GA5: Data Sampling + Transformation + Multivariate random variables + CLT – Matlab solution

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%% GA5 – Transformations and Multivariate Ransom Variables

%% Flight_Simulator - Rayleigh-data
clear all

%Creation of Rayleigh-distributed data-points
N=10000;  %Number of datapoints
y = rand(N,1);  %Random numbers between 0 and 1
sigma = 7;  %Rayleigh-function parameter (mean=sigma*sqrt(pi/2))
x = sqrt(-2.*sigma^2.*log(1-y));  %Invers cdf of Rayleigh-
distribution

%Scatter-plot of the random Rayleigh-distributed data-points
figure(1)
scatter(1:N,x,'.')

%Histogram of the data-points -> Rayleigh-density function
figure(2)
hist(x,100);

%For comparason a plot of the matemathical Rayleigh-function
for i=1:100
    xx(i)=N*max(x)/100*i./sigma^2.*exp(-i^2./(2*sigma^2.));
%Rayleigh-function renormeret
end
figure(3)
plot(1:35,xx(1:35))



%% Exponential_data
clear all

%Creation of exponential-distributed data-points
N=10000;  %Number of datapoints
y = rand(N,1);  %Random numbers between 0 and 1
lambda = 1/8;  %Exonential-function parameter
x = -1/lambda.*log(1-y);  %Invers cdf of exponential-distribution

%Scatter-plot of the random exponential-distributed data-points
figure(4)
scatter(1:N,x,'.')

%Histogram of the data-points -> ExponentialRayleigh-density
function
figure(5)
hist(x,100);

%For comparason a plot of the matemathical Exponential-function
for i=1:80
    xx(i)=N*max(x)/100*lambda.*exp(-i*max(x)/80.*lambda);
%Exponential-function renormeret
end
figure(6)
plot(1:80,xx(1:80))
```

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%% Linear function of uniform distribution
clear all;

X=rand(1,10);  %10 random numbers between 0 and 1
Y=4*X-2;  %Random numbers between -2 and 2
figure(7)
scatter(1:10,Y,'x')



%% Resistors in series
clear all;

R1=240*rand(1,100000)+2280;
R2=10*rand(1,100000)+95;
R=R1+R2;
figure(8)
hist(R,250)
Mean_R=mean(R)
SD_R=sqrt(var(R))

R0=250*rand(1,100000)+2375;
figure(9)
hist(R0,250)
Mean_R0=mean(R0)
SD_R0=sqrt(var(R0))

R3=125*rand(1,100000)+1187.5;
R4=125*rand(1,100000)+1187.5;
R34=R3+R4;
figure(10)
hist(R34,250)
Mean_R34=mean(R34)
SD_R34=sqrt(var(R34))



%% Central limit theorem
clear all

for sumNumber=1:9
     number =sumNumber;
[x1,y1,x2,y2] = GiveMeX(sumNumber); %Average of sumNumber
Rayleigh/Uniform stochastic variables
figure(11)
plotMitsubplot(x1,y1,number,sumNumber) %Plot of the 9 Rayleight
stochastic variables
figure(12)
plotMitsubplot(x2,y2,number,sumNumber) %Plot of the 9 Uniform
stochastic variables
end

function [x1,y1,x2,y2] = GiveMeX(number)
for n=1:100000
  x1(n) = sum(Rayleigh_rand(number))/number; %The average stochastic
variable of number Rayleigh stochastic variables
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```
  x2(n) = sum(Uniform_rand(number))/number; %The average stochastic
variable of number Uniform stochastic variables
end

[y1 x1] = hist(x1,101);
y1 =101.*y1./(sum(y1)*round(max(x1))); %Normalized histogram -> cdf

[y2 x2] = hist(x2,101);
y2 =101.*y2./(sum(y2)*round(max(x2))); %Normalized histogram -> cdf
end

function plotMitsubplot(x,y,number,sumNumber) %Plot of the 9 average
stochastic variables
subplot(3,3,number)
plot(x,y,'b','linewidth',2)
grid
hold on
axis([min(x) max(x) 0 max(y) ])
title(['Terms:', num2str(sumNumber)])
end

function x = Rayleigh_rand(N) %Generation of N Rayleigh distributed
random numbers
xx = rand(N,1);
sigma = 1;
x = sqrt(-2.*sigma^2.*log(1-xx));
end

function x = Uniform_rand(N) %Generation of N uniform distributed
random numbers
x = rand(N,1);
end
```

