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Mathematical Skills for Data Scientists
Lab Exercises 7

CSCM70

Lab 7 Solutions

Mathematical Skills for Data Scientists

Lab Exercises 7 – 5 Marks (Due: 12/11/22)

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Question 1

Exercise 1. Write a routine that takes as input a function f and a natural number N, then generates N random numbers x_i between 0 and 1 and computes the average of all function values $f(x_i)$. Compare the result to $\int_0^1 f(x)dx$. (marks 2)

Answer 1:

We make a function named as routine(func,N).

routine.m

Where func will be the passed function with N as the number of intermediate numbers between 0 and 1 . We calculate the average of N function values.

We chose the function as f(x) = 2x.

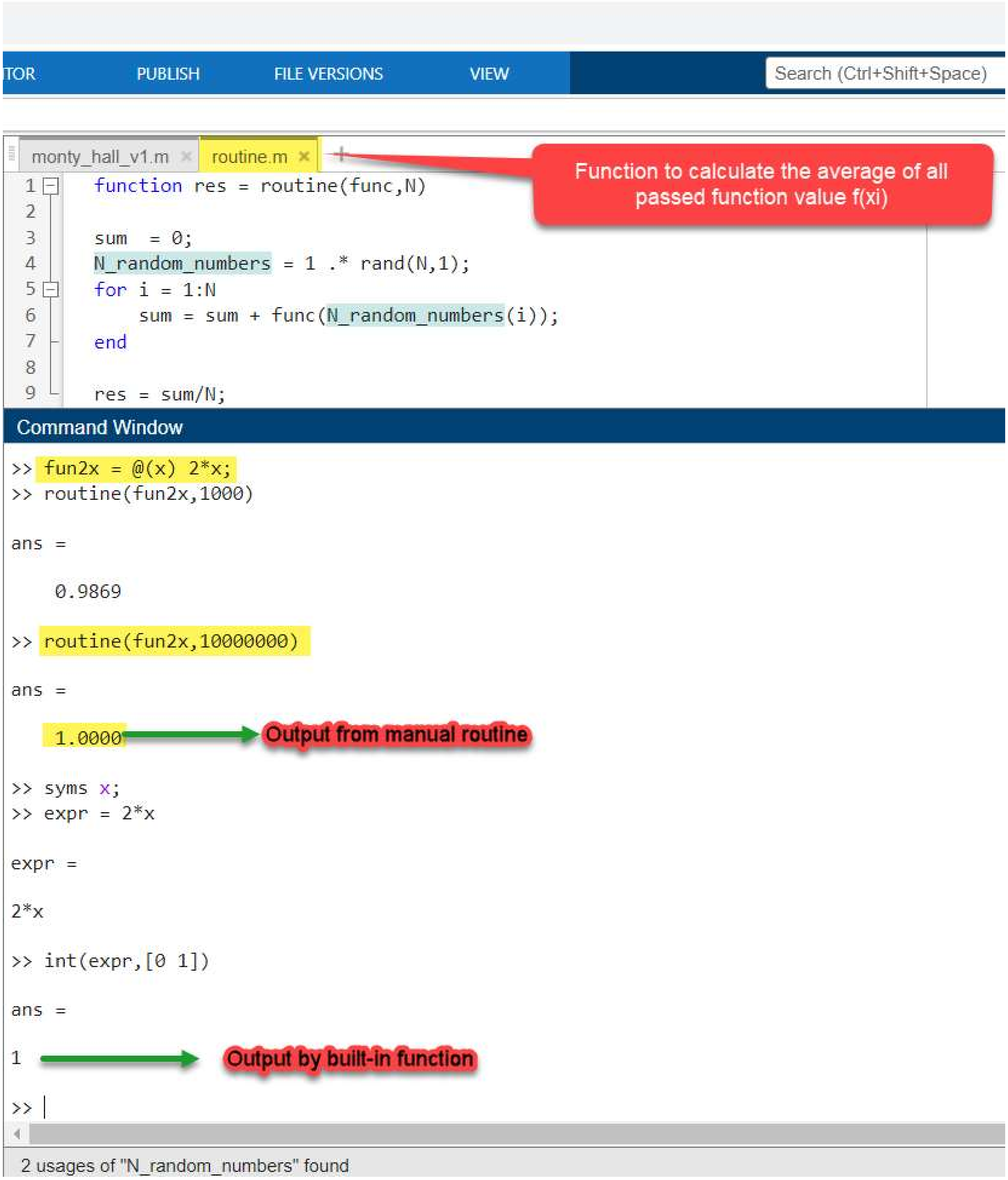
The indefinite integral of which is x^2. Definite integral of 2x would be $1^2 - 0^2$.

