלטה



$a[1]$	$a[2]$	$a[3]$
2_2	3_1	1_3

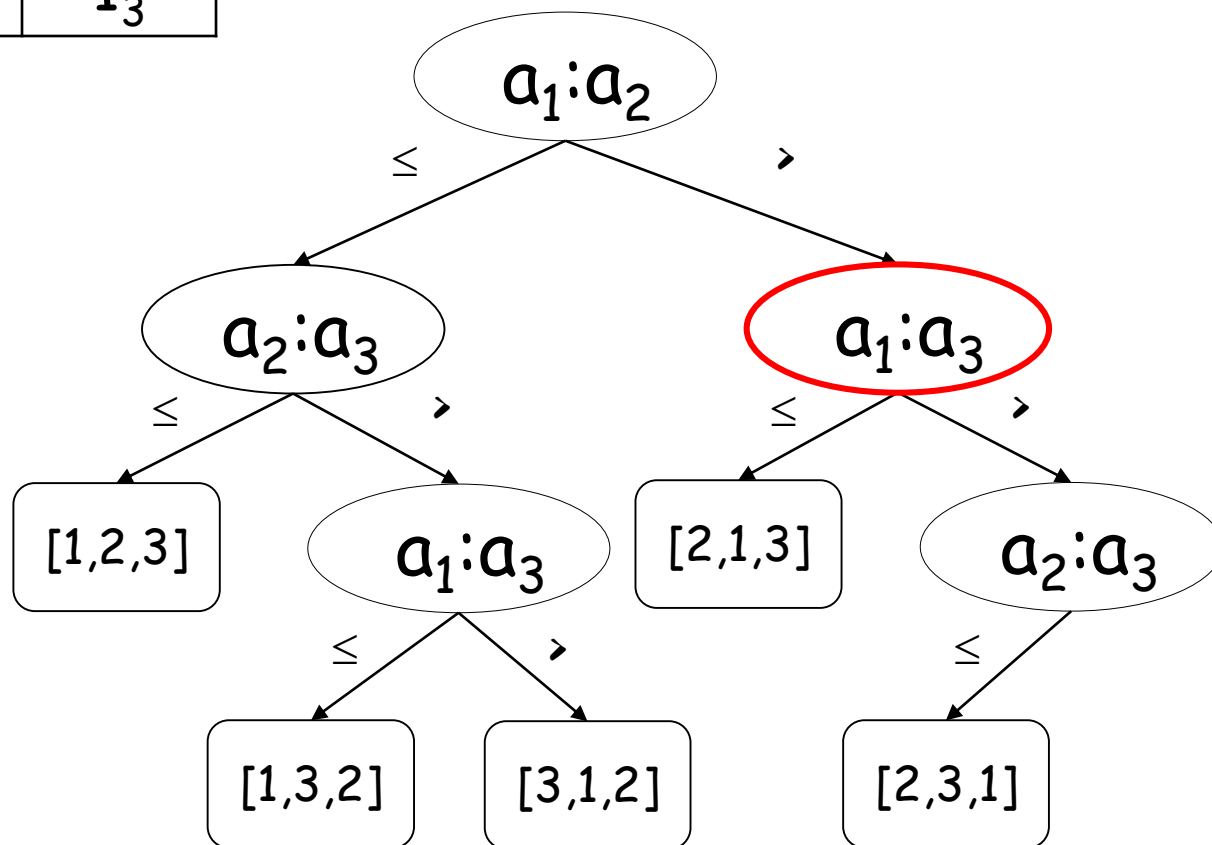
עץ החלטה





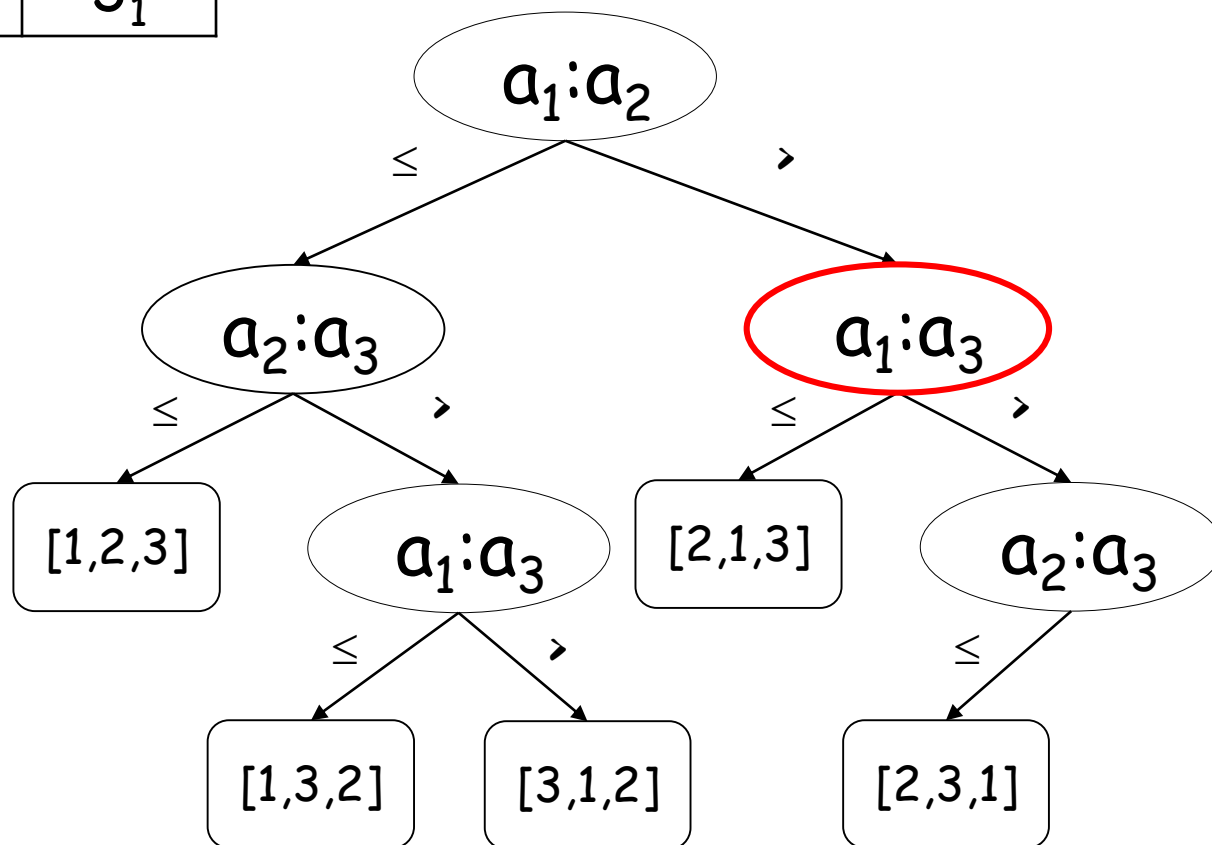
$a[1]$	$a[2]$	$a[3]$
2_2	3_1	1_3

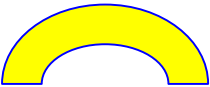
עץ החלטה



$a[1]$	$a[2]$	$a[3]$
2_2	1_3	3_1

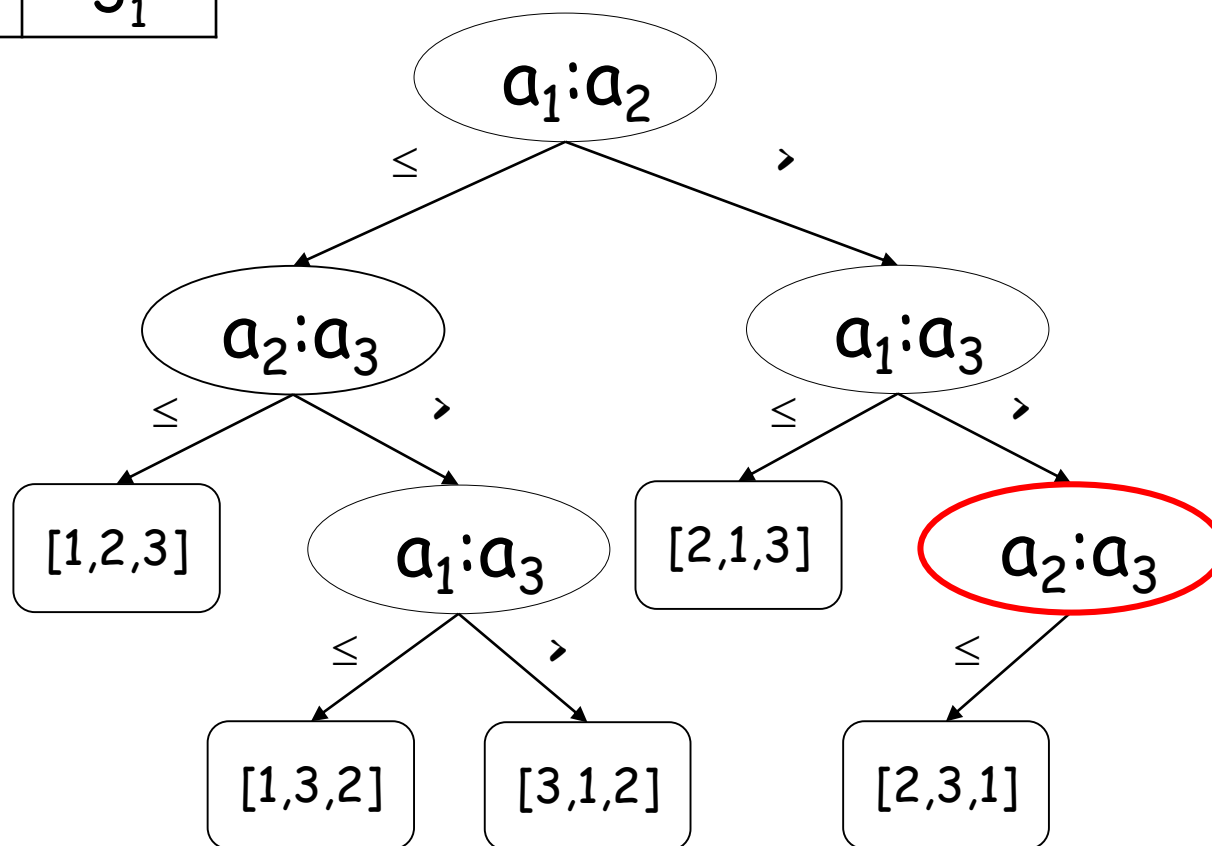
עץ החלטה

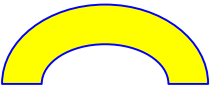




$a[1]$	$a[2]$	$a[3]$
