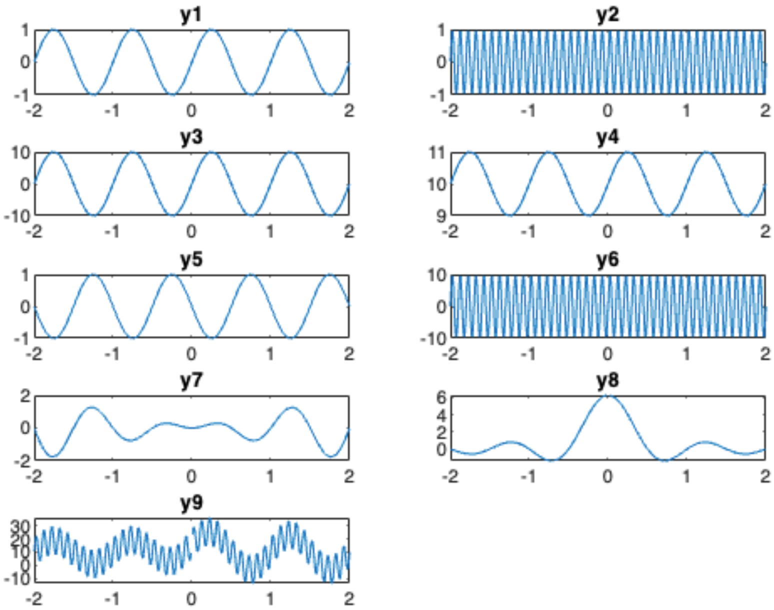
Alperen Bağ
2018400279
12.04.2020

CMPE 362 HW 1

1-



Let's say

$$x_1 = A * \sin(a * t)\ \ (A\ and\ a\ are\ real\ numbers)$$
$$x_2 = B * \sin(b * t)\ \ (B\ and\ b\ are\ real\ numbers)$$

These figures indicate;

- $f_{x_1} < f_{x_2}\ \ when\ a > b$
- $Amplitude\ of\ x_1 > Amplitude\ of\ x_2\ \ when\ A > B$
- Adding a positive value to signal shifts the signal upward.
- Adding a positive value to parameter inside sin shifts the signal rightward.
- Summation of sinusoidal waves creates a periodic wave.

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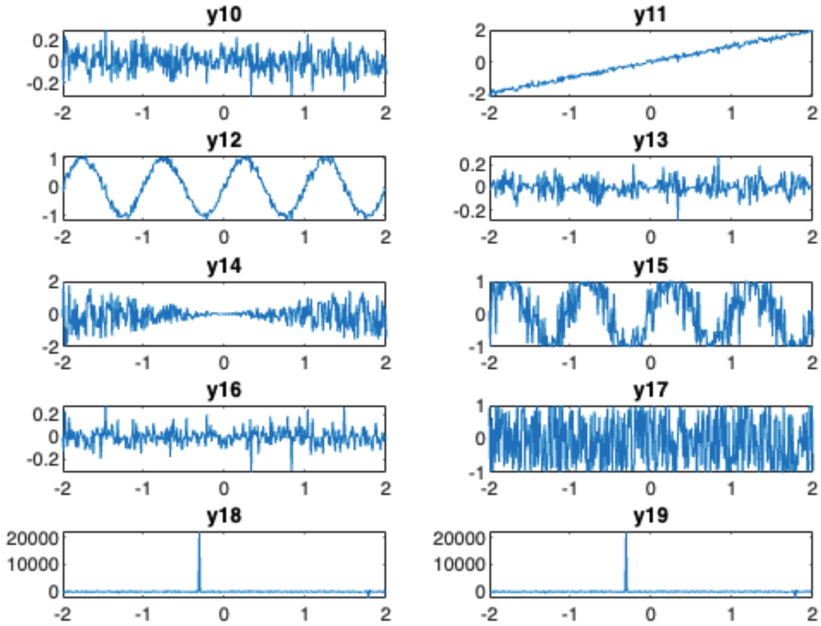
2-



- y10 signal is a noise signal generated using normal distribution (1,0). y11 and y12 signals are the noisy version of time vector and y1.
- y13 is also a noisy signal. Its amplitude is close to zero where the amplitude of y1 is near to zero. Points around the peaks of y1 are transformed to a more unstable signal because of the multiplication with a random variable.
- Amplitude of y14 is close to zero around t=0, because the signal is multiplied by t. In addition, inside sin function is multiplied by z, and that leads to a noisy signal.