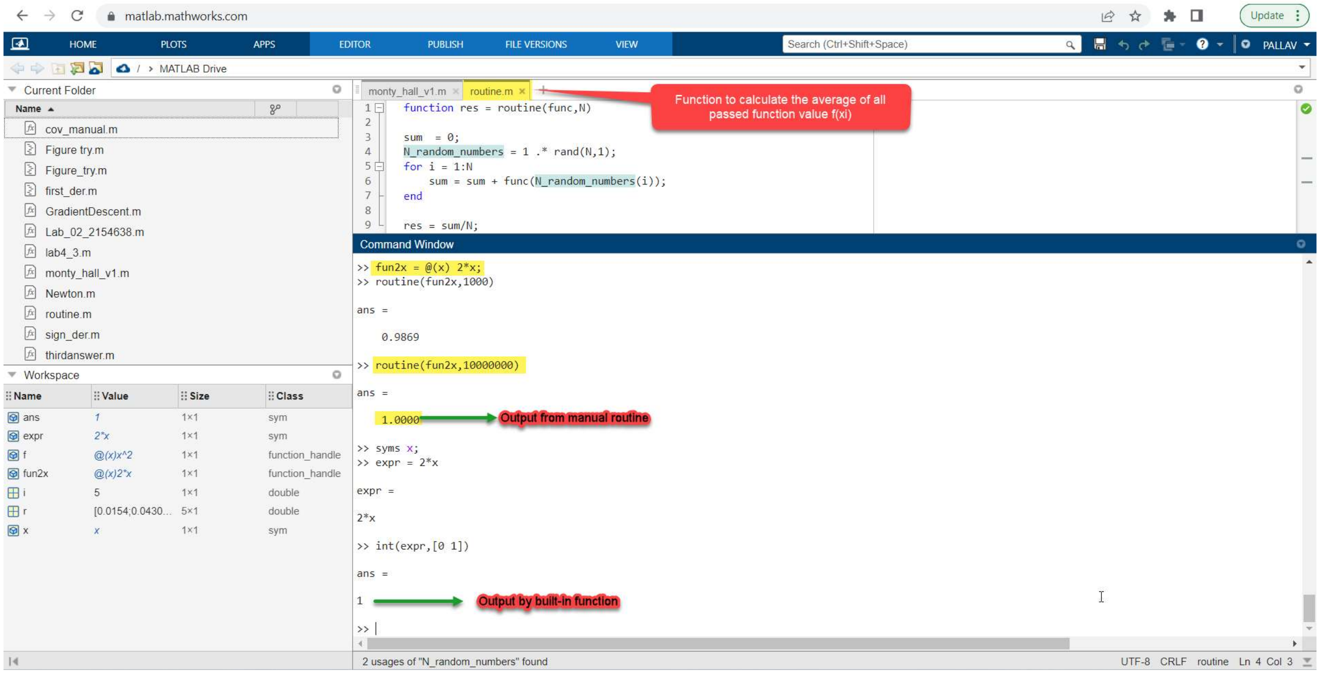
We then compare the result with the built-in function : int which calculate the definite integral of a function between certain range. Reference: https://in.mathworks.com/help/symbolic/sym.int.html . The output of which is equal to our manual routine output.

