EE2703: Applied Programming Lab
Week3: Forier Approximation

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1 Objectives

- Finding Forier coefficients using Integral method
- Finding Forier coefficients using "Least square fit model" and comparing with original coefficients
- Plotting coefficients in semilog and log-log scale
- plotting estimated functions with original functions

2 Theory

The Forier series is given by

$$f(x) = a_0 + \sum_{k=1}^{\infty} a_k cos(kx) + b_k sin(kx) \tag{1}$$

The coefficients a_k and b_k are calculated by

$$a_0 = \frac{1}{2\pi} \int_0^{2\pi} f(x)dx \tag{2}$$

$$a_k = \frac{1}{\pi} \int_0^{2\pi} f(x)cos(kx)dx$$
$$b_k = \frac{1}{\pi} \int_0^{2\pi} f(x)sin(kx)dx \tag{3}$$

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- The above equations use the Direct Integration method of finding the Fourier series
- We shall also use the Least Squares method to find the Fourier approximation.
- We will plot forier coefficients obtained through both methods and compare them
- Finally we will re-create the functions using second method and compare with original functions

3 Plots

3.1 Creating the functions

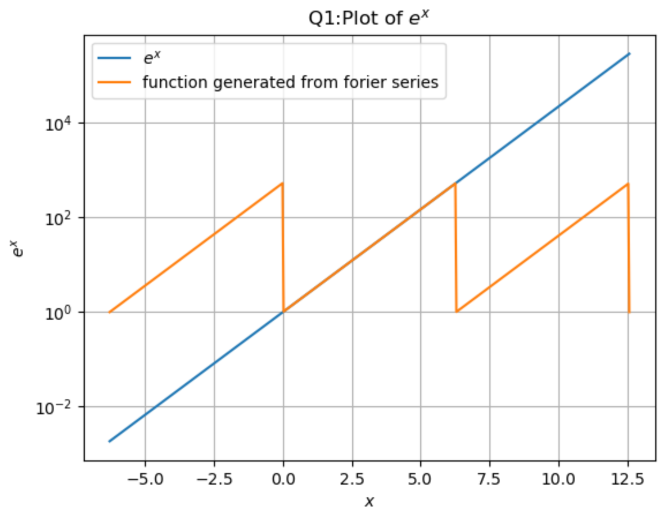

Figure 1: Plot of e^x in periodic and normal form using forier transform

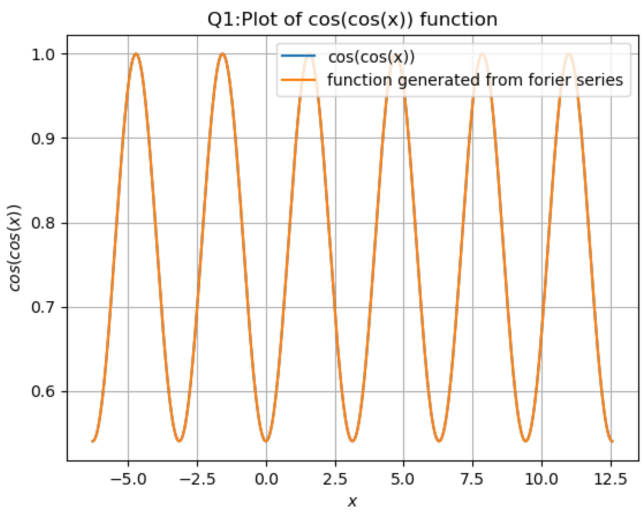

Figure 2: Plot of $cos(cos(x))$ in periodic and normal form using forier transform

As we can see, there is no difference in the plot of periodic(cos(cos(x)) and cos(cos(x)). This is because the period of cos(cos(x)) is pi