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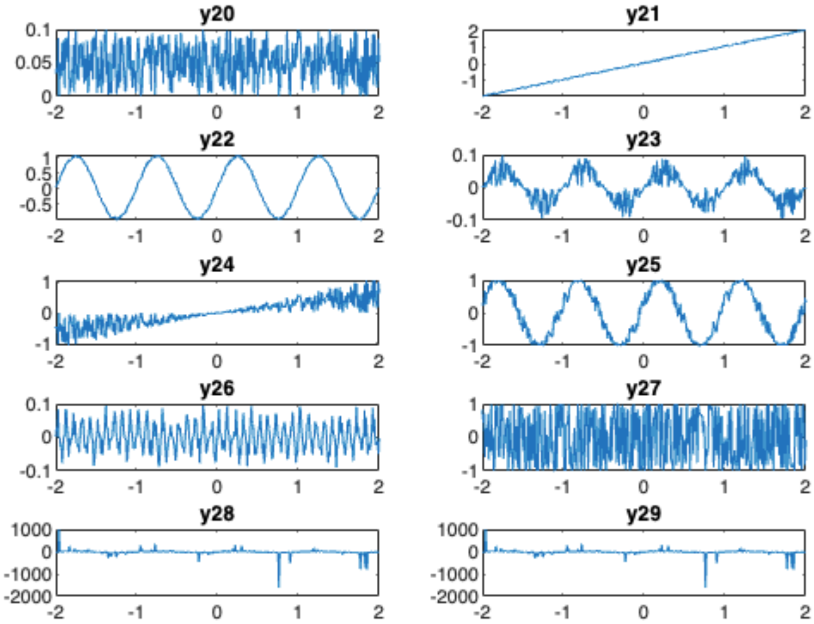

- Here, instead of normal gaussian (1,0) random variable, we use uniform random variable. Because uniform random variable is between 0 and 1, y20 does not have a negative value.
- y21 is again a noisy version of time vector as well as y22. Here the noise is less than the gaussian noise.
- Because noise is always positive this time, the form of y23 is better conserved than y13.
- We can say the same things for y26 and y27. In addition, frequency of y27 looks more than the one of y26.

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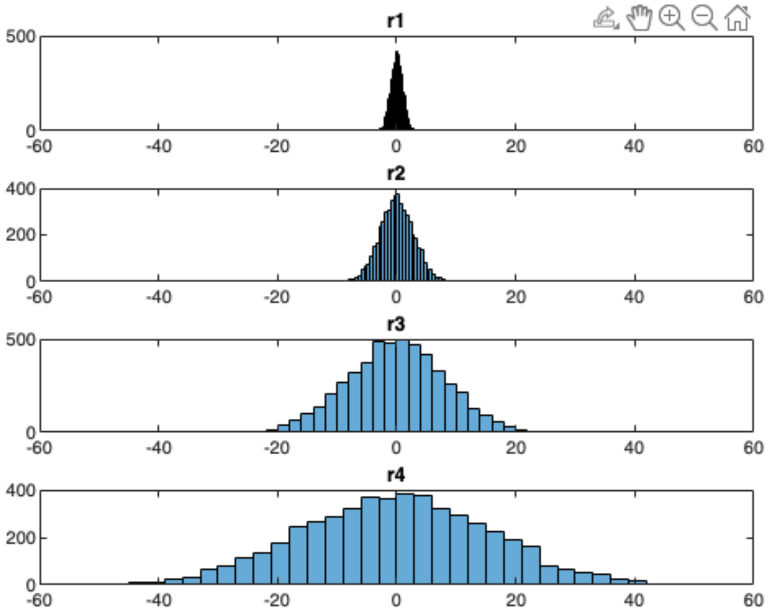
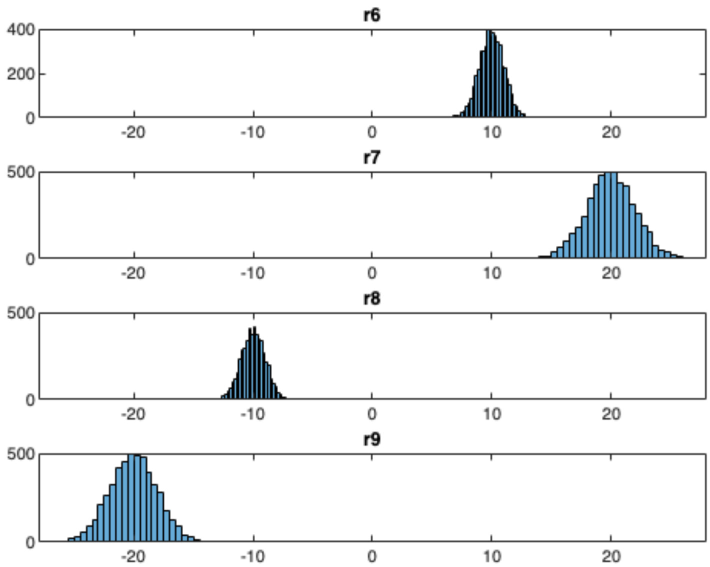


All figures have the same mean but different variances. Variance is increasing downward.

