



## **Random Sampling**

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### **LEVEL**

High school or university students with basic knowledge in Mathematics.

### **OBJECTIVES**

To use the calculator's built-in spreadsheet tool to make elementary statistical evaluations for real-life problems. To understand the notion of "random number" and its importance for statistical evaluations.

### **Corresponding eActivity**

S05RAND.g1e (for Activity1), S05NICE.g1e (for Activity2)

### **OVERVIEW**

We will see how to random values for a statistical evaluation with the use of calculator and how to demonstrate their basic characteristics.

### **EXPLORATORY ACTIVITIES**

[Note]

1. Some exercises are placed inside eActivities presuming that they are solved in classrooms. Students are recommended to discuss their solutions with their teacher and classmates.

2. The solutions to exercises are included in eActivities.

Here we describe two activities. For their mathematical background refer for example to [LM], page 211-255.

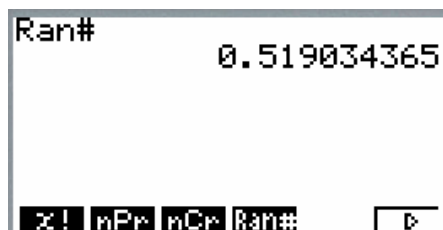
## Random Sampling

### Activity 1 (S05RAND.g1e):

The article "random" is rather popular and its real-life meaning partially differs from the meaning in statistics. When someone says: "I walked through the town and randomly met with Juliana", he/she does not mention dozens (possibly hundreds) unknown people he/she also passed by in the streets. All these people have also been randomly met. The person did not notice them as he/she is not familiar with them. But in the statistical meaning of the word, all these encounters have been random, too.

Thus, in the World of Statistics, all facts and events live together: known, unknown, correct, wrong, frightening, welcome, and all others. To simulate reality, we can simulate such random events using random numbers.

(a) (Refer to Random Number) Generate a random number. Press **OPTN** **F6** (to move to the extended submenu) and then **F3** (PROB – from probability). Press **F4** (Ran#) and **EXE**. A number between 0 and 1 appears.



Notice that the values 0 and 1 themselves will never appear. Only the "inner values" (greater than zero and less than one) are generated.

## EXERCISES A

### Exercise 1.

Ask your classmates about their results. Have they received the same number? Discuss.

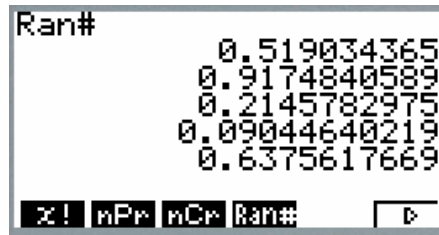
## SOLUTIONS to EXERCISES A

### Exercise 1

Receiving the same number is possible but unlikely. The calculator's set of random numbers is huge. A parallel occurrence of the same number is not excluded but its probability is extremely low.

(b) (Refer to Selected Digit) All random numbers have the format 0.xxxxxxxx. The first digit is always zero - but the digits after the decimal point vary. Select a digit from 0 to 9. Generate random numbers as long as your preferred digit appears at the decimal first place after the decimal point. Count the number of trials you have to make. [Hint] To generate the next random number, simply press **EXE**.

## Random Sampling



### EXERCISES A

#### Exercise 2.

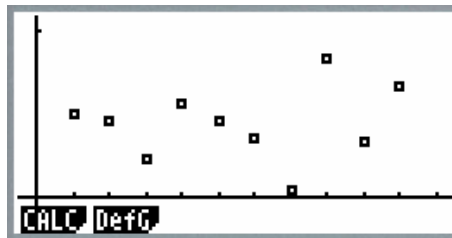
Repeat the previous experiment 10 times. Register the lengths of the intervals between two consecutive appearances of random numbers starting with the same first digit. Have you observed any regularity in the length of the intervals? Discuss.

### SOLUTIONS to EXERCISES A

#### Exercise 2

The break between two identical first digits can be of any length. This property guarantees that the numbers are really random.

(c) (Refer to [Graphing](#)) Place 10 random values into a spreadsheet table. Draw a scattered graph. Notice that its points do not create any regular pattern – this is another indication of a random set of figures.



(d) (Refer to [Calculate Mean](#)) Calculate the mean of the ten intervals you have registered. Discuss your result with your classmates. The mean should be not far from 0.5.

SHEET	A	B	C	D
1	0.8753	0.496		
2	0.5529			
3	0.5616			
4	0.7166			
5	0.7109			
=CellMean(A1:A10)				

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This naturally only holds for larger amounts of random numbers. Here, the mean of ten random numbers is 0.496. The mean value can vary in a neighborhood of 0.5 – become bigger and smaller depending on their (random) combination.

