

# Universal Law of Generalization

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



- Let's say I eat this leaf, and I feel sick.



- What other leaves might I avoid?



- What other leaves might I avoid?



- There is a “consequential region” of different possible objects that satisfy the property of being sickness-inducing leaves.
- I have generalized the property to other leaves.





- The region basically tells you how generalizable a property is
- A bigger region will mean there are more objects that share that property

# Property: being able to reach things on a high shelf

The consequential region (spread of objects that have this property) might be easy to estimate here



The celebrities would be considered objects that may/may not be in the region.

# Property: being able to reach things on a high shelf

The consequential region (spread of objects that have this property) might be easy to estimate here

But sometimes it might not be obvious.



The celebrities would be considered objects that may/may not be in the region.



# Which animals have the T-9 hormone?



- Let's say you know canaries have T-9 hormones.

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

# Which animals have the T-9 hormone?



- Let's say you know canaries have T-9 hormones.
- What other animals might have them?

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

# Which animals have the T-9 hormone?

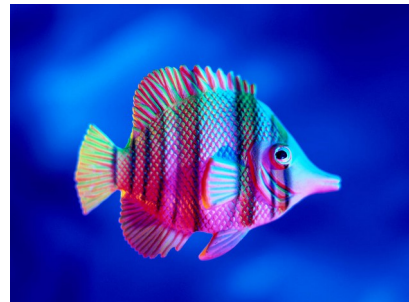
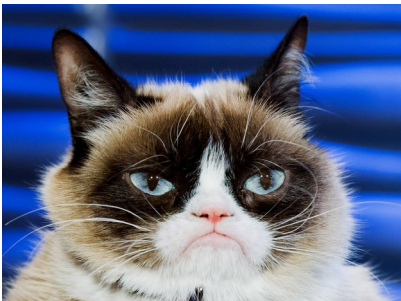
- Let's say you know canaries have T-9 hormones.



Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



# Which animals have the T-9 hormone?

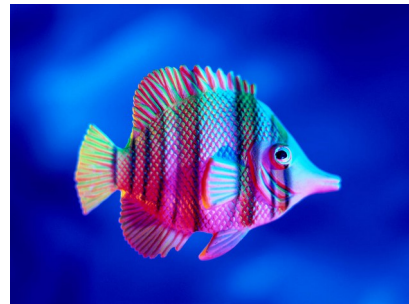
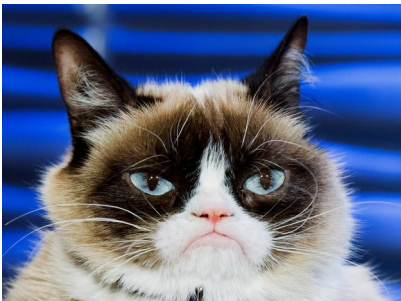


- Let's say you know canaries have T-9 hormones.
- What other animals might have them? It's not obvious which objects (animals) are in the region R (which has the property "animals that have the T-9 hormone"). The spread of the consequential region, or the number of objects/animals that share this property, is not obvious.

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder





2. [10pts, HELP] What is the probability of getting  $x=1$  for regions containing  $x=0$ ?

You can think of it as:



- A canary ( $x=0$ ) has the T-9 hormone
- The canary is in a region  $R$  where all objects in  $R$  share the property of having a T-9 hormone
- You don't know the exact spread of the region  $R$
- But there are different possible hypothetical regions,  $R$ , and say the canary ( $x=0$ ) is in all of them.

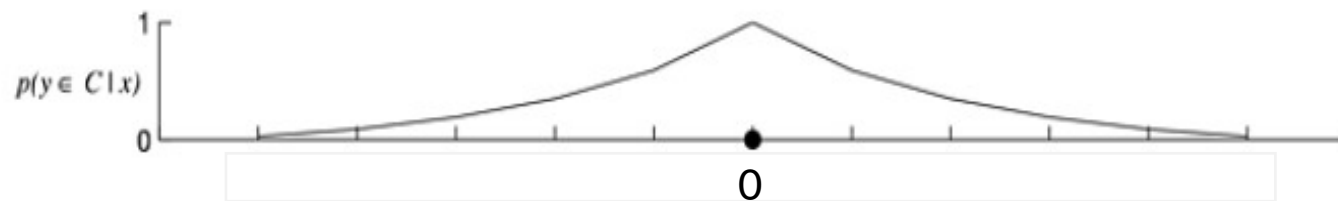
Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



- What's the probability that a robin ( $x=1$ ) has a T-9 hormone?
- What's the probability that a robin is in the  $R$  of objects that have the property of having a T-9 hormone (the region to which canary,  $x=0$ , belongs)?



$|I| = 1$  ☐

0

$|I| = 2$  ☐

$|I| = 3$  ☐

$|I| = 4$  ☐

$|I| = 5$  ☐

$|I| = 6$  ☐

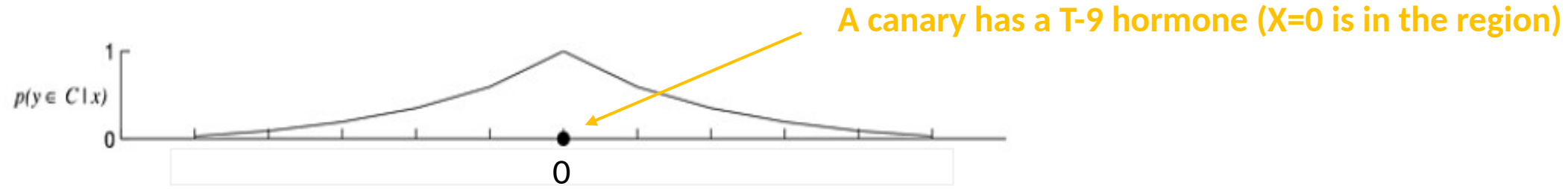
Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

X axis: different objects that are arranged by just one feature.

