Agent Based Models and Mean Field Games for Finance and Economics

To ultimate goal of this project is to tackle key challenges of Agent-based modelling (ABM) by leveraging recent developments in mean-field game (MFG) theory and machine learning/reinforcement learning.

Agent-based modelling (ABM) is a computational methodology for representing the behaviour of individuals to study social. In essence, ABM creates a digital environment in which many agents can act in complex and strategic ways in as spirit of a game theory. The ABM reveal adaptation and learning mechanisms that are critical for understanding how the economy works. As such ABM provide an attractive alternative to the classical statistical or phenomenological equilibrium models used Finance and Economics. Statistical models use past data to predict the future. These may be successful but often only works on a short time horizons and under the assumption that the environment is stationary, but fail in the face of great change such as financial crises or when one wants to study situations that have not happened in the past. While ABM can provide a next-generation toolkit for tackling many of the challenging problems in finance and a wider economy one needs to face the following challenges:

Systematic approach to efficient calibration of ABM, is still widely open problem. The aim is to tackle calibration problem by developing inference methods for a dynamical system using machine learning approach.

Realistic models are high-dimensional and simulations of these are often intractable (NP-hard). By using MFG paradigm one can reduce the dimension of the model by exploring symmetries. In that setup, the decisions each small agent makes depends on the statistical properties of the states and strategies of other agents. This enables systematic reduction of the dimension of the state space while preserving key statistical properties of the model.

MFG approach provides a theoretical underpinning for a large class of ABM (which often lack theoretical foundation). This is critical to build reliable and more robust ABM models and helps to avoid pitfalls encountered when solely relying on simulations methods.

To ultimate goal of this project is to address all three challenges by the interdisciplinary research team from across UoE and translate research outcomes to practical industrial solutions by working closely with our partner HSBC.

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