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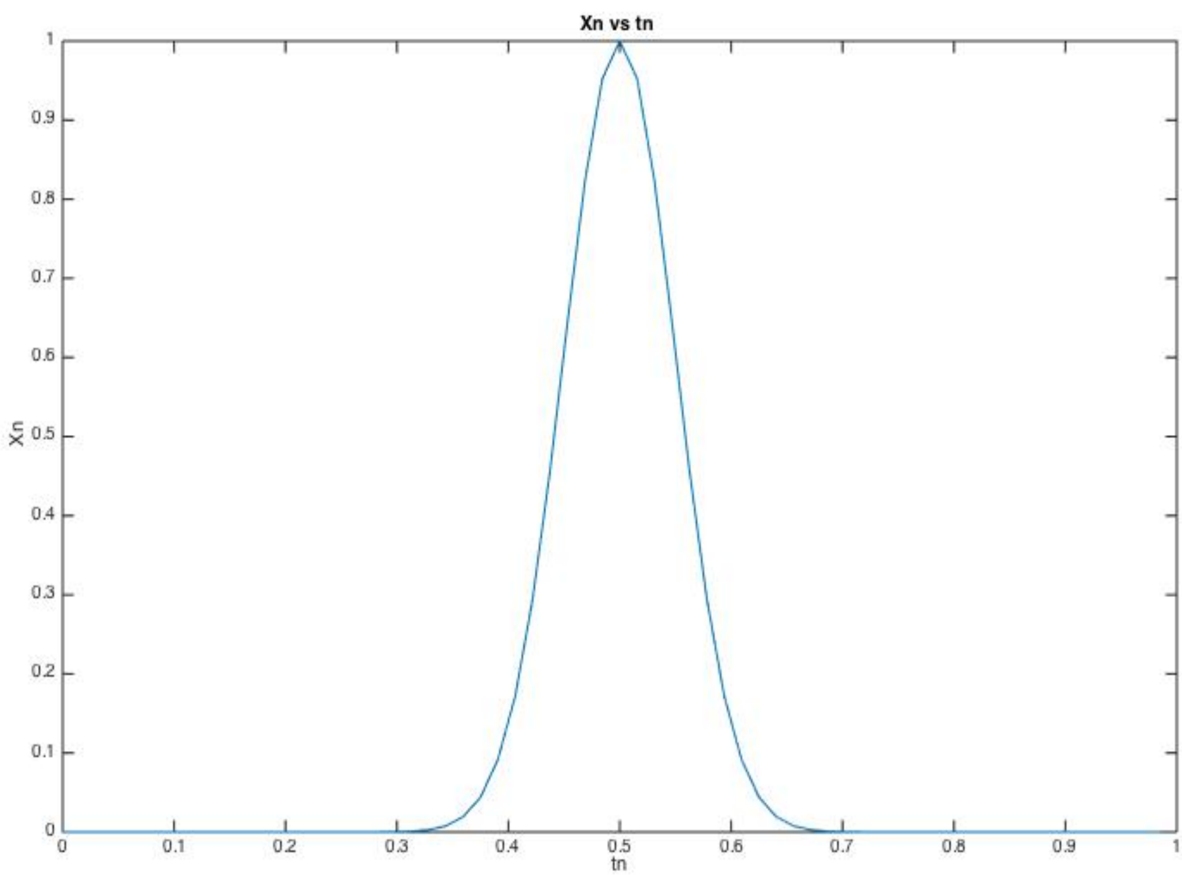
(a) We first begin by creating our variables and using the created variables to make our signal, Xn. We can then plot our signal Xn against tn and the output image is shown below;

```
N = 64;
a = 200;
n = linspace(0,63,64);
tn = n/N;
xn = exp((-a)*(tn - 0.5).^2);

figure;
plot(tn,Xn);
xlabel('tn')
ylabel('Xn')
title('Xn vs tn')
```