Ref: From Sir's Lecture -

OUTPUT MATLAB: COMMAND WINDOW

Output of answer 1





Question 2

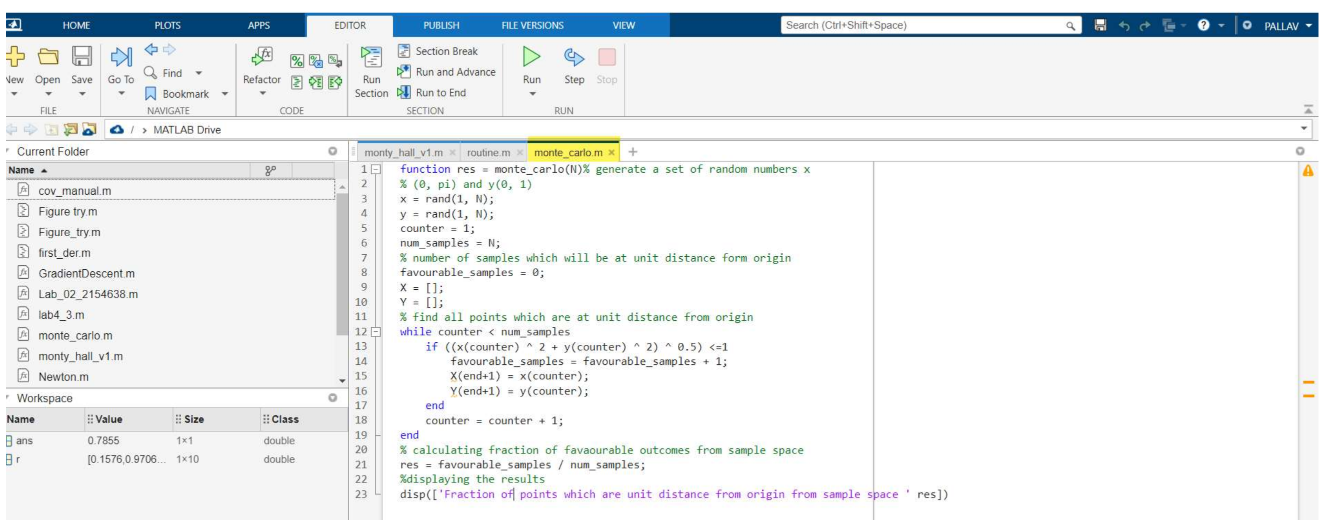
Exercise 2. Write a function that generates points in the unit square (points (x, y) with $0 \leq x \leq 1, 0 \leq y \leq 1$) uniformly at random, and keeps track of which fraction of them are within a distance of 1 from the origin. What does this Monte-Carlo method compute? (marks 2)

Answer 2.1

Developed a routine named `monte_carlo(N)`, where `N` denotes the number of randomly generated points between 0 and 1 on the x and y axis.

monte_carlo.m

The points which are at within a distance of 1 from origin means that, their unit distance from the origin is 1 unit. Distance of point (x, y) from $(0, 0)$ is calculated by : $((x-0)^2 + (y-0)^2)^{1/2} = (x^2 + y^2)^{1/2}$



We use a while loop to check the distance of each point and count the number of favourable outcomes by the `favourable_samples` variable.

