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*

Commercial:

- **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**.