LEMPS – User Guide (1.0.170221)

Table of Contents

[Introduction 2](#_Toc475481737)

[Installation 2](#_Toc475481738)

[Workflow 2](#_Toc475481739)

[Mathematical model 3](#_Toc475481740)

[Input/Output files 3](#_Toc475481741)

[Structure of the XML-documents 3](#_Toc475481742)

[Running the solver 3](#_Toc475481743)

[Example 3](#_Toc475481744)

# Introduction

LEMPS (Lagrangian Engine for Methods of ParticleS) is a general-purpose open-source c++ library that facilitates the application and implementation of meshless numerical methods. The goal of the LEMPS-project is to establish a meshless solver that can solve user-defined system of PDE-s over a set of spatially distributed nodes (particles) in one, two, or three dimensions. Solutions can be governed by the priori implemented schemes like SPH, DEM, etc.

To read a short introduction of the project with simple examples please visit the project page: <https://bitbucket.org/lempsproject/>

# Installation

Please note that currently, LEMPS cannot be installed on Windows, it supports only MAC OS and Ubuntu systems.

The installation requires a very few dependencies to be installed. These dependencies are:

* Visual Toolkit 7.0.0 ([link](http://www.vtk.org/files/release/7.0/VTK-7.0.0.zip)),
* Common utilities ([link](https://bitbucket.org/lempsproject/commonutils/downloads/commonutils-1.0.170221.zip)),
* ProLog ([link](https://bitbucket.org/lempsproject/prolog/downloads/prolog-1.0.170221.zip)),
* HandyXML ([link](https://bitbucket.org/lempsproject/handyxml/downloads/handyxml-1.0.170221.zip)).

You can perform the installation process including the dependencies using the Installation tool for LEMPS ([link](https://bitbucket.org/lempsproject/installation/downloads/install-1.0.170221.sh)). By typing the command

$ sh intall-1.0.170221.sh

in terminal in the folder, you would like to install LEMPS, the installer downloads and installs the necessary files in your system. After installation, the executable (**pmsimple)** will be placed in the bin directory and a **start.sh** file will be generated in the installation directory. The installer also adds the executable to your environmental variables so you can run it from different directories. In certain cases, when environmental variables are not available (through ssh-connection) you can perform computations using the **start.sh** file in the desired folder.

# Workflow

LEMPS aims the goal of generality at two individual levels: the user, and the intermediate developer levels. Throughout this document only the user-level will be investigated and explained. During the application procedure of LEMPS the user is not required to code or re-compile any parts of the solver before performing calculations. The geometrical layout, equations and simulation parameters are provided to the solver through XML and ASCII or binary VTK documents.

When the user defines a problem to solve, the following steps should be always done as a workflow (more or less in a strict order) before the calculation could be started:

1. Define **constant** and **variable** quantities that are global values during the calculation.
2. Create a calculation domain. This is an axis-aligned rectangular box in which the particles can occupy their locations. No particles can exist out of this box. The domain can be one, two, or three dimensional and bounds the included space with periodic or symmetric boundaries. The domain must be divided into cells whom edge length must be equal to the particle interaction radius.
3. Generate **particle system** inside the domain over a uniform grid. The particle system handles neighbour search, sorting, etc. Neighbour search depends on the grid of the domain.
4. Define **field**s over the particle system. The definition can depend on constants and variables.
5. Interpret your equations considering the discrete particle system and define them as **functions** using the defined constants, variables and fields.
6. Finally, define the **simulation parameters** to govern the calculation flow and result registration.

Note: This is a short summary of these fundamental steps, more information about the modelling process will be placed in the following sections.

# Mathematical model

This section explains the fundamental structure of the solver. Before going into deeper explanations, it is strongly recommended to read the Workflow section.

Building equations in arbitrary spatial dimensions that depend on fields of any quantity

# Input/Output files

# Structure of the XML-documents

# Running the solver

# Example