Obuda University John von Neumann Faculty of Informatics			Institute of Biomatics and Applied Artificial Intelligence	
Name and code: Blockchain Programming (NBVBP0EBNE) **Credits*: 4*** Computer Science Engineering BSc , MSc 2020/21 year II. semester				
Responsible person of subject: Dr. Katalin Szenes				
Subject lecturers: Dr. Katalin Szenes, Bence Tureczki				
Prerequisites (with code):				
Weekly hours:	Lecture: 2	Seminar.: 0	Lab. hours: 2	Consultation: 0
Way of assessment (exam or midterm grade):	exam			
Course description:				
Goal: We want to help our students using blockchain in the Microsoft Azure. The significance of the blockchain database keeps growing both with its special privacy options and with the cryptocurrency. This tool provides for special support of corporate governance. After the basics of corporate governance, the blockchain programming will be illustrated step-by-step. By the end of term the students will establish a Strategic & Competitive Intelligence Center where they can submit information by blockchain transactions in a hidden way, using their public / private key instead of publishing their name.				

Course description:

Having discussed the definition of corporate governance, we provide an introduction to blockchain programming through a practical example use case. First every student builds his / her node and creates on it a private blockchain database, then everybody copies his / her blockchain database to the node of every other student. This way a network of blockchain nodes is established. The subjects to be introduced will be:

- our governance definition based on real life experiences
- excellence criteria and pillars for corporate operations & asset handling
- how blockchain supports the governance of the corporate
- the basic operations of the blockchain
- the types of the transactions of the blockchain
- the blockchain embedded Merkle tree data structure
- concerns that arise in blockchain development
    - advantages and disadvantages of a blockchain database
    - famous problems
    - methods for their handling in the industry
- well-known hashing algorithms
- the blockchain development tools of Azure Blockchain Service
- Azure cloud tools that support application development in a blockchain environment
    - Visual Studio Code
    - Microsoft Virtual Network
    - Windows Virtual Machines
    - Azure Active Directory
    - Azure Blob Storage
- a virtual model of a Strategic & Competitive Intelligence Center

Lecture schedule	
Education week	*Topic*
1-3.	Lecture: To support the corporate in fulfilling its strategic goals we define the excellence criteria and the pillars for corporate operations & asset handling. We give a real life experience based governance definition. We introduce how the blockchain supports the governance of the corporate by contributing to the data integrity by design. Laboratory work: The students register for Azure Student Subscription. In the Visual Studio Code service of Microsoft Azure cloud we write example programs in C# programming language for storing and searching data in a blockchain. Seminar: The students learn the basic operations of the blockchain database. We examine some efficient programming algorithms for these basic operations.

4-6.	Lecture: The students learn the basic transactions of the blockchain database and how to handle these transactions in Merkle tree data structures. Laboratory work: In the Visual Studio Code service of Microsoft Azure cloud we write example programs in C# programming language to illustrate some of the transactions of a blockchain database. Seminar: The students solve mathematical problems such as how to has a block using the Merkle data structure in practical exercises. We bring to light the advantages of these data structures in the prevention and detection of malicious data manipulation.
7-9.	Lecture: The students learn how to structure the data within a block of the blockchain database. We show how to embed Merkle trees into the blocks according to the industry best practice of Ethereum blockchain. Laboratory work: In the Azure Blockchain Service we present a useful combination of the blockchain and Merkle tree data structures. We illustrate with practical examples some of the advantages of such a combination. Seminar: We solve complex mathematical problems using blockchain and Merkle tree data structures. The students learn both creating Merkle trees and some of the most commonly used programming algorithms related to the combination of these data structures.
10-11.	Lecture: We explain how a Strategic & Competitive Intelligence Center can support the strategic goals of the corporate. Then we specify and group some of the tasks of a Strategic & Competitive Intelligence Center based on our practical experiences. Laboratory work: To model a virtual Strategic & Competitive Intelligence Center the students create a virtual network in the Microsoft Virtual Network of Windows Virtual Machines and log in to these machines using Azure Active Directory. Then the students collect news from the internet and store them in Azure Blob Storage. Seminar: The students continue working in five groups. Each group is responsible for a subset of the tasks of our virtual Strategic & Competitive Intelligence Center. The grouping of the students can based on their individual interests and goals.