2_2	1_3	3_1

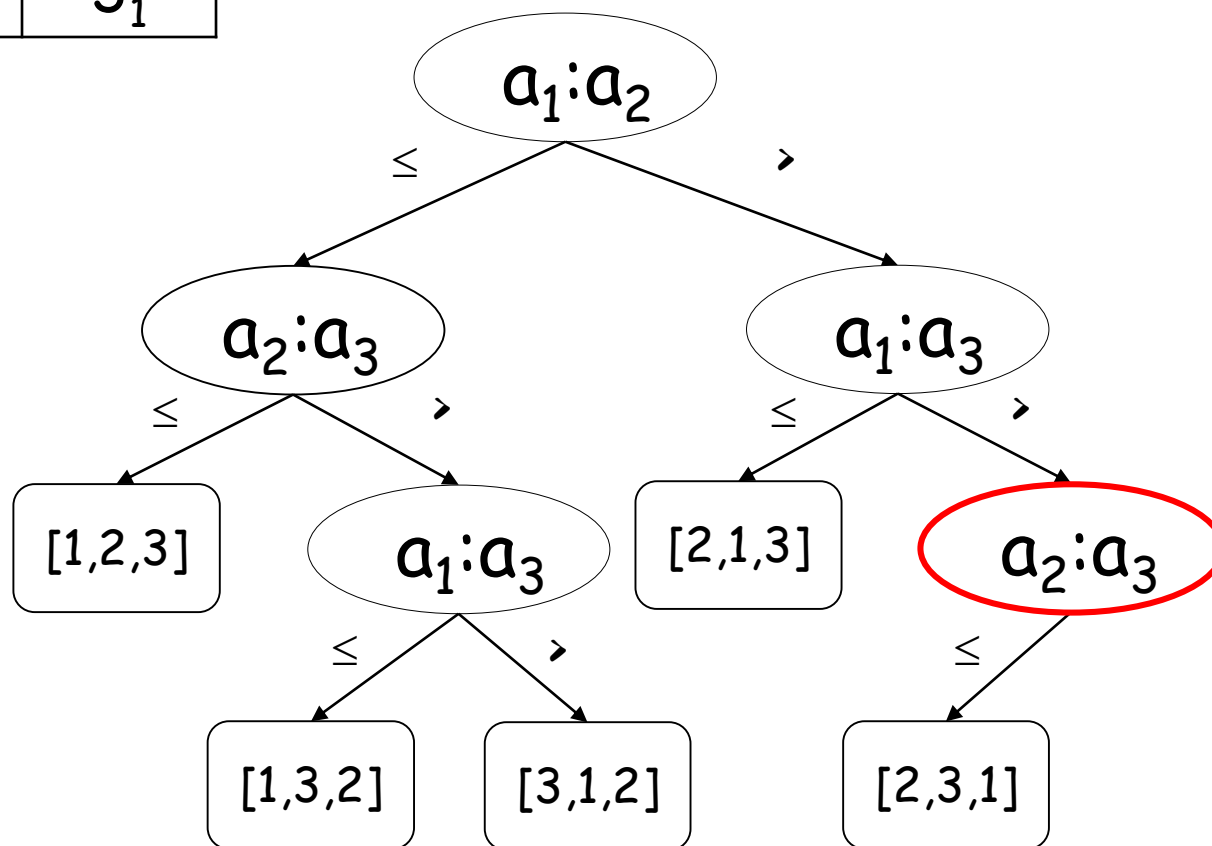
עץ החלטה





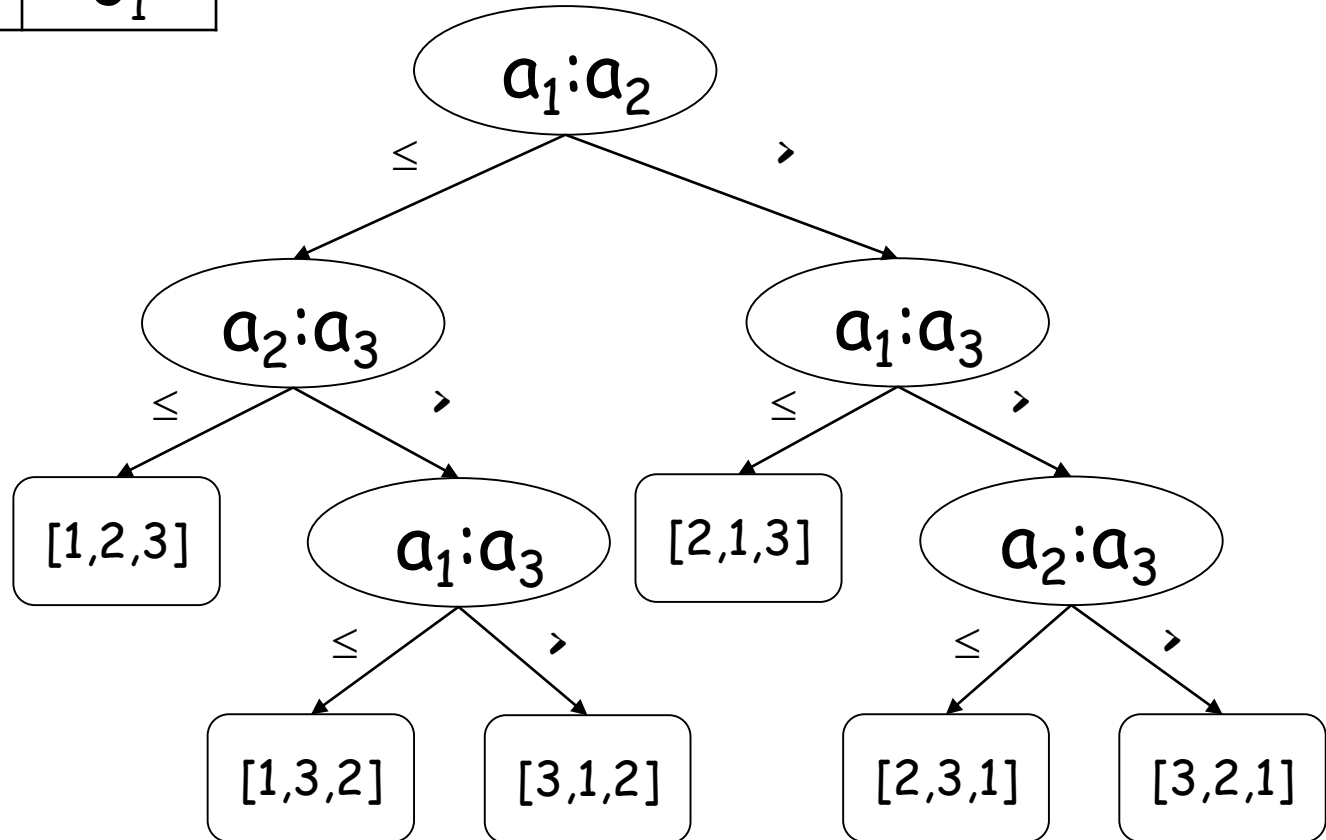
$a[1]$	$a[2]$	$a[3]$
1_3	2_2	3_1

עץ החלטה

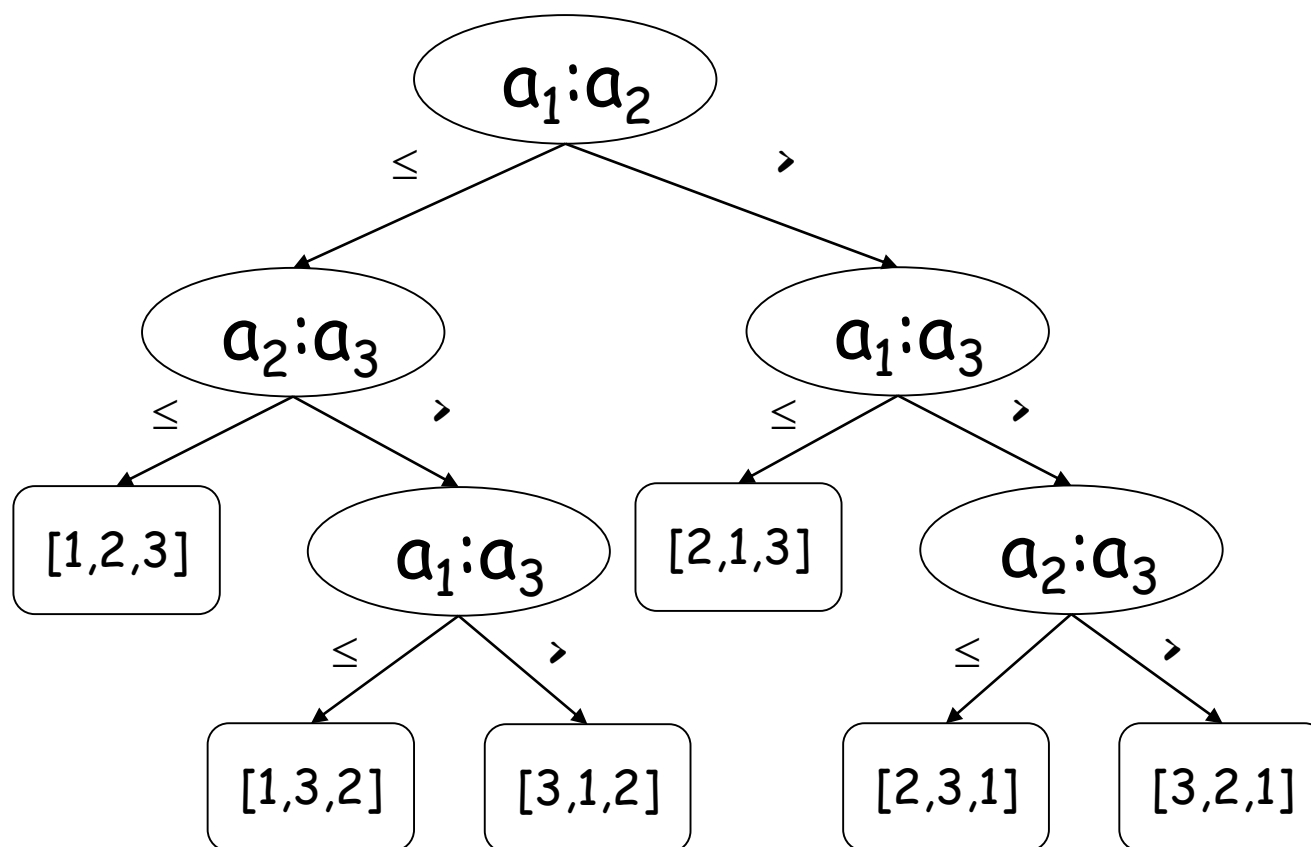


$a[1]$	$a[2]$	$a[3]$
1_3	2_2	3_1

עץ החלטה

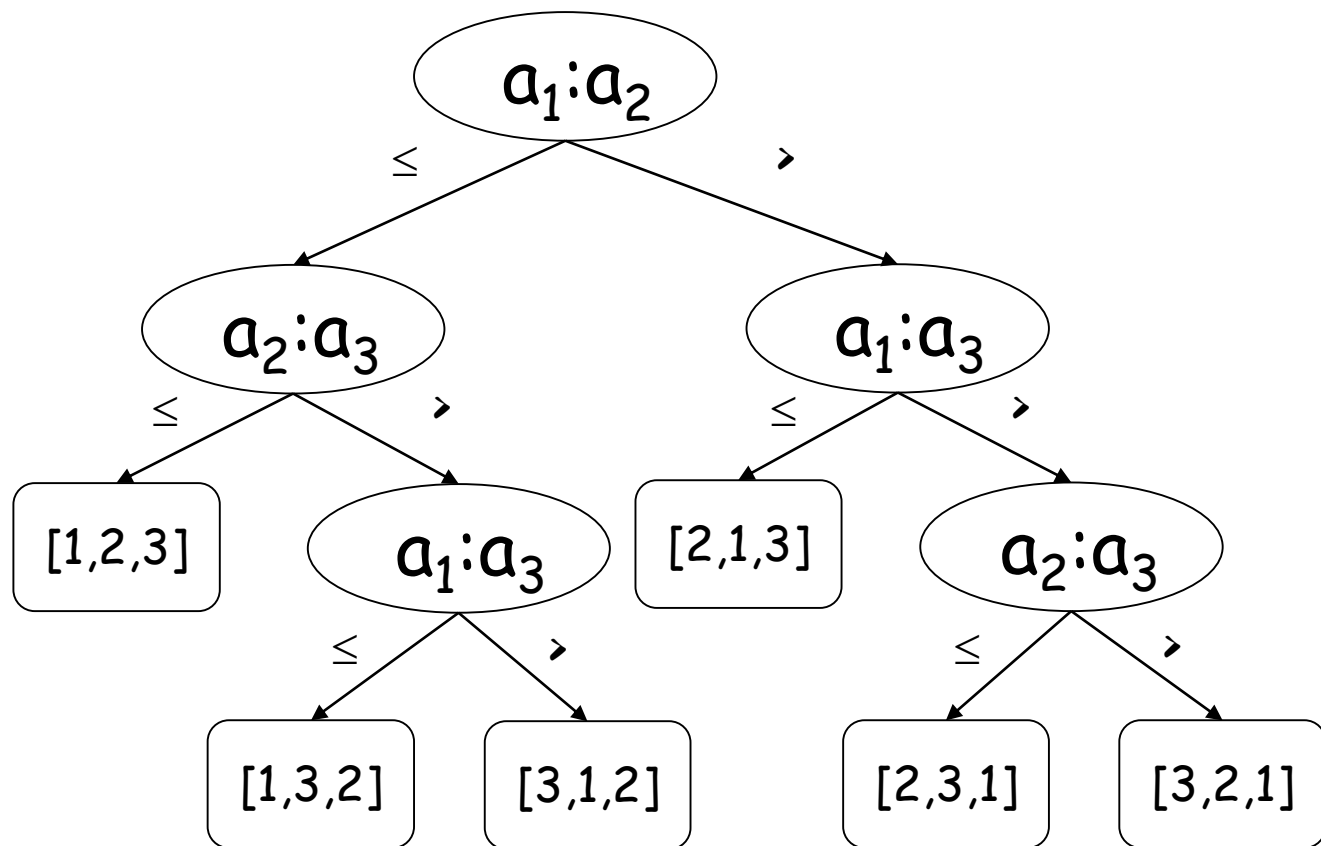


איזה סוג עץ הוא עץ החלטה ?

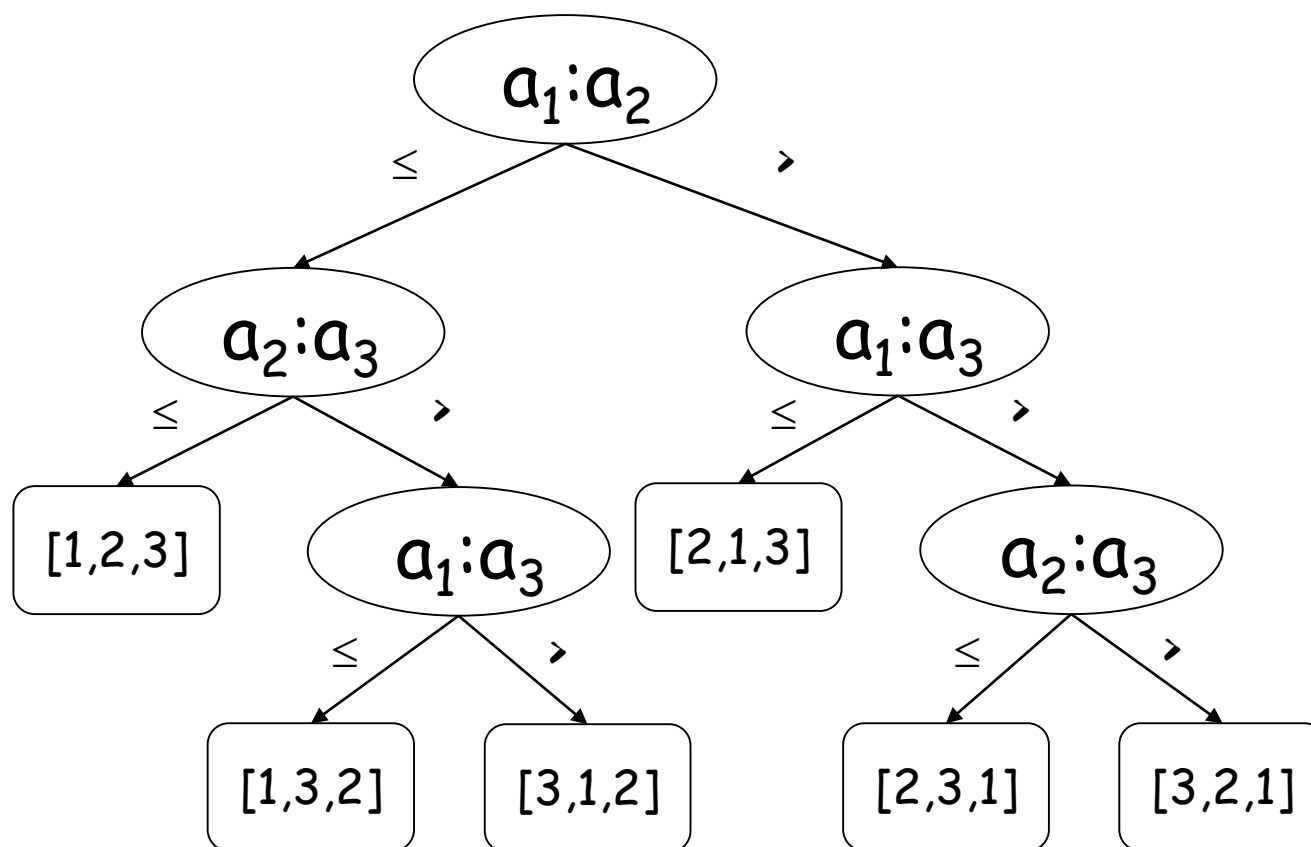


איזה סוג עץ הוא עץ החלטה ?

