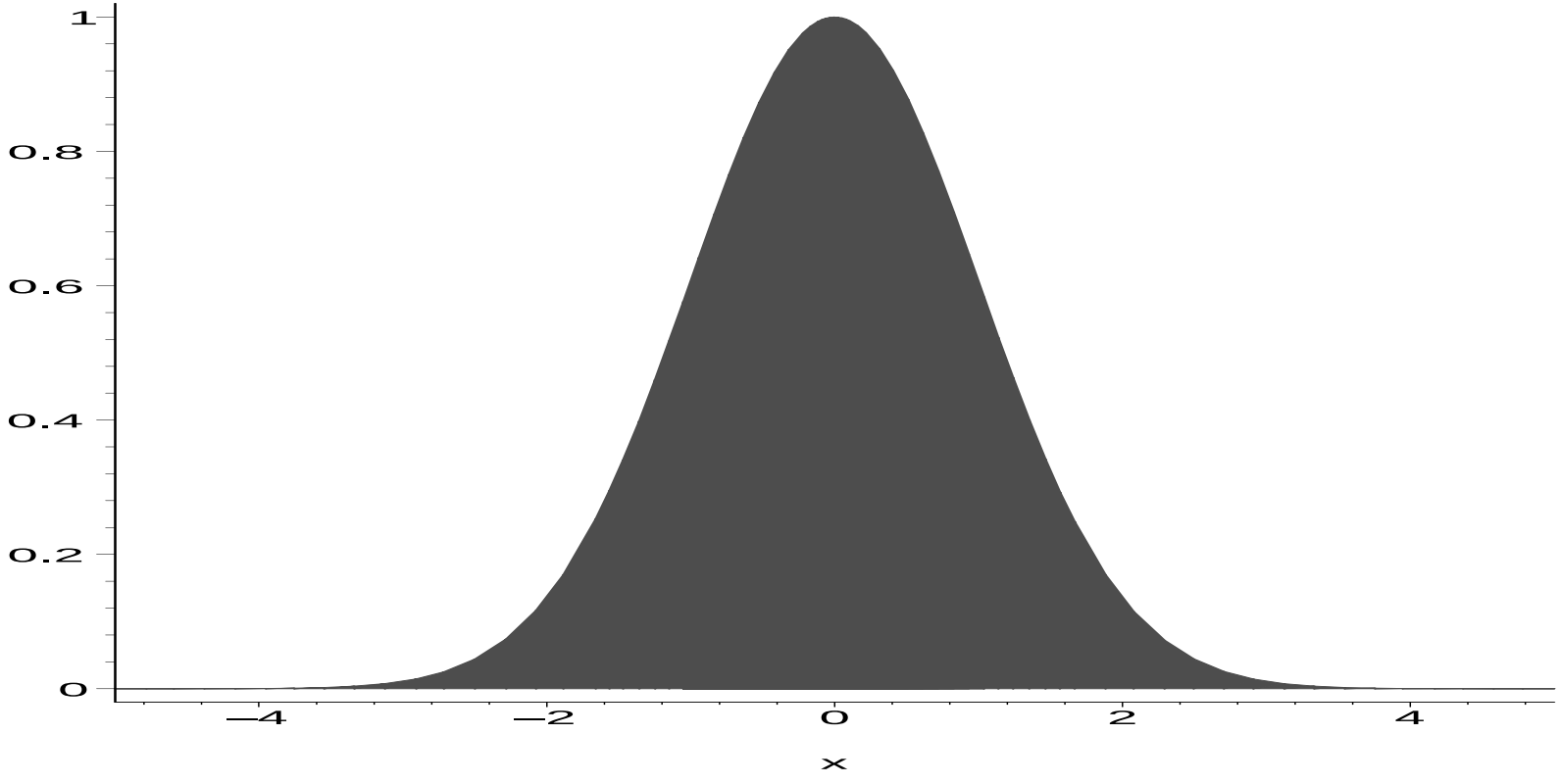
The Normal Curve

Gene Quinn

The Normal Curve

The Normal or bell curve is centered at 0, and extends to infinity in both directions.



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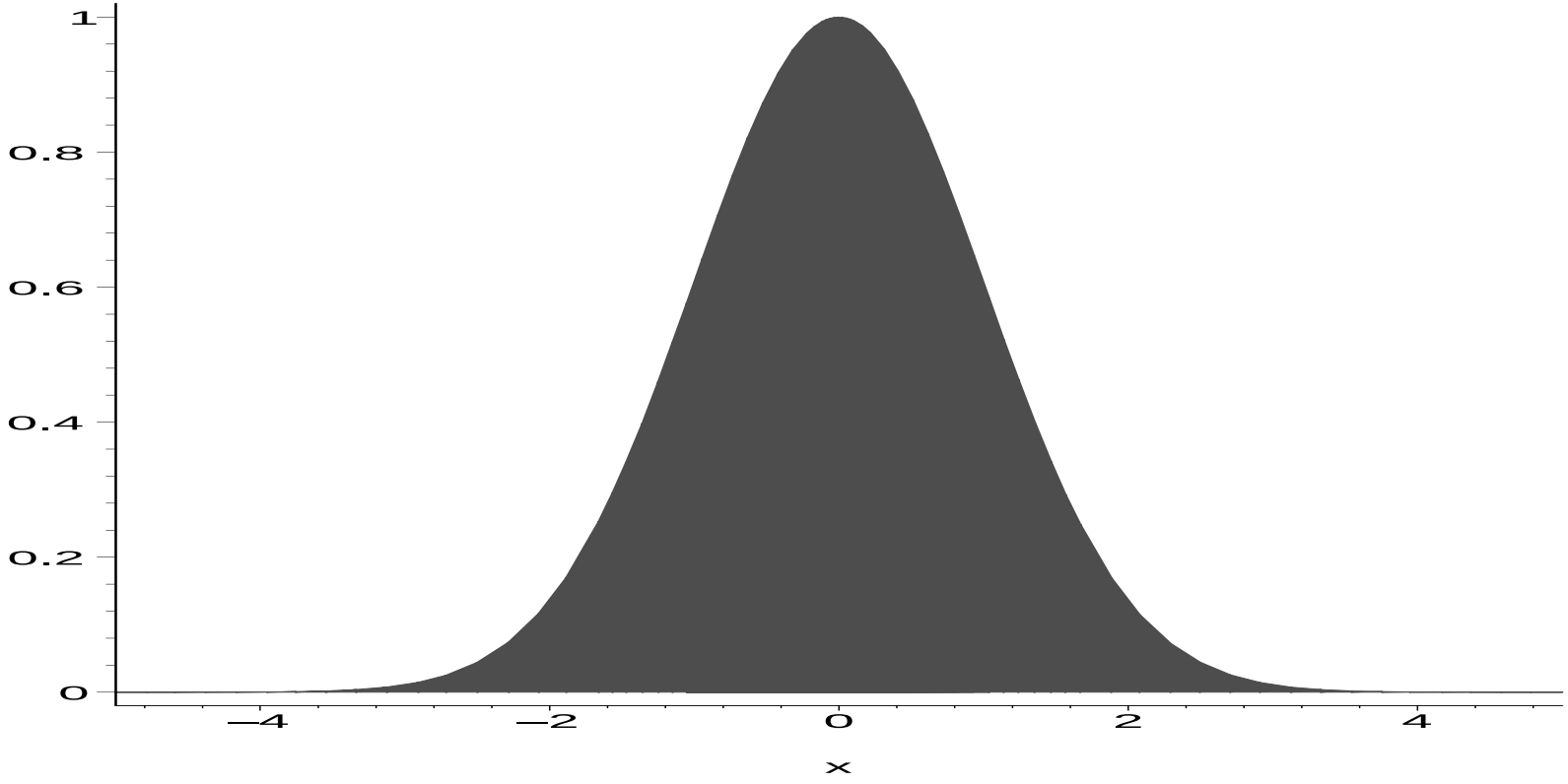

The total area under the bell curve is 1.

