Blockchain Data Analytics Syllabus

Fall 2019

Instructor Information

Instructor	Email	Office Location & Hours
Cuneyt Gurcan Akcora	cakcora@umanitoba.ca	TBA, 09:00-10:00, Monday

General Information

Description

Over the last couple of years, Bitcoin cryptocurrency and the Blockchain technology that forms the basis of Bitcoin have witnessed an unprecedented attention. As Blockchain applications proliferate, so does the complexity and volume of data stored by Blockchains. Analyzing this data has emerged as an important research topic, already leading to methodological advancements in the information sciences. Although there is a vast quantity of information available, the consequent challenge is to develop tools and algorithms to analyze the large volumes of user-generated content and transactions on Blockchains, to glean meaningful insights from Blockchain data. The objective of the course is to train students in data collection, cleaning and modeling for Blockchain Data Analytics on public blockchains, such as Bitcoin and Ethereum. We will also cover the Libra blockchain of Facebook.

This class will be taught as a seminar class, and will primarily consist of reading, reviewing, and presenting research papers. There will be two papers assigned to each student, selected from the reading list. A specific problem will be assigned to each group, and the resulting Python/R code will be incorporated in what will become a Manitoba Blockchain tool on a Github repository. Students will hold bi-weekly project progress meetings.

Prerequisites

Students need to be able to code in the statistical computing language R or/and Python.

Expectations and Goals

Students will be able to achieve the following learning objectives at the completion of the course.

- Learn the history of digital currencies and problems that prevented their adoption. What are the real-life use cases of Blockchain? How Blockchain differs from earlier solutions?
- Learn the concepts of consensus and proof-of-work in distributed computing to understand and describe how blockchain works.
- Learn data models for addresses, transactions and blocks in cryptocurrencies and Blockchain platforms.
- Use Python and R to extract Blockchain blocks and store the transaction network on Bitcoin and Ethereum Blockchains.
- Model weighted, directed multi-graph Blockchain networks and use graph mining algorithms to identify influential users and their transactions.
- Predict cryptocurrency and crypto-asset prices in real time.
- Extract and mine Smart Contracts on the Ethereum blockchain.

Course Materials

Required Materials

The survey "Blockchain: a graph primer (2019 edition)" will be provided in e-copy and used as the course book.

Course Schedule

Week	Topic	Reading
Week 1	Networks, linking and consensus	• Bitcoin's Academic Pedigree, Narayanan. • BlockSci: Design and applications of a blockchain analysis platform, Kalodner.
Week 2-3	Digital currencies, Cryptocurrencies	• Bitcoin and beyond: A technical survey on decentralized digital currencies, Tschorch. • Bitcoin: A peer-to-peer electronic cash system, Nakamoto. • Blockchain: a graph primer, Akcora.
Week 4	Blockchain Platforms, Smart Contracts	• Ethereum: A Next-Generation Smart Contract and Decentralized Application platform • Smart Contracts – Blockchains in the Wings, Bocek.
Week 5-6	Graph Models for Blockchain Data Analytics	• Bitcoin Transaction Graph Analysis, Fleder. • Uncovering the Bitcoin blockchain: an analysis of the full users graph, Di Francesco Maesa. • The Graph Structure of Bitcoin, Di Francesco Maesa. • Forecasting bitcoin price with graph chainlets, Akcora.
Week 7	Influence and Centrality	• Social networks: Prestige, centrality, and influence, Rusinowska. • Incremental k-core decomposition: algorithms and evaluation, Sariyuce.
Week 8	Clustering	• Clustering in weighted networks, Opsahl. • Clustering and community detection in directed networks: A survey, Malliaros.
Week 9	Anomaly Detection	• Egret: Extortion graph exploration techniques in the bitcoin network, Datta. • BitcoinHeist: Topological data analysis for ransomware detection on the Bitcoin blockchain, Akcora.
Week 10	Visualization	• BitIodine: Extracting Intelligence from the Bitcoin Network, Spagnuolo.

Week	Topic	Reading
		• BiVA: Bitcoin Network Visualization & Analysis, Datta. • Bitconeview: visualization of flows in the bitcoin transaction graph, Di Battista.
Week 11	Blockchain Data Privacy and Security. Next generation blockchains, Monero, ZCash and others.	• Privacy in Blockchain Systems, Wahab and Danezis. • An empirical analysis of anonymity in zcash, Kappos. • An empirical analysis of traceability in the monero blockchain, Moser.
Week 12-13	Project presentations	

Grading

- Review of papers: 30%
- Attendance 15%
- Project:
  - Final report: 20%
  - Code progress in semester 5% every 2 weeks (total, 10%)
- Project presentation: 25%

Academic Integrity

Students are encouraged to discuss course concepts and the general interpretation of project problems with other students in the class.

In the project, any code copied from the Internet must be properly cited in code, and explained in the project report. Code plagiarism without correct attribution will be reported to the Faculty of Science.

Following conventions for citing reference materials in scientific writing is mandatory. Submitting the work of another person as your own constitutes academic misconduct.

Students are to abide by the university's policies regarding academic dishonesty which can be found on this web site: http://umanitoba.ca/student/resource/student_advocacy/academicintegrity/students/