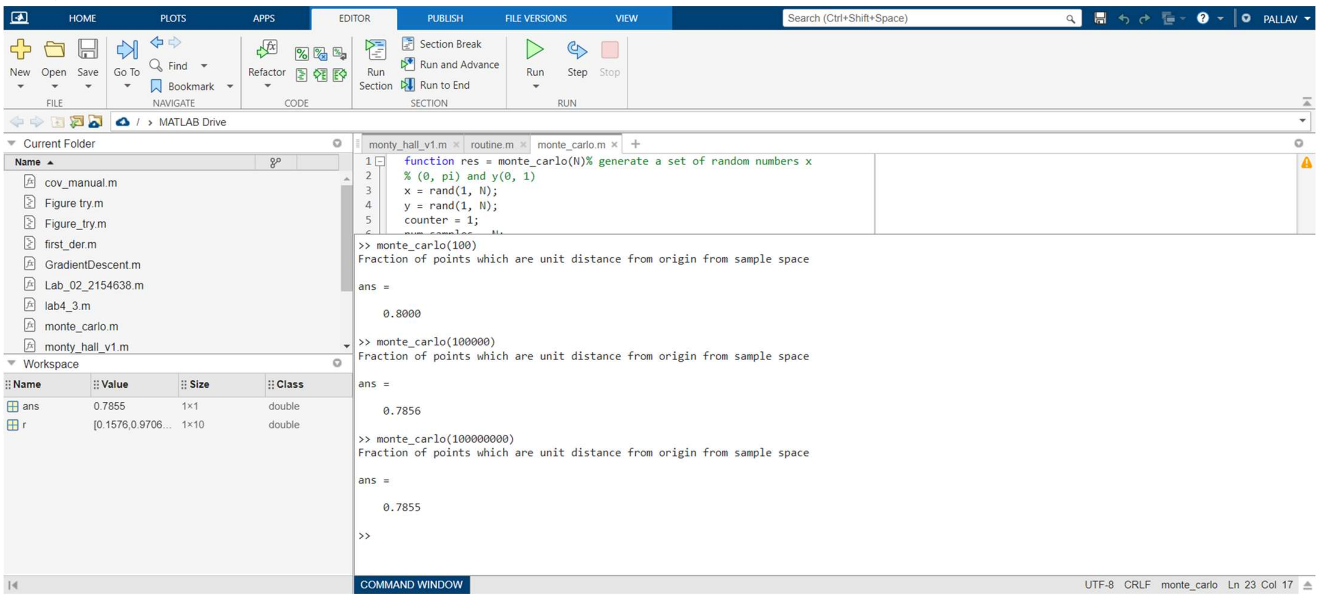
The result, that is the fraction of `favourable_samples` is stored in `res` and calculated as:

$$\frac{No.\ of\ favourable\ outcomes}{Total\ number\ of\ samples}$$

Ref: From Sir's Lecture -

OUTPUT MATLAB: COMMAND WINDOW

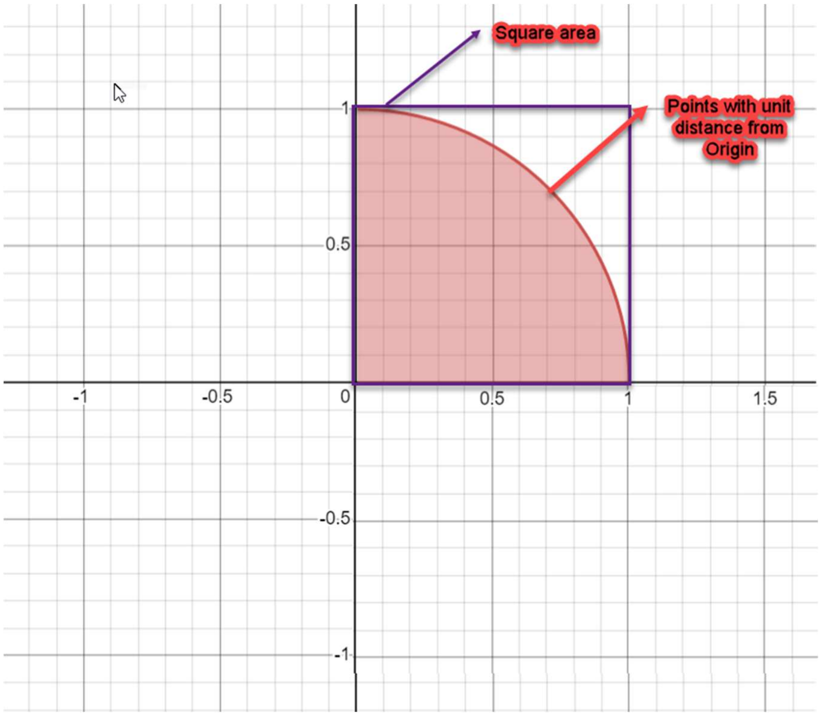
Output of answer 2




```
monte_carlo(100)
Fraction of points which are unit distance from origin from sample space

ans =

    0.8000

monte_carlo(100000)
Fraction of points which are unit distance from origin from sample space

ans =

    0.7856

monte_carlo(100000000)
Fraction of points which are unit distance from origin from sample space

ans =

    0.7855
```