3.2 Obtaining Fourier Series Coefficients

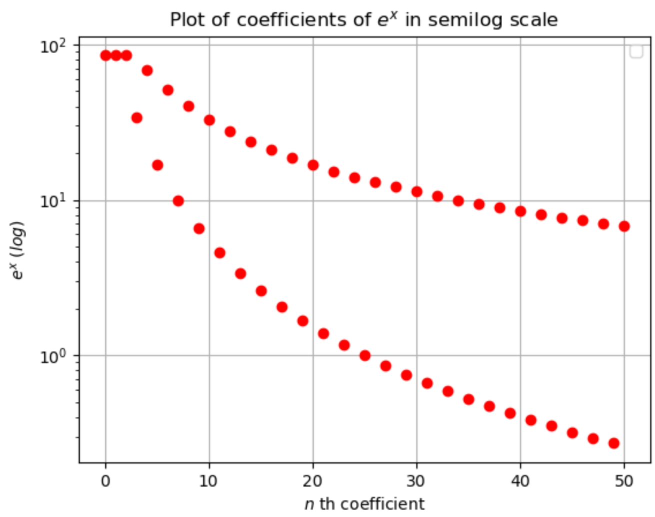

Figure 3: semilog plot of coefficients of e^x

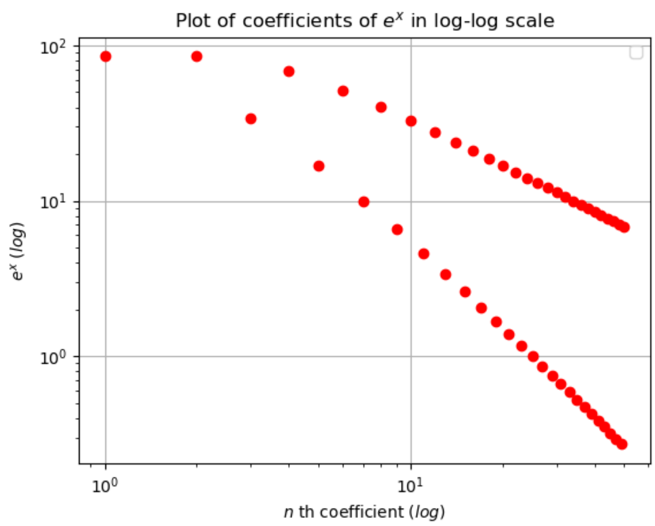

Figure 4: Log-Log plot of coefficients of e^x

In case of e^x log of the coefficients is approximately proportional to log of kth index.Hence log-log plot is almost linear in case of e^x.

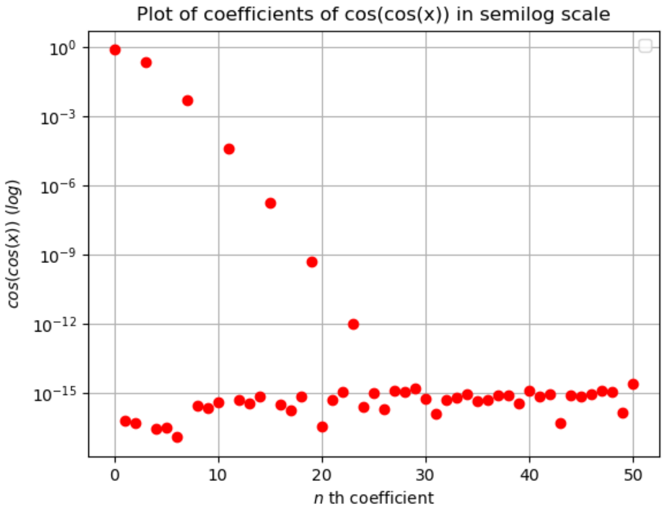

Figure 5: Semilog plot of coefficients of cos(cos(x))

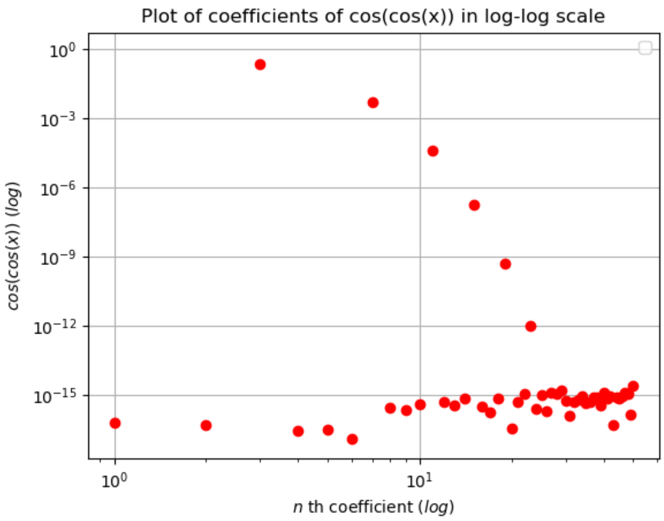

Figure 6: Log-Log plot of coefficients of cos(cos(x))

The semilogy plot of cos(cos(x)) coefficients are almost linear. bn coefficients of cos(cos(x)) are nearly zero because cos(cos(x)) is an even function. From the plot of cos(cos(x)), we can see that it is approximately sinusoidal with period of 2*pi. Hence the value converges more quickly as compared to e^x

3.3 Obtaining Fourier Series Coefficients using Least Squares Approach

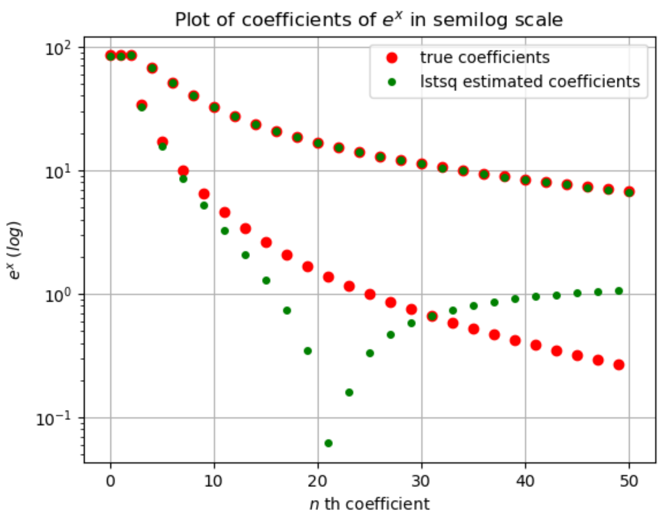

Figure 7: Semilog plot of lstsq estimated coefficients of e^x

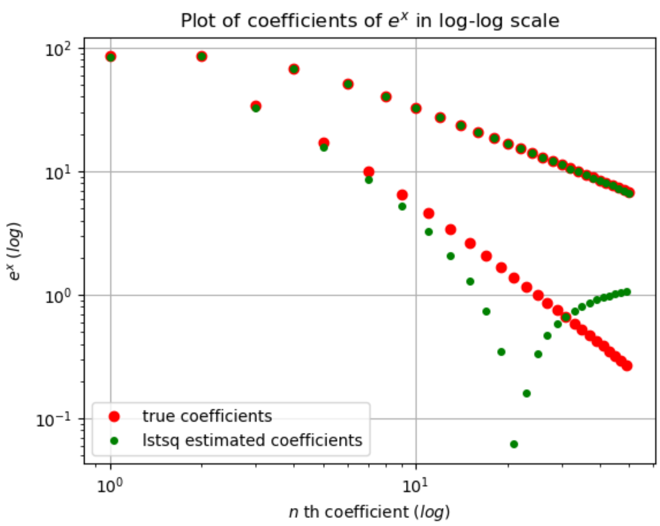

Figure 8: log-log plot of lstsq estimated coefficients of e^x

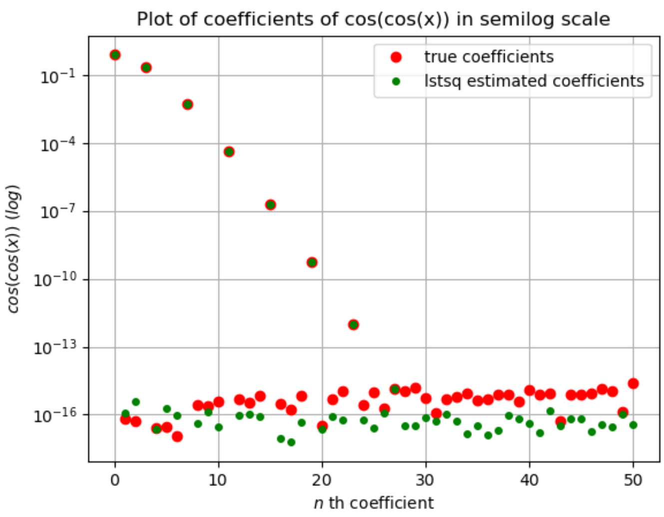

Figure 9: Semilog plot of lstsq estimated coefficients of $cos(cos(x)$

