Introduction to Optimization / Optimization in Applications
6^{th} Computer Class: Topology optimization 2D and 3D models

April 4, 2024

16/07

Submission of solutions by **July ~~15~~** via the moodle. Solutions are required to be worked on individually. Please submit a PDF document containing your solutions, including well written explanatory text, code and figures.

`Recommended is to read carefully the papers:`
- A 99 line topology optimization code written in Matlab,
- Efficient topology optimization in MATLAB using 88 lines of code,
- An efficient 3D topology optimization code written in Matlab.

1. Working with the code Top99 and code top88. In this part, we will compare different techniques used to optimize a simply supported beam under a central load. Since the structure is symmetric, we will only model the right part of the structure.

   (a) Run the code top.m with the input parameters: `top(80,30,0.3,3,2)`. Document your results with the optimal final design and plot the value of the objective function (compliance) over the number of iterations,

   (b) Vary the value of the penalty `penal` within the interval $[1, 5]$. What do you observe? Give interpretations of the results (Optimal design, number of iterations).
   Hint: use `top(80,30,0.5,penal,2)`,

   (c) Explain the effects of the penatly factor on the optimization.

   (d) Vary the value of `rmin` within the interval $[1, 5]$ and give interpretations of the results (Optimal design, number of iterations).
   Hint: use `top(80,30,0.5,3.0,rmin)`

   (e) What is the difference between the two approaches used in the codes beso.m and top.m?

2. Working with the code top88.m and building a 2D bridge model. Read carefully the paper "Efficient topology optimization in Matlab using 88 lines of code". Run the code top88.m while changing the input parameters and have a good understanding of the code, see the differences with the previous codes (Beso.m and top.m)

   (a) Run the attached code "top88BridgeOpt.m" with the input parameters: `nelx=30`, `nely=30`, `volfrac=0.5`, `penal=3.0`, $r_{min} = 2$ and `ft=1`. Change the type of filtering `ft` , save the two plots and make interpretations about the effect of the filtering.

   (b) Write in your own words the difference between the sensitivity and density filtering.

3. Visualization of the distibution of Von Mises Stress

   (a) Run the code "VonMises2D.m" and save the final plots of the optimized structure and the Von Mises distributions.

   (b) Visualize the distributions of the Von Mises stress of the bridge created in 2.(a)

   (c) Visualize the distributions of the Von Mises stress of a truss bridge built using top.m or top88.m.

4. Topology optimization 3D models:

   (a) Read the paper "An efficient 3D topology optimization code written in Matlab" carefully and choose one of the existing model, implement it in top3d and conduct the optimization. Save the final results.