2.1

Text, letter

Description automatically generated

2.2

For N=4, we can pick points: (1,3),(2,4),(3,1),(4,2). It's easy to see that these points are shattered by positive rectangles. So mH(4)=24.

The idea is that for any two points, if we draw a rectangle using them as diagnoal points, the rectangle should NOT contain any other point. Otherwise, whenever the two diagnoal points have values 1, the middle point will have value 1 as well, which excludes the possibility of having -1.

For N=5, if we draw horizontal and vertical lines through each of the four points above, the plane is divided into grids. The four points enclusing a 9-grid area. It's clear that the fifth point can't lie within the 9-grid area. Otherwise, there'll always a rectangle (constructed by two points) contains the fifth point.

In the same way, if we place the fifth point outside the 9-grid area, it's easy to see that the point will always lie below or above at least two points (in either x or y direction). These three points construct a rectangle which contains a point in it. This shows that mH(5)<25.

We have the VC dimension dVC(H)=4, and mH(N)≤∑i=04(Ni).

2.3

Text, letter

Description automatically generated

2.4

Text

Description automatically generated

Sample Size: 45290

2.5

Text, letter

Description automatically generated

Text, letter

Description automatically generatedText, letter

Description automatically generatedText, letter

Description automatically generated

2.6

To show that k is a break point for H, we need to show H cannot shatter any

set of k points x1, xk.

• If k is a break point, then mH (k) < 2k,

• In general, it is easier to find a break point for H than to compute the full

growth function for that H.

• So the correct option is (d)

2.7

Text, letter

Description automatically generated

Text, letter

Description automatically generated

2.8

Text, letter

Description automatically generated

Text, letter

Description automatically generated