

# Usage of FreeFEM programs attached to Chapter 9 in “Shape Optimization Problems”

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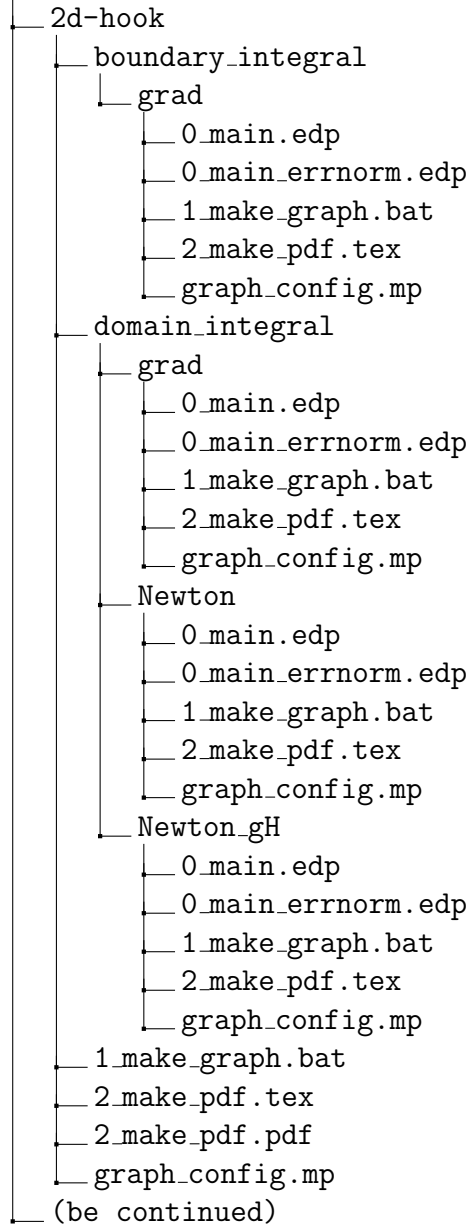
December 9, 2020

## 1 Tree of folders and files

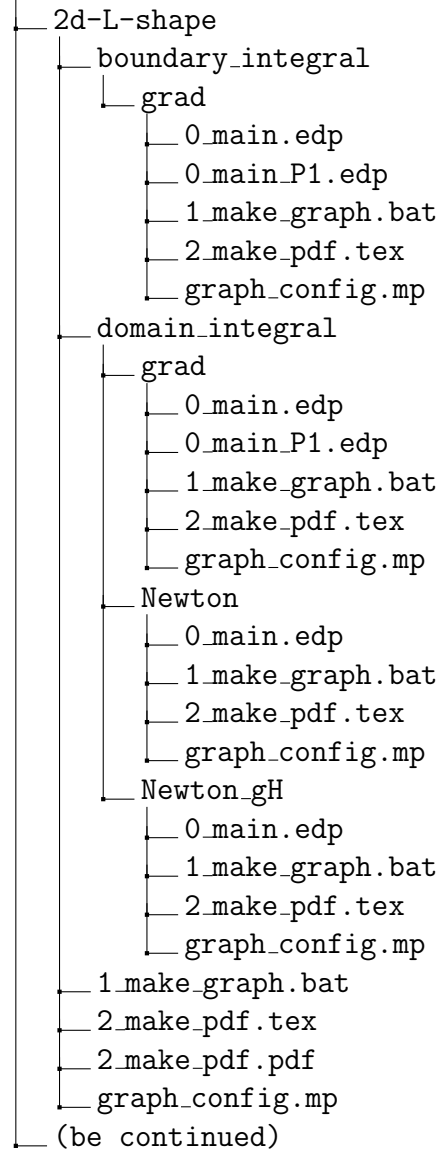
```
9.11.5.shape_elastic
├── 2d-cantilever
│   ├── boundary_integral
│   │   └── grad
│   │       ├── 0_main.edp
│   │       ├── 1_make_graph.bat
│   │       ├── 2_make_pdf.tex
│   │       └── graph_config.mp
│   ├── domain_integral
│   │   ├── grad
│   │   │   ├── 0_main.edp
│   │   │   ├── 1_make_graph.bat
│   │   │   ├── 2_make_pdf.tex
│   │   │   └── graph_config.mp
│   │   ├── Newton
│   │   │   ├── 0_main.edp
│   │   │   ├── 1_make_graph.bat
│   │   │   ├── 2_make_pdf.tex
│   │   │   └── graph_config.mp
│   │   └── Newton_gH
│   │       ├── 0_main.edp
│   │       ├── 1_make_graph.bat
│   │       ├── 2_make_pdf.tex
│   │       └── graph_config.mp
│   ├── 1_make_graph.bat
│   ├── 2_make_pdf.tex
│   ├── 2_make_pdf.pdf
│   └── graph_config.mp
└── (be continued)
```

```
(9.11.5.shape_elastic)
├── 2d-hole
│   ├── boundary_integral
│   │   └── grad
│   │       ├── 0_main.edp
│   │       ├── 1_make_graph.bat
│   │       ├── 2_make_pdf.tex
│   │       └── graph_config.mp
│   ├── domain_integral
│   │   ├── grad
│   │   │   ├── 0_main.edp
│   │   │   ├── 1_make_graph.bat
│   │   │   ├── 2_make_pdf.tex
│   │   │   └── graph_config.mp
│   │   ├── Newton
│   │   │   ├── 0_main.edp
│   │   │   ├── 1_make_graph.bat
│   │   │   ├── 2_make_pdf.tex
│   │   │   └── graph_config.mp
│   │   └── Newton_gH
│   │       ├── 0_main.edp
│   │       ├── 1_make_graph.bat
│   │       ├── 2_make_pdf.tex
│   │       └── graph_config.mp
│   ├── 1_make_graph.bat
│   ├── 2_make_pdf.tex
│   ├── 2_make_pdf.pdf
│   └── graph_config.mp
└── (be continued)
```

