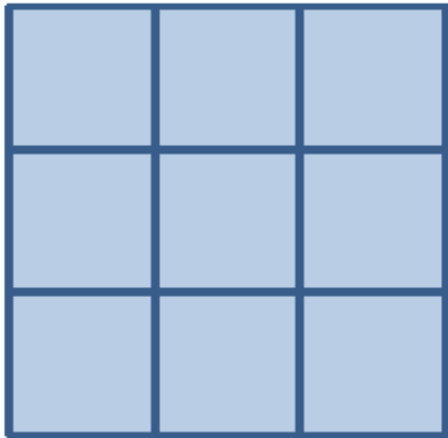


CompSci 171: Intro AI

Homework 5

Games

1.a Tic-Tac-Toe – how many states?



Assume we always start with X:

Empty: 0

1X: $C(9,1) = 9$

1X1O: $C(9,1)C(8,1) = 72$

2X1O: $C(9,2)C(7,1) = 252$

2X2O: $C(9,2)C(7,2) = 756$

3X2O: $C(9,3)C(6,2) = 1260$

3X3O: $C(9,3)C(6,3) = 1680$

4X3O: $C(9,4)C(5,3) = 1260$

4X4O: $C(9,4)C(5,4) = 630$

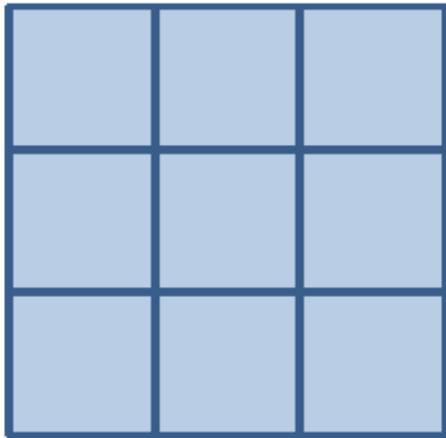
5X4O: $C(9,5)C(4,4) = 126$

Total:

$1+9+72+252+756+1260+1680+1260+630+126 = 6046$

(This includes invalid board positions, e.g. a board with a row of 'X' and another of 'O')

1.b Tic-Tac-Toe –depth of the complete game tree?



1st level: position of first X

2nd level: position of first Y

3rd level: position of second X

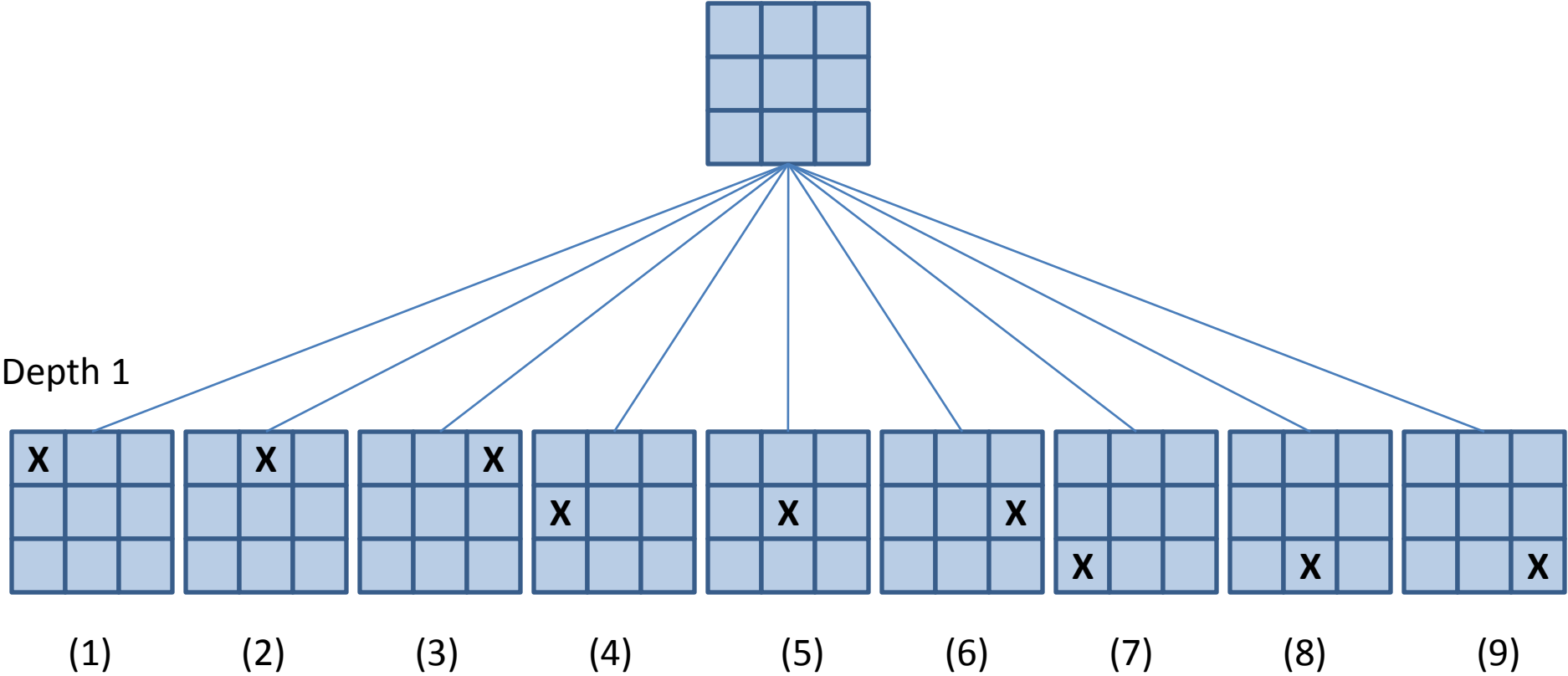
4th level: position of second Y

...

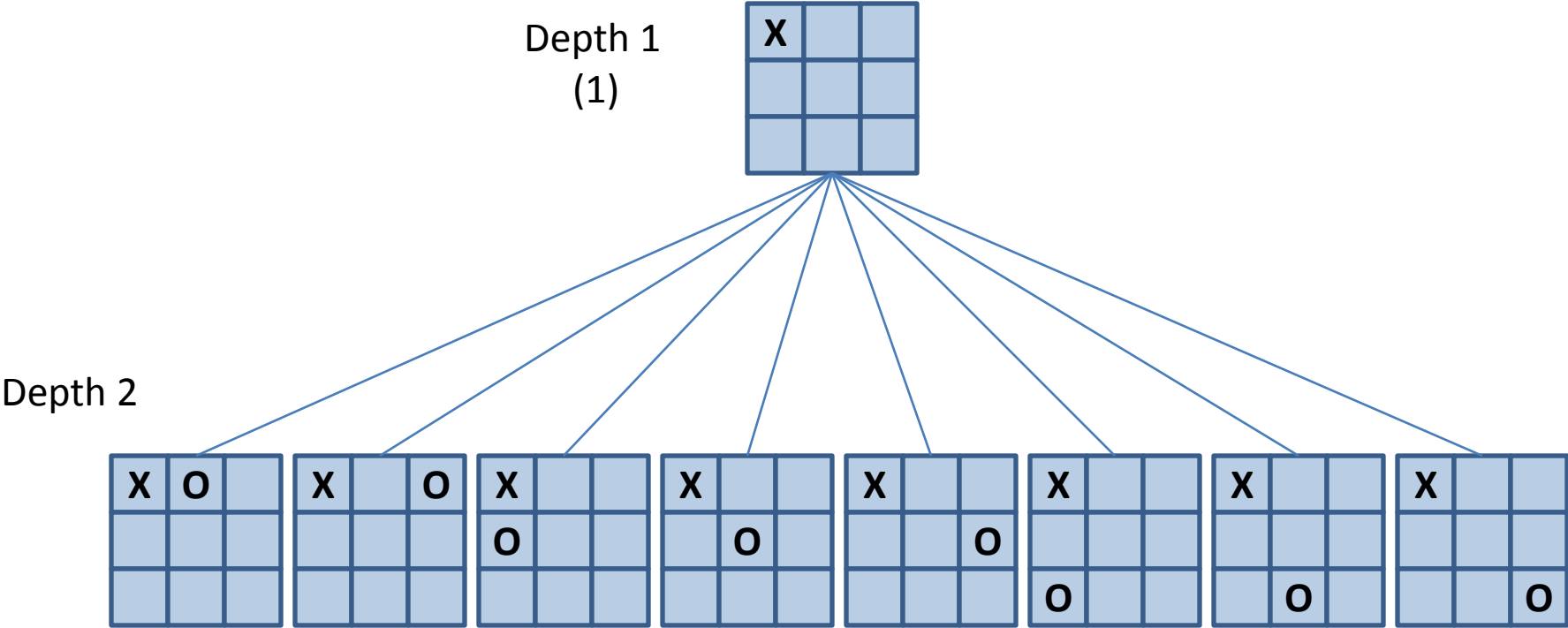
Complete game: depth 9

Contains all the valid board positions from (a), assuming we always start with X

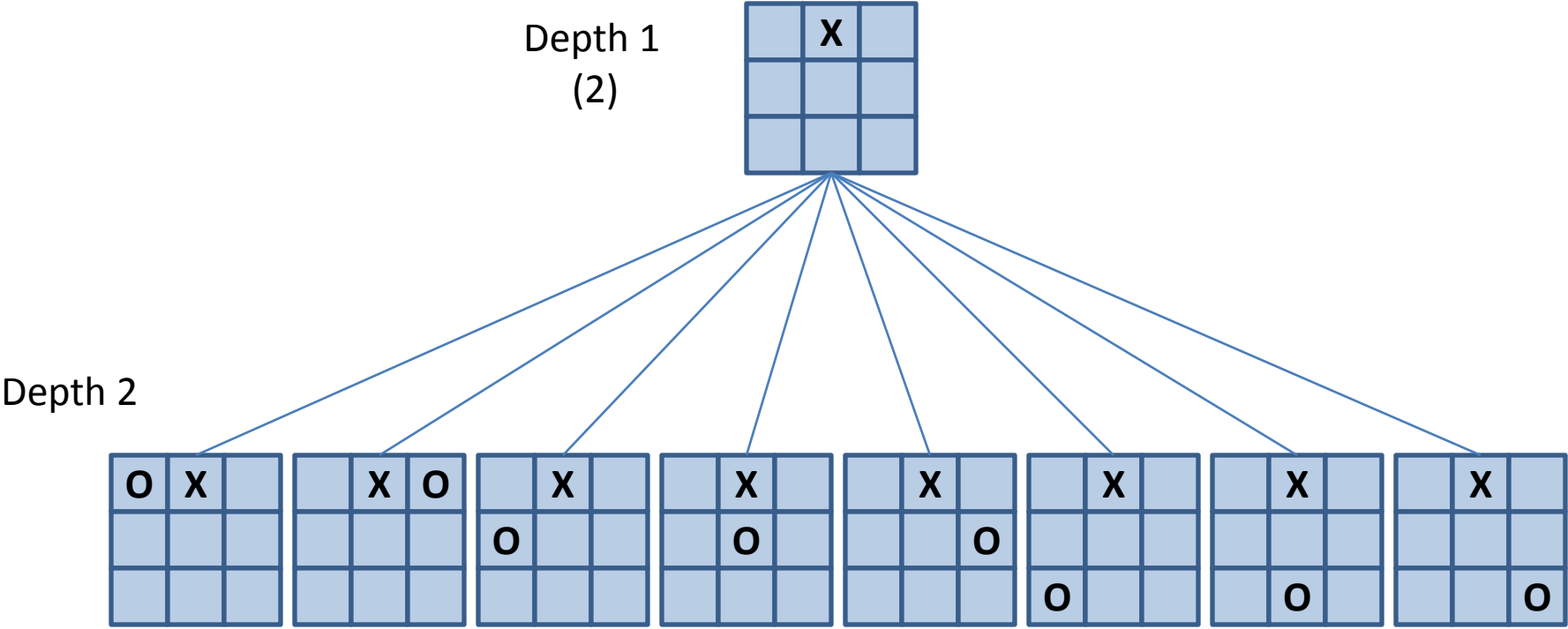
1.c Tic-Tac-Toe – game tree (depth 2)?



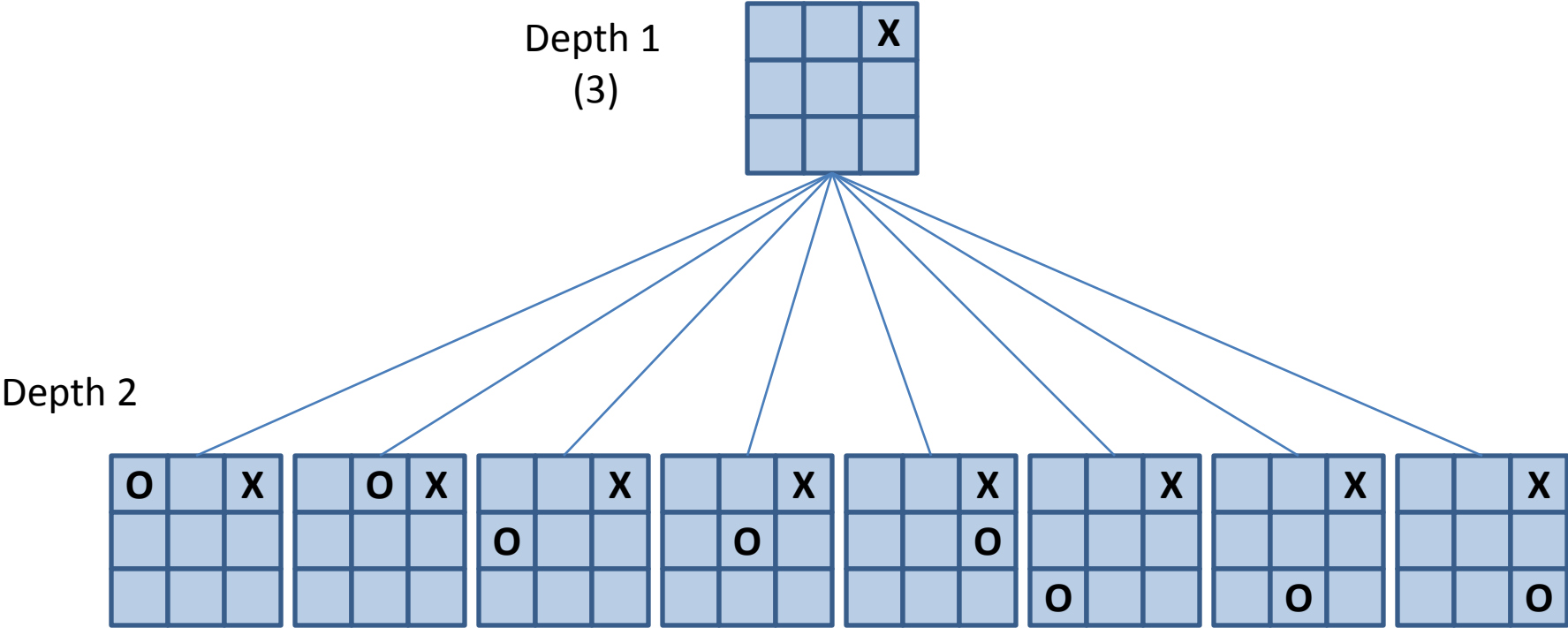
1.c Tic-Tac-Toe – game tree (depth 2)?



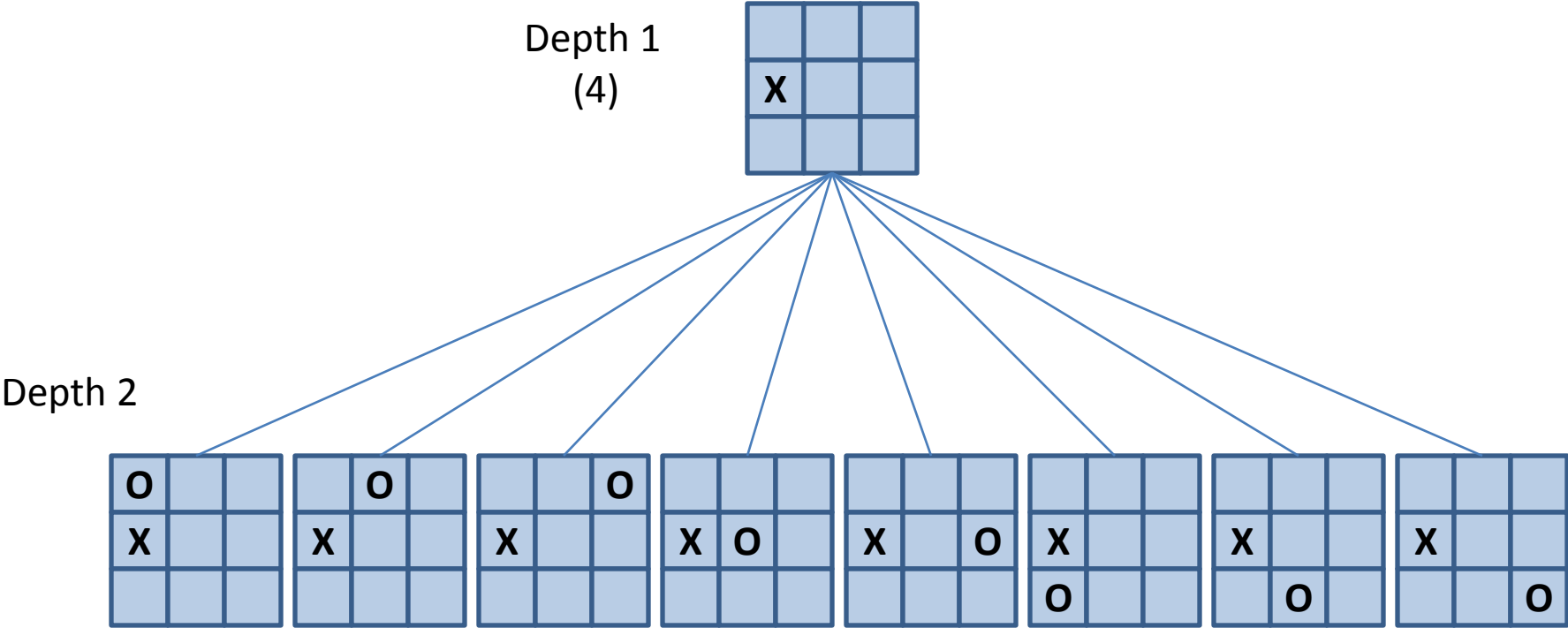
1.c Tic-Tac-Toe – game tree (depth 2)?



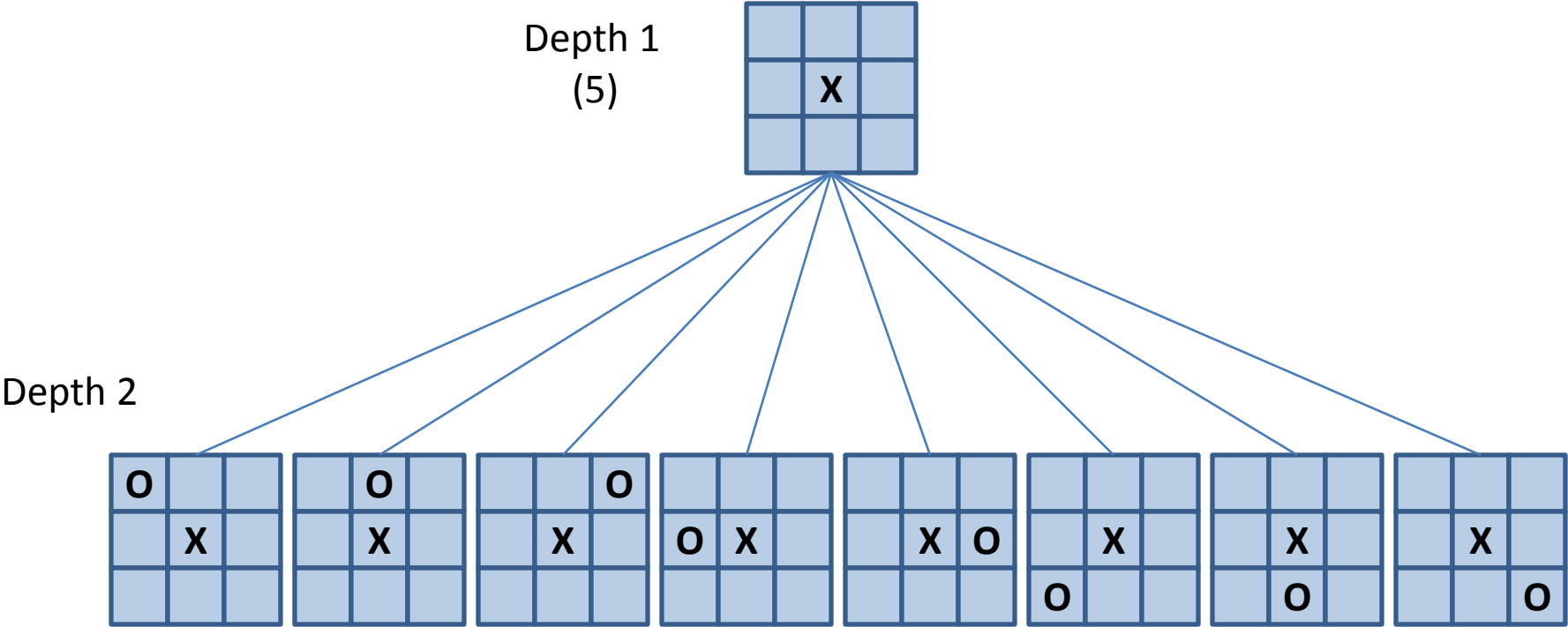
1.c Tic-Tac-Toe – game tree (depth 2)?



