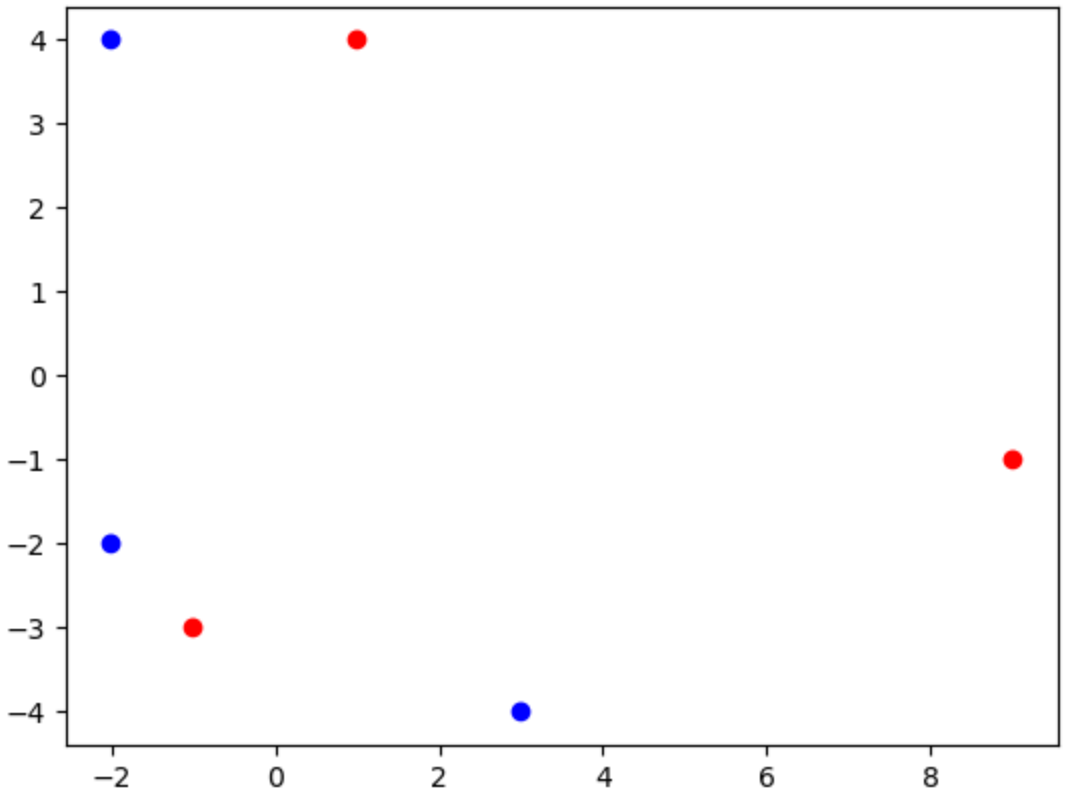
Consider training a decision tree on the data set shown below:

x_1	x_2	y
-1	-3	+
1	4	+
-2	4	-
3	-4	-
9	-1	+
-2	-2	-

When plotted, this data looks like:



The red points are from the positive class, while the blue points are from the negative class.

Which of the following questions will be made the root of the decision tree if we wish to minimize the uncertainty with respect to the Gini index?