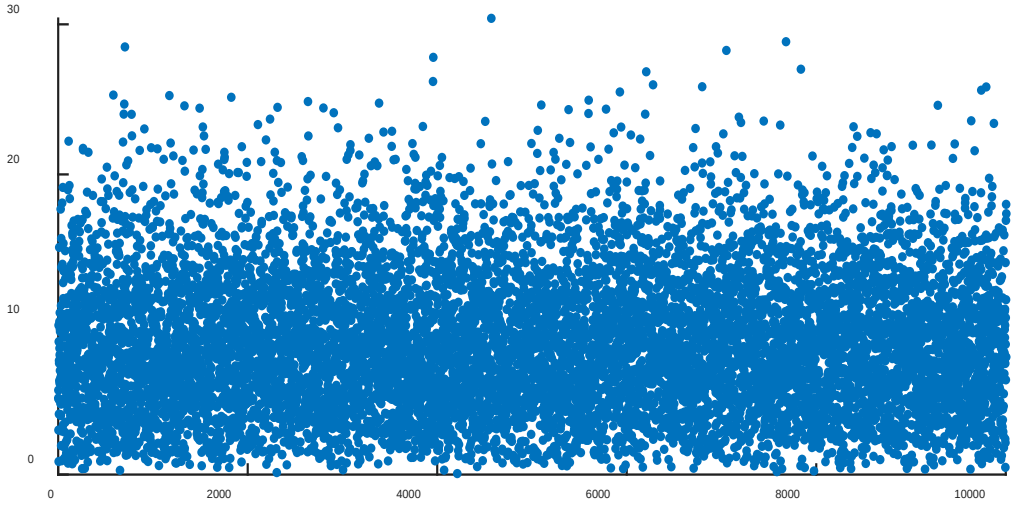
>> GA5_LMa_240918

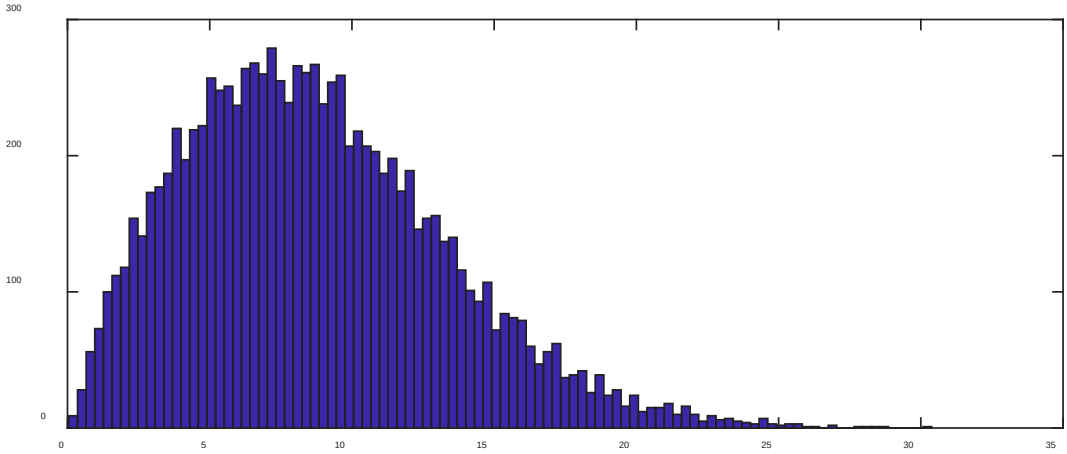
Mean_R = 2.5002e+03
SD_R = 69.2575