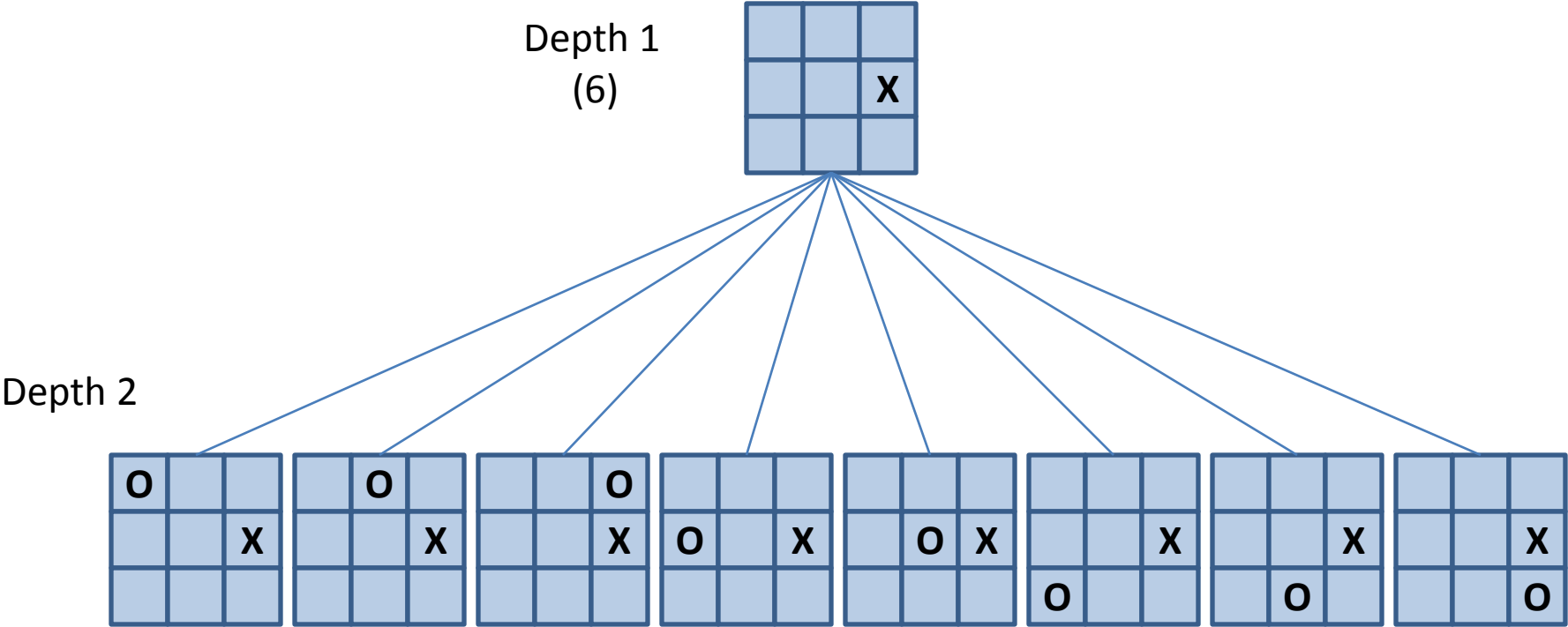
1.c Tic-Tac-Toe – game tree (depth 2)?



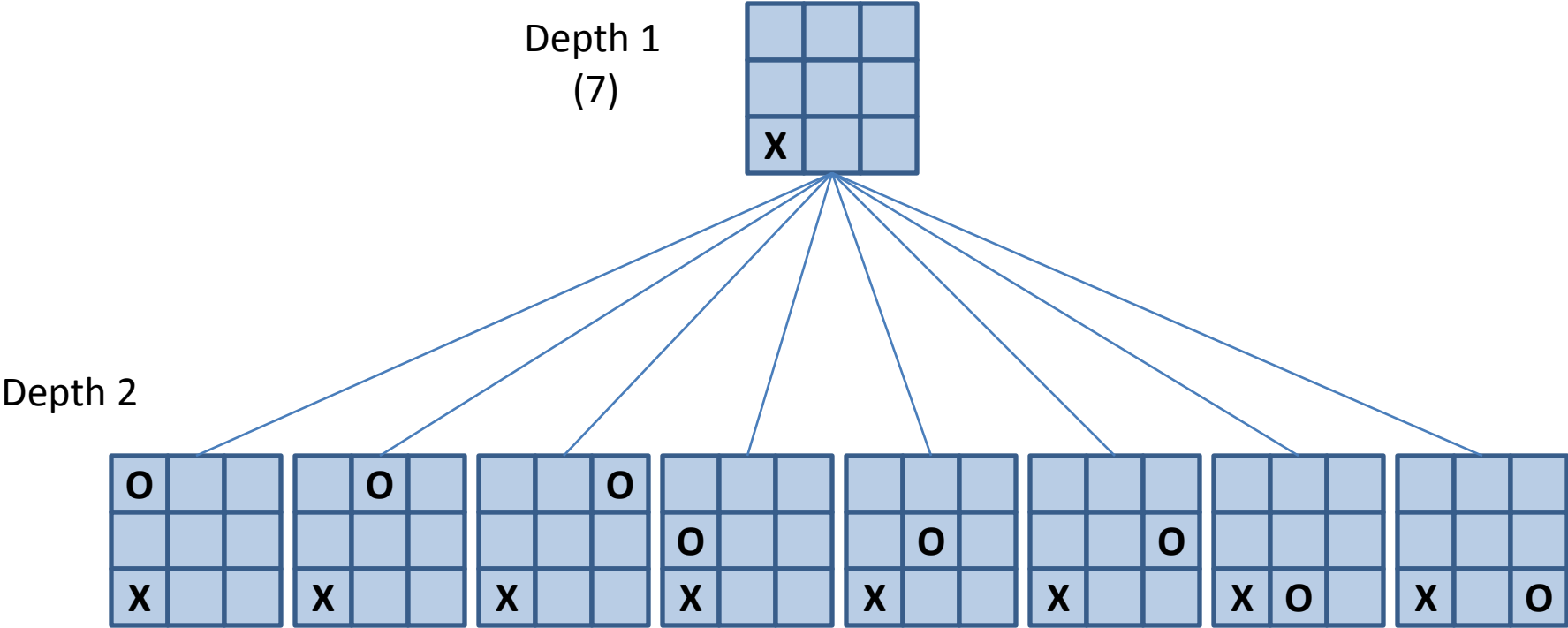
1.c Tic-Tac-Toe – game tree (depth 2)?



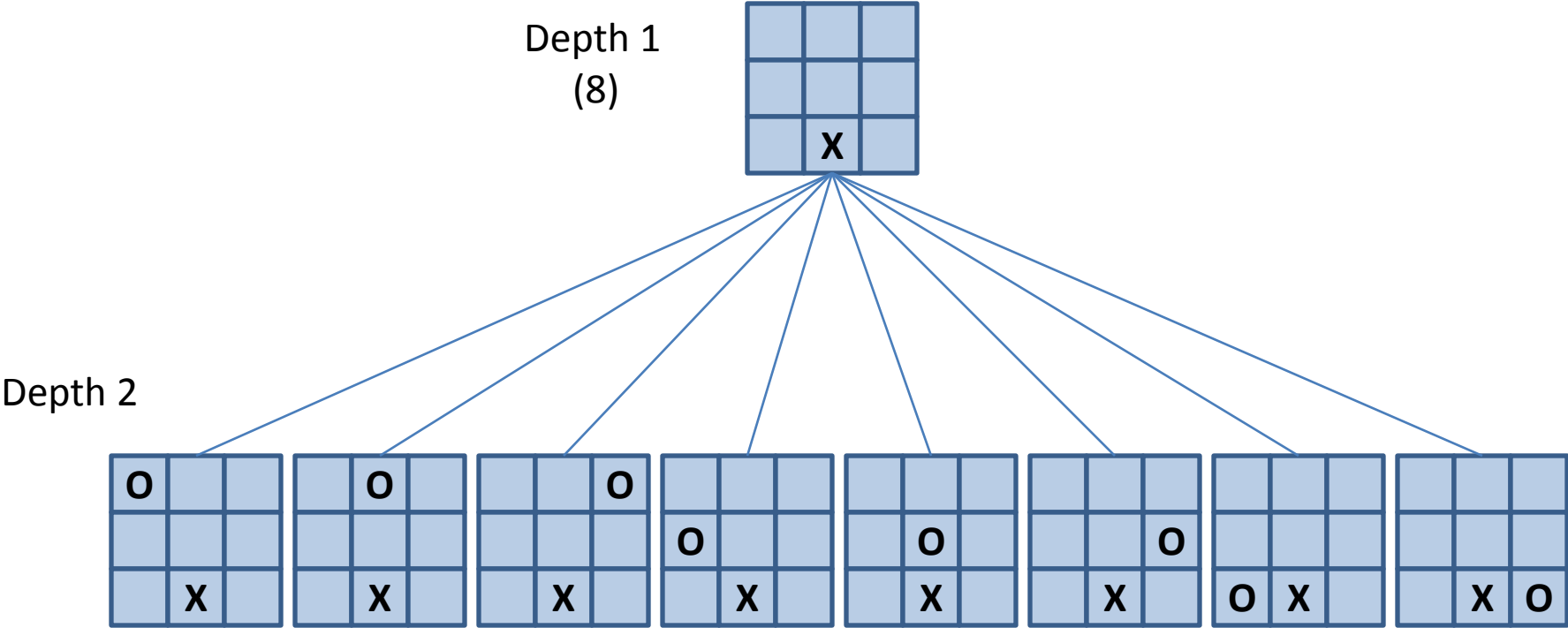
1.c Tic-Tac-Toe – game tree (depth 2)?



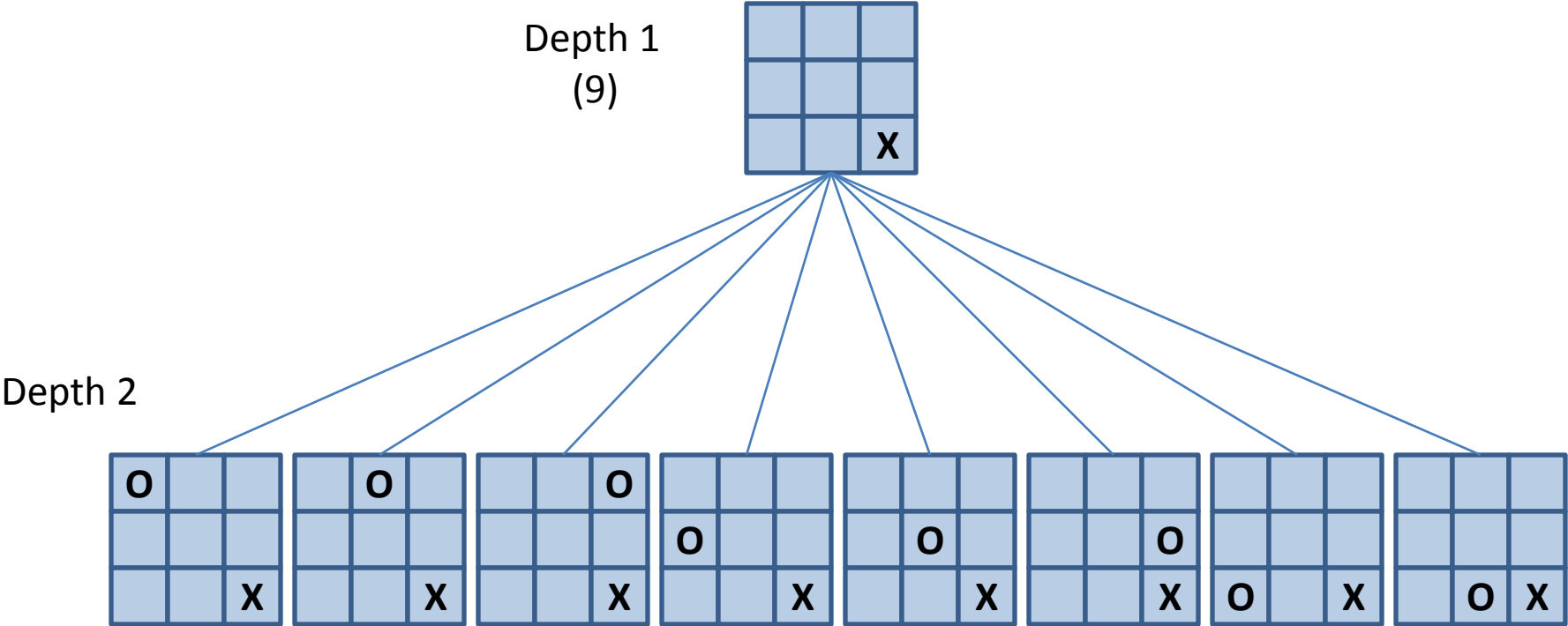
1.c Tic-Tac-Toe – game tree (depth 2)?



1.c Tic-Tac-Toe – game tree (depth 2)?



1.c Tic-Tac-Toe – game tree (depth 2)?



1.d Tic-Tac-Toe – Evaluation of the positions at level 2

The linear evaluation function:

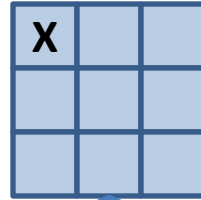
$$3 * X2 + X1 - (3 * O2 + O1)$$

For tree of depth 2, there is one X and one O on the board. The linear evaluation function:

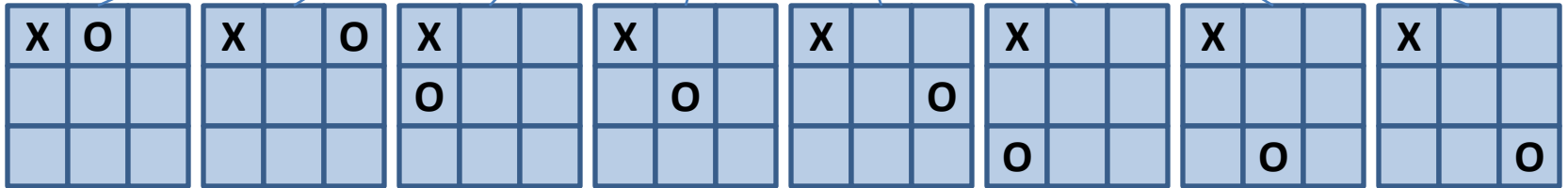
$$X1 - O1$$

1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(1)



Depth 2



X=2
Y=1
F=2-1 = 1

F=2-2
F=0

F=2-1
F=1

F=2-3
F=-1

F=3-2
F=1

F=2-2
F=0

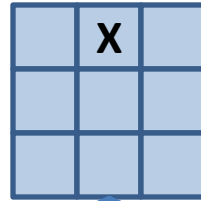
F=3-2
F=1

F=2-2
F=0

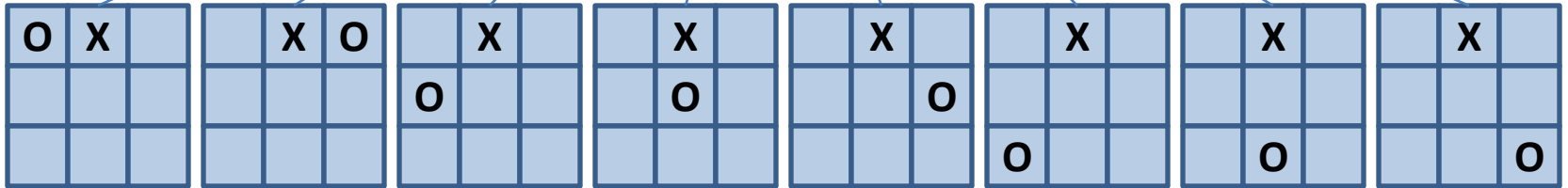
min

1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(2)



Depth 2



F=-1

F=-1

F=1

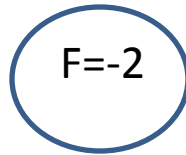
F=-2

F=0

F=-1

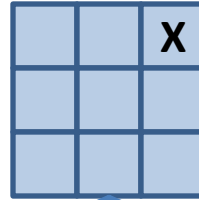
F=0

F=-1

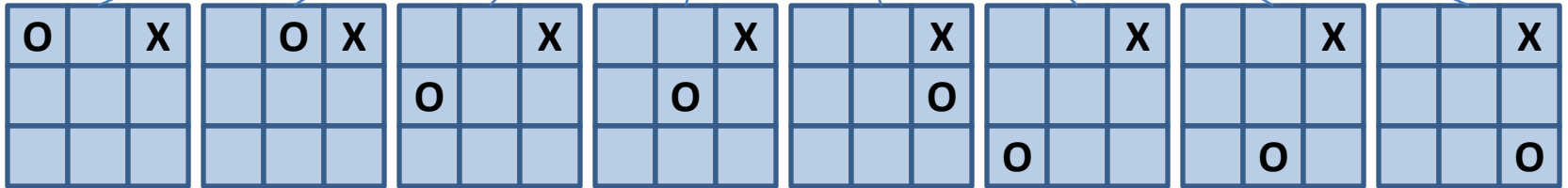


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(3)



Depth 2



F=0

F=1

F=1

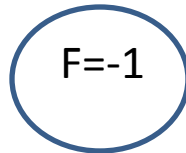
F=-1

F=0

F=0

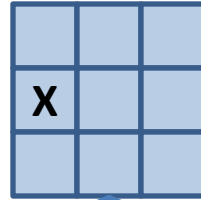
F=1

F=0

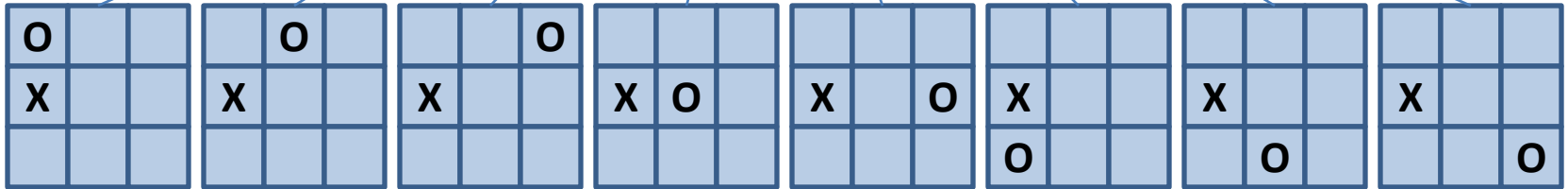


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(4)



Depth 2



F=-1

F=0

F=-1

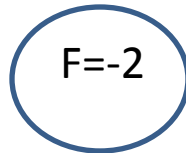
F=-2

F=0

F=-1

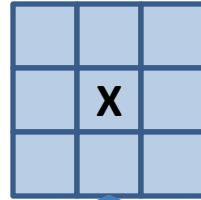
F=0

F=-1

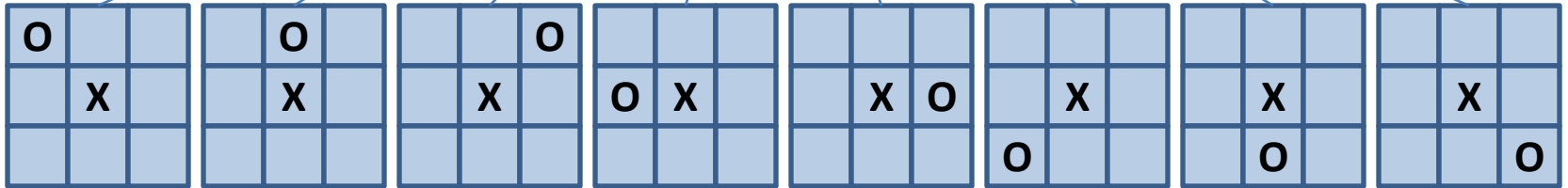


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(5)



Depth 2



F=1

F=2

F=1

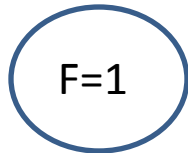
F=2

F=2

F=1

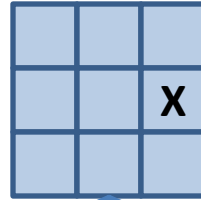
F=2

F=1

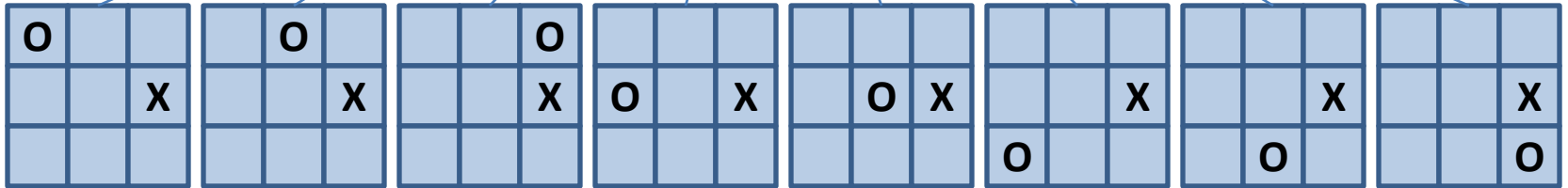


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(6)



Depth 2



F=-1

F=0

F=-1

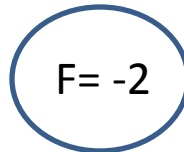
F=0

F= -2

F=-1

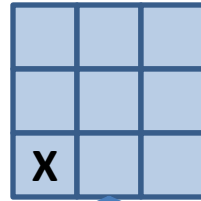
F=0

F=-1

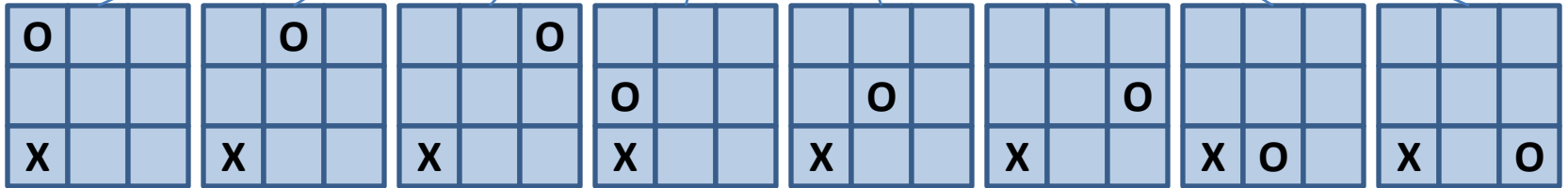


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(7)



Depth 2



F=0

F=1

F=0

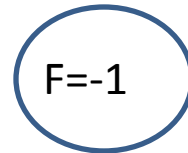
F=1

F=-1

F=1

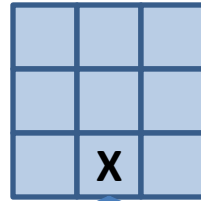
F=1

F=0

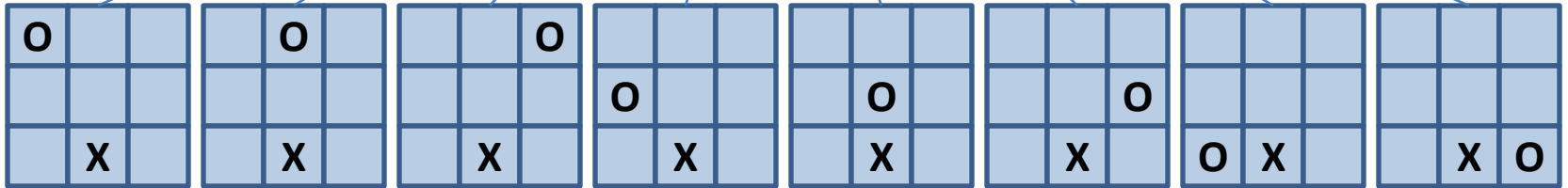


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(8)



Depth 2



F=-1

F=0

F=-1

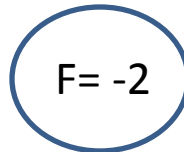
F=0

F= -2

F=-1

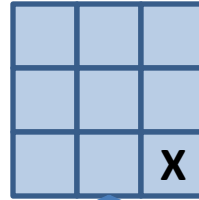
F=-1

F=-1

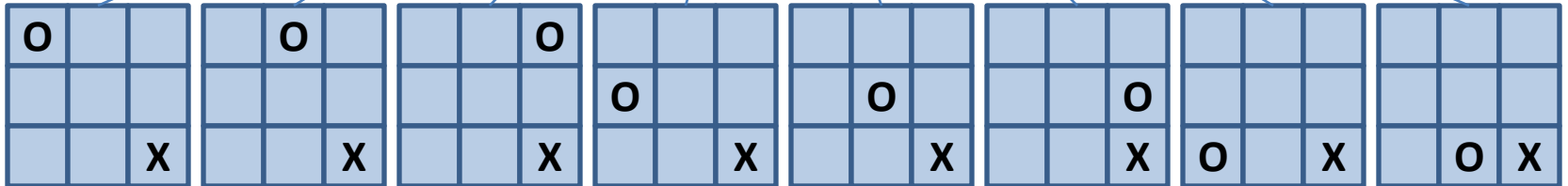


1.d Tic-Tac-Toe – game tree (depth 2)?