(9.11.5\_shape\_elastic)



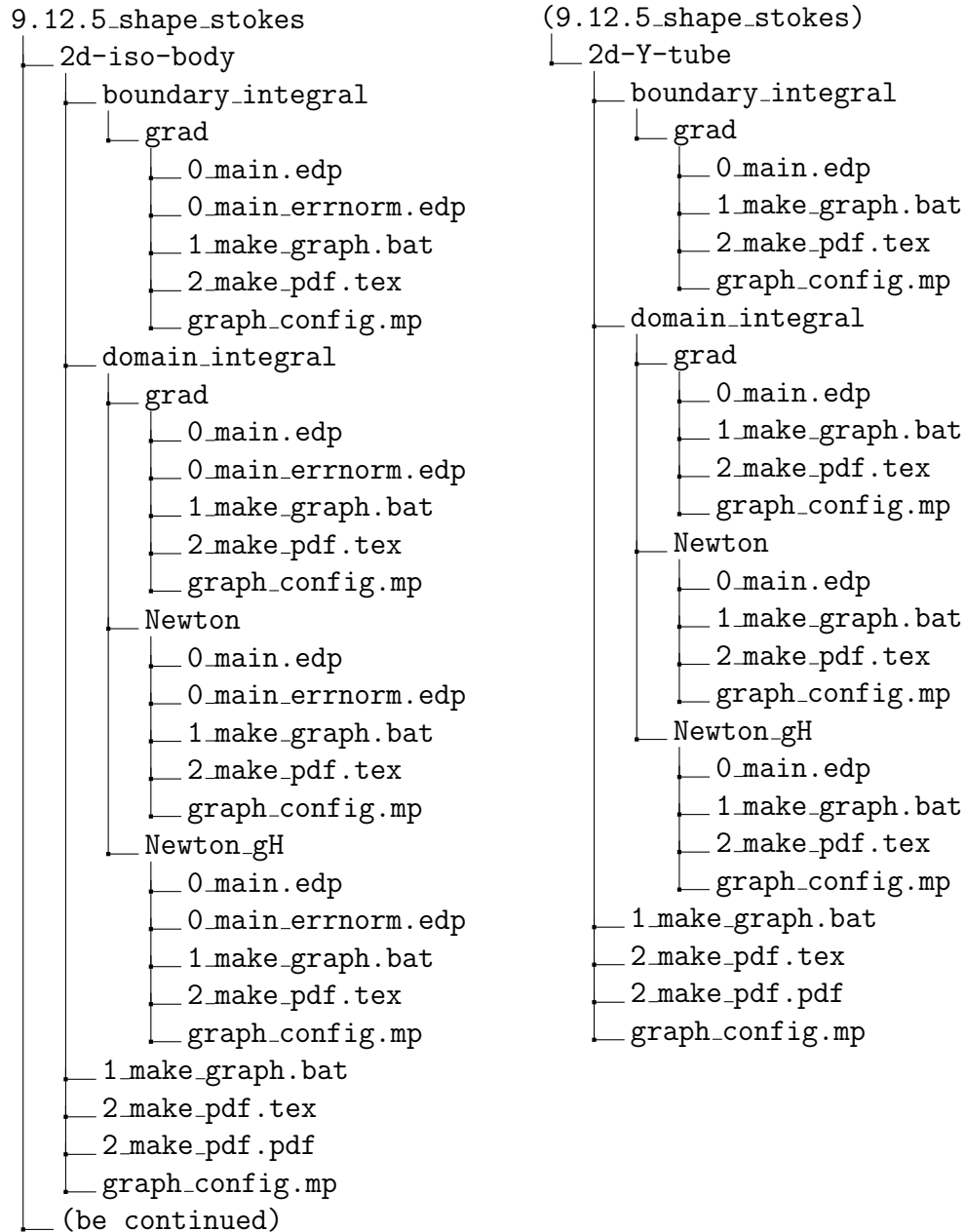
(9.11.5\_shape\_elastic)



```

(9.11.5.shape_elastic)
├── 3d-cantilever
│   ├── boundary_integral
│   │   ├── grad
│   │   │   ├── 0_main.edp
│   │   │   ├── 1_make_graph.bat
│   │   │   ├── 2_make_pdf.tex
│   │   │   └── graph_config.mp
│   │   └── domain_integral
│   │       ├── grad
│   │       │   ├── 0_main.edp
│   │       │   ├── 1_make_graph.bat
│   │       │   ├── 2_make_pdf.tex
│   │       │   └── graph_config.mp
│   │       ├── Newton
│   │       │   ├── 0_main.edp
│   │       │   ├── 1_make_graph.bat
│   │       │   ├── 2_make_pdf.tex
│   │       │   └── graph_config.mp
│   │       └── Newton_gH
│   │           ├── 0_main.edp
│   │           ├── 1_make_graph.bat
│   │           ├── 2_make_pdf.tex
│   │           └── graph_config.mp
│   ├── 1_make_graph.bat
│   ├── 2_make_pdf.tex
│   ├── 2_make_pdf.pdf
│   └── graph_config.mp

