Chapter 6
Simulating the Behavior of the Human Brain Using Sparse Linear Algebra on Distributed Memory Platforms:
Applying Tasking to MPI Communication

ABSTRACT

This chapter presents some novel approaches that show the effective use of tasking to solve linear algebra problems at a distributed level. Encapsulating distributed memory transfer calls within tasking is an efficient and relatively easy and transparent way to deal with the important unbalancing between communication and computation speed. Unlike the previous chapters, the authors use as a test case one real application that makes use of some of the operations previously described, such as the computation of a batch of sparse and independent linear systems of equations. This is one of the most challenging applications in computing today, the simulation of the human brain. The reader will see different techniques based on tasking that help not only to minimize the unbalancing between communication and computation, but also to balance problems highly unbalanced, such as the simulation of a multimorhology neuron net.

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INTRODUCTION TO HUMAN BRAIN SIMULATION

The model presented for the simulation of the Human Brain consists of two major tasks (Akar et al., 2019): i) computation of the voltage capacitance on the neurons morphology, and ii) exchange of the spikes among those neurons connected through synapses. In this model, the neurons are seen as multi-compartment cables composed of active electrical elements (see Figure 1).

Figure 1. Multi-compartment model implemented for the simulation of the human brain (Peyser, 2017)