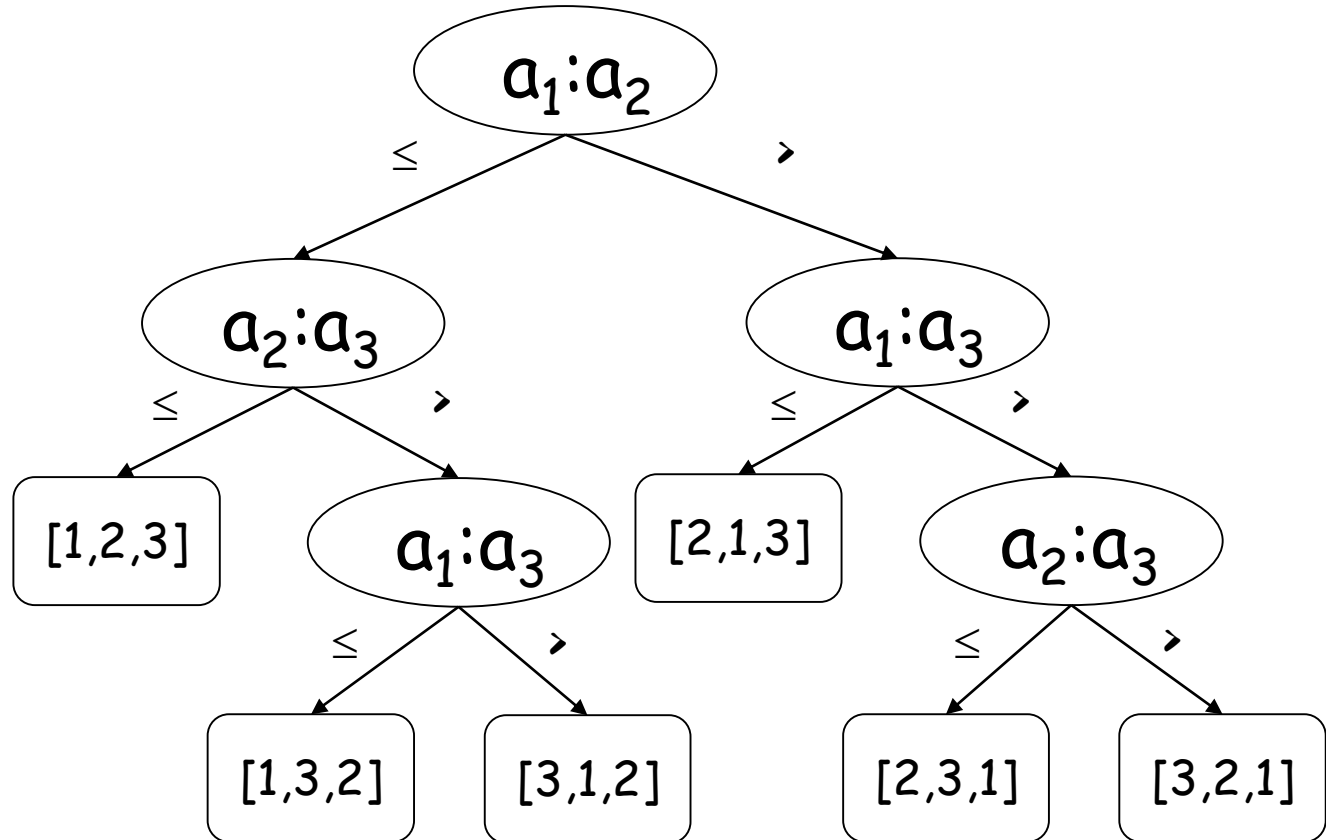
עץ בינרי מלא



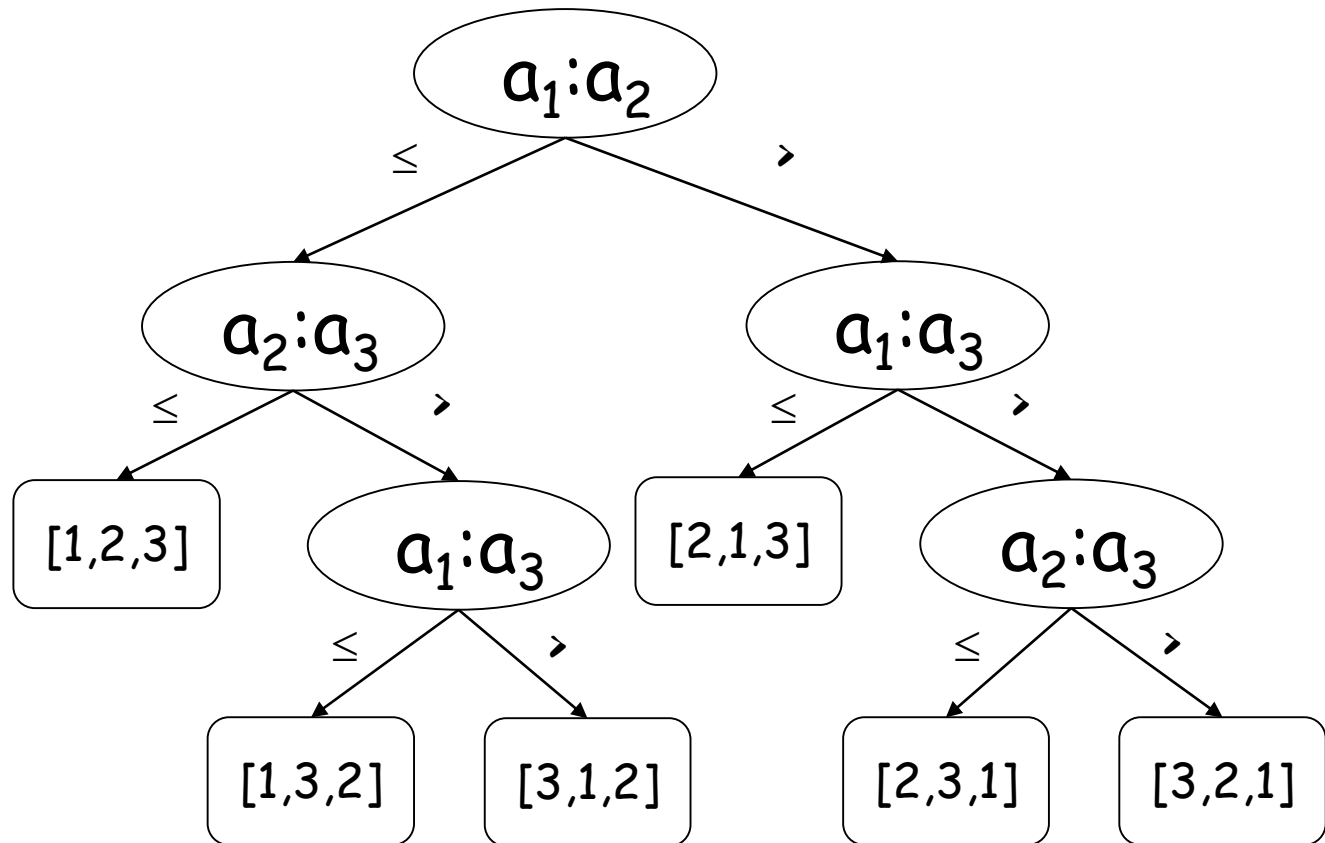
מהו מסלול בעץ?



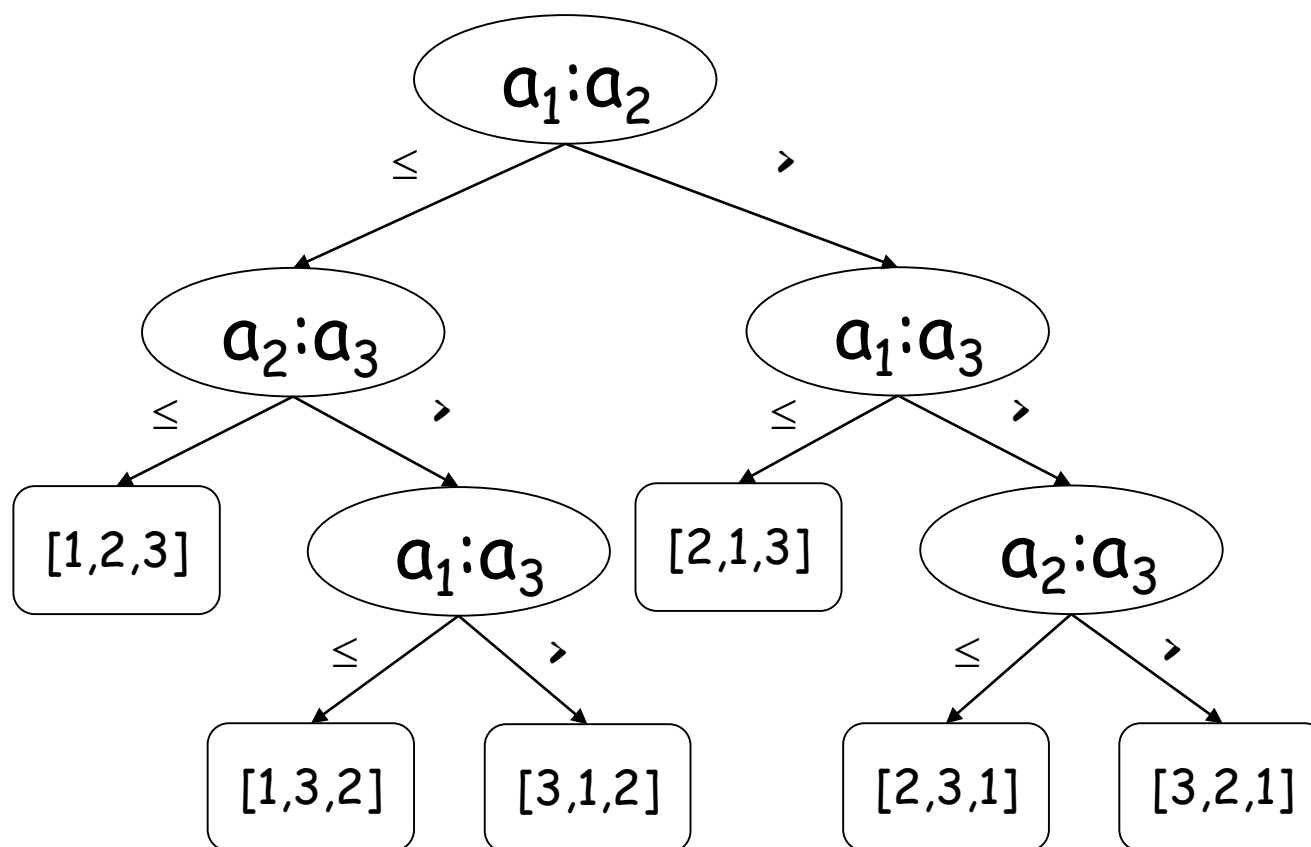
מהו מסלול בעץ? ריצה מסוימת



מה מציין עלה?

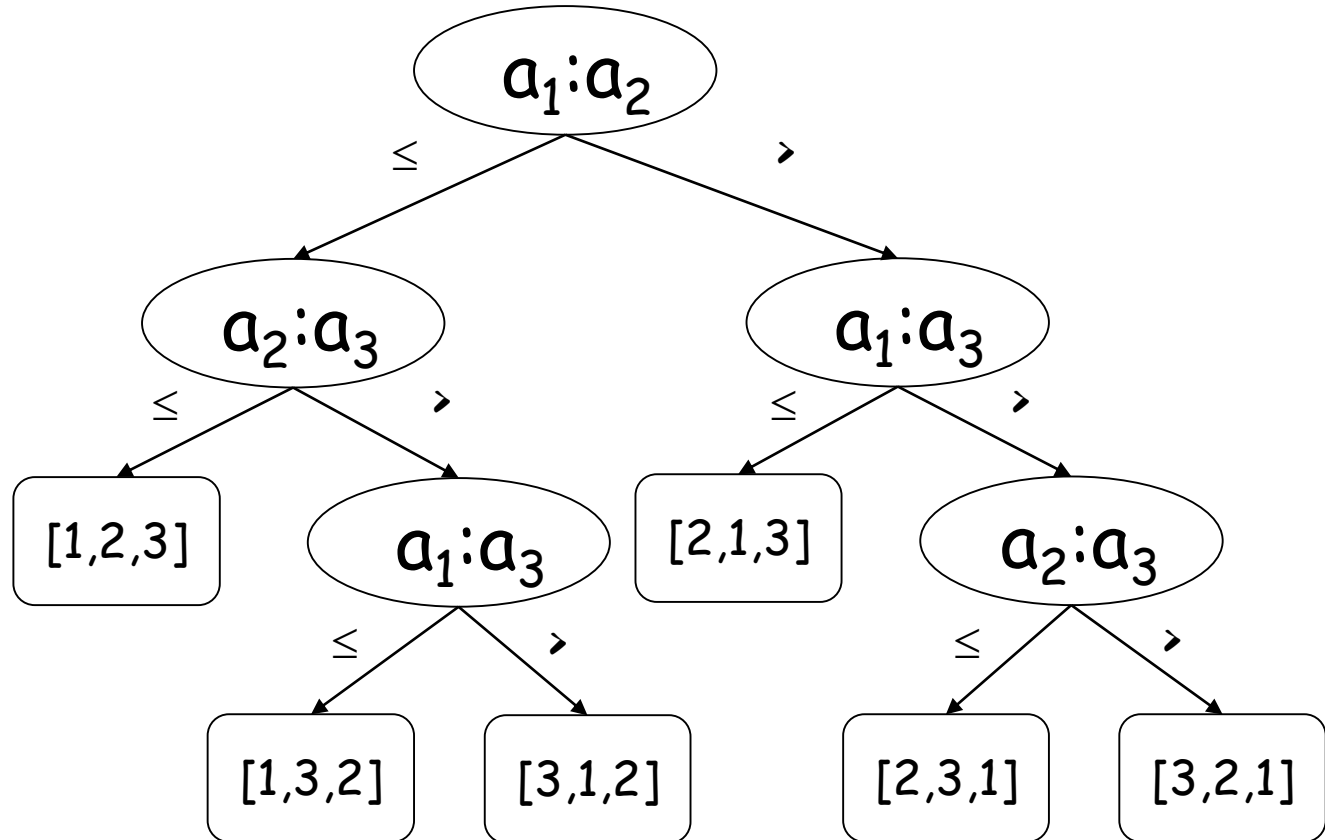


מה מציין עלה? פלט אפשרי של המיון



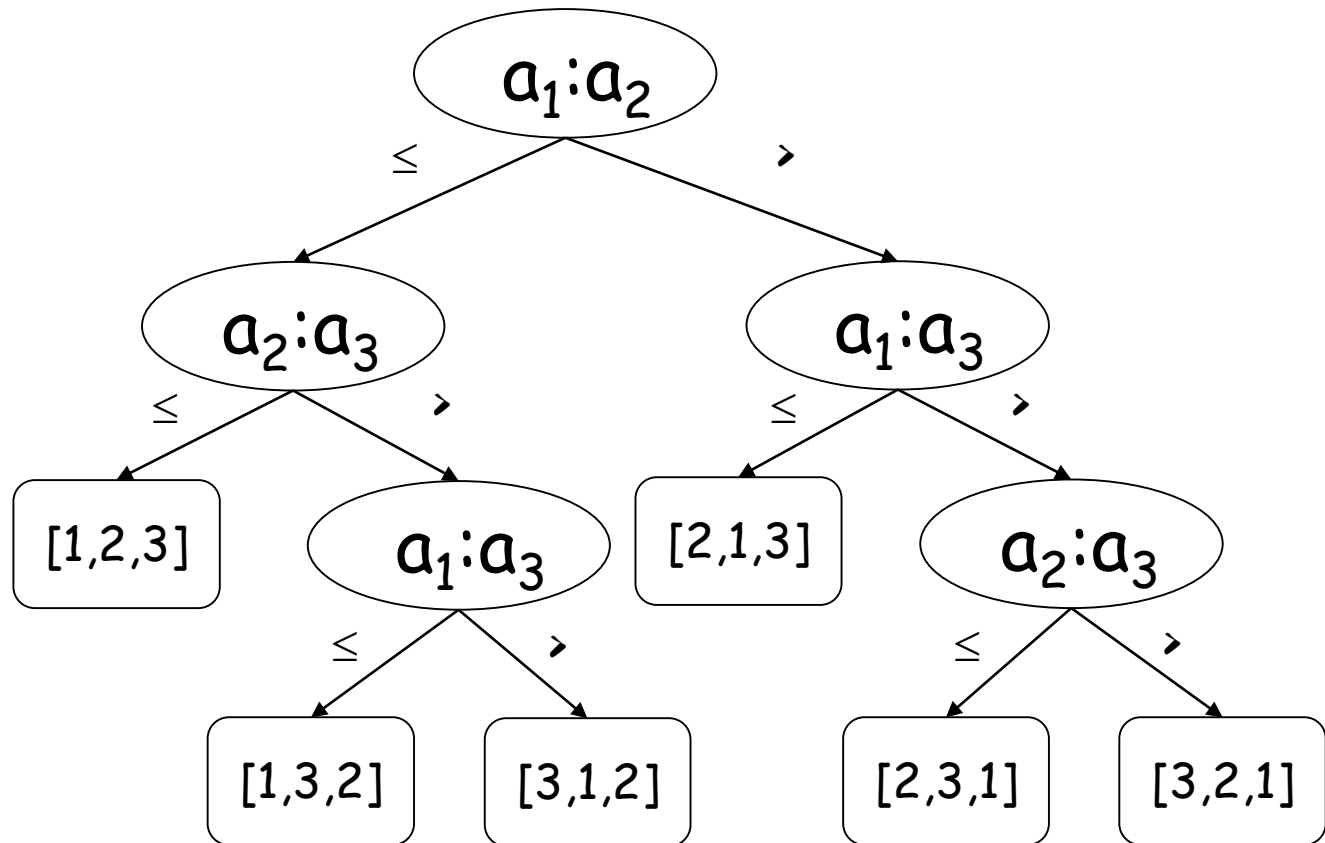
מסקנה:

= כמות העלים

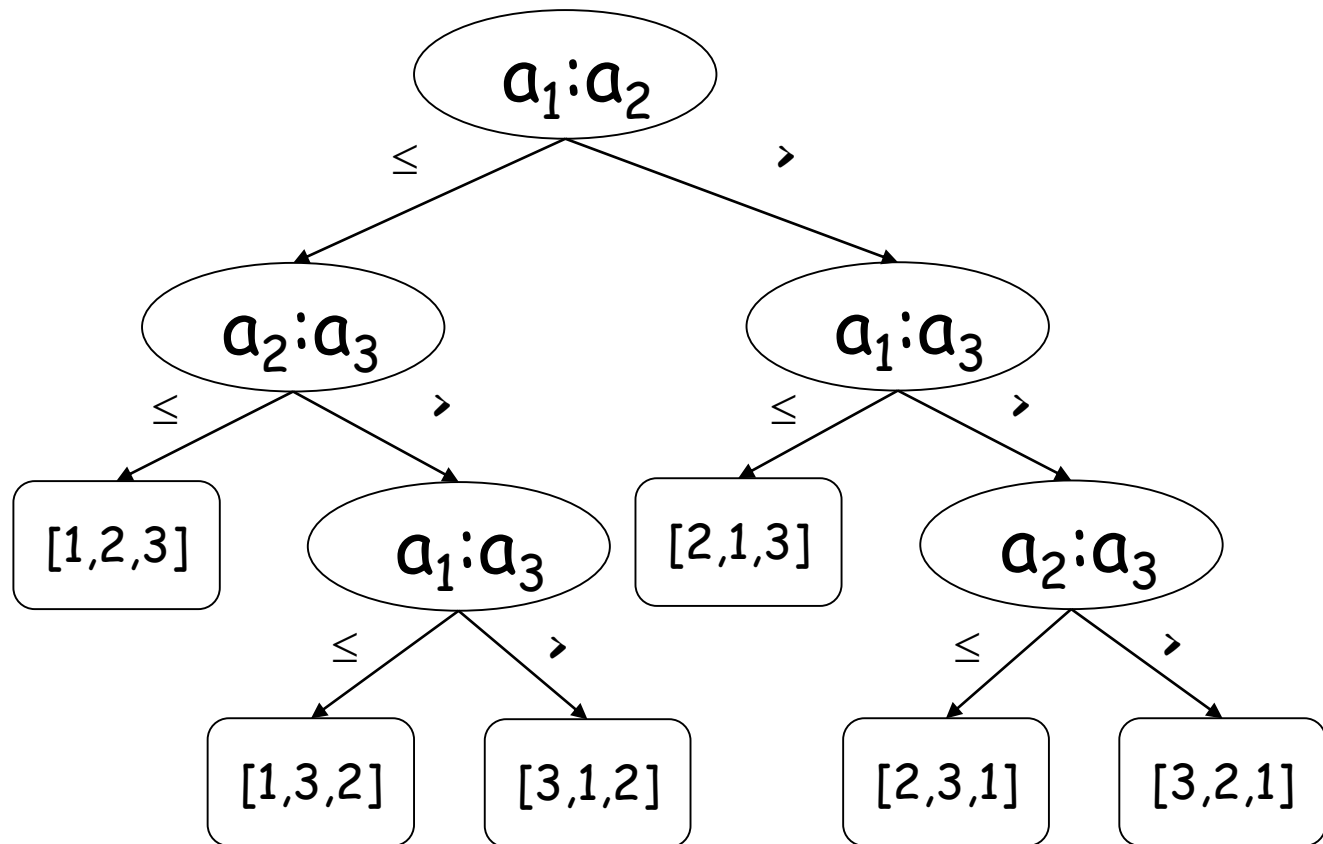


מסקנה:

כמות העלים = $n!$

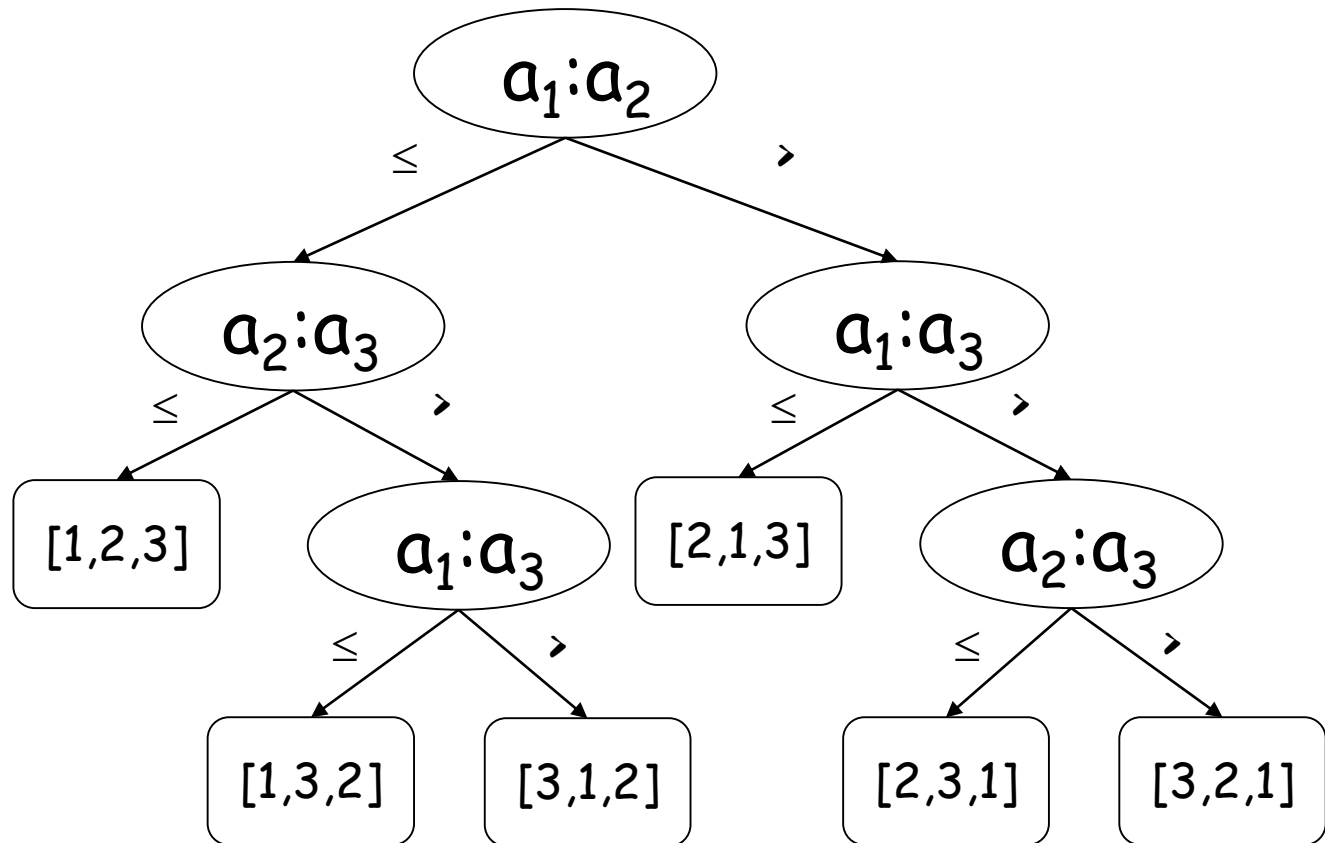


מה מייצג המסלול הארוך ביותר?



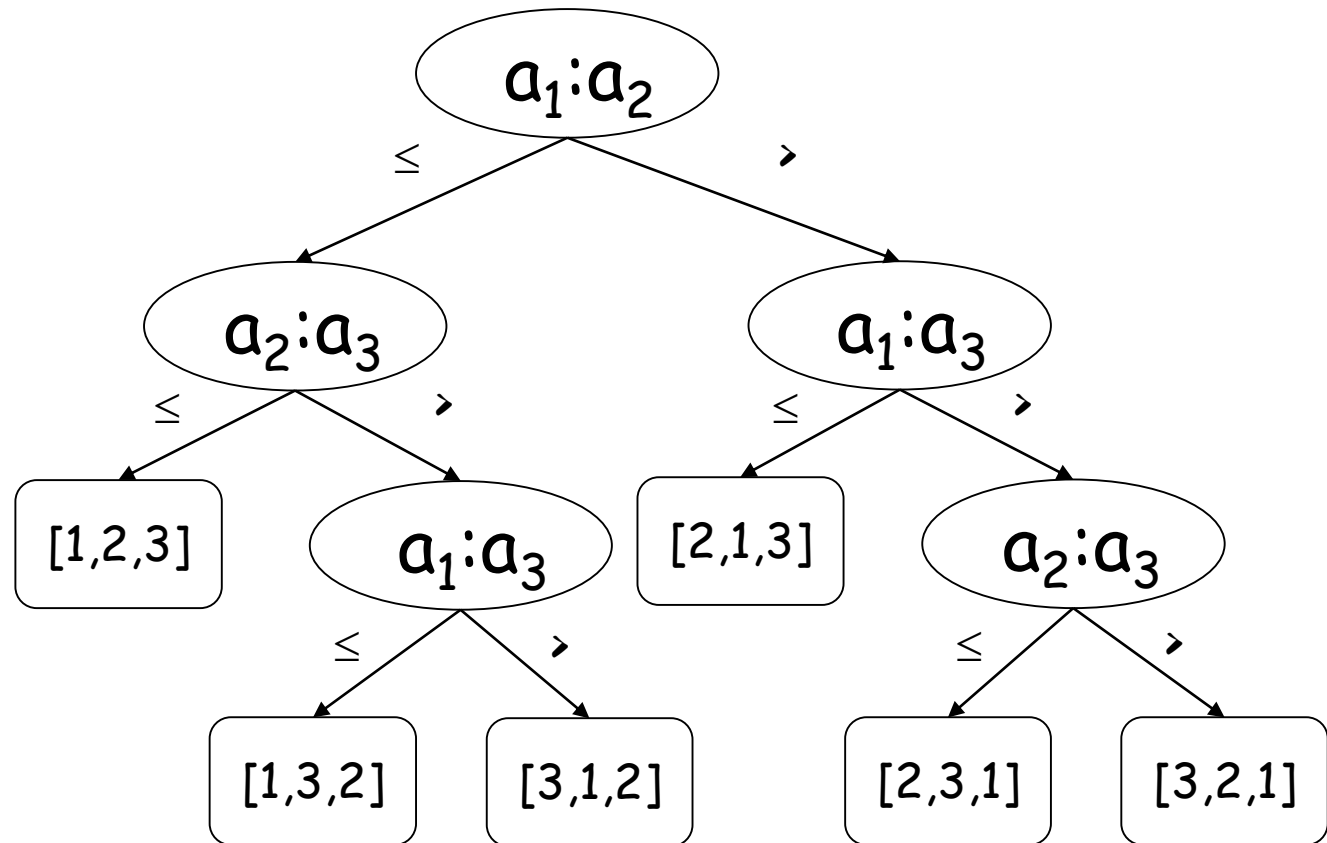
מה מייצג המסלול הארוך ביותר?