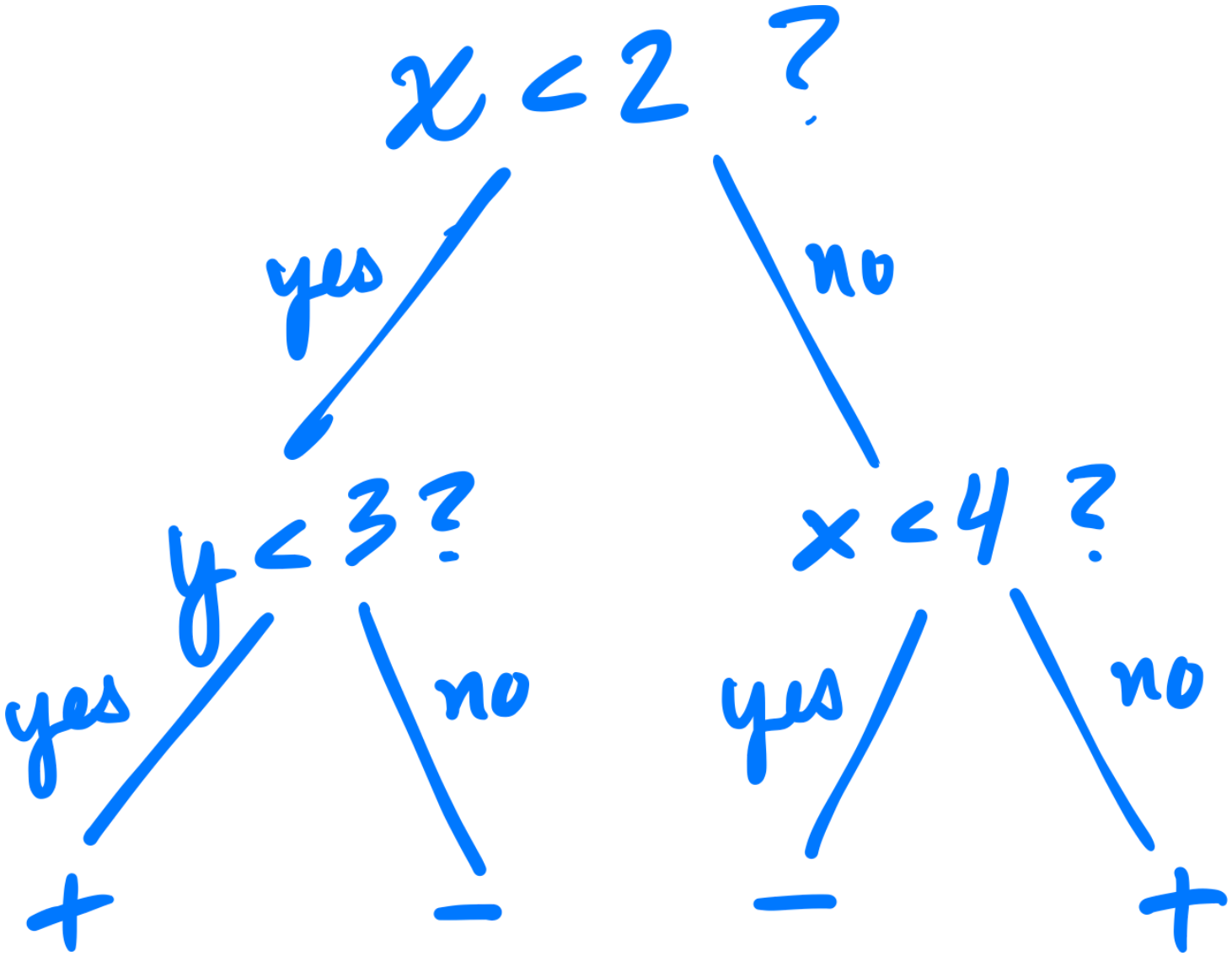
( ) Is $x_1 < -2.0$?
(x) Is $x_1 < -1.5$?
( ) Is $x_1 < 0.0$?
( ) Is $x_1 < 2.0$?
( ) Is $x_1 < 6.0$?
( ) Is $x_2 < -3.5$?
( ) Is $x_2 < -2.5$?
( ) Is $x_2 < -1.5$?
( ) Is $x_2 < 1.5$?
( ) Is $x_2 < 4.0$?

The question above splits the data into a left child node containing data for which the answer to the root question is "yes", and right child node containing data for which the answer to the root question is "no".

What question will be chosen to replace the right child node?

