EE2703 : Applied Programming Lab
Experiment 4

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Abstract

The problem is to find the fourier coefficients of the given functions by different methods. Various plots are generated along the way.

Introduction

There are two mathematical functions ($exp(x)$ and $cos(cos(x))$) for which the fourier coefficients are to be found. One method is to straightforwardly use the formulae for the coefficients. This involves integration using the `quad()` method. The other method is to estimate the coefficients so that the sum of squared differences between the original function reconstructed function turns out to be the minimum. `lstsq()` is used to solve this. The results obtained are compared and plotted against each other for comparison.

Additional implementations

The question number is to be given as the argument while running the code to output specific parts of the program. Instead `'all'` can be sent as argument to display every result. A list of available arguments are displayed if no arguments are given.

The mathematical functions are stored as lambda functions. This enables us to analyse new functions just by adding a single line of code describing that particular function.

Results

1.Plotting the functions

Lambda functions are written for each of the given functions. These functions are plotted by calculating $f(x)$ for x in `linspace(-2PI, 4PI, 400)`. It is seen that the function $cos(cos(x))$ is periodic while $exp(x)$ is not. Since we will be integrating over 2PI, the result we get using the fourier coefficients will be a periodic function that repeats itself over the period 2PI.

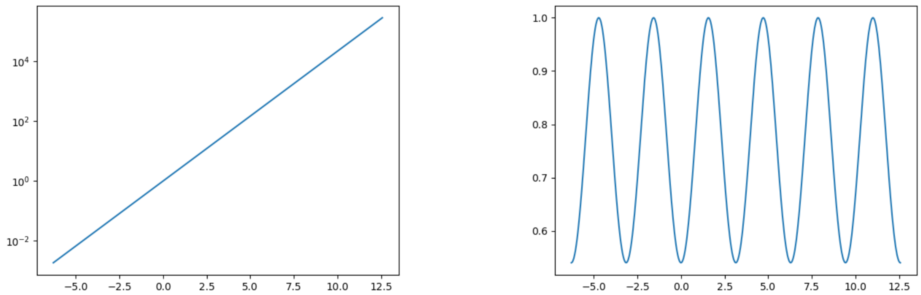

Figure 1: plots of the actual functions

2.Computing fourier coefficients

The computation of fourier coefficients is done by integrating $f(x)cos(nx)$ and $f(x)sin(nx)$ over 2PI for various values of n for each of the functions. `quad()` function is used for integration.

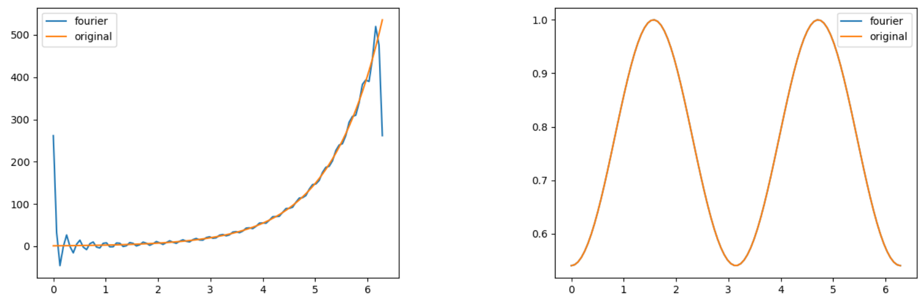

Figure 2: obtained by integration

3.Plot of coefficients

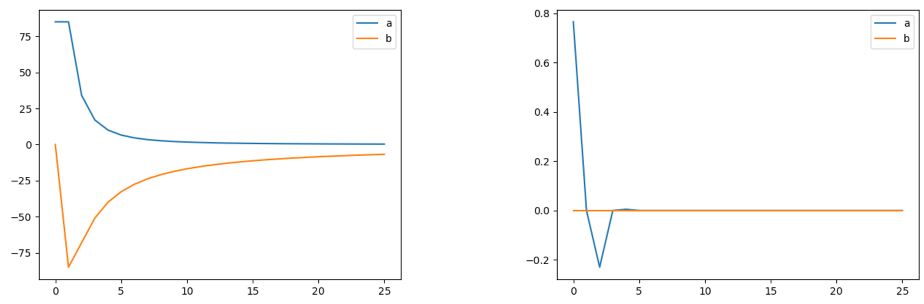

Figure 3: normal plot

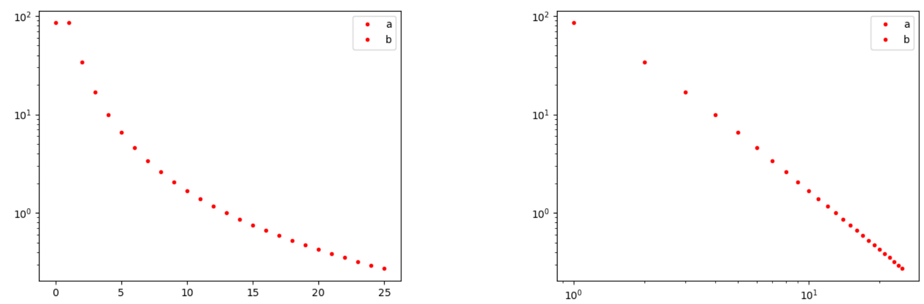

Figure 4: exp(x)

