IBFEM-4i Training

Hands-on: Random FEM (RFEM)

Introduction

In this tutorial we will look at the steps required to prepare and run simulation using the Random Finite Element Method (RFEM) approach.

RFEM modelling can be a 'compute expensive' process (i.e. it requires substantial computing power). Because of time constraints on this course we will use some pre-prepared data for this tutorial to gain an appreciation of the steps required whilst avoiding the need to wait for each step to complete.

Using software from PortableApps on your USB Flash Drive

1. To open a PortableApp program first start up the portable apps suite from the IBFEM USB Flash Drive (start.exe, with icon as shown in Figure 1) provided to you for this course.

Figure 1. Portable Apps icon.

This should open Portable Apps in your start menu, you may need to click on the arrow to show hidden programs.

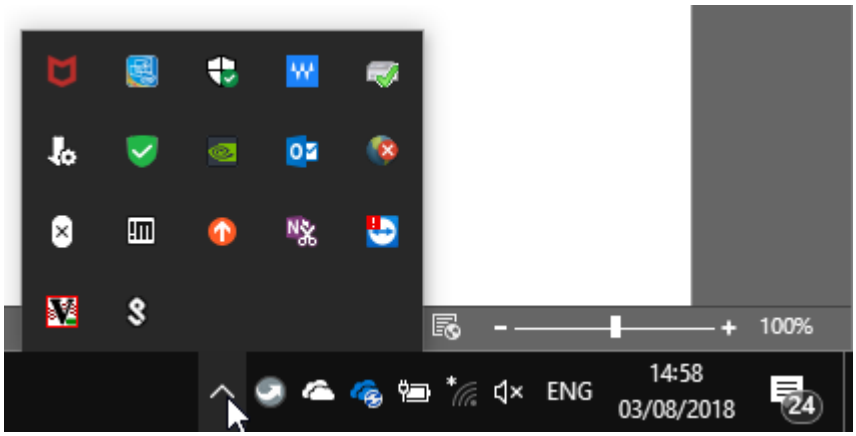

Figure 2. Opening Portable Apps launches a Windows style start menu in your taskbar to access the software.

2. Click on the Portable Apps icon to open the 'Start Menu' and search for the desired software program (e.g. Notepad++). Click on it to open the program (see Figure 3). Once open you should see a graphical user interface window (GUI) as shown in Figure 4. These steps may differ slightly depending on your machine's setup.

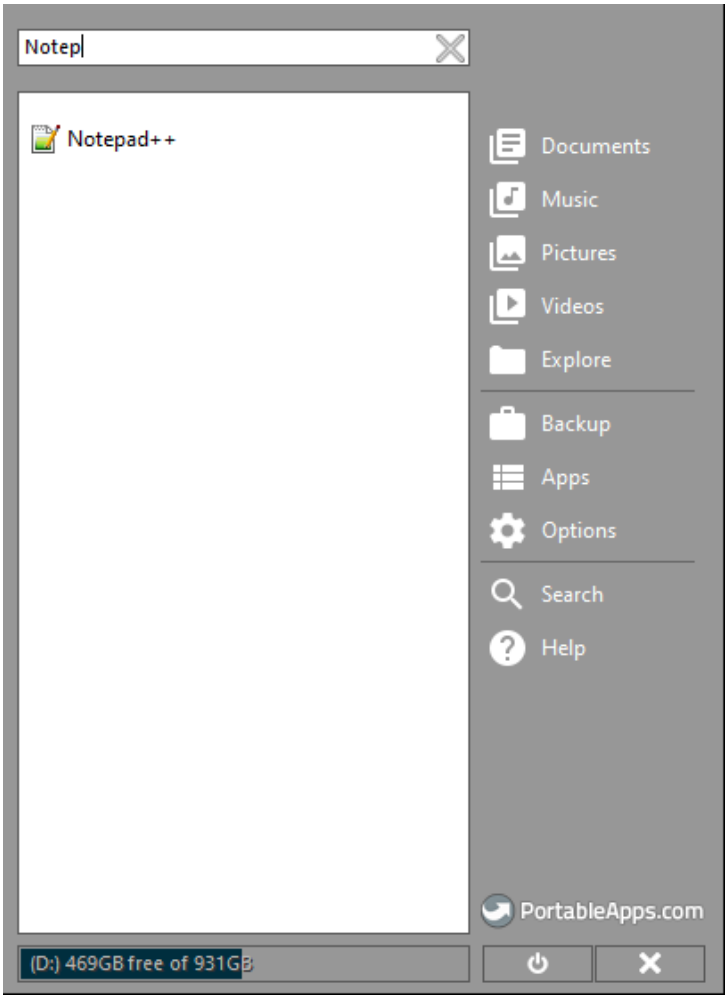

Figure 3. Portable Apps menu used to find software on the USB Flash Drive.