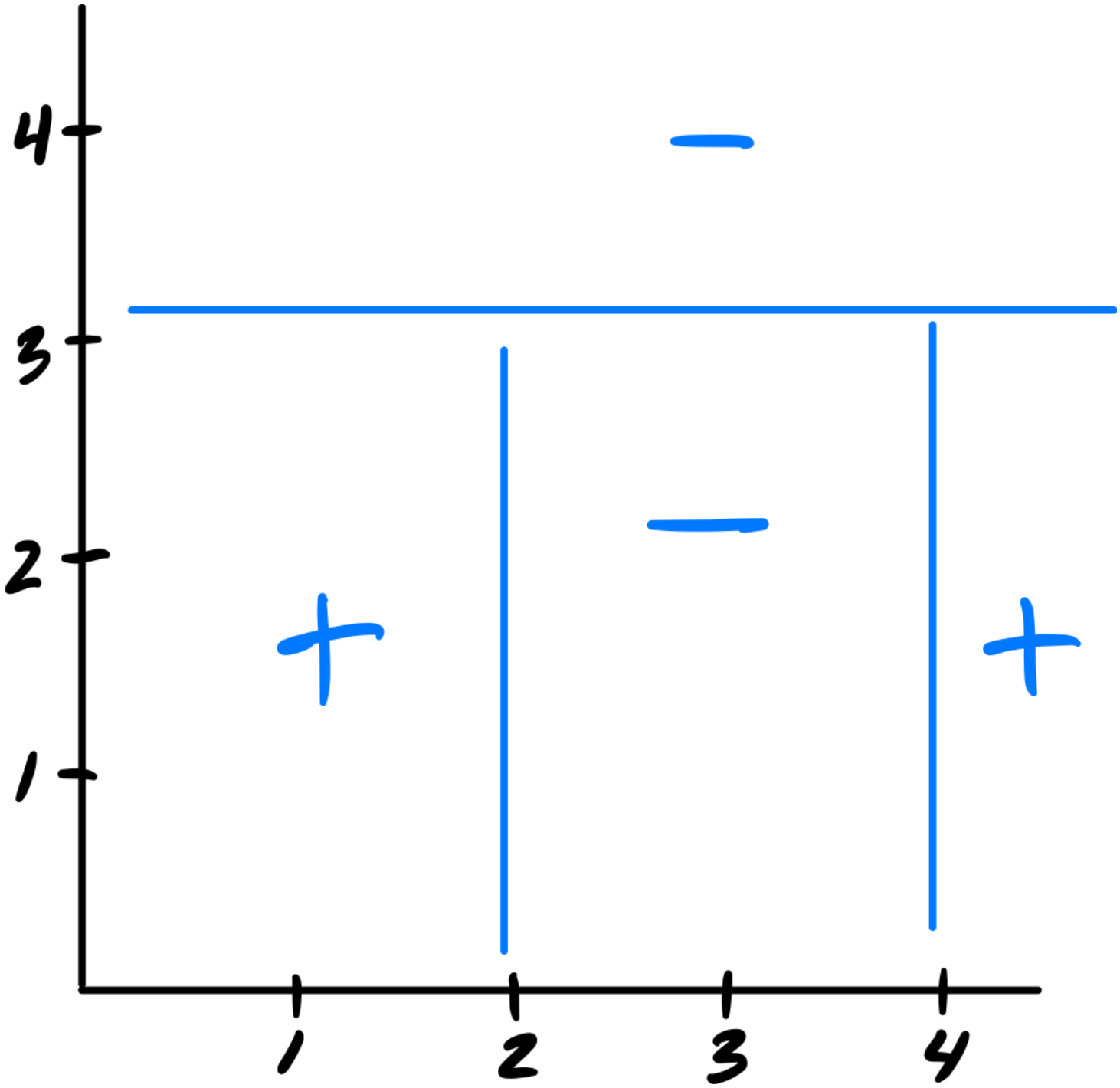
( ) Is $x_1 < -2.0$?
( ) Is $x_1 < -1.5$?
( ) Is $x_1 < 0.0$?
( ) Is $x_1 < 2.0$?
( ) Is $x_1 < 6.0$?
(x) Is $x_2 < -3.5$?
( ) Is $x_2 < -2.5$?
( ) Is $x_2 < -1.5$?
( ) Is $x_2 < 1.5$?
( ) Is $x_2 < 4.0$?

Consider the decision tree shown below.