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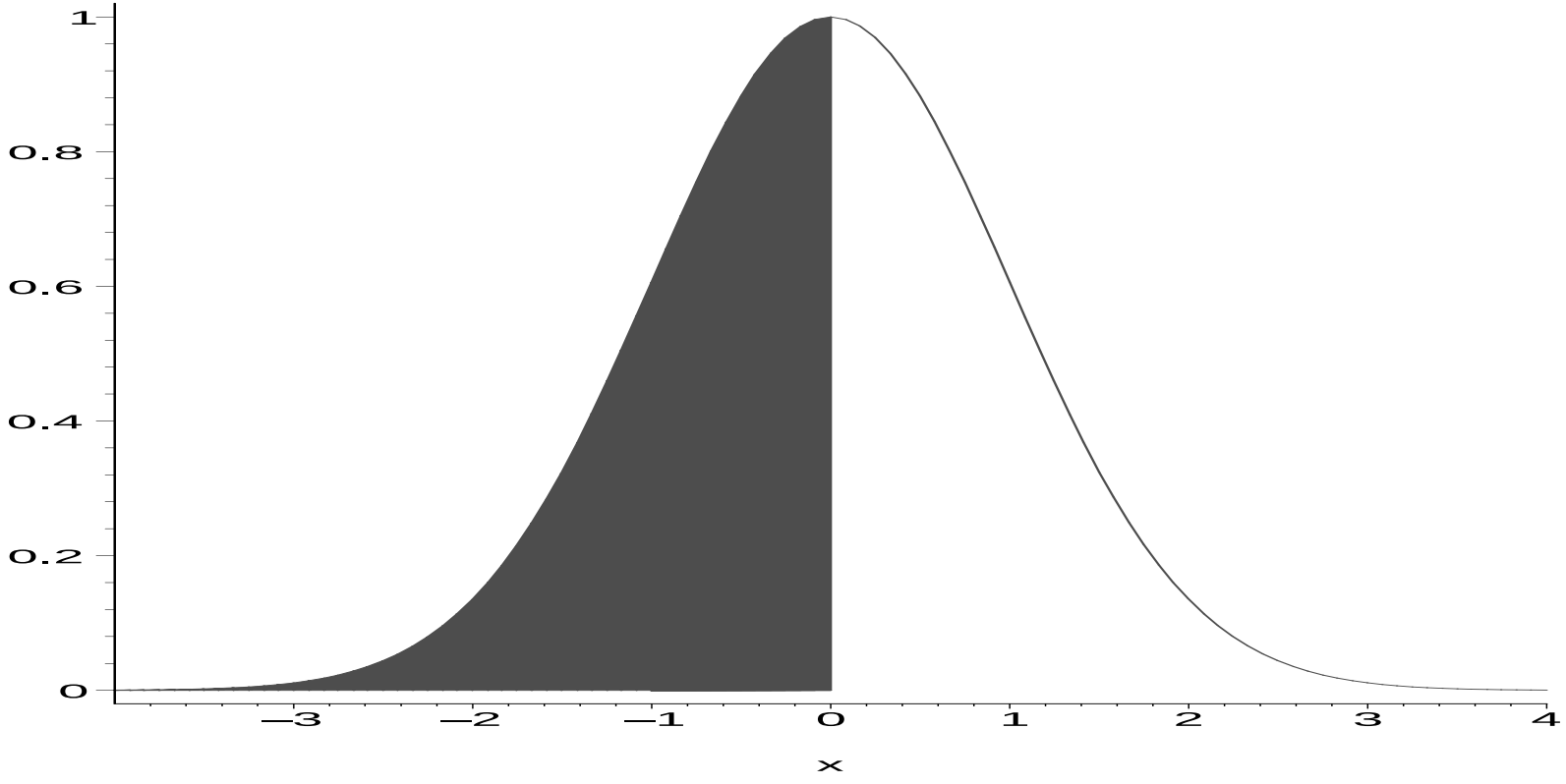
The curve is symmetric about 0,



so the area to the left of zero under the bell curve is 0.5.

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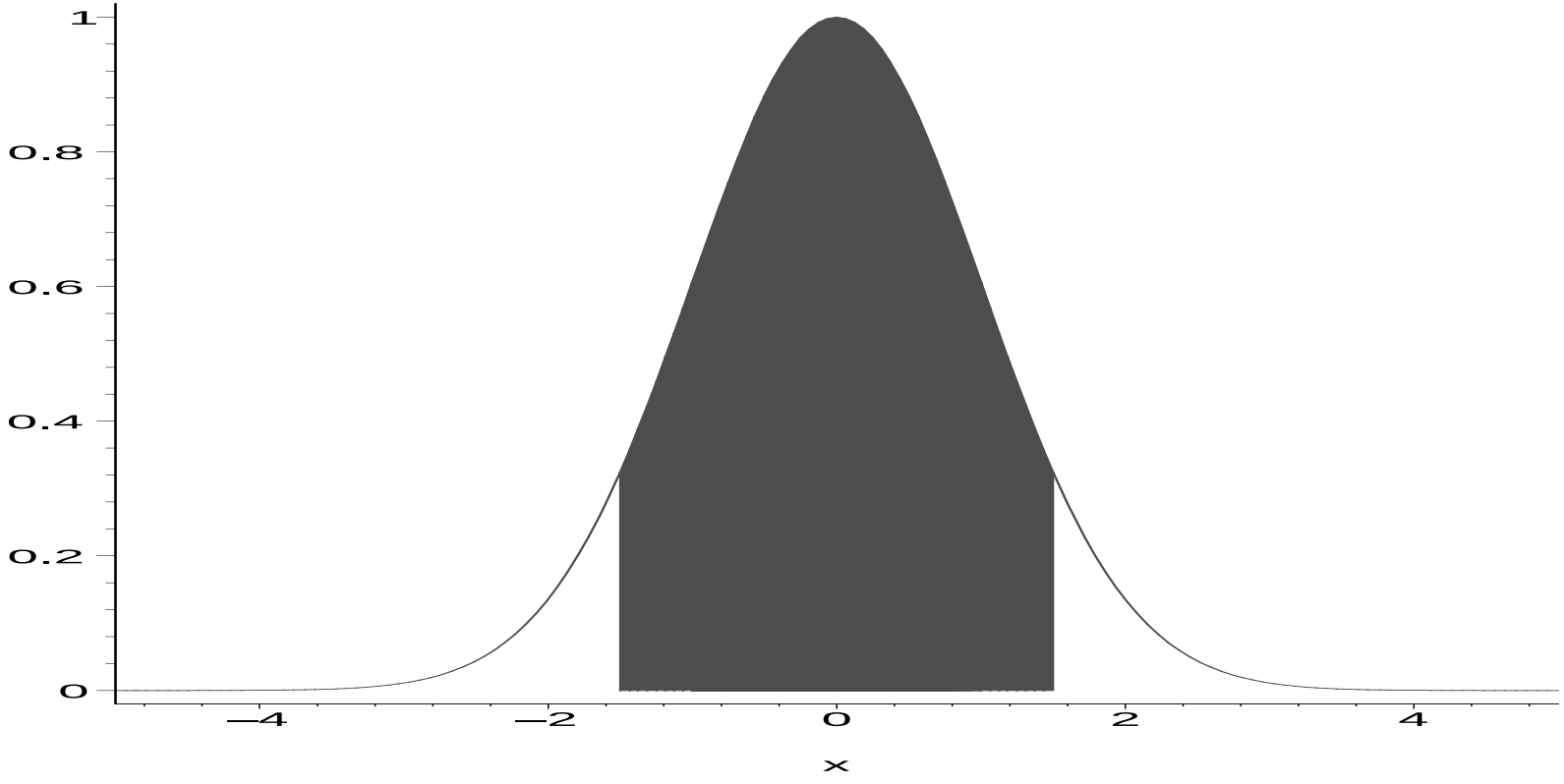
Often we are interested in the area above some interval centered at zero,



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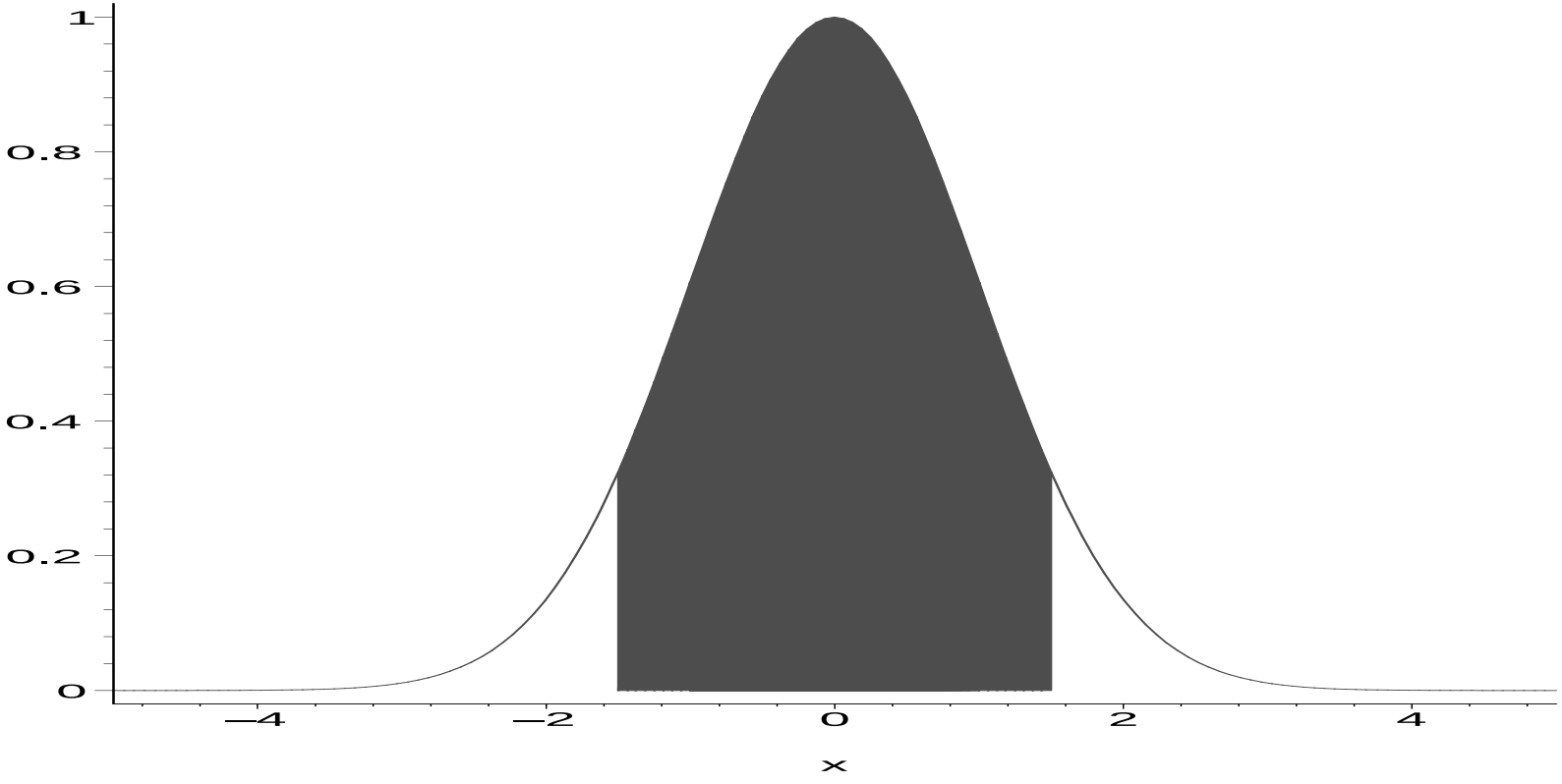

Unfortunately there is no simple formula for calculating this.