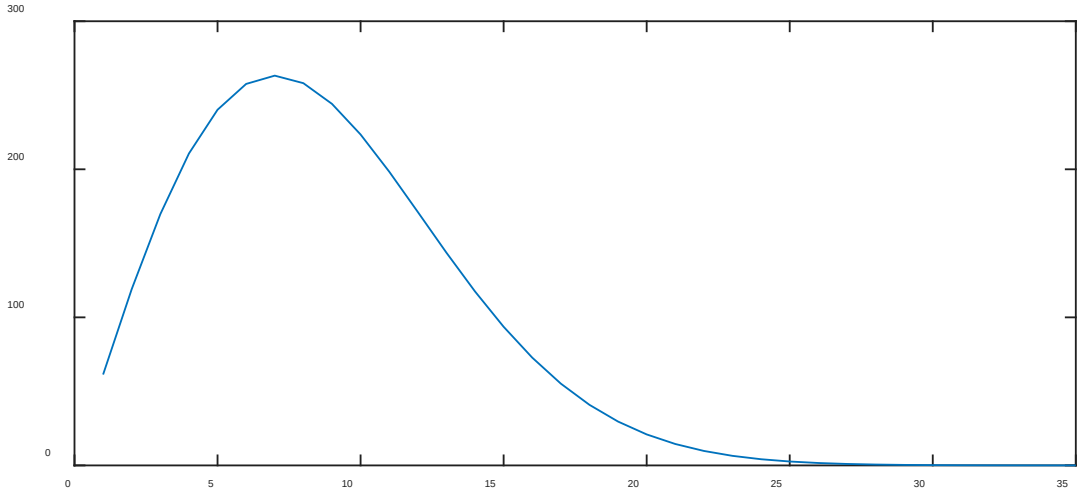
Mean_R0 = 2.5000e+03
SD_R0 = 72.1336

Mean_R34 = 2.4999e+03
SD_R34 = 51.0191

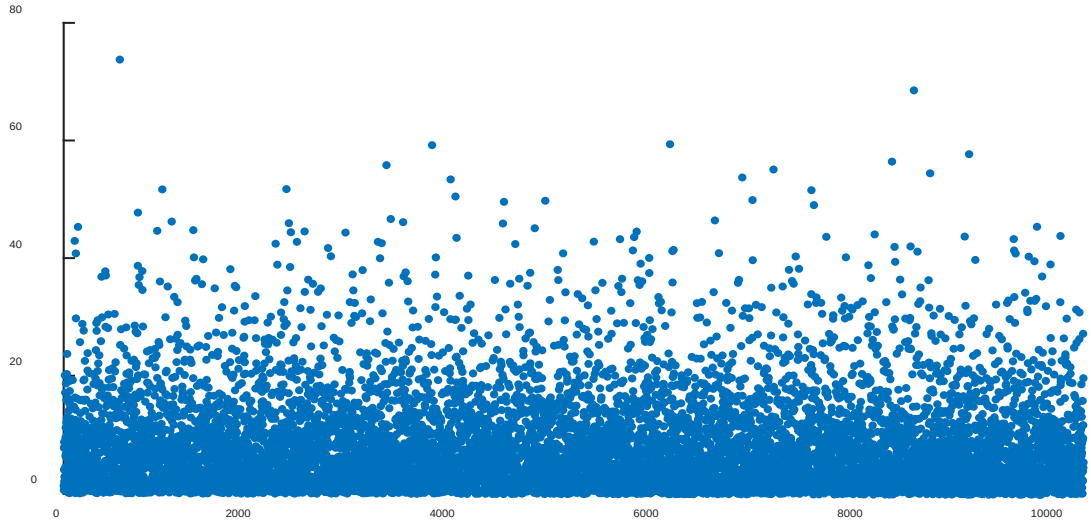
