1 Introduction

Generally, when answering a question with a simulation process, we do the following:

1. Define the process we want to model.
2. Build a mathematical model of the process.
3. Write a numerical algorithm solving the model.
4. Write simulation code implementing the algorithm.
5. Visualise results.
6. Produce a statement, or a tool from the results.

Each step may involve going backwards, in order to validate previous steps.

1.1 Models

A model is a simplified representation of a real system. It is a mathematical description of the system, which is used to predict the behaviour of the system. For example, ordinary or partial differential equations are common models for natural processes:

$$F = ma = m\frac{d^2x}{dt^2}$$

A few examples of models:

- The Millenium-XXL Project is an N-body methods model simulating the generation of galaxy clusters in order to evaluate how plausible the "cold dark matter" hypothesis is.
- Another N-body methods model: Particulate Flow Simulation. This simulates blood flow in order to better understand issues caused by deformed blood cells.
- Micro and nano simulations are useful for modelling environments where usual patterns no longer hold.

Many models are based on differential equations. These usually have some core assumption of *equilibrium* (where some derivative is equal to zero). For example, a heat transfer model might assume that in a model involving vertices connected by edges, the temperature of each vertex is equal to the average of the temperatures of its neighbours.