Assignment -2

PH1050 - Computational Physics

On Iteration, Flow Control and Lists

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Problem Statement

Part-1: Machine epsilon is the smallest float number that the machine can use for computations.

On a 64-bit processor, Machine Epsilon is 2^-52. Our goal is to compute the value of it using loop

Part-2: The value of functions with Gaussian integral has interesting properties when comparing value of area under the curve with various values of standard deviation. Our goal is to find this relation and find out the reasoning behind it.

Aim

1) To find MachineEpsilon using a while loop and a for loop
2) To find relation of area under the curve and standard deviation

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Code Structure

Part-1)

-Finding Machine epsilon with a while loop

-Finding Machine epsilon with a For loop

Part-2)

-Creating the Gaussian function and plotting for $\sigma = 100$

-creating 2 lists of data that cover large range of domain

-Plotting the LogLog plot of both data

Code

(Copy pasted from .nb file)

In[337]:=

```
(* when e becomes less than machine epsilon, Mathematica will ignore it in computations *)
Clear["Global`*"]

e = 1;
While[1.0 + e /2- 1.0 ≠ 0,
If[1.0 + e /2- 1.0 == 0 , Break];
e = e/2
]
(* The value of e is Machine epsilon now *)
N[e]
```

Out[340]=

2.22045×10^{-16}

In[341]:=

```
e = 1;
For[e=1,1.0 + e/2 -1.0 ≠ 0, e = e/2 , Continue]
N[e]
```

Out[343]=

2.22045×10^{-16}

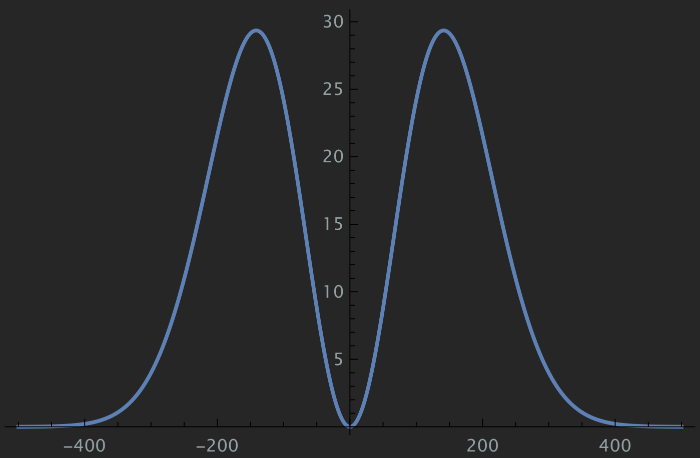
In[344]:=

```
u[x_,σ_ , μ_:0] := x^(2) Exp[-((x-μ)/σ)^2  /2] /(σ Sqrt[2 Pi])
u[x,σ]
TestData = Table[{x,u[x,100 , 0]} , {x , -500,500,1}];
ListLinePlot[TestData]
```

Out[345]=

$$\frac{e^{-\frac{x^2}{2\sigma^2}} x^2}{\sqrt{2\pi}\,\sigma}$$

Out[347]=



In[348]:=

```
list1 = {1/1000};

(* Making 55 sample points that are evenly spaced in a decade *)
Do[AppendTo[list1 , list1[[-1]] + 10^(Floor[Log[10,list1[[-1]]]])] , 54]
N[list1]
```

Out[350]=

{0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009, 0.01,
0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6,
0.7, 0.8, 0.9, 1., 2., 3., 4., 5., 6., 7., 8., 9., 10., 20., 30., 40., 50., 60.,
70., 80., 90., 100., 200., 300., 400., 500., 600., 700., 800., 900., 1000.}

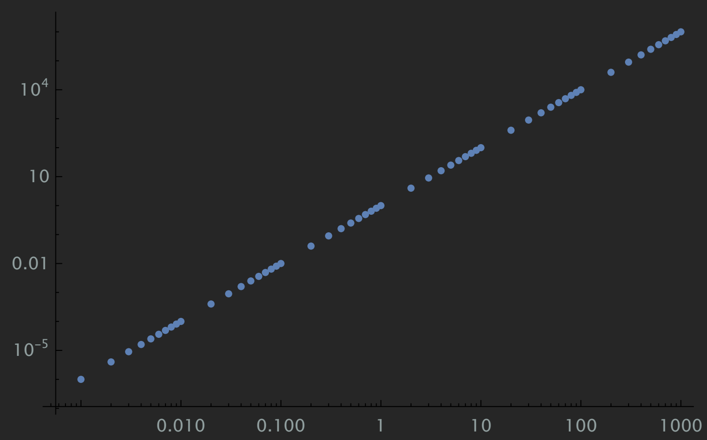
In[351]:=

```
list2 = {};
upperLimit = 1000;
lowerLimit = 1/1000;
numberOfSteps = 120;
stepSize = (Log[10,upperLimit] - Log[10,lowerLimit])/(numberOfSteps - 1);
AppendTo[list2,lowerLimit];
Do[AppendTo[list2 , 10^(Log[10,list2[[-1]] + stepSize)], numberOfSteps -1];
(* N[list2] *)
```

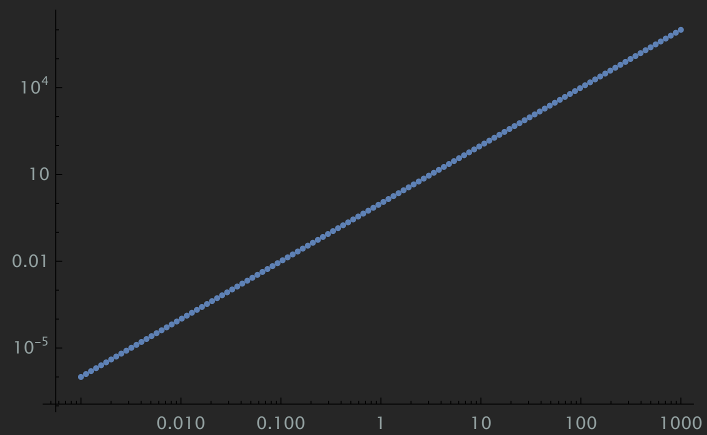
In[358]:=

```
I1 = {# , NIntegrate[u[x,#] , {x,-#*10,#*10}]}&/@list1;
plt1 = ListLogLogPlot[I1, PlotRange→All]
I2 = {# , NIntegrate[u[x,#] , {x,-#*10,#*10}]}&/@list2;
plt2 = ListLogLogPlot[I2, PlotRange→All]
```

Out[359]=



Out[361]=



Conclusion

-The area under the curve for the function is the variance because

Variance = $\int_{-\infty}^{\infty} (x-\mu)^2 \, P(x) \, dx$

here μ is 0 and P(x) {probability density} is our Gaussian integral because it's integral is 1

(took help from chatgpt to know more about gaussian function)

-Since Variance = σ^2, Log Log plot would be a line with slope 2

-Mathematica shows error for large limit of integral for a small σ, there for each σ would require its own suitable limit for integration

Comment

I came up with a way to create data list in one line of code
and apply function to all the elements of list at once using &/@ command