Rayleigh-distributed data

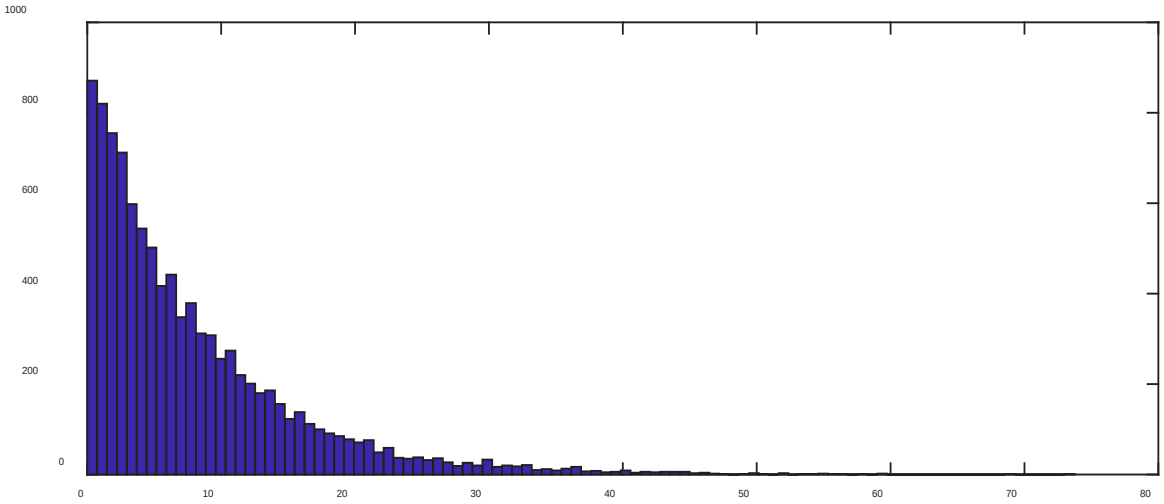


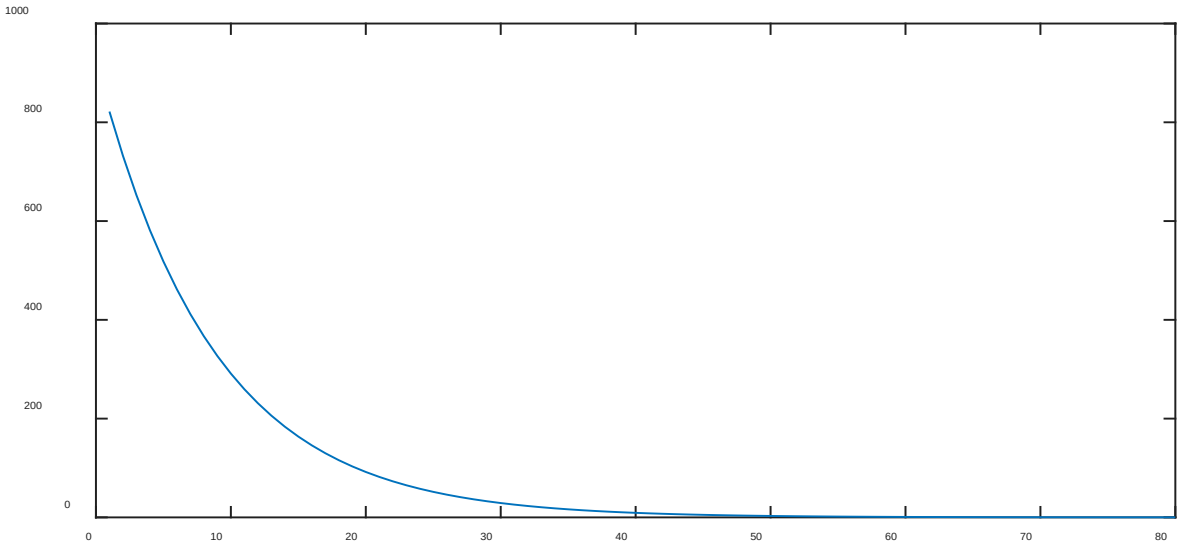




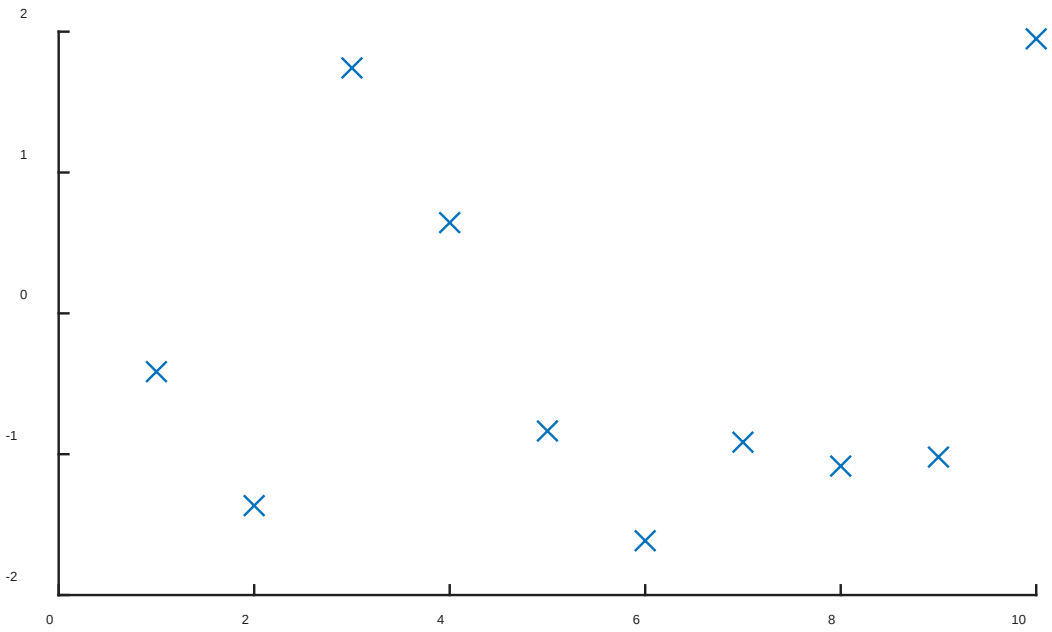