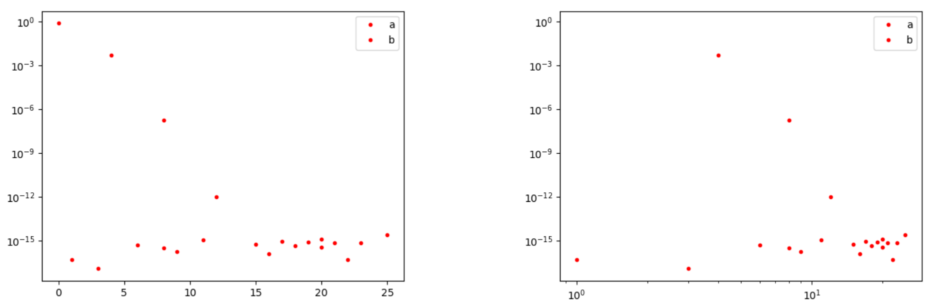

Figure 5: cos(cos(x))

(a) $cos(cos(x))$ is an odd function. Therefore, the b_n values are all zero.

(b) $cos(cos(x))$ can be expressed as a weighted sum of finite number of sinusoidal harmonics, while e^x requires infinite number of such sinusoids.

4.Using least squares

The fourier coefficients are solved using `lstsq()`. The resulting function is shown below.

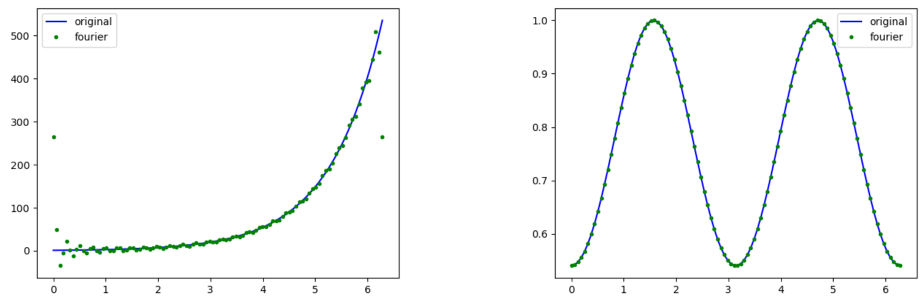

Figure 6: obtained using least squares

5.Least squares fourier coefficients

The coefficients obtained using least squares are displayed in the graph below.

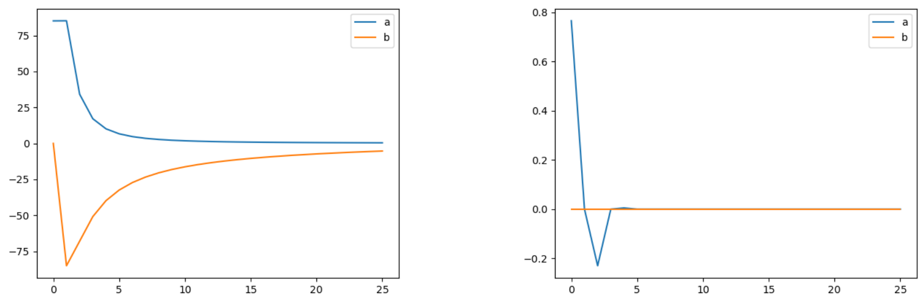

Figure 7: obtained using least squares

6.Comparing coefficients

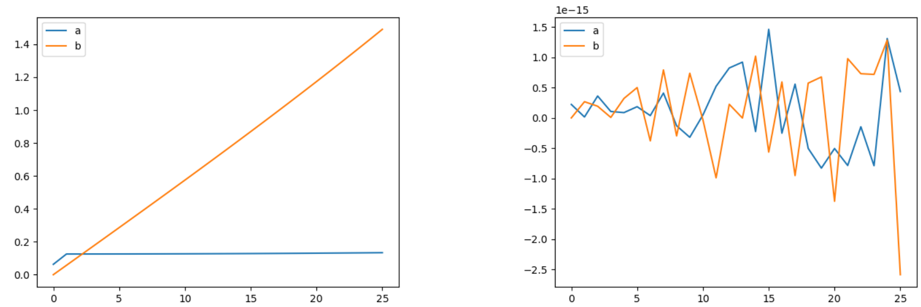

Figure 8: difference in values obtained

There is a little bit of error in the coefficients of exponential function. Whereas the coefficients of $cos(cos(x))$ match very well.

7.Plotting function obtained by least squares

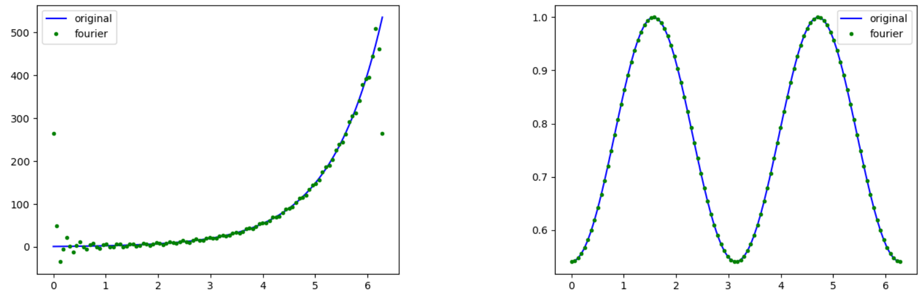

Figure 9: obtained using least squares

The reconstruction of $cos(cos(x))$ is nearly perfect while $exp(x)$ is not. The reason is that $cos(cos(x))$ can be written as a sum of finite number of scaled harmonics while $exp(x)$ cannot.

Conclusions

The problem of fourier approximations is handled. Various methods for finding fourier coefficients have been utilized. Integration is done using `quad()` function.