

Mining Complexity

Blockchain Development

Time: 60 mins

Introduction

In this class, the student/s will learn about mining complexity and how to validate the mined block.

Recall Commands Used

<code>hashlib.sha256()</code>	<code>sha256()</code> accepts the input string as a parameter and creates a hash object.
<code>str(random.random())</code>	Generates a random string
<code>encode('utf-8')</code>	Encodes into a binary string
<code>json.dumps()</code>	Convert a Python object (usually a dictionary) into a JSON-formatted string for data interchange and storage.
<code>"n" * difficultyLevel</code>	Repeats n as specified in difficultyLevel

Vocabulary

- **Mining Complexity** is a measure of how hard it is for miners to add new blocks to the blockchain, adjusting to ensure a secure and steady block creation process.
- **Difficulty Level** indicates the difficulty of solving problems and adding new blocks; it changes to maintain a steady pace of block creation and network security.
- **Mining Validation:** Miners solve complex puzzles to verify transactions and add them to the blockchain.
- **Mining Limit** sets the maximum rate at which new blocks are added to the blockchain, regulating transaction validation speed and ensuring network stability.
- **Proof of Work** is a technique where miners compete to solve complex math puzzles to add new blocks of transactions to the blockchain.
- **Hashrate** measures a network's computational power for processing transactions and mining new blocks, directly impacting security and efficiency.

Learning Objectives

Student/s should be able to:

- **Recall** how the block and its data is hashed.
- **Explain** how to calculate and represent block difficulty and how proof of work plays an important role in the blockchain.
- **Demonstrate** the significance of zeros to determine mining complexity of a block.

Activities

1. Class Narrative: (2 mins)

- Brief the student/s about the consensus mechanism covered so far and further we shall explain the process of proof of work process and mining complexity. Explain how to validate the mined block from the blockchain.

2. Concept Introduction Activity: (5 mins)

- Let the student/s play the explore-activity to observe how to display blocks with difficulty level and validate a mined block.
- Explain the process of proof of work and how miners compete to solve the problem to add new blocks.
- Explain the need of mining complexity in blockchain and introduce the process of mining validation and mining complexity of a block.
- Using the slides, explain that the student/s will learn:
 - to add and display difficulty level.
 - to mine a block of transaction with difficulty level 4.
 - to set the mining limit and add the valid block and highlight the invalid block.

3. Activity 1: Generate Hash with Difficulty Level(14 mins)

Teacher Activity: (7 mins)

- Explain about the difficulty levels of a block by making the puzzle complex.
- Explain how to perform hashing of the block to represent difficulty with the help of zeros in the hash value.

Student Activity: (7 mins)

- Guide the student/s to generate and display the hash of a block with a difficulty level.

4. Activity 2: Generate Hash with Difficulty Level 4 (12 mins)

Teacher Activity: (3 mins) .

- Recall the concept of the generating hash value of a block with the difficulty level.
- Explain how to perform mining of a block with difficulty level 4 and generate its hash value.

Student Activity: (9 mins)

- Guide the student/s to mine a block of transaction with difficulty level 4 and generate the hash value with difficulty level.

5. Activity 3: Add Mining Limit (12 mins)

Teacher Activity: (6 mins)

- Guide student(s) about how miners spend extra computational efforts on solve complex puzzles.
- Explain the concept of mining and block validation with the help of mining limit and block difficulty.
- Explain highlighting the invalid mined block on the output.

Student Activity: (6 mins)

- Guide the students to perform validation of the block and highlight the invalid block in the block chain.

6. Introduce the Post class project: (2 min)

Load the project and demonstrate how to perform mining and validation of the blocks and highlight invalid blocks for a real estate transaction application.

7. Test and Summarize the class learnings: (5 mins)

- Check for understanding through quizzes and summarize learning after respective missions.
- Summarize the overall class learning towards the end