## Random Sampling

### EXERCISES A

#### Exercise 3.

Take two last digits of the year in which you are born. (If it is 1987, use 87.) Generate random numbers until one starting with them. Make a guess: How many random numbers (in average) you will have to make before your pair shows up?

### SOLUTIONS to EXERCISES A

#### Exercise 3

As there are 100 different pairs of digits (00 to 99) coming in a random order, your pair can in average come as fiftieth. If you are unlucky, it may show up much later as some pairs can come repeatedly.

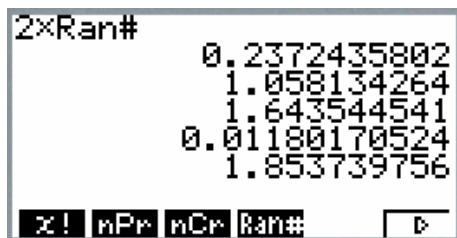
#### Activity 2 (S05NICE.g1e):

The random numbers between 0 and 1 are not "nice". If we need random numbers, their values are rather different. For example:

- Tossing a coin generates one of two cases that can be denoted as 0 and 1.
- Throwing a dice generates a random number from 1 to 6.
- In Lotto the numbers depend on the country in which it is played.

So, we would prefer having a possibility to transform the values generated by the calculator to our preferred interval.

(a) (Refer to Tossing Coin) At the beginning we expand the interval of random numbers from 0 to 2. The method is simple – multiply (by two) the random number from the interval 0 to 1. The value will be from 0 to 2 – excluding the interval edges. Thus, each of them starts with 0 or 1 *before* the decimal point.



(b) (Refer to Nice Tossing) The above method generates appropriate random number, but their format is rather complex. They are not easy to read. We would appreciate results that only contain what we need. To get them, the decimal part must be truncated i.e. omitted regardless of its size. The whole number (0 or 1) is the only figure of our interest.

The INT function performs that. It belongs among numerical functions. When the RUN-MATH window is open, press the  $\square$  button. Then  $\square$  and  $\square$  (NUM). The numerical submenu appears. Its second item is the INT function. Thus, pressing  $\square$  inserts it. The expression to be truncated is its argument.

Its argument will be enclosed into the parentheses. First type "(2x". Then press  $\square$   $\square$  to move to the extended submenu. Then  $\square$  (PROB) and  $\square$  (Ran#). Type the closing parenthesis and press  $\square$ . A random number 0 or 1 appears. Pressing  $\square$  generates new and new random numbers in our requested format.

## Random Sampling

```
Int (2×Ran# )      1
Int (2×Ran# )      0
Int (2×Ran# )      0
0
x! nPr nCr Ran#  ▸
```

(c) (Refer to Throwing Dice) First we need to expand the interval to cover 6 different values. Thus,

$$6 \times \text{Ran\#}$$

is the appropriate formula.

```
6×Ran#
2.574161062
0.647886882
4.301570344
3.335535812
5.274379786
x! nPr nCr Ran#  ▸
```

The first numbers generated by this formula vary between 0 and 5. Thus adding one to the result will produce numbers between 1 and 6.

```
6×Ran# +1
3.951357951
6.782713859
5.230868612
2.728762769
6.749285525
6.552891845
x! nPr nCr Ran#  ▸
```

## EXERCISES B

### Exercise 1.

Truncate the random numbers from the above activity to generate the random whole numbers 1 to 6.

### Exercise 2.

In an equivalent of Lotto in Slovakia, people guess six numbers between 1 and 49. Recommend a strategy for generating them (presuming that all 6 numbers must be different).

### Exercise 3.

Use your own random number generator, randomly select five students from your class.

### Exercise 4.

Can we skip or neglect any number generated by a random number generator when, say, selecting classmates?

## ***Random Sampling***

### **SOLUTIONS to EXERCISES B**

#### ***Exercise 1.***

Use the formula  $\text{INT}(6*\text{Ran}\# + 1)$

#### ***Exercise 2.***

The first number is selected randomly. The second one is generated (and only chosen if it differs from the first one). The third one must differ from both selected before. This repeats until six different digits are generated.

#### ***Exercise 3.***

Give an ordering number to each of your classmates (e.g. using their alphabet order). Build a random number generator generating all these numbers. Generate first five different random numbers.

#### ***Exercise 4.***

It is not recommended. You could introduce elements removing randomness.

### **REFERENCE**

[LM] Douglas A. Lind and Robert D. Mason, *Basic Statistics for Business and Economics*, Irwin/McGraw-Hill, 1997. ISBN 0-256-19408-4