5-



Changing the mean shifts the distribution. I changed the mean by adding a value to all random numbers. For the variance, all numbers multiplied by a another value.

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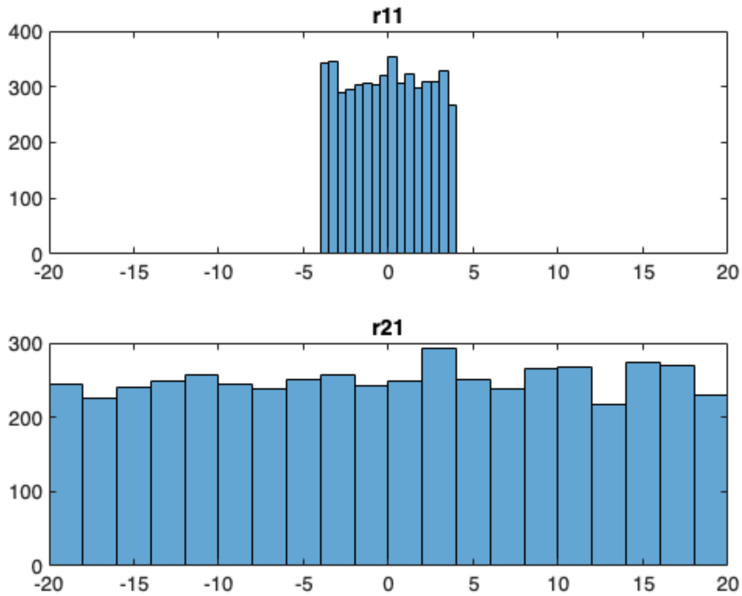
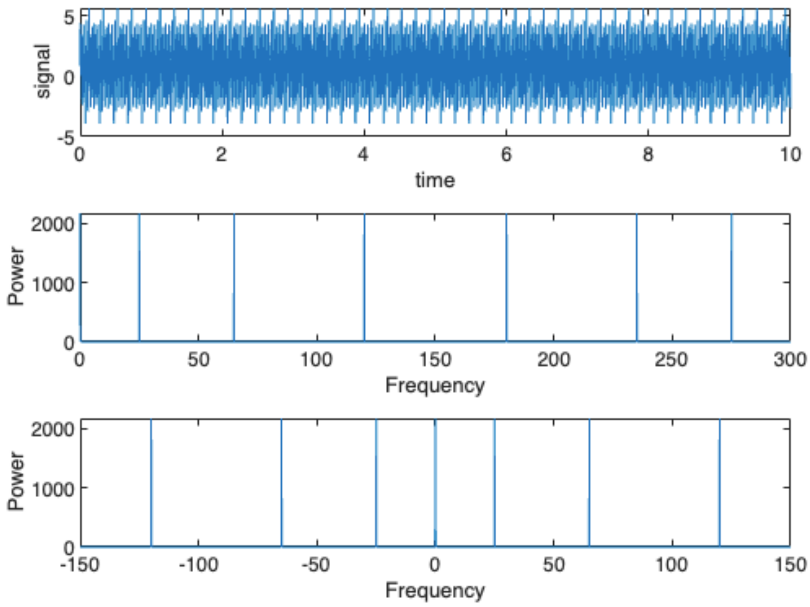
6-



For the first one, random vector is multiplied by 8 and then 4 is subtracted. For the second one, random vector is multiplied by 40 and then 20 is subtracted.

