FYS-4096 Computational Physics, exercise 14

Return your solution to project `exercise14` under your GitLab group for this course by Friday 5 AM.

Tag the final version with `final` keyword, and make sure to include a file `problems_solved` in the repository. The `problems_solved`-file should be a comma separated list of problems you have solved.

Problem 1 (3 XP)

Find the maxima of the functions

- ‘$f(x) = \frac{\sin\left(x^3 + \frac{x}{|x|+1}\right)}{1+x^2}$, $x \in [-3, 3]$‘
- ‘$f(x, y, z, v) = \frac{3\,\mathrm{sech}[3\sin(v)+z]\exp[-(z-1)^2]}{1+\sqrt{|x|y^2}}$‘, ‘$x, y, z, v \in [-1, 1]$‘

Problem 2 (3 XP)

You will find a dataset at https://www.tut.fi/fys/fys4096/fitting_data.npz with two arrays, ‘x‘ and ‘y‘. The data is best visualized with a log-log plot.

Fit the function ‘$y(x) = A\lambda\exp(-\lambda x) + B\alpha(\beta - 1)(1 + \alpha x)^{-\beta}$‘ to the data via the parameters ‘$A, B, \lambda, \beta,$‘ and ‘α‘. Make sure that the fit looks good in the log-log plot. Visualize your fit.

Problem 3 (4 XP)

You will find a datafile containing the real and imaginary part of the complex refractive index for various elements at https://www.tut.fi/fys/fys4096/elements_optical_properties.h5. This data is from https://www.refractiveindex.info.

It can be loaded in Python like this:

```
import pandas as pd
df = pd.read_hdf('elements_optical_properties.h5', 'optical_properties')
```

Your job is to train a few-layer feedforward neural network that gives out the real and imaginary part of the refractive index when you feed it with the atomic number of your element and the wavelength of your laser (in µm).

For simplicity, you can restrict your dataset only to atomic numbers 35 - 40.

You might want to use the `tensorflow` Python package.

Visualize how well your NN fits the data.