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Because there is no simple formula, a table is often used.

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z	Area
0.00	0.00
0.50	38.29
1.00	68.27
1.50	86.64
2.00	95.45
2.50	98.76
3.00	99.73

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1.00	68.27
1.50	86.64
2.00	95.45
2.50	98.76
3.00	99.73

In this table, the Areas are in percentages.

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If the first entry is 1.5, the table gives the area under the curve from -1.5 to 1.5.

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The first entry is the distance above and below zero to include in the interval.

If the first entry is 1.5, the table gives the area under the curve from -1.5 to 1.5.

The second entry gives the percentage of the total area that is over this interval - 86.64 in this case.

The Normal Curve

This table can be used to find the area under the bell curve from $-z$ to z for some number z.

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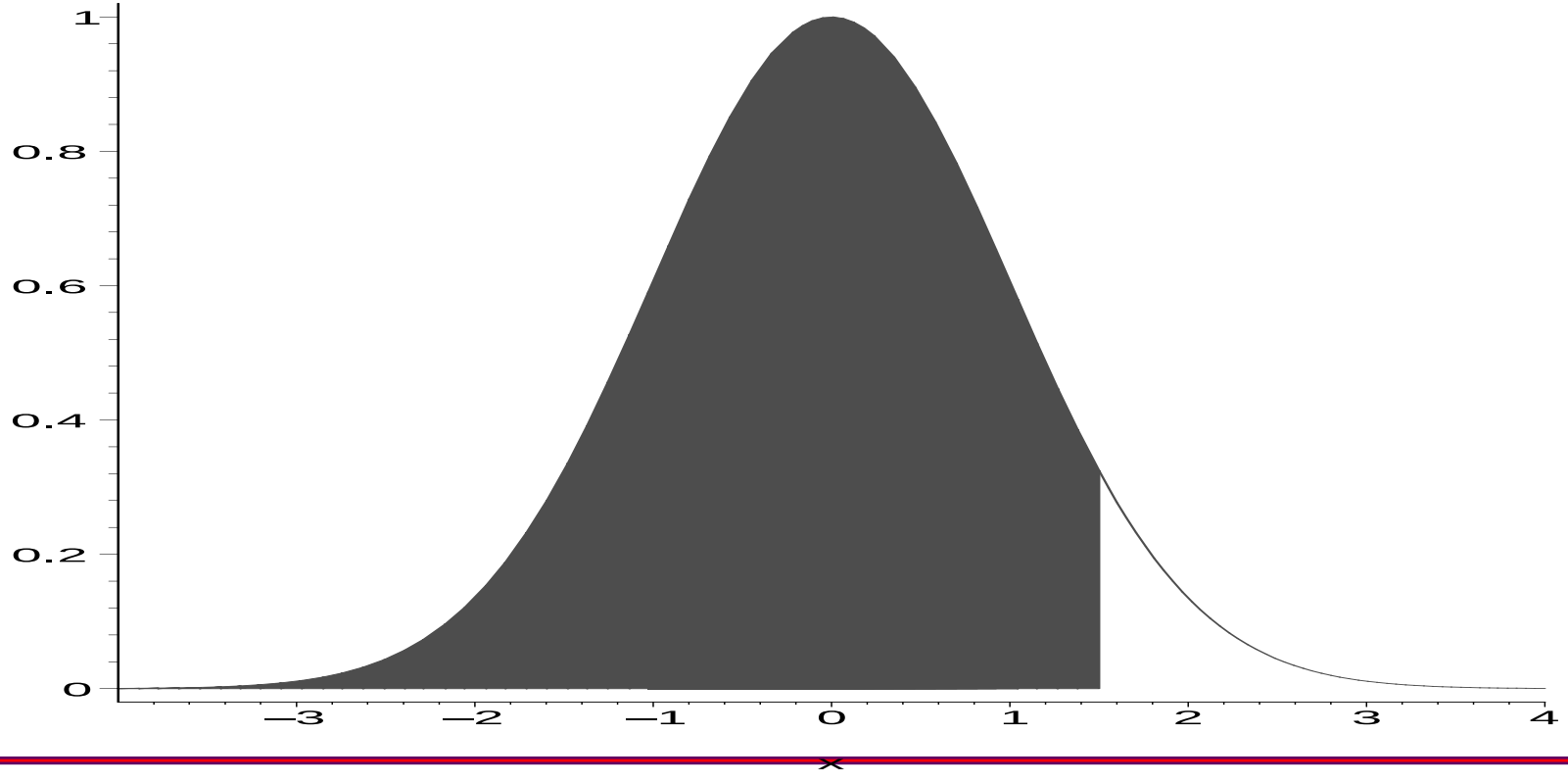
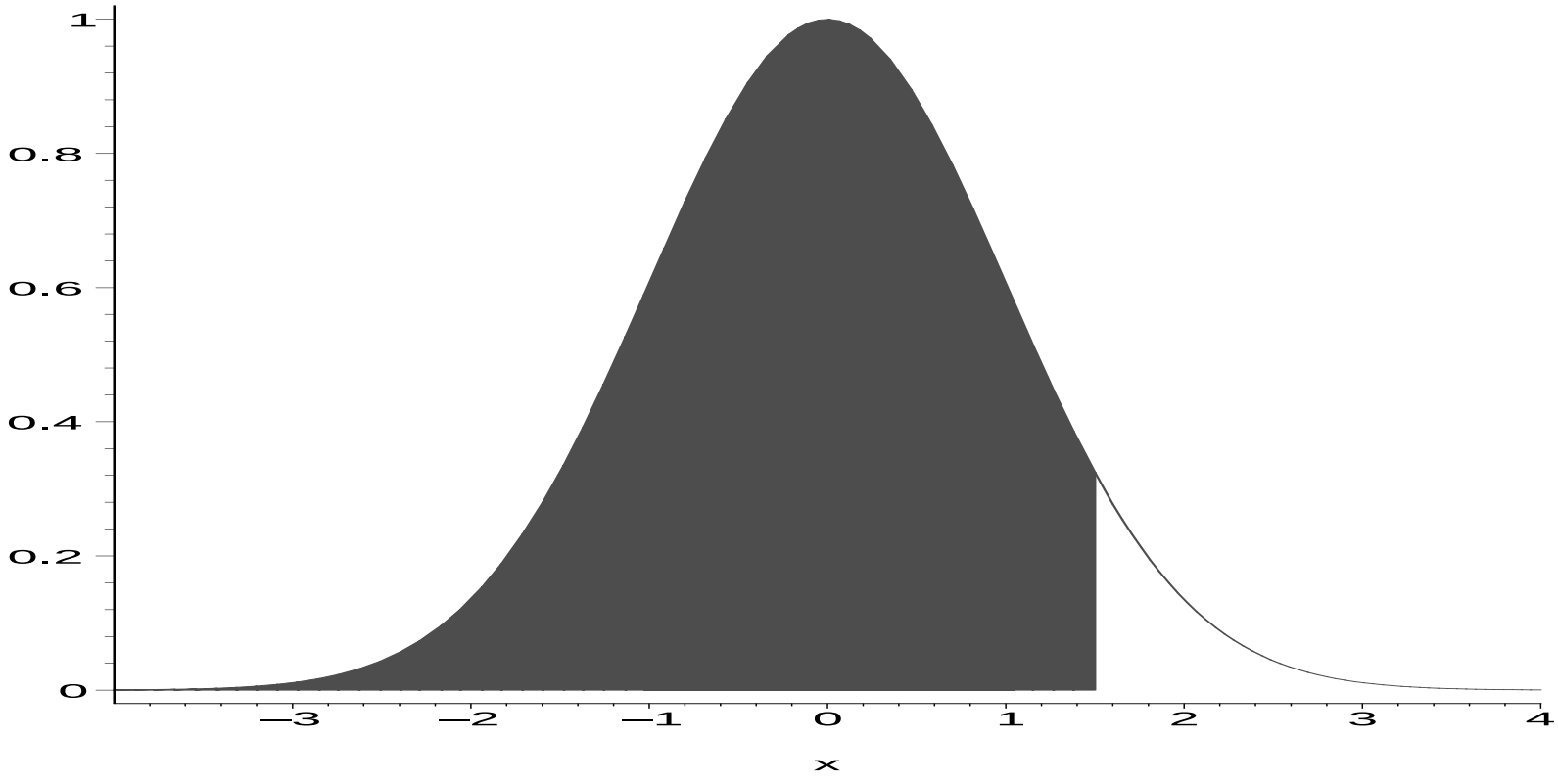
Sometimes, we are interested in the percentage of a normal population *below* a certain value:



The Normal Curve



We cannot directly use the table to find an area of this form.

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Suppose we want to find the area under the bell curve to the left of 1.5.

From the table, we know that 86.64% of the area is between -1.5 and 1.5.

