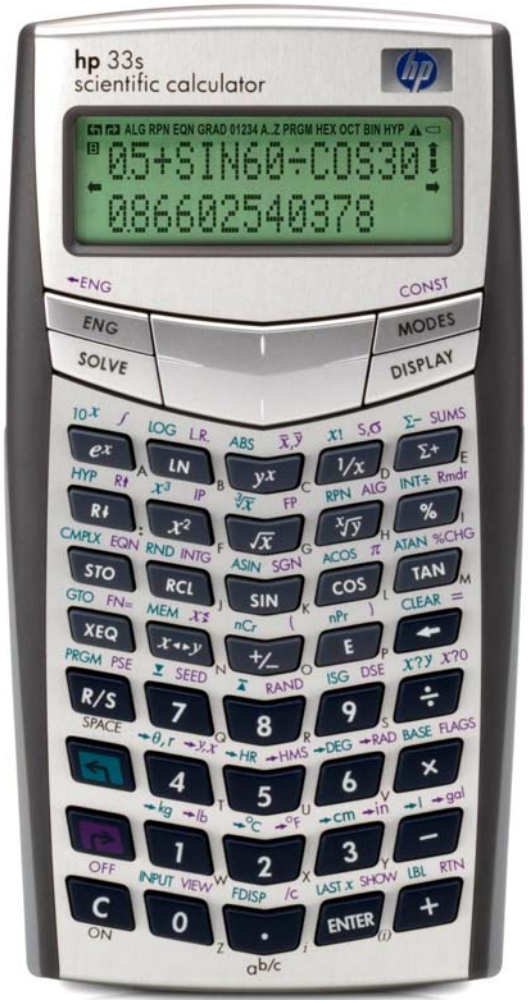
hp calculators



HP 33S Using random numbers for simulations

Random numbers

Simulation

Practice using random numbers for simulations

Random numbers

Random numbers have uses as varied as games and stock market simulations. On the HP 33S, generating random numbers involves providing a starting decimal seed to the calculator using the [↗] [SEED] function. Random numbers between 0 and 1 are then generated sequentially using the [↗] [RAND] function.

A different series of random numbers will be generated from each decimal number used as an initial seed. Using the same initial seed will result in the same series of random numbers.

Simulation

A useful application of random numbers is to simulate complex processes that involve the element of chance. These simulations can be as easy as simulating the flip of a coin or can be quite elaborate. The examples below are far from exhaustive, but provide an illustration of how random numbers can be used on the HP 33S.

Practice solving problems angles and times

Example 1: Simulate flipping a coin four times. Use a starting seed of 0.123456.

Solution: When a coin is flipped, the probability of heads is 0.5 and of tails also 0.5. Let the decimal range of 0 < random number < 0.5 equate to observing a "heads." The decimal range of 0.5 <= random number <1 will equate to a tails. Store the initial seed and then generate the four random numbers.

In RPN or algebraic mode: [0] [.] [1] [2] [3] [4] [5] [6] [↗] [SEED]

Figure 1

In RPN or algebraic mode: [↗] [RAND]

Figure 2

In RPN or algebraic mode: [↗] [RAND]

Figure 3

In RPN or algebraic mode: [↗] [RAND]

Figure 4

In RPN or algebraic mode: [↗] [RAND]

Figure 5

Answer: The first three random numbers are in the range 0.5 <= random number <1, and therefore equate to the result "heads." The fourth random number is in the range 0 <= random number < 0.5, and is therefore a result of "tails." Figures 2 through 5 show the display assuming algebraic mode.

Example 2: Nelson's Newstand sells newspapers and has experienced demand for newspapers as follows over the last 50 days: 10 newspapers on 5 of the days; 15 newspapers on 20 of the days; 20 newspapers on 15 of the days; and 25 newspapers on 10 of the days. Using random numbers and an initial seed of 0.234567, simulate demand for the next 5 days.