Depth 1
(9)



Depth 2



F=0

F=1

F=0

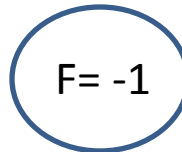
F=1

F= -1

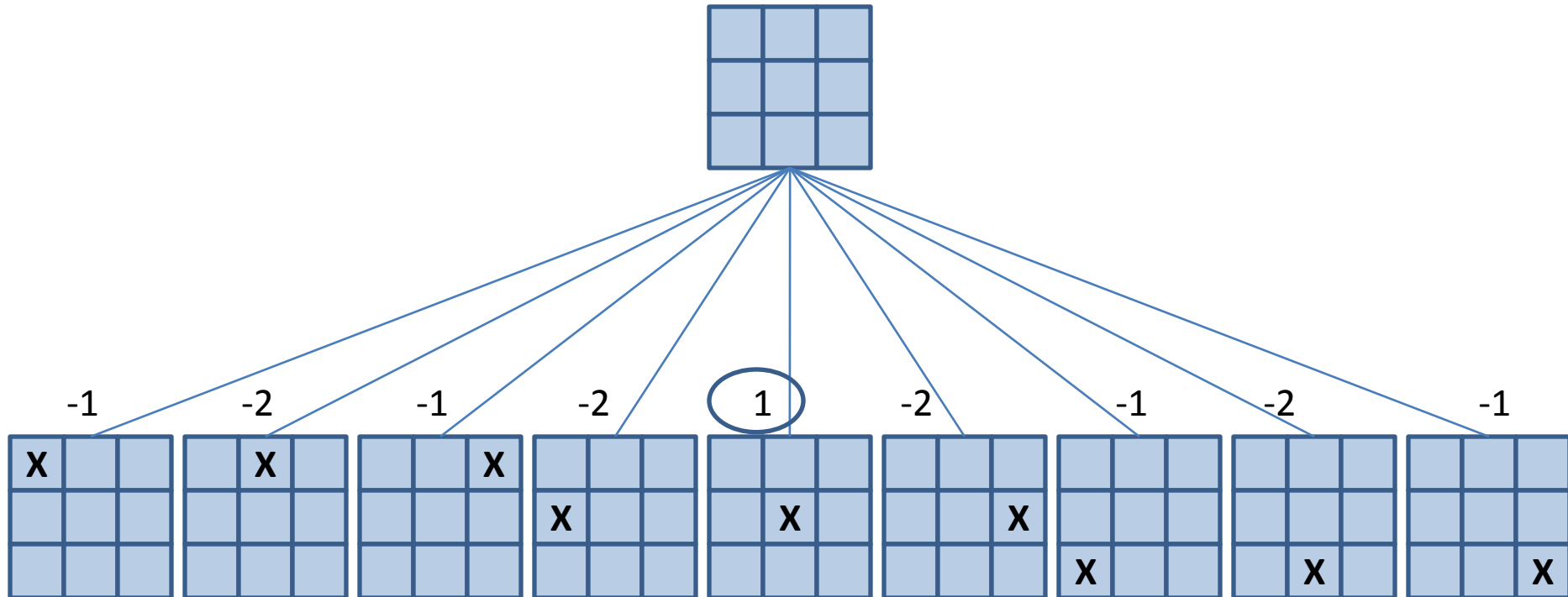
F=1

F=0

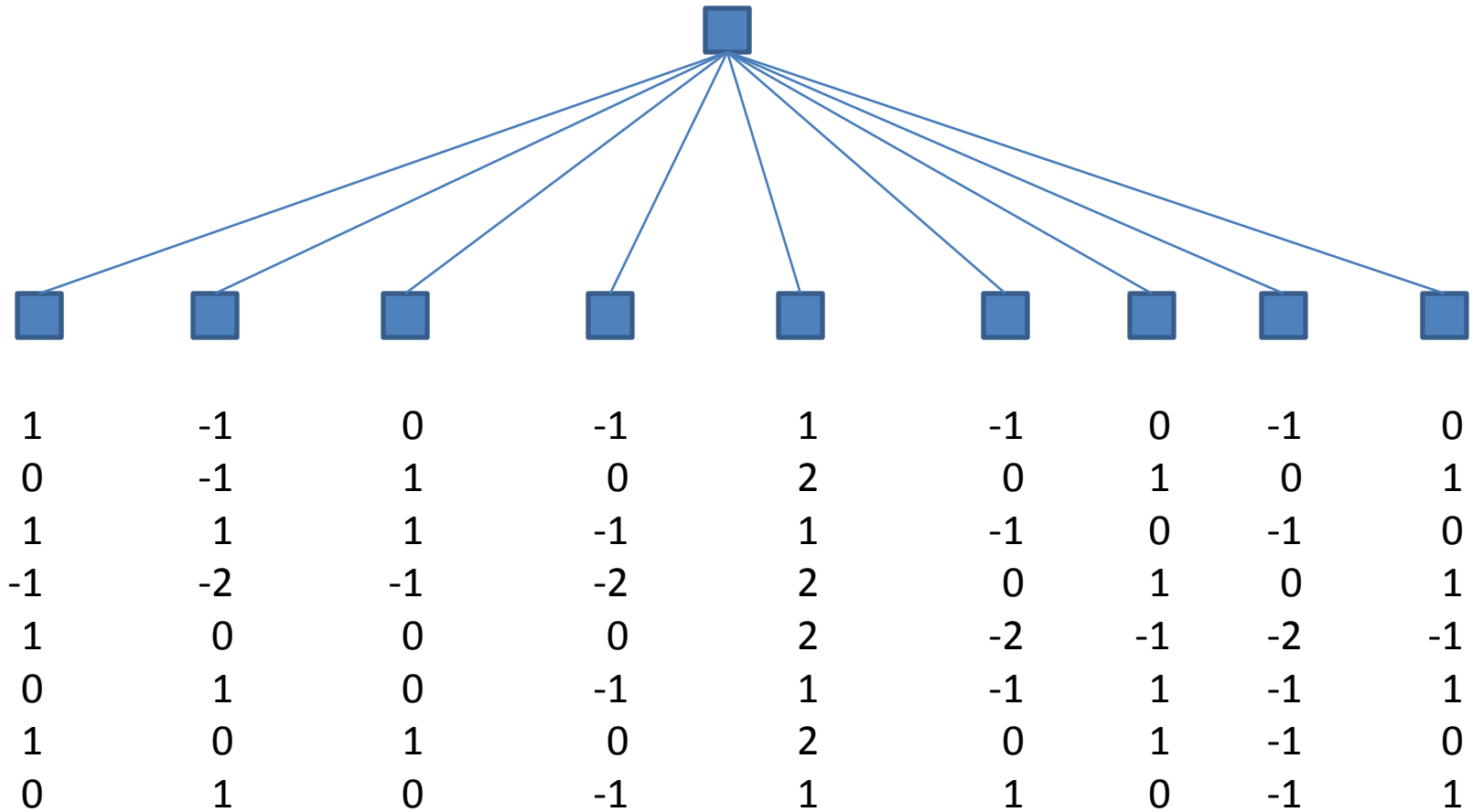
F=1



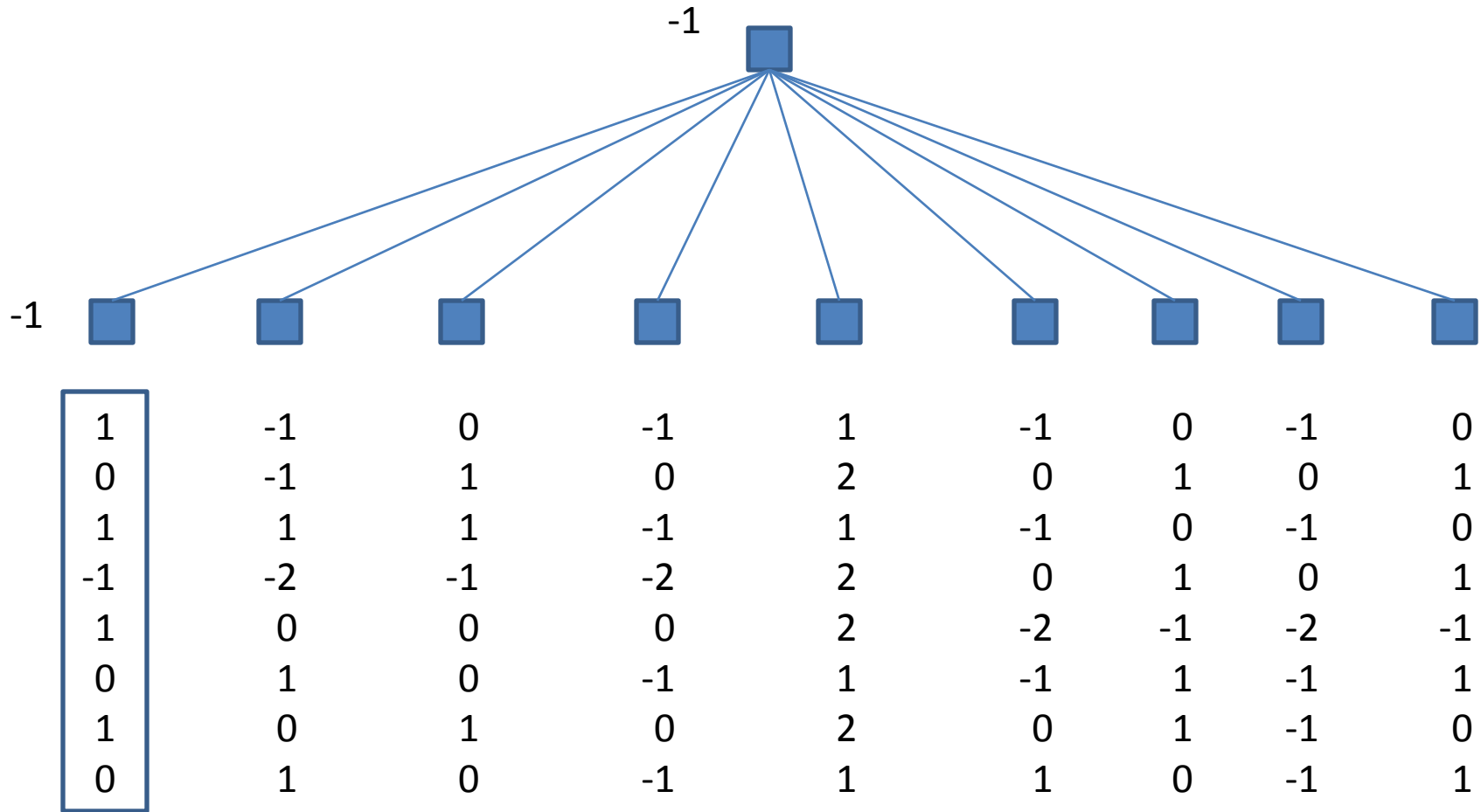
1.d Tic-Tac-Toe – game tree (depth 2)?



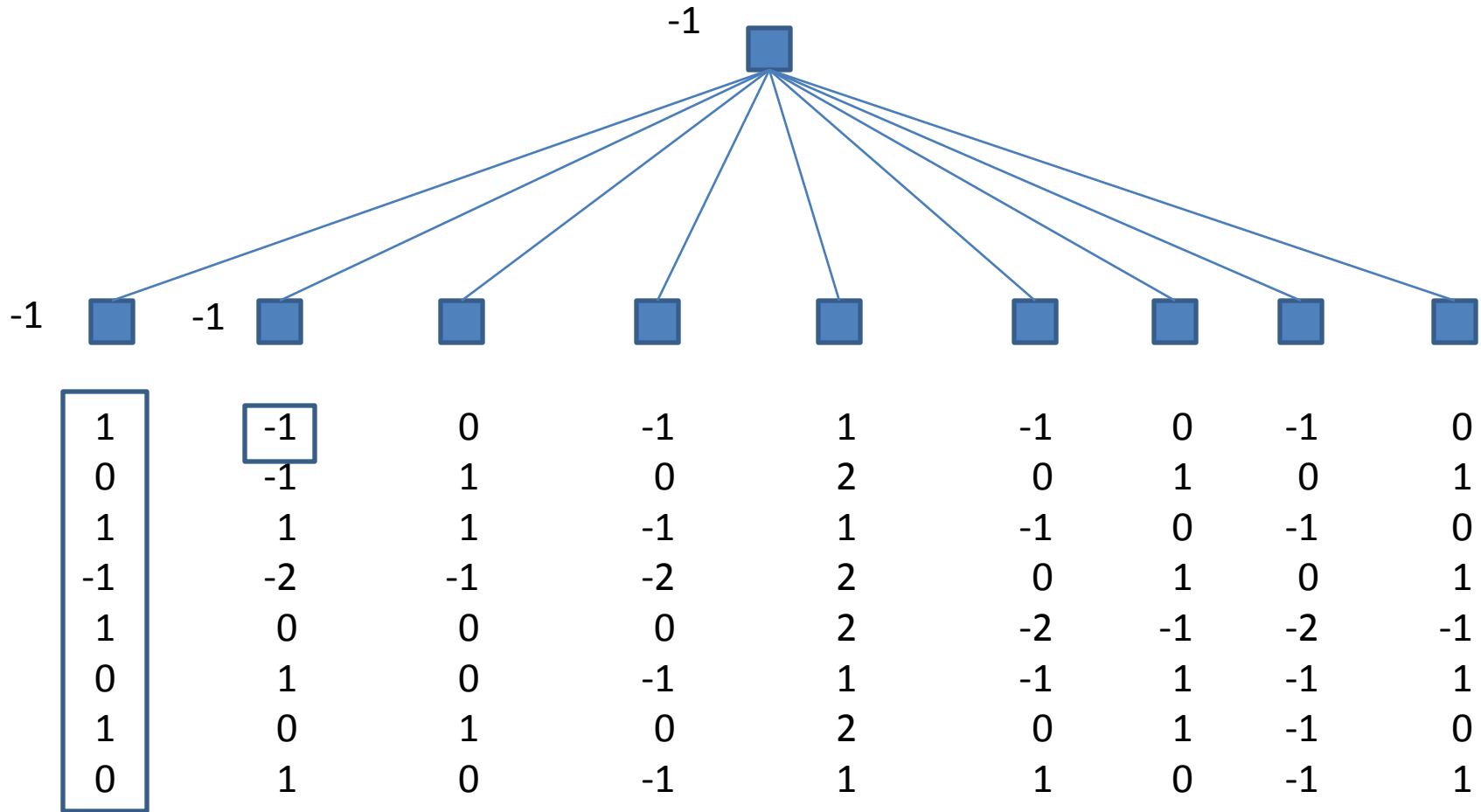
1.e Tic-Tac-Toe – pruned subtrees



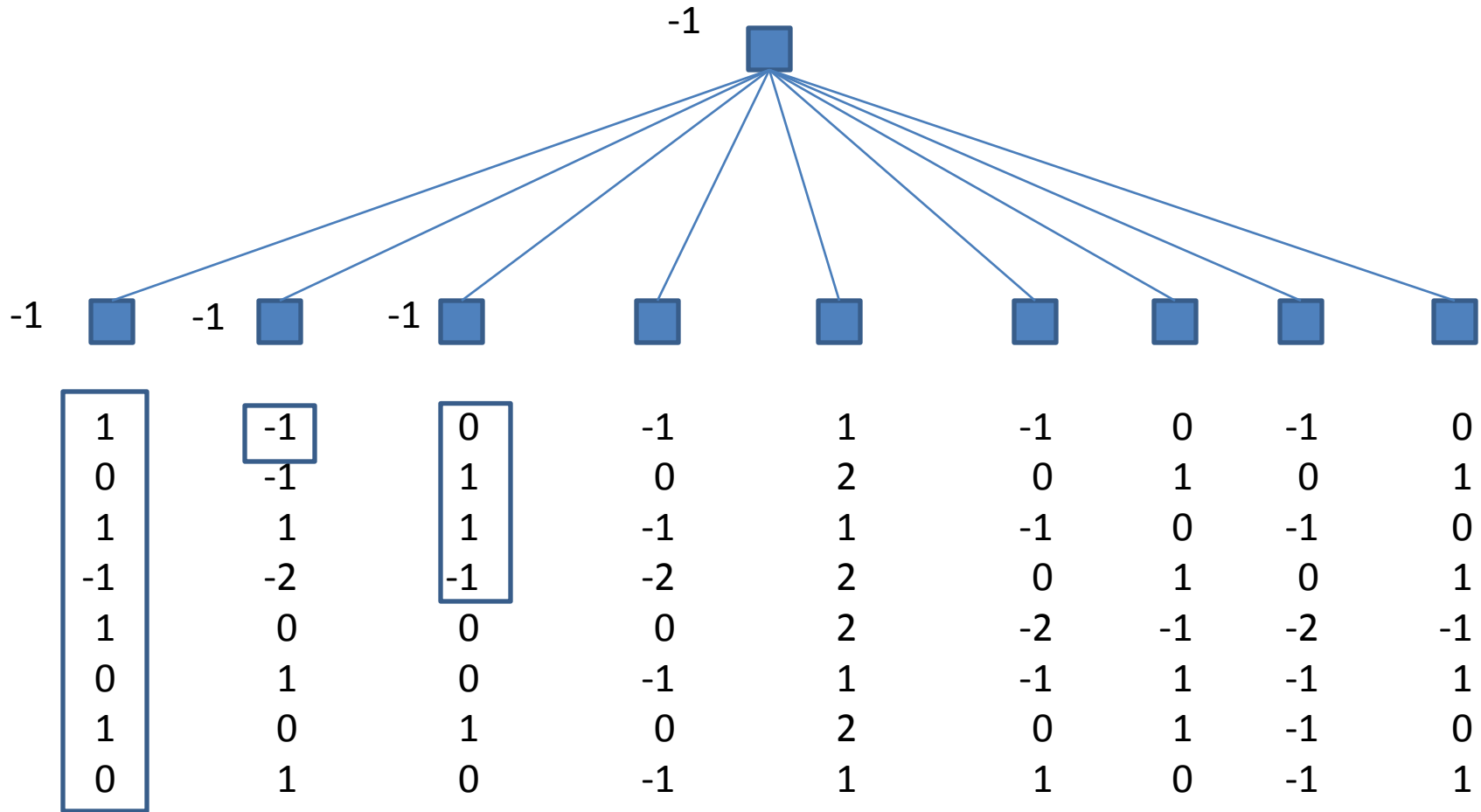
1.e Tic-Tac-Toe – pruned subtrees (L-R)



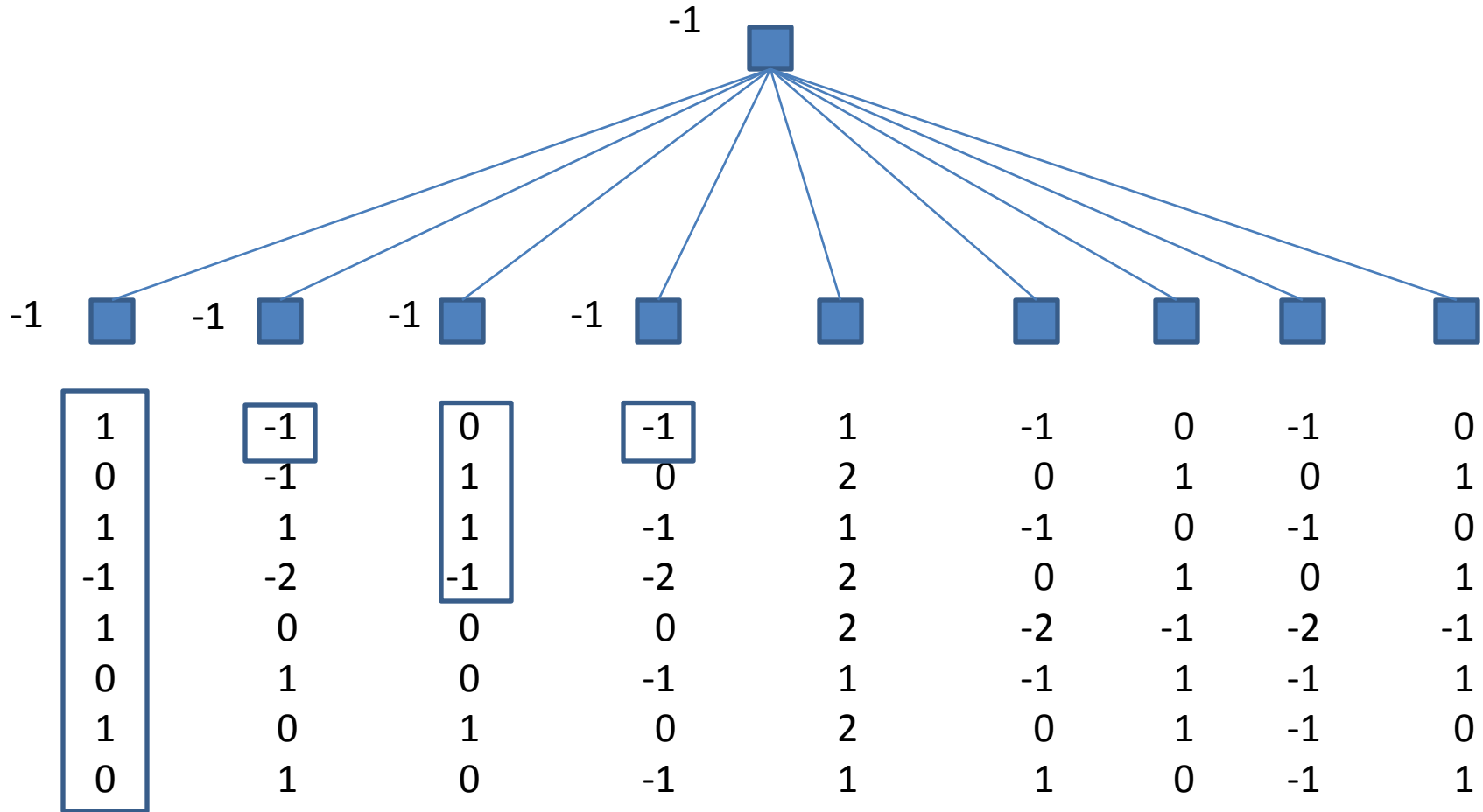
1.e Tic-Tac-Toe – pruned subtrees (L-R)