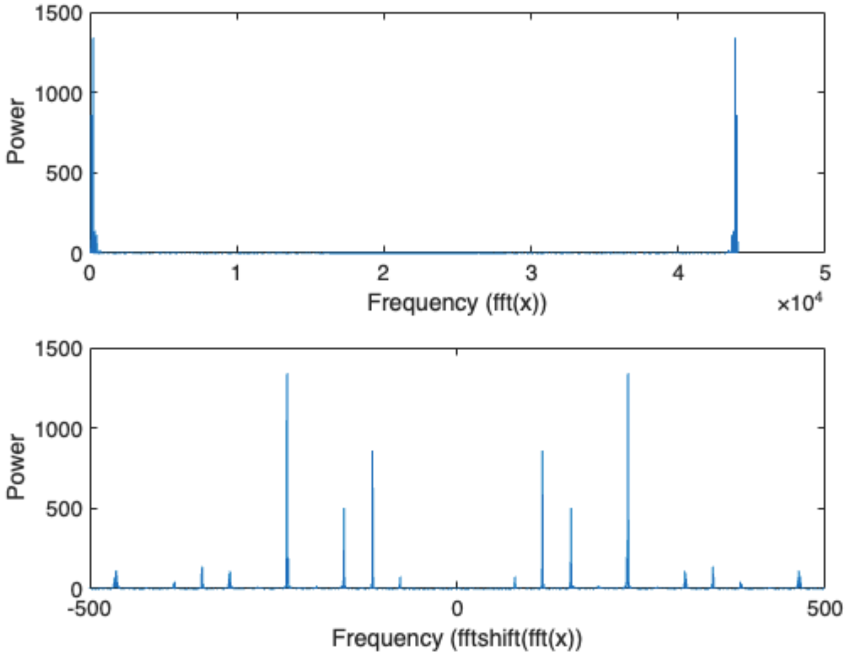
7-



$$x(t) = a_0 + 2 * \sum_{k=1}^{3} a_k * e^{j2\pi f_k t}$$

$$f = [25\ Hz, 65\ Hz, 120\ Hz]$$

8-



9- lena.png

Mean: 124.0425
Standard Deviation: 47.8557
Maximum Value: 245
Max Location: (274,396)
Minimum Value: 25
Min Location: (72,4)

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Codes

HW1_firstpart.m

```
% Q1
figure;
t = -2:0.01:2;

% Signals
y1 = sin(2*pi*t);
y2 = sin(2*pi*10*t);
y3 = 10*sin(2*pi*t);
y4 = sin(2*pi*t)+10;
y5 = sin(2*pi*(t- 0.5));
y6 = 10*sin(2*pi*10*t);
y7 = t.*sin(2*pi*t);
y8 = sin(2*pi*t)./t;
y9 = y1+y2+y3+y4+y5+y6+y7+y8;

% Plots
subplot(5,2,1);
plot(t,y1);
title("y1");
subplot(5,2,2);
plot(t,y2);
title("y2");
subplot(5,2,3);
plot(t,y3);
title("y3");
subplot(5,2,4);
plot(t,y4);
title("y4");
subplot(5,2,5);
plot(t,y5);
title("y5");
subplot(5,2,6);
plot(t,y6);
title("y6");
subplot(5,2,7);
plot(t,y7);
title("y7");
subplot(5,2,8);
plot(t,y8);
title("y8");
subplot(5,2,9);
plot(t,y9);
title("y9");

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

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```
% Q2
figure;
z = randn(1,401)*0.1;  % Random signal (Normal)

% Signals
y10 = z;
y11 = z+t;
y12 = z+y1;
y13 = z.*y1;
y14 = t.*sin(2*pi*z);
y15 = sin(2*pi*(t+z));
y16 = z.*y2;
y17 = sin(2*pi*(t+10*z));
y18 = y1./z;
y19 = y11+y12+y13+y14+y15+y16+y17+y18;

% Plots
subplot(5,2,1);
plot(t,y10);
title("y10");
subplot(5,2,2);
plot(t,y11);
title("y11");
subplot(5,2,3);
plot(t,y12);
title("y12");
subplot(5,2,4);
plot(t,y13);
title("y13");
subplot(5,2,5);
plot(t,y14);
title("y14");
subplot(5,2,6);
plot(t,y15);
title("y15");
subplot(5,2,7);
plot(t,y16);
title("y16");
subplot(5,2,8);
plot(t,y17);
title("y17");
subplot(5,2,9);
plot(t,y18);
title("y18");
subplot(5,2,10);
plot(t,y19);
title("y19");

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

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```
% Q3
figure;
z = rand(1,401)*0.1;  % Random Signal (Uniform)

% Signals
y20 = z;
y21 = z+t;
y22 = z+y1;
y23 = z.*y1;
y24 = t.*sin(2*pi*z);
y25 = sin(2*pi*(t+z));
y26 = z.*y2;
y27 = sin(2*pi*(t+10*z));
y28 = y1./z;
y29 = y21+y22+y23+y24+y25+y26+y27+y28;

% Plots
subplot(5,2,1);
plot(t,y20);
title("y20");
subplot(5,2,2);
plot(t,y21);
title("y21");
subplot(5,2,3);
plot(t,y22);
title("y22");
subplot(5,2,4);
plot(t,y23);
title("y23");
subplot(5,2,5);
plot(t,y24);
title("y24");
subplot(5,2,6);
plot(t,y25);
title("y25");
subplot(5,2,7);
plot(t,y26);
title("y26");
subplot(5,2,8);
plot(t,y27);
title("y27");
subplot(5,2,9);
plot(t,y28);
title("y28");
subplot(5,2,10);
plot(t,y29);
title("y29");

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Q4
```

```
figure;

r1 = randn(5000,1);                 % mean = 0, var = 1
r2 = sqrt(8).*randn(5000,1);        % mean = 0, var = 8
r3 = sqrt(64).*randn(5000,1);       % mean = 0, var = 64
r4 = sqrt(256).*randn(5000,1);      % mean = 0, var = 256

% Plots
subplot(4,1,1);
histogram(r1);
xlim([-60, 60]);
title("r1");
subplot(4,1,2);
histogram(r2);
xlim([-60, 60]);
title("r2");
subplot(4,1,3);
histogram(r3);
xlim([-60, 60]);
title("r3");
subplot(4,1,4);
histogram(r4);
xlim([-60, 60]);
title("r4");

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Q5
figure;

r6 = randn(5000,1) + 10;              % mean =  10, var = 1
r7 = sqrt(4).*randn(5000,1) + 20;     % mean =  20, var = 4
r8 = randn(5000,1) - 10;              % mean = -10, var = 1
r9 = sqrt(4).*randn(5000,1) - 20;     % mean = -20, var = 4

% Plots
subplot(4,1,1);
histogram(r6);
xlim([-28, 28]);
title("r6");
subplot(4,1,2);
histogram(r7);
xlim([-28, 28]);
title("r7");
subplot(4,1,3);
histogram(r8);
xlim([-28, 28]);
title("r8");
subplot(4,1,4);
histogram(r9);
xlim([-28, 28]);
```

```
title("r9");

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% Q6
figure;

r11 = rand(5000,1)*8 - 4;
r21 = rand(5000,1)*40 - 20;

% Plots
subplot(2,1,1);
histogram(r11);
xlim([-20, 20]);
title("r11");
subplot(2,1,2);
histogram(r21);
xlim([-20, 20]);
title("r21");

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

HW1_question7.m