Solution: The first step will be to translate the past demand into ranges for our random numbers for the simulation. Out of past 50 days, demand was 10 on 5 of these days, or 10% of the time. Out of the past 50 days, demand was 15 on 20 of these days, or 40% of the time. Out of the past 50 days, demand was 20 on 15 of these days, or 30% of the time. Finally, out of the past 50 days, demand was 25 on 10 of the days, or 20% of the time. This information can be summarized in a table as shown below.

Demand	Probability
10	0.1
15	0.4
20	0.3
25	0.2

Next, we need to assign a range for each level of demand that corresponds to the relative probability for that demand. It is this range that will be used to classify each random number as a specific simulated demand.

Demand	Probability	Range
10	0.1	0.0 < random number <= 0.1
15	0.4	0.1 < random number <= 0.5
20	0.3	0.5 < random number <= 0.8
25	0.2	0.8 < random number < 1.0

Note that each range corresponds to the probability of each outcome (the range between 0.1 and 0.5 is 40% of the possible outcomes of the random numbers and therefore reflects the 40% chance that a demand of 15 will occur). Store the initial seed and then generate the five random numbers. Evaluate each random number as it is generated.

In RPN or algebraic mode: [0] [.] [2] [3] [4] [5] [6] [7] [↗] [SEED]

Figure 6

In RPN or algebraic mode: [↗] [RAND]

Figure 7

This corresponds to a demand of 20 newspapers. In RPN or algebraic mode: [↗] [RAND]

Figure 8

This corresponds to a demand of 15 newspapers. In RPN or algebraic mode: [↗] [RAND]

Figure 9

This corresponds to a demand of 20 newspapers. In RPN or algebraic mode: [↗] [RAND]

Figure 10

This corresponds to a demand of 20 newspapers. In RPN or algebraic mode: [↗] [RAND]

Figure 11

This corresponds to a demand of 20 newspapers. In RPN or algebraic mode: [↗] [RAND]

Answer: The results were demands of 15, 20, 20, 20 and 20 newspapers. If the simulation were carried out for a longer period (which could be done by writing a program), other levels of demand would be generated. Figures 6 through 11 show the display assuming algebraic mode.

Example 3: Simulate rolling 2 dice. Use a starting seed of 0.345678

Solution: When a die is rolled, the result is equally likely to be a 1, 2, 3, 4, 5, or 6. Since the HP 33S random numbers are decimal numbers, it will be necessary to transform them into integers between 1 and 6. Since the lowest possible valid value of rolling a die is 1, the process to transform a decimal random number into a value between 1 and 6 will be:

Result = The integer value of (the random number x 6 plus 1)

It is necessary to multiply the decimal random number generated by 6, add 1 and take the integer value of the result. Since two die are to be rolled, this will be done two times. Store the initial seed and then generate the first random number.

In RPN or algebraic mode: 0 . 3 4 5 6 7 8 [shift] SEED

Figure 12

In RPN or algebraic mode: [shift] RAND

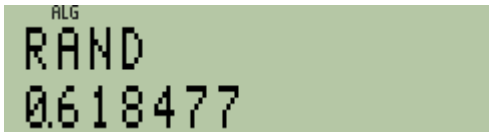


Figure 13

In RPN mode: 6 × 1 + [shift] IP

In algebraic mode: × 6 + 1 ENTER [shift] IP

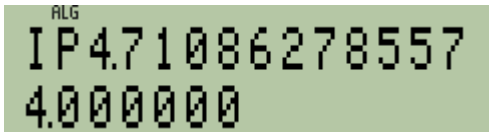


Figure 14

In RPN or algebraic mode: [shift] RAND

Figure 15

In RPN mode: 6 × 1 + [shift] IP

In algebraic mode: × 6 + 1 ENTER [shift] IP

Figure 16

Answer: The value of the first die was a 4 and the second was a 5, for a total on the two dice of 9. Figures 12 through 16 show the display assuming algebraic mode.