

## 4.1: Random Variables

### Learning Objectives

- To learn the concept of a random variable.
- To learn the distinction between discrete and continuous random variables.

### Definition: random variable

A random variable is a numerical quantity that is generated by a random experiment.

We will denote random variables by capital letters, such as  $X$  or  $Z$ , and the actual values that they can take by lowercase letters, such as  $x$  and  $z$ .

Table 4.1.1 gives four examples of random variables. In the second example, the three dots indicates that every counting number is a possible value for  $X$ . Although it is highly unlikely, for example, that it would take 50 tosses of the coin to observe heads for the first time, nevertheless it is conceivable, hence the number 50 is a possible value. The set of possible values is infinite, but is still at least countable, in the sense that all possible values can be listed one after another. In the last two examples, by way of contrast, the possible values cannot be individually listed, but take up a whole interval of numbers. In the fourth example, since the light bulb could conceivably continue to shine indefinitely, there is no natural greatest value for its lifetime, so we simply place the symbol  $\infty$  for infinity as the right endpoint of the interval of possible values.

Table 4.1.1: Four Random Variables

Experiment	Number X	Possible Values of X
Roll two fair dice	Sum of the number of dots on the top faces	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Flip a fair coin repeatedly	Number of tosses until the coin lands heads	1, 2, 3, 4, ...
Measure the voltage at an electrical outlet	Voltage measured	$118 \leq x \leq 122$
Operate a light bulb until it burns out	Time until the bulb burns out	$0 \leq x < \infty$

### Definition: discrete random variable

A random variable is called discrete if it has either a finite or a countable number of possible values. A random variable is called continuous if its possible values contain a whole interval of numbers.

The examples in the table are typical in that discrete random variables typically arise from a counting process, whereas continuous random variables typically arise from a measurement.

### Key Takeaway

- A random variable is a number generated by a random experiment.
- A random variable is called discrete if its possible values form a finite or countable set.
- A random variable is called continuous if its possible values contain a whole interval of numbers.

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