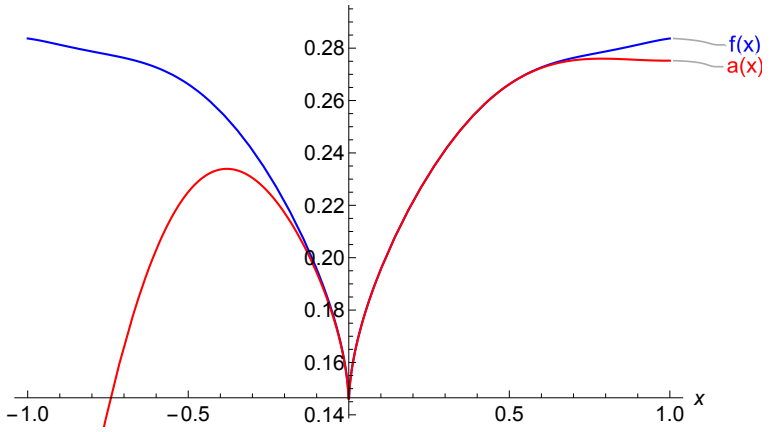
Evaluating Mathematical Functions

Homework 2
Due 8 February 2023

Given are the following mathematical functions,

$$
\begin{aligned}
f(x) &= \sin^3(x^2)\ \cos^2\left(\sqrt{|x|}\right)\ \left(1 - e^{-x^2/4}\right) + \frac{1}{7}\, e^{\sqrt{|x|}\cos(|x|)}\,, \\
a(x) &= 0.142857\, e^{\sqrt{|x|}\cos(|x|)} + \left[0.0000161538 + 0.000428688\,(-0.3+x) + 0.00496393\,(-0.3+x)^2\right. \\
&+ \left. 0.0326821\,(-0.3+x)^3 + 0.133107\,(-0.3+x)^4 + 0.338467\,(-0.3+x)^5)\right]\ \cos^2(\sqrt{|x|})\,,
\end{aligned}
$$

where $a(x)$ is the Taylor approximation of $f(x)$ for $-0.5 \le x \le 1$. Both functions are shown graphically in this figure:



Task

Write a structured Fortran program that reads x (real number) from standard input (i.e., keyboard) and computes and writes the values of $f(x)$ and $a(x)$ to standard output (i.e., terminal).

Code design

1. Your code must contain a detailed preamble.
2. Use the `IMPLICIT NONE` statment to declare your variables as `REAL` or `INTEGER`.
3. Comment on the different steps in your program.
4. The following quantities are to be written to standard output: x, $f(x)$, $x(x)$, and $\Delta(x) \equiv |f(x) - a(x)|$.
5. Run the program for the following terminal inputs for x: -0.5, -0.25, 0, 0.25, 0.5, 0.75, 1.0. Record (i.e., cut-and-paste) your results in a file named `results.txt`.

Submit your homework (Fortran source code and `results.txt` as a `gzipped tar` file (instructions on how to create this file are provided below). MAKE SURE YOU FOLLOW THESE INSTRUCTIONS when submitting your homework. Otherwise you will lose points.

HOMEWORK SUBMISSION INSTRUCTIONS

1. Change to the home directory on your machine (i.e., type `cd`).
2. Create a sub-directory named `LastFirst_HW2`
3. Copy your Fortran 90 source code and the `results.txt` file to `LastFirst_HW2` using the `cp` command.
4. Type `cd` to change back to the home directory.
5. Execute `tar -czvf LastFirst_HW2.tgz LastFirst_HW2/.`

(turn over)

This will create a gzipped archive file named `LastFirst_HW2.tgz` in your home directory. Type `ls -lF` to find out if the file has been create successfully. You can view the content of the archive with `tar -tzvf LastFirst_HW2.tgz`.

Email `LastFirst_HW2.tgz` to `ewhart317@gmail.com`. Put `PHYS 317 HW 2` in the subject line.