Exponential-distributed data



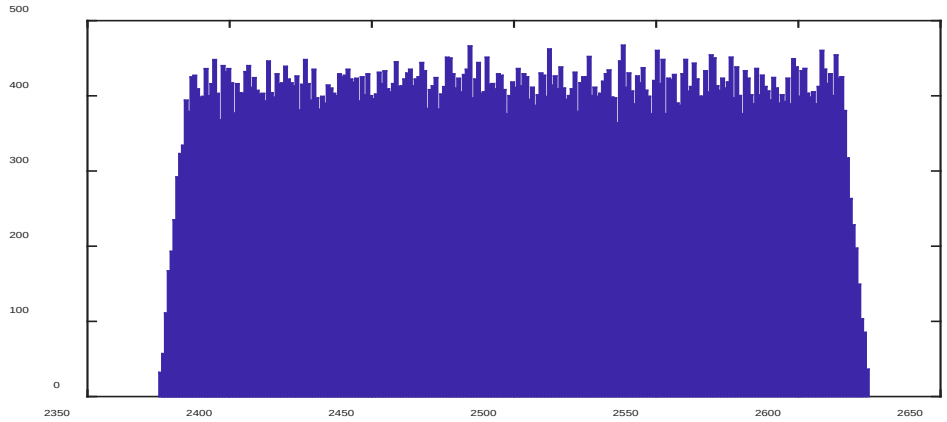




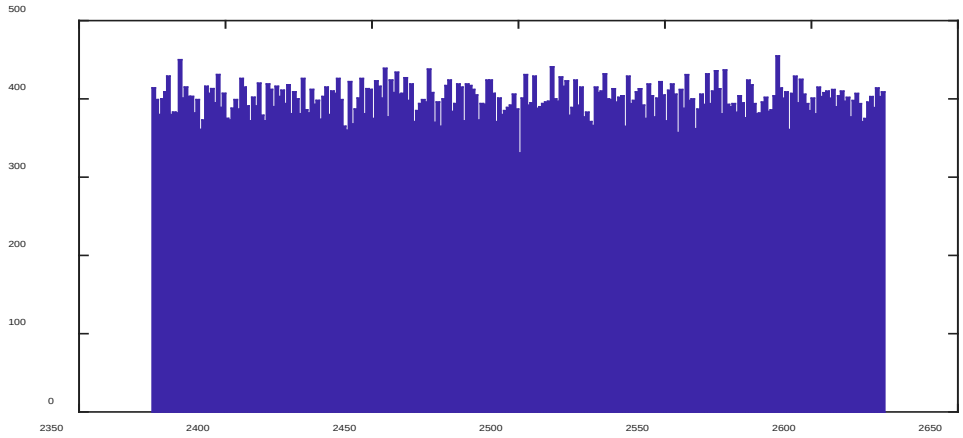
10 uniform distributed random numbers [-2,2]