Answer 2.2

This Monte-Carlo indicates gives us a probability distribution of points which are at a distance of 1 from the origin in the space $0 \leq x \leq 1$ and $0 \leq y \leq 1$. That is this gives us ¼ of a circle of radius = 1 unit .



Reference: https://www.desmos.com/calculator/ivud1auwvw

Question 3

Exercise 3. Download the data1 file from the assignment portal. Calculate the mean an standard deviation of the data set.

Assuming the data is normally generated, how many values would exceed 300? How man values would be negative?

Compare this to how many values actually exceed 300 and how many actually are negativ and comment on any discrepancies. (marks 1)

Answer 3

Reference: https://www.varsitytutors.com/hotmath/hotmath_help/topics/normal-distribution-of-data

```
%read data from table
t = readtable("data_1.csv","Delimiter",',')
array_data1 = table2array(t)
```

mean(array_data1) = 66.3294

std(array_data1) = 209.8658

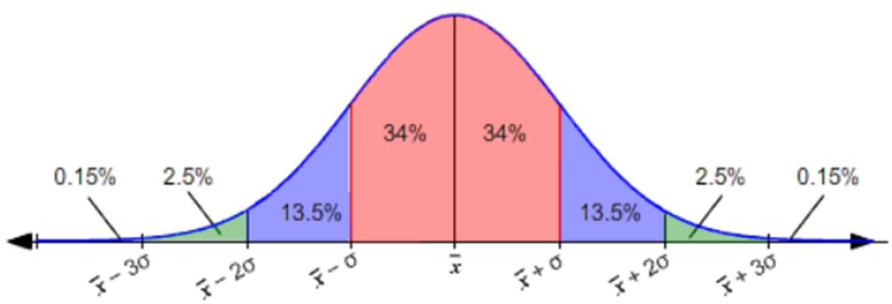
Mean of data: 66.3294

Standard Deviation of data: 209.8658

Mean + Std deviation = 276.1952

Mean + 2*std deviation = 486.0610

That is, if $\bar{x}$ is the mean and σ is the standard deviation of the distribution, then 68% of the values fall in the range between $(\bar{x} - \sigma)$ and $(\bar{x} + \sigma)$. In the figure below, this corresponds to the region shaded pink.



Therefore, about 13.5 + 2.5 + 0.15 = 16.15% values will be greater than 300 .

That is 0.1615*2000 = 323 values would be approximately greater than 300.

Negative values: almost 13.5 + 2.5 + 0.15 = 16.15% values must be negative , i.e., 323 values will surely be negative.

Also as from 34% , approximately 68%(209.8658 - 66.3294 / 209.8658) values , i.e , 23% of 2000 = 465 , therefore 323 + 465 = 788 values must be negative.