Y axis: probability  $y$  is in a region given that  $x$  is in a region



$|H| = 1$



$|H| = 2$



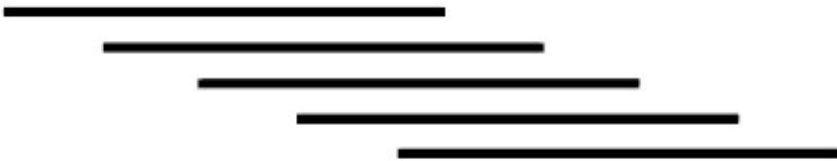
$|H| = 3$



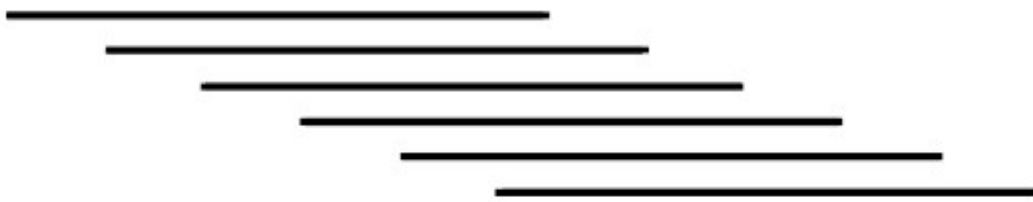
$|H| = 4$



$|H| = 5$



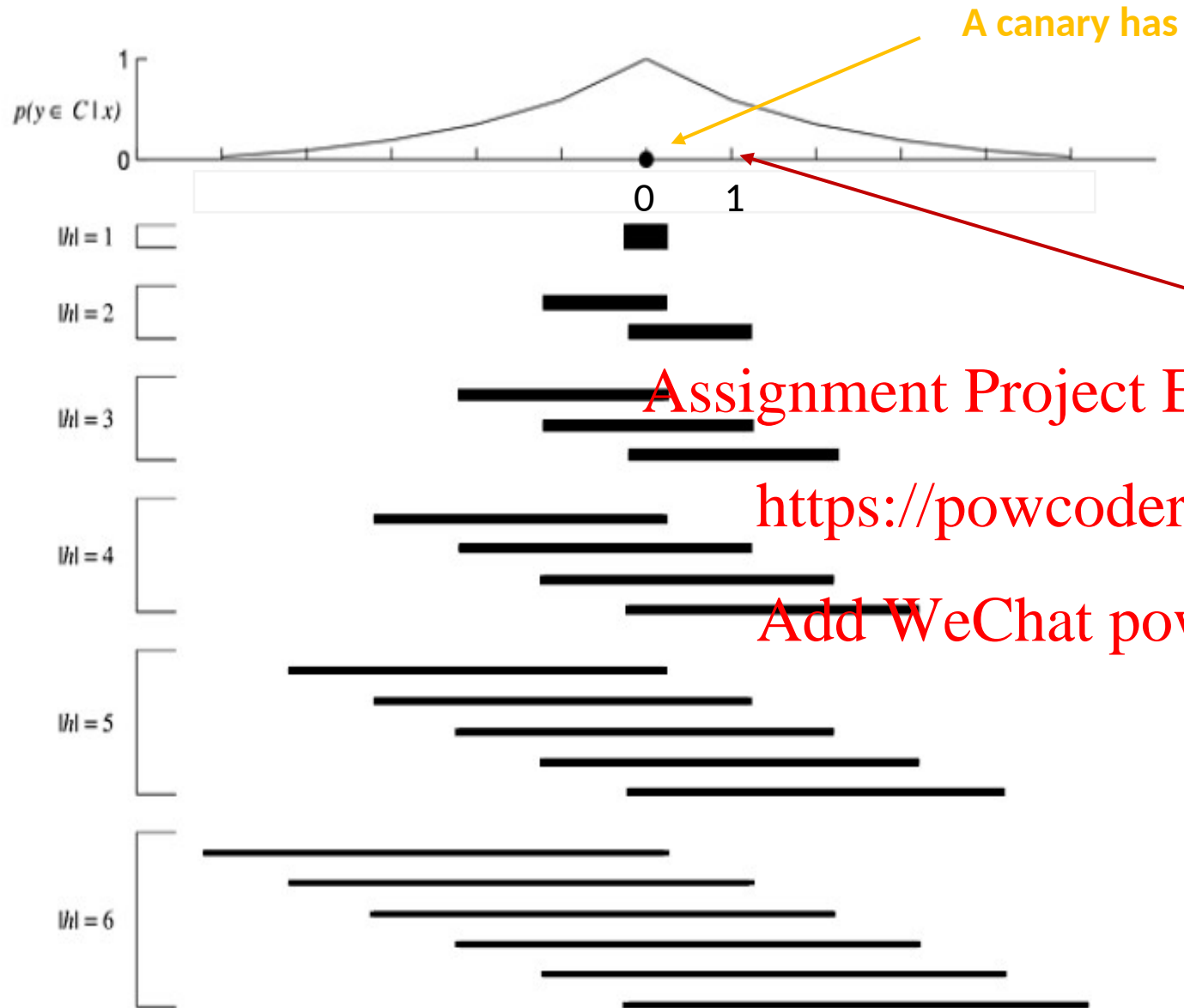
$|H| = 6$



Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



A canary has a T-9 hormone ( $X=0$  is in the region)

What's the probability that a robin is in the region of "animals that have a T-9 hormone"?

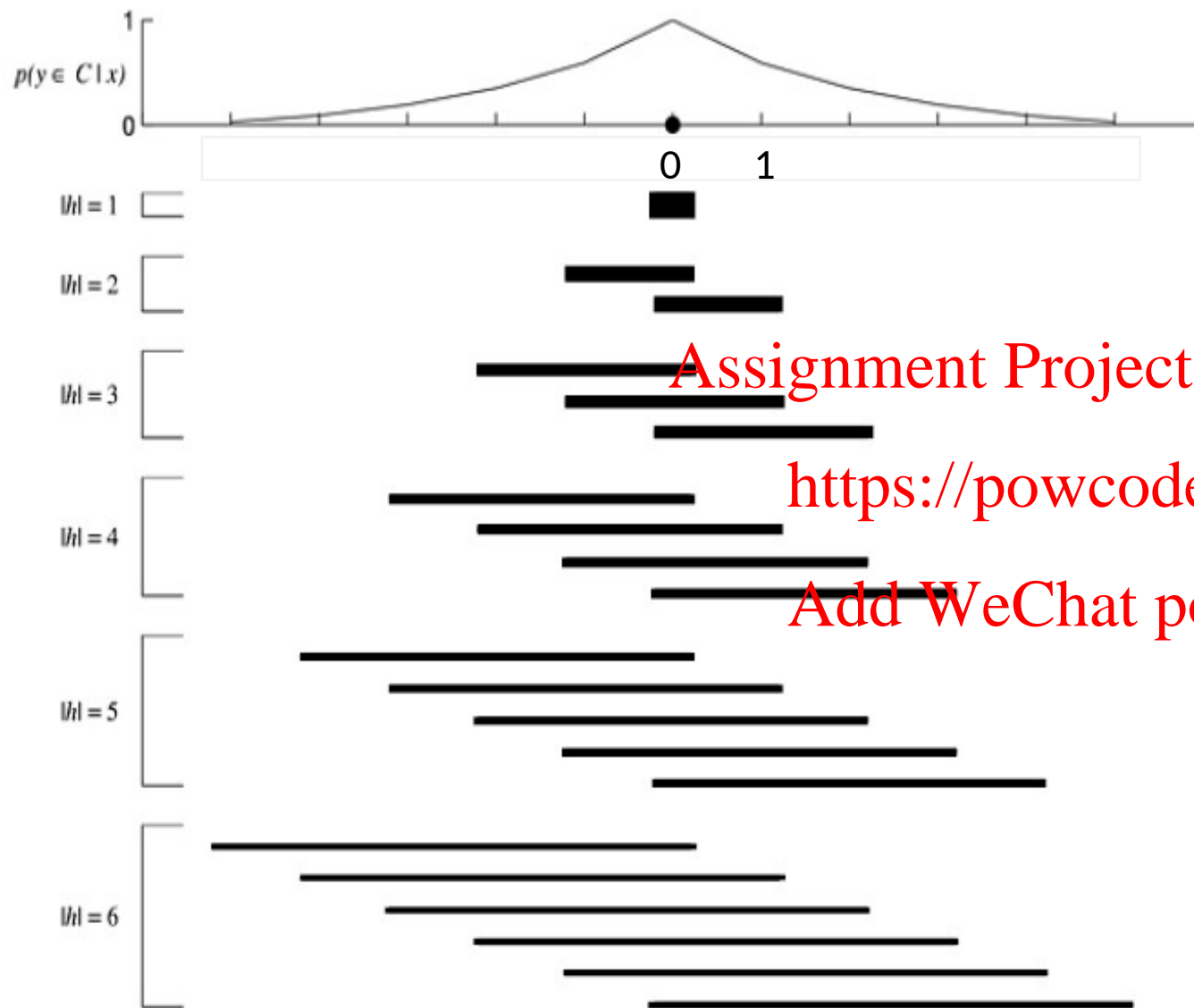
Assignment Project Exam Help

(What's the probability that  $X=1$  is in the region given that  $X=0$  is in the region?)

<https://powcoder.com>

Add WeChat powcoder

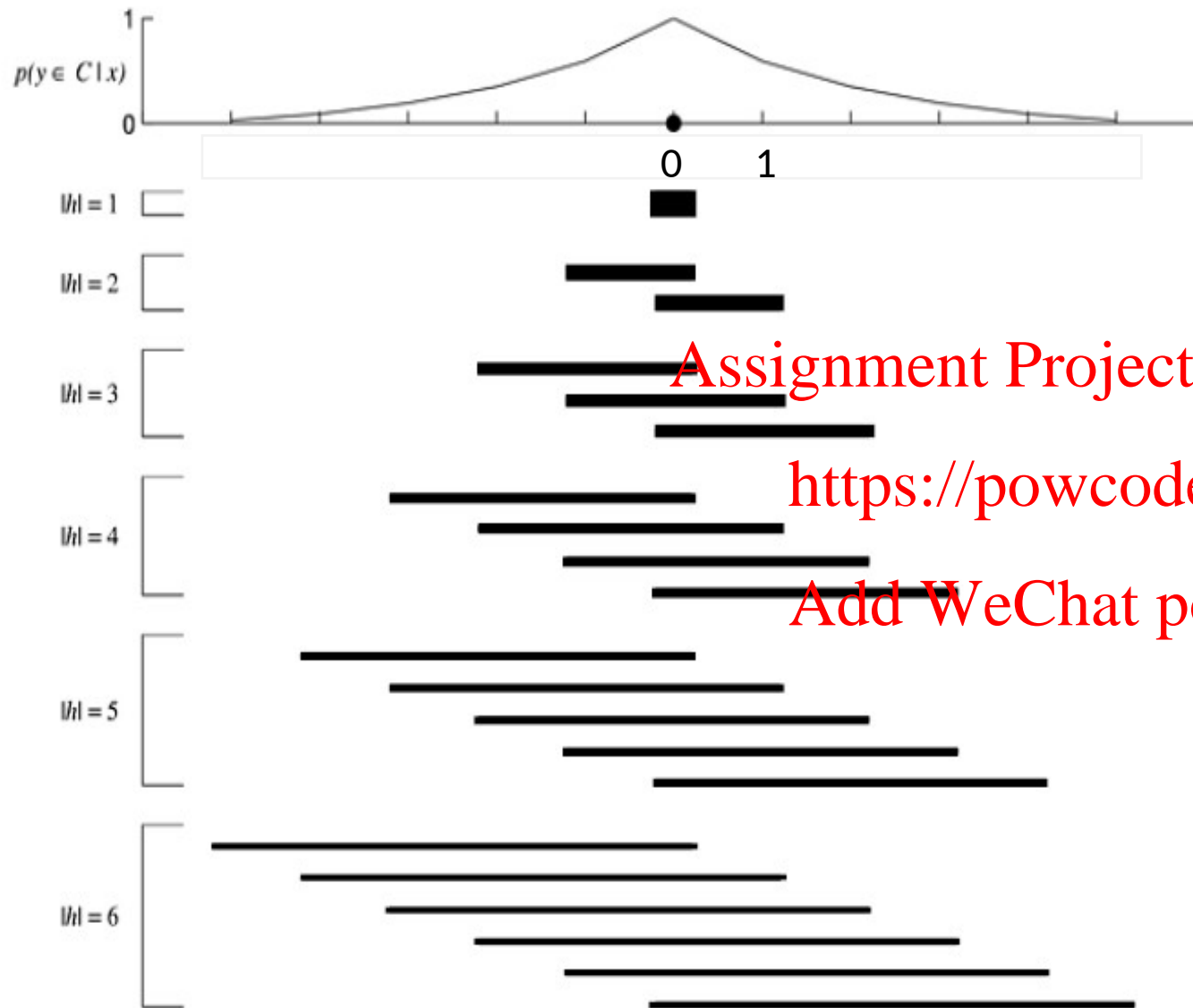




Here, we don't know what the spread of the consequential region will be.

