

Project title: Game Theoretic Models for Design of Fair Decentralised Financial Markets

Project description:

The ultimate goal of this project is to develop novel technologies for modelling and managing decentralised finance. The last several years have seen explosive growth in open and decentralised financial infrastructure. This is improving access, reducing costs, and increasing innovation in the area of financial services. The core infrastructure for the decentralised finance and open finance ecosystem will be decentralised exchanges. These will allow anyone to create new products and markets, trade, and build dApps (distributed applications) utilising such decentralised exchanges in conjunction with other emerging protocols and platforms. Markets on a decentralised exchange can be anything from futures on the price of oil or bitcoin, S&P 500 options, swaps, and more. The aim of the decentralised platforms is to be trust-minimising, performant, and scalable, and include strong on-chain governance around market creation and abuse prevention. However, despite ongoing research, many theoretical questions in this direction remain unanswered.

The decentralised finance projects are typically built on top of blockchain and based on either proof of work or proof of stake algorithms. This raises a number of questions about the robustness and security, in particular in the light of strong financial incentives for trying to subvert such systems. Furthermore since the platforms are open and operating without central control there are a number of challenges to ensure that their design makes them fair, safe and minimising financial risks for users and across the economy. The key challenges to be tackled by the fellow and the research team as part of this project:

- How to secure proof-of-stake blockchain underpinning a decentralised market: resilience against cartels, anti-cartels and censorship attacks. Relationship between value of the token used in proof-of-stake and the value of the markets the network underpins.
- How to design fair markets in the situation of full transparency. This includes the questions of how to efficiently prevent front running or using the market margins mechanism to bully other participants. Fundamentally this is about ensuring the markets are fair for all participants.
- How to appropriately incentivise participants so that the markets are liquid in a way that balances needs of users (low transactions costs, liquid markets) and the market makers. Dynamic trading fees reflecting the price of liquidity are a part of the answer but finding a useful economic model for pricing liquidity will be one of the aims of the project.

To address these the fellow will use market data provided by the industrial partner and use these to build innovative models that can be used to reason about decentralised finance. The data provided by the industrial partner should be analysed in the first stages of the project to inform which tools and techniques are the most appropriate in addressing the problems.

The data provided will include history of all trading on the platform, including the state of the limit-order book at each instant of time. Even a small market is creating on the order of several gigabytes per day of trading. Models developed as part of the project must be parsimonious, yet capture the key features of the decentralised system (see e.g. <https://vegaprotocol.io/papers/vega-protocol-whitepaper.pdf> for details of features of such complex system).

The models that the research team will develop will use existing work on limit order book modelling, games, mean-field games, q-learning and algorithmic trading theory. The fellow should have prior knowledge (ideally including having made significant advances) in at least one of the above fields.

For further information and to obtain a letter of support needed for the application please contact Dr David Siska, School of Mathematics, (<https://www.maths.ed.ac.uk/~dsiska/>).