

ESRC Conference on Diversity in Macroeconomics

New Foundations for Social Cognition and Strategic Interaction

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My background

Academic:

- 9 years at LSE as a BSc/MSc/PhD student
- **Theoretical Computer Science** (algorithms and complexity)
- **Game Theory** (equilibrium computation)
- Ongoing ESRC ABM project: **Simulating banking networks**

Commerical:

- **Algorithmic Trading** of financial futures

Extremely limited knowledge of neuro-science

Vittorio Gallese Mirror Neurons and Social Cognition

- brain activity during execution/observation of actions
- embodied simulation as the basis of the capacity to understand others' intentional behavior

Scott Kelso Coordination and Anti-coordination

- brain activity during human coordination/anti-coordination
- dynamics of a human coordinating with a machine

Sheri Markose Arms Race in Novelty and Surprises

- need to innovate to out-smart hostile agents in an arms race
- strategic innovation outside the ambit of extant game theory

The Mirror System

- Potential **biological explanation for imitation** in social interactions
- Is mirroring relevant **beyond direct experience of actions, emotions, and sensations?**
- Real-time decisions vs. "offline" extended deliberation; strategizing can involve **intentional hiding on actions/emotions, or even deception**
- Economic actions in response to **information events**; is mirroring relevant when we learn new information?
- Can it help us understand **group dynamics** (e.g. herding)?

Coordination/anti-coordination

- **Understanding brain activity when we coordinate or anticoordinate** either intentionally or unintentionally with another individual
- **Dynamics of a human trying to coordinate with a machine**; gained new understanding of the parameter space of HKB equations (c.f. Doyne's approach in CRISIS)
- Interesting parallel with modern financial markets that comprise a mix of human and algorithmic decision makers
- **Dynamics is one of the key things we want to study**
- How do we go from **insights about the individual** to **understanding emergent behaviour in systems with huge numbers of interacting agents?**

Problems with Game Theory

- **Equilibrium selection**
- **The need to mix in equilibrium**
- **Computational complexity**
- **Query complexity**
- **Cases where the solution concept doesn't make sense**
- **Lack of information**
- **Bounded rationality**
- **A model can never tell the whole story**

A defence of Game Theory

- In general, **game theory has not succeeded in "yielding definite and reliable predictions"**
- Even with extreme assumptions about ration//preferences, **strategic interaction is very unpredictable**
- Outcomes are highly sensitive to **norms, culture, psychology, and sociology** in many application
- At the same time, I think game theory can offer some valuable insights **"analytic narratives"** (Bates et al.), but it is not well-suited to being driven by data
- **Different tools for different jobs**: sometimes **simulation is absolutely the right tool for the job** (hostile agents and innovation)

NASDAQ agent-based model

- **1998:** NASDAQ commissioned an agent-based model
- Motivated by pending decimalization
- Explored effects of changes to market microstructure
- Serious resources went into model development and calibration
- **Trading agents were implemented as learners**
- Six predictions arose from the model
- **2001:** NASDAQ implemented decimalization
- **All six predictions overwhelmingly supported by data**

Co-evolution of hostile agents

- Regulators vs financial institutions; **High-frequency traders** competing with one and other and other market participants
- Are **game-theoretic ideas relevant**? **Yes**, e.g., bluffing
- Can we build useful game-theoretic model to deliver useful insights? **Probably not.**
- Can Agent-Based modelling deliver (ABM) insights, e.g., about changes in regulation, or Flash Crashes? **Yes.**
- Machine learning, evolutionary algorithms can be used to allow agents to learn. After all, these approaches are **actually used by designer of trading algorithms**
- Is it easy to do this well? **Absolutely not.**