These black bars are all possible spreads of the CR, generated randomly

(Note that if you are instructed to find the probability of getting  $x=1$  for regions containing  $x=0$ , you need to make sure all your regions contain  $x=0$ )



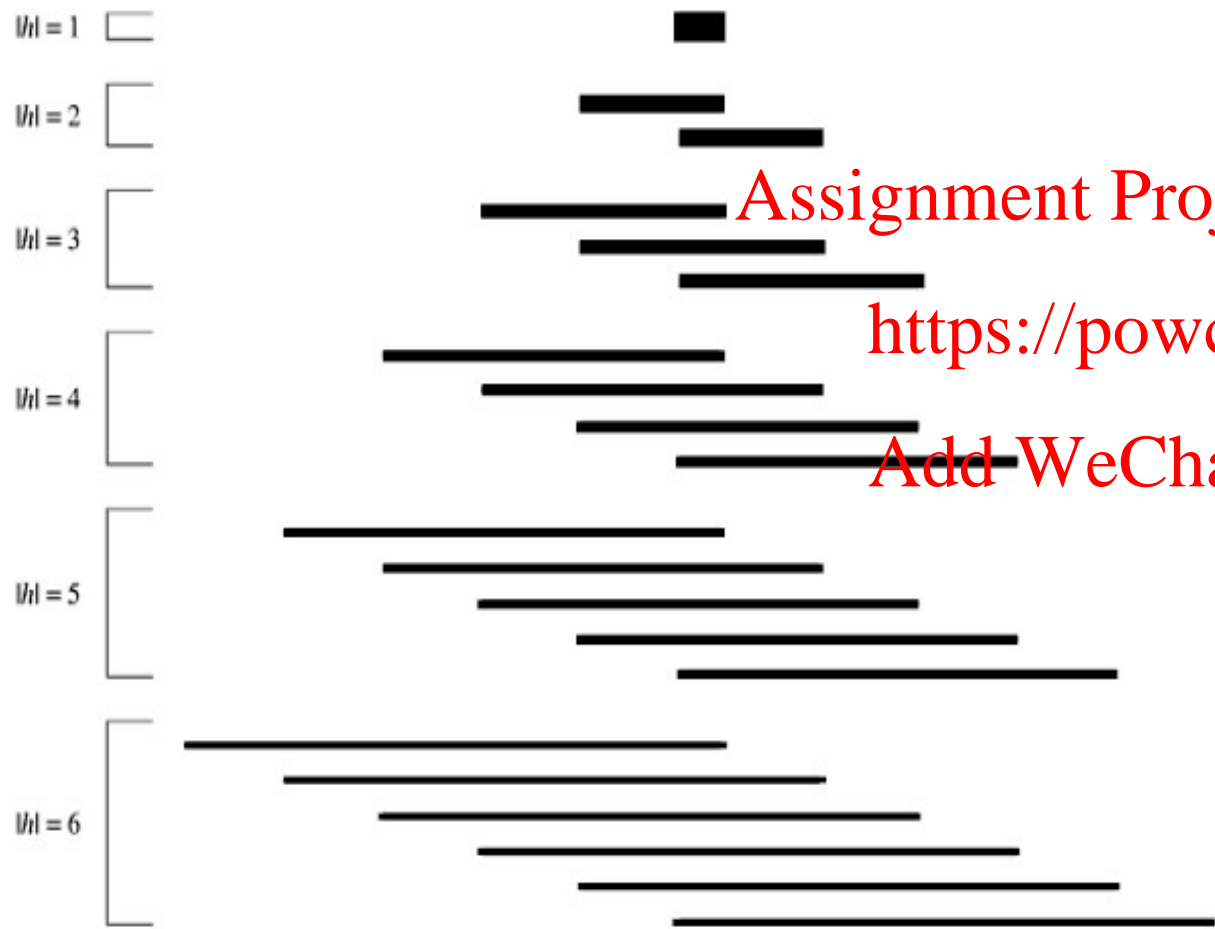
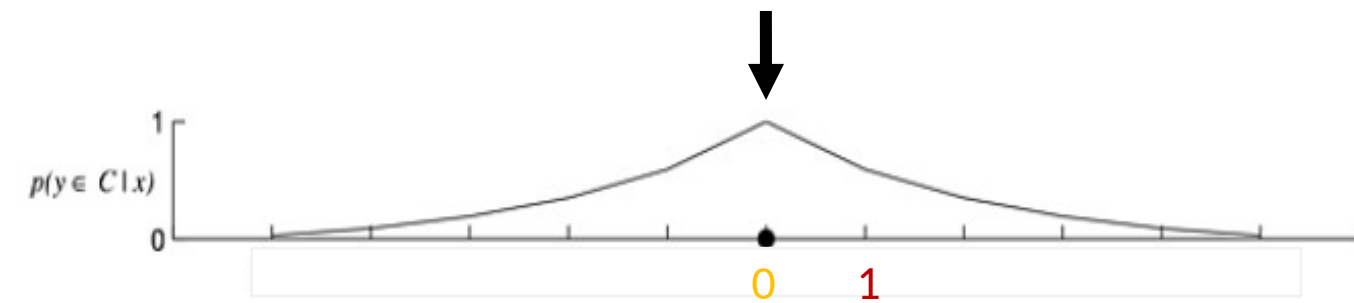
Because we don't know what the true spread of the consequential region (property: animals that have a T-9 hormone) is, we will use all these possible Rs to determine the probability that  $x=1$  (or "robin") is included in that region.

# So how do we actually determine this?

Assignment Project Exam Help

2. [10pts, HELP] What is the probability of getting  $x=1$  for regions containing  $x=0$ ?

<https://powcoder.com>  
Add WeChat powcoder



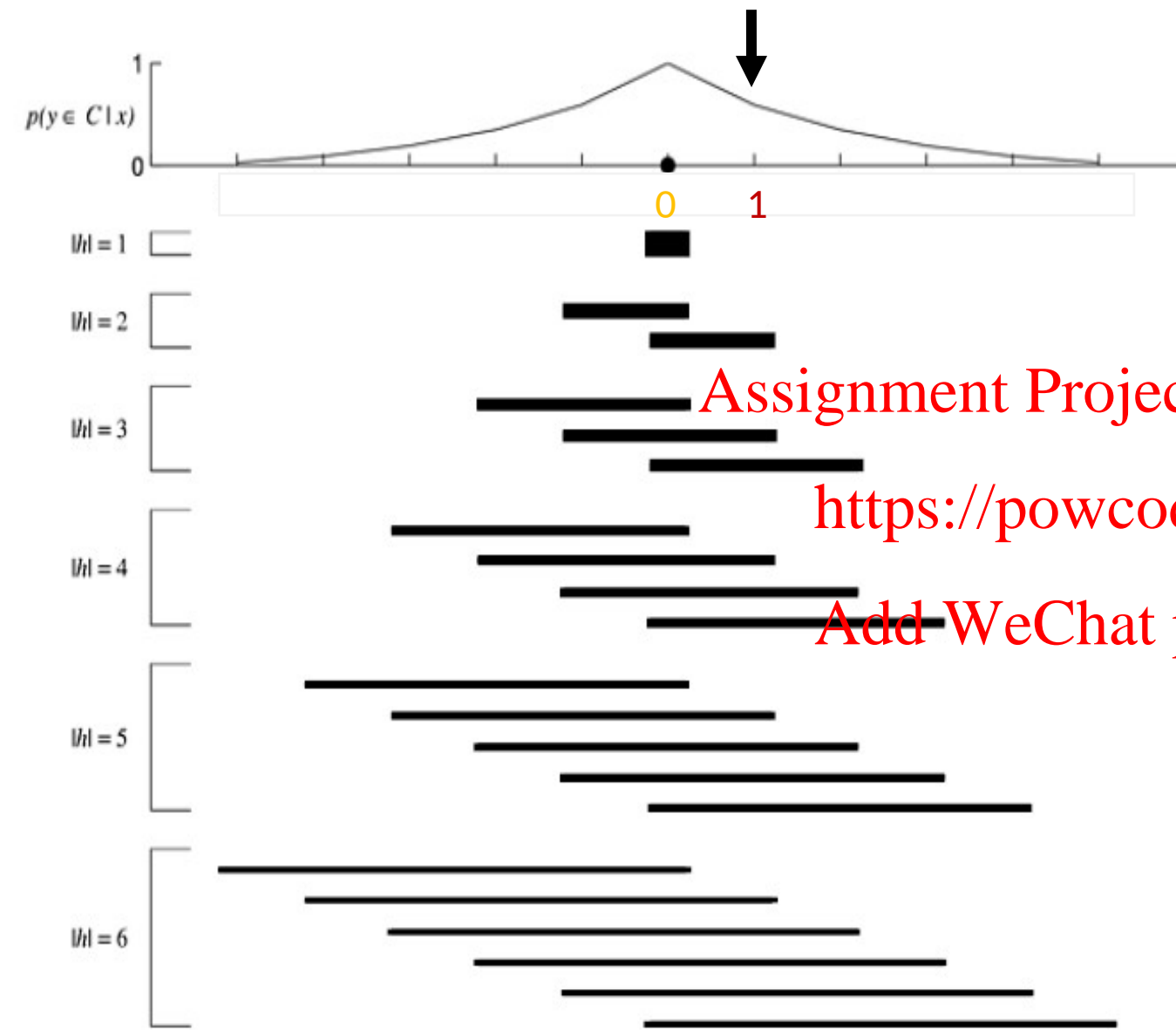
- This graph can tell you the relative probabilities of the different objects within it
- **Canary**, at 0, has the highest probability.