מספר ההשוואות שאלגוריתם מיון **הכי טוב** צורך **במקרה הגרוע**

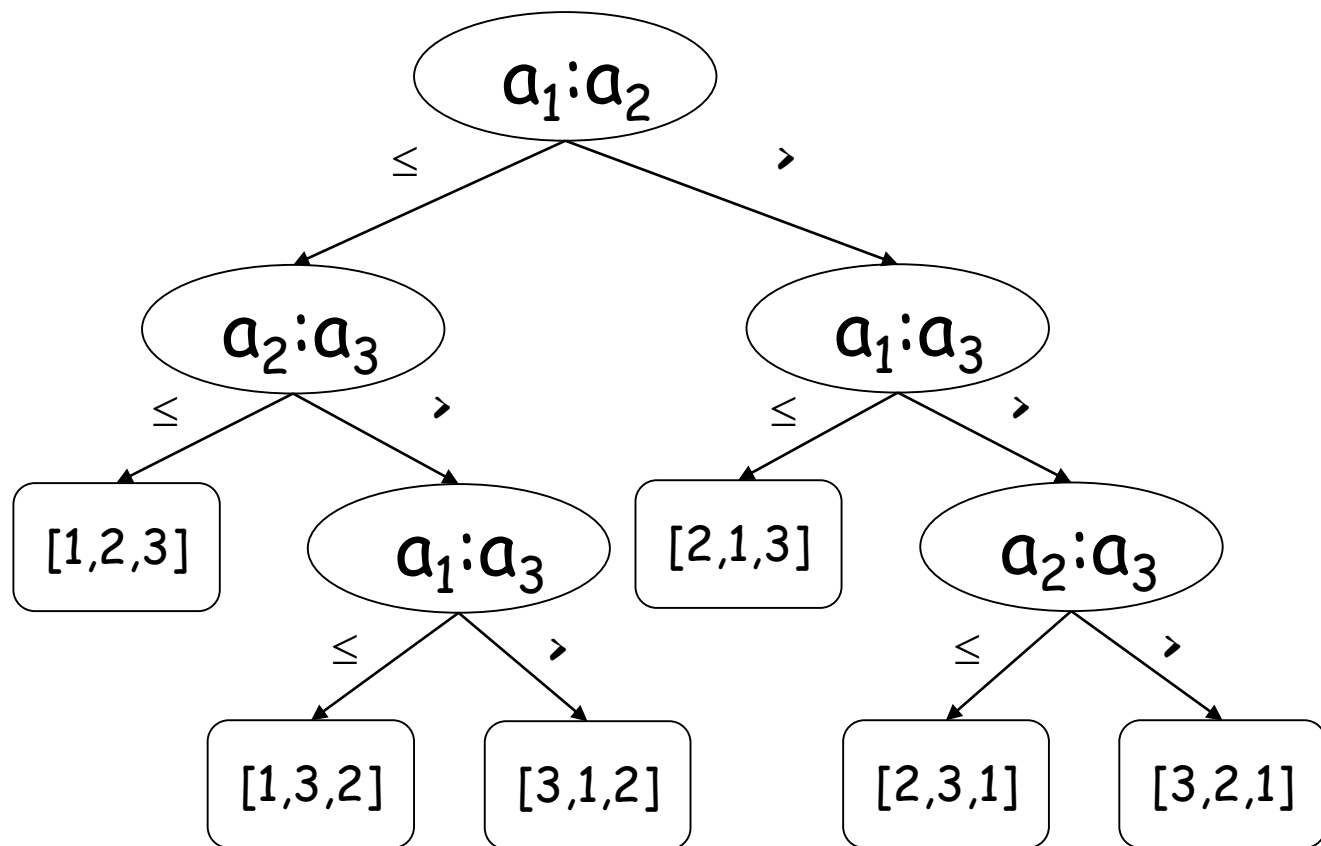


מסקנה:

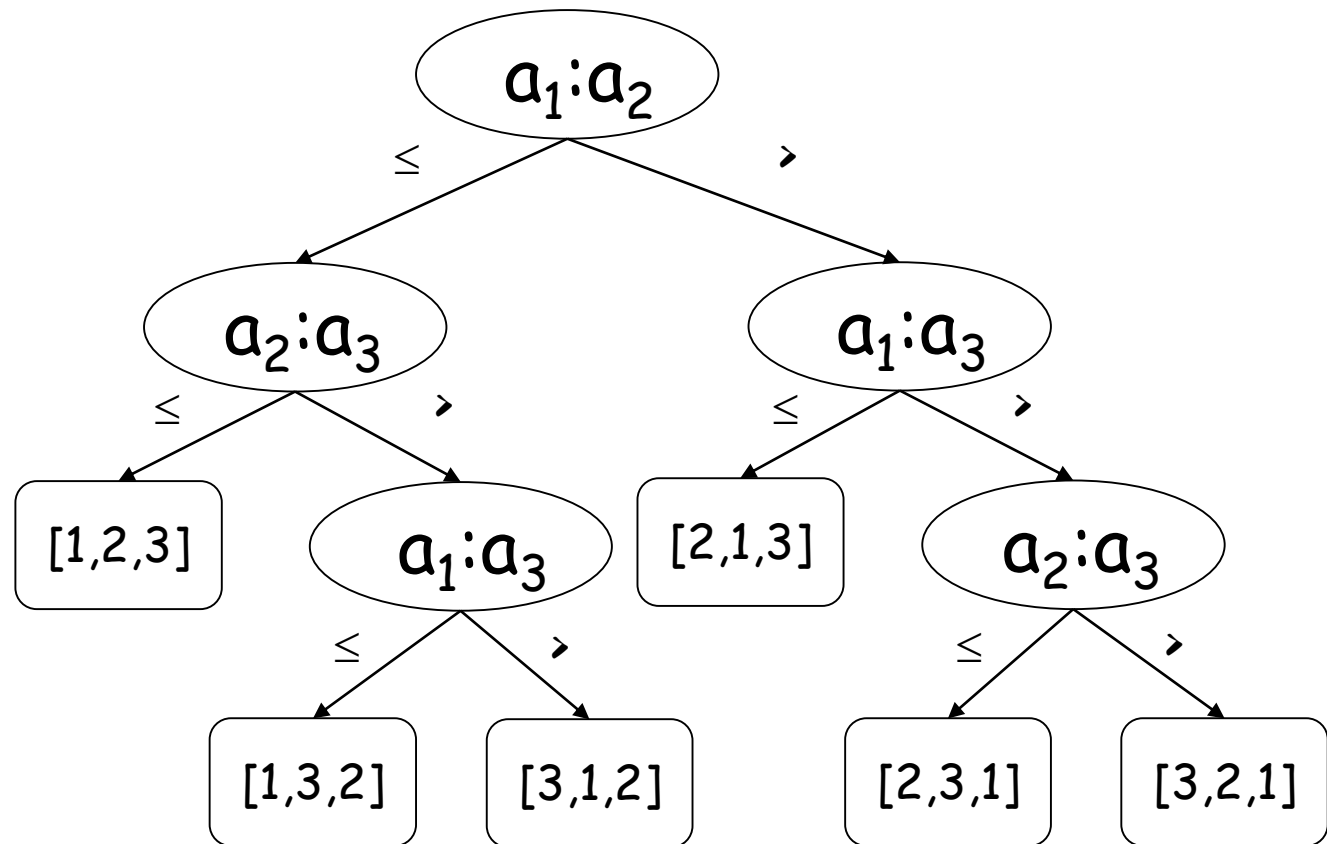
גובה העץ מייצג את מספר ההשוואות המתבצעות במקרה הגרוע
באלגוריתם הכי טוב



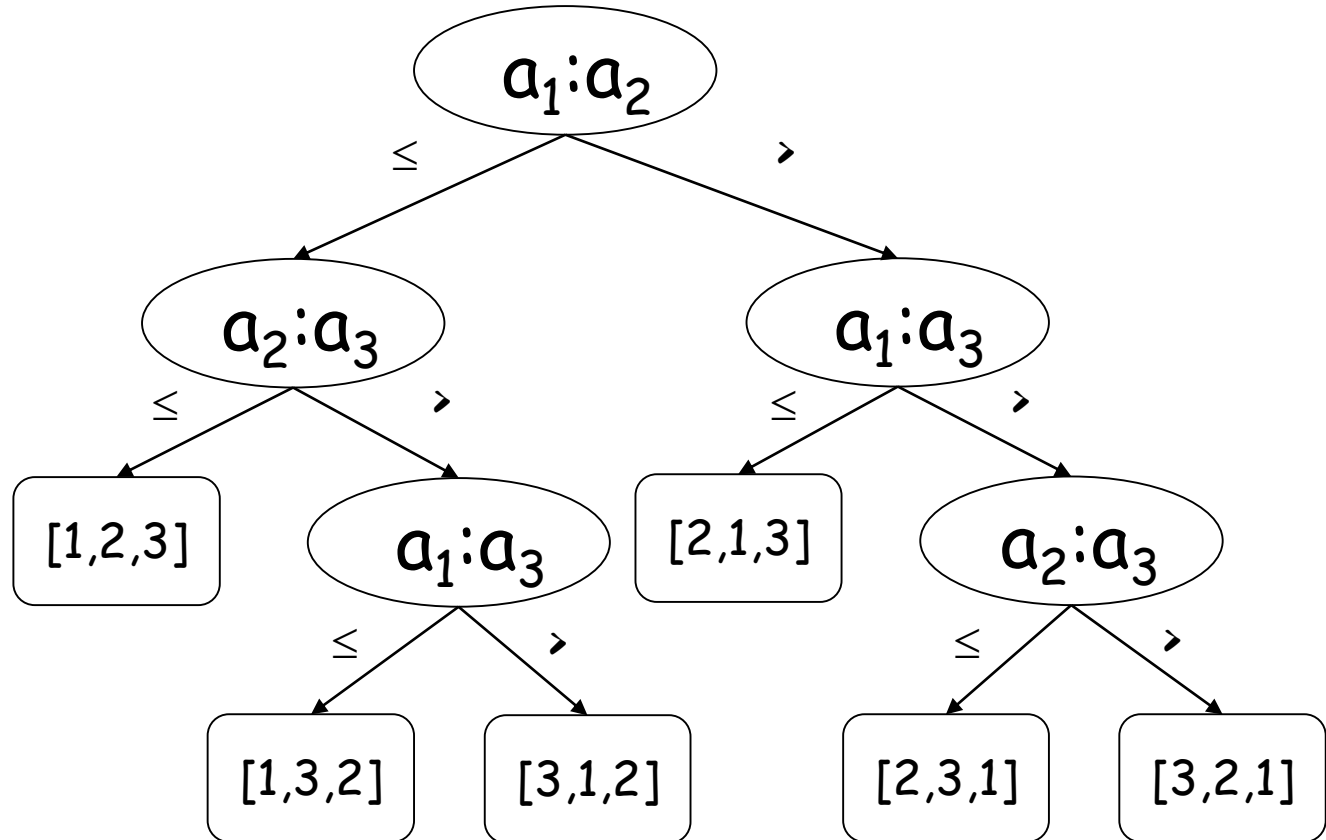
מה גובה העץ במקרה הטוב ביותר?
ומה נוכל ללמוד מכך?



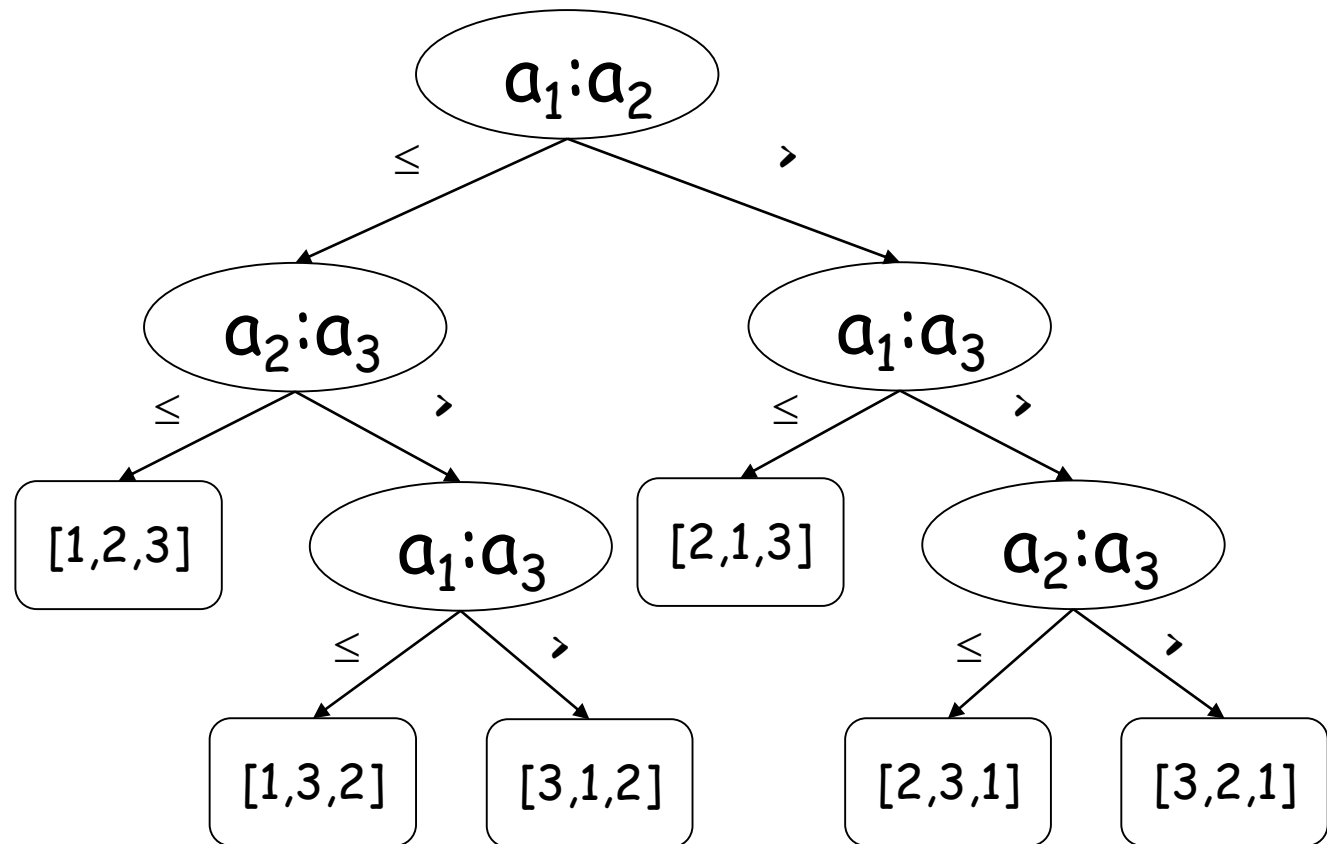
בעץ החלטה $n!$ עלים ולכן גובהו **לפחות** $\log n!$