```
% I took the scripts shown in ps as reference in this question

figure;
load("mysignal.mat");

subplot(3,1,1);
plot(t,x);
xlabel('time');
ylabel('signal');

y = fft(x);             %discrete fourier transform

n = length(x);          % number of samples
f = (0:n-1)*(fs/n);     % frequency range
power = abs(y).^2/n;    % power of the DFT
subplot(3,1,2);
plot(f,power);
xlabel('Frequency (fft(x))');
ylabel('Power');

y0 = fftshift(y);         % shift y values
f0 = (-n/2:n/2-1)*(fs/n); % 0-centered frequency range
power0 = abs(y0).^2/n;    % 0-centered power

subplot(3,1,3);
```

```
plot(f0,power0);
xlabel('Frequency (fftshift(fft(x))');
ylabel('Power');
```

HW1_question8.m

```
% I took the scripts shown in ps as reference in this question

[y,fs] = audioread('music.wav'); %y=sampled data and Fs is the sampling rate
l=length(y);

Y = fft(y);                 % discrete fourier transform
f = (0:l-1)*(fs/l);         % frequency range
power = abs(Y).^2/l;

subplot(2,1,1);

plot(f,power);
xlabel('Frequency (fft(x))');
ylabel('Power');

Y0 = fftshift(Y);           % shift y values
f0 = (-l/2:l/2-1)*(fs/l); % 0-centered frequency range
power0 = abs(Y0).^2/l;    % 0-centered power

subplot(2,1,2);

plot(f0,power0);
xlabel('Frequency (fftshift(fft(x))');
ylabel('Power');
xlim([-500 500]);
```

HW1_question9.m

```
img = imread("lena.png");   % Read image
gray_img = rgb2gray(img);   % Convert image to gray
flat_img = double(gray_img(:)); % Data type conversion for std calculation
avg = mean(flat_img);
sd = std(flat_img);
[max_value, max_index] = max(flat_img);
[min_value, min_index] = min(flat_img);

[max_loc_x, max_loc_y] = ind2sub(size(gray_img),max_index); % Index to subscript
[min_loc_x, min_loc_y] = ind2sub(size(gray_img),min_index); % Index to subscript
```