CSCI E-118: Introduction to Blockchain and Bitcoin

Lecturer: Nodari Gogoberidze

Disclaimer: This syllabus is subject to change, particularly before the first day of class on January 25th. Any updates to the syllabus subsequent to the start of class will be communicated in lecture and through announcements.

Course Overview

Semester and Year: Spring 2021
Day/Times: Mondays at 7:20 pm - 9:20 pm Eastern Time
Format: Lectures given live on Zoom web conference. All lectures are also recorded and made available on Canvas.
Contact Information: Before class begins, interested students may email at gnodar01@gmail.com. Once class begins, enrolled students should use Piazza, or the Canvas messaging system. I will respond to emails within 24 hours.

Course Outline

The bitcoin blockchain, a universal ledger where bitcoin transactions are recorded, is leading the cryptocurrency revolution. In parallel, the Ethereum blockchain, dubbed the "world's computer," offers a new paradigm for decentralized application development. This course introduces students to how the blockchain works, how transactions are stored in a tamper-proof and immutable fashion, and the mechanisms for achieving network consensus. Through practice with tools available for the Ethereum ecosystem, students write and deploy smart contracts to the blockchain, build decentralized applications, and develop an understanding of the underlying cryptographic principles. In addition, the broader societal implications of this nascent technology are discussed.

Prerequisites

Previous experience programming in Python, or a basic course in programming such as CSCI E-50. Basic knowledge of cryptography helps, but is not required. Students will need computers with enough RAM to comfortably run a virtual machine running Ubuntu; 4 GB minimum, but 8 GB or more would be ideal.

This course will require students to download and install a Virtual Machine (VM) in order to run a fresh install of the Ubuntu Linux Distribution. In this VM, students will also install several tools for blockchain development. Installation instructions, and an installation script, will be provided. The use of the VM is not strictly mandatory in order to complete the assignments. All submitted

programming assignments however, must be able to run inside the teaching staff's VM for grading purposes.

A simple diagnostic Homework 0 testing for basic knowledge of Python is due before the second lecture. If you are able to complete Homework 0 you are able to take the course.

Course Textbook

Mastering Ethereum, Building Smart Contracts and DApps, 1st Edition (Andreas M. Antonopoulos, Gavin Wood Ph. D.)

- The contents of the book, chapter by chapter, is available for free here:
  - https://github.com/ethereumbook/ethereumbook
- If you are interested in paperback, kindle, or just generally supporting the authors, it is available for purchase here:
  - https://www.amazon.com/Mastering-Ethereum-Building-Smart-Contracts/dp/1491971940

Mastering Bitcoin: Programming the Open Blockchain, 2nd Edition (Andreas M. Antonopoulos)

- The contents of the book, chapter by chapter, is available for free here:
  - https://github.com/bitcoinbook/bitcoinbook
- If you are interested in paperback, kindle, or just generally supporting the authors, it is available for purchase here:
  - https://www.amazon.com/Mastering-Bitcoin-Programming-Open-Blockchain/dp/1491954388

Expectations

Students are expected to submit

- 4 assignments (40% of final grade)
- 4 Reading Reflections (40% of final grade)
- Final Project (20% of final grade)

Note that the Expectations are higher for Graduate Credit: the Final Project is expected to be more substantial in scope and/or more considerate of theory.

Attending or watching all recorded lectures is expected.

Letter Grades

The Grading scheme is as follows:

- 95% or greater yields the letter grade A
- 90% A-
- 87% B+

- 84% B
- 80%B-
- 77% C+
- 74% C
- 70% C-

Reading Reflections

Reading Reflections are a chance to explore news and opinions in the blockchain space. Students will be assigned articles to read from sources such as:

- The Harvard Business Review
- The MIT Technology Review
- The Cornell Academic Arxiv
- Medium / Hackernoon Websites & Blogs

All students will be expected to read the articles, and post a reflection on Piazza. These Piazza posts will be reviewed and discussed in class, as time permits. Since it is not required to attend the class live, students will not be expected to express their viewpoints during lecture, however those that wish to do so are highly encouraged.

Weekly Topics

Week 1, Jan 25, 2021:

- Course Overview, Philosophy & Logistics
- Introduction to Blockchain and Bitcoin
- Trust and the “Tragedy of the Commons”. The journey to Blockchain’s mainstream adoption.

