ExAMPLER

An ExCALIBUR Project

A roadmap towards exascale agent-based modelling:

A brief overview of the ExAMPLER project

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ExAMPLER: project summary

Using exascale computing, what software support do we need to co-design, build, validate, and explore policy scenarios with empirical ABM in a one-day transdisciplinary workshop?

1. Assess 'exascale readiness' using Systematic Literature Review and Benchmarking

2. Vision of exascale ABM and one-day transdisciplinary workshop scenario s/w requirements

3. Roadmap for delivering the vision founded on exascale training and learning

4. Engage with ABM community and other ExCALIBUR projects; respond to opportunities

HPC/ABM Review

HPC in ABM: State-of-the-art and ways forward

Position paper

Exascale Empirical Agent-Based Modelling

ExAMPLER Roadmap

Skills Training
Software
Barriers
Networks
Research
Funding

Community Report

W'shops
SSC/ESSA
iEMSs
GIScience
AAMAS
AAG

Polhill et al. (2023)

Visioning: Capabilities, Use Cases, Threats

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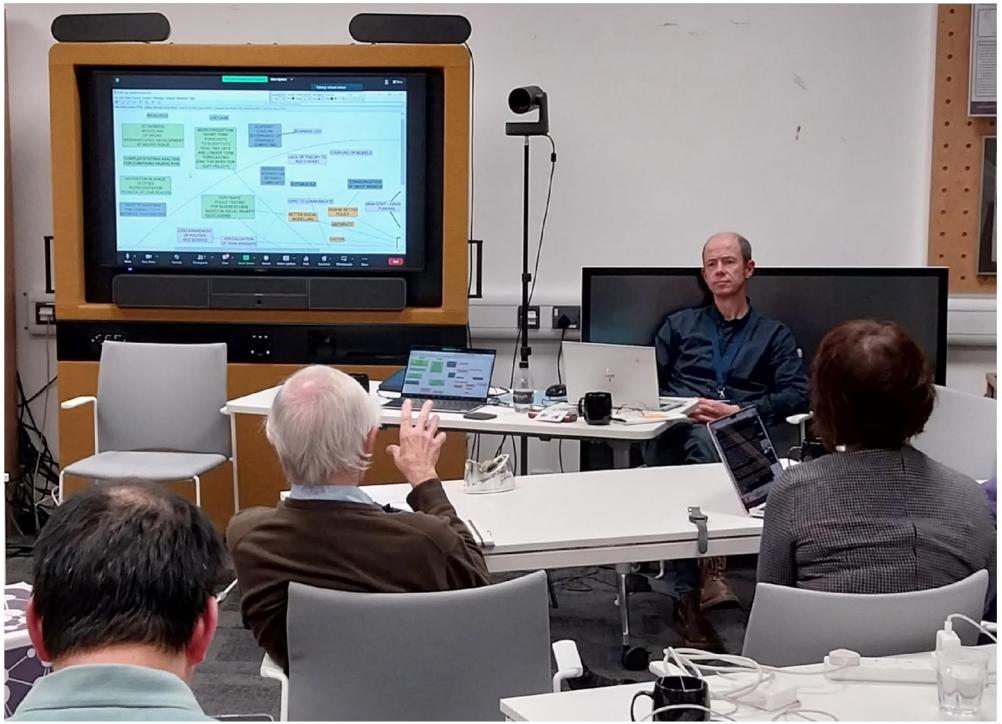
Threat: Inequitable access to exascale resources	Threat: Increased Energy Consumption
Threat: Ethics of 1:1 Social Simulation	Threat: Dependence on AI for Analysis
Use Case: Individual-based Social Science	Use Case: Rapid Real-Time Policy Modelling
Use Case: Formalizing Social Theories	Use Case: Model Emulation
Capacity: AI	Capacity: Data

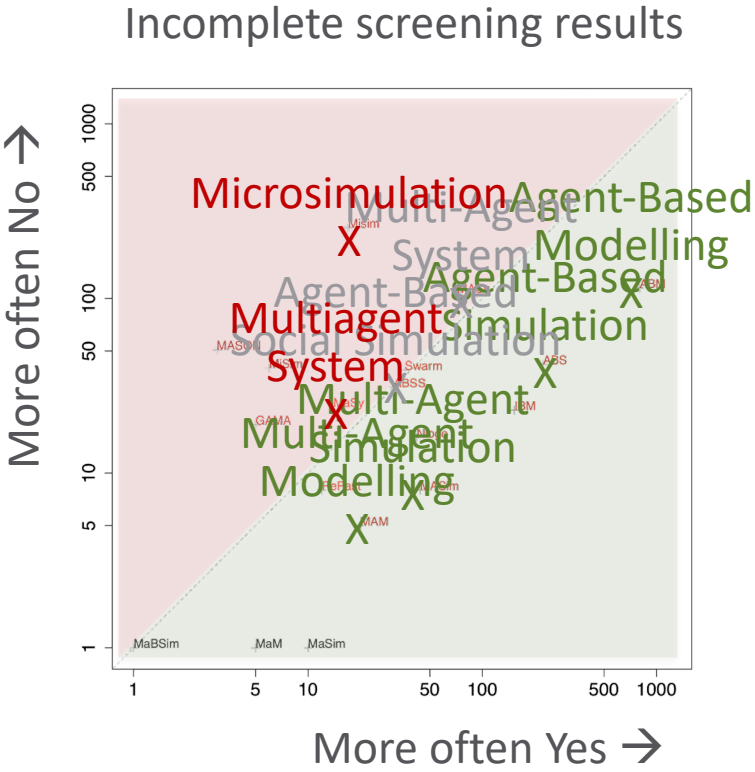


Hare et al. (2024)

Terminology!!