ACTUAL DATA :

Only 73 values are greater than 300

```
>> sum(a>300)

ans =

    73

>>
```

Negative values:

```
>> sum(a<0)

ans =

     0

>>
```

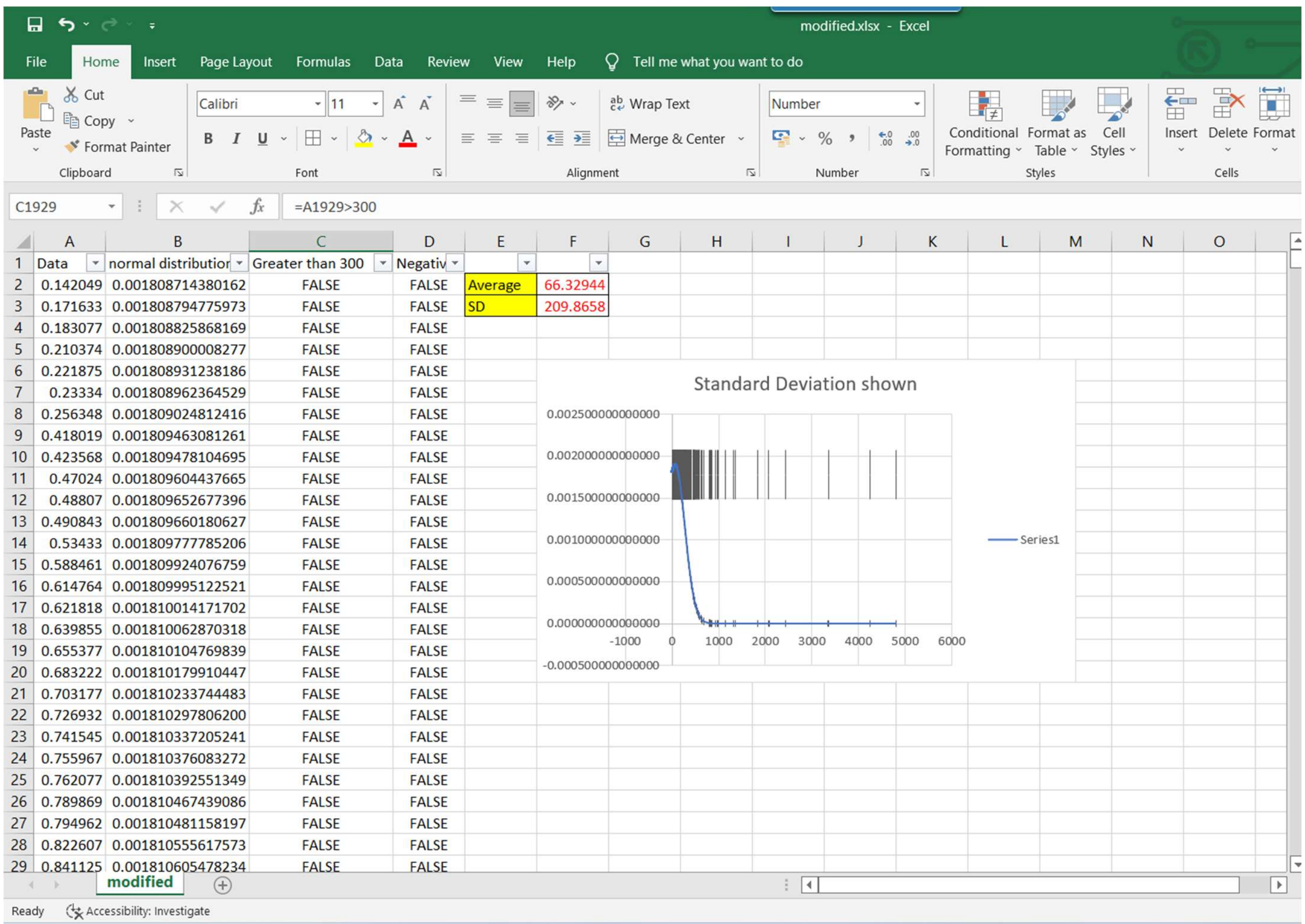
☹, there are no values which are negative.