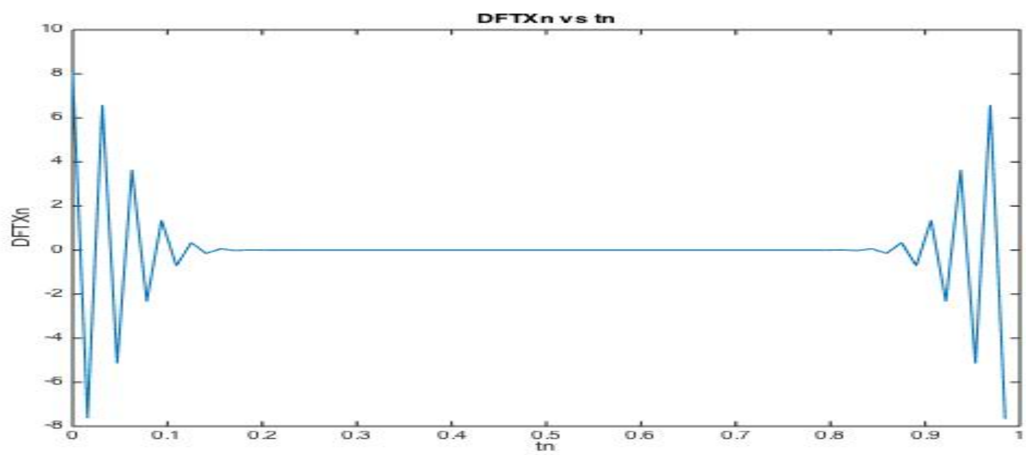


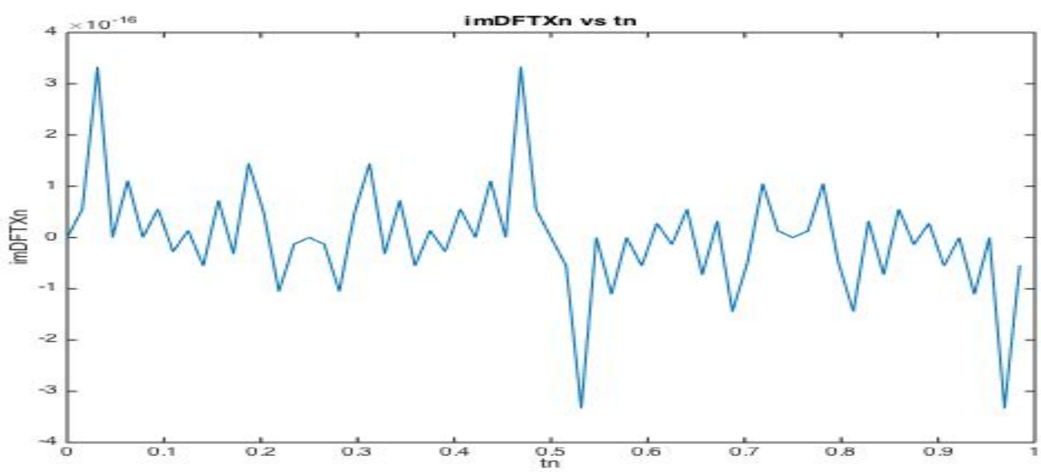
Next to compute the DFT of our signal Xn, we use the FFT command in matlab and call it DFTXn. However, we can't simply plot our DFT as matlab ignores the imaginary part so we have to create a new variable, imDFTxn, to get our imaginary plot to show. This produces the next two plots shown below;

```
DFTXn = fft(Xn);
imDFTXn = imag(DFTXn);

figure;
plot(tn,DFTXn);
xlabel('tn')
ylabel('DFTXn')
title('DFTXn vs tn')

figure;
plot(tn,imDFTXn);
xlabel('tn')
ylabel('imDFTXn')
title('imDFTXn vs tn')
```