  Relevant Reading:
  - Mastering Bitcoin, chapter 1

  Required Reading:
  - Reading Reflection 1

Week 2, Feb 1: **HW 0 due. Reading Reflection 1 Due.**

- Introduction to Blockchain and Bitcoin continued
- Blockchain Cryptography

  Relevant Reading:
  NOTE: the following two cover largely the same material, I suggest to read one thoroughly and briefly review the other. My suggestion is to read the Ethereum book chapter in depth and review the Bitcoin book, but that is up to you.
  - Mastering Bitcoin, chapter 2

- Mastering Ethereum, chapter 4

Week 3, Feb 8: **HW 1 due.**

- Installations in Linux
- Consensus Mechanisms

Relevant Reading:

- Mastering Bitcoin, chapter 10
- Mastering Ethereum, chapter 14

Required Reading:

- Reading Reflection 2

Week 4, Feb 15: President's Day - No class

Week 5, Feb 22: **HW 2 due. Reading Reflection 2 Due.**

- Bitcoin Script
- Introduction to Ethereum

Relevant Reading:

- Mastering Ethereum, chapter 1 and 3
- Mastering Bitcoin, chapters 6 and 7

Week 6, March 1:

- Overview of Open Source and Open Source-Licenses: MIT, BSD, Apache v 2.0, GPL, and others.
  - Using Open Source Commercially
  - The Academic, Open Source, and Industrial Establishments
  - How Open-Source is developed/made: "Trusting" Open-Source
- Building an Ethereum decentralized application
  - Introduction to Solidity
  - Introduction to Remix

Relevant Reading:

- Mastering Ethereum, chapter 2 and 7
- If interested in non-solidity programming languages: Mastering Ethereum, chapter 8 and 9

Required Reading:

- Reading Reflection 3

Week 7, March 8: **HW 3 Due. Reading Reflection 3 Due.**

- Building an Ethereum decentralized application continued

Relevant Reading:

- Mastering Ethereum, chapter 6 and 13

Week 8, March 15: Spring Break - No Class

Week 9, March 22: **Project proposal due.**

- Deploying to the Ethereum Blockchain

Relevant Reading:

- Mastering Ethereum, chapter 11 and 12

Week 10, March 29: **HW 4 due.**

- Ethereum Improvement Proposals (EIPs)
- ERC-20 Tokens

Relevant Reading:

- Mastering Ethereum, chapter 10
- Mastering Ethereum, Appendix A: Ethereum Standards

Required Reading:

- Reading Reflection 4

Week 11, April 5 : **Reading Reflection 4 Due.**

- Initial Coin Offerings (ICOs)

Week 12, April 12:

- Private Blockchains
  - Major Tech companies and the Blockchain
  - Privacy, Data Acquisition, and Cloud Computation
- Blockchain Schools of Thought
  - Comparing and contrasting the Web 2.0 & Web 3.0.

Week 13, April 19: **Final Project - Software Due.**

- Payment Channels

Relevant Reading:

- Mastering Bitcoin, chapter 12

Week 14, April 26: **Final Project - Demonstration Due.**

- The Frontiers of Blockchain
  - Research and Development
  - Applications

Week 15, May 3: Review of submitted projects & Guest Speakers

Week 16, May 10: Review of the submitted projects & Guest Speakers

Final Project

The final project involves solving a problem in Blockchain technology. The final project is composed of:

- project proposal
    - explanation of the problem to solve (15% of project grade)
    - a short summary explaining the intended solution (15% of project grade)
- software solving the problem (40% of project grade)
- a demonstration showing the solution (30% of project grade)

(Note that software engineering involves both coding and communication and the grade breakdown of the final project reflects that.)

Students are free to choose the subject matter of their final project, there are no hard requirements. Examples will be discussed and provided, however students are not required to emulate what is shown in the examples. A set of minimum requirements will be outlined, but it is important to note that depending on the nature of the chosen project, the minimum requirements may not be applicable. In these cases, the requirements will be adjusted according to what is outlined in the project proposal.

Graduate Students are required to put additional effort into the final project. Again, depending on the nature of the chosen project, requirements will be communicated by reviewing project proposals.

The demonstration of the final project is likewise dependent on the chosen project. It could be a pdf document outlining features, a walk through of the code in a Jupyter Notebook, or a video.

The proposal is due by **Week 9,** the code must be submitted by **Week 13**. The demonstration of the software is due **Week 14**. Selected projects will be discussed by the class during weeks 15 and 16, with permission of the students.

Academic Integrity

You are responsible for understanding Harvard Extension School policies on academic integrity: https://www.extension.harvard.edu/resources-policies/student-conduct/academic-integrity , and how to use sources responsibly. Stated most broadly, academic integrity means that all course work submitted, whether a draft or a final version of a paper, project, take-home exam, online exam, computer program, oral presentation, or lab report, must be your own words and ideas, or the sources must be clearly acknowledged. The potential outcomes for violations of academic integrity are serious and ordinarily include all of the following: required withdrawal (RQ), which means a failing grade in the course (with no refund), the suspension of registration privileges, and a notation on your transcript.

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