Syllabus

USI Blockchain Winter School: Writing Smart Contracts

February 14–18, 2022

Peter H. Gruber

Course Description

Blockchain technology solves the important problem of automating transactions between agents in an efficient, flexible and trustworthy manner. It is one of the pillars of the digital finance revolution. New and specific skills are needed to fuel this revolution: Smart contracts require a distinct way of thinking and a novel programming approach, different from standard procedural programming.

This course introduces students to the relevant theoretical concepts and provides a hands-on introduction to writing smart contracts on a modern blockchain. The goal is to equip students with the necessary skills and useful background knowledge for creating simple smart contracts and for deploying them on the Algorand blockchain.

Organisation

The course will be held in English. Students who cannot participate in person for whatever reason will have the opportunity to participate via live stream. Students will have to bring:

- A laptop with the Anaconda environment installed
- A mobile phone
- All necessary software is free and open source and will be installed at the beginning of the course.

Target Group and Prerequisites

The course is aimed at master or advanced bachelor students in economics or finance as well as partitioners from the finance industry. Students should have basic programming skills in Python and a keen interest in the topic. (Students with no Python experience can alternatively complete online tutorials before the begin of the winter school.) No experience in blockchain is required. While many examples will be from finance and economics, the course is sufficiently general for students from other fields to profit from it.

Course Objectives

After this course, students will be able to interact programmatically with the Algorand blockchain as well as to create their own tokens and NFTs. They will have learnt to express simple governance structures, business processes and financial assets as smart contracts. They will be able to implement these smart contracts in Python and to deploy them on the Algorand blockchain. They will understand the differences between functional and contract-oriented programming, as well as the risks specific to smart contract programming. They will be able to access and analyze blockchain data. Beyond the technical skills, they will have learnt about organizing their work on smart contracts, about the market for programming talent and how to start a blockchain business.

Methods, Course Work

Teaching organised as an in-person winter school. Online participation will be made possible for those who cannot travel. Teaching consists of 28 units of 45 minutes each, plus voluntary exercise sessions. This corresponds to a standard 3 ECTS course.

Classes are based on realistic applications and take students from theory to mastery in five steps:

1. Lecture with short presentation of a new concepts
2. Guided tour: students and lecturer work together on applying the new concept
3. Short rationalization of the lessons learned
4. Individual exercises with possibility to ask questions during the exercise session
5. Discussion of students' solutions to exercises in class

A typical day is organised as follows:

- Discussion of the exercises and lessons learnt from the previous day (1 unit, except first day)
- Lecture with introduction of new concepts
- Application lab
- Additional lecture
- Exercise session

Grading

Grading is based on individual homeworks (20%) and a project after the end of the course, that is completed individually or in small groups.

Homeworks are simple applications of what had been learnt during a day. The exercises are handed in via the blockchain.

The project work starts at the end of the winter school. Students have six weeks after the end of the winter school for completing the project.

Class material and literature

Literature, slides, sample programs in Jupyter notebooks, solutions to exercises and class videos are made available digitally. Literature consists of original papers and original documentation.

Contents

About

The Università della Svizzera italiana (USI) is the public university of the canton of Ticino in southern Switzerland. Established in 1996, it currently has about 3'350 students. According to the 2020 Business School Ranking of the Financial Times, USI's master program in Finance ranks number 47 world-wide.

The Algorand blockchain is a latest-generation, flexible and energy-efficient blockchain. Since 2021, Algorand has been carbon-neutral. It allows programming a vast range of smart contacts in a developer-friendly way and has very low transaction costs. Algorand is based on the work of Silvio Micali (MIT), winner of the Turing prize, often dubbed as the "Nobel prize in informatics".

Peter H. Gruber has PhDs in financial economics and particle physics. He is Senior Lecturer at the Università della Svizzera italiana (USI) in Lugano. He has been teaching programming to economics and finance students at USI, St. Gallen, Geneva and Bocconi since 2005. Before this, he was part of the neutrino physics efforts at CERN. His current research interests are asset pricing, blockchain economics and data science with non-traditional data sets, and data visualization. He represents USI in the Algorand University program, of which USI is a founding member.