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Probability Distribution: Applications

Learning Objective: Find the probability distribution of discrete random variables, and use it to find the probability of events of interest.

We've seen how probability distributions are created. Now it's time to use them to find probabilities.

Example: Changing Majors

A random sample of graduating seniors was surveyed just before graduation. One question that was asked is: How many times did you change majors? The results are displayed in a probability distribution.

x	0	1	2	3	4	5
P(X = x)	.28	.37	.23	.09	.02	.01

Using this probability distribution we can answer probability questions such as: What is the probability that a randomly selected senior has changed majors more than once? This can be written as $P(X > 1)$.

More than once would be translated to:

- $P(X > 1) = P(X = 2) + P(X = 3) + P(X = 4) + P(X = 5)$
- $P(X > 1) = 0.23 + 0.09 + 0.02 + 0.01$
- $P(X > 1) = 0.35$

As you just saw in this example, we need to pay attention to the wording of the probability question. The key words that told us which values to use for X are **more than**. The following will clarify and reinforce the **key words** and their meanings.

Key Words

Let's begin with some everyday situations using **at least** and **at most**.

Suppose someone said to you, "I need you to write **at least 10 pages** for a term paper." What does this mean? It means that 10 pages is the smallest amount you are going to write. In other words, you will write **10 or more** pages for the term paper. This would be the same as saying, "**not less than** 10 pages." So, for example, writing 9 pages would be unacceptable.

On the other hand, suppose you are considering the number of children you will have. You want **at most 3 children**. This means that 3 children is the most that you wish to have. In other words, you will have **3 or fewer** children. This would be the same as saying, "**not more than** 3 children." So, for example, you would not want to have 4 children.

The following table gives a list of some key words to know. Suppose a random variable X had possible values of 0-5.

Key Words	Meaning	Symbols	Values for X
more than 2	strictly larger than 2	$X > 2$	3, 4, 5
no more than 2	2 or fewer	$X \leq 2$	0, 1, 2
fewer than 2	strictly smaller than 2	$X < 2$	0, 1
no less than 2	2 or more	$X \geq 2$	2, 3, 4, 5
at least 2	2 or more	$X \geq 2$	2, 3, 4, 5
at most 2	2 or fewer	$X \leq 2$	0, 1, 2
exactly 2	2, no more or no less, only 2	$X = 2$	2

Now try these activities to see if you get the idea.

Learn By Doing

1/1 point (graded)
A random variable X has possible values of 1-6.

Would the following value of X be included if we want at most 4? Choose **yes** if the value is included. Choose **no** if the value is not included.

X = 1

- (●) yes ✔
- ( ) no

Answer
Correct: At most 4 means X is 4 or fewer, so X = 1 would be included.

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Learn By Doing

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A random variable X has possible values of 1-6.

Would the following value of X be included if we want at most 4? Choose **yes** if the value is included. Choose **no** if the value is not included.

X = 2

- (●) yes ✔
- ( ) no

Answer
Correct: At most 4 means X is 4 or fewer, so X = 2 would be included.

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Learn By Doing

1/1 point (graded)
A random variable X has possible values of 1-6.

Would the following value of X be included if we want at most 4? Choose **yes** if the value is included. Choose **no** if the value is not included.

X = 3

yes ✔

no

Answer
Correct: At most 4 means X is 4 or fewer, so X = 3 would be included.

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Learn By Doing

1/1 point (graded)
A random variable X has possible values of 1-6.

Would the following value of X be included if we want at most 4? Choose **yes** if the value is included. Choose **no** if the value is not included.

X = 4

yes ✔

no

Answer
Correct: At most 4 means X is 4 or fewer, so X = 4 would be included.

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Learn By Doing

1/1 point (graded)
A random variable X has possible values of 1-6.

Would the following value of X be included if we want at most 4? Choose **yes** if the value is included. Choose **no** if the value is not included.

X = 5

yes

no ✔

Answer
Correct: At most 4 means X is 4 or fewer, so X = 5 would not be included.

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Learn By Doing

1/1 point (graded)
A random variable X has possible values of 1-6.

Would the following value of X be included if we want at most 4? Choose **yes** if the value is included. Choose **no** if the value is not included.

X = 6

yes

no ✔

Answer
Correct: At most 4 means X is 4 or fewer, so X = 6 would not be included.

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Learn By Doing

1/1 point (graded)
A random variable X has possible values of 1-6.

Which is the appropriate list of values for X if we want no more than 3?

X = 0, 1, 2, 3

X = 1, 2, 3 ✔

X = 3, 4, 5, 6

○ X = 4, 5, 6

Answer
Correct: **No more than** 3 means 3 is the largest value for X. We want $X \leq 3$.

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Before we move on to the next section on the means and variances of a probability distribution, let's revisit the changing majors example:

x	0	1	2	3	4	5
P(X = x)	.28	.37	.23	.09	.02	.01

Question: Based upon this distribution, do you think it would be unusual to change majors 2 or more times?

Answer: $P(X \geq 2) = 0.35$. So, 35% of the time a student changes majors 2 or more times. This means that it is not unusual to do so.

Question: Do you think it would be unusual to change majors 4 or more times?

Answer: $P(X \geq 4) = 0.03$. So, 3% of the time a student changes majors 4 or more times. This means that it is fairly unusual to do so.

After we learn about means and standard deviations, we will have another way to answer these types of questions.
