Personal Statement

My current research interests lie in the field of algorithmic game theory and mechanism design, wherein I am interested in studying theoretical frameworks and the relationships between market mechanisms. This is an interdisciplinary field, lying at the intersection of theoretical economics and computer science, and its results find applications in both areas.

While my formal background is in mathematics (in which I am currently finishing my MSci at Imperial College London), over the course of my 4-year degree my interest has shifted away from pure mathematics towards agent-based problems, including algorithmic game theory but also AI. Part of the cause for this shift is that I was previously not exposed to these areas to fully appreciate them, and part is that I was attracted to the scope that exists for research in these areas, and their practical relevance.

In particular: by treating the dynamics of games rather than the equilibria themselves, algorithmic game theory connects to agent-based computational economics, allowing the study of out-of-equilibrium phenomena and microfoundational problems. Conversely, many algorithms studied in the context of games/markets may be generalized to the broader context of optimization and machine learning – the contrapositive of "If your laptop can't find it, then neither can the market" is that a realistic model of information propagation in the market will allow for computationally efficient multi-agent co-ordination mechanisms.

I became exposed to this area towards the end of my second year, when I noticed an apparent analogy between market price propagation and backpropagation algorithms. On hindsight, I am uncertain if this analogy exists or is of importance, but and in my effort to better formulate my problem, I studied economic theory literature in greater detail and became very familiar with mechanism design and algorithmic game theory.

Apart from economic theory, I have studied computer science and machine learning independently from projects and courses I did, as well as my AI internship at Goldman Sachs, where I worked on data analysis projects involving NLP and recurrent neural networks. In the latter two years of my MSci program, I have focused on electives in machine learning, statistics, game theory and dynamical systems. Several writing samples of machine learning/AI-related articles I've written are available on my blog[1].

My intended career path after my PhD is in academia, and I have an existing background in academic research; even prior to focusing on game theory, I had worked on several independent research projects in pure mathematics as listed on my CV. I have also worked on research projects in theoretical economics, and from this I produced one significant contribution to property rights theory that is closely related to my current area of interest [2]. Apart from independent work, I am accustomed to working in research teams, such as a supervised pure mathematics project I did under Prof Richard Thomas and some work I did in formal theorem proving under Prof Kevin Buzzard at Imperial.

My broader long-term interests have to do with agent-based problems at large, including (1) agent-based computational economics and the research directions opened by my PhD project, and (2) problems relating to agent foundations. These are both fields of crucial importance to AI research, and while my current PhD plan pertains most closely to the first, computational and economic models of bounded rationality are relevant to the latter area, and I believe that a PhD will provide me with an academic background that is closely suited to both.

The Durham Business school has a strong program in game theory and theoretical economics; in particular, my research problem could be interpreted as pursuing a certain economic perspective of bounded rationality, which is of interest to the work of Prof Spyros Galanis.

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[1] The Winding Number

[2] Abhimanyu Pallavi Sudhir. *A mathematical definition of property rights in a Debreu economy*. 2021. arXiv: 2170.09651 [econ.TH]