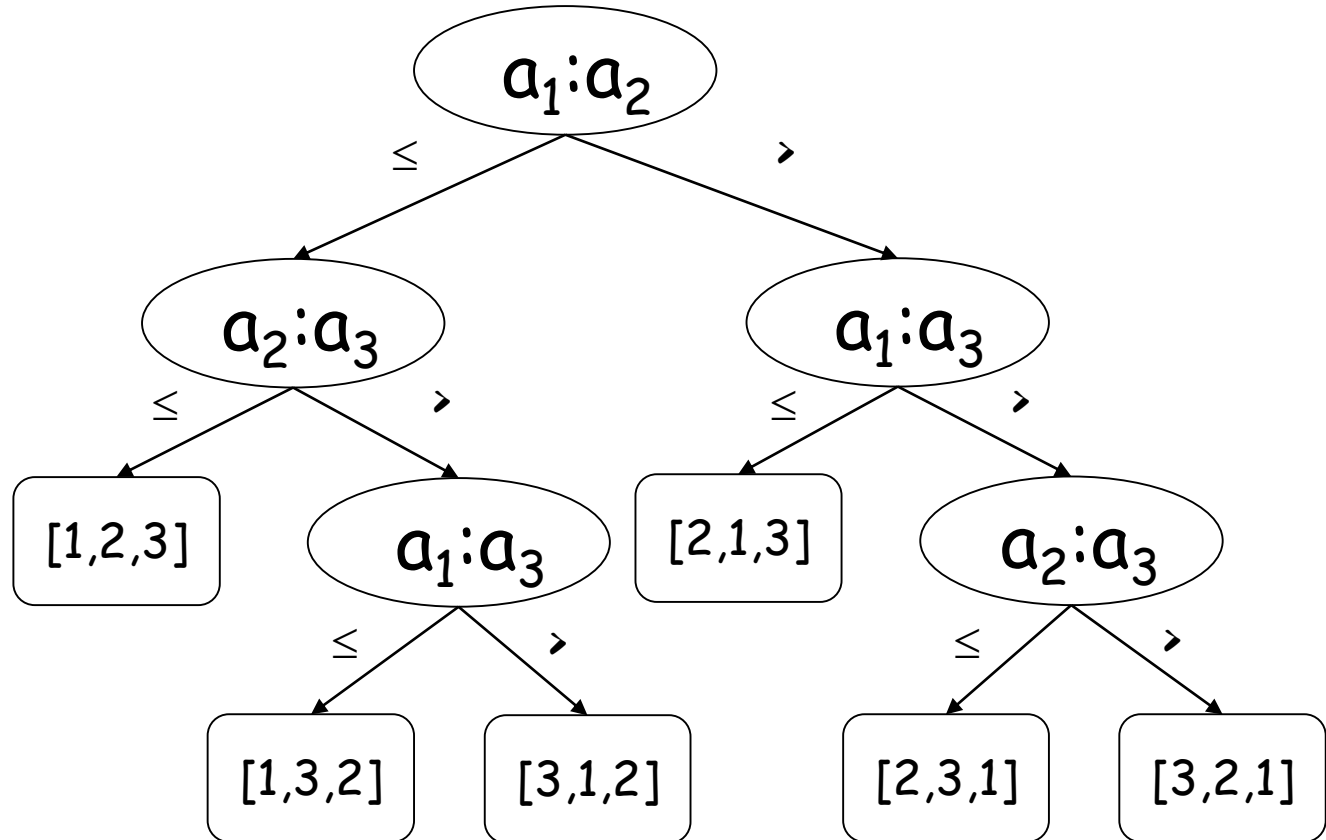
$n! =$



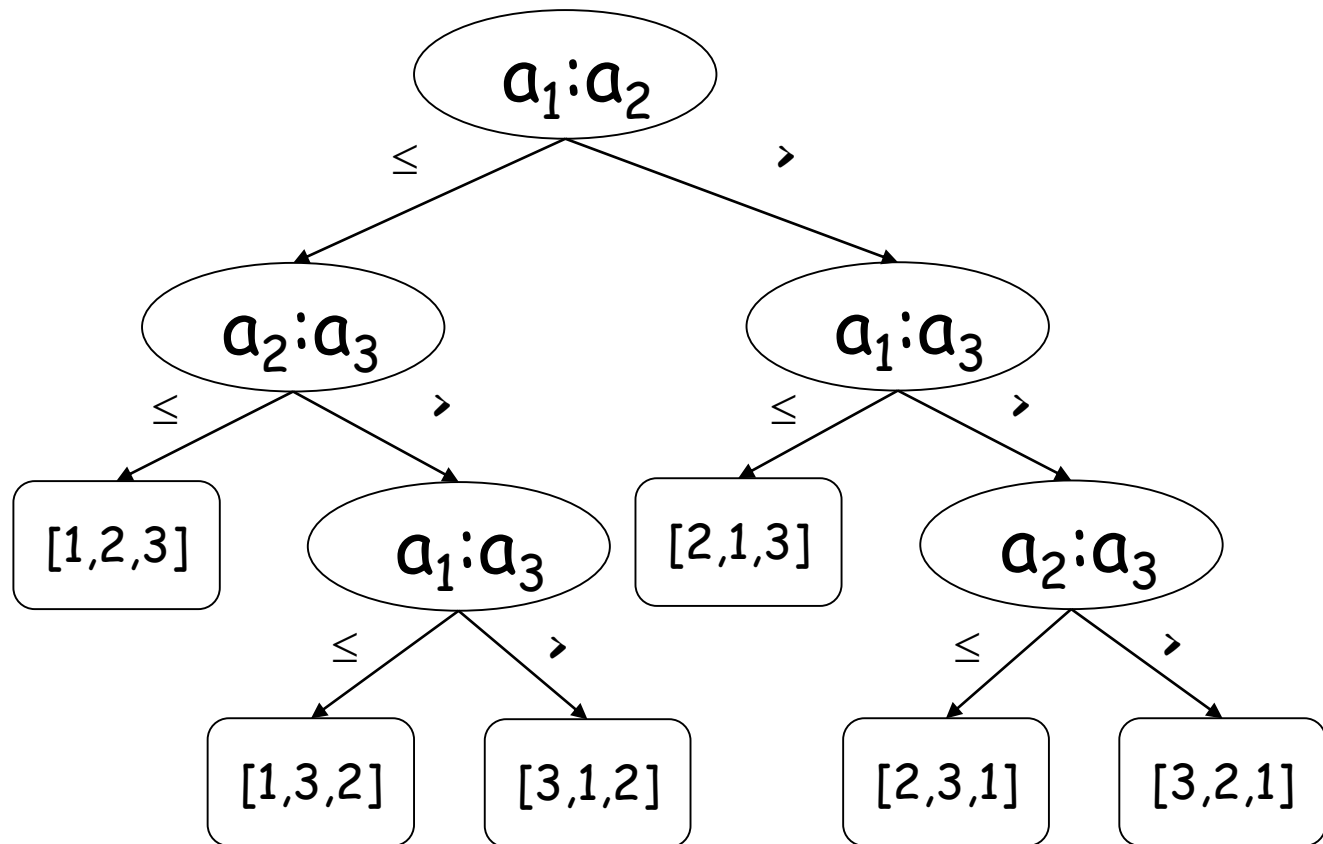
$$n! = 1 \cdot 2 \cdot 3 \dots n$$



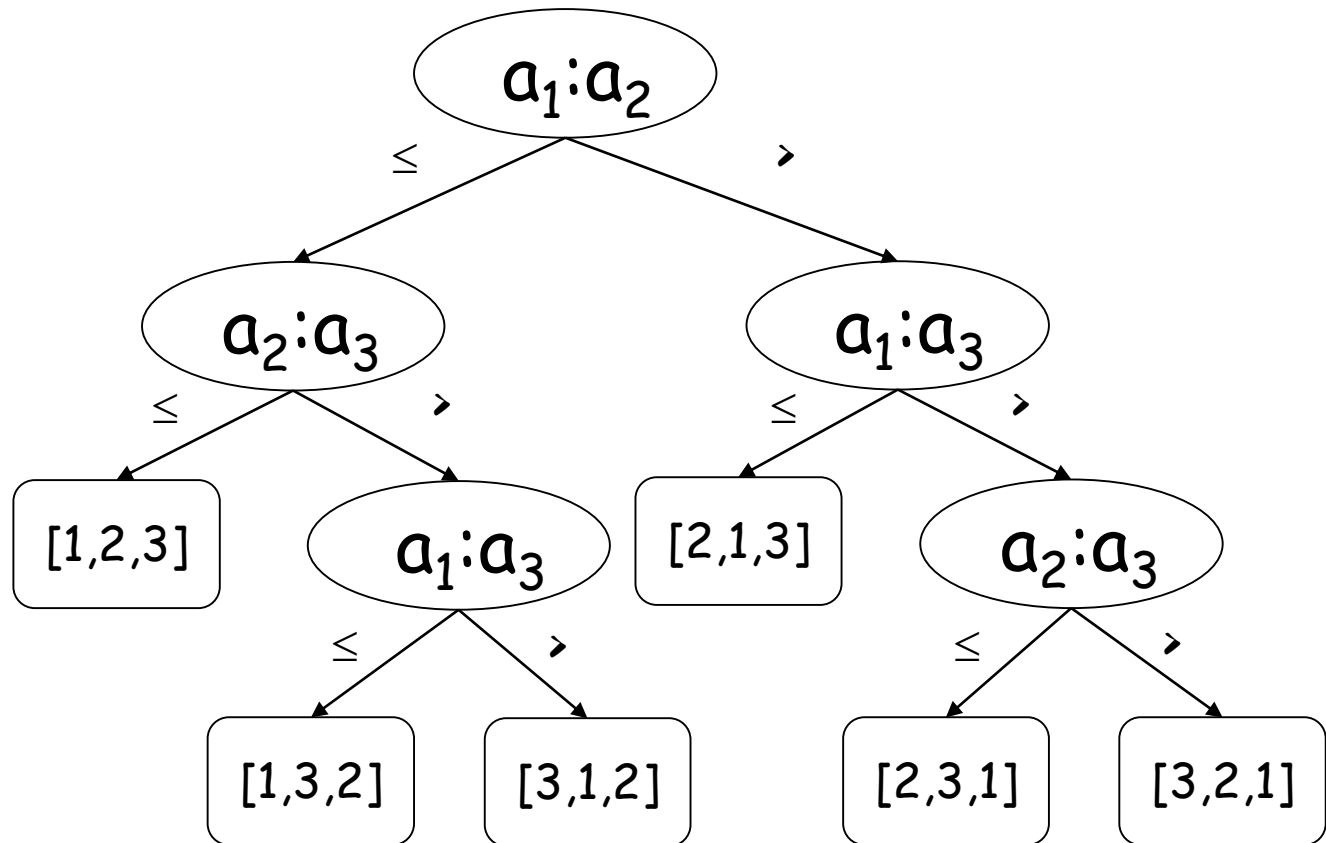
$$n! = 1 \cdot 2 \cdot 3 \dots n < n \cdot n \dots n$$



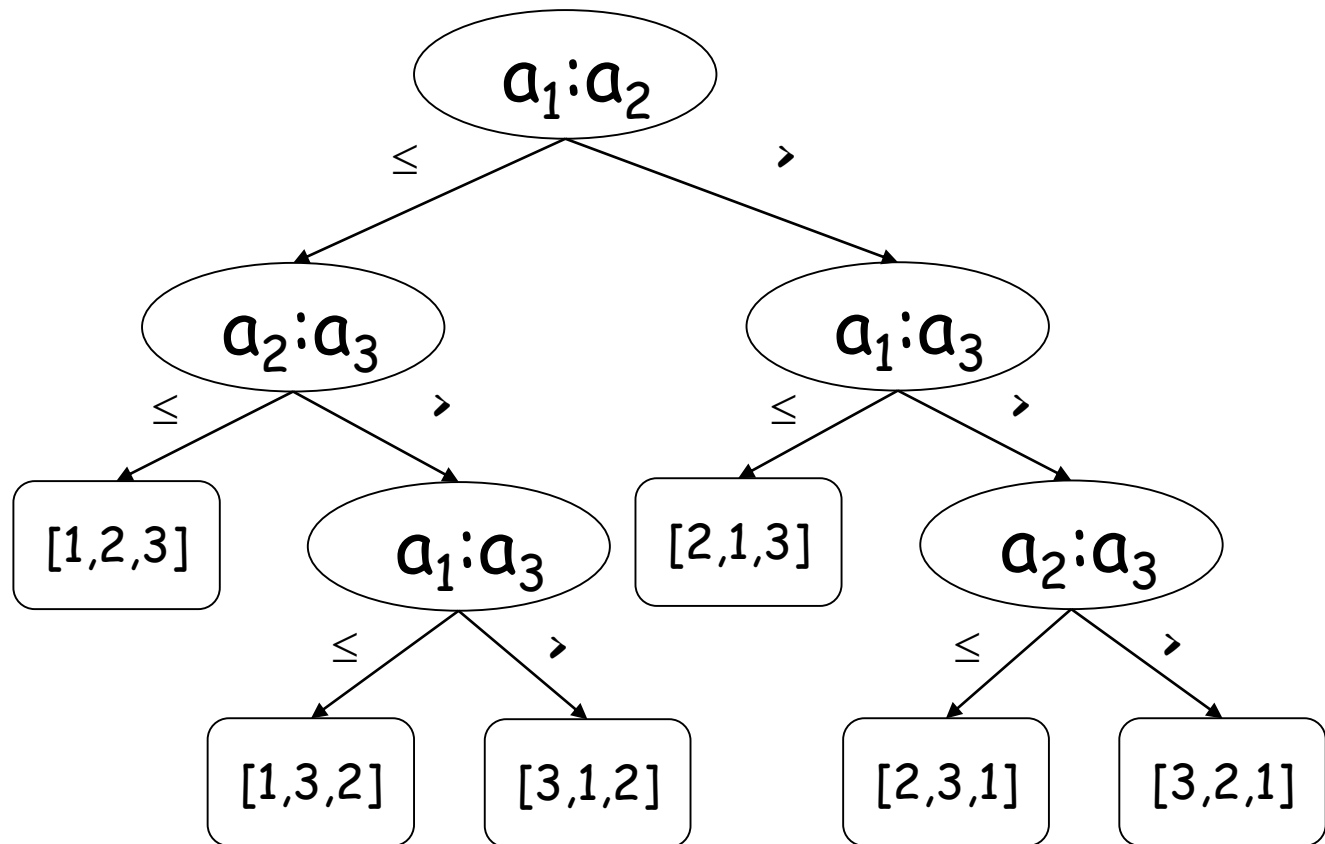
$$n! = 1 \cdot 2 \cdot 3 \dots n < n \cdot n \dots n = n^n$$