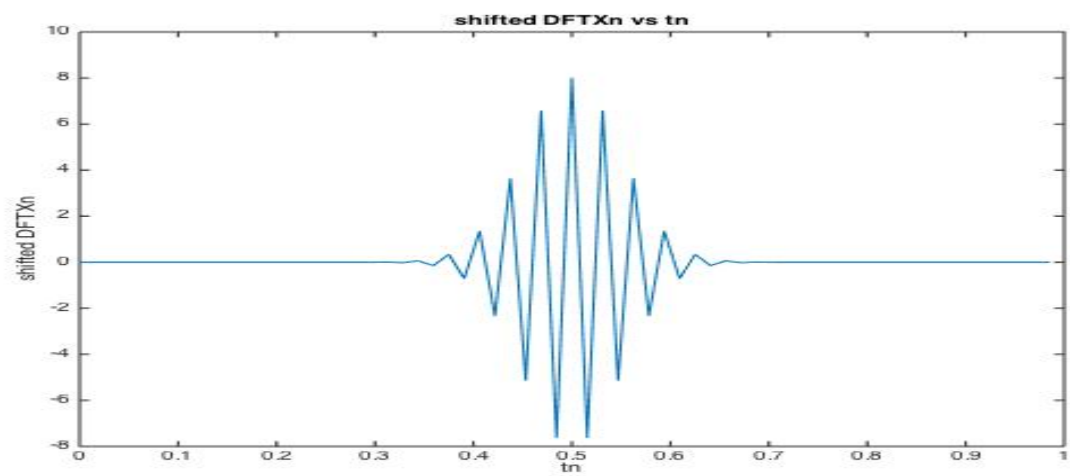


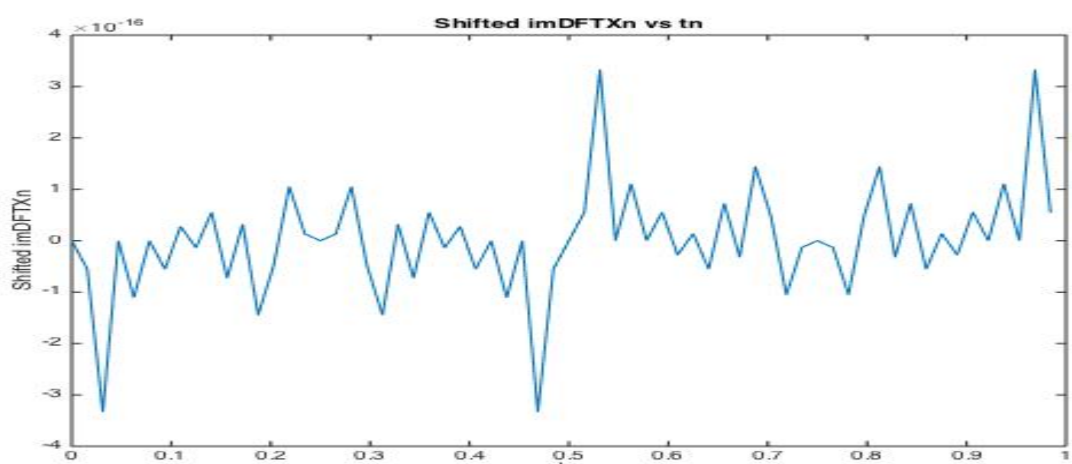
(b) To compute the shifted DFT, we apply the fftshift function to our output DFT, real and imaginary. This yields two additional plots as seen below;

```
shiftDFTXn = fftshift(DFTXn)
shiftimDFTXn = fftshift(imDFTXn)

figure;
plot(tn,shiftDFTXn);
xlabel('tn')
ylabel('shifted DFTXn')
title('shifted DFTXn vs tn')

figure;
plot(tn,shiftimDFTXn);
xlabel('tn')
ylabel('Shifted imDFTXn')
title('Shifted imDFTXn vs tn')
```