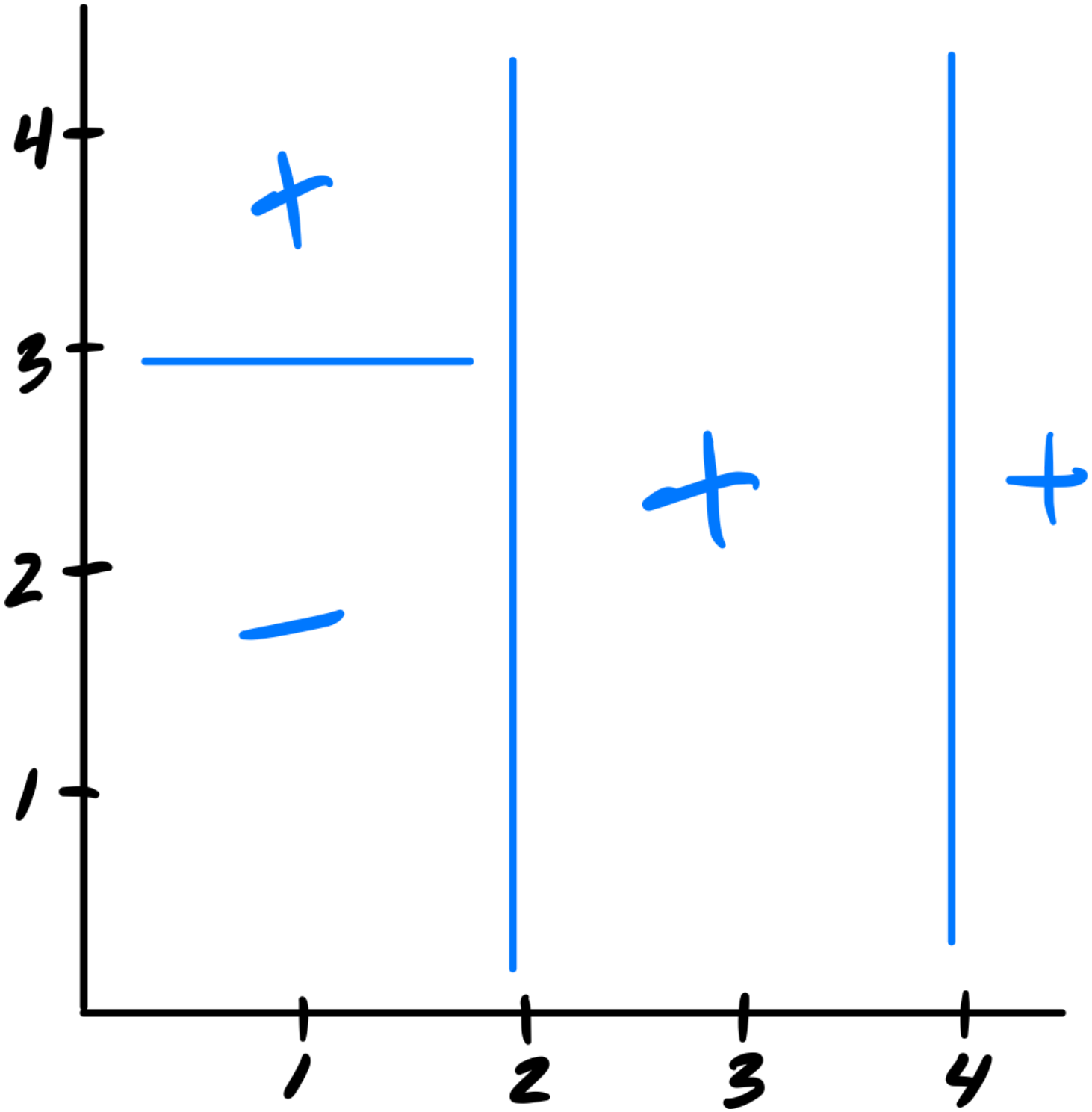


Which of the below shows its decision boundaries?