Reason of such discrepancies:

We assumed the data as normally distributed and did our analysis on the same , rather than that we when we normalized the data

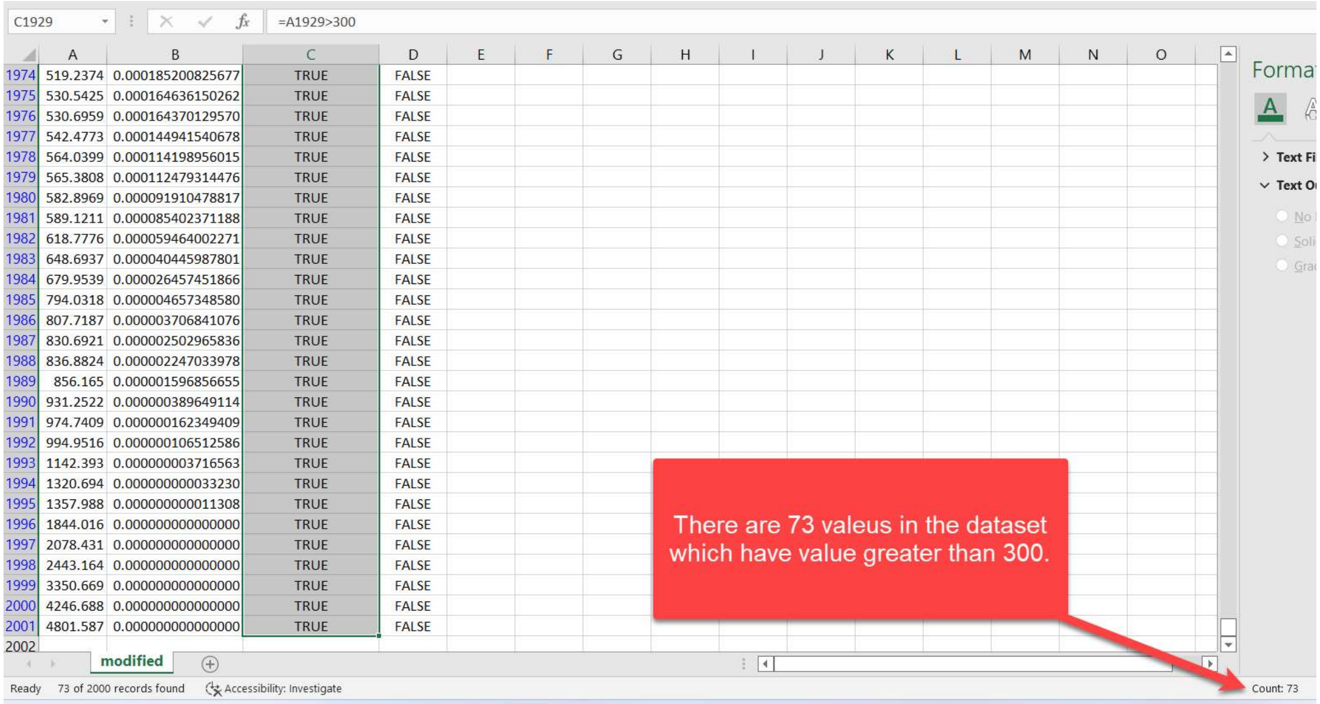
modified.xlsx

OUTPUT EXCEL:

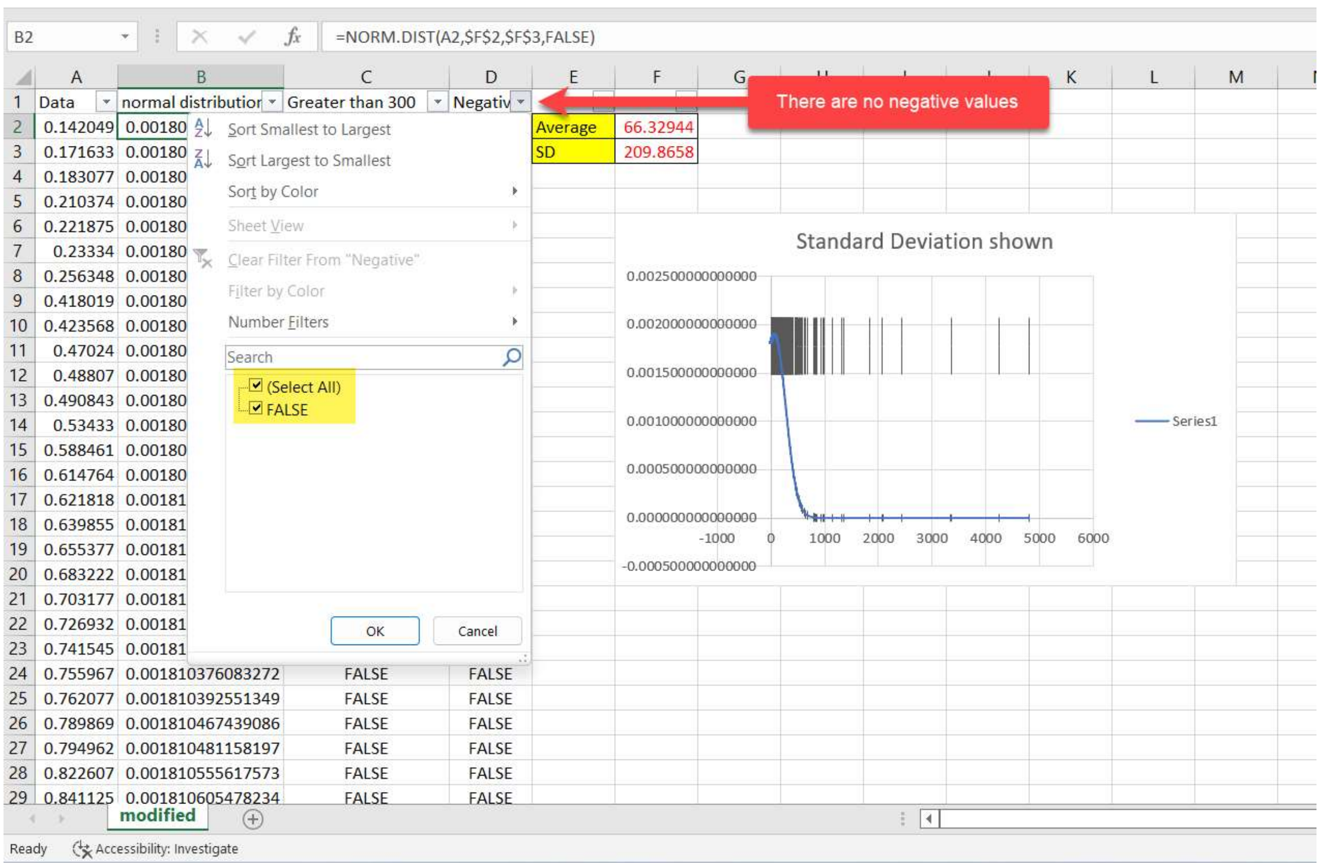


Actual data:

Column C calculates if a value is greater than 300. That is only 73 values are >300 .



Column D shows if the value in A is less than 0 . We find that after applying filter, there are no negative values.



The reason of discrepancies is because the dataset contains extreme values or outliers. Therefore our distribution is skewed. And hence our initial estimate did not give proper results.

References:

1. *Definite and indefinite integrals - MATLAB int - MathWorks India*. In.mathworks.com. Retrieved December 16, 2022, from https://in.mathworks.com/help/symbolic/sym.int.html

2. Conic Sections: Circle. Desmos. Retrieved December 16, 2022, from https://www.desmos.com/calculator/ivud1auwvw

3. Varsity Tutors. (2016). Normal Distribution of Data. Varsitytutors.com. https://www.varsitytutors.com/hotmath/hotmath_help/topics/normal-distribution-of-data

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