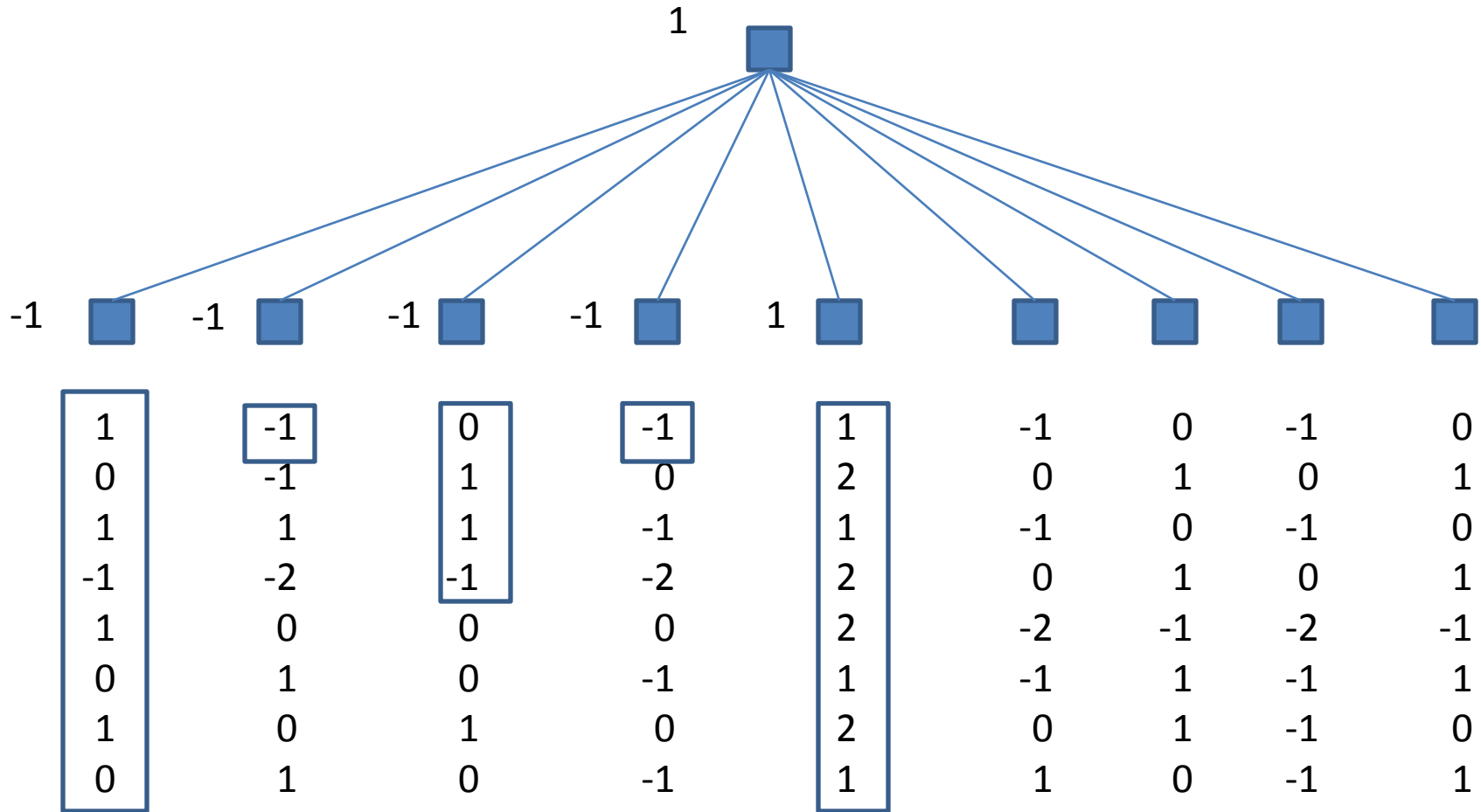
1.e Tic-Tac-Toe – pruned subtrees (L-R)



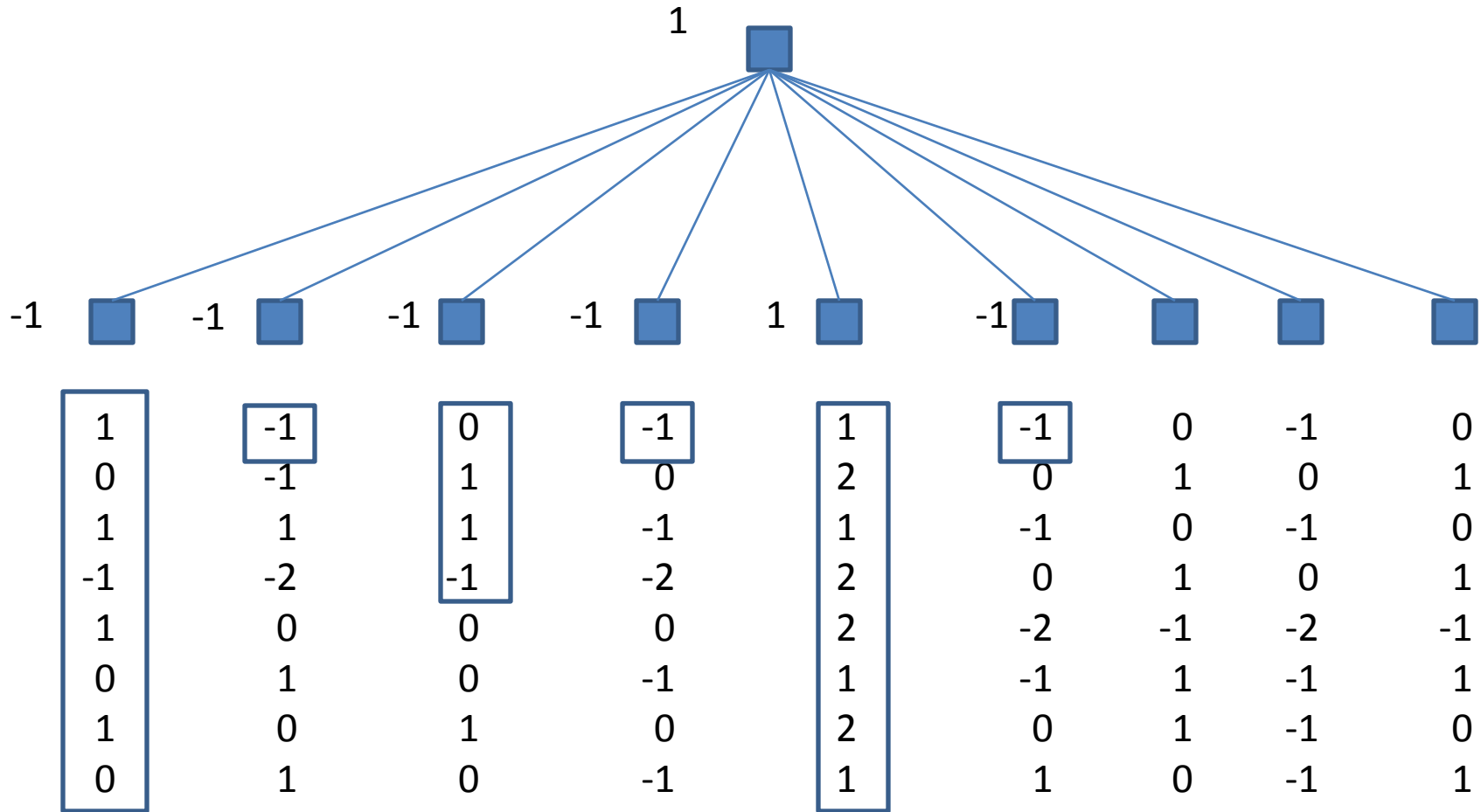
1.e Tic-Tac-Toe – pruned subtrees (L-R)



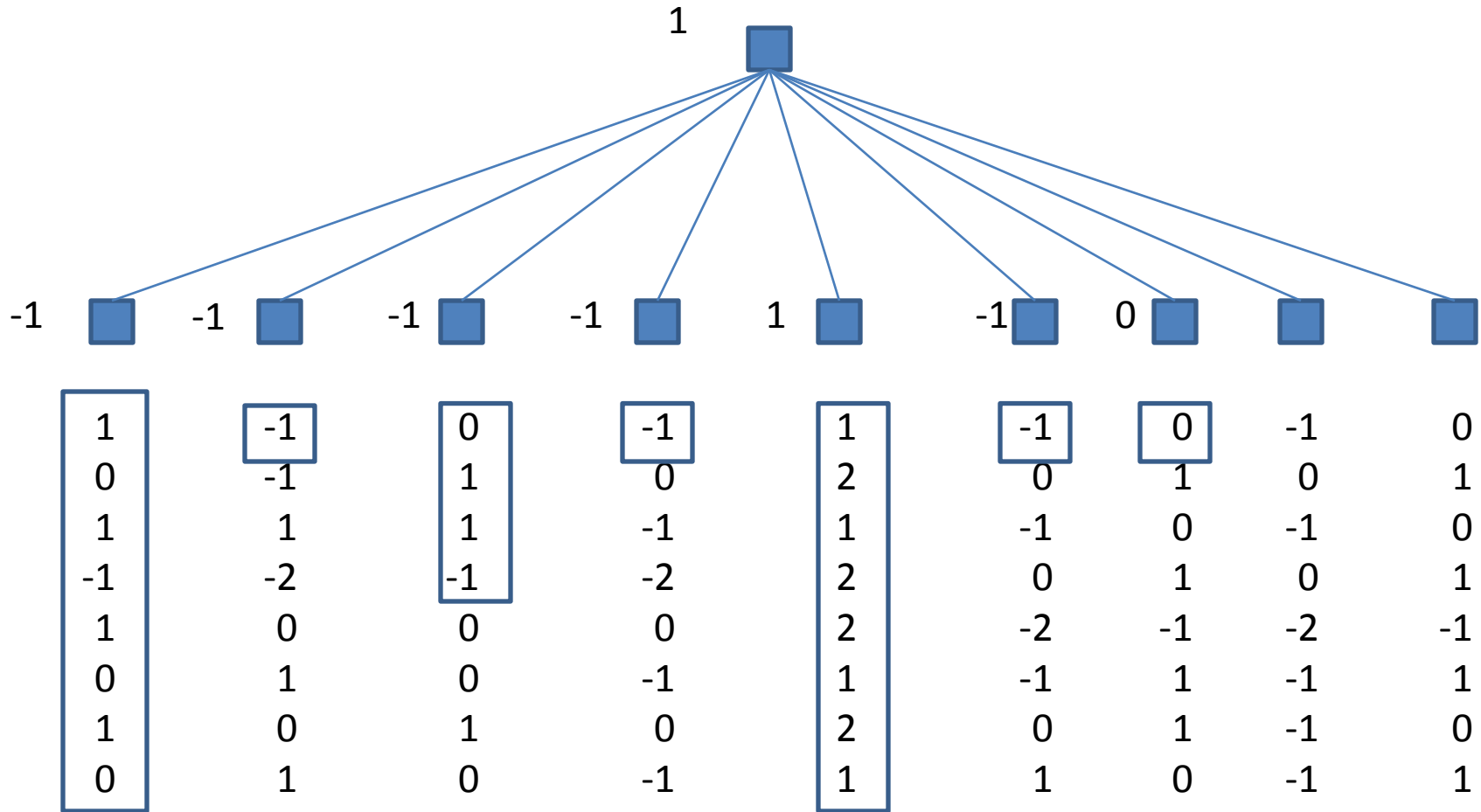
1.e Tic-Tac-Toe – pruned subtrees (L-R)



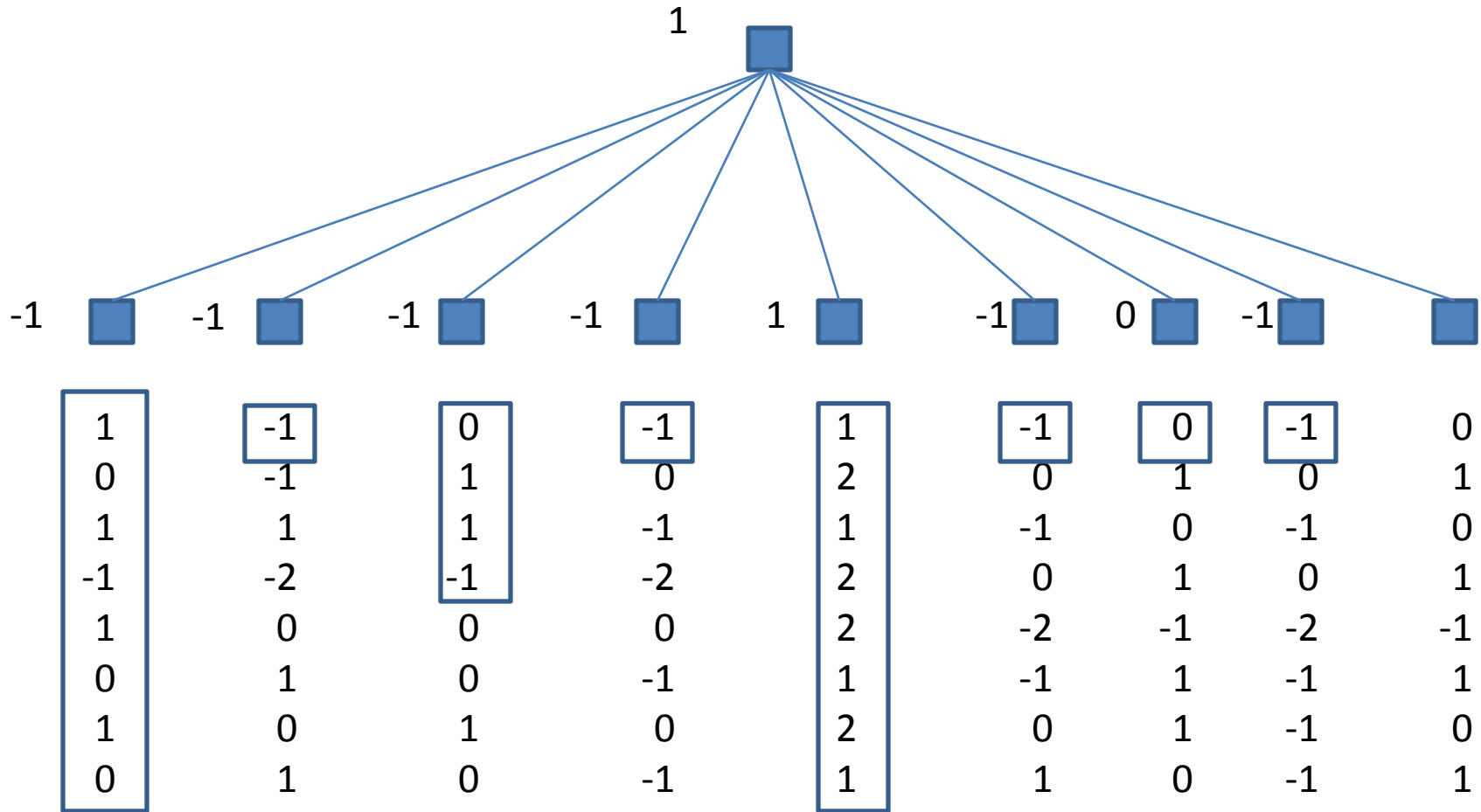
1.e Tic-Tac-Toe – pruned subtrees (L-R)



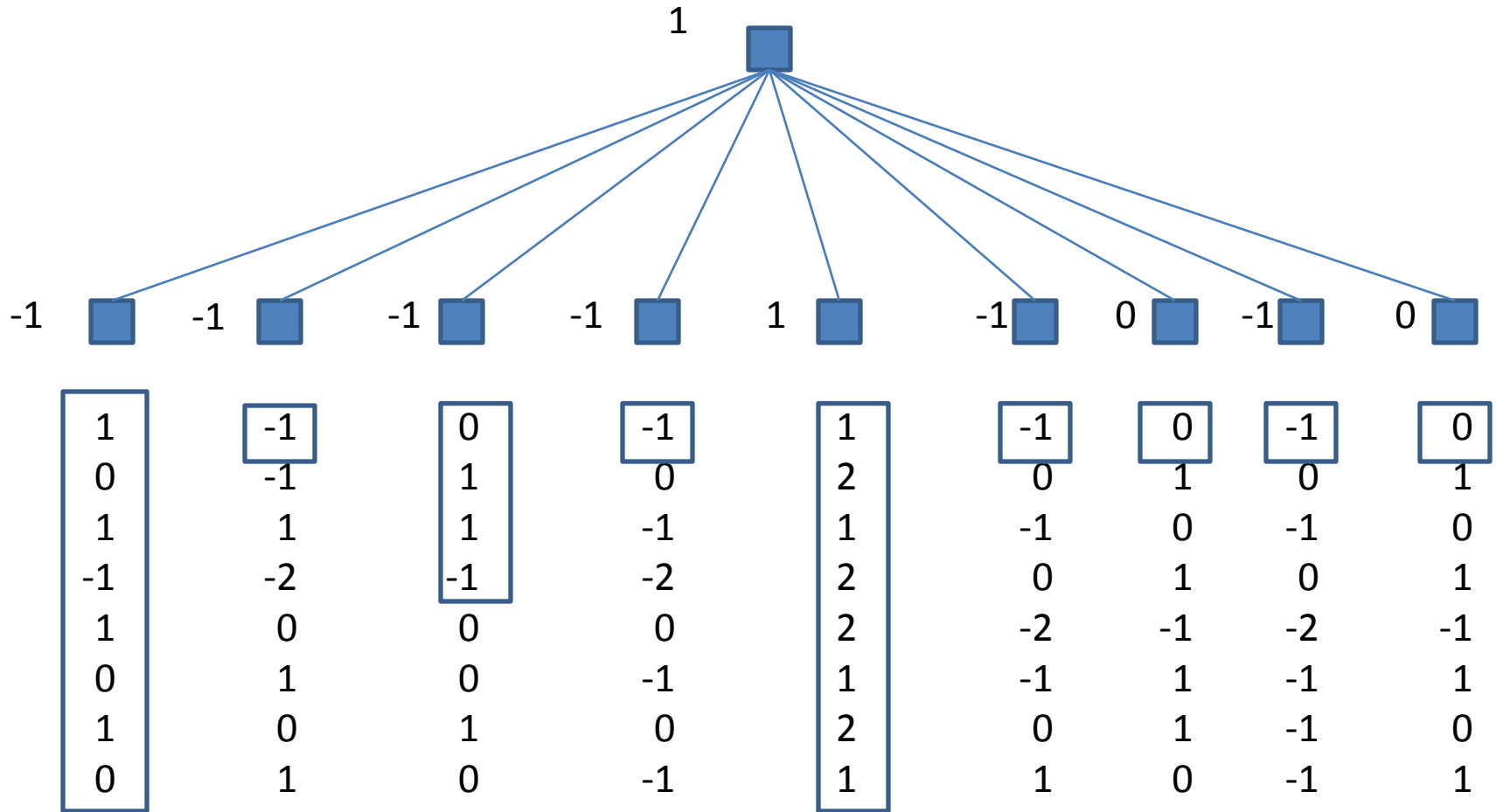
1.e Tic-Tac-Toe – pruned subtrees (L-R)



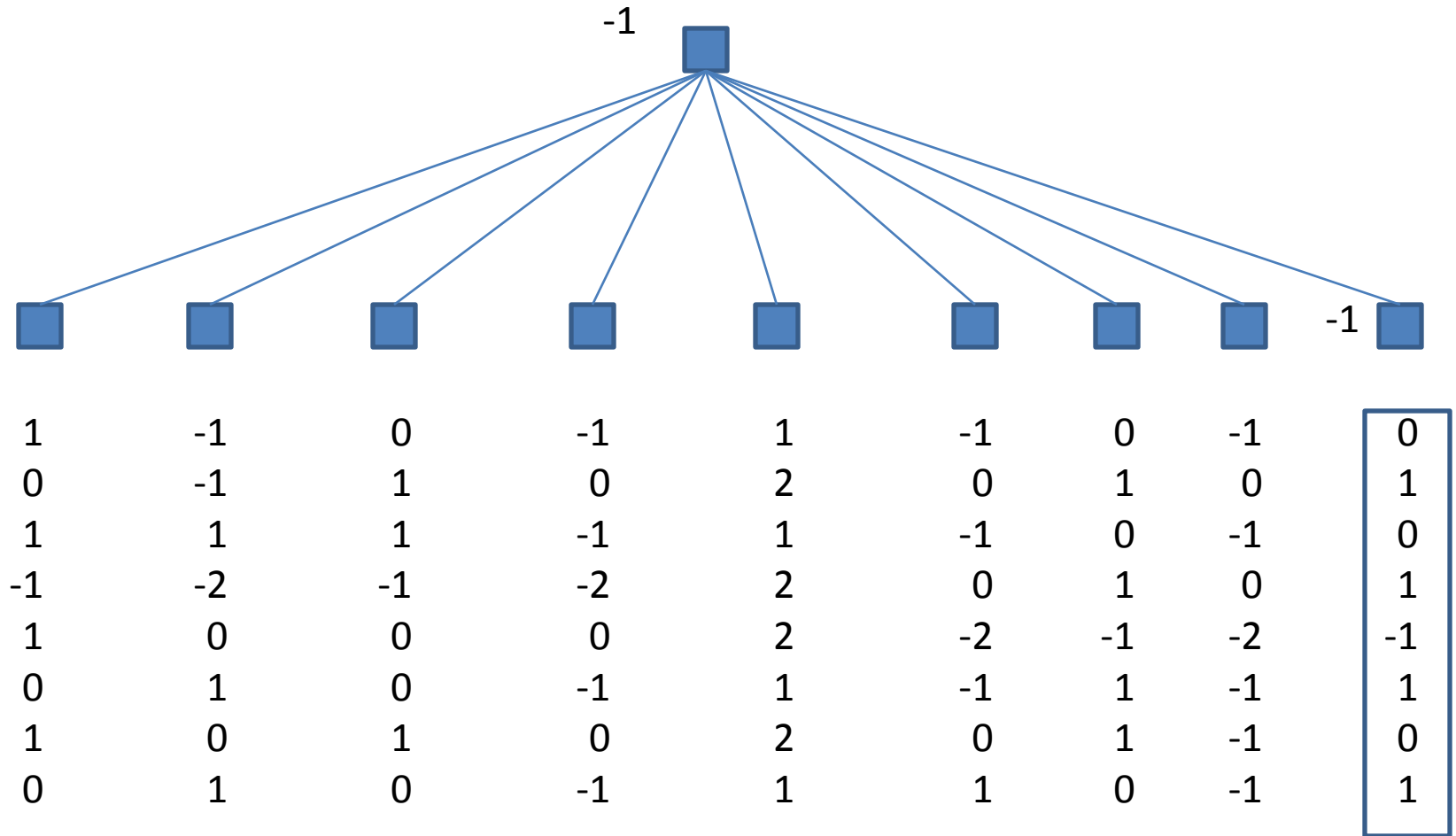
1.e Tic-Tac-Toe – pruned subtrees (L-R)



