PHYS 210, Assignment 12

Create a new directory somewhere in your home directory with the name `yourusername_assignment_12` to store the files you will create for this assignment. To hand the assignment in, copy the directory with your results to `/home2/phys210/yourusername/`. Make sure it's there and has the right permissions (read and execute for everyone, write for you).

1 Exception handling

A common philosophy in python code is: "easier to ask for forgiveness than permission". That is, instead of checking if something is a valid operation, do it and deal with it in case it fails.

Suppose you have a file with two columns of words, i.e., a dictionary (in the literal sense of the word, not the python object). Write a function `dictionary_lookup` the takes a filename and a word s_1 as arguments and returns the word corresponding to s_1 in the dictionary. Write your function such that the program is not interrupted by an exception when trying to open a file that does not exist or accessing a word that is not in the dictionary.

Put the commented code in a file called `exceptions.py`.

2 Numerical differentiation

The derivative of a differentiable function $f \in C^1$ can be defined as

$$\frac{\mathrm{d}f(x)}{\mathrm{d}x} = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h} \ . \tag{1}$$

Finite difference methods of numerical differentiation use this definition to compute an (approximate) derivative for a function. Specifically, for some small but finite h,

$$\frac{\mathrm{d}f(x)}{\mathrm{d}x} \approx \frac{f(x+h) - f(x)}{h} \ . \tag{2}$$

Write a function `deriv` that takes a function object f, a position x, and an optional parameter h. It should return the derivative $\mathrm{d}f(x)/\mathrm{d}x$. Make sure your function accepts arrays.

Plot the derivative of $\sin(x) + 10x$ using your function `deriv`, as well as the analytical derivative, in a subplot. In a second subplot, plot the fractional difference between your function and the true solution. Save your figure as `derivativ.pdf`. For which values of h does your function become inaccurate?

Put the commented code in a file called `deriv.py`.

As an aside, exploiting the Cauchy-Riemann equations, the derivative of a holomorphic function (which applies to most functions you will encounter in physics) can be approximated as

$$\frac{\mathrm{d}f(x)}{\mathrm{d}x} \approx \Im\left(\frac{f(x+\imath h)}{h}\right) \ . \tag{3}$$

For the same h, this formula can be a lot more accurate than (2).