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



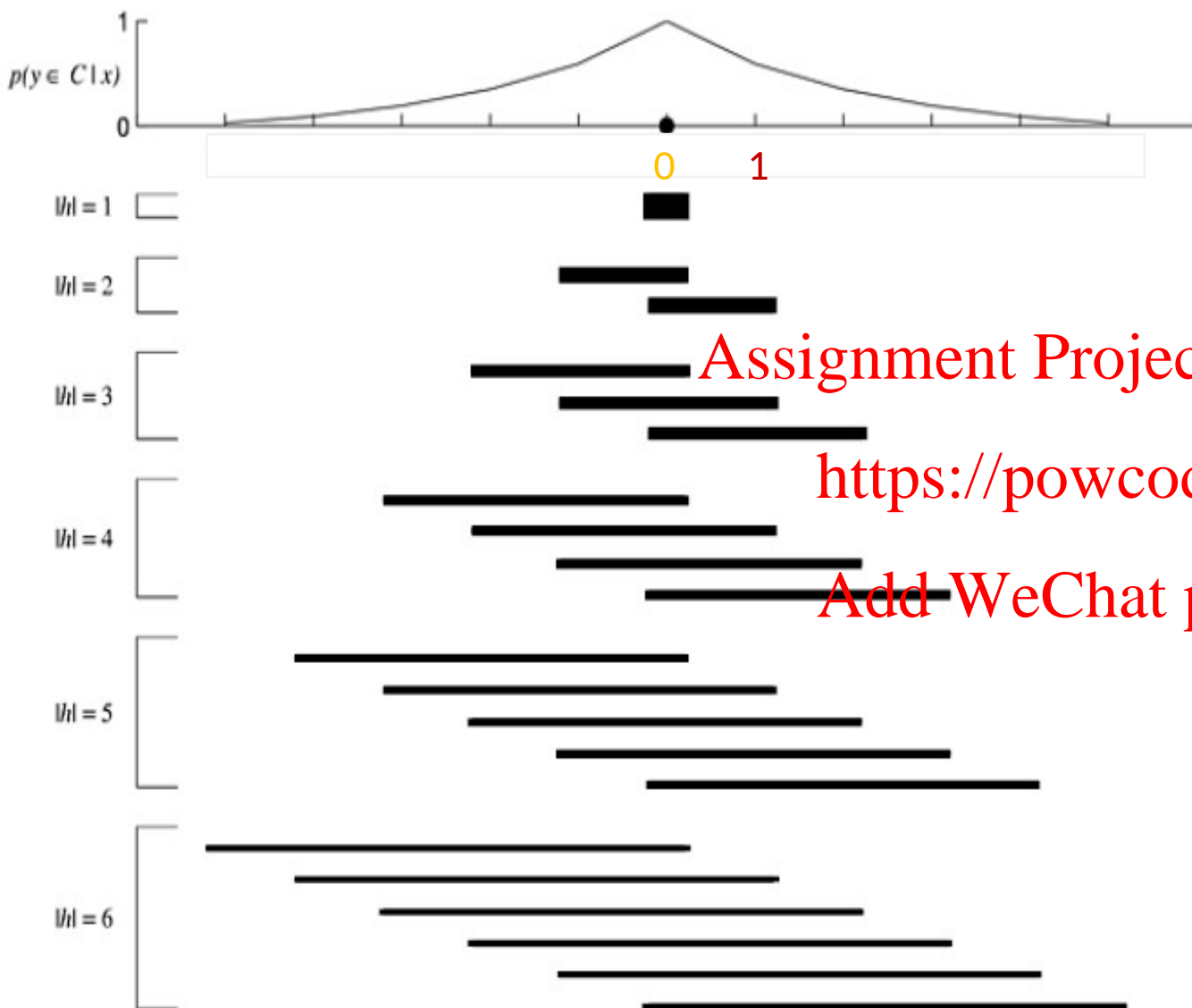


- This graph can tell you the relative probabilities of the different objects within it
- **Canary**, at 0, has the highest probability. **Robin**, at 1, has a slightly lower probability, and so on.

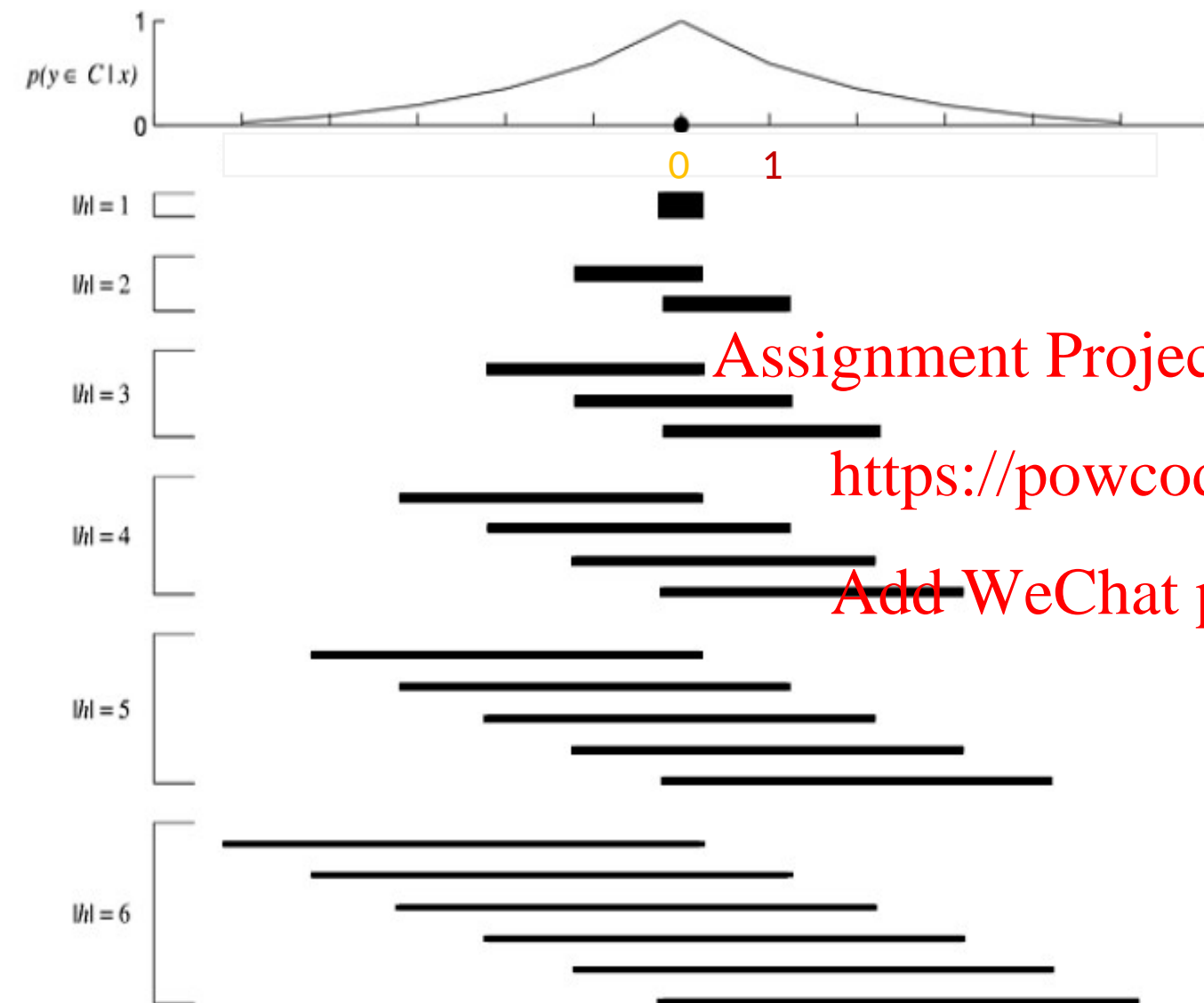
Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



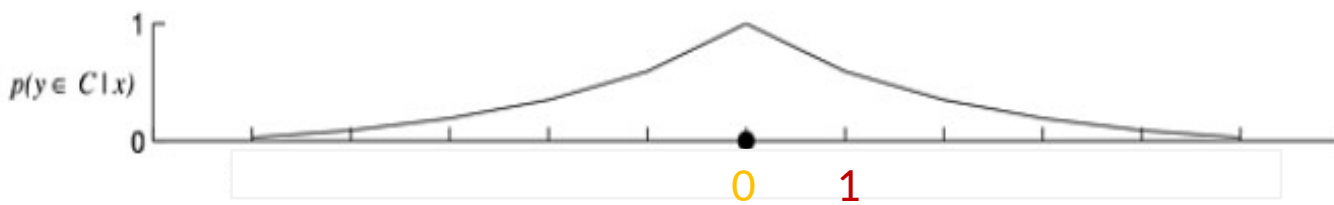
- This graph can tell you the relative probabilities of the different objects within it
- **Canary**, at 0, has the highest probability. **Robin**, at 1, has a slightly lower probability, and so on.
- The y axis of this graph represents the probability that you would sample object  $x$  (if you considered all possible CRs).