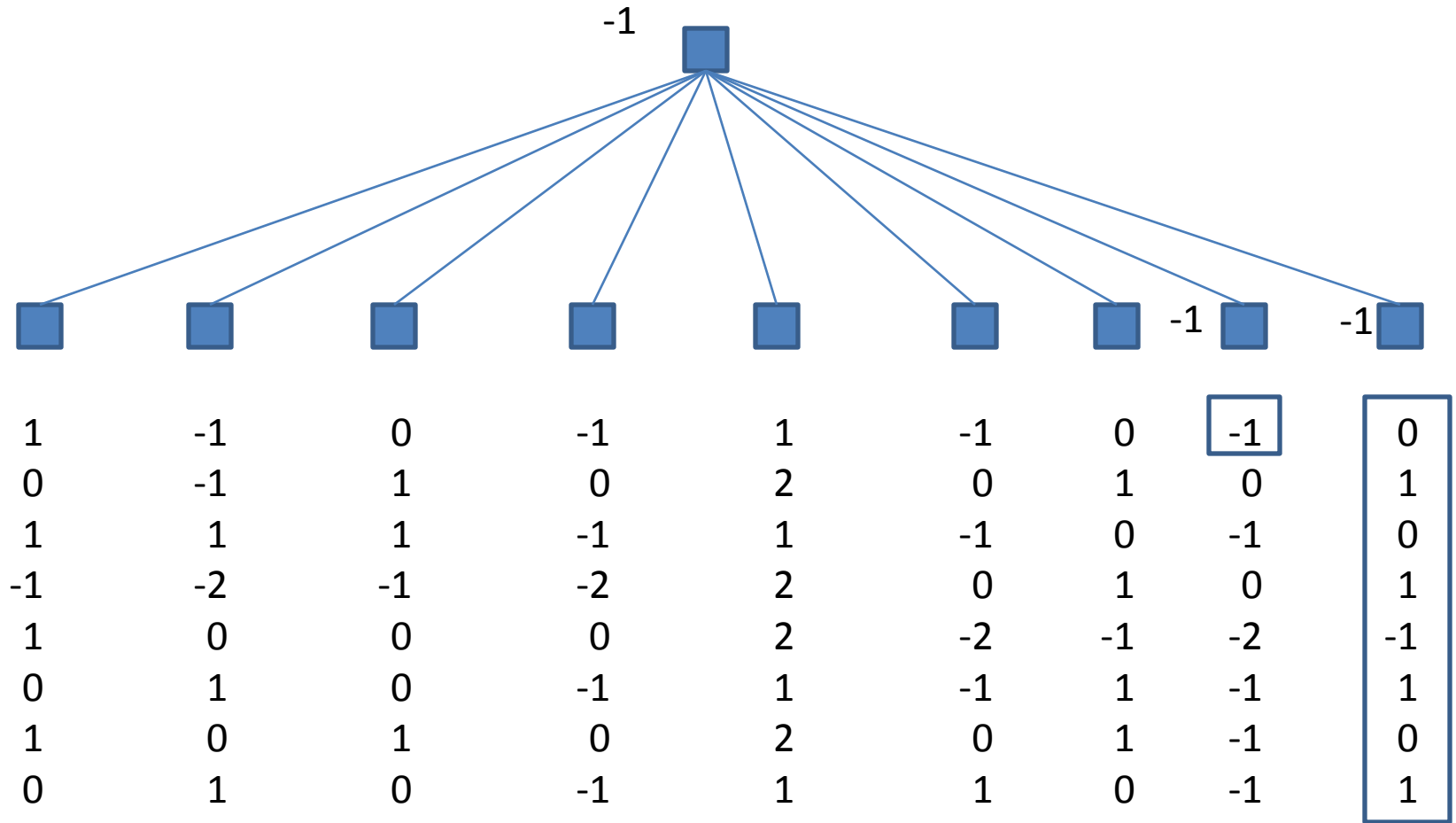
1.e Tic-Tac-Toe – pruned subtrees (L-R)



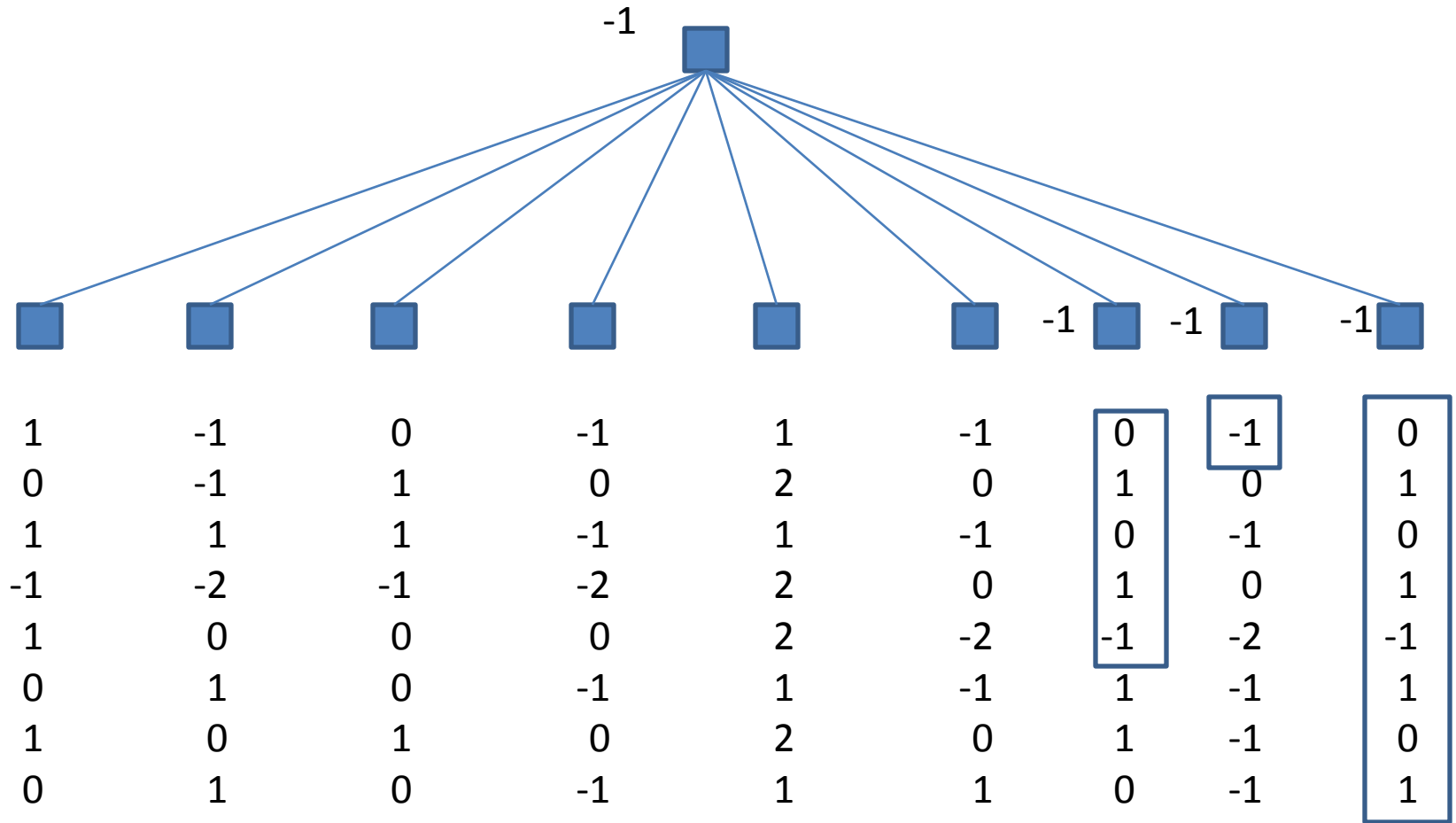
1.e Tic-Tac-Toe – pruned subtrees (R-L)



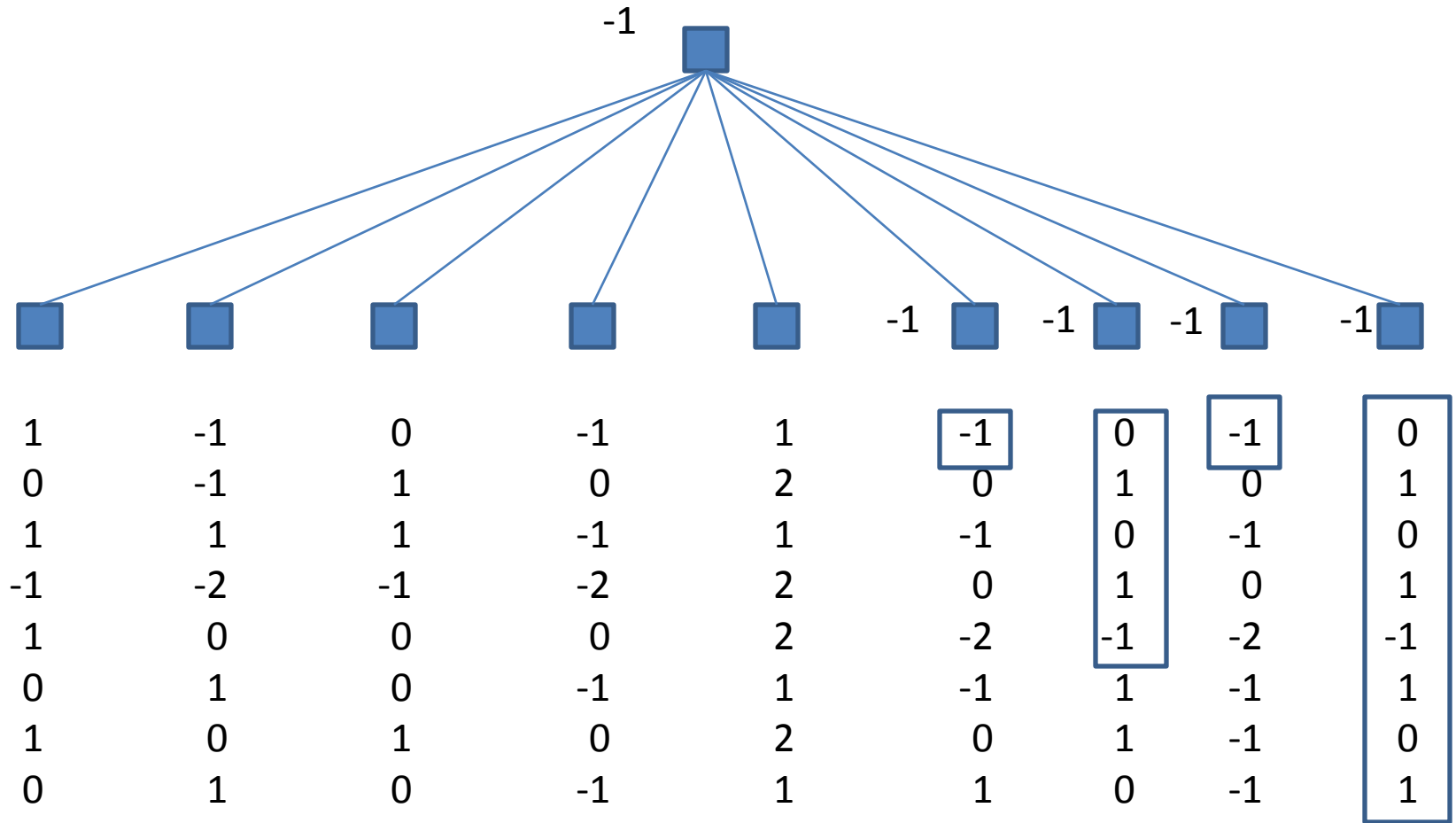
1.e Tic-Tac-Toe – pruned subtrees (R-L)



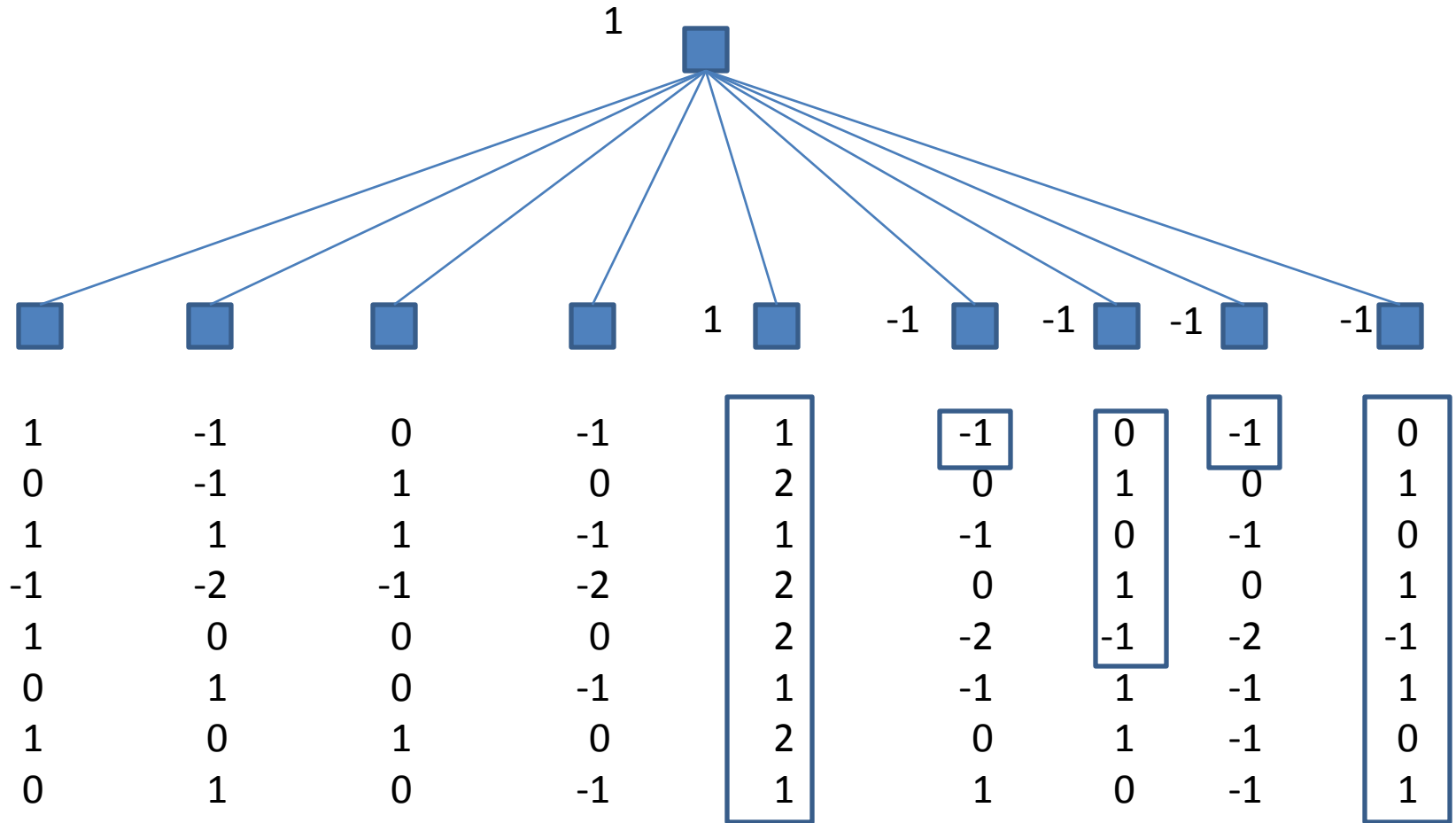
1.e Tic-Tac-Toe – pruned subtrees (R-L)



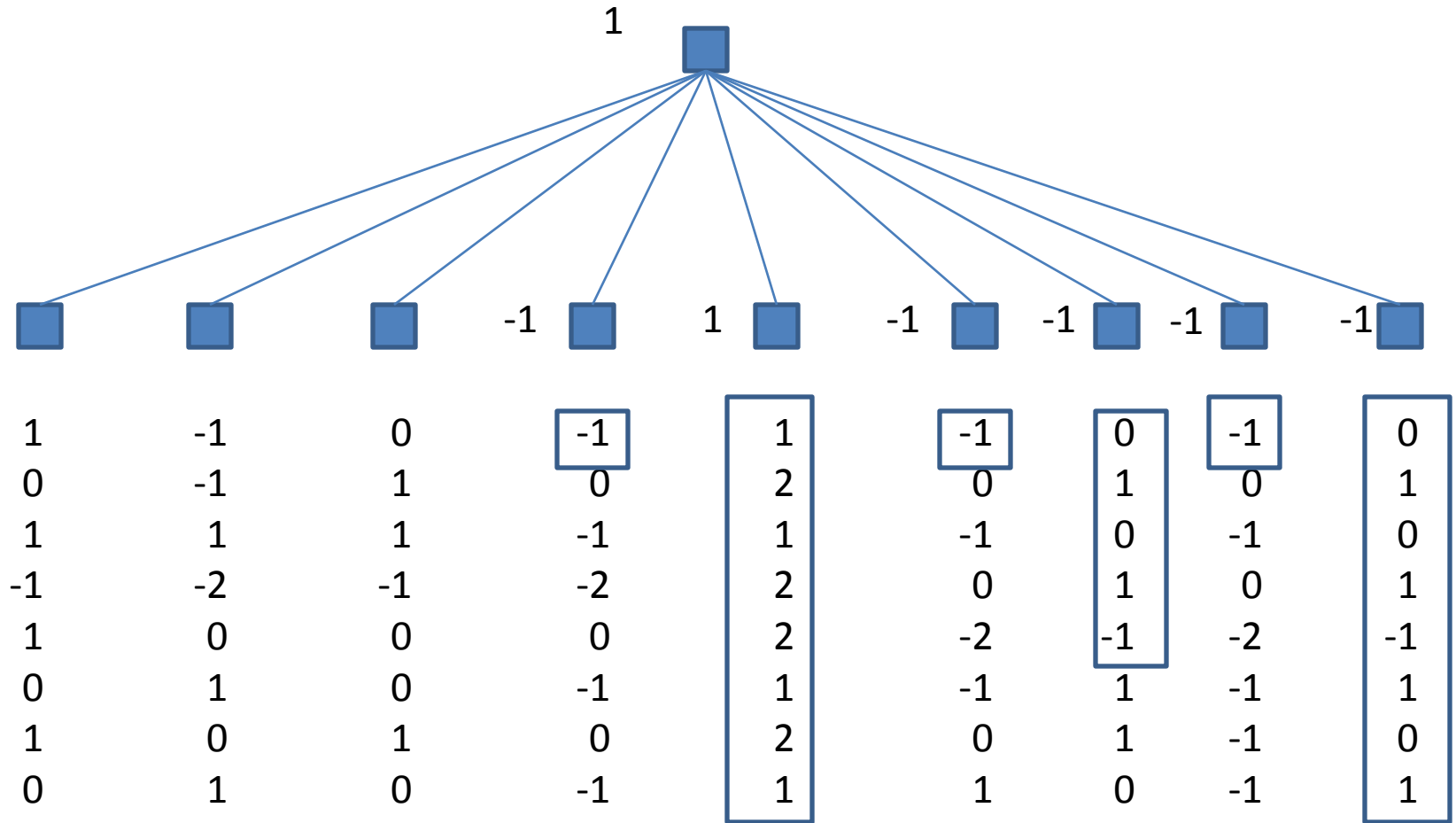
1.e Tic-Tac-Toe – pruned subtrees (R-L)



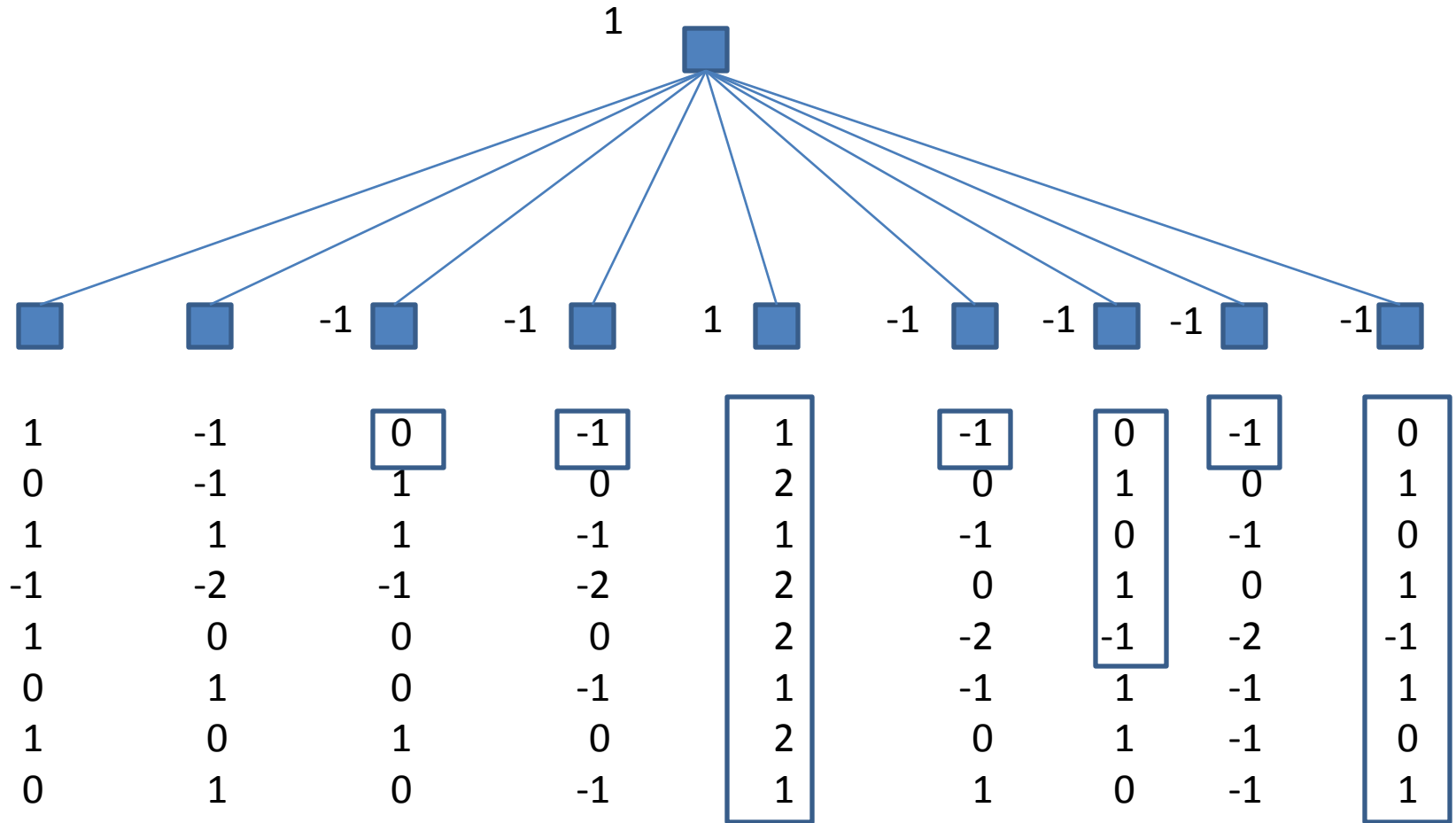
1.e Tic-Tac-Toe – pruned subtrees (R-L)



