

Accuracy and Precision in Measurements

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WHAT'S COVERED

This tutorial will discuss accuracy in measurement versus precision through the following exploration:

1. Contrasting Accuracy and Precision

1a. Scale Example

1b. Dartboard Example

1. Contrasting Accuracy and Precision

When talking about **accuracy**, the focus is on how close the measurement is to what the measurement should have been.

Precision, on the other hand, is concerned with how consistent the measurements are to each other. In other words, how close are the measurements to a single value, regardless of whether or not that single value is the right answer.



TERMS TO KNOW

Accuracy

The extent to which the values, when considered all together, center around the correct value for a variable.

Precision

The extent to which the values are very close to each other, even if they are not near the correct value.

1a. Scale Example

Suppose you work for a consumer report company that sells personal weight scales. It's your job to decide whether each of these scales, labeled #1, #2, #3, and #4, are accurate, precise, both, or neither.

You take someone who weighs 161.8 pounds and placed them on the four different scales, five times each.

Take a look at Scale #1 and determine if this scale is accurate, precise, both, or neither.

Scale 1				
Accuracy ✓ Precision ✗				
160.4	158.8	161.4	164.2	162.0

Scale #1 is accurate because the numbers average out to the right answer of 161.8. Although it reported a fairly low number such as 158.8 and a high number of 164.2, by and large, the numbers average out to what's pretty close to the right answer.

However, Scale #1 is not precise because the numbers are not close to a single value every time.

Take a look at Scale #2 and determine if this scale is accurate, precise, both, or neither.

Scale 2				
Accuracy ✗ Precision ✓				
168.2	167.8	167.8	168.0	168.4

You can tell just by looking at the numbers that all values are within 1 pound of each other, which means it is precise. Remember, it doesn't need to be close to the actual correct number, but they need to be close to each other.

But take a look at the average. The average of Scale #2 is about 168, which is overestimating by at least 7 pounds, so this scale is not accurate.

Take a look at Scale #3 and determine if this scale is accurate, precise, both, or neither.

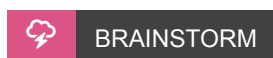
Scale 3				
Accuracy ✓ Precision ✓				
161.0	161.8	161.6	162.0	161.2

All of these are within a pound of each other. They're also very close to 161.8 pounds, the true weight of the individual you selected. Having the numbers all close to each other make it precise, and the numbers average out to be very close to the correct weight of 161.8. Therefore, Scale #3 is both accurate and precise.

Take a look at Scale #4 and determine if this scale is accurate, precise, both, or neither.

Scale 4				
Accuracy ✗ Precision ✗				
161.8	170.2	165.4	168.4	164.8

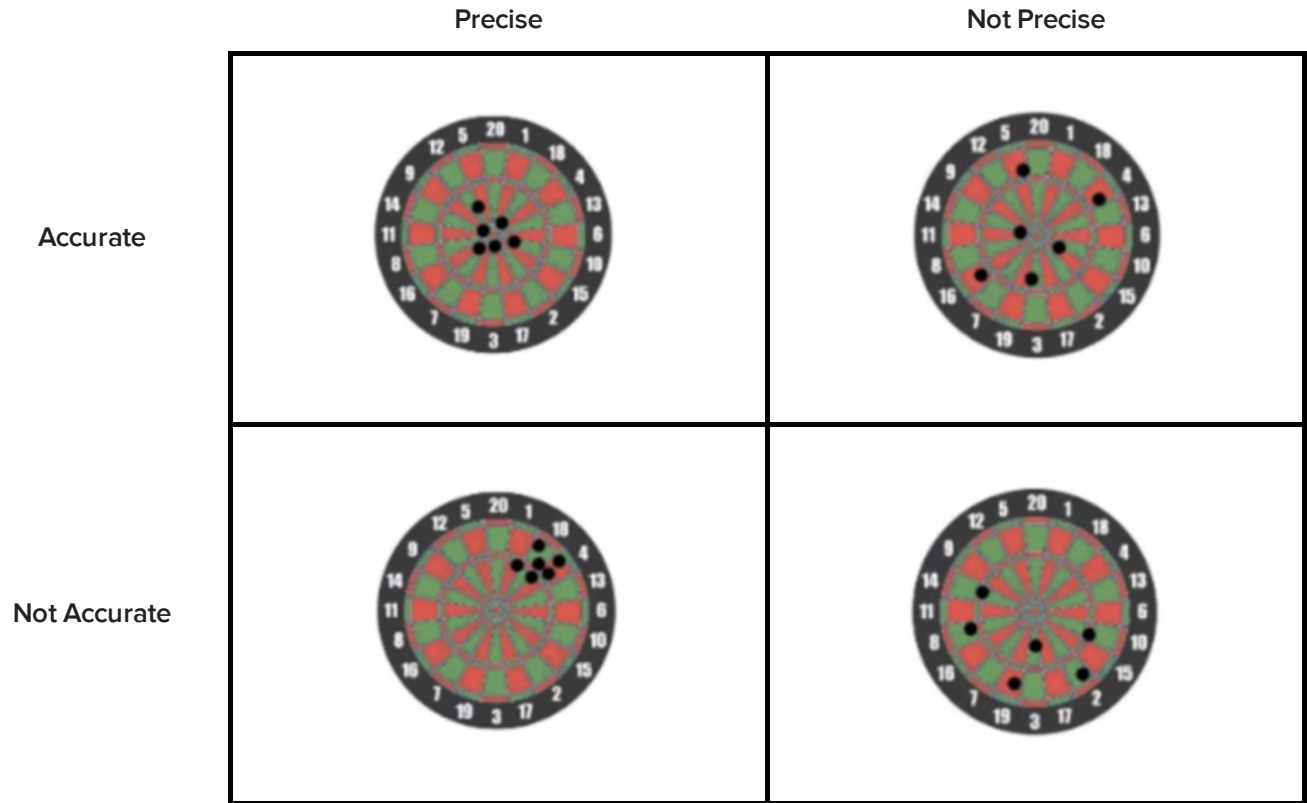
It actually did get the correct weight of 161.8 once, but if you look at the five measurements taken as a whole, they're pretty far off and they tend to overestimate. They don't really center around the right number all that much, so it's not accurate. The numbers are also all over the place, so this scale is not precise.



If you worked for a consumer report company and you were evaluating the above scales, which scale would you choose and why?

1b. Dartboard Example

A dartboard is a very popular example of precision and accuracy, assuming the bulls-eye is the desired outcome, or “value”.



For the cases above:

- *Precise and Accurate*: In the top left corner, the darts are clumped together AND around the bulls-eye.
- *Not Precise, but Accurate*: In the top right corner, the darts are not clumped together, but they loosely surround the bulls-eye.
- *Precise, but Not Accurate*: In the bottom left corner, the darts are clumped together, but not around the correct “value”, or in this case, the bulls-eye.
- *Not Precise nor Accurate*: In the bottom right corner, the darts are spread out and are not surrounding the bullseye.



SUMMARY

By contrasting accuracy and precision, you now know that accuracy is how close the measurements are to the right answer, though they may not necessarily land exactly on the correct answer. Precision is how consistent measurements are with each other, even if they are not near the correct value.

Generally, you will see them clumped together. In a given measurement scenario, high accuracy and high precision is ideal.

Good luck!

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