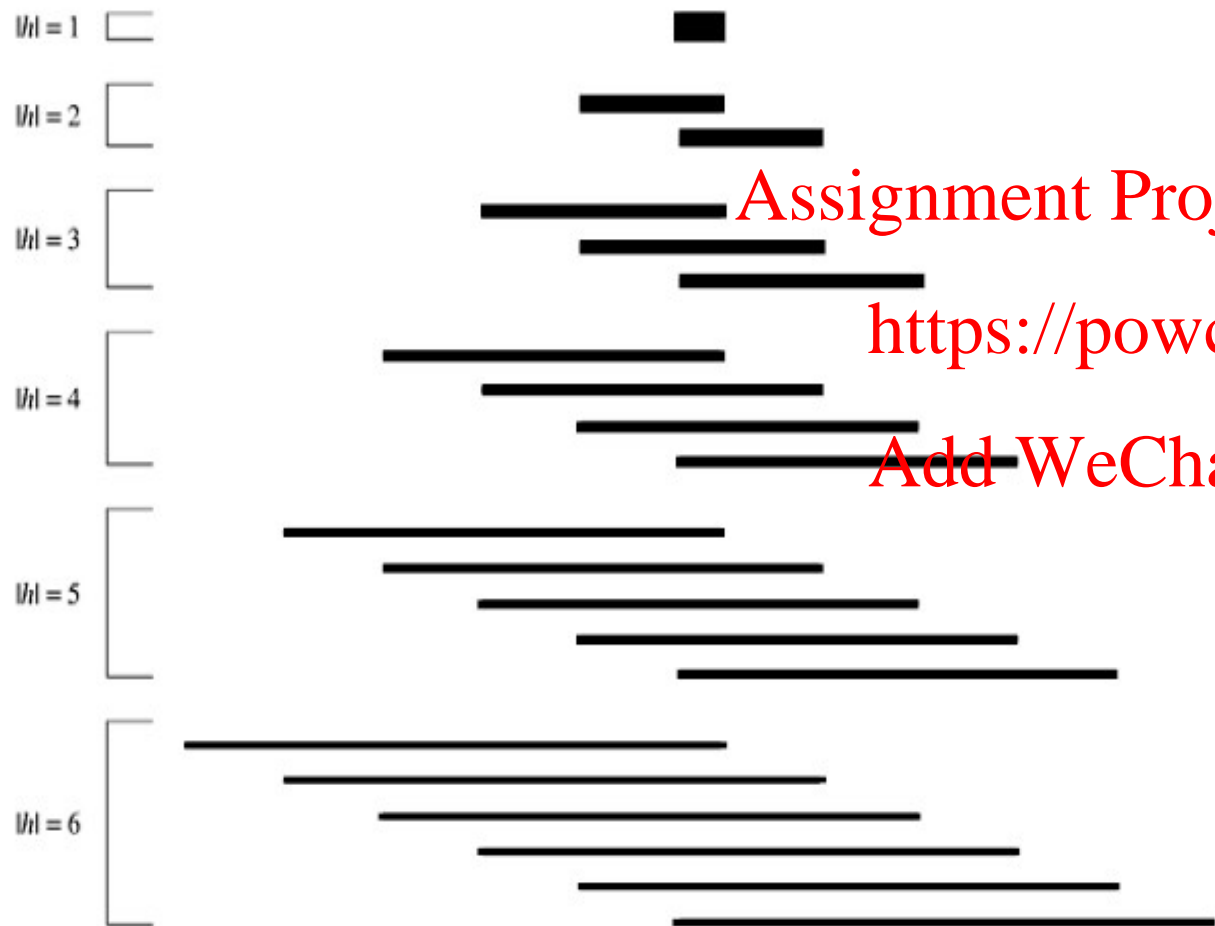
- This graph can tell you the relative probabilities of the different objects within it
- **Canary**, at 0, has the highest probability. **Robin**, at 1, has a slightly lower probability, and so on.

*In the HW, canary is the only observed object in that property; is in all the regions.*

*So if we sampled objects from all the regions, canary will be sampled the most (every time) whereas robin will be sampled less, and so on.*



So what does this mean?



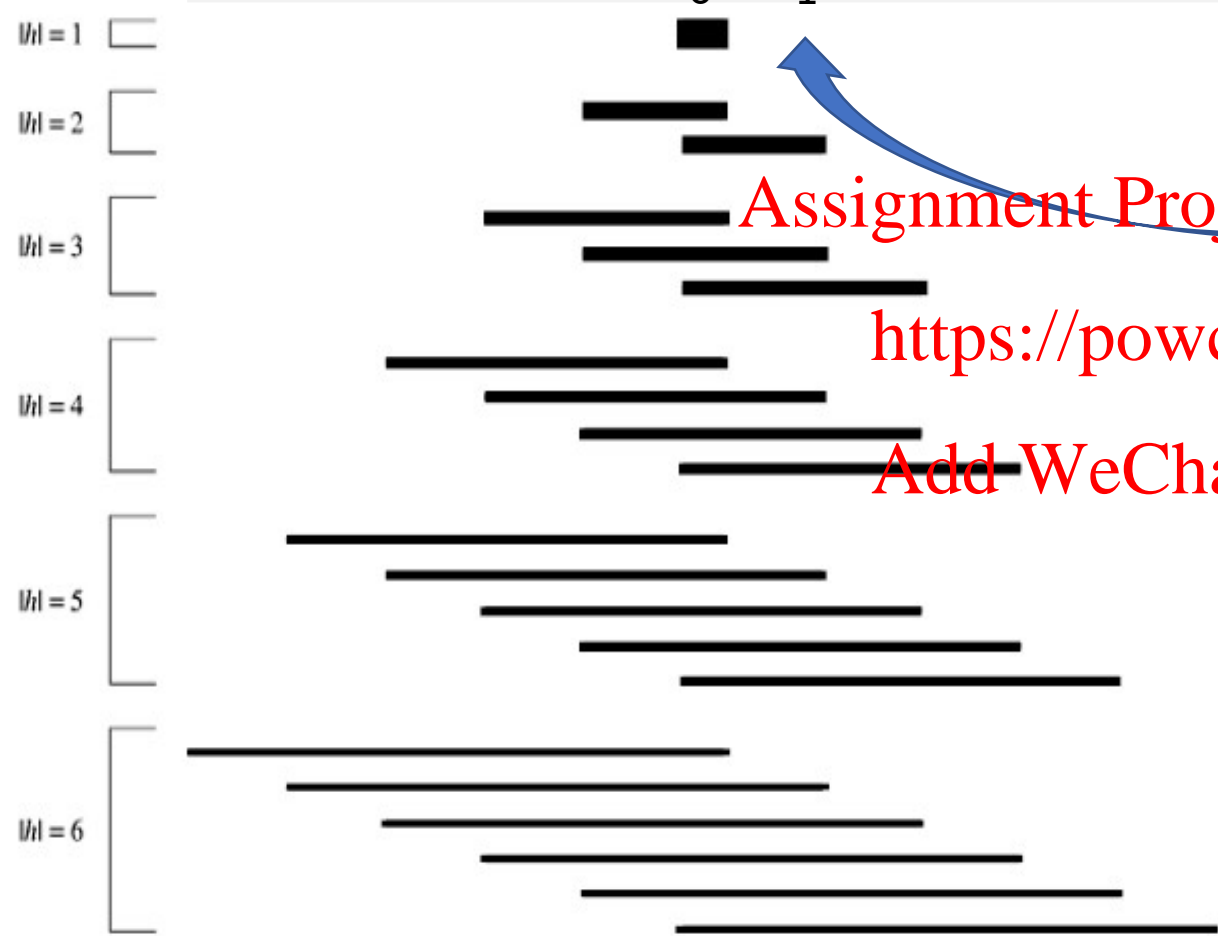
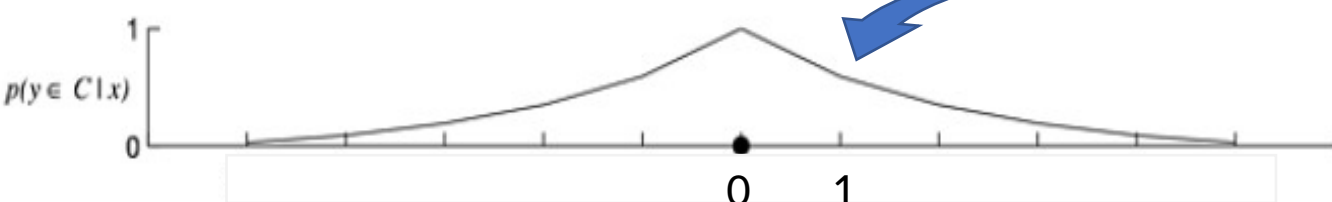
Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

- The y axis of this graph represents the probability that you would sample object  $x$  (if you considered all possible CRs).