2
1
0
-1
-2
0
2
4
6
8
10

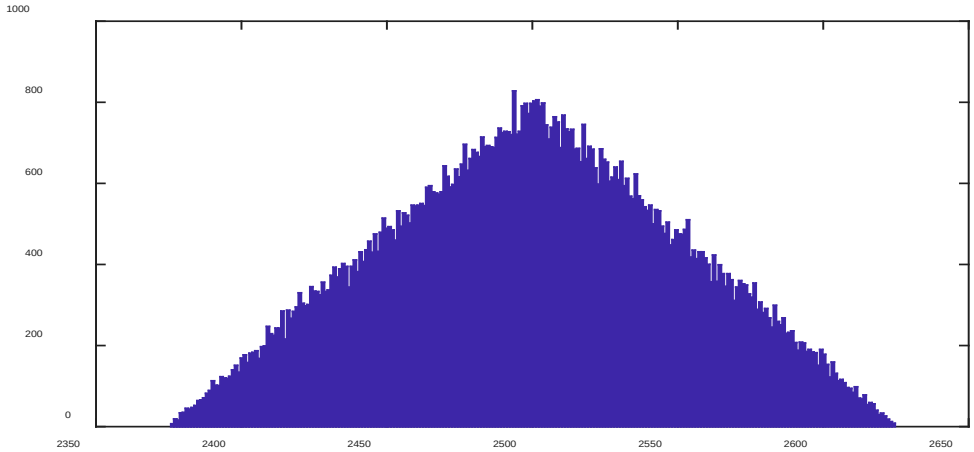
Sum of stochastic variables



Sum of two uniform distribured 5%-resistors: R_1=2.4kΩ and R_2=100Ω

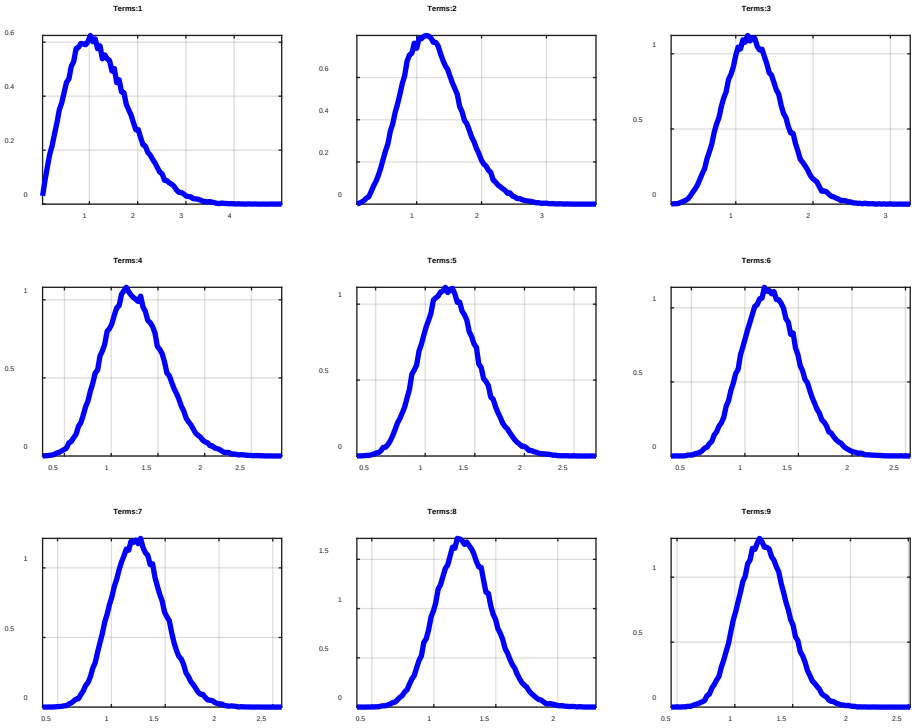


One uniform distributed 5%-resistor: R= 2.5kΩ