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This means that 13.3% is outside the interval $[-1.5, 1.5]$.

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So $100 - 6.65$ or 93.35% of the area is below 1.5.

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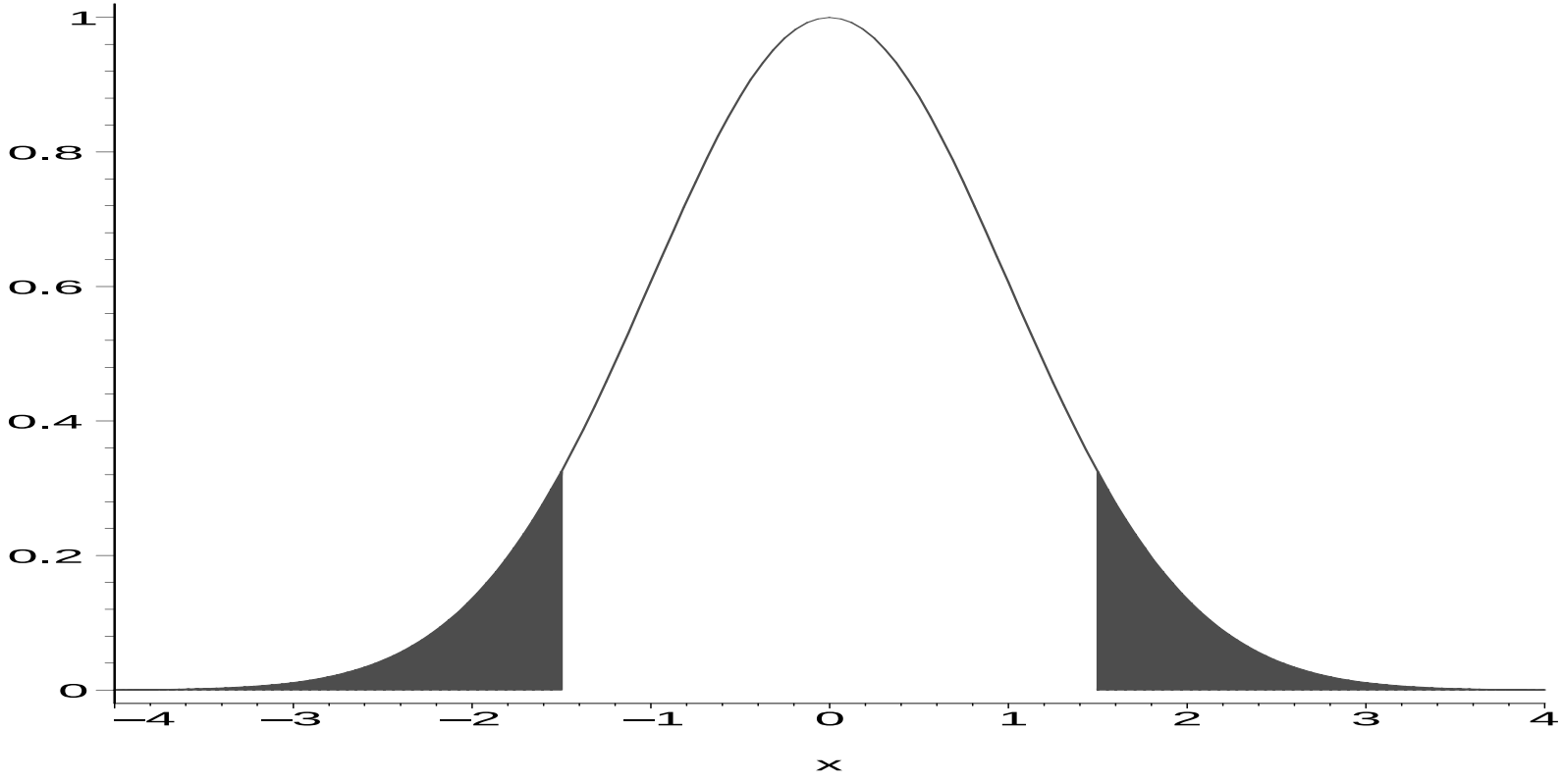
Another area we can indirectly find from the table is:



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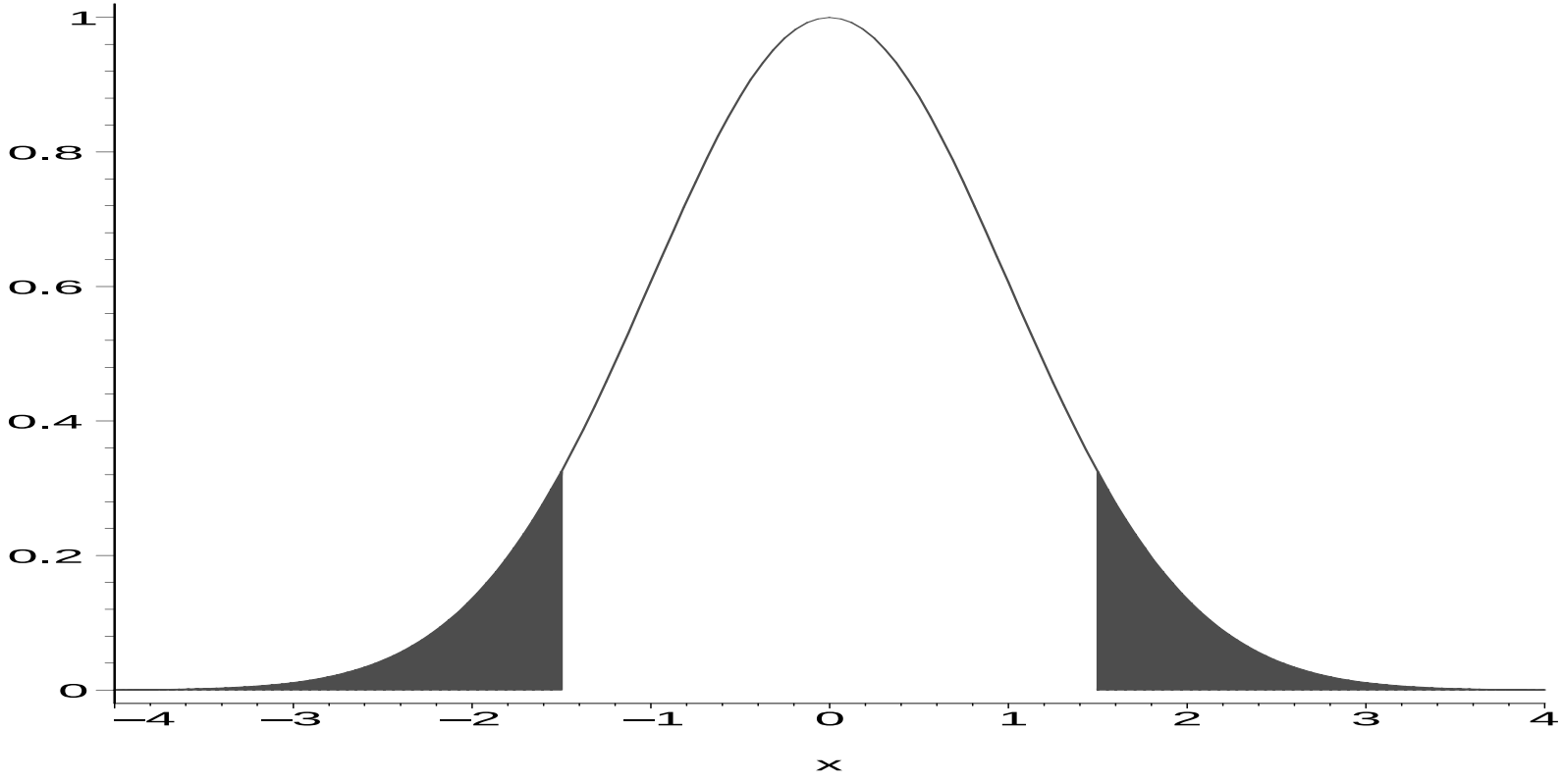

We know the total area under the bell curve is 1, and the table gives the *unshaded* area, so we can subtract the table value from 1.

Using a Spreadsheet

Most spreadsheet programs have a function that computes the area under a bell curve.

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NORMSDIST returns the *proportion* of the area that lies to the left of the value given.

Using a Spreadsheet

Most spreadsheet programs have a function that computes the area under a bell curve.

The function **NORMSDIST** gives the area under the bell curve of the standard normal distribution.