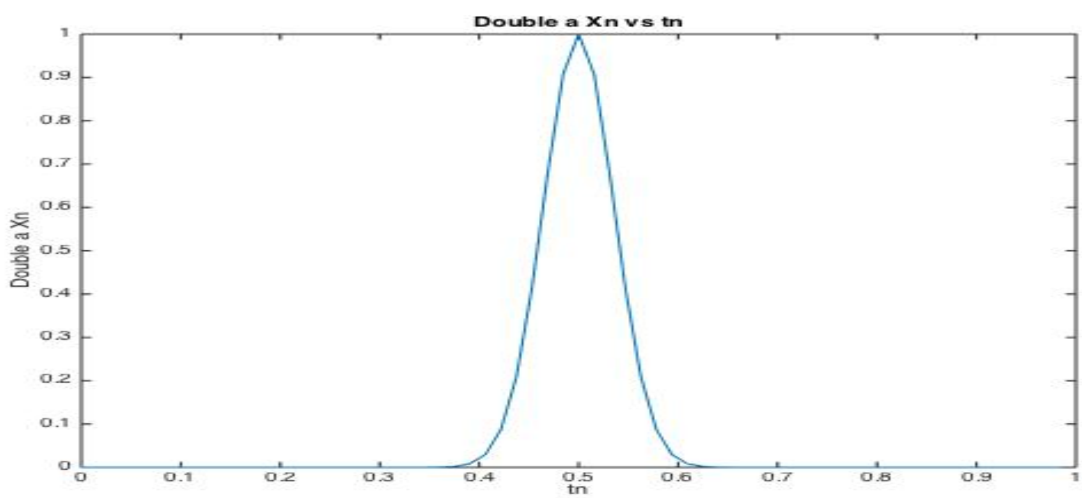


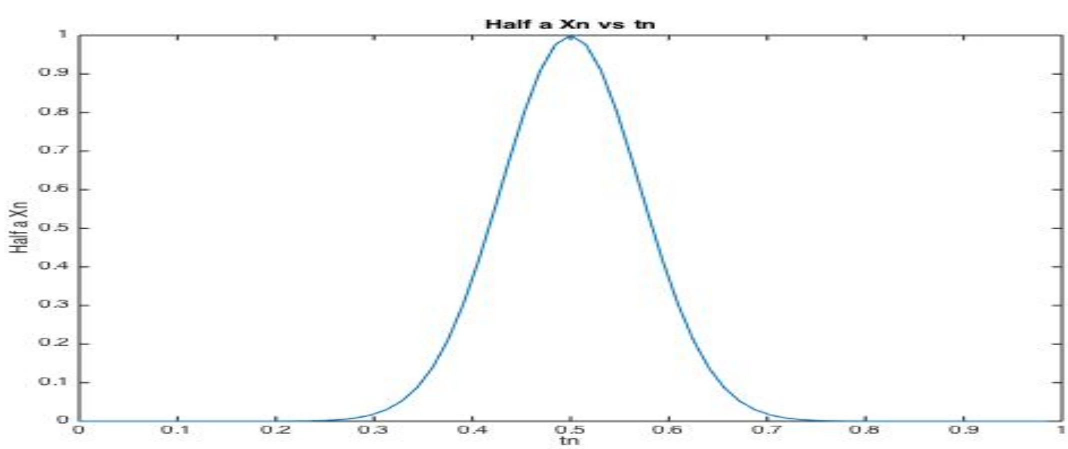
(c) Doubling or halfing the magnitude of ‘a’ seems to effect the horizontal stretch of our original signal function, Xn. Notice when we double ‘a’, Xn gets skinnier while halving it makes it wider**.**

```
DubXn = exp((-2*a)*(tn - 0.5).^2);
HafXn = exp((-0.5*a)*(tn - 0.5).^2);

figure;
plot(tn,DubXn);
xlabel('tn')
ylabel('Double a Xn')
title('Double a Xn vs tn')

figure;
plot(tn,HafXn);
xlabel('tn')
ylabel('Half a Xn')
title('Half a Xn vs tn')
```