12-14.	Lecture: We examine popular encryption hashing algorithms (e.g.: KECCAK-256) and based on one of these algorithms we illustrate step-by-step the creation of a blockchain database and its transaction handling in Merkle trees. Laboratory work: In Azure Blockchain Service, first every student builds his / her node and creates on it a private blockchain database, then everybody copies his / her blockchain database to the node of every other student. This way a network of blockchain nodes is established. We test the functionality of our blockchain database in the virtual model of the Strategic & Competitive Intelligence Center that we formerly created. Each group of students is responsible for testing a subset of the functions of the virtual model with respect to the tasks that they had formerly chosen. Seminar: We show practical methods from the industry to handle some of the mathematical problems (e.g.: the Double-spending problem) that might arise when we build a blockchain solution.

Midterm requirements

For the signature student participation in the lectures, seminars and labs is required.
All project work exercises in seminars and labs are required to complete during the midterm.

Assessments schedule

Education week	*Topic*
1-13.	Project work exercises in labs and seminars related to the topics of the given education week

Final grade calculation methods

Achieved result	Grade
89%-100%	excellent (5)
76%-88<%	good (4)
63%-75<%	average (3)
51%-62<%	satisfactory (2)
0%-50<%	failed (1)

Final grade = grade of exam
To take the exam the student must get the signature during midterm.

Type of exam

Oral

Type of replacement

The student who fails to obtain signature during the midterm can take a replacement exam for signature on the last week of education if the student notified all lecturers in e-mail before the last week of education about his / her difficulties in meeting the midterm requirements. The exam is oral and includes all topics of midterm.

References
Obligatory literature: K. Szenes, B. Tureczki: “AI supported Corporate Governance” to appear in the proceedings of SAMI 2021 conference IEEE 19th World Symposium on Applied Machine Intelligence and Informatics, January 21-23, 2021. Herl'any, Slovakia K. Szenes, B. Tureczki: „Supporting corporate governance on blockchain basis“ to appear in the proceedings of 2nd International Conference on Central European Critical Infrastructure Protection organized by: Bánki Donát Faculty of Mechanical and Safety Engineering, Óbuda University, November 16-17, 2020. Budapest, Hungary K. Szenes, B. Tureczki: “Blockchain basics, applications”, workshop presentation & article, “Blockchain and deep learning workshop”, Institute for Computer Science and Control September 5, 2019. H-1111 Budapest, XI. dist., Kende street 13-17, Hungary download article: https://nextcloud.sztaki.hu/s/ya4LRkz75Kmj4og#pdfviewer download presentation: https://www.slideshare.net/secret/IgHgKBIQ4w5ePj

Recommended exercise:

Trying to become a Microsoft Learn Student Ambassador
is highly recommended for every student
https://studentambassadors.microsoft.com/

Recommended literature:

S. Dharanikota, S. Mukherjee, C. Bhardwaj, A. Rastogi, A. Lal: "Celestial: A Smart Contracts Verification Framework", Microsoft Research, MS paper ID: MSR-TR-2020-43, December, 2020. India
download: https://www.microsoft.com/en-us/research/uploads/prod/2020/12/celestial.pdf

S. Satija, A. Mehra, S. Singanamalla, K. Grover, M. Sivathanu, N. Chandran, D. Gupta, S. Lokam: "Blockene: A High-throughput Blockchain Over Mobile Devices", OSDI 2020
14th USENIX Symposium on Operating Systems Design and Implementation organized by: USENIX, November 4-6, 2020
download: https://www.microsoft.com/en-us/research/uploads/prod/2020/10/blockene-osdi20-5f97c46c0dae1.pdf

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Expert Reviewer in the Subject Matter Expert Team: Katalin Szenes

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