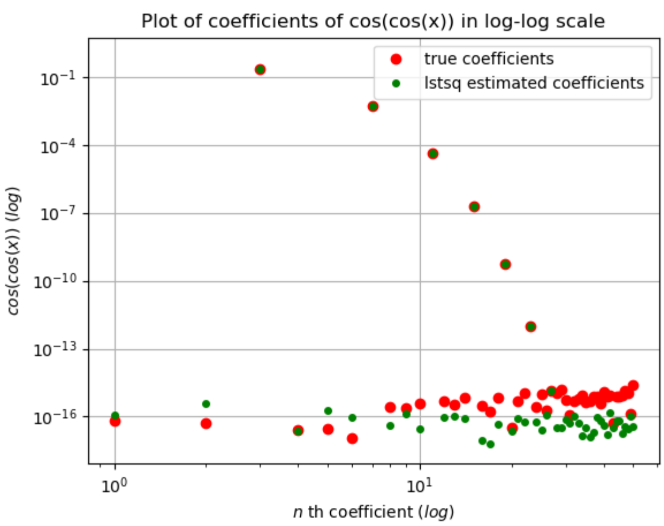

Figure 10: log-log plot of lstsq estimated coefficients of $cos(cos(x))$

3.4 Plotting the estimated functions

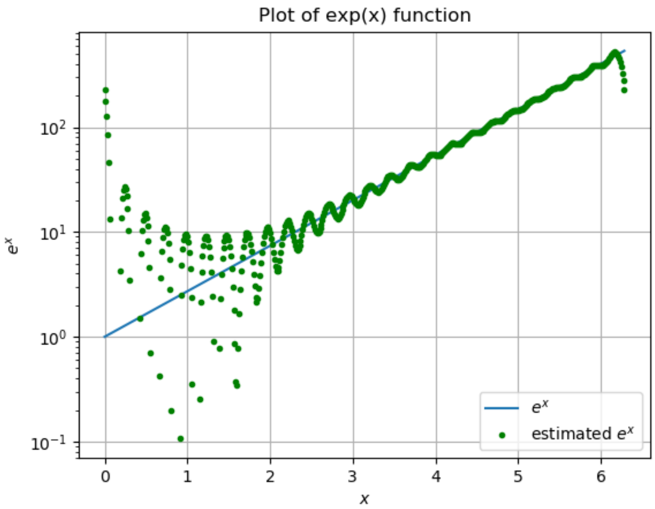

Figure 11: plot of estimated e^x function

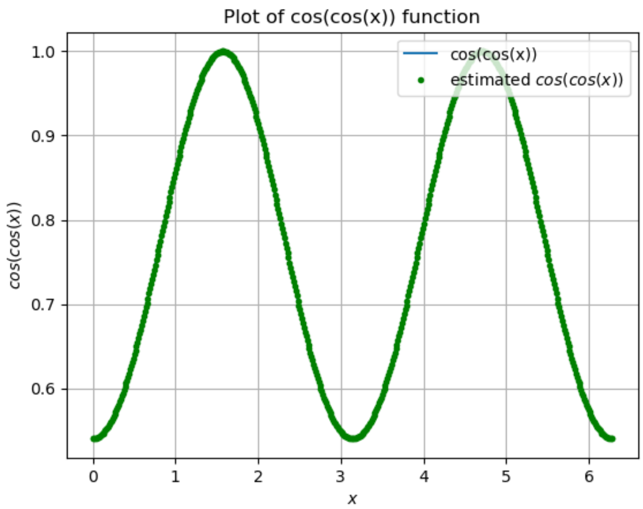

Figure 12: plot of estimated cos(cos(x)) function

4 Conclusion

We plotted and analysed the two ways of generating Fourier coefficients for the given two functions e^x and cos(cos(x)). The methods used are the direct evaluation of the Fourier Series formula and the Least Square approach's best fit. The Least Square approach's values fit well for cos(cos(x)) but diverge for e^x