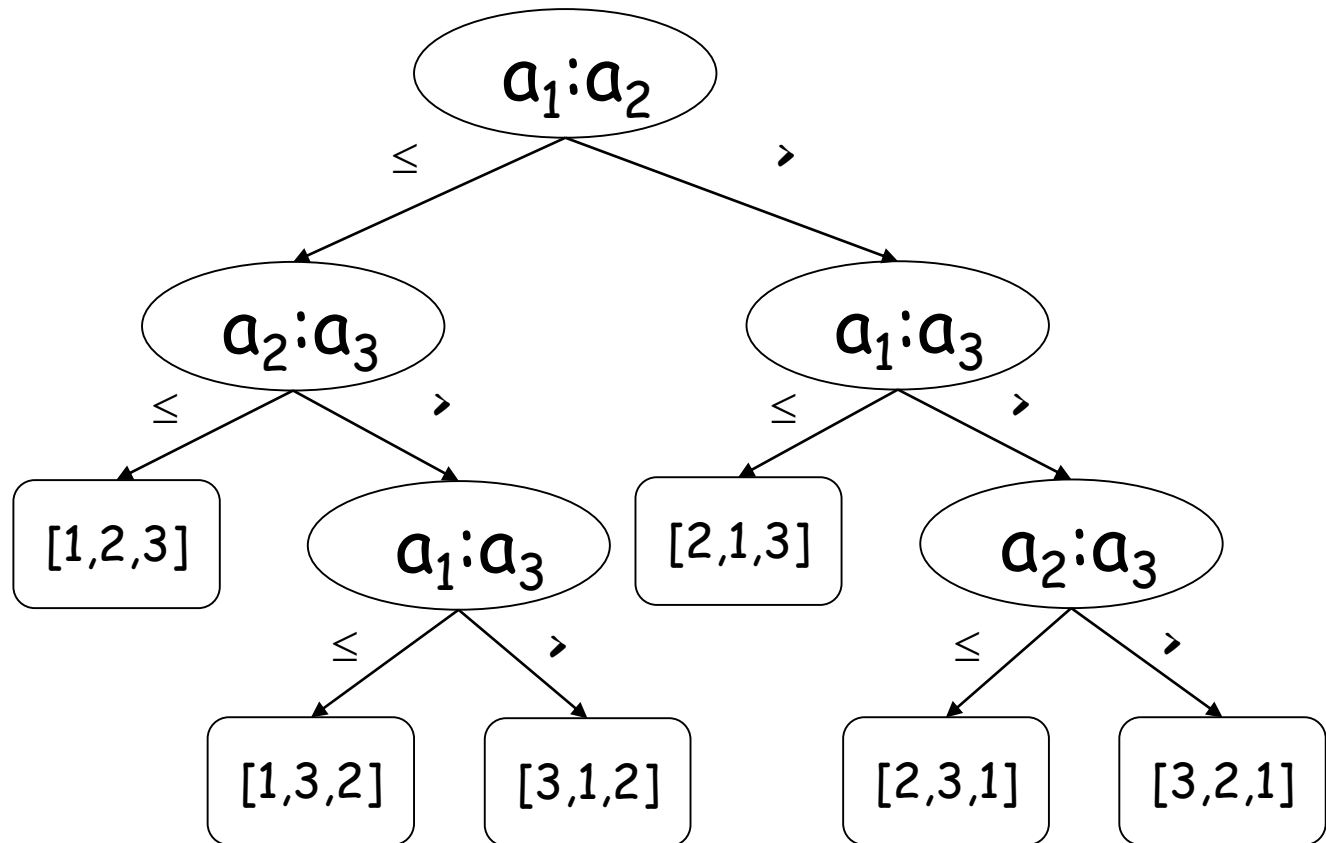
$$n! < n^n$$



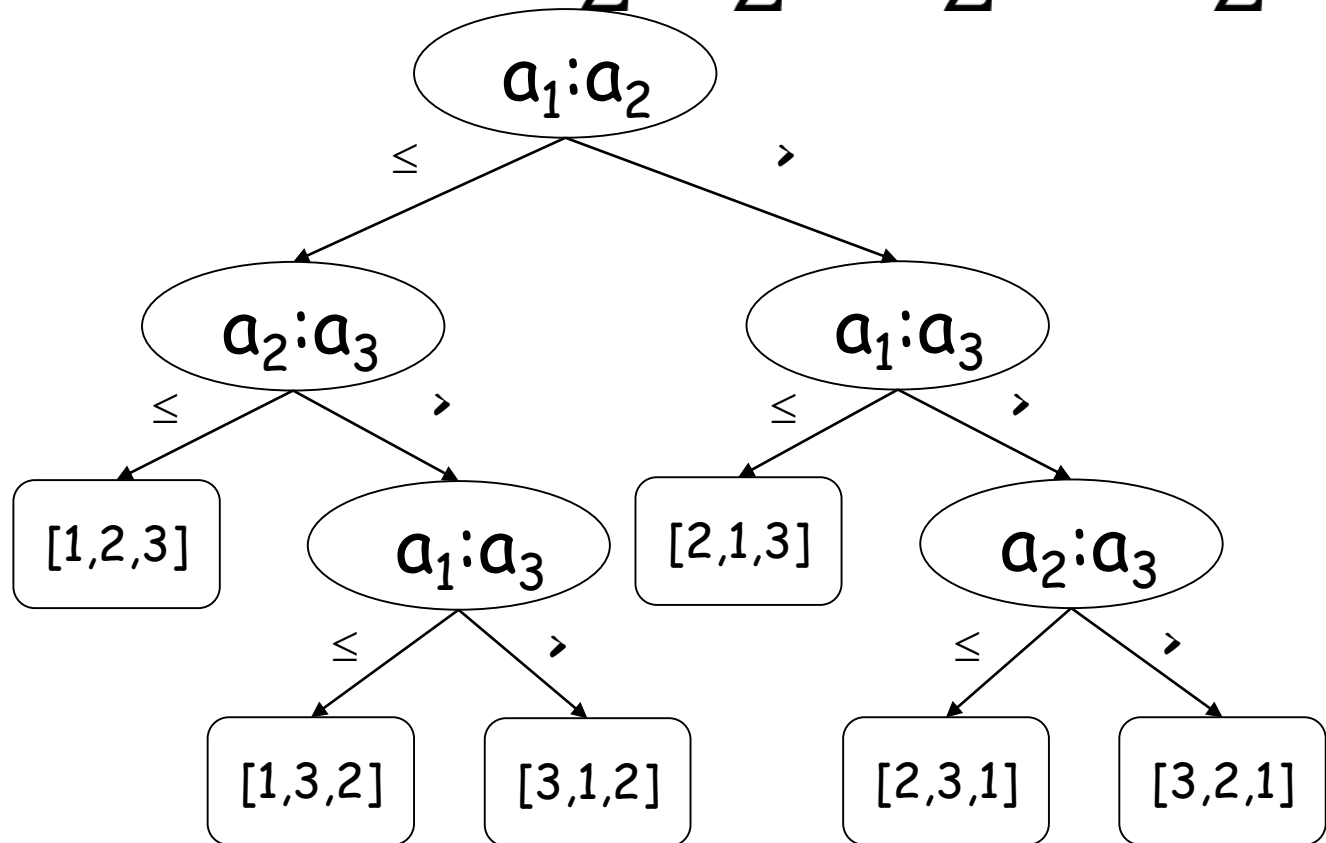
$$\log n! < \log n^n$$



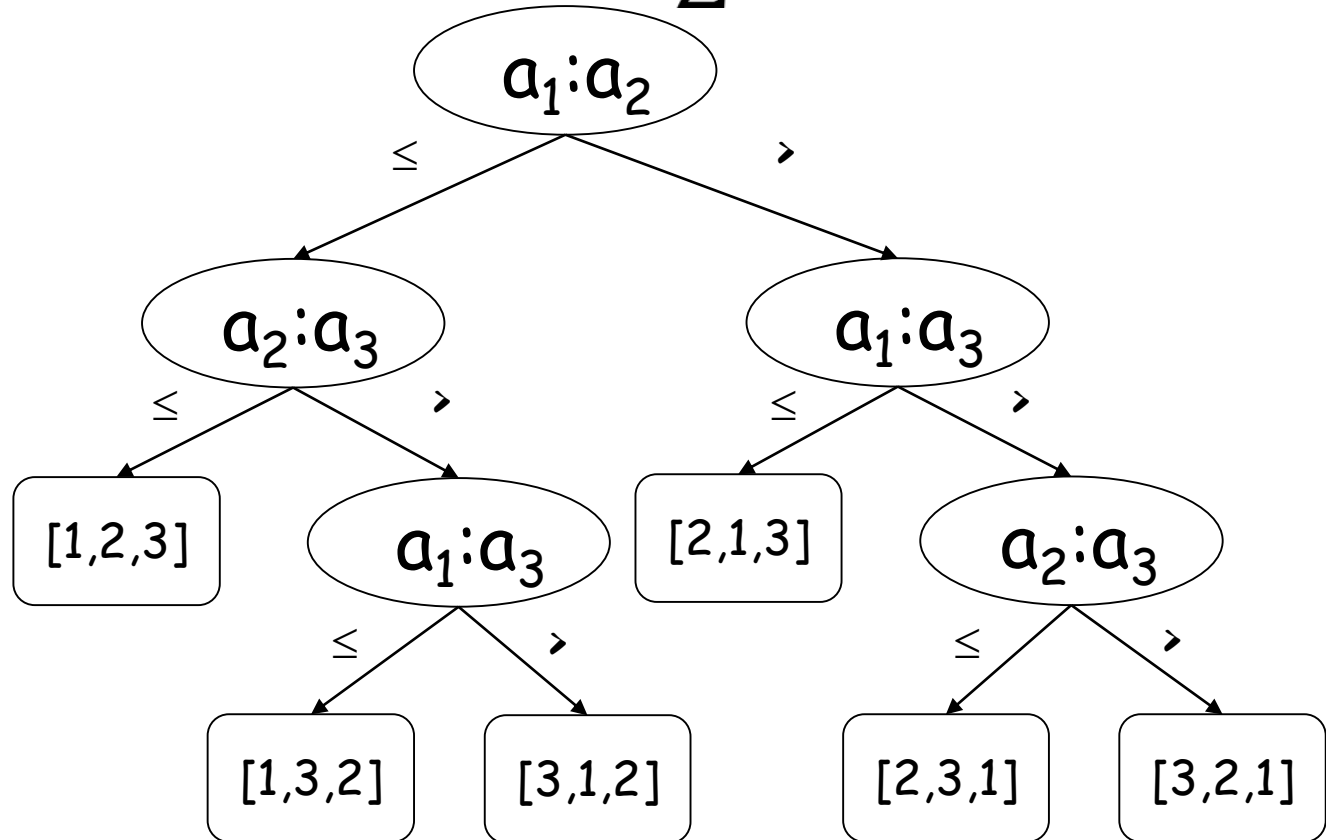
$$\log n! < n \cdot \log n$$



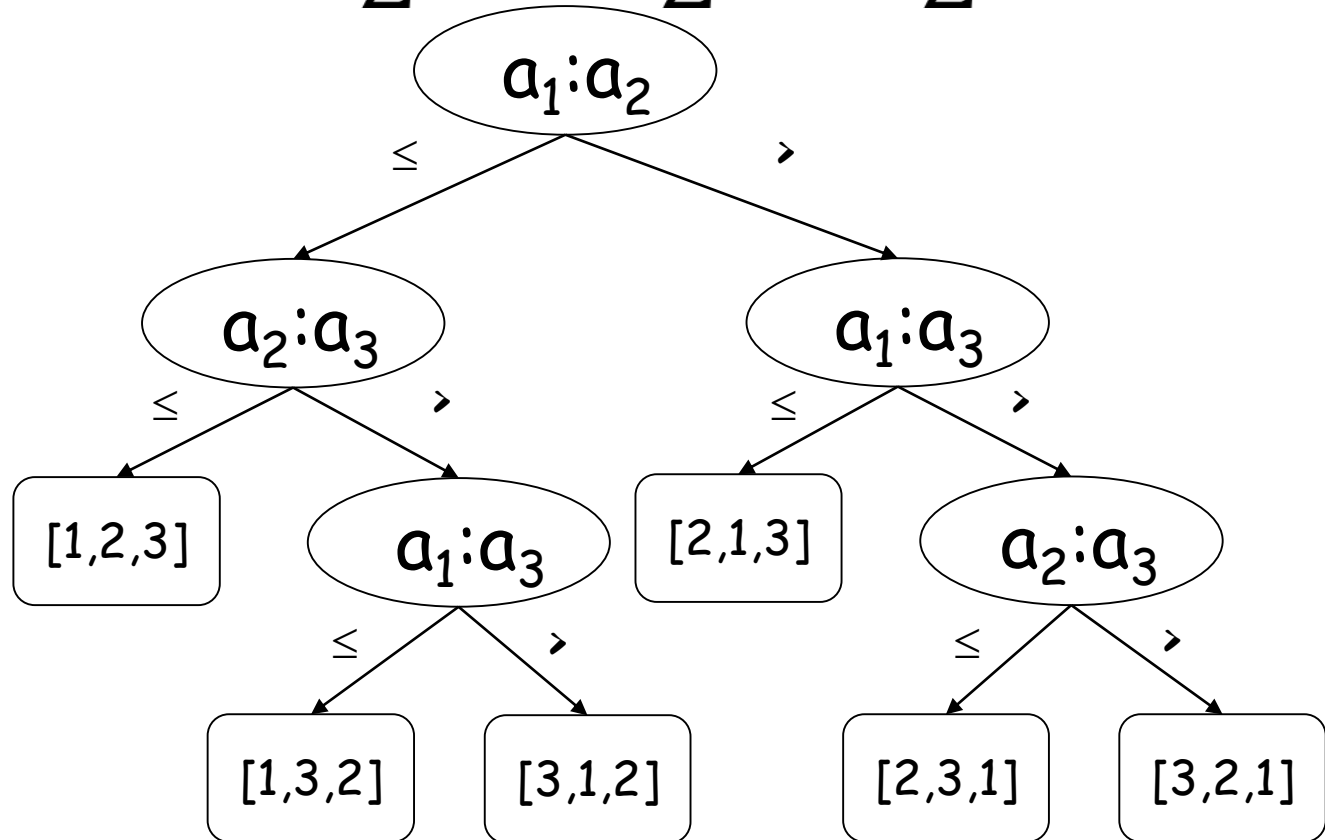
$$n! = 1 \cdot 2 \cdots n > \frac{n}{2} \cdot \frac{n}{2} \cdots \frac{n}{2} = \left(\frac{n}{2}\right)^{\frac{n}{2}}$$



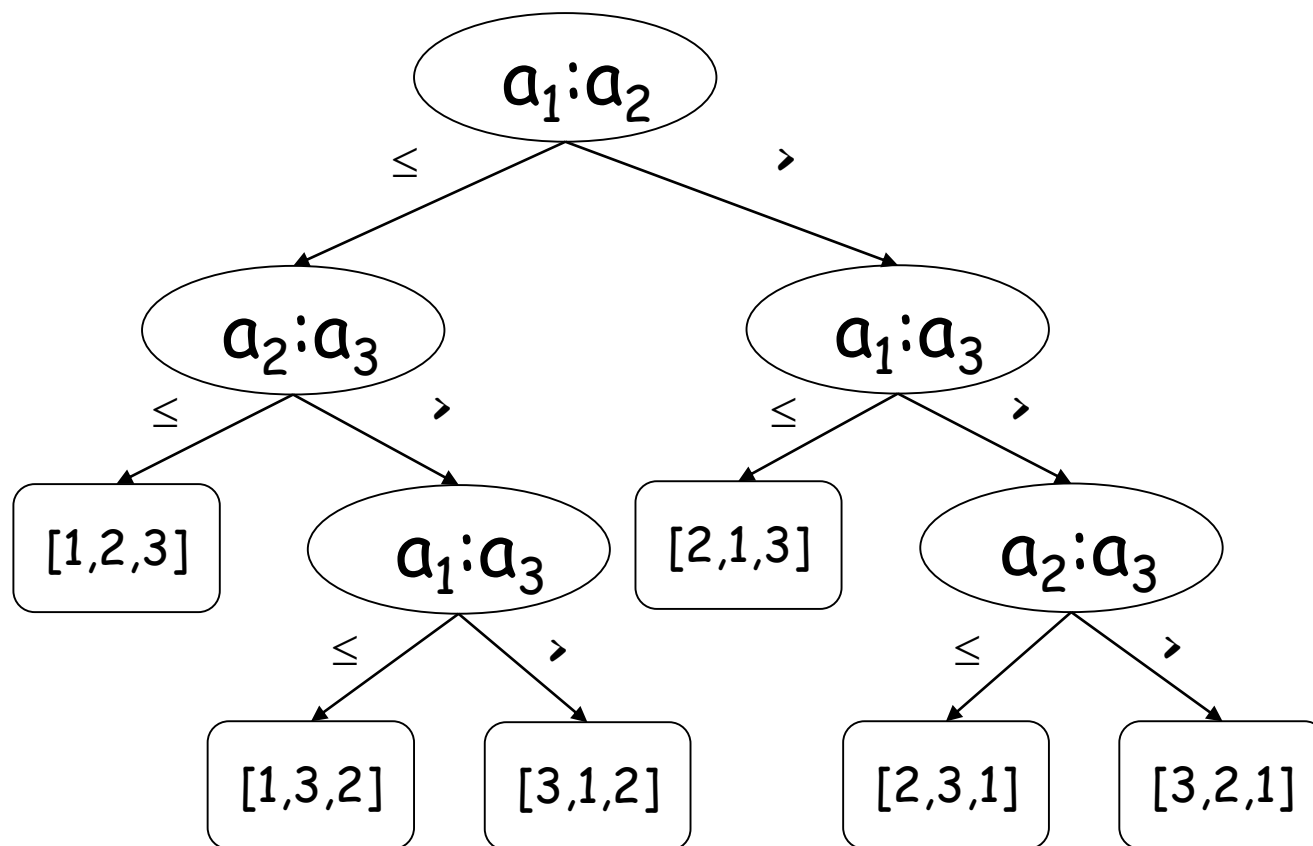
$$n! > \left(\frac{n}{2}\right)^{\frac{n}{2}}$$



