Global Scale Human Agent-Based Modeling

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Introduction
Modeling populations of humans on a global scale is rare due to complications in social interaction between humans as well as the complexities with simulating on a large scale. We aimed to reduce these complexities by using parallel computing and MATLAB to shorten the length of large scale simulations so they are more usable. We are interested in the processes to simulate on a global scale rather than the exact application of this model. Math characterizes our world in a precise way and we aim to use mathematical language to model society on a global scale.

Simulating Lifestyle Well-Being

We used an agent based model from Open ABM by Dr. Christopher Thron (Texas A&M) that originally simulated a population of 10,000 agents to model a global population.

- The initial index values for conspicuous and inconspicuous well-being are chosen randomly and independently on a normal Gaussian distribution.
- Each year new lifestyle choices are made available for a fraction of the agents to choose from.
- Agents will either accept or reject these choices
- New well-being indices are calculated and the process is repeated

The below code exhibits the criteria in which an agent makes a decision. If the value of the new available lifestyle choices, w, is greater than the current lifestyle choices, W, then the agent will have an increased well-being index. When w > W the agent makes a decision that increases their inconspicuous, I(n), and conspicuous, C(n), well-being. An agent’s proposed actual well-being is represented by A(n).

\[ A(n) = [1 + a]C(n)I(n) \]

Computational Requirements

We translated this model from Scilab into MATLAB and after obtaining the same results in both applications we worked on speeding up the processing time of this simulation.

This model took long to process because each year each individual agent’s initial conspicuous and conspicuous well-being are initialized on a random Gaussian distribution. Instead of waiting for each group of agents waiting on their turn to make their lifestyle decision each year we parallelized the code so that each population worked on a separate CPU core. This works because each population is not dependent on one another since agents only react to the means of the population they are in. Each agent makes their decision based on the mean of well-being of the population they’re in, and this represents the available choices on the market.

A simulation of eight billion agents using this agent based model took approximately eleven hours and 640 GB of memory. The below left graph demonstrates the linearity of this model and run time on eight cores with N number of agents. The below right graph indicates the decrease in processing time when implementing parallel code. Using parallel sped up this model six times.

Interprocess Communication

To simulate populations that affect each other we implemented interprocess communication. This provides a way for an operating system to facilitate the coordination of multiple simulations that are completed on separate processors to interact with each other. Whereas before each simulation used its own set of available lifestyle choices agents react to each year, now we wanted to use the means of different populations for the agents to react to collectively so that these systems interacted with each other.

Below are graphs showing the phase change in means over time of ten different populations that interacted by combining their standard deviations during each year of the time loop. Each line represents a separate population.

Looking Forward

In order to model how populations in these simulations interact with each other we could create a web of social interactions within the group and instead of agents responding to an overall mean of the group, have them respond only to the mean of other agents that they are in contact with. This would increase our interest in how agents react with each other and would include a need for collaboration in the field of sociology.

References

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