MATH920: Lattice Methods for PDEs

Course syllabus

Times	MF 2:30-3:20PM, Phillips 385
Office hours	MF 12:30-2:00PM, and by email appointment, Chapman 451
Instructor	Sorin Mitran

1 Motivation

2 Course topics

3 Course materials

3.1 Bibliography

Additional material is available in the course material repository (`/biblio` subdirectory)

3.2 Slides

Lessons	**Topics**
Lesson01	TEN, KIN, CON
Lesson02	ELS
Lesson03	DNN-ELS
Lesson04	PLS
Lesson05	DNN-PLS
Lesson06	NSF
Lesson07	DNN-NSF
Lesson08	VEF
Lesson09	DNN-VEF
Lesson10	NET
Lesson11	DNN-NET
Lesson12	SNN-NET
Lesson13	ACT
Lesson14	SNN-ACT

3.3 Data sets

The following codes generate data sets for various continuum modles

Nr.	**Topic**	**Problems**	**Solutions**
1	LSQ, TensorFlow	Homework01	
2	ELS	Homework02	
3	PLS	Homework03	
4	NSF	Homework04	
5	VEF	Homework05	
6	NET	Homework06	
7	ACT	Homework07	

4 Computational resources

Though the course concentrates on concepts within continuum mechanics and machine learning, the computational implementation of these concepts is essential to an appreciation of the utility of the considered approaches. Templates are provided for all computational applications, typically comprising:

1. Generation of data for constitutive relations;
2. Definition of deep neural networks that approximate the constitutive relation data;
3. Numerical methods (finite element, finite volume) that solve the classical formulations of continuum mechanics, e.g., Cauchy elasticity equations, Navier-Stokes flow equations.

4.1 SciComp@UNC Linux environment

This course uses a customized Linux environment named SciComp@UNC available to students as a virtual machine in which all course software is preinstalled, and course applications are preconfigured. Download Virtual Box and the SciComp@UNC virtual machine image.

Various software tools for carrying out and documenting practical scientific computation will be successively introduced:

- TeXmacs: editing of documents containing live computation
- SciPy: scientific Python environment
- TensorFlow: machine learning platform accessible from Python
- Mathematica: system for numerical, symbolic, and graphical computation with DNN support
- Gnu compilers (Fortran, C++): high-performance compiled code development
- Julia: a high-performance interactive environment
- Paraview: data visualization
- BEARCLAW: a package for solving PDEs using finite volumes
- FreeFEM++: a package for solving PDEs using finite elements

The Mathematica commercial package is accessible to students while connected to the campus network (either directly or remotely through the UNC VPN server).

4.2 Course material repository

Course materials (lecture notes, workbooks, homework, examination examples) are stored in a repository that is accessed through the subversion utility, available on all major operating systems. The URL of the material is http://mitran-lab.amath.unc.edu/courses/MATH768.

The initial svn checkout is made using commands:

```
mkdir ~/courses
cd ~/courses
svn co svn://mitran-lab.amath.unc.edu/courses/MATH768
```

On SciComp@UNC the initial checkout can be carried out through the terminal commands:

```
cd ~/courses
make MATH768
```

Update the course materials before each lecture by:

```
cd ~/courses/MATH768
svn update
```

Links to course materials will also be posted to this site, but the most up-to-date version is that from the subversion repository, so carry out the svn update procedure prior to each lecture.