Explicit representation of **dynamic interactions** of **heterogeneous individual** (aggregations of) **humans**

(households, groups, businesses, organizations and/or governments)



Challenges – or benefits?

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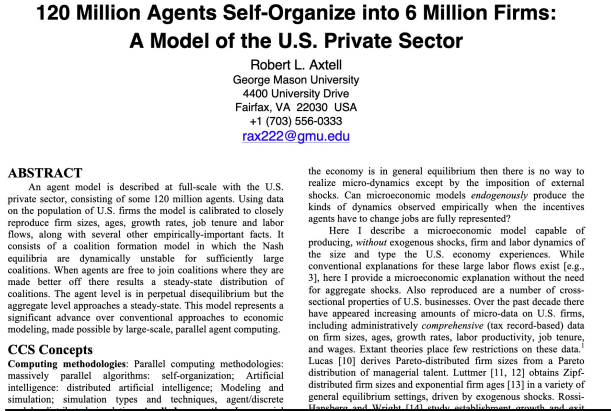
- High-throughput – one run per core – parameter space / initial conditions exploration
  - Can this be done on GPUs as well as CPUs?
  - Improvements in calibration and validation?
- Parallelism – will agent interactions kill the benefits?
  - Cognitive / Adaptive / AI decision-making algorithms
    - Typically only feasible now with small-scale models
  - Rob Axtell's model of US economy
    - Had to model HR departments…
    - …Parallelism is also a challenge for societies!
- Accessibility of infrastructure
  - Compute time and memory unpredictable (Polhill 2022)
    - Need adaptive schedulers – fun computing science!?



120 Million Agents Self-Organize into 6 Million Firms: A Model of the U.S. Private Sector

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ABSTRACT

An agent model is described at full-scale with the U.S. private sector, consisting of some 120 million agents. Using data on the population of U.S. firms the model is calibrated to closely reproduce firm sizes, ages, growth rates, job tenure and labor flows, along with several other empirically-important facts. It consists of a coalition formation model in which the Nash equilibria are dynamically unstable for sufficiently large coalitions. When agents are free to join coalitions where they are made better off there results a steady-state distribution of coalitions. The agent level is in perpetual disequilibrium but the aggregate level approaches a steady-state. This model represents a significant advance over conventional approaches to economic modeling, made possible by large-scale, parallel agent computing.

CCS Concepts

Computing methodologies: Parallel computing methodologies: massively parallel algorithms: self-organization; Artificial intelligence: distributed artificial intelligence; Modeling and simulation; simulation types and techniques, agent/discrete

the economy is in general equilibrium then there is no way to realize micro-dynamics except by the imposition of external shocks. Can microeconomic models *endogenously* produce the kinds of dynamics observed empirically when the incentives agents have to change jobs are fully represented?

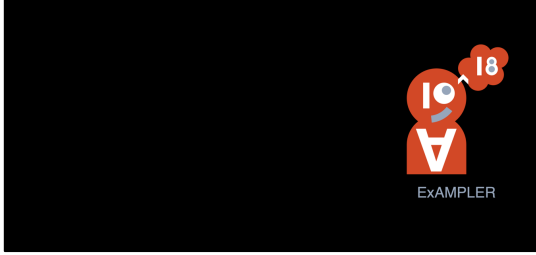
Here I describe a microeconomic model capable of producing, *without* exogenous shocks, firm and labor dynamics of the size and type the U.S. economy experiences. While conventional explanations for these large labor flows exist [e.g., 3], here I provide a microeconomic explanation without the need for aggregate shocks. Also reproduced are a number of cross-sectional properties of U.S. businesses. Over the past decade there have appeared increasing amounts of micro-data on U.S. firms, including administratively *comprehensive* (tax record-based) data on firm sizes, ages, growth rates, labor productivity, job tenure, and wages. Extant theories place few restrictions on these data.[1] Lucas [10] derives Pareto-distributed firm sizes from a Pareto distribution of managerial talent. Luttmer [11, 12] obtains Zipf-distributed firm sizes and exponential firm ages [13] in a variety of general equilibrium settings, driven by exogenous shocks. Rossi-

CONTENT

ANTISOCIAL SIMULATION: USING SHARED HIGH-PERFORMANCE COMPUTING CLUSTERS TO RUN AGENT-BASED MODELS

DECEMBER 14, 2022 THESUBMISSIONAUTHOR LEAVE A COMMENT

By Gary Polhill



Axtell RL (2016) Proc AAMAS 15
Hare M et al. (2024) AAMAS 23
Polhill G (2022) Rev Artif Soc Soc Sim, 14 Dec
Polhill G et al. (2023) Rev Artif Soc Soc Sim, 29 Sep

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