

Towards a Comprehensive Decentralization Metric for DAOs

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The proliferation of Decentralized Autonomous Organizations (DAOs) and blockchain systems has underscored the critical need for sophisticated measures of decentralization. These measures are pivotal for evaluating the systems' robustness, fairness, and resistance to manipulation. Traditional decentralization metrics, such as the Gini and Nakamoto coefficients, although useful, often fail to capture the intricate dynamics of decentralization, especially in scenarios where collusion among entities is possible. This research introduces an innovative probabilistic framework designed to bridge this gap. Our approach merges complexity and entropy analyses within a probabilistic model, offering a nuanced lens through which to examine decentralization across DAOs and blockchain systems. Central to our methodology are two metrics: a frequency-based measure leveraging histogram analysis for an approximated control distribution among entities, and a brute-force measure that delineates the exact control distribution over all entity combinations. Given its computational demand, the brute-force measure is particularly suited for small samples, establishing a benchmark against which the frequency-based approach's precision is gauged. By integrating these metrics into a comprehensive simulation framework that also encompasses traditional measures, we embark on an extensive analysis of various blockchain and DAO scenarios. Initial results suggest our probabilistic framework not only aligns with conventional measures in straightforward contexts but also reveals intricate insights in complex situations where collusion and the subtleties of resource distribution are paramount. This work significantly advances the discourse surrounding governance in DAOs and blockchain systems, demonstrating the critical role of probabilistic models in dissecting and understanding decentralization, thereby setting the stage for future explorations in decentralized system analytics.