ME 575 — Homework 3

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Introduction

For this assignment, I worked on optimizing the same 10-bar truss problem from the first homework, but with the gradients for the objective and the contraints provided by my own algorithms. I did the assignment entirely in Python 3. The following four approaches were used for computing the gradients:

1. Forward-difference
2. Complex-step
3. Forward-mode autodifferentiation (provided by Google's `JAX` library)
4. Analytic adjoint

1 Truss Derivatives

Let A be the array containing the cross-sectional areas of the ten bars that make up the truss. Let m be the total mass of the truss. Let σ be the array containing the stress on each of the ten bars. The derivatives calculated by each of the four methods were:

- $\frac{dm}{dA}$ — mass with respect to each cross-sectional area (array of size 10)
- $\frac{d\sigma}{dA}$ — all stresses with respect to each cross-sectional area (2D-array of size 10×10)

Figure 1:

Figure 2:

2 Truss

It is interesting to note that bar 9, the bar made of the strongest material, was allowed to have the highest stress of any of the bars.

Figure 3: Convergence of objective value over function evaluations. The bottom plot is the same as the middle, but zoomed in for clarity.

Table 1: Comparison of number of function calls required for convergence.

Algorithm	Matyas	Rosenbrock	Brachis.
Custom	7.9	25e3	0
pyOptSparse: SNOPT	0.14	11309	