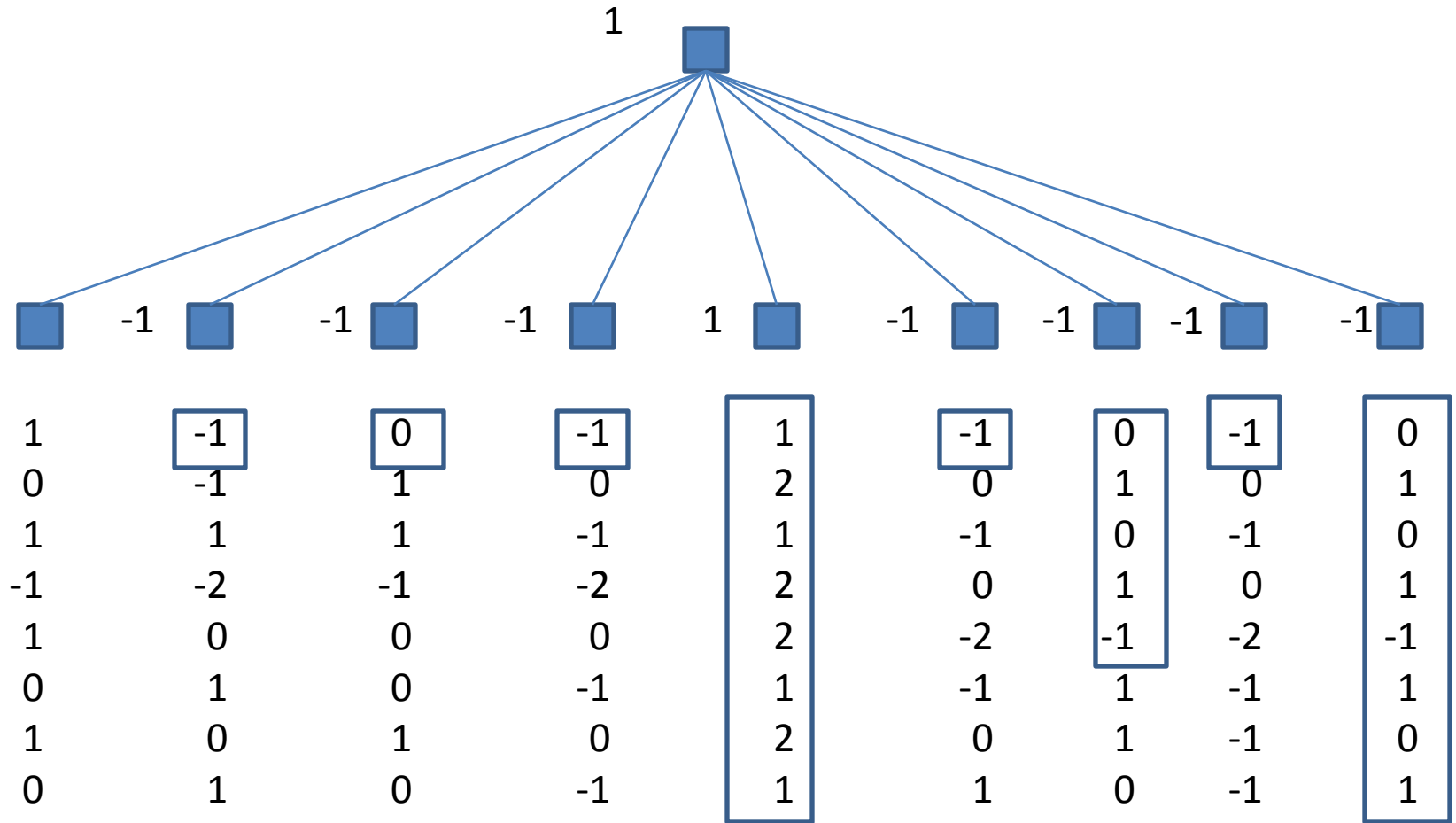
1.e Tic-Tac-Toe – pruned subtrees (R-L)



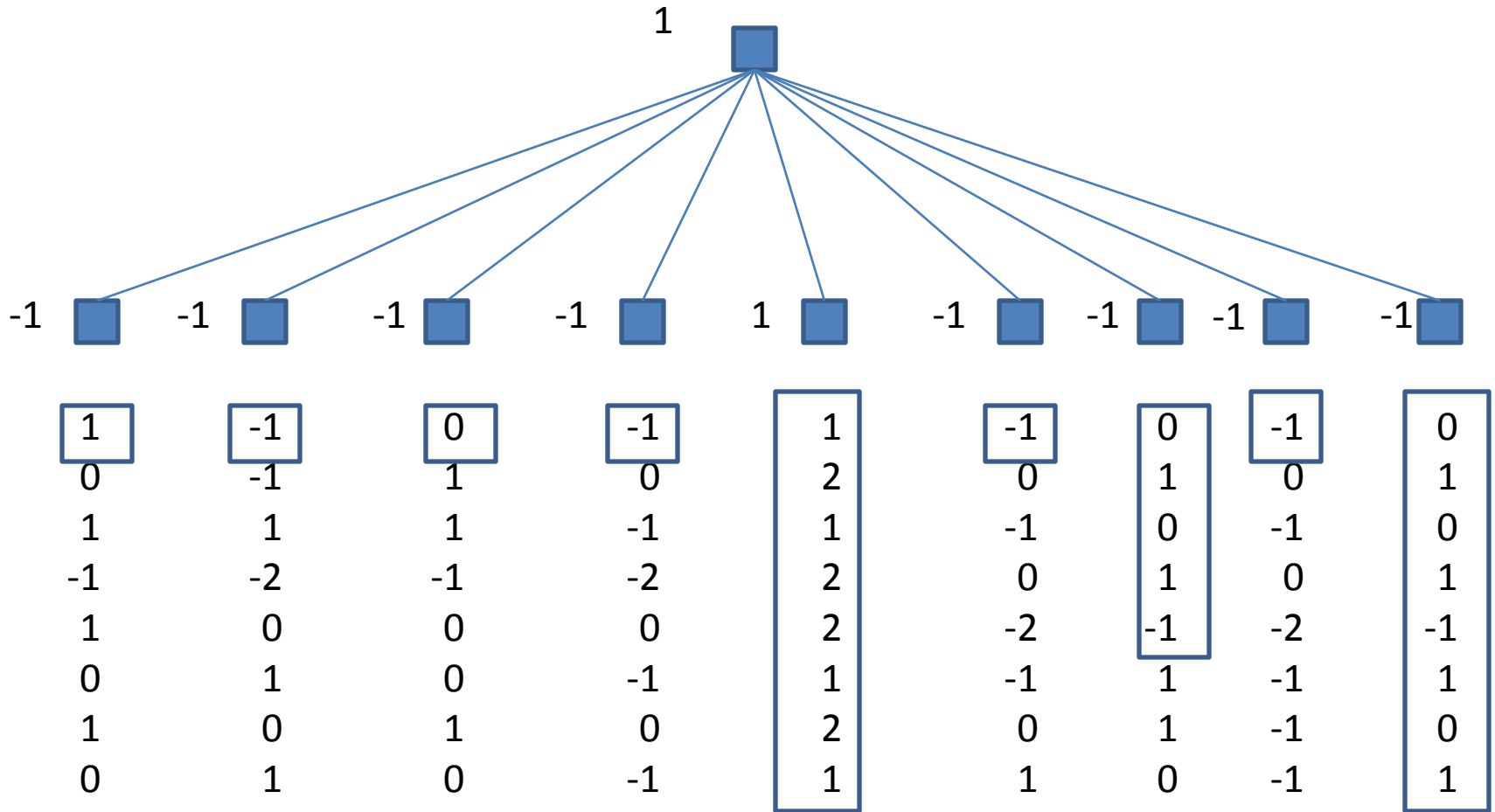
1.e Tic-Tac-Toe – pruned subtrees (R-L)



1.e Tic-Tac-Toe – pruned subtrees (R-L)



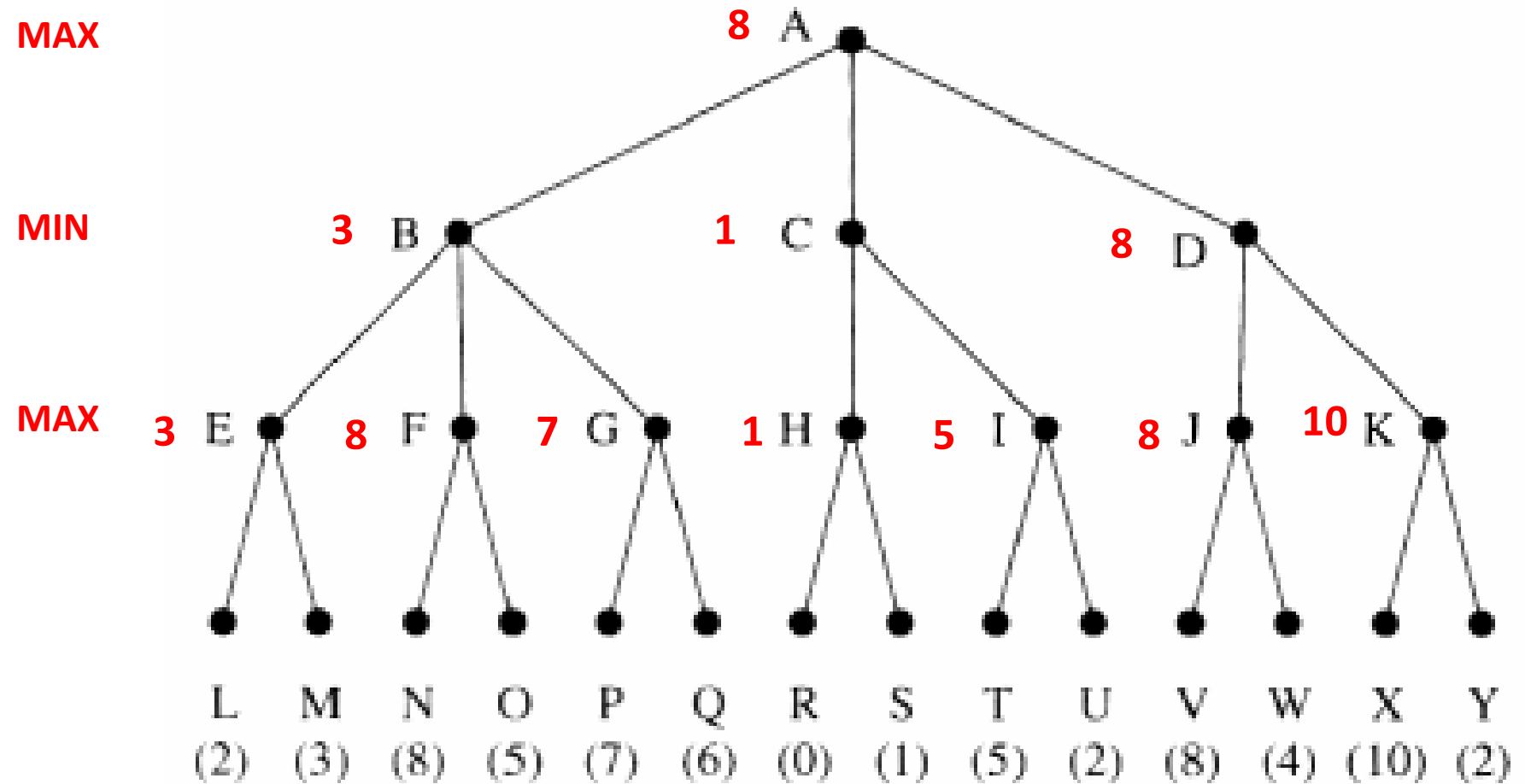
1.e Tic-Tac-Toe – pruned subtrees (R-L)



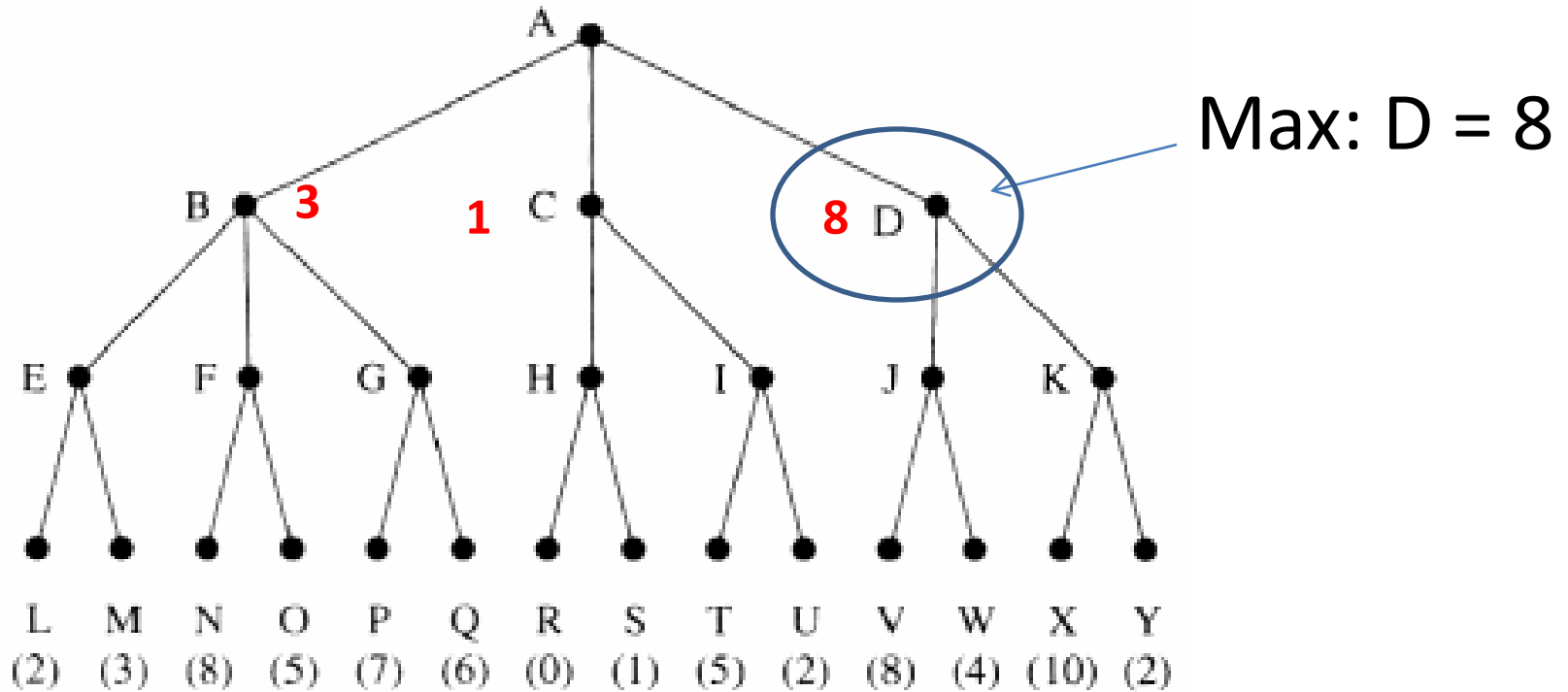
1.f Tic-Tac-Toe – Property of leaf values

The leaf values should be ordered from lowest to highest from left to right.