```



## 2 Explanation of folders and files

The index number of **9.11.5** in the first folder name **9.11.5\_shape\_elastic** corresponds to Section 9.11.5 in the book. The folder name **2d-cantilever** refers to the type of problem. In the folders **boundary\_integral** and **domain\_integral**, the shape derivatives  $\bar{g}_0$  and  $\bar{g}_1$  of the boundary integral type and  $g_0$  and  $g_1$  of the domain integral type are used, respectively. The folder names **grad**, **Newton** and **Newton\_gH** contain the script for solving the problem using the  $H^1$  gradient method,  $H^1$  Newton method and  $H^1$  Newton method using Hesse gradient, respec-

tively. In each folder, the roles of files are as follows:

- **0\_main.edp** is an executable file written in the FreeFEM language. You can edit it by a text editor. To run the program, **FreeFEM** (<https://freefem.org/>) has to be installed.
- **0\_main\_errnorm.edp** is provided for evaluation of distance  $\|\phi_k - \phi^*\|_X$  from an approximate minimum point  $\phi^*$ .
- In **0\_main\_P1.edp**, the P1 elements are used to solve the state determination problem and the  $H^1$  gradient method.
- **1\_make\_graph.bat** is a batch file for Windows system to make graphs from the output files obtained by running **0\_main.edp** and **0\_main\_errnorm.edp** (if there is) using **MetaPost**. To run the program, a  $\text{\TeX}$  distribution have to be installed. In the distribution, for example, **C:/texlive/2020/bin/win32/mpost.exe** is used. If the batch file does not work, you can type in **%mpost graph\_config.mp** on **Command prompt** for Windows and **Terminal** for Mac. By running the command, graph files in **EPS** format will be generated.
- **2\_make\_pdf.tex** is a  $\text{\TeX}$  file to create a PDF file from the **EPS** files where all the graphs are plotted.
- The files **1\_make\_graph.bat** and **2\_make\_pdf.tex** in parent folders are made available after **0\_main.edp** and **0\_main\_errnorm.edp** (if there is) in all the child folders are executed. The files **2\_make\_pdf.pdf** in parent folders are the output files generated by running **2\_make\_pdf.tex**.