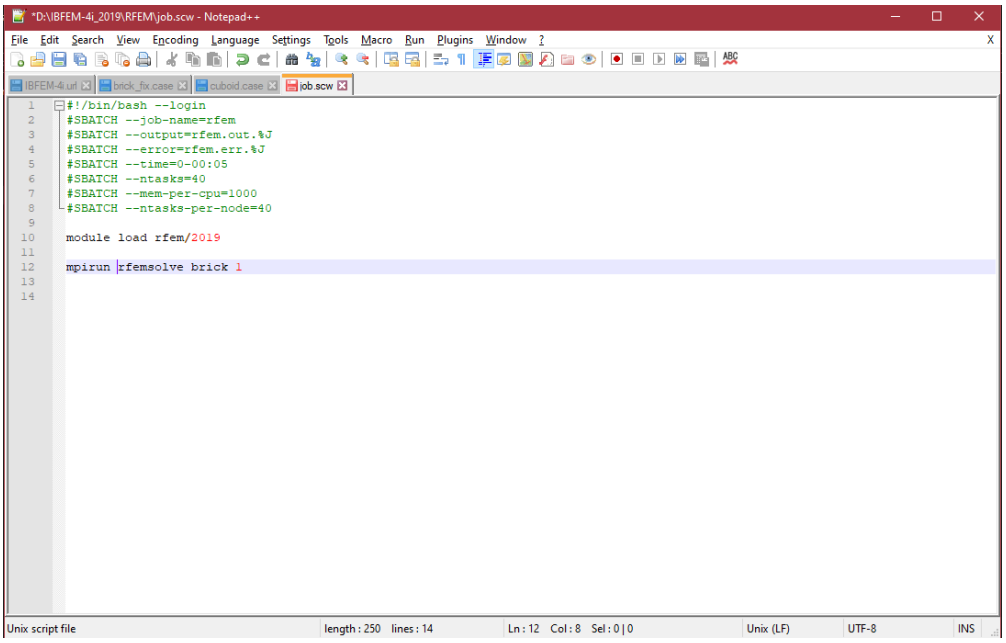

Figure 4. GUI for portable version of Notepad++.

Connecting to the Supercomputing Wales cluster

The use of a high-performance computing (HPC) facility demands a training course in its own right. However, here we will guide you through a 'quick start' guide to connect to and run a job on the Supercomputing Wales (SCW) facility.

To achieve this, we will use two software programs contained on the PortableApps platform:

PuTTY: A command line interface (CLI) used to log in to SCW and run commands.

WinSCP: A GUI for file transfer between the remote SCW cluster and your local PC.

Both these programs should be launched from PortableApps using the steps described above.

3. To connect using PuTTY:
    a. Type 'USERNAME@sunbird.swansea.ac.uk' in the 'Host Name (or IP address)' box, where 'USERNAME' is your username.
    b. Ensure that 'Port' is 22 and 'Connection type' is SSH, as shown in Figure 5.
    c. Click 'Open'.
    d. This will open a CLI. Enter your password when requested, see Figure 6.
    NOTE: When typing your password you will not see any characters appear in the CLI, this is standard behaviour to protect your security.
    e. You will now be logged into SCW

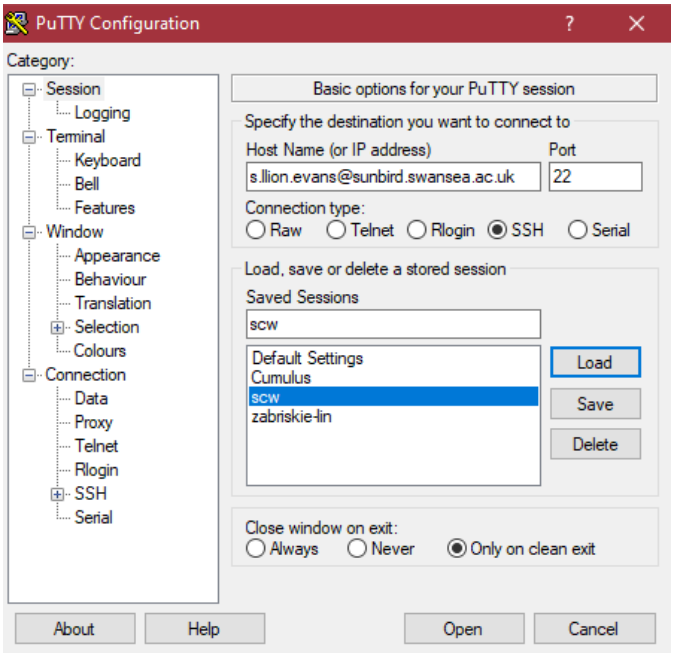

Figure 5. Login GUI for PuTTY.