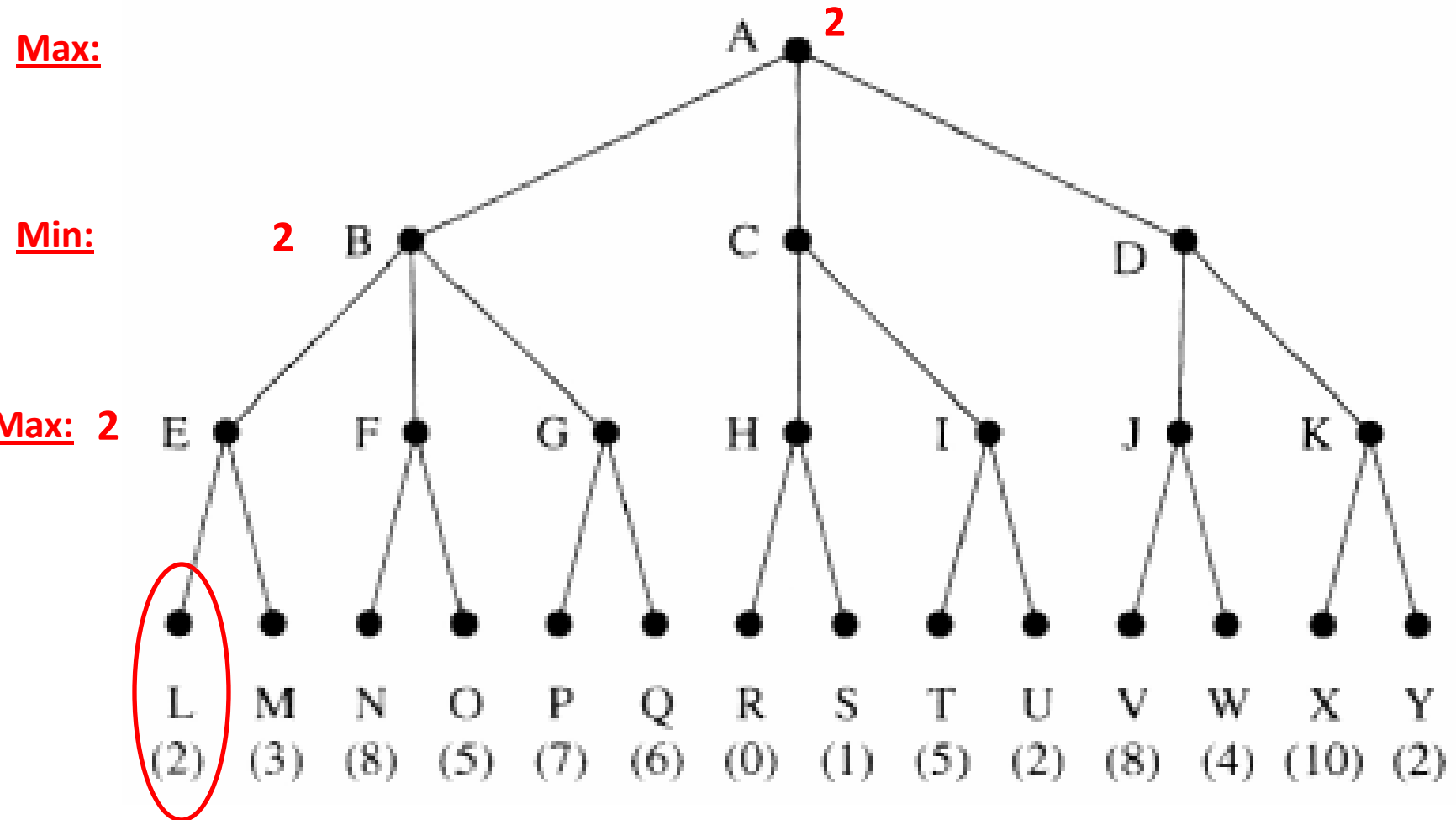
2. Min-Max



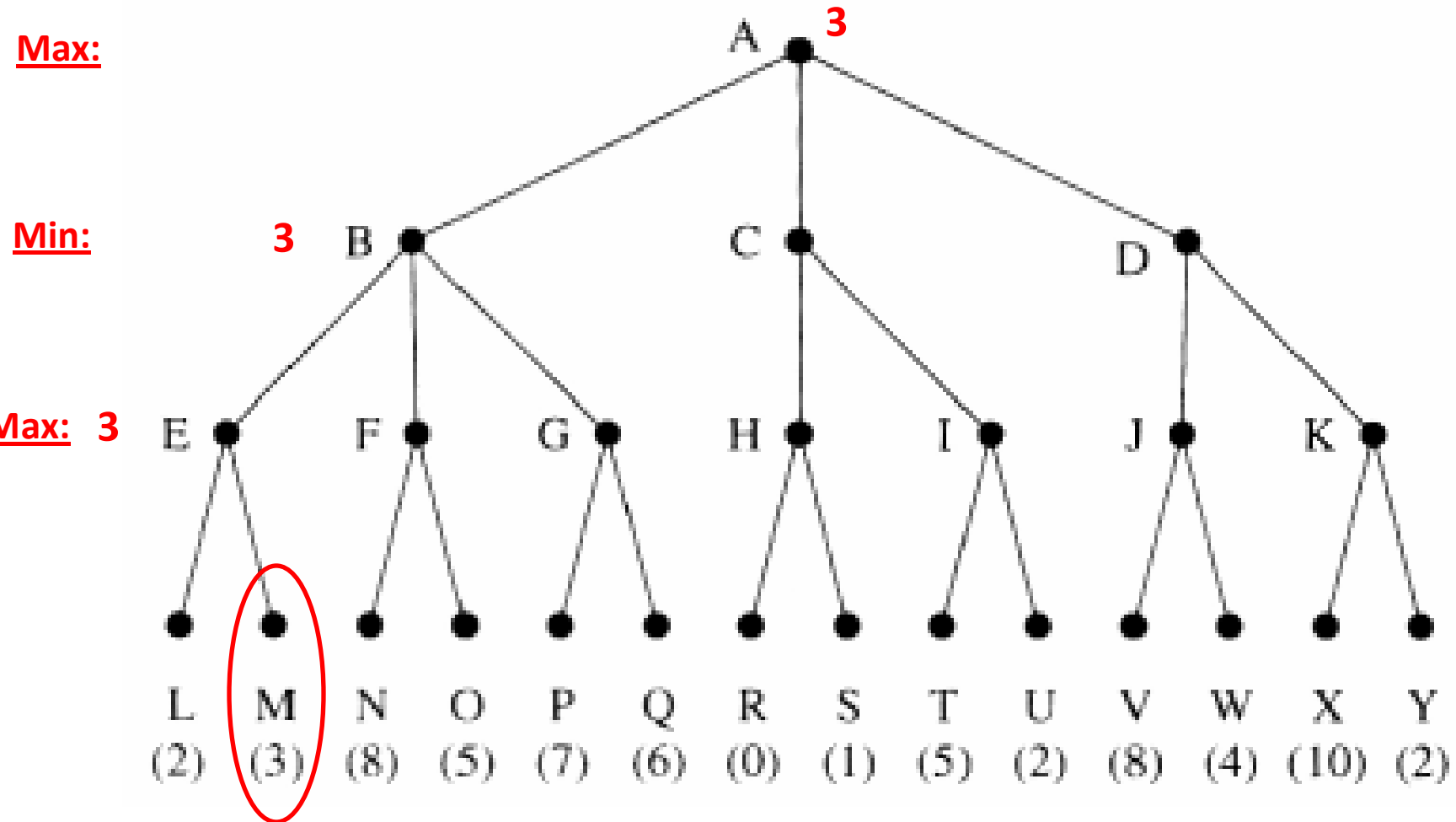
2.a First (MAX) player choice



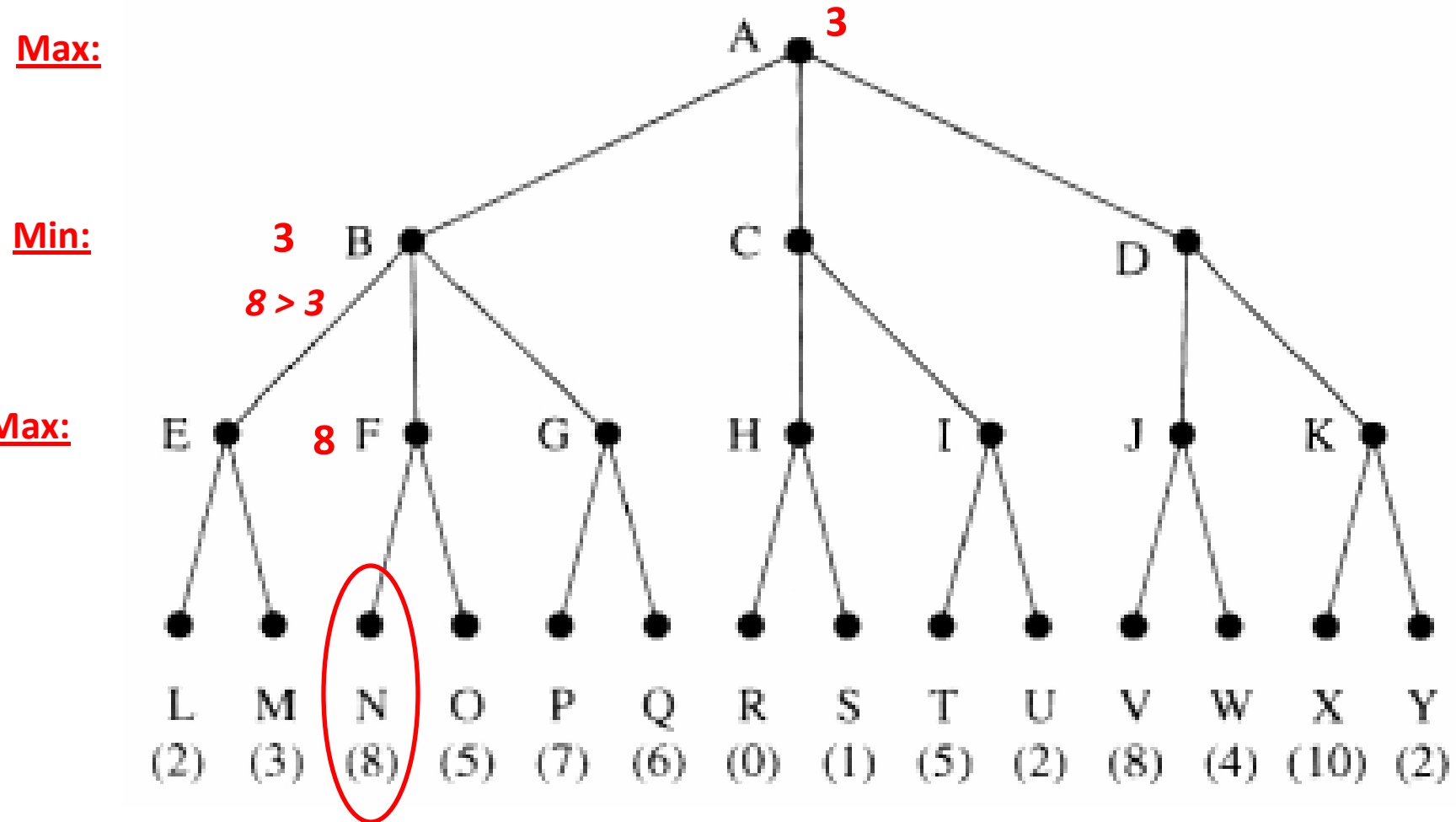
2.b Which nodes would not need be examined



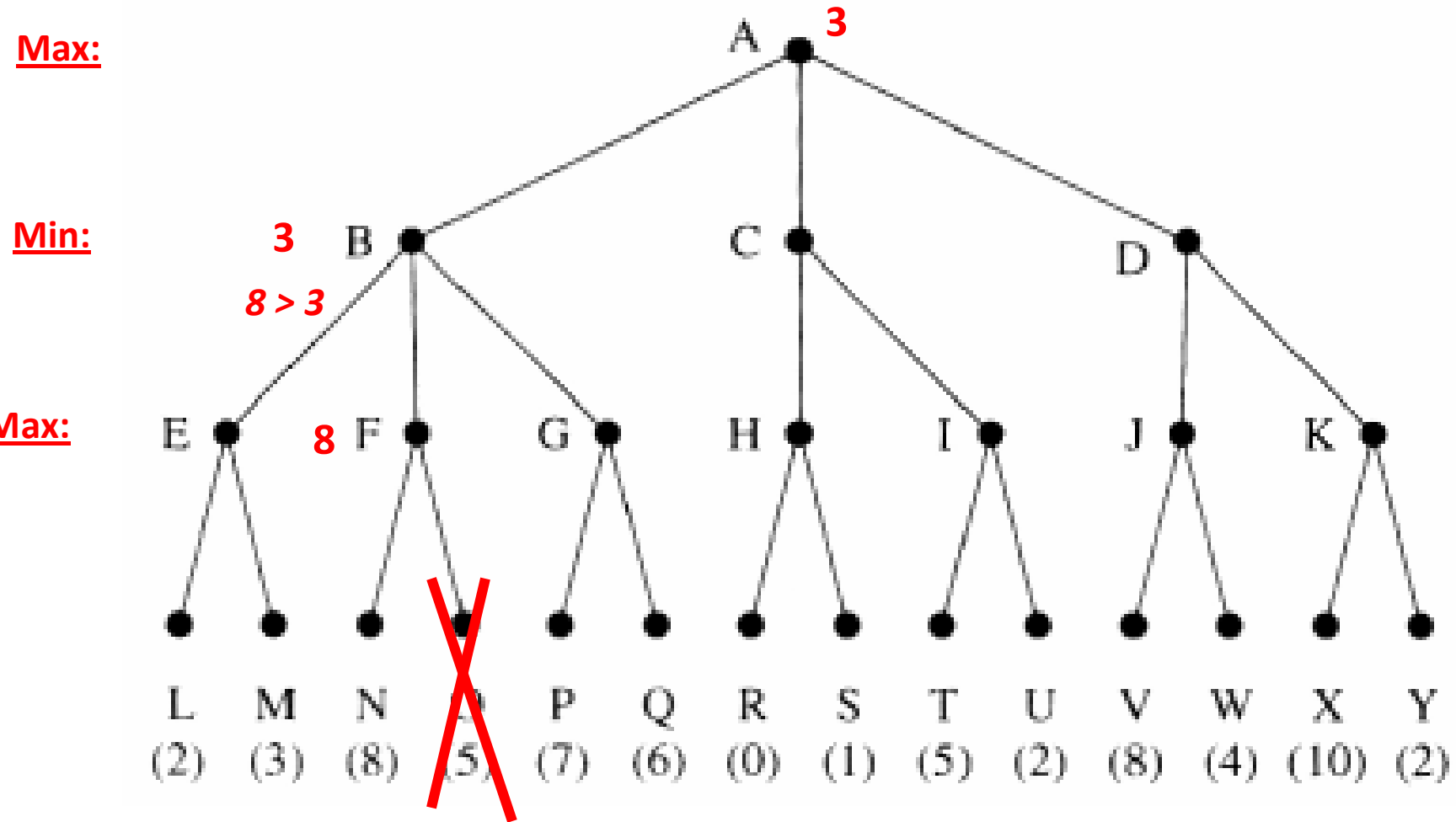
2.b Which nodes would not need be examined



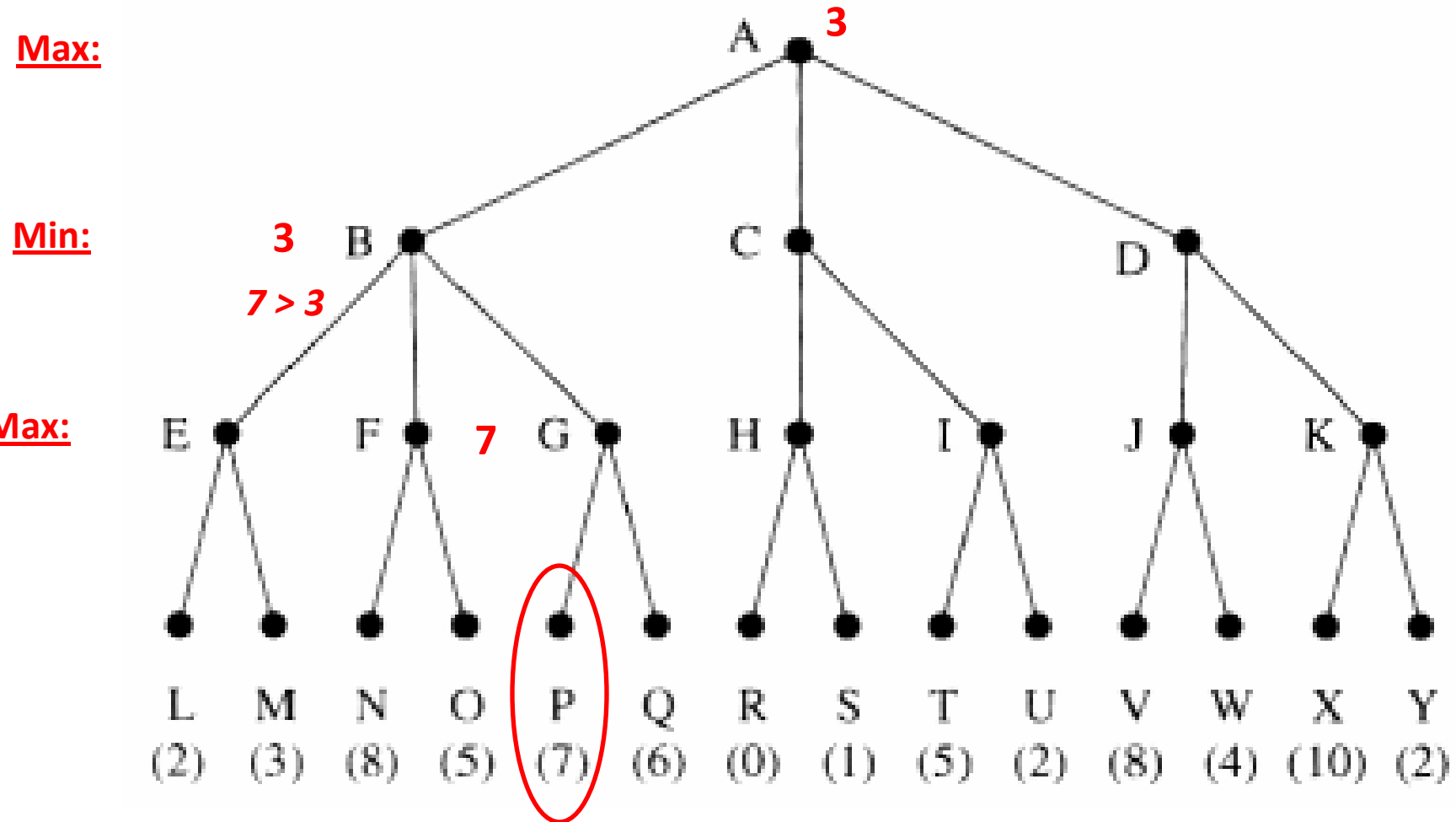
2.b Which nodes would not need be examined



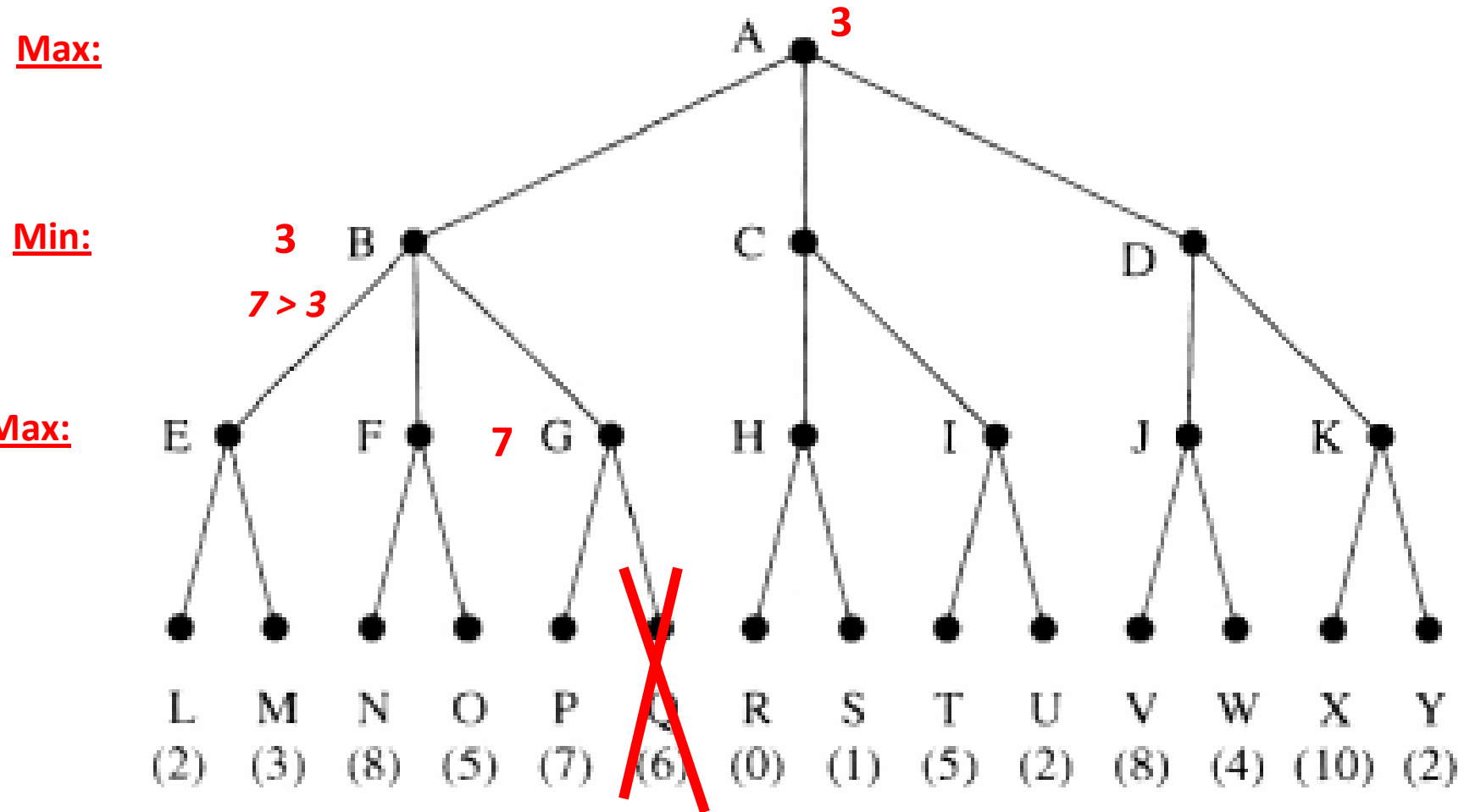
2.b Which nodes would not need be examined



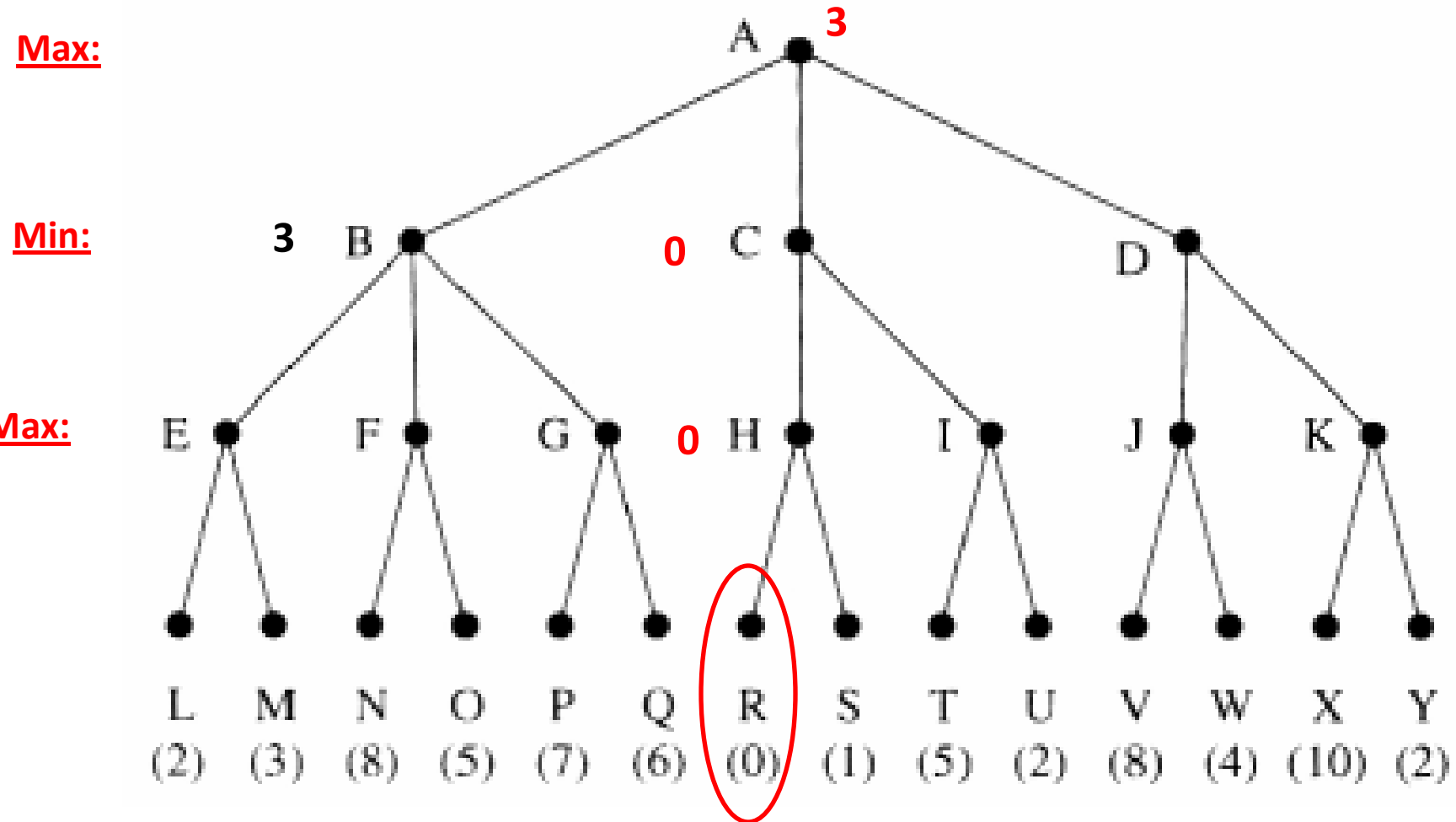
2.b Which nodes would not need be examined



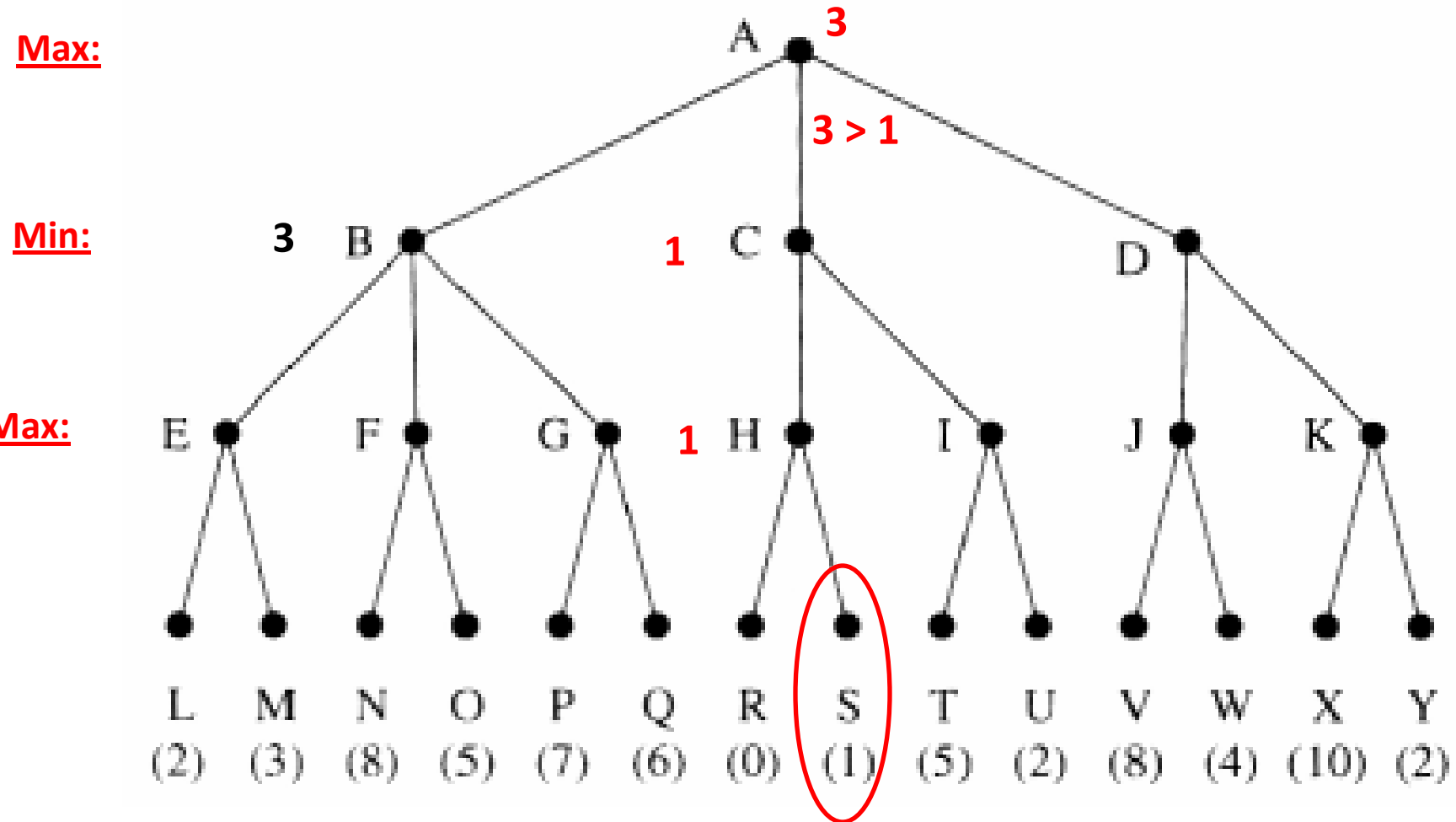
2.b Which nodes would not need be examined