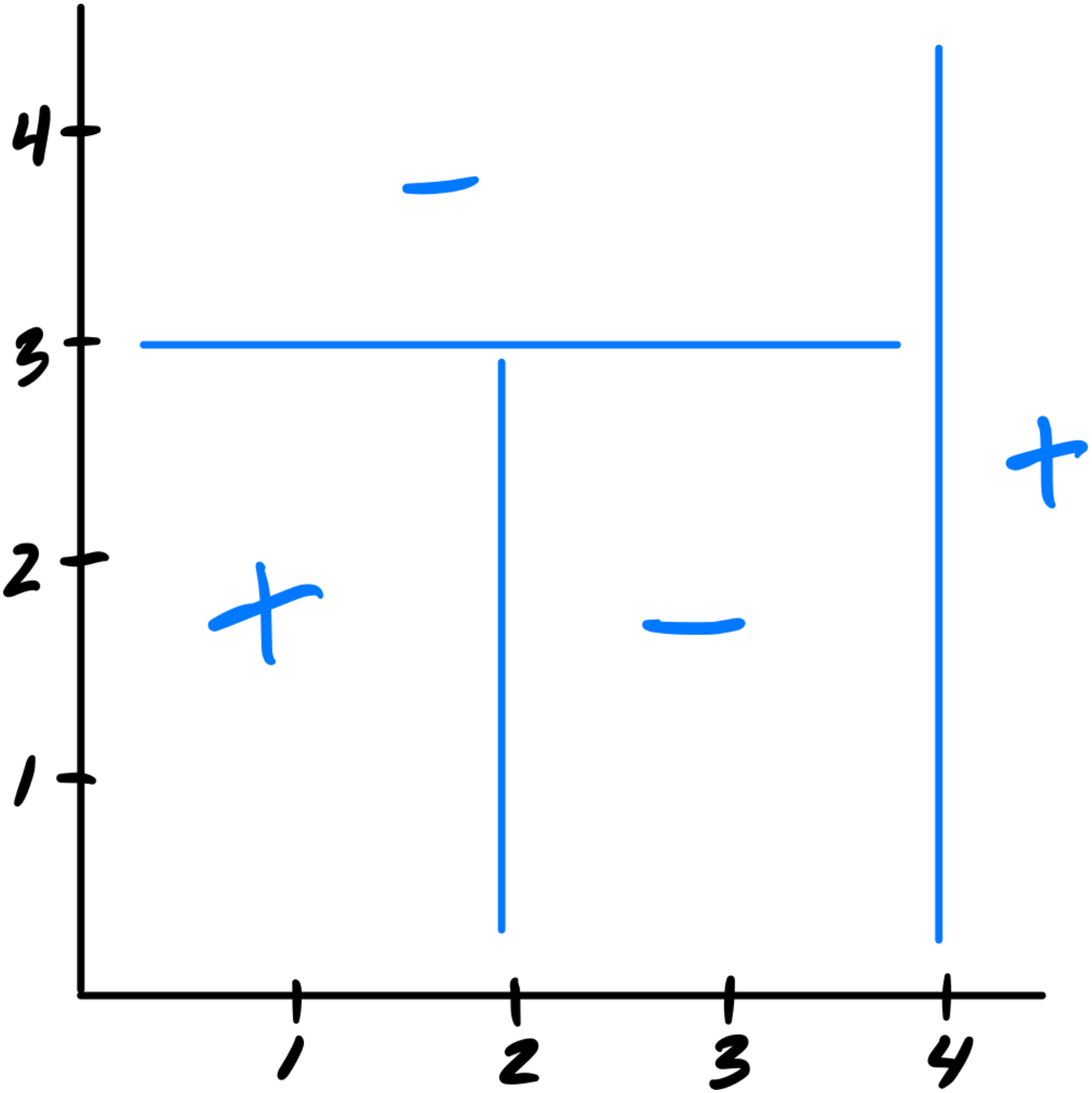
( )


