Evolutionary Dynamics of The Ethereum Transaction Network

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We are witnessing a revolution in the financial system, which is being replaced by the new and innovative Decentralized Finance (DeFi). DeFi projects are tackling long-standing problems and addressing inefficiencies in our current system, improving financial inclusion, increasing liquidity and reducing costs. In contrast to the traditional system, where financial applications are difficult to access, rigid, hard to use and expensive, DeFi applications are open and permissionless. Anyone can access them, all they need is an internet connection.

But what really makes this self-organized market of digital currencies attractive for the research community is that, unlike in the traditional financial system, all transactions are publicly available. This represents an unprecedented scenario that allows us to understand and explain the evolution and adoption of a financial system by capturing the complex behavior that emerges from the relationships between users.

In this work we focus on the Ethereum Blockchain, the largest decentralized computing platform in terms of users and usage. We have analyzed the transactions that occur in the network under a complex system perspective, in which nodes are the accounts that operate and links represent the transactions between them. We describe the dynamics and evolution of the system by analyzing its structure and computing its properties over time. Finally, we explore the relationships that exist between these properties and the future price of the network cryptocurrency called Ether (ETH).

Since this system is an evolving system, it is important to define dynamic intervals that capture the evolution of the system. Unlike other works that propose to create networks with an arbitrary time interval, [2], we use the method developed by Darst et al. [1], that detects evolutionary changes in the configuration of a complex system and generates intervals accordingly. In this method, the size of each interval is determined by maximizing the similarity between the sets of events within consecutive intervals.

We applied the Dynamic time-slicing method [3] on our dataset and found that the activity of the network can be measured by considering regular time intervals of 14 days. We also found a strong correlation between the similarity score obtained from the Dynamic time-slicing method and the Ethereum price.

Next, we analyzed the properties of the resulting networks and found that the degree distribution of the networks are highly heterogeneous, where a small fraction of addresses tend to trade with the vast majority, while most addresses hardly trade with others. We found that the networks are disassortative and present very low clustering.

Finally, we explored the relations between the network properties and the future price of Ethereum and found a strong negative correlation between the exponent of the degree distribution and the price. Hence, our results suggest that the transaction network contains relevant information to explain the evolution and adoption of the system.

[1] A. Darst, R. K., B. Granell, C., C. Arenas, A., D. Gmez, S., E Saramki, J., and F Fortunato, S., *Detection of timescales in evolving complex systems.* , Scientific reports **6**, 39713 (2016).

[2] A. Liang, J., B. Li, L., and C. Zeng, D. *Evolutionary dynamics of cryptocurrency transaction networks: An empirical study.*, PloS one, **13(8)** (2018).

[3] https://github.com/rkdarst/dynsnap/blob/master/doc