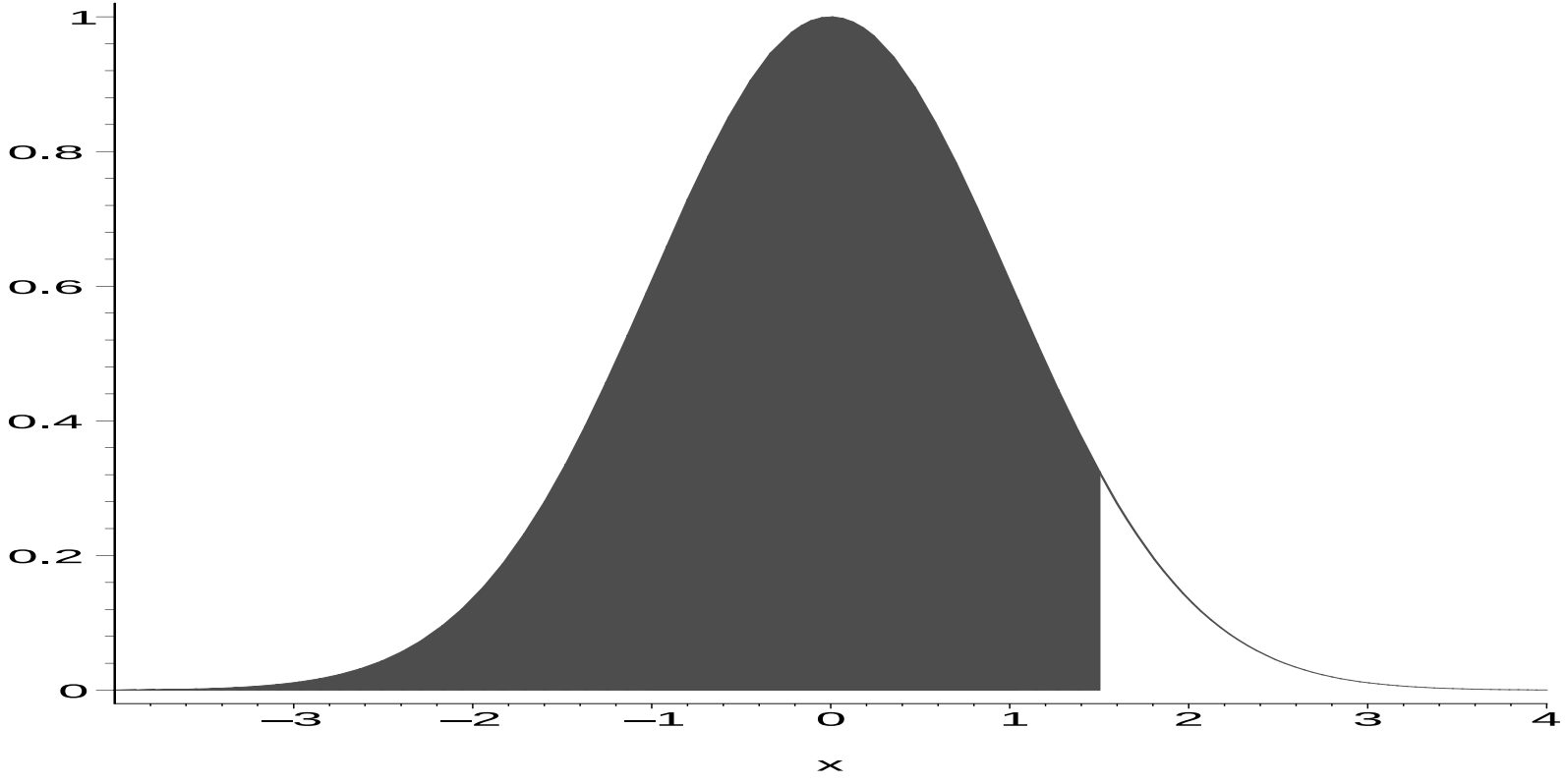
The **NORMSDIST** takes a single argument which is interpreted as a position on the horizontal axis.

NORMSDIST returns the *proportion* of the area that lies to the left of the value given.

So, for example if we code **=NORMSDIST(1.5)** the result is 0.9332.

NORMSDIST

Keep in mind the picture that goes with **NORMSDIST**:



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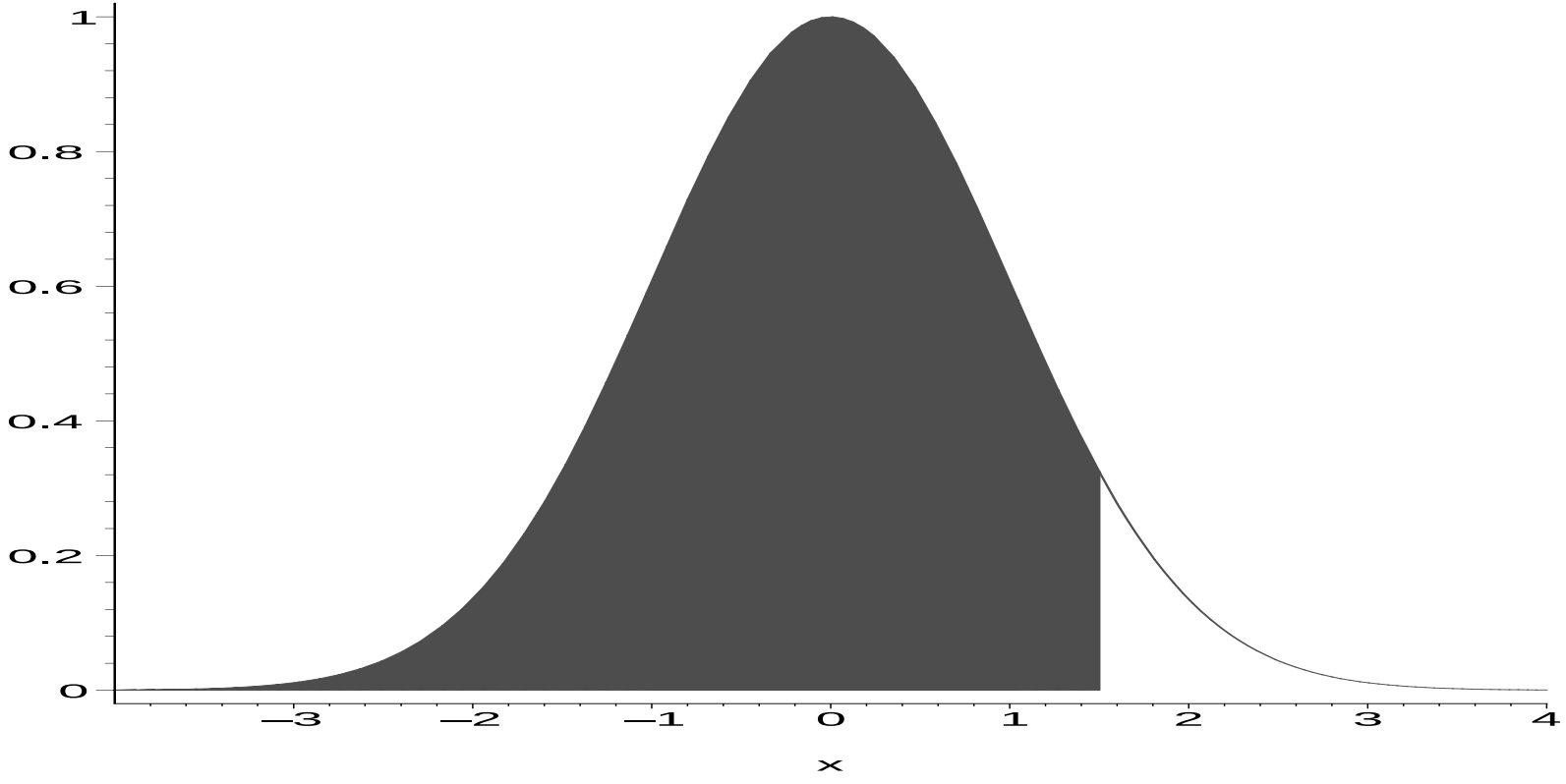
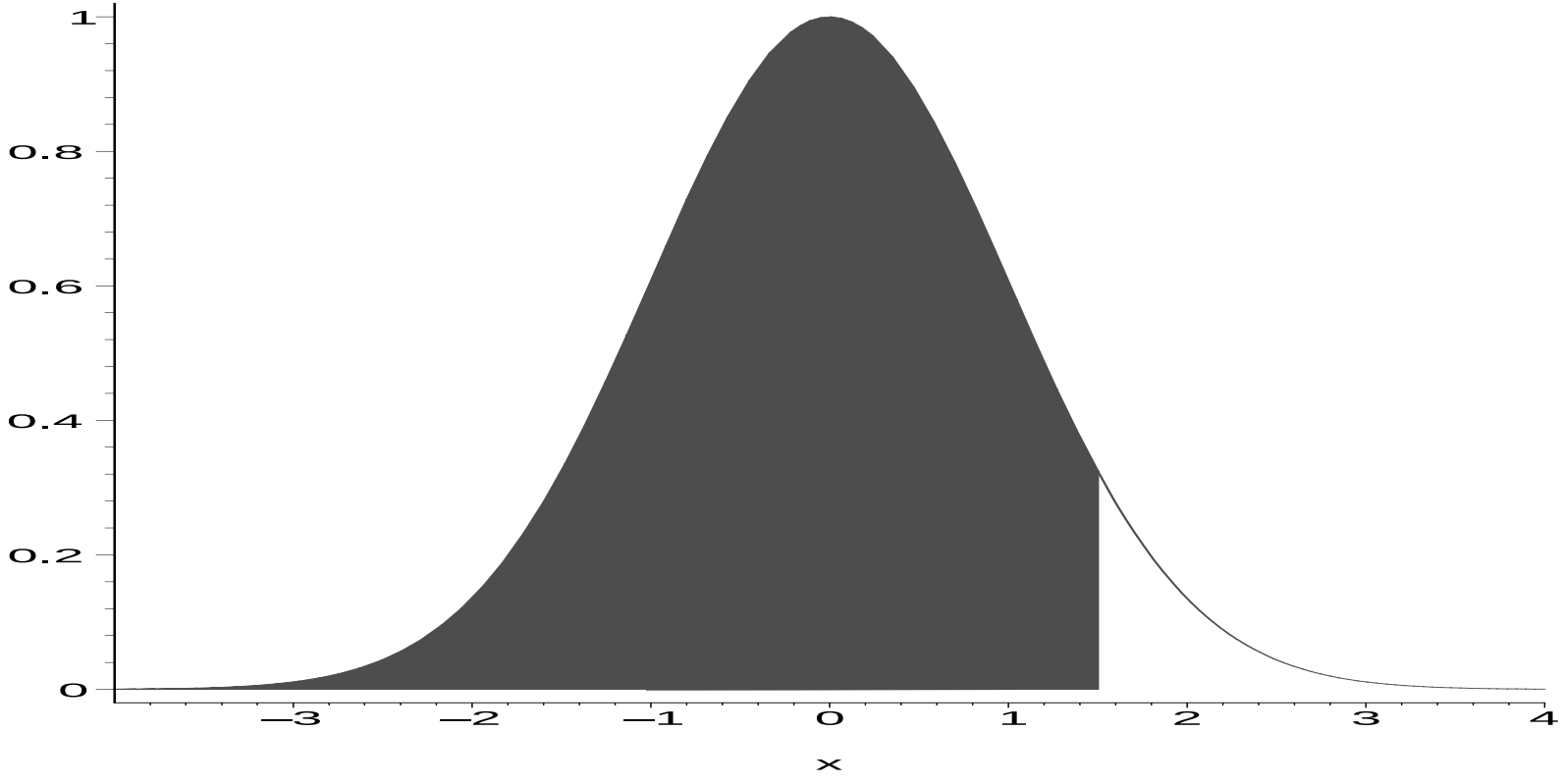


With some ingenuity, most areas that are of interest can be calculated with **NORMSDIST**.