- You can compute the y value at any x using this procedure:

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

Y value at concept X =

$$\sum_R P(X|R)P(R)$$

$$\sum_R P(X|R)P(R)$$

=

$$P(X|A)*P(A)$$

+

$$P(X|B)*P(B)$$

+

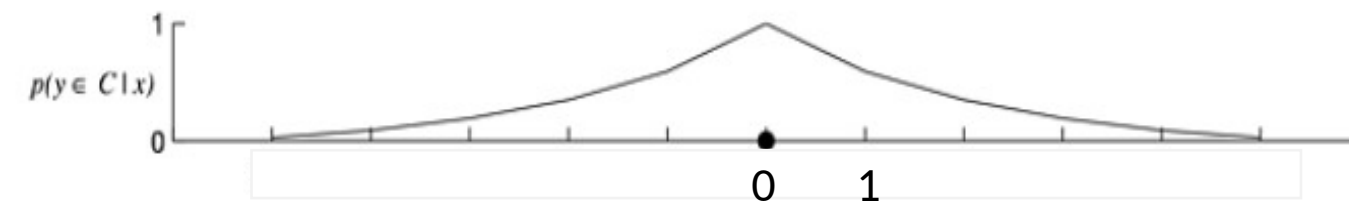
$$P(X|C)*P(C)$$

+

$$P(X|D)*P(D)$$

+

.....



$|I| = 1$

A

$|I| = 2$

B

C

$|I| = 3$

.....

$|I| = 4$

$|I| = 5$

$|I| = 6$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

$$\sum_R P(X|R)P(R)$$

=

$$P(X|A)*P(A)$$

+

$$P(X|B)*P(B)$$

+

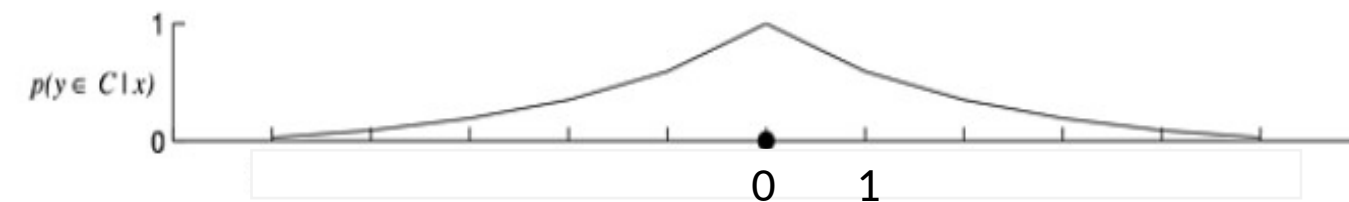
$$P(X|C)*P(C)$$

+

$$P(X|D)*P(D)$$

+

.....



$|I| = 1$

A

$|I| = 2$

B

C

$|I| = 3$

.....

$|I| = 4$

$|I| = 5$

$|I| = 6$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

(For example, you  
could compute this  
for  $X=1$ )

\*NOTE: If X is not in the consequential region R, then for that specific R,

$$P(X|R)P(R) = 0$$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

\*NOTE: If  $X$  is not in the consequential region  $R$ , then for that specific  $R$ ,

$$P(X|R)P(R) = 0$$

1. [5pts, HELP] Write a function called **contains** that takes a region and checks if it contains a given point.

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

-3.2

4.8

All the regions in this assignment should contain  $x=0$ , but how would you check if they contain  $x=1$ ?

\*NOTE: If X is not in the consequential region R, then for that specific R,

$$P(X|R)P(R) = 0$$

1. [5pts, HELP] Write a function called **contains** that takes a region and checks if it contains a given point.

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

-3.2

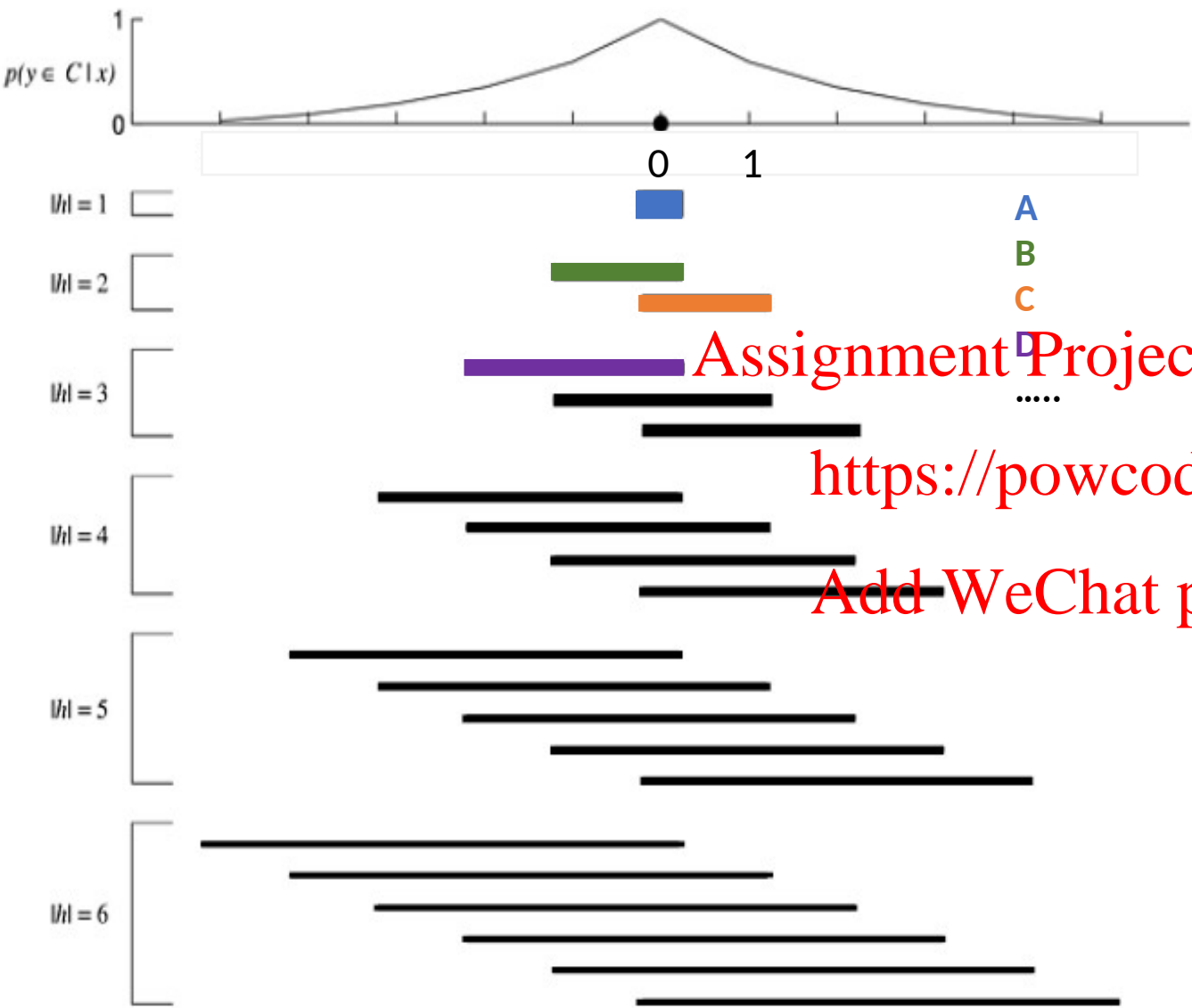
4.8

All the regions in this assignment should contain x=0, but how would you check if they contain x=1?

edge1 <= (x=1) <= edge2



What's the probability of getting  $x=1$ , for regions containing  $x=0$ ?



Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

$$\sum_R P(X|R)P(R)$$

=

$$P(X|A)*P(A)$$

0

+

$$P(X|B)*P(B)$$

0

+

$$P(X|C)*P(C)$$

+

$$P(X|D)*P(D)$$

0

+

.....

$$P(X|R)P(R)$$

Probability of  
observing object X in  
the region R

Probability of you  
sampling region R

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

(if you put all objects  
that were in R in a  
bag, what would the  
probability of  
sampling this  
particular object X  
be?)

(e.g. if you put all  
regions in a bag, what  
would the probability  
of you sampling that  
particular region R  
be?)

$$\sum_R P(X|R)P(R)$$

probability that your object  $x=1$  (or whatever  $x$  you specify) will have the same feature as  $x=0$  (or whatever other  $x$  you specify) as the most probable object; the object that is in all  $R$ ).