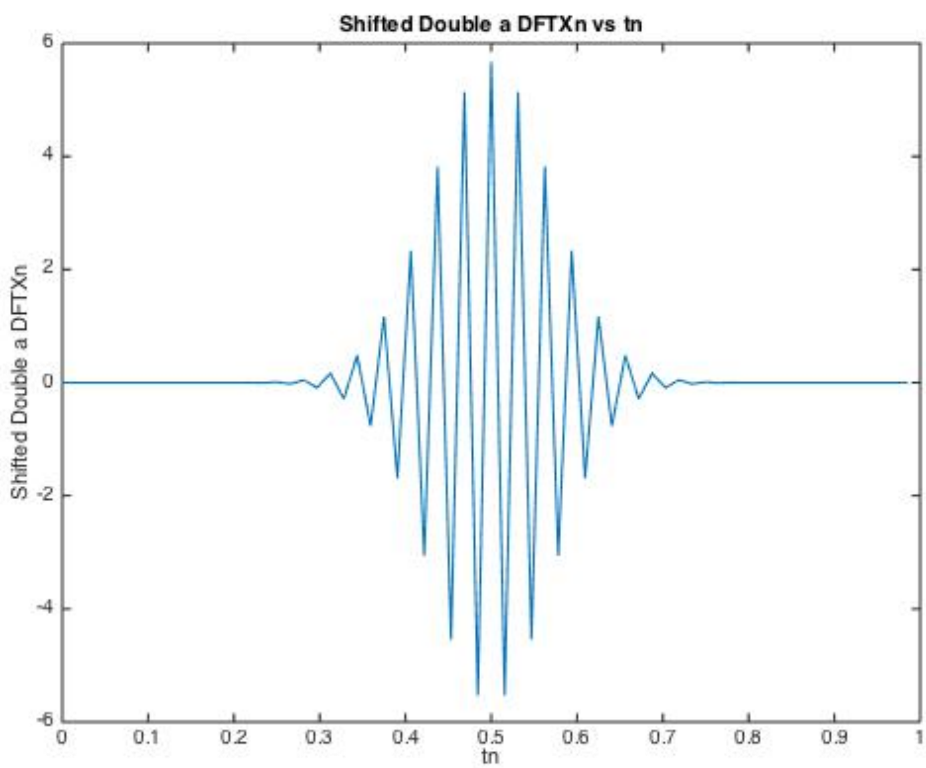
When doubling 'a', the shifted DFT of signal Xn has smaller amplitude than the original 'a' but the frequency is larger. Even though in the plot amplitude looks bigger but note the y axis. When halving 'a', the amplitude is greater than the original but the frequency is less.