NORMSDIST

Also keep in mind that **NORMSDIST** is for the *standard normal distribution*



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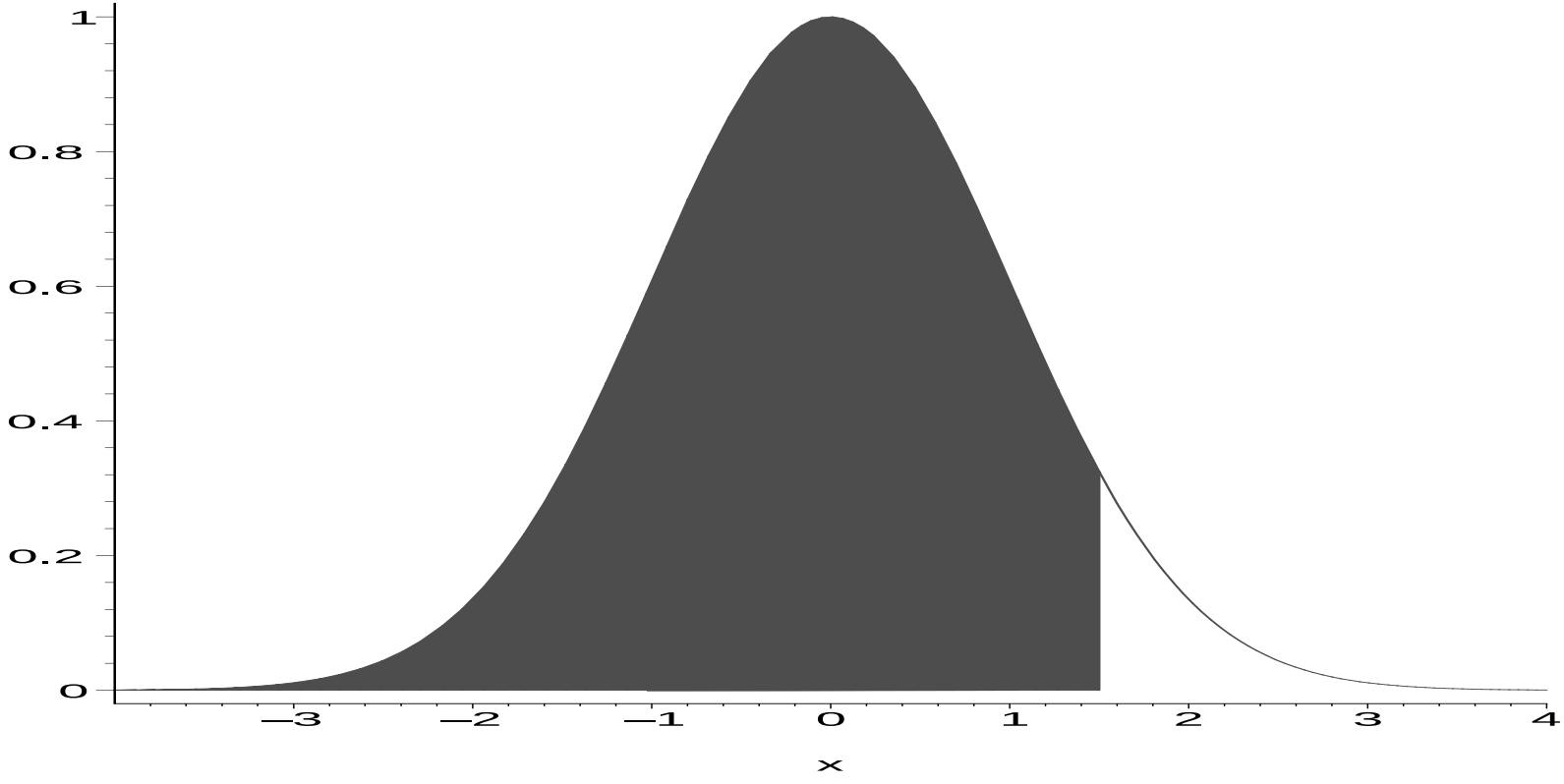

The standard normal distribution has mean 0 and standard deviation 1.

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In this case a different function usually called **NORMDIST** must be used.

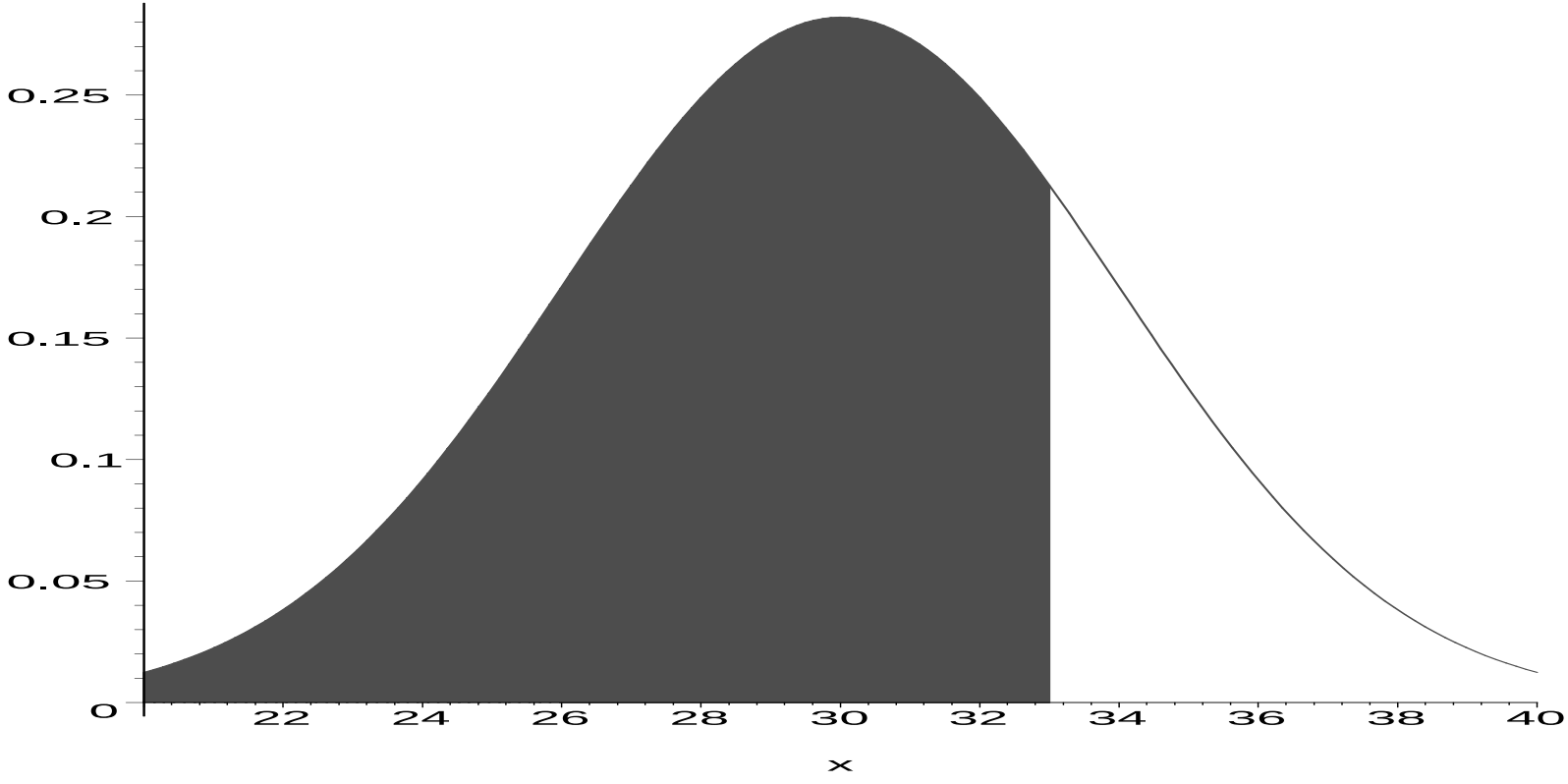
In addition to the proportion of the population, **NORMDIST** requires that we supply the mean and standard deviation of the bell curve.