Add WeChat powcoder

Computing this sum is marginalizing over every possible  $R$  there could be (since you don't know the true  $R$ , you see what  $P(X|R)$  would be under any of the possible  $R$ s)

# How to compute $P(X|R)$ and $P(R)$

$P(X|R)$      $1/(\text{length of the } R \text{ you have currently sampled})$     (if  $X$  is in  $R$ , and 0 otherwise)

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

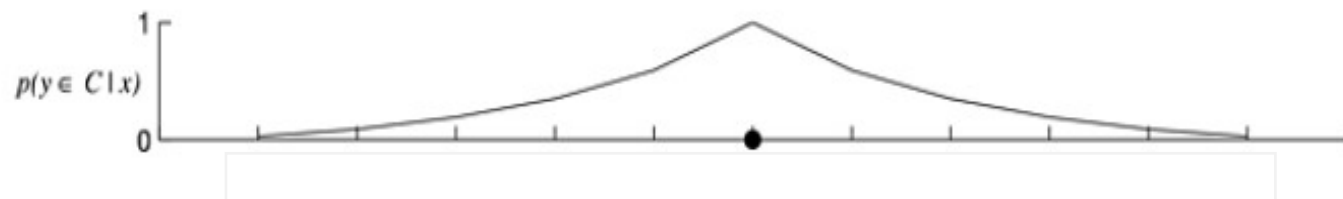
$P(R)$      $1/(\text{number of } R\text{s})$     (since every  $R$  has the same chance of being sampled)