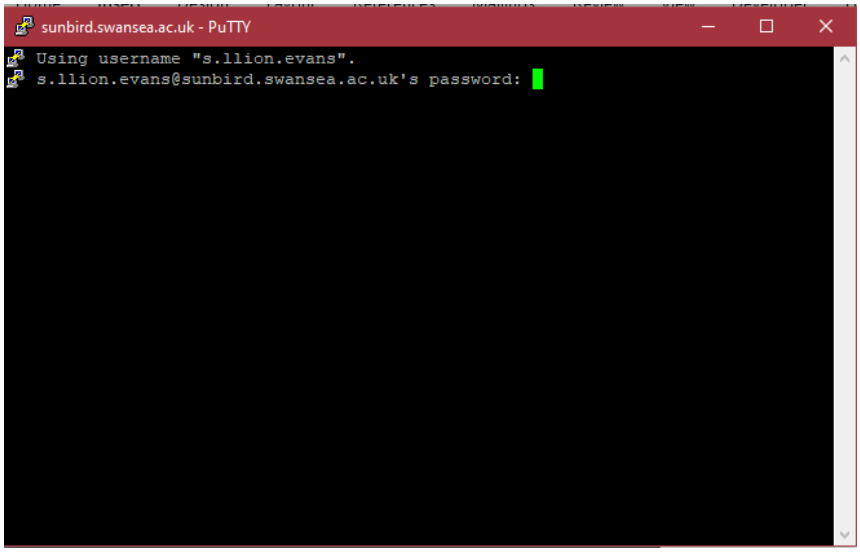

Figure 6. Command line interface (CLI).

4. To use WinSCP for file transfer:
    a. After you've opened the program click 'New Site' on the top left of the window.
    b. Select SCP from the 'File Protocol' dropdown menu, see Figure 7.
    c. Type 'sunbird.swansea.ac.uk' in the 'Host Name' box.
    d. Ensure 'Port number' is 22.
    e. Enter your username and password in the appropriate boxes.
    f. Click 'Login'.
    g. You will be presented with a GUI showing your local PC files on the left and remote files (i.e. SCW) on the right. You can use this to browse and transfer files.

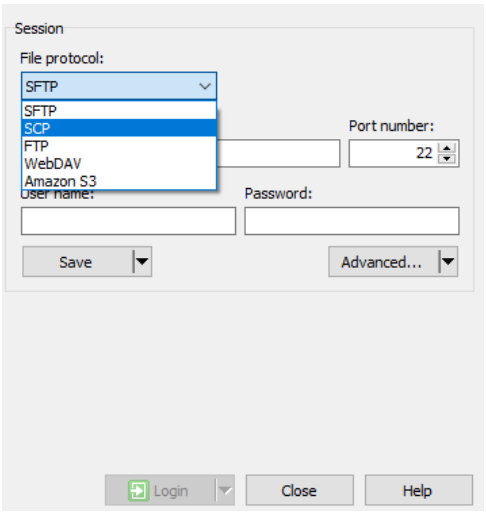

Figure 7. Login window for WinSCP.

Running an RFEM job

5. After logging into SCW with PuTTY, you can access the pre-installed RFEM programs by typing:
   `$ module load rfem/2019`
   NOTE: Do not type '$', this is the CLI symbol for the command prompt.

6. Now copy the data to your current working directory by typing:
   `$ cp $RFEMDATA/* .`
   NOTE: There is a space followed by 'period' or 'full stop' character after the asterisk.
   You can click 'refresh' in WinSCP to view the copied files (also for all other following steps).

7. The first step in the process is to create a random field. This is done by typing the following in the same directory as your data
   `$ rfemfield brick brick 1`
   The output of the previous command creates new files appended by the realistion "1".

