AE588
Assignment 1: Basic Python and Journal Paper Review

Submission Instructions

Please submit both your report (in PDF) and source code to Gradescope. You must make two separate submissions: submit your report to `Assignment 1 (PDF)` and source code to `Assignment 1 (code)`.

Your grade will be based on your report, not solely on the autograder's score. Please make sure to include all figures and key outputs in your report.

Code submission

Name your runscripts as `prob1_1.py`, `prob1_2.py`, and `prob3_1.py` for Problems 1.1, 1.2, and 1.3, respectively. The autograder will execute your scripts using the following commands: `python prob1_1.py`, `python prob1_2.py`, and `python prob1_3.py`. As long as you have these 3 files, feel free to use other Python files. For instance, you might define a function in `func.py` and then import it in `prob1_1.py`.

Please note that the autograder only tests if your code runs without errors; however, it does not check whether the outputs of your code (figures and printouts) are correct. It also does not show the figure outputs on Gradescope. Therefore, passing all tests does not imply that you will get full credit. If the tests fail in your final submission, points will be deducted. You can resubmit your scripts as many times as you wish before the deadline.

Autograder Environment

Python 3.10.6, Numpy 1.25.2, Scipy 1.11.2, and Matplotlib 3.7.2.

Other packages are not installed by default but can be added upon request. Please email the GSI (shugok@umich.edu) and provide the package name, (its version), and a brief explanation of why you need it. If your script fails with `ModuleNotFoundError`, it means you're using a package not installed on the autograder.

Problems

1.1 (5 pts) Consider the one-dimensional function

$$f(x) = \frac{1}{12}x^4 + x^3 - 16x^2 + 4x + 12.$$

Plot the function using Python and matplotlib; making sure that you program the function as a Python function. Find the approximate location and classify the minimum point(s).

1.2 (5 pts) Consider the two-dimensional function

$$f(x_1, x_2) = x_1^3 + 2x_1x_2^2 - x_2^3 - 20x_1.$$

Plot the function contours and find the approximate location and classify the minimum point(s).

1.3 (40 pts) Consider the two-dimensional function

$$f\left(x_1, x_2\right) = \left(1 - x_1\right)^2 + \left(1 - x_2\right)^2 + \frac{1}{2}\left(2x_2 - x_1^2\right)^2,$$

Plot the contours of this function and find the minimum graphically. Then, use off-the-shelf optimization software to find the minimum. Verify that the optimizer converges to the minimum you found graphically. Show the optimization path and plot the function values versus the iterations. Try different starting points, including points far away from the minimum.

1.4 (50 pts) Browse through different journal articles on engineering design optimization and select one that catches your interest. [1] Briefly summarize the paper's findings, evaluate its importance, provide constructive criticism, and see if you can infer new insights. Please limit your write up to two pages. Pay particular attention to:

- Problem formulation (Is it well posed? Classify the problem(s) according to Chapter 1 of the textbook)
- Optimization method used (classify the method(s) according to Chapter 1 of the textbook)
- Models, and solvers (see overview of solvers in Chapter 3)
- Suitability of methods to solve the problem
- Practicality of the results
- Conclusions (hint: draw your own conclusions before reading the conclusions in the paper and then compare)

Please attach a copy of the article at the end of your report and submit as a single PDF.

[1] Some suggestions: Structural and Multidisciplinary Optimization, AIAA Journal, Journal of Aircraft, Aerospace Science and Technology, Optimization and Engineering. Do not confuse a conference paper or proceedings with a journal paper.