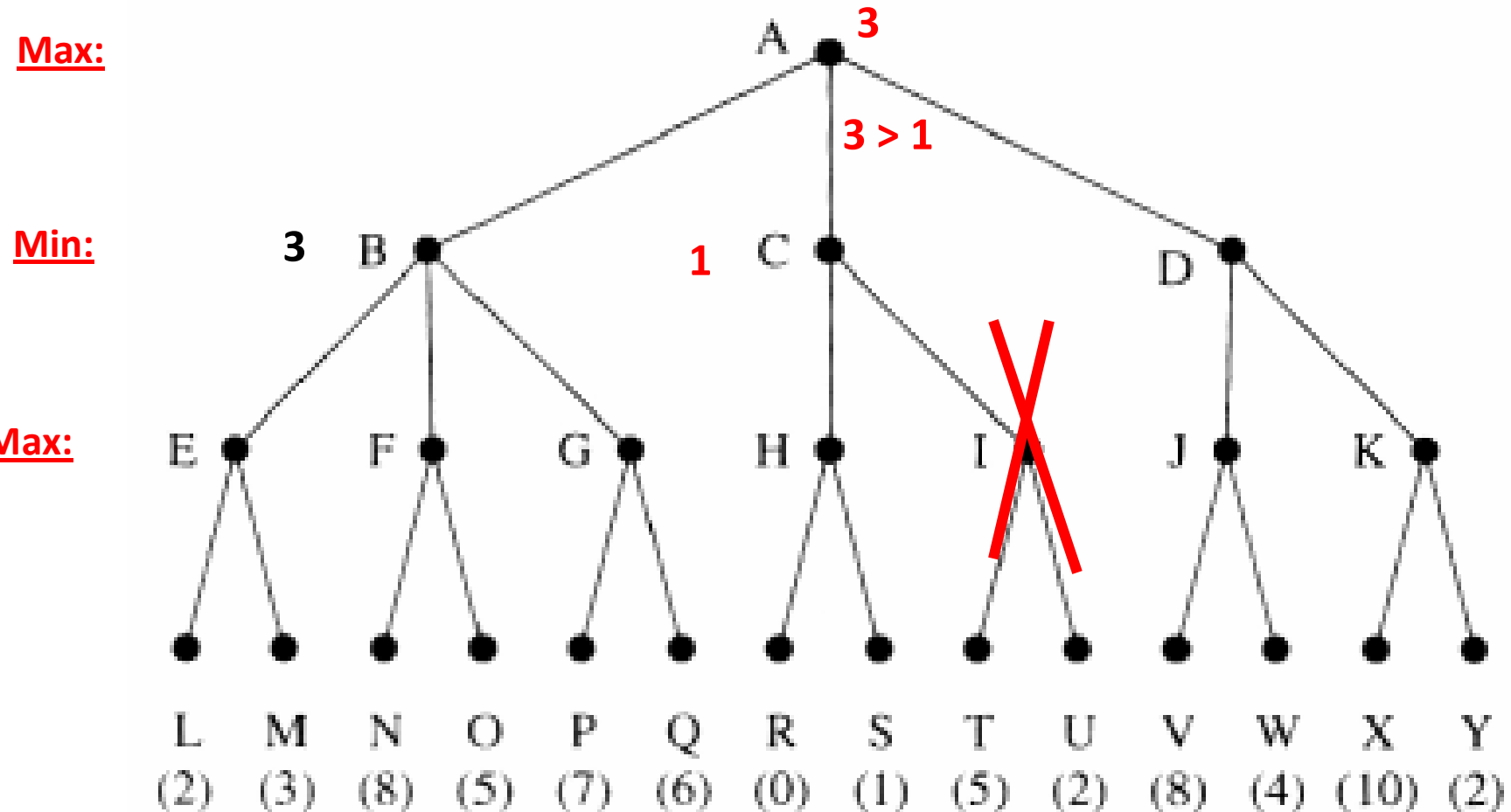
2.b Which nodes would not need be examined



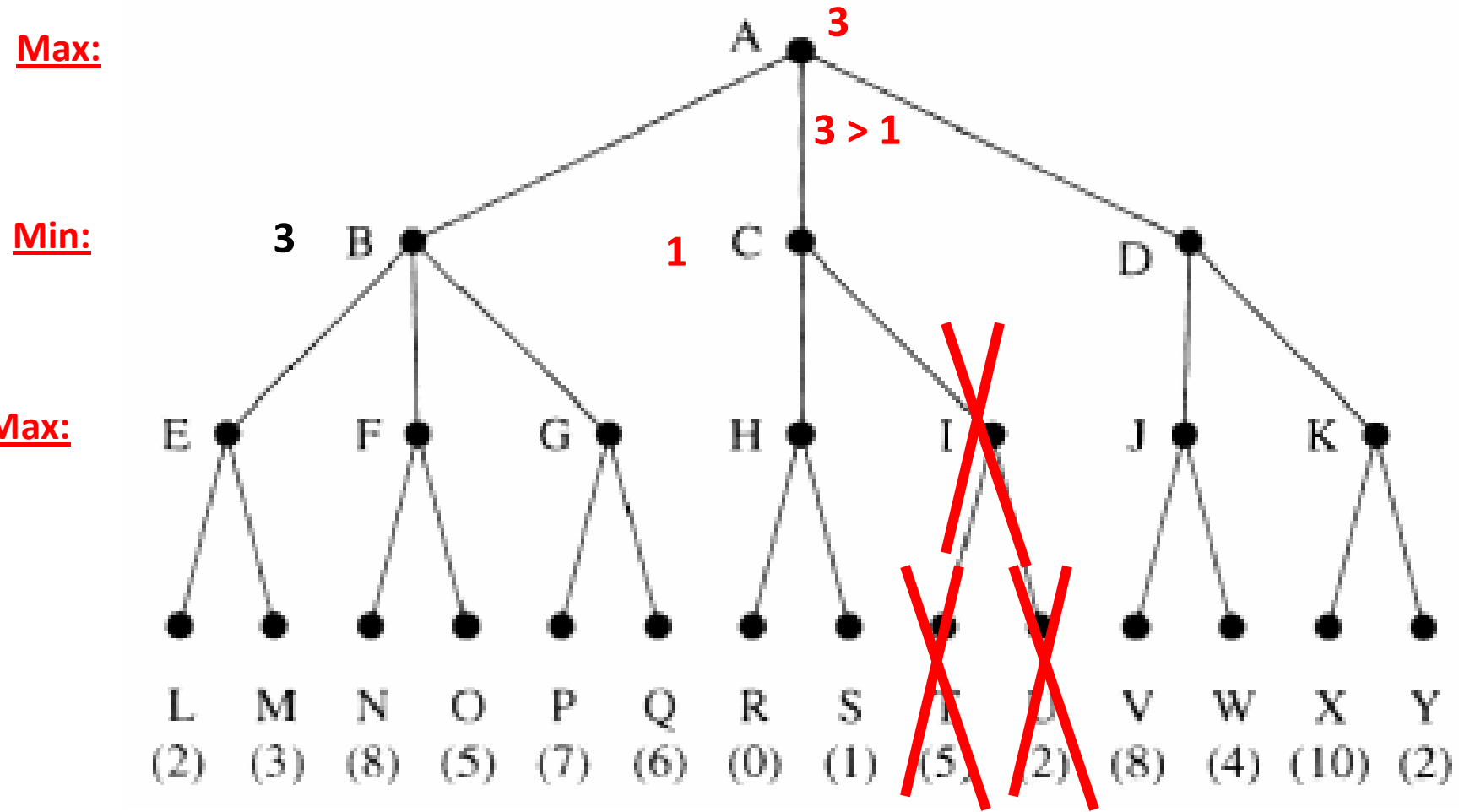
2.b Which nodes would not need be examined



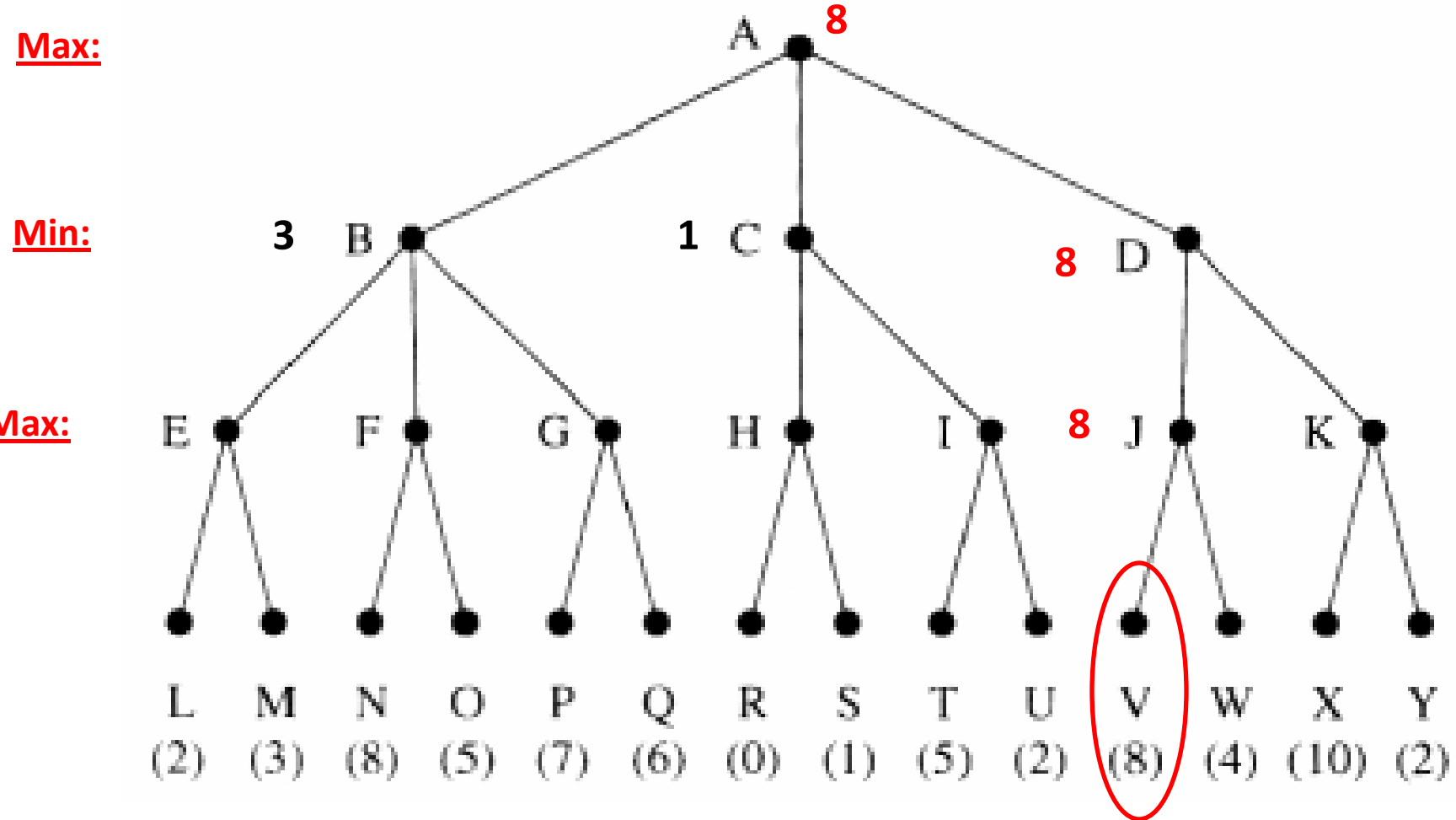
2.b Which nodes would not need be examined



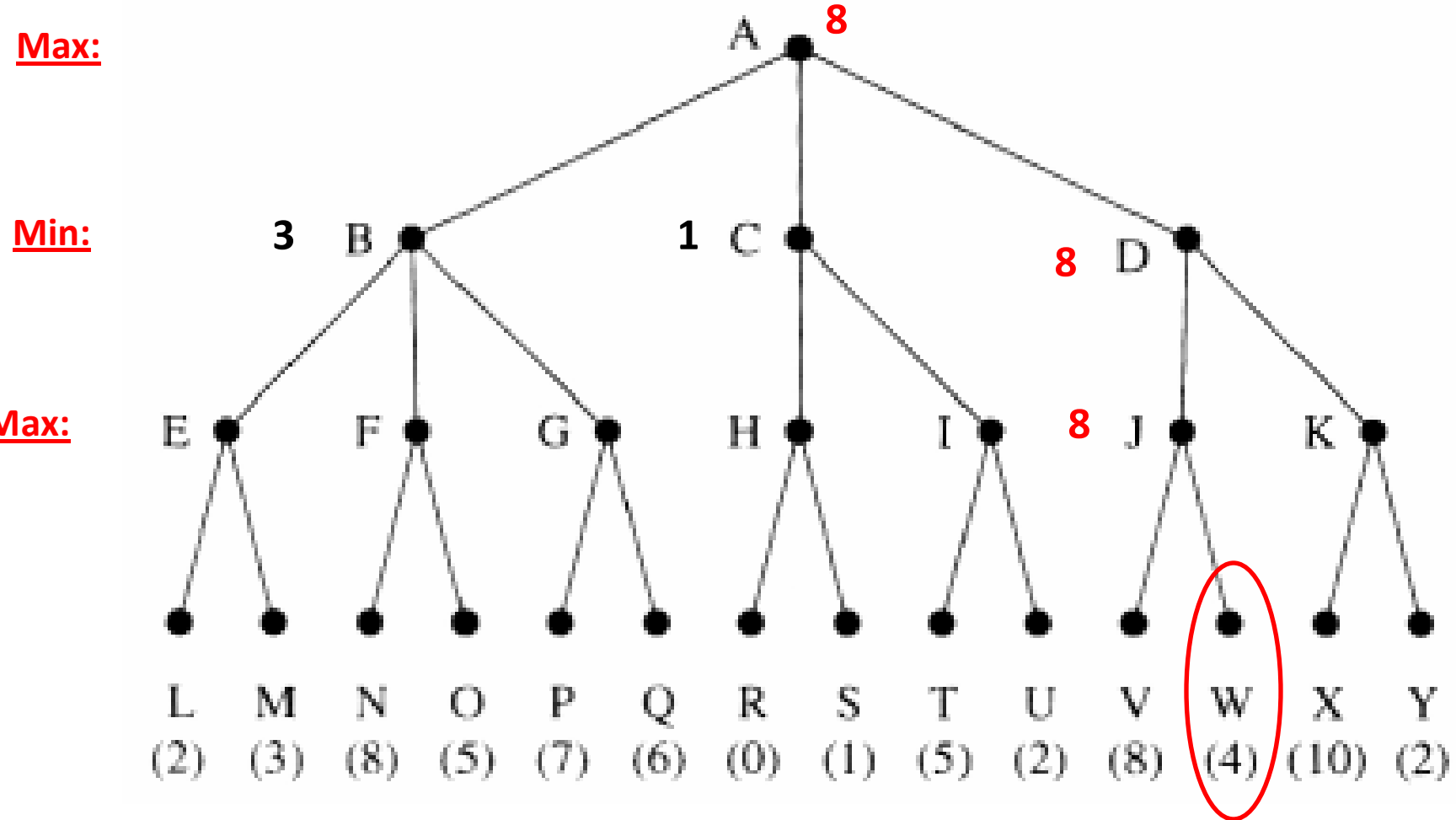
2.b Which nodes would not need be examined



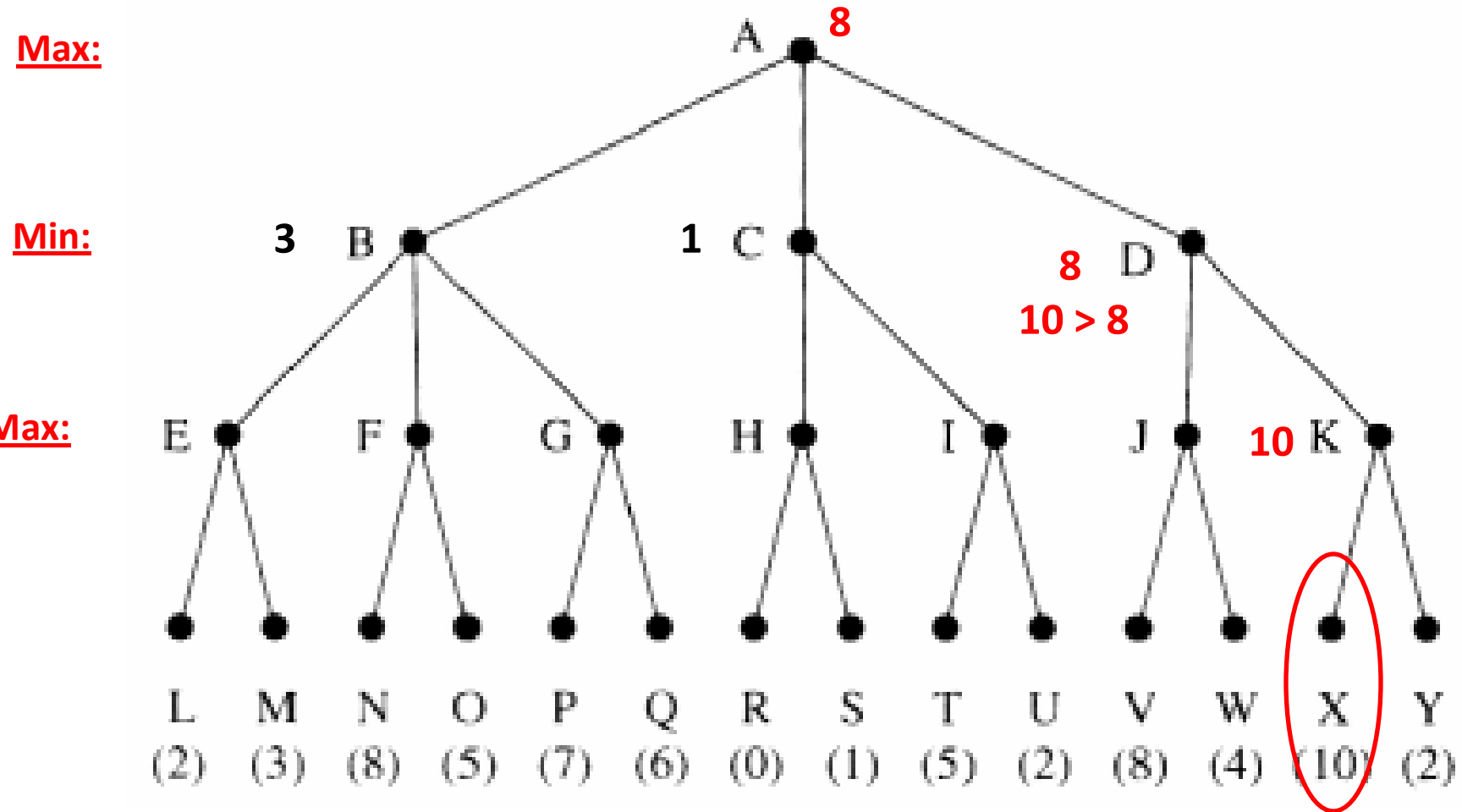
2.b Which nodes would not need be examined



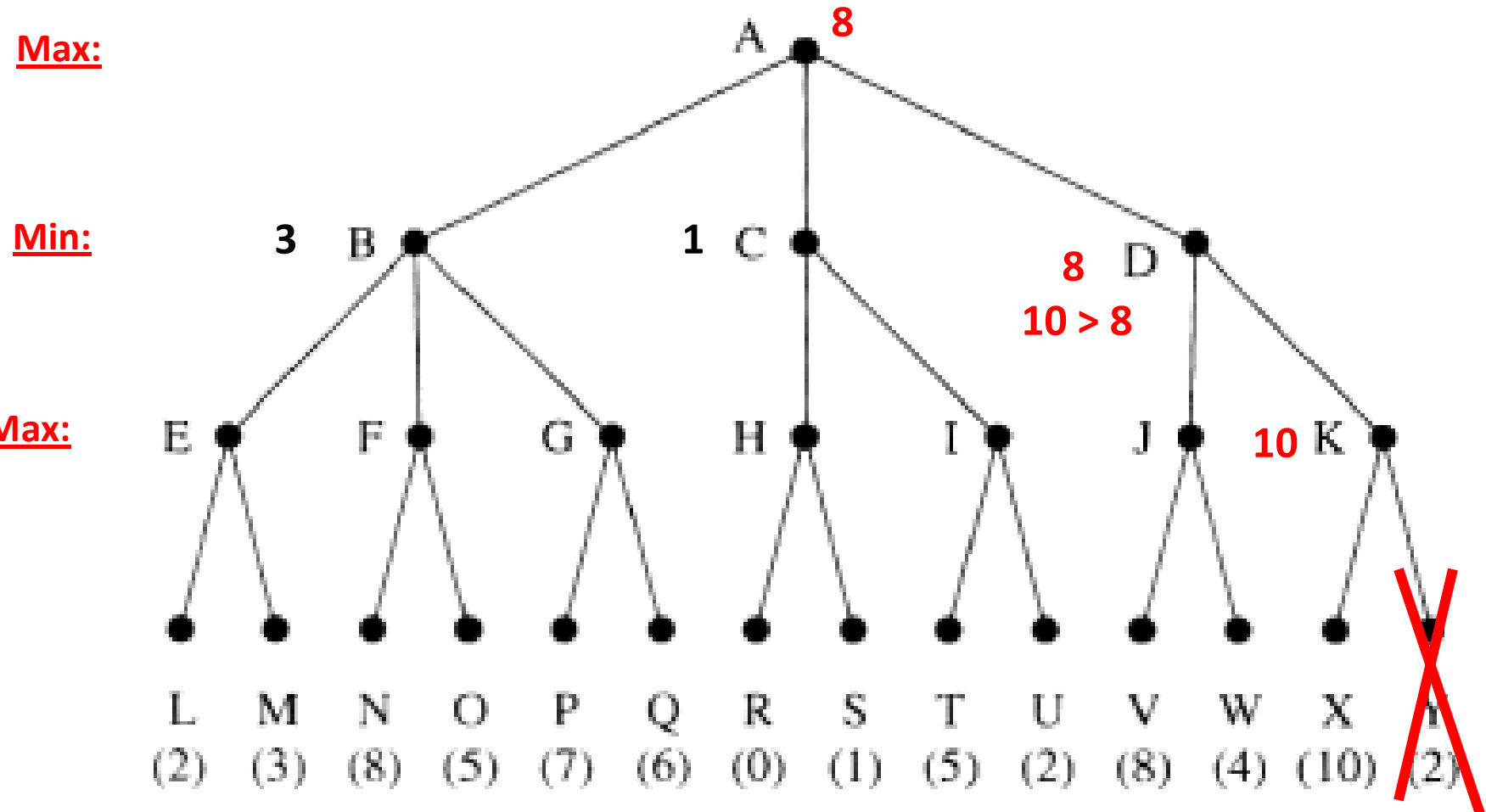
2.b Which nodes would not need be examined



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2.b Which nodes would not need be examined

Min:

Max:

