HW #1 (Jan. 26, 2016): Computational Physics

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deadline: Feb. 2, 2016 5pm

1. The following five data points are given: $f(0.2) = 0.0015681$, $f(0.3) = 0.0077382$, $f(0.4) = 0.023579$, $f(0.5) = 0.054849$, $f(0.6) = 0.10696$. This problem is about writing a code to evaluate $f(0.16)$ and $f(0.46)$ by using the Lagrange interpolation, i.e., a fourth-order polynomial interpolation function **(25 pts)**.

   - Write a program for the Lagrange interpolation by using the Neville's method. Compute $f(0.16)$ and $f(0.46)$ and estimate their numerical uncertainties or numerical errors. **(20 pts)**
   - Compare the above result to the result using a linear interpolation. **(5 pts)**

2. Write a program to calculate the first-order and second-order derivatives of $f(x) = x^3 cos(x)$ at $x \in [\pi/2, \pi]$ and estimate the numerical accuracy. You may use the three-point formulas for the calculations of the first-order and second-order derivatives. Use 100 uniform intervals in the range. For the boundary points, you may use the formulas discussed in the class or extrapolated values by using the linear interpolation or the Lagrange interpolation. The numerical accuracy at each x value can be obtained by comparing with the analytical result. **(15 pts)**

3. Write a program to calculate the integral

$$\int_0^1 exp(-x)dx \tag{1}$$

   and estimate its numerical accuracy by using the Simpson rule. The numerical accuracy can be obtained by comparing with the analytical result. **(10 pts)**