

1 Exercise 1. Finite Difference Approximation and Convergence

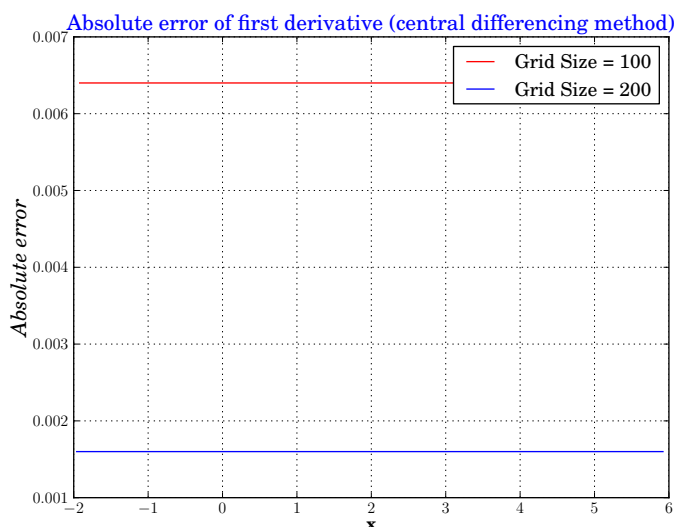


Figure 1: Plot of the absolute error of first derivative with forward method for 200 and 100 cell grid size.

figure 1 shows the plot of absolute error of first derivative with forward method for two different grid size. (100 and 200 cell grid size) and figure 2 shows the plot of absolute error of first derivative with central method for two different grid size. (100 and 200 cell grid size)

figure 3 shows the plot of first derivative with forward method for two different grid size. (100 and 200 cell grid size) and figure 4 shows the plot of first derivative with central method for two different grid size. (100 and 200 cell grid size)

As it is shown in the figure 1 and 2 the absolute error for forward method get decreased with relation $\frac{(ABS-ERR)_1}{(ABS-ERR)_2} = \frac{1}{2}$ and for central method $\frac{(ABS-ERR)_1}{(ABS-ERR)_2} = \frac{1}{4}$ as we expected. So we can conclude that these methods converges to first derivative of our function.

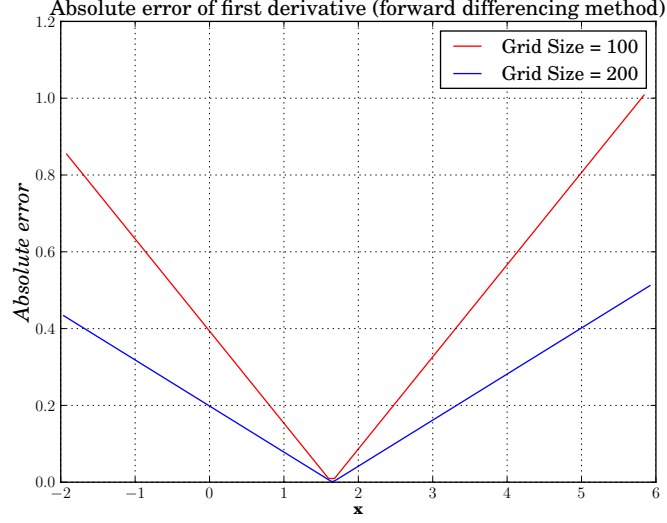


Figure 2: Plot of the absolute error of first derivative with forward method with central method for 200 and 100 cell grid size.

2 Exercise 2. Finite Difference Approximation and Convergence

By teylor expansion we can derive the following equations:

$$f(x_0 + h) = f(x_0) + hf'(x_0) + h^2 f''(x_0)/2 + h^3 f'''(x_0)/6 + \mathcal{O}(h_o^4) \quad (1)$$

and

$$f(x_0 - h) = f(x_0) - hf'(x_0) + h^2 f''(x_0)/2 - h^3 f'''(x_0)/6 + \mathcal{O}(h_o^4) \quad (2)$$

Simply by adding the equation number 1 and 2 we can derive the following formula:

$$f''(x_0) = \frac{f(x_0 + h) - 2f(x_0) + f(x_0 - h)}{h^2} + \mathcal{O}(h_o^2) \quad (3)$$

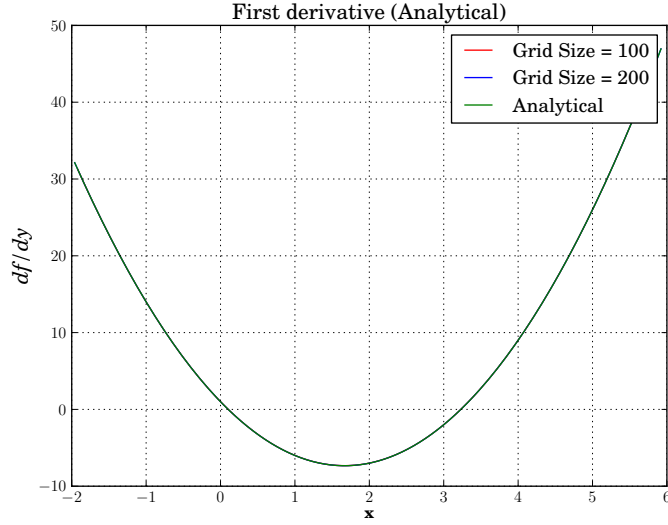


Figure 3: Plot of first derivative with forward method for 200 and 100 cell grid size.

3 Exercise 3. Interpolation: Cepheid Lightcurve

Figure 5 shows the interpolation of Cepheid Lightcurve with piecewise linear, piecewise quadratic, Lagrange, Cubic Hermit, and Cubic Spline methods. It is obvious that for this set of data Lagrange and Cubic Hermit methods are not a good approximation for interpolating the Cepheid Lightcurve function so we need to use the other methods for finding the interpolation. Figure 6 shows just answer of interpolation Cepheid Lightcurve with piecewise linear, piecewise quadratic, Cubic Spline methods. With this set of data quadratic interpolation is the best method for finding the missing values.

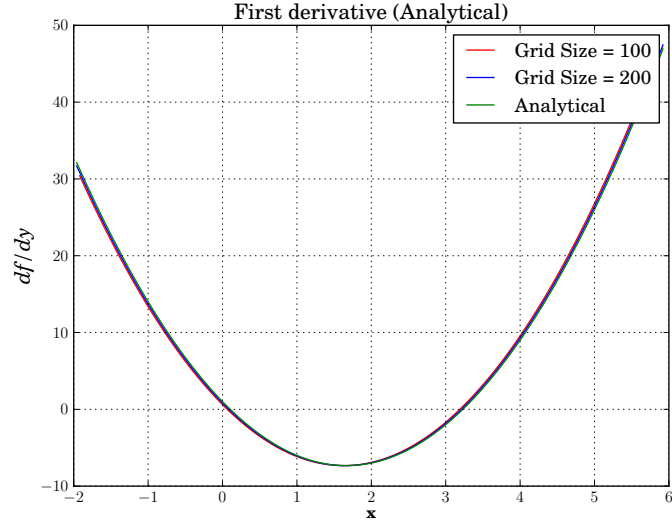


Figure 4: Plot of first derivative with forward method with central method for 200 and 100 cell grid size.

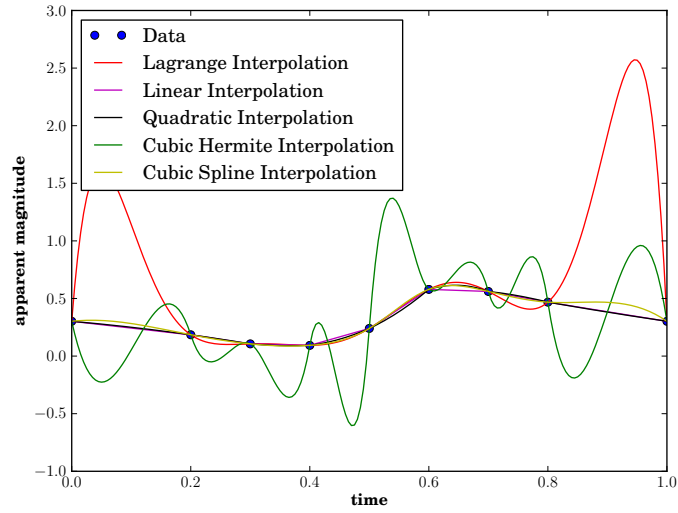


Figure 5: Interpolation of Cepheid Lightcurve with different methods.

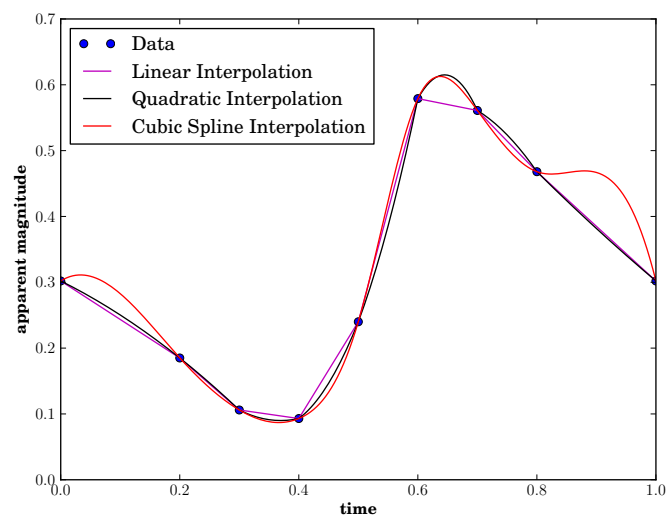


Figure 6: Interpolation for Cepheid Lightcurve with piecewise linear, piecewise quadratic, and cubic spline methods.