

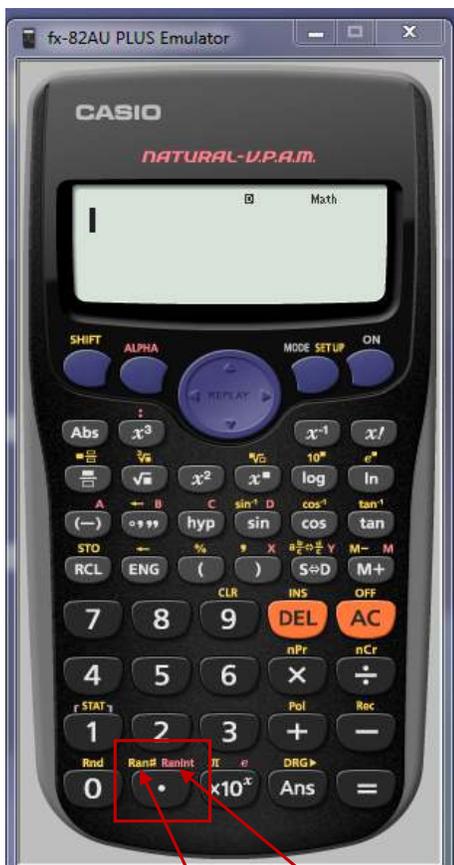
## Statistical Simulations

**Simulation** is a way to model random events, the simulated outcomes closely match real-world outcomes. By observing simulated outcomes, researchers gain insight in solving real world problems. Some statistical situations do not lend themselves to a precise mathematical analysis, time-consuming, or expensive to analyse. In these situations, simulation may approximate real-world results, requiring less time, effort, and/or money.

A simulation is useful only if it closely mirrors real-world outcomes.

The steps required to produce a useful simulation are presented below.

1. Describe the possible outcomes
2. Link each outcome to one or more random numbers
3. Choose a source of random numbers.
4. Choose a random number
5. Based on the random number, note the "simulated" outcome
6. Repeat steps 4 and 5 multiple times; preferably, until the outcomes show a stable pattern
7. Analyse the simulated outcomes and report on the simulated results.



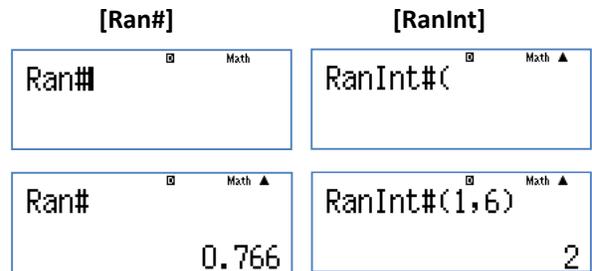
Using the [Ran#] and [RanInt] key.

**[Ran#]** generates a random number from 0.000 to 0.999, that is 1000 distinct random numbers.

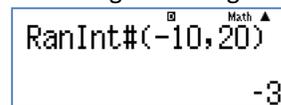
**[RanInt]** generates random integers between a lower bound and an upper bound number specified by the user.

Both [Ran#] and [RanInt] are accessed through the [.] key.

**[Ran#]** is in yellow and is accessed by pressing [SHIFT] [.] and **[RanInt]** is in red and is accessed by pressing [ALPHA] [.]



Note: Negative integers can also be generated.

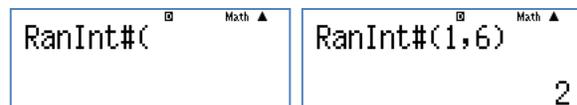


This activity will focus on using the **RanInt** feature of the FX82AU+ model.

### Example 1:

Generate the rolls of a 6 sided fair dice.

Using  $\text{RanInt}(1,6)$  will generate the numbers 1, 2, 3, 4, 5 or 6 randomly.

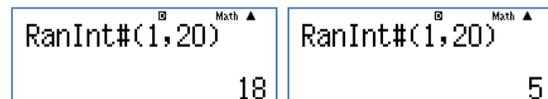


Each time you press the [=] key a new random integer is generated.

### Example 2:

Generate the rolls of a 20 sided fair dice.

Using the  $\text{RanInt}(1,20)$  this will generate the numbers 1, 2, 3, 4, 5, ..., 18, 19 or 20 randomly.



Each time you press the [=] key a new random integer is generated.

Suppose you want to find out the probability that a family with three children contains exactly one girl.

A family with three children could be simulated by flipping a coin three times or flipping three coins simultaneously and recording the results would represent a family of three children.

You would need to repeat this experiment many times to calculate an estimated probability of having exactly one girl in three children families.

The results of twenty "family sets" achieved by flipping three 10 cent coins, is shown in the chart below.

 B G G	 B B G	 B G G
 B B B	 G G G	 B G B
 B G G	 B G G	 G G B
 B G G	 B B G	 B G G
 G G B	 G G B	 B G B
 G B B	 B G B	 B B B
 G G B	 B G B	

3-children family	Tally	Count	Probability
3 boys and 0 girls		2	$\frac{2}{20} = 0.1 = 10\%$
2 boys and 1 girl		7	$\frac{7}{20} = 0.35 = 35\%$
1 boy and 2 girls		10	$\frac{10}{20} = 0.5 = 50\%$
0 boys and 3 girls		1	$\frac{1}{20} = 0.05 = 5\%$

### Problem

Use RanInt(1,2) to generate sets of three-children families to complete the table. Use RanInt(1,2) three times for each 'family'. You can write G (=1) or B (=2) to represent each child's gender.


3-children family	Tally	Count	Probability
3 boys and 0 girls			
2 boys and 1 girl			
1 boy and 2 girls			
0 boys and 3 girls			

Repeat the random simulation of three children families again.


3-children family	Tally	Count	Probability
3 boys and 0 girls			
2 boys and 1 girl			
1 boy and 2 girls			
0 boys and 3 girls			

Theoretically:

3 children family	Theoretical probability
3 boys and 0 girls	$\frac{1}{8} = 0.125 = 12.5\%$
2 boys and 1 girl	$\frac{3}{8} = 0.375 = 37.5\%$
1 boy and 2 girls	$\frac{3}{8} = 0.375 = 37.5\%$
0 boys and 3 girls	$\frac{1}{8} = 0.125 = 12.5\%$

How do your results compare with the theoretical values?

### Activity

Scissors, paper rock is a game played in many cultures. Two people face each other while holding one hand behind their back. On the count of three they bring their hand forward with either, an open palm (paper), two fingers (scissors) or a fist (rock).

- Paper beats rock (paper covers the rock)
- Rock beats scissors (rock smashes scissors)
- Scissors beats paper (scissors cuts paper)
- If two symbols are the same it is a draw and the game is replayed.

Design a simulation, using RanInt, for two players to play the game three times, for a 'best of three' contest.

Use the 7 steps identified to produce a useful simulation for playing the game 'Scissors, paper rock' presented on the previous page.

For further tips, more helpful information and software support visit our website: [www.casio.edu.monacocorp.co.nz](http://www.casio.edu.monacocorp.co.nz)