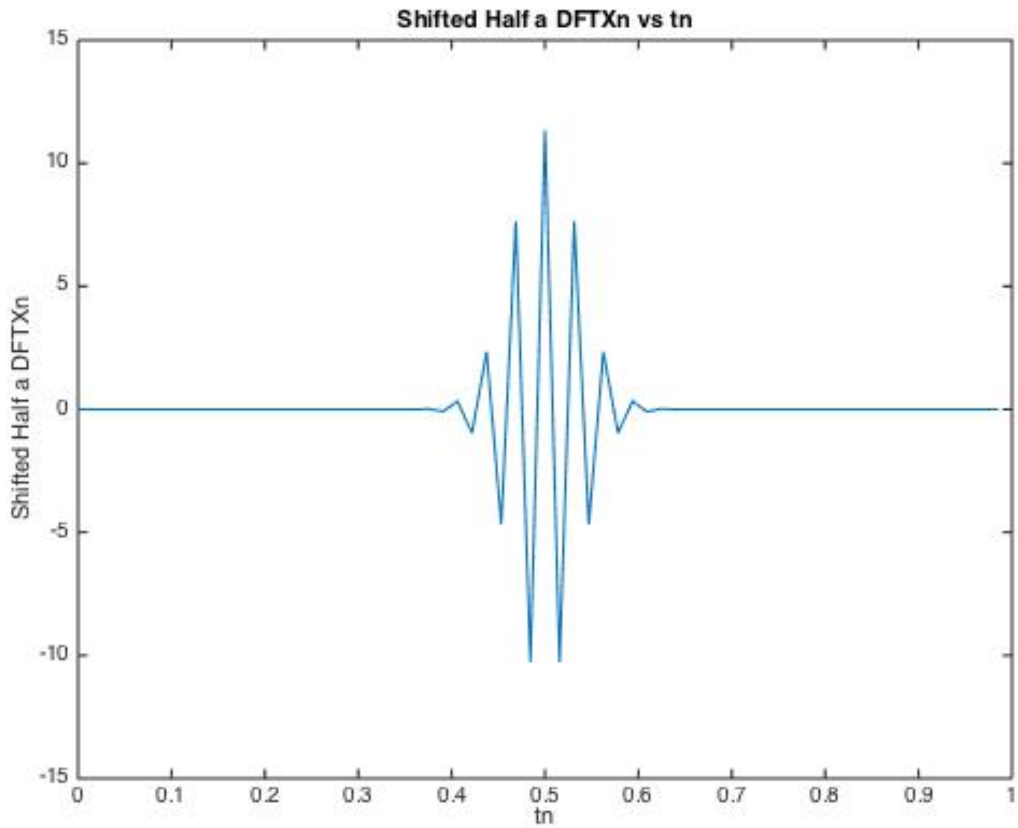
```
DFTDubXn = fft(DubXn);
DFTHafXn = fft(HafXn);
IMG_DFTDubXn = imag(DFTDubXn);
IMG_DFTHafXn = imag(DFTHafXn);

shiftDFTDubXn = fftshift(DFTDubXn);
shiftDFTHafXn = fftshift(DFTHafXn);
IMG_shift_DFTDubXn = fftshift(IMG_DFTDubXn);
IMG_shift_DFTHafXn = fftshift(IMG_DFTHafXn);

figure;
plot(tn, shiftDFTDubXn);
xlabel('tn')
ylabel('Shifted Double a DFTXn')
title('Shifted Double a DFTXn vs tn')

figure;
plot(tn, shiftDFTHafXn);
xlabel('tn')
ylabel('Shifted Half a DFTXn')
title('Shifted Half a DFTXn vs tn')
```

