

# Lab 01 Getting Started and step-1

## Computational Methods for PDEs Summer School 2019

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### 1. Virtual Machine setup

- Download and install “VirtualBox” for your machine. See <https://www.virtualbox.org/wiki/Downloads> and choose “windows host” (if you are running windows), “OS X hosts” (if you are running MacOS), or install it under Linux (depends on the distribution).
- Download the virtualbox image linked at <http://www.math.clemson.edu/~heister/dealvm/>. The .ova file is 3.6GB big so complete this step before traveling to Fort Collins.
- Double-click the .ova file and “import” it into virtualbox. When prompted pick the amount of RAM and number of cores (if unsure pick 2 cores and 4GB of RAM unless you know if your machine has more). You will need in the order of 20GB of disk space.

### 2. The Virtual machine

- The machine is a light-weight Ubuntu with various things installed. If needed, you can install additional software. You can use “synaptic” to do that.
- To get the latest files for this workshop run `dealvm-install pdeschool2019` in a terminal window. This will create a directory `~/pdeschool2019`. Rerunning the command will update to the latest version. Please close the terminal and open a new one after typing this.
- The following directories are of interest:
  - `pdeschool2019/` – Here you can find the lecture notes, exercises, codes, etc.
  - `deal.II/installed/` – This is the installation directory of deal.II, you probably don’t need to access it directly though.
  - `deal.II/dealii` – The deal.II source directory.
  - `deal.II/dealii/examples/` – all tutorial programs.
  - `libs/` – libraries deal.II depends on.
- to make a copy of tutorial 1, configure, compile, and run it:

```
cp -r ~/deal.II/dealii/examples/step-1 ~/
cd ~/step-1
cmake .
make
./step-1
```
- IDE: open `qtcreator .` in the directory of the example and uncheck the `Desktop` kit.

### 3. Tasks for tutorial step-1:

1. See documentation at [https://www.dealii.org/current/doxygen/deal.II/step\\_1.html](https://www.dealii.org/current/doxygen/deal.II/step_1.html)
2. `~/pdeschool2019/lab01/step-1/` already contains a clean version of step-1 for you to work with (we removed the extensive comments using `make strip-comments` in the file, see above to find the original version).

3. Setup the project using `cmake .` and then compile and run inside qtcreator and look at the output files. You can view `.eps` files with `gv <filename>`, for example `gv grid-1.eps`.
4. Looking at `.eps` files is somewhat clunky. Switch to outputting `.svg` files instead as they open in firefox (can you guess the function name?).
5. Add the line `triangulation.reset_manifold(0);` after the call to `::hyper_shell`. We already added the line commented out in the modified version of step-1. What happens now? Why are only the corners refined?
6. Create an image of an L-shape domain (add a function `third_grid()` to step-1) with one global refinement.
7. Refine the L-shaped mesh adaptively around the re-entrant corner several times but with a twist: refine all cells with the distance between the center of the cell and re-entrant corner is smaller than  $1/3$ .
8. Bonus: Create a helper function that takes a reference to a `Triangulation` and prints the following information: number of levels, number of cells, number of active cells. Test this with all of your meshes.
9. Bonus: Create a mesh that represents the surface of a torus and refine it 2 times globally. Output to vtk format and check the output. Note that your `Triangulation` needs to be of type `Triangulation<2,3>`, which we probably do not discuss this week.
10. Bonus: Take a look at step-49 and read the included `.msh` file in your modified step-1 program.