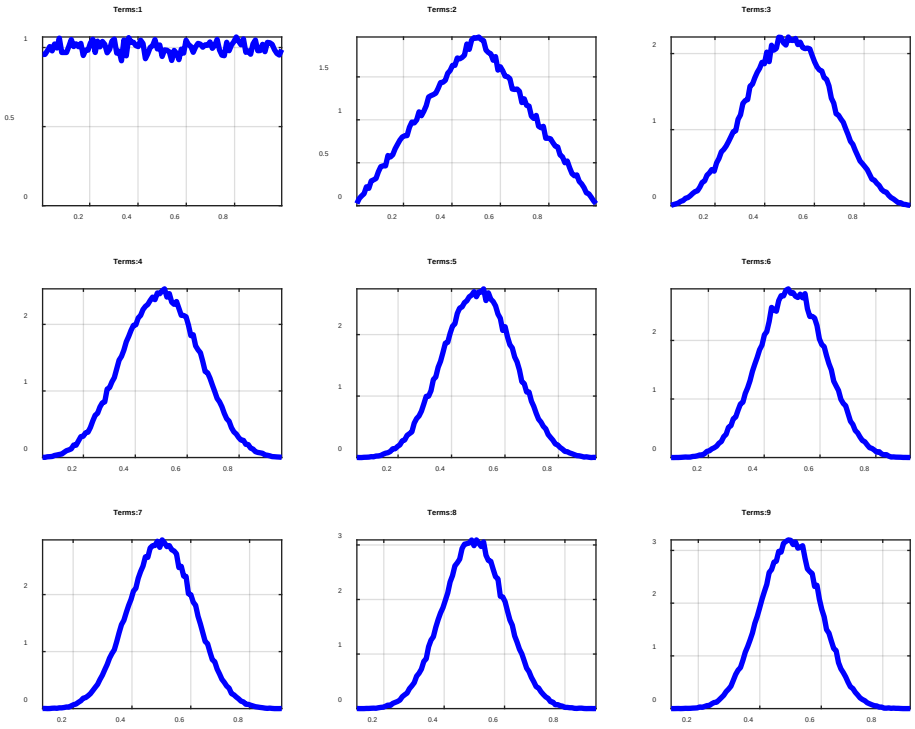


Sum of two equal uniform distribured 5%-resistors: R_3=1.25kΩ and R_4=1.25kΩ

Central Limit Theorem (CLT)



Average of 1-9 Rayleigh distributed random variables



Average of 1-9 Uniform distributed random variables