If the mean is u and the standard deviation is s, syntax of the **NORMDIST** function is:

=NORMDIST(value,u,s,true)

Proportion Below a Given Value

The proportion of the area under a bell curve below a given value is:



=NORMDIST(value,u,s,true)

Proportion Below a Given Value

Example: Waist measurements of a certain population have bell curve distribution with mean 34.2 and standard deviation 2.1.

What proportion of this population has a waist measurement of 36 or less?

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What proportion of this population has a waist measurement of 36 or less?

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=NORMDIST(36,34.2,2.1,true)

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What proportion of this population has a waist measurement of 36 or less?

In this case the syntax for the formula is:

=NORMDIST(36,34.2,2.1,true)

In this case, the result is 0.71

Proportion Below a Given Value

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What proportion of this population has a waist measurement of 36 or less?

In this case the syntax for the formula is:

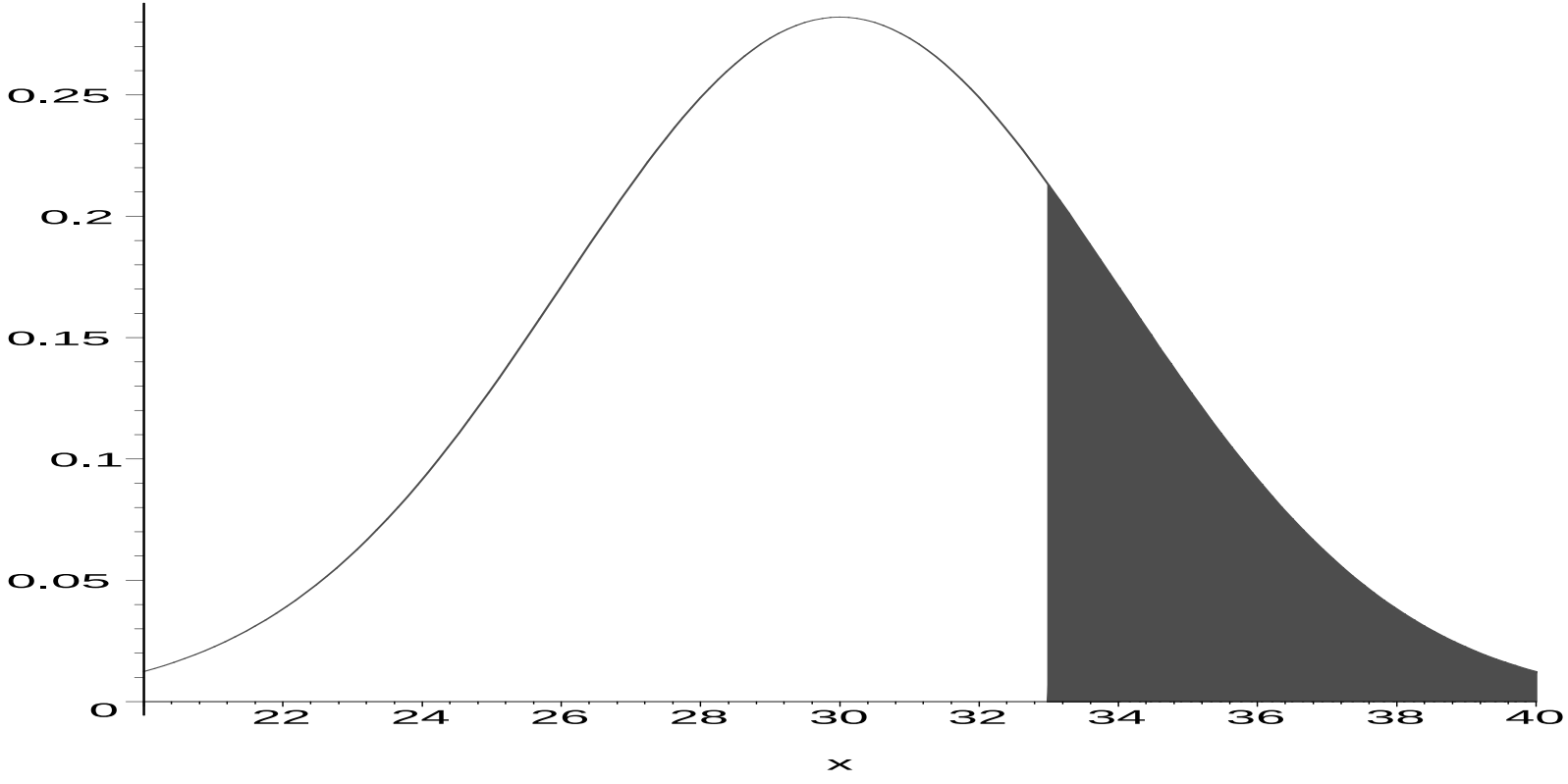
=NORMDIST(36,34.2,2.1,true)

In this case, the result is 0.71

This tells us that in a bell curve population with mean 34.2 and standard deviation 2.1, 71 percent of the population has a measurement of 36 or less.

Proportion Above a Given Value

The proportion of the area under a bell curve above a given value is:



=1-NORMDIST(value,u,s,true)

Proportion Below a Given Value

Example: Waist measurements of a certain population have bell curve distribution with mean 34.2 and standard deviation 2.1.

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What proportion of this population has a waist measurement of 36 or greater?

In this case the syntax for the formula is:

=1-NORMDIST(36,34.2,2.1,true)

In this case, the result is 0.29

Proportion Below a Given Value

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What proportion of this population has a waist measurement of 36 or greater?

In this case the syntax for the formula is:

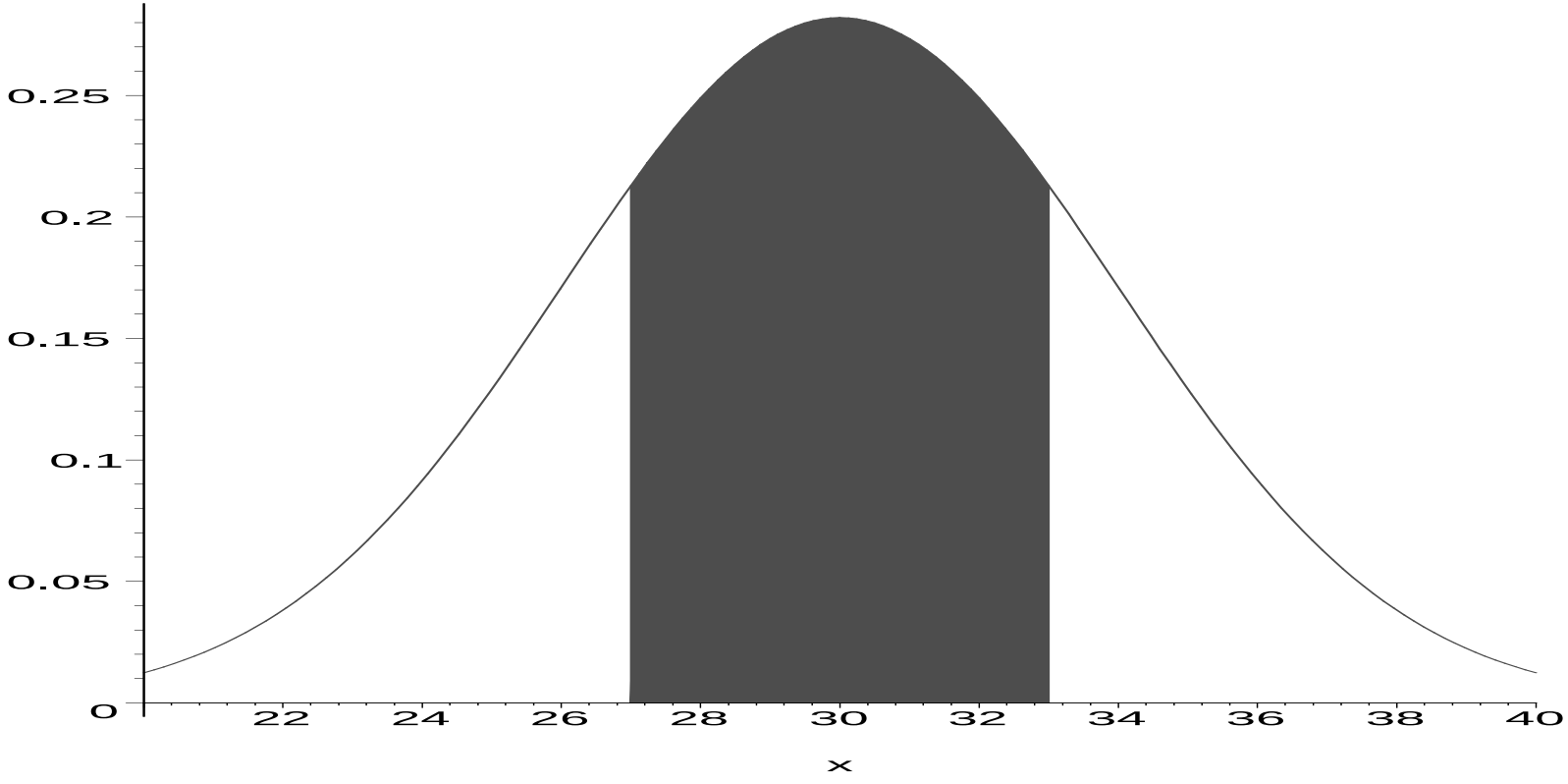
=1-NORMDIST(36,34.2,2.1,true)

In this case, the result is 0.29

This tells us that in a bell curve population with mean 34.2 and standard deviation 2.1, 29 percent of the population has a measurement of 36 or more.

