LITHUANIAN COMPUTER SOCIETY
VILNIUS UNIVERSITY, INSTITUTE OF DATA SCIENCE AND DIGITAL TECHNOLOGIES
LITHUANIAN ACADEMY OF SCIENCES


## 16th Conference on

# DATA ANALYSIS METHODS
## for Software Systems

**November 27–29, 2025**

**Druskininkai, Lithuania, Hotel "Europa Royale"**
https://www.mii.lt/DAMSS

VILNIUS UNIVERSITY PRESS
Vilnius, 2025

**Co-Chairs:**

Dr. **Saulius Maskeliūnas** (Lithuanian Computer Society)
Prof. **Gintautas Dzemyda** (Vilnius University, Lithuanian Academy of Sciences)

**Programme Committee:**

Dr. **Jolita Bernatavičienė** (Lithuania)
Prof. **Juris Borzovs** (Latvia)
Prof. **Janusz Kacprzyk** (Poland)
Prof. **Ignacy Kaliszewski** (Poland)
Prof. **Bożena Kostek** (Poland)
Prof. **Tomas Krilavičius** (Lithuania)
Prof. **Olga Kurasova** (Lithuania)
Assoc. Prof. **Tatiana Tchemisova** (Portugal)
Assoc. Prof. **Gintautas Tamulevičius** (Lithuania)
Prof. **Julius Žilinskas** (Lithuania)

**Organizing Committee**:

Dr. Jolita Bernatavičienė
Prof. Olga Kurasova
Assoc. Prof. Viktor Medvedev
Laima Paliulionienė
Assoc. Prof. Martynas Sabaliauskas
Prof. Povilas Treigys

**Contacts**:

Dr. Jolita Bernatavičienė
*jolita.bernataviciene@mif.vu.lt*
Prof. Olga Kurasova
*olga.kurasova@mif.vu.lt*
Tel. (+370 5) 2109 315



https://doi.org/10.15388/DAMSS.16.2025
ISBN 978-609-07-1200-9 (digital PDF)

# Toward a Multi-Dimensional Assessment of Blockchain Decentralization: Empirical Evidence and MCDM-Based Integrative Framework

**Mindaugas Juodis, Ernestas Filatovas, Remigijus Paulavičius**

Institute of Data Science and Digital Technologies
Vilnius University

*mindaugas.juodis@mif.vu.lt*

Blockchain decentralization remains one of the most debated and multidimensional topics in distributed systems research. Although decentralization is often referred to as a core blockchain property, its quantitative assessment across different system perspectives (wealth, network, consensus, transactions, etc.) is still fragmented. This work contributes to the ongoing academic effort to establish a measurable and comparable framework for evaluating decentralization from multiple perspectives. We already examined wealth decentralization by analyzing cryptocurrency ownership concentration across major blockchains, including Bitcoin, Ethereum, and Layer-2 networks such as Arbitrum, Optimism, and Polygon. The results revealed structural concentration patterns in asset distribution when analyzed with classical inequality measures (e.g., Gini coefficient, Shannon entropy, Herfindahl–Hirschman Index). We also introduced a randomized group-sampling estimation approach that provides more robust concentration estimates across heterogeneous blockchain ecosystems. We also investigated transaction-level concentration patterns across UTXO- and account-based models using various metrics and compared Bitcoin, Ethereum, and multiple Layer-2 solutions, uncovering systemic dependencies between transaction-flow structure and the underlying ledger architecture. Building on these findings, our current research agenda expands to three additional aspects of decentralization: consensus, governance, and network. Each aspect is approached through distinct empirical

analyses – validator and staking concentration in consensus protocols, voting power and proposal diversity in governance systems, and node distribution across geographies, ISPs, and client implementations in network topology. Finally, we outline an ongoing effort to integrate all five aspects – wealth, transactions, consensus, governance, and network – into a unified Composite Decentralization Index (CDI). The CDI will be developed using multi-criteria decision-making (MCDM) methods, enabling weighted aggregation of diverse indicators and comparative evaluation across blockchain ecosystems. This approach is expected to yield an empirically grounded and methodologically coherent measure of holistic decentralization, bridging the gap between theoretical definitions and observable blockchain behavior.