

MatMOL: a MATLAB Method Of Lines library

The MatMOL Group (2009)

Description

Many physical and chemical processes are distributed parameter systems, i.e., systems in which state variables depend on several independent variables (such as time and space), and which are described by sets of nonlinear partial differential equations (PDEs). The method of lines (MOL) is probably the most widely used approach to the solution of evolutionary PDEs, and the objective of this paper is to report on the development of a Matlab[®] based MOL toolbox.

Basically, the MOL proceeds in two separate steps:

- approximation of the spatial operators, using finite difference, finite element, finite volume methods, and
- time integration of the resulting semi-discrete (discrete in space and continuous in time) equations using an ODE or DAE solver.

MatMOL contains a set of linear spatial approximation techniques, e.g., finite difference or finite elements methods, implemented using the concept of differentiation matrices, as well as a set of nonlinear spatial approximations, e.g., flux limiters and some spectral methods like proper orthogonal decomposition or chebichev polynomials. In addition, several time integrators, including basic explicit methods and some advanced linearly implicit methods, are included. For more information about these techniques, the reader is referred to the bibliography (6; 1; 8; 2; 5; 9).

Philosophy

The underlying philosophy of these developments is to provide the user with a variety of easily understood methods, and a collection of application examples that can be used as Matlab[®] templates for the rapid prototyping of new dynamic simulation codes.

The MatMOL is available free of charge FOR NON-COMMERCIAL use on an as is basis. The authors cannot be held liable for any deficiency, fault or inconvenience resulting from the use of MatMOL.

Version history and contents

2004: Version: 1.0

- 1D and 2D finite difference and finite volume approximation stencils on uniform and nonuniform grids.
- Examples: Burgers' equation and a catalytic reactor.
- Reference: (7)

2008: Version: 1.1

- Addition of advanced nonlinear solution techniques: flux limiting functions and adaptive gridding techniques.
- Additional examples: a dispersive jacketed tubular reactor (to be downloaded separately).
- Reference: (3)

2009: Version: 1.2

- Addition of the FEM in 1D problems.
- Addition of spectral methods like the laplacian spectral decomposition, the POD technique for model reduction.

2009: Version: 1.3

- Addition of the Laplacian Spectral Decomposition and the Chebichev polynomials.
- Update of the finite differences codes

2009: Version: 1.4

- New version of the Movgrid (Dynamic regridding) toolbox.
- Additional Benchmark examples
- New structure of the toolbox and the webpage

Installation

The different files containing the MatMOL packages can be FREELY downloaded from the webpage www.matmol.org. A free registration is required before downloading the packages. In the menu at the left of the screen you will find the label Downloads and inside it three different options:

- Source files. In this label one can find a zip file containing:

- The ordinary differential equations solvers.
- The partial differential equations methods with:
 - * The finite differences codes
 - * The finite elements codes
 - * The spectral methods codes including the proper orthogonal decomposition, the laplacian spectral decomposition or Chebichev polynomials.
 - * The dynamic and static regridding codes
 - * The flux slope limiters
- Tutorial examples, containing a zip file with some examples employed for tutorial purposes (7).
- Benchmark examples, containing a zip file with some benchmark examples (3).

The installation is easy and proceeds in the following steps:

1. Go to the download tab
2. Choose the `Source files` link and download the corresponding zip file.
3. Unzip the zip file to a desired directory, e.g., `C:\Program Files\Matlab\R2006a\MatMOL`. A number of subdirectories are unzipped.
4. Add all new subdirectories to your Matlab[®] path to make them accessible from any directory.

In order to try the configuration and for illustrative purposes, a number of examples (including some benchmark problems) are available in the MatMOL webpage. The user is recommended to read the Benchmark examples document (also included in the MatMOL webpage) for more information. The installation proceeds as follows

- Go to the download tab
- Choose `Tutorial examples` or `Benchmark examples` and download the corresponding zip file
- Unzip it into a given directory.
- Try the test by running the main file, e.g., `burgers_main.m`.

Updates

Updates and novel developments are announced on the website of the MatMOL toolbox. Alternatively, by sending an e-mail to Alain Vande Wouwer Alain.VandeWouwer@umons.ac.be it is possible to join the MatMOL mailinglist which informs about updates and new features.

References

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