Proportion Between Two Values

The proportion of the area under a bell curve between two given values **a** and **b** is:



NORMDIST(b,u,s,true)-NORMDIST(a,u,s,true)

Proportion Between Two Values

Example: Waist measurements of a certain population have bell curve distribution with mean 34.2 and standard deviation 2.1.

What proportion of this population has a waist measurement between 32 and 36?

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What proportion of this population has a waist measurement between 32 and 36?

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=NORMDIST(36,34.2,2.1,true)-NORMDIST(32,34.2,2.1,true)

In this case, the result is 0.57

Proportion Between Two Values

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What proportion of this population has a waist measurement between 32 and 36?

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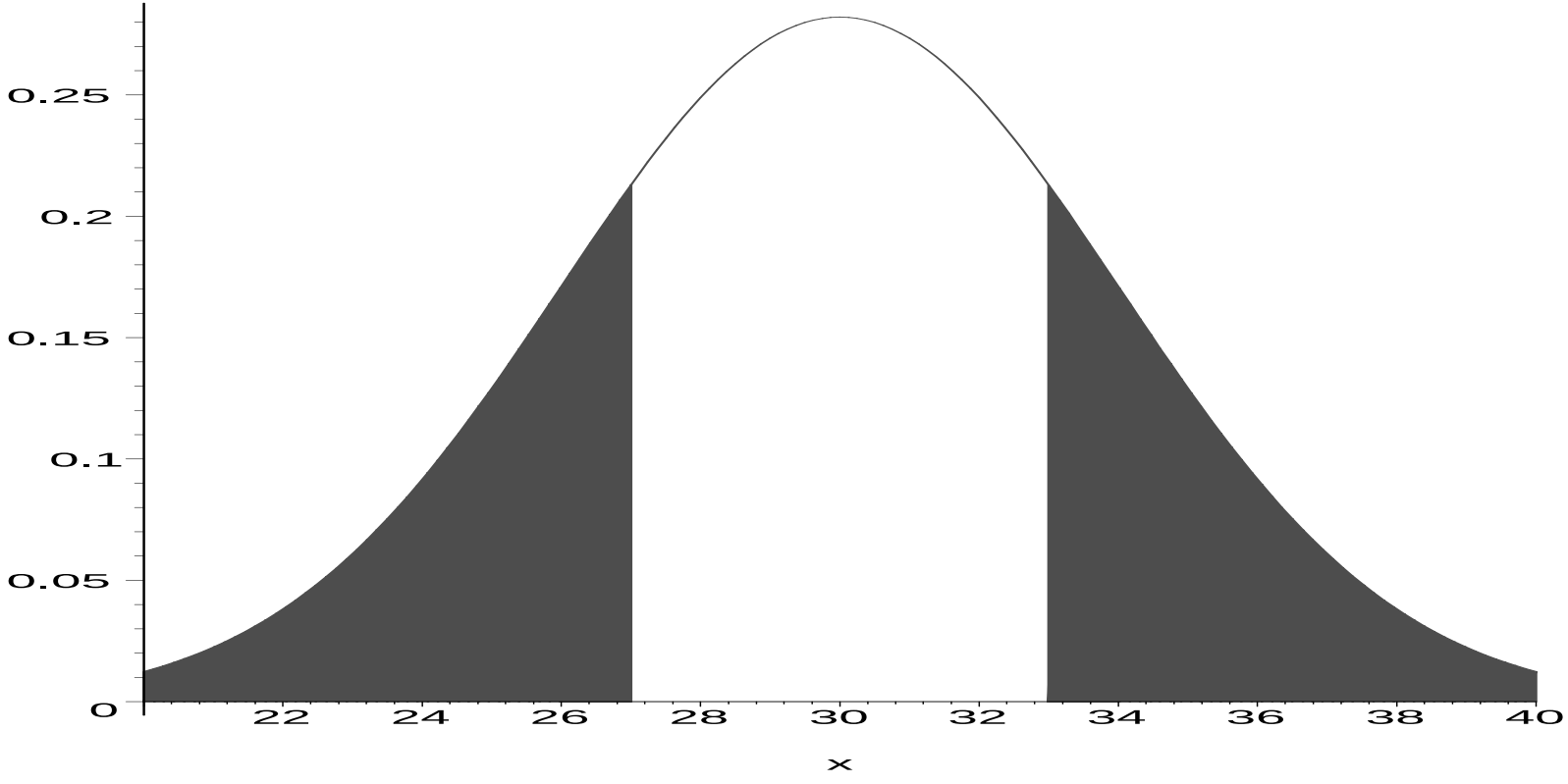
=NORMDIST(36,34.2,2.1,true)-NORMDIST(32,34.2,2.1,true)

In this case, the result is 0.57

This tells us that in a bell curve population with mean 34.2 and standard deviation 2.1, 57 percent of the population has a measurement between 32 and 36.

Proportion Outside an Interval

The proportion of the area under a bell curve below a given value **a** or above a second value **b** is:



1-(**NORMDIST(b,u,s,true)-NORMDIST(a,u,s,true)**)

Proportion Outside an Interval

Example: Waist measurements of a certain population have bell curve distribution with mean 34.2 and standard deviation 2.1.

What proportion of this population has a waist measurement below 32 or above 36?

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=1-(NORMDIST(36,34.2,2.1,true)-NORMDIST(32,34.2,2.1,true))

In this case, the result is 0.43

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In this case, the result is 0.43

This tells us that in a bell curve population with mean 34.2 and standard deviation 2.1, 57 percent of the population has a measurement between 32 and 36.

Example

Assuming scores on an IQ test are distributed as a bell curve with mean 100 and standard deviation 15.

What proportion of the population would have scores below 97?

- A) 0.58
- B) 0.49
- C) 0.38
- D) 0.42

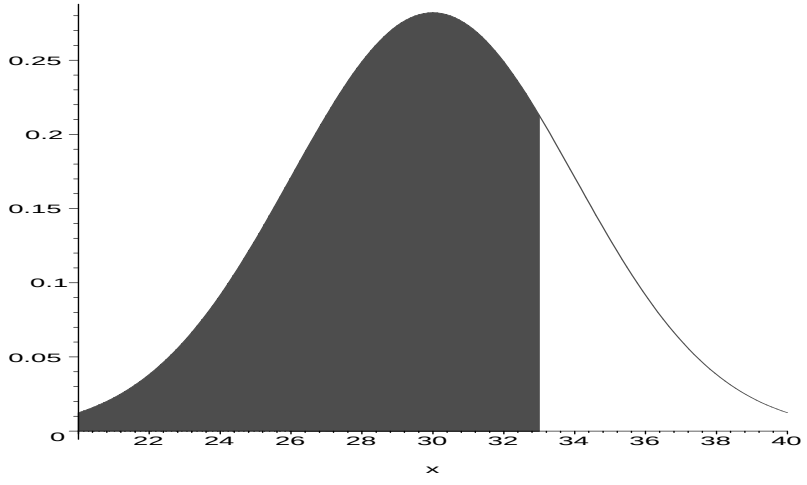
Example

Assuming scores on an IQ test are distributed as a bell curve with mean 100 and standard deviation 15.

What proportion of the population would have scores below 97?

Answer: D (.42)

=NORMDIST(97,100,15,true)



Example

Assume weights in a population are distributed as a bell curve with mean 175 and standard deviation 30.

What proportion of the population would weigh more than 200?

- A) 0.20
- B) 0.15
- C) 0.10
- D) 0.05

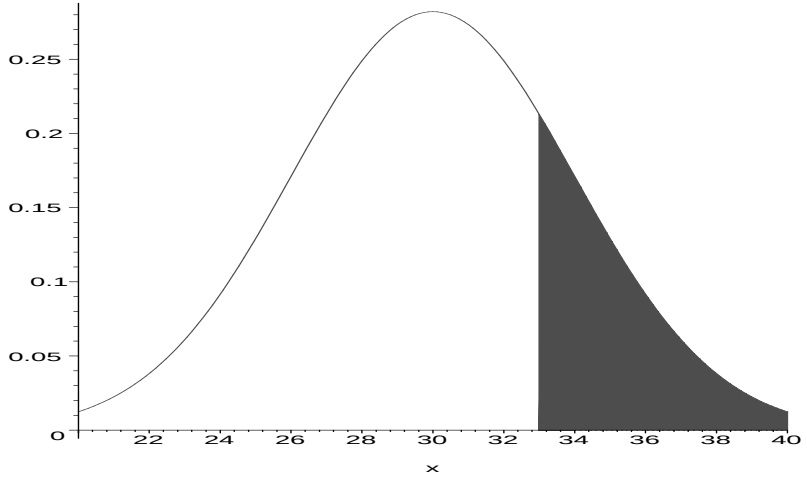
Example

Assume weights in a population are distributed as a bell curve with mean 175 and standard deviation 30.

What proportion of the population would weigh more than 200?

Answer: A (.20)

=1-NORMDIST(200,175,30,true)



Example

Assume systolic blood pressure follows a bell curve distribution with a mean of 120 and a standard deviation of 40.

What proportion of the population would have systolic pressure between 100 and 140?

- A) 0.45
- B) 0.32
- C) 0.38
- D) 0.28

Example

Assume systolic blood pressure follows a bell curve distribution with a mean of 120 and a standard deviation of 40.

What proportion of the population would have systolic pressure between 100 and 140?

Answer: C (0.38)

=NORMDIST(140,120,40,true)-
NORMDIST(100,120,40,true)