4
3
2
1
−
−
+
+
1
2
3
4

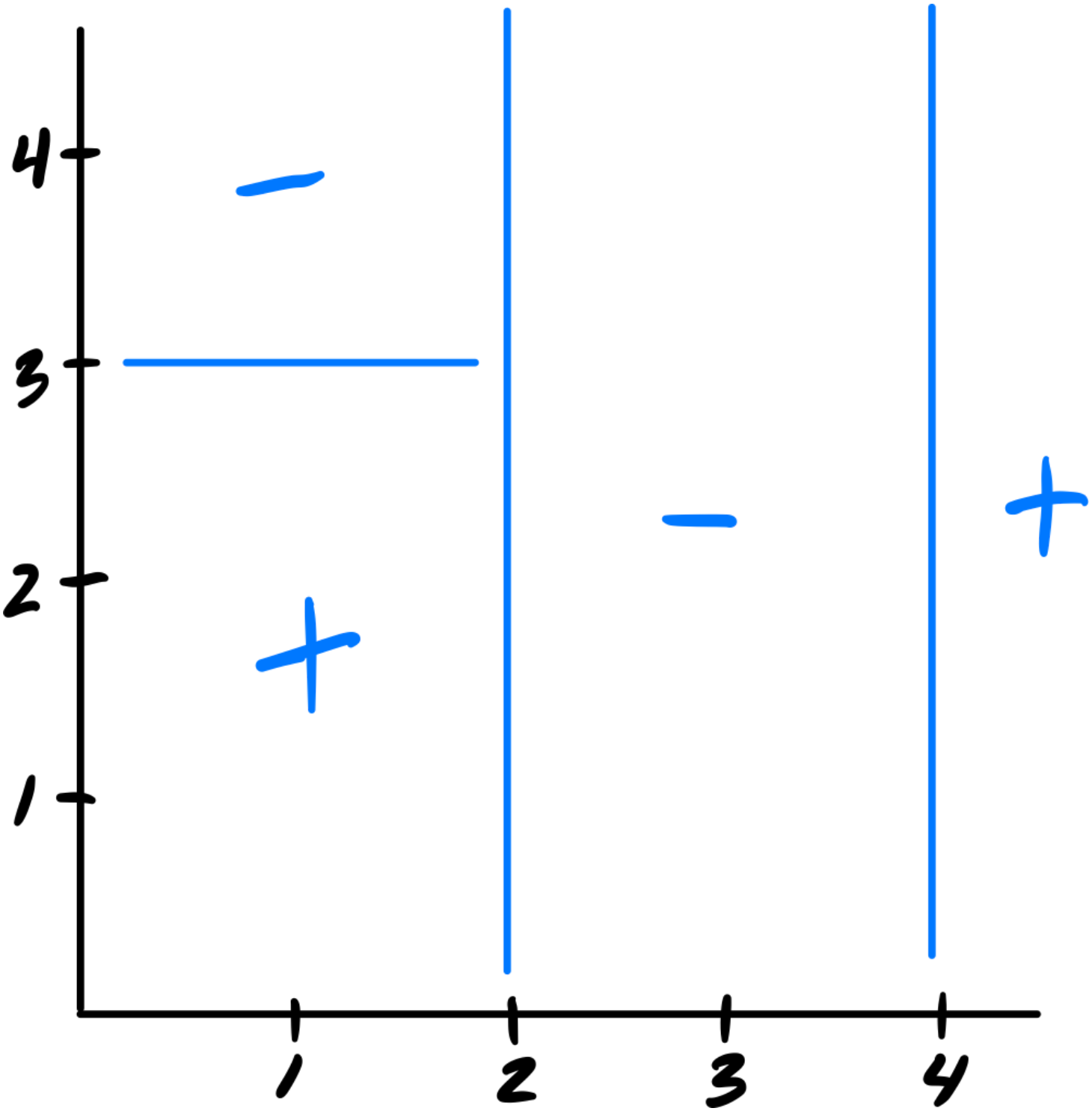
( )


4
3
2
1
+
−
+
+
1
2
3
4

( )



(X)



Suppose a feature has been used in a node in a decision tree. True or false: in the standard decision tree learning algorithm discussed in class, that feature can be used again in questions within the subtree rooted at that node.

(X) True

( ) False

Suppose a decision tree has been trained using the algorithm from lecture. Suppose the root node of a decision tree is the question $x_1 < 5?$. Can the left child (the child corresponding to the "yes" branch) chosen by the training algorithm be the question $x_1 < 10?$

( ) Yes
(x) No

Suppose a decision tree has been trained using the algorithm from lecture. Suppose the root node of a decision tree is the question $x_1 < 5?$. Can the left child (the child corresponding to the "yes" branch) chosen by the training algorithm be the question $x_1 < 1?$

(x) Yes
( ) No

Suppose that boosting has been used to train the following four decision stumps:

$$H_1(\vec{x}) = \begin{cases} 1 & x_1 \geq 3 \\ -1 & \text{otherwise} \end{cases}$$
$$H_2(\vec{x}) = \begin{cases} -1 & x_2 \geq 1 \\ 1 & \text{otherwise} \end{cases}$$
$$H_3(\vec{x}) = \begin{cases} -1 & x_2 \geq -2 \\ 1 & \text{otherwise} \end{cases}$$
$$H_4(\vec{x}) = \begin{cases} 1 & x_1 \geq 4 \\ -1 & \text{otherwise} \end{cases}$$

Assume that the "performance" of each decision stump was $\alpha_1 = 2$, $\alpha_2 = 5$, $\alpha_3 = 1$, $\alpha_4 = 10$.

Suppose $\vec{x} = (2, 3)$. What does the overall boosting classifier $H(\vec{x})$ predict for this point?

( ) Class 1
(X) Class -1