# Why do we do this?

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder



$|h| = 1$  ☐



$|h| = 2$  ☐



$|h| = 3$  ☐



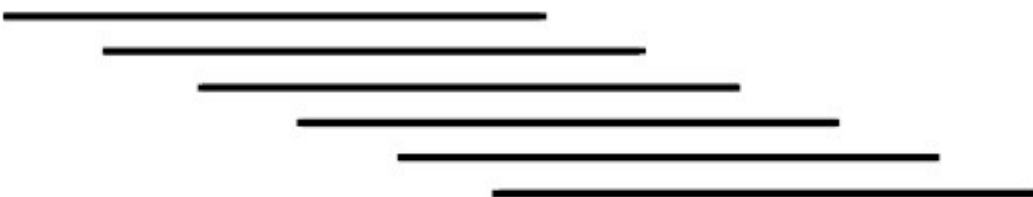
$|h| = 4$  ☐



$|h| = 5$  ☐



$|h| = 6$  ☐



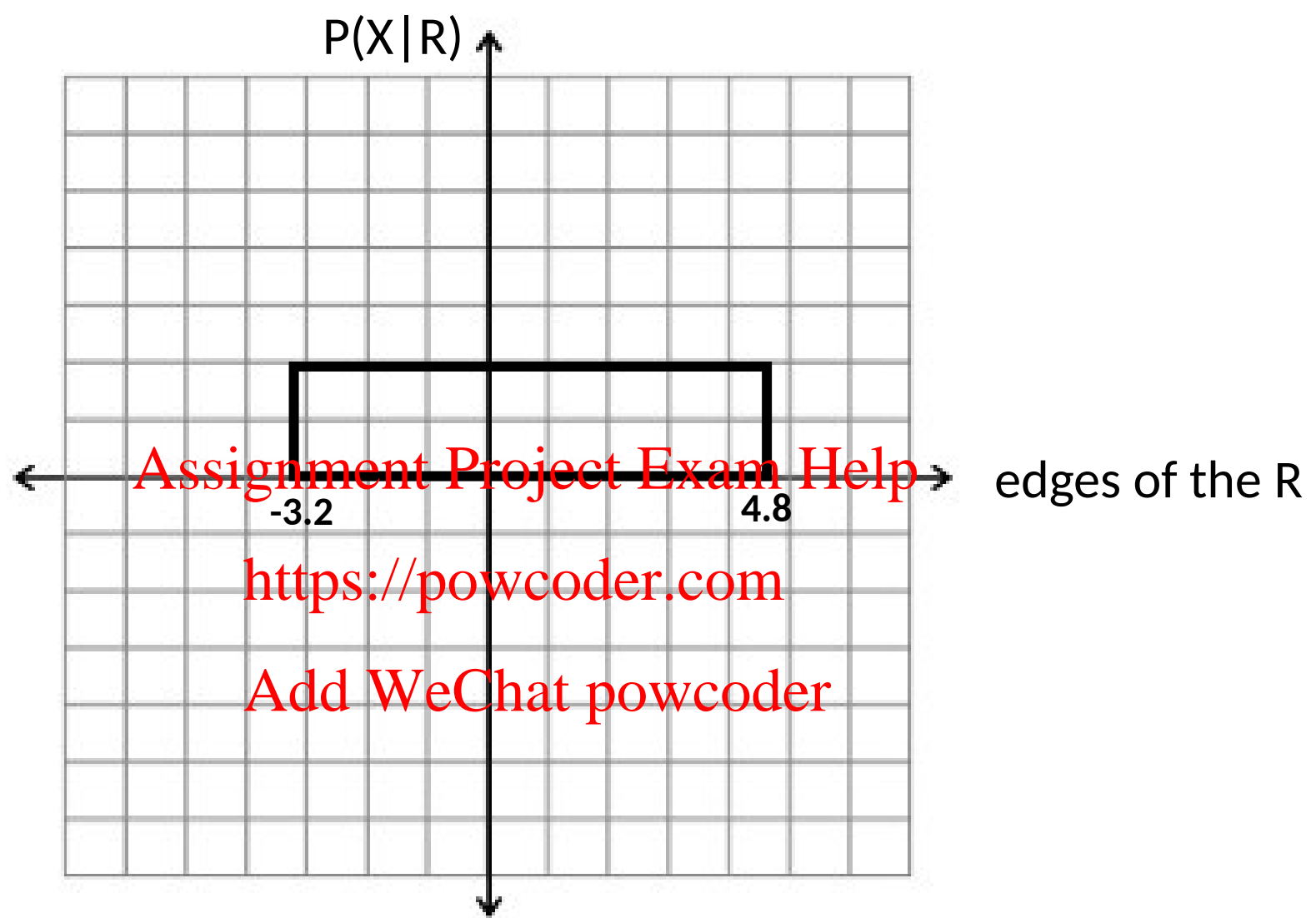
Assignment Project Exam Help

<https://powcoder.com>

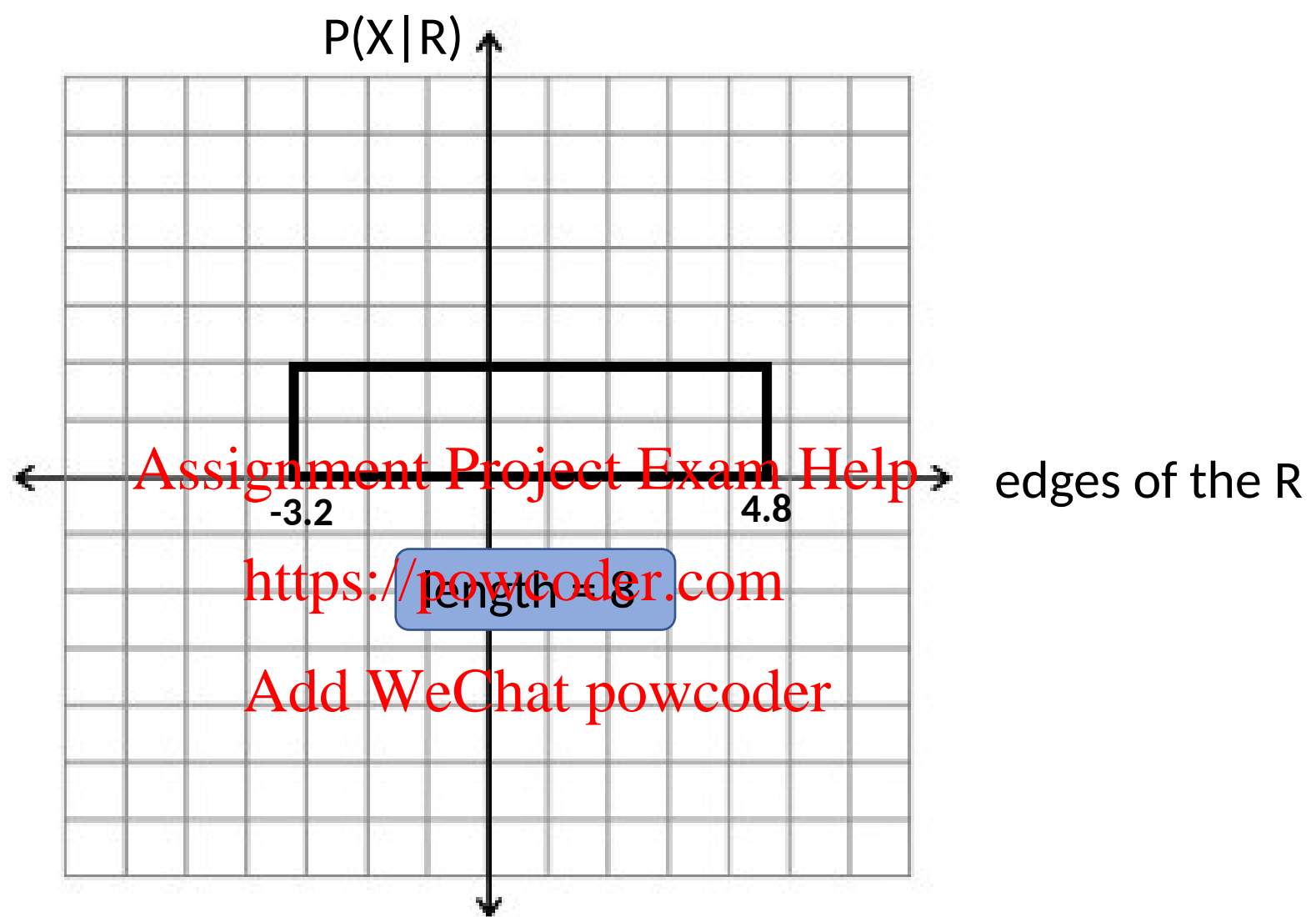
Add WeChat powcoder

• You can think of each of these Rs as a uniform distribution

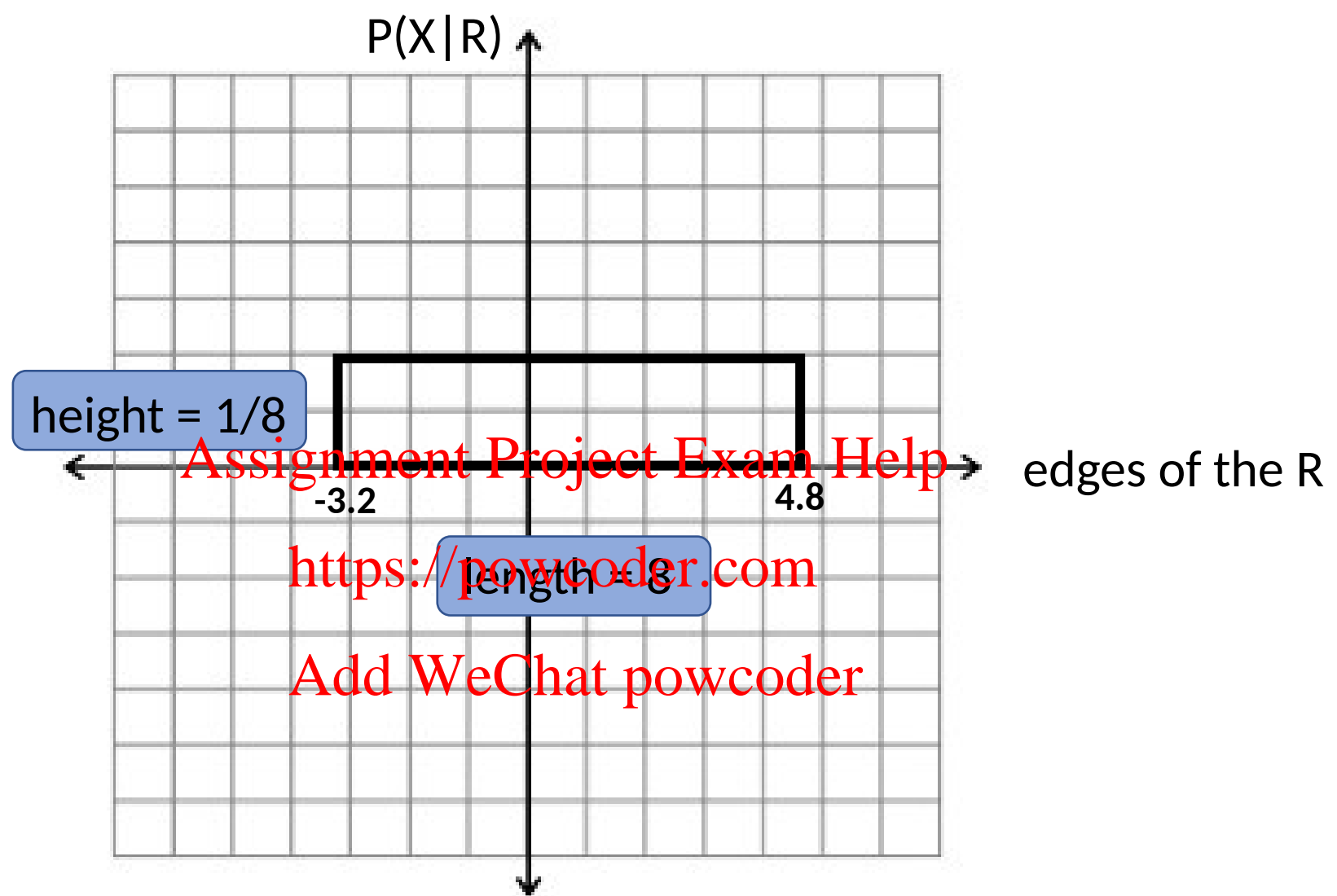




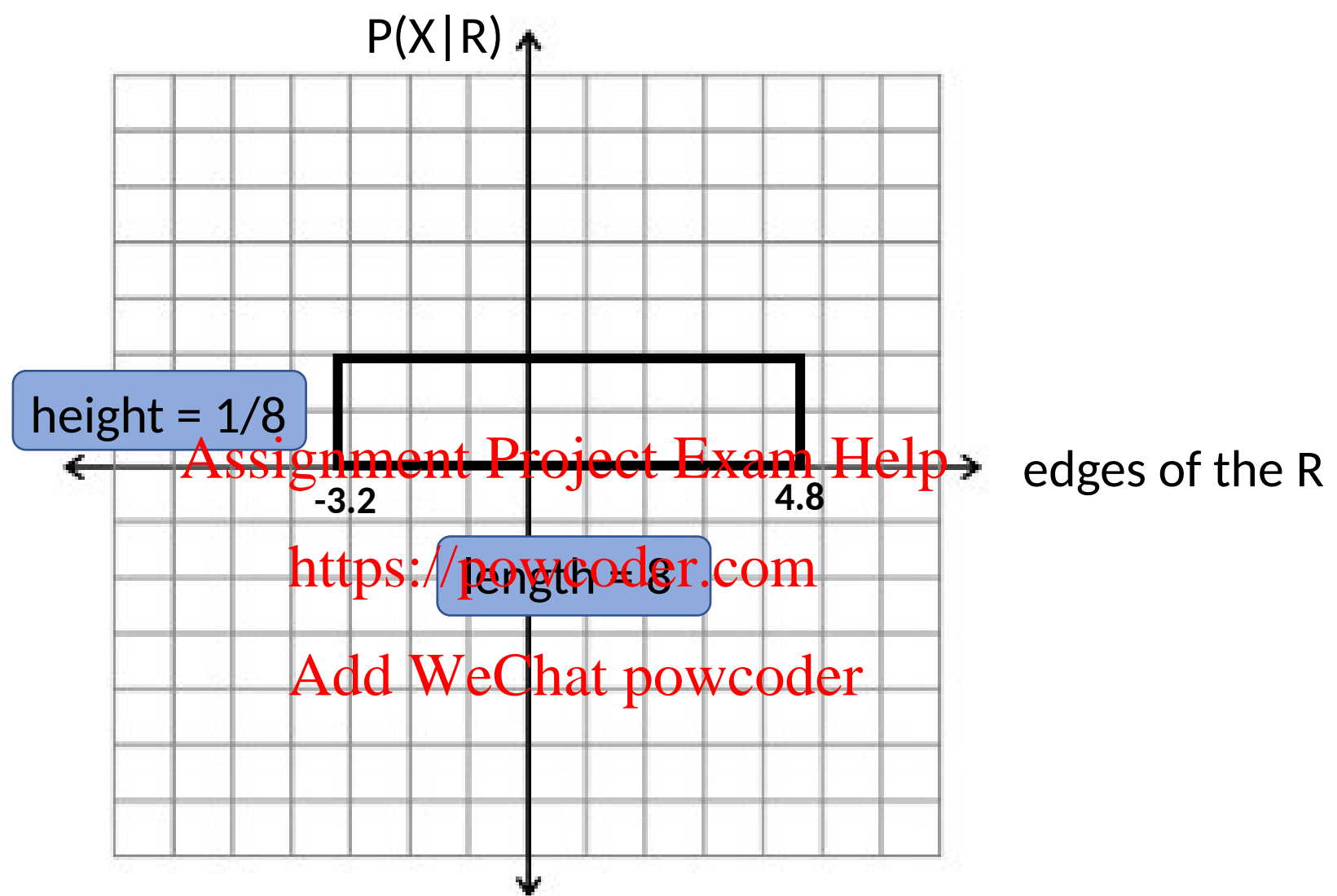
$$\int_L^R (\text{ConsequentialRegion}) = 1 \quad ; \text{ the area of this rectangle} = 1$$



Since the length is 8,



Since the length is 8, for length\*height to = 1, height has to be  $1/8$



Hence,  $P(X|R) = 1/(\text{length of } R)$

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder

## Assignment Project Exam Help

4. [5pts, HELP] One way to check if the curve has an exponential decrease is to plot a logarithmic y axis and look for a straight line. Why does this check if the curve is exponential?

<https://powcoder.com>  
Add WeChat powcoder



# Scaling of axes

- Takes an axis that is written in normal, linear interval form [1,2,3,4....]
- And instead writes it as  $[e^1, e^2, e^3, e^4, e^5]$   
(or  $[10^1, 10^2, 10^3, 10^4, 10^5]$ , which is equivalent because of the change of base formula)
- That changes the spacing of points  
(and causes a distortion; where the exponential is changing a lot, the corresponding spacing on the y axis decreases by just one space, making it seem as if the exponential just decreased by a little, not a lot)
- `plt.yscale`

Assignment Project Exam Help

<https://powcoder.com>

Add WeChat powcoder