8. Some files required for the analysis don't vary from one realisation to the next (in this case the .bnd and .fix files). We will duplicate them with the appended realisation number so that the solver can find them. Type the two commands below:
   `$ cp brick.bnd brick-1.bnd`
   `$ cp brick.fix brick-1.fix`

9. To run the job type:
   `$ sbatch job.scw`
   Once submitted you will receive the message: 'Submitted batch job $JOB-ID'
   The progress of the job can be monitored by typing
   `$ squeue -u <your_username>`

10. Once complete, convert the output into ParaView format by typing
    `$ pf2ensi brick-1`

11. Using WinSCP, copy all the files with *ensi* in the filename to the local computer (preferably to the USB Flash Drive). You can do this with 'Drag & Drop' from the right to left side. View the results using ParaView (see 'Visualising the simulation data' instructions).

12. Compare the visualisation of your results with your neighbours'. You should have different results due to the randomised variations in material properties.

13. If you'd like to run another realisation, ask the course tutor what to do next.

Visualising the simulation data

14. Visualisation of the RFEM results is performed in ParaView. If you are not familiar with ParaView you could browse through the basic usage of ParaView tutorial which also included on your USE Flash Drive (again this is its own training course). **\\Pendrive\Documents\IBFEM-4i_2018\Tutorials\Tutorial_ParaView.pdf**
15. To open the RFEM data:
    a. **'File > Open** ' and browse to wherever you saved the results files e.g. F://Documents/Data/ParaFEM/brick-1
    b. Select the 'brick-1.ensi.case' file
    c. From the dropdown menu for 'Files of type' choose: 'EnSight Files(*.case *.CASE *.Case)'.
    d. Click 'OK'
    e. Click 'Apply' in the properties box, which is in the bottom left of the window.
    f. To change which results you're viewing (e.g. stress or displacement), select from the dropdown menu in the top left.

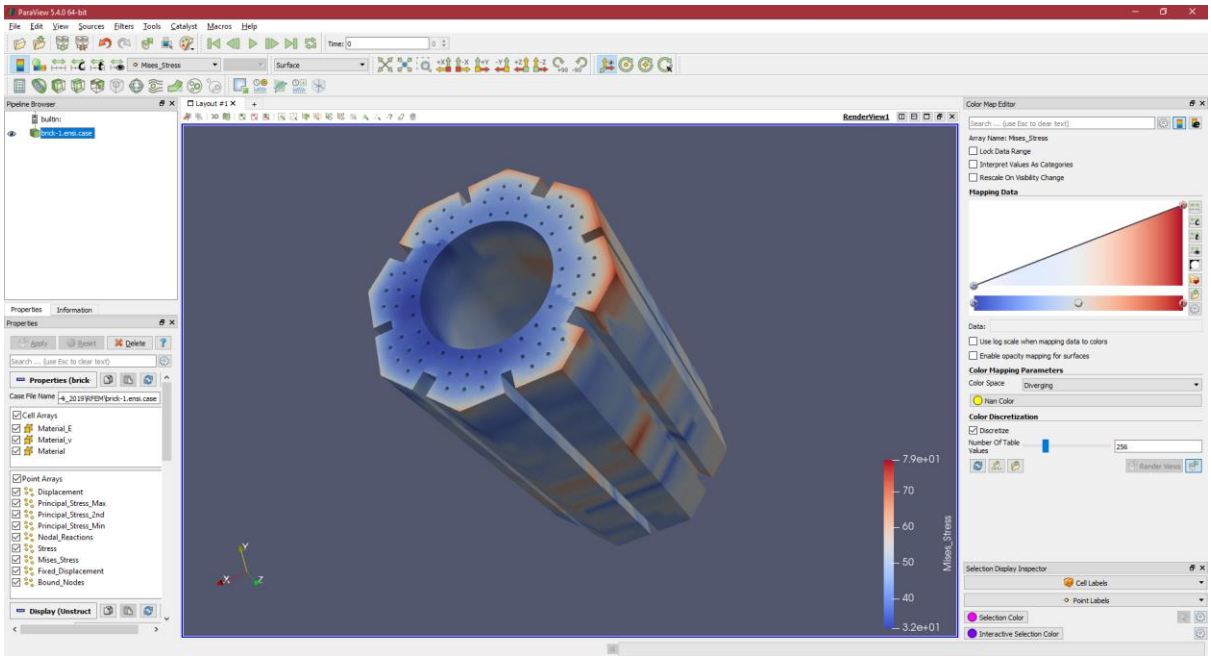

Figure 8. Results from RFEM realisation visualised in ParaView.