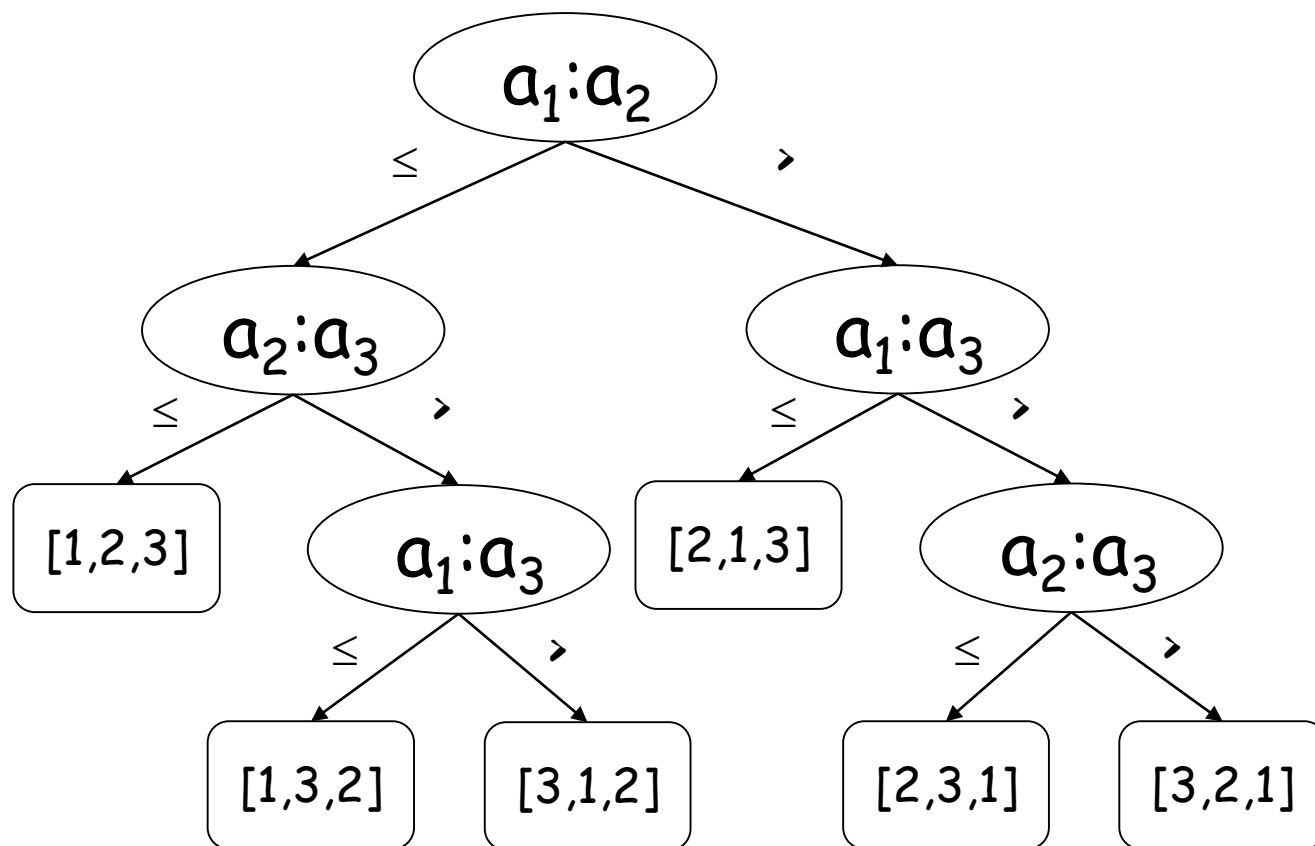
$$\log n! > \log \left(\frac{n}{2}\right)^{\frac{n}{2}} > \frac{n}{2} \log \frac{n}{2}$$



$$\log n! = \theta(n \log n)$$



כל אלגוריתם למיון מבוסס השוואות צורך $\Omega(n \log n)$
השוואות במקרה הגרוע



מיון מניה

הנחות:

- איברי הקלט מספרים שלמים בתחום 0 עד k .
- הקלט הוא מערך $A[1..n]$.
- הפלט: מערך $B[1..n]$ איברי המערך A ממוינים.
- מערך עזר: $C[0..k]$.

Counting sort(A, B, k)

for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$

for $j \leftarrow 1$ to n do

$C[A[j]] \leftarrow C[A[j]] + 1$; $C[i] = |\{key = i\}|$

for $i \leftarrow 1$ to k do

$C[i] \leftarrow C[i] + C[i-1]$; $C[i] = |\{key \leq i\}|$

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

Counting sort(A, B, k)

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C						

for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	0	0	0	0	0	0

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	0	0	1	0	0	0

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	0	0	1	0	0	1

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	0	0	1	1	0	1

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	1	0	1	1	0	1

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	1	0	2	1	0	1

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	1	0	2	2	0	1

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	0	2	2	0	1

for $j \leftarrow 1$ to n do $C[A[j]] \leftarrow C[A[j]] + 1$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	0	2	3	0	1

for $i \leftarrow 1$ to k do $C[i] \leftarrow C[i] + C[i-1]$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	0	2	3	0	1

for $i \leftarrow 1$ to k do $C[i] \leftarrow C[i] + C[i-1]$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	2	2	3	0	1

for $i \leftarrow 1$ to k do $C[i] \leftarrow C[i] + C[i-1]$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	2	4	3	0	1

for $i \leftarrow 1$ to k do $C[i] \leftarrow C[i] + C[i-1]$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	2	4	7	0	1

for $i \leftarrow 1$ to k do $C[i] \leftarrow C[i] + C[i-1]$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	2	4	7	7	1

for $i \leftarrow 1$ to k do $C[i] \leftarrow C[i] + C[i-1]$

	$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$
A	2	5	3	0	2	3	0	3

	$B[1]$	$B[2]$	$B[3]$	$B[4]$	$B[5]$	$B[6]$	$B[7]$	$B[8]$
B								

	$C[0]$	$C[1]$	$C[2]$	$C[3]$	$C[4]$	$C[5]$
C	2	2	4	7	7	8

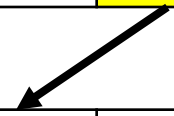
for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B							3	



	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	2	2	4	7	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

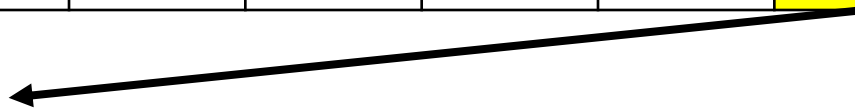
	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B							3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	2	2	4	6	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

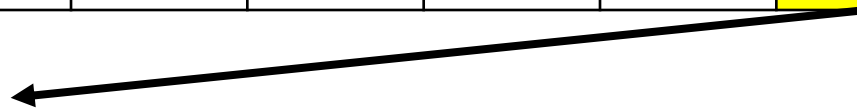


	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B		0					3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	2	2	4	6	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3



	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B		0					3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	1	2	4	6	7	8

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3



	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B		0				3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	1	2	4	6	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3



	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B		0				3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	1	2	4	5	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B		0		2		3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	1	2	4	5	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B		0		2		3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	1	2	3	5	7	8

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0		2		3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	1	2	3	5	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0		2		3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	3	5	7	8

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

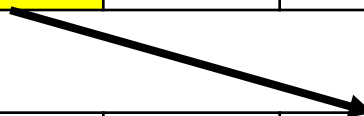


	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0		2	3	3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	3	5	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3



	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0		2	3	3	3	

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	3	4	7	8

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0		2	3	3	3	5

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	3	4	7	8

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0		2	3	3	3	5

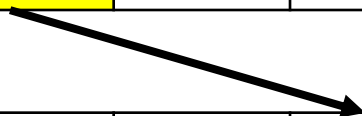
	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	3	4	7	7

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

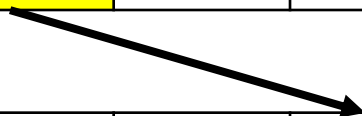


	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0	2	2	3	3	3	5

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	3	4	7	7

for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3



	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0	2	2	3	3	3	5

	C[0]	C[1]	C[2]	C[3]	C[4]	C[5]
C	0	2	2	4	7	7

Counting sort(A, B, k)

$\Theta(k)$ for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$
for $j \leftarrow 1$ to n do
 $C[A[j]] \leftarrow C[A[j]] + 1$; $C[i] = |\{\text{key} = i\}|$
for $i \leftarrow 1$ to k do
 $C[i] \leftarrow C[i] + C[i-1]$; $C[i] = |\{\text{key} \leq i\}|$
for $j \leftarrow n$ downto 1 do
 $B[C[A[j]]] \leftarrow A[j]$
 $C[A[j]] \leftarrow C[A[j]] - 1$

Counting sort(A, B, k)

$\Theta(k)$ for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$

$\Theta(n)$ for $j \leftarrow 1$ to n do

$C[A[j]] \leftarrow C[A[j]] + 1$; $C[i] = |\{\text{key} = i\}|$

for $i \leftarrow 1$ to k do

$C[i] \leftarrow C[i] + C[i-1]$; $C[i] = |\{\text{key} \leq i\}|$

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

Counting sort(A, B, k)

$\Theta(k)$ for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$

$\Theta(n)$ for $j \leftarrow 1$ to n do

$C[A[j]] \leftarrow C[A[j]] + 1$; $C[i] = |\{\text{key} = i\}|$

$\Theta(k)$ for $i \leftarrow 1$ to k do

$C[i] \leftarrow C[i] + C[i-1]$; $C[i] = |\{\text{key} \leq i\}|$

for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

Counting sort(A, B, k)

$\Theta(k)$ for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$

$\Theta(n)$ for $j \leftarrow 1$ to n do

$C[A[j]] \leftarrow C[A[j]] + 1$; $C[i] = |\{\text{key} = i\}|$

$\Theta(k)$ for $i \leftarrow 1$ to k do

$C[i] \leftarrow C[i] + C[i-1]$; $C[i] = |\{\text{key} \leq i\}|$

$\Theta(n)$ for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

Counting sort(A, B, k)

$\Theta(k)$ for $i \leftarrow 0$ to k do $C[i] \leftarrow 0$

$\Theta(n)$ for $j \leftarrow 1$ to n do

$C[A[j]] \leftarrow C[A[j]] + 1$; $C[i] = |\{\text{key} = i\}|$

$\Theta(k)$ for $i \leftarrow 1$ to k do

$C[i] \leftarrow C[i] + C[i-1]$; $C[i] = |\{\text{key} \leq i\}|$

$\Theta(n)$ for $j \leftarrow n$ downto 1 do

$B[C[A[j]]] \leftarrow A[j]$

$C[A[j]] \leftarrow C[A[j]] - 1$

$\Theta(n+k)$

כיצד יתכן שקיבלנו מיון לינארי?



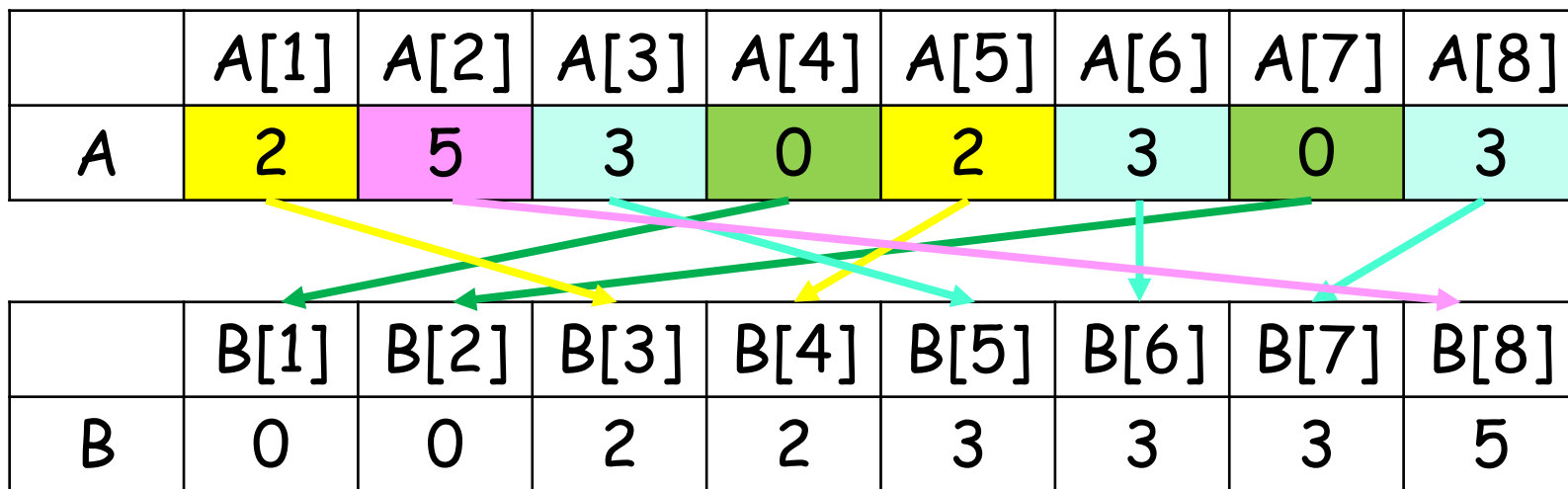
כי המיון אינו מבוסס השוואות!

מיון מניה הוא רק דוגמא אחת אפשרית למיון
שאינו מבוסס השוואות



אבל נשים לב שהוא מבוסס
הנחה על הקלט!

מיון יציב



מיון יציב

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0	2	2	3	3	3	5

מיון יציב

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0	2	2	3	3	3	5


מיון יציב

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3

	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0	2	2	3	3	3	5

מיון יציב

	A[1]	A[2]	A[3]	A[4]	A[5]	A[6]	A[7]	A[8]
A	2	5	3	0	2	3	0	3



	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]	B[8]
B	0	0	2	2	3	3	3	5