

## AMALFI

Automated Learning in Large Multilayer Cryptoasset Transaction Graphs

<b>Programm / Ausschreibung</b>	Kooperationsstrukturen, Kooperationsstrukturen, Bridge Ausschreibung 2022	<b>Status</b>	abgeschlossen
<b>Projektstart</b>	01.03.2023	<b>Projektende</b>	31.08.2025
<b>Zeitraum</b>	2023 - 2025	<b>Projektlaufzeit</b>	30 Monate
<b>Keywords</b>	cryptoassets, graph learning, multilayer networks, big graphs		

### Projektbeschreibung

Dieses Projekt untersucht Graph-Lernmethoden für große, mehrschichtige Kryptoasset-Transaktionsgraphen. Die erwarteten Ergebnisse und Innovationen sind: (i) ein kollaborativ erstellter Kryptoasset-Wissensgraph, der als Ground-Truth-Datensatz für maschinelle Lernverfahren dient; (ii) neuartige, systematisch evaluierte Graph-Lernmethoden, die auf die Aufgabe der Kryptoasset-Analyse zugeschnitten sind; und (iii) eine neuartige mehrschichtige Konzeptualisierung für Transaktionsgraphen und eine systematische Bewertung skalierbarer Graphverarbeitungsansätze. Die Forschungsergebnisse werden innerhalb von 3-5 Jahren nach dem Projekt in hochwertigen wissenschaftlichen Einrichtungen veröffentlicht und für die kommerzielle Verwertung durch den Unternehmenspartner aufbereitet.

### Abstract

This project investigates graph learning methods for large, multilayer cryptoasset transaction graphs. The expected results and innovations are: (i) a collaboratively constructed cryptoasset knowledge graph that serves as a well-defined ground truth dataset for learning tasks; (ii) novel, systematically evaluated graph learning methods tailored to cryptoasset analytics task; and (iii) a novel multilayer conceptualization for transaction graphs and a systematic evaluation of scalable graph processing approaches. Research results will be published in high-quality scientific venues and prepared for commercial exploitation by the company partner within 3-5 years after the project.

### Endberichtkurzfassung

The AMALFI project (Automated Learning in Large Multilayer Cryptoasset Transaction Graphs) investigated the effectiveness and efficiency of graph learning algorithms for analyzing interconnected cryptoasset transaction graphs across multiple blockchain platforms including Bitcoin, Ethereum, and Tron. Executed from March 2023 to August 2025, the project successfully achieved all three primary research objectives while exceeding publication targets.

The project developed a comprehensive approach for collaborative ground-truth attribution, refining TagPack and ActorPack data models to support semantic concepts and resolve entity ambiguities across data sources. A Git-based collaborative infrastructure enables systematic collection, validation, and provenance tracking of attribution data, resulting in a

substantial cryptoasset knowledge graph comprising tags from open and proprietary sources. Novel LLM-based methods for data quality assessment outperform baseline approaches by 37.4% in F1-score.

Graph learning innovations include automated DeFi service categorization achieving 0.89 purity, bot detection methods for Ethereum, and cross-chain key reuse analysis discovering 1.6 million keys reused across UTXO-based and account-based systems. A systematic literature review (SoK) analyzed 99 representative publications, revealing distinct financial-focused and blockchain-focused research communities. The project conceptualized and implemented a novel multi-layer framework for representing cryptoasset transaction graphs, validated through empirical studies of governance networks in decentralized autonomous organizations.

The GraphSense platform provides scalable storage and analytics infrastructure based on Apache Cassandra and Spark, enabling the practical implementation of multi-layer transaction graph analysis. Scientific excellence is demonstrated through 7 peer-reviewed publications in top-tier venues including Journal of Cybersecurity, Journal of Finance and Data Science, Ledger, and a BIS working paper, involving collaborations with Bank for International Settlements and Université de Montréal.

### **Projektkoordinator**

- Complexity Science Hub Vienna CSH - Verein zur Förderung wissenschaftlicher Forschung im Bereich komplexer Systeme

### **Projektpartner**

- Iknaio Cryptoasset Analytics GmbH