Parallel simulation of large population dynamics

Cristina Montañola-Sales (a)(b), Josep Casanovas-Garcia (a)(b), B.S.S. Onggo (c), Jose M. Cela-Espín (a)(b), A. Kaplan-Marcusán (d)

(a) Barcelona Supercomputing Center (b) Universitat Politècnica de Catalunya (c) Lancaster University (d) Universitat Autònoma de Barcelona

Introduction

Agent-based modeling and simulation is a promising methodology that can be used in the study of population dynamics. We present the design and development of a simulation tool which provides basic support for modeling and simulating agent-based demographic systems. Our results prove that agent-based modeling can work effectively in the study of demographic scenarios which can help to better policy planning and analysis. Moreover, parallel environment looks suitable for the study of large-scale individual-based simulations of this kind.

A parallel simulator for demographics

We developed Yades, a parallel agent-based demographic simulation tool [2][3]. Yades runs on top of a discrete-event simulator. Yades is implemented using µsik parallel simulation library [4], where a model is formed by:

- a set of interacting logical processes (LP), implemented as µsik processes which communicate through events.
- Multiple LPs are mapped onto a physical process (µsik kernel) that is run on top of a processing element (PE). A machine can have more than one PE (e.g., in multi-core architecture).

There are 2 types of agents: family units and regions.

Family Unit agents handle first four demographic components (Fertility and birth, Mortality, Marital status and Economic status) while Region agents handle domestic migrations, immigration, changes in simulation parameters and policy reports.

- For social scientists and policy model developers, the common approach in ABM simulation where models have to be specified in computer programs/codes is not ideal. To solve this problem, Yades incorporates 3 components:
  - a web user interface, which allows demographic modelers to specify demographic model components in a number of representations familiar to demographers (i.e., regression and statistical distribution function).
  - a demographic simulation library, which uses a scalable parallel discrete-event simulation engine and supports both sequential and parallel execution of the simulation model [2] and a good performance [3].
  - the simulation code generator, which produces the corresponding C++ code ready to be compiled.

With this design, users should be able to reap the performance offered by parallel computers transparently.

Conclusions

We showed an innovative application of parallel simulation in demography, an important field in social science that is increasingly used as the basis for policy planning and analysis.

We demonstrated how agent-based simulation can be run using a scalable parallel discrete-event simulation engine.

Future research directions

- To allow multiple regions to be run on a processing element
- Introducing the concept of household which would allow one or more members of the same family unit to live in separate regions.
- To enrich the agent-based model with macro variables such as IDH, GPD and economic trends on regions
- Test it with real case studies.

Literature cited


Further information: cristina.montanola@bsc.es