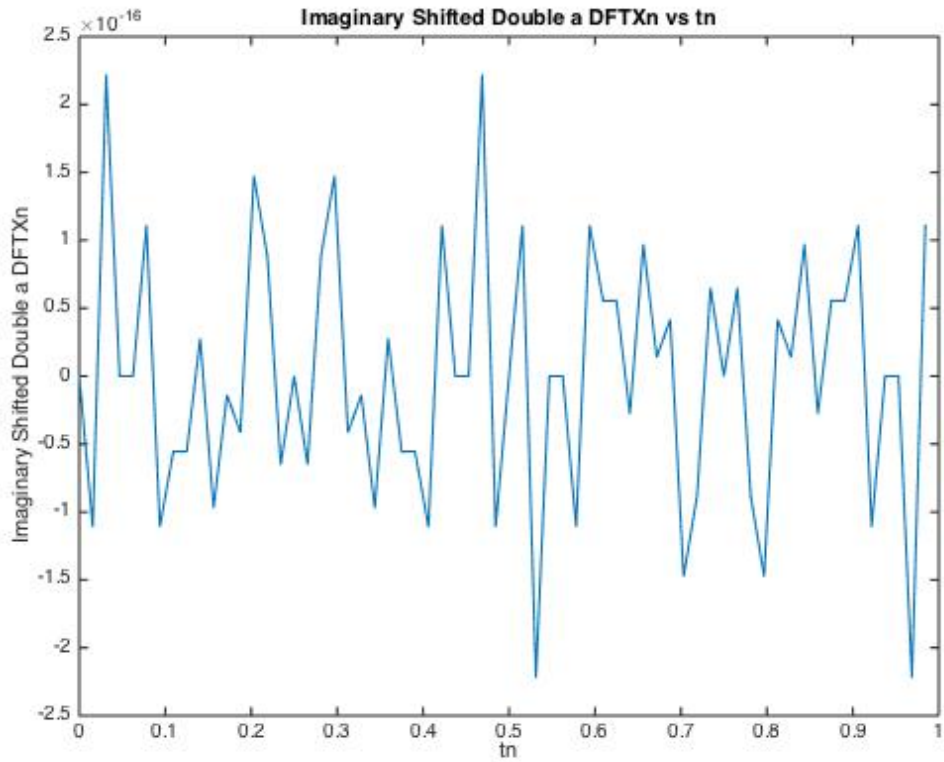


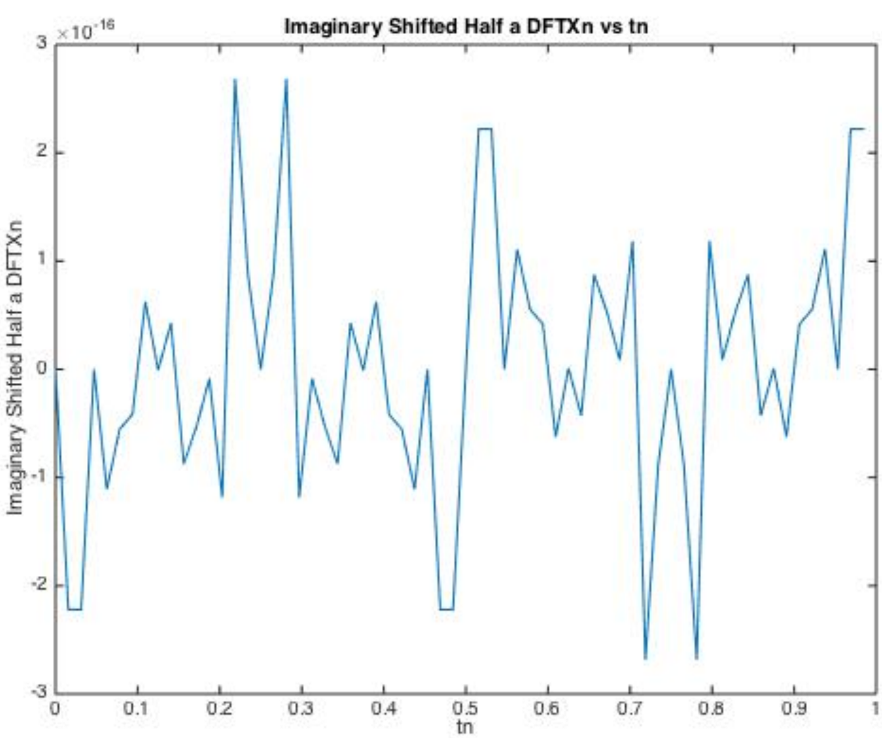


Similar results are seen in the imaginary part; the frequency increases while the amplitude decreases when doubling ‘a’, and frequency decreases while amplitude increases when halving ‘a’.

```
figure;
plot(tn, IMG_shift_DFTDubXn);
xlabel('tn')
ylabel('Imaginary Shifted Double a DFTXn')
title('Imaginary Shifted Double a DFTXn vs tn')

figure;
plot(tn, IMG_shift_DFTHafXn);
xlabel('tn')
ylabel('Imaginary Shifted Half a DFTXn')
title('Imaginary Shifted Half a DFTXn vs tn')
```

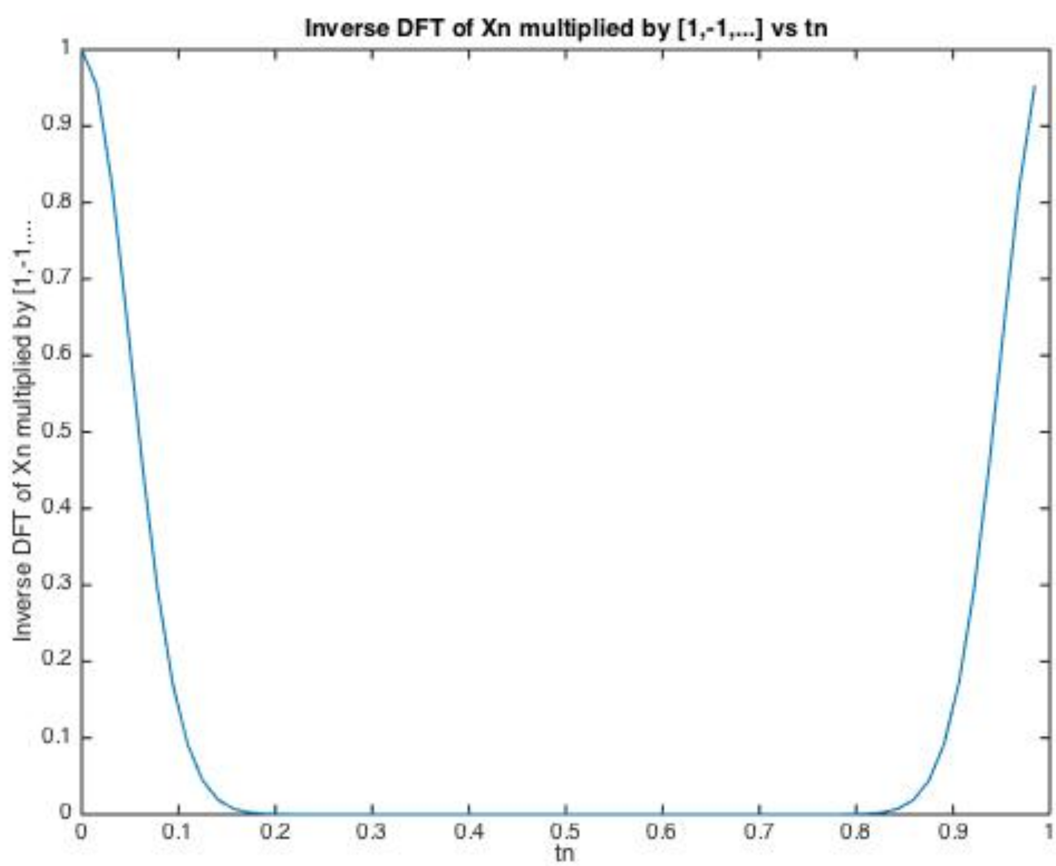

Imaginary Shifted Double a DFTXn vs tn
×10^-16
Imaginary Shifted Double a DFTXn
tn
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Imaginary Shifted Half a DFTXn vs tn
×10^-16
Imaginary Shifted Half a DFTXn
tn
3
2
1
0
-1
-2
-3
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

(d) Finally, we create a new row of [1,-1,...] and then multiply that by our DFT output of Xn we got in the beginning. We then take the inverse DFT of that using the ifft command and plot the new signal as a function of tn.

```
alternating_row = (-1).^[0:63];
alternatingDFTXn = (alternating_row).*(DFTXn);
inv_alternatingDFTXn = ifft(alternatingDFTXn);


figure;
plot(tn, inv_alternatingDFTXn);
xlabel('tn')
ylabel('Inverse DFT of Xn multiplied by [1,-1,...')
title('Inverse DFT of Xn multiplied by [1,-1,...] vs tn')
```



In comparison with the original signal Xn, this signal seems like an 'fft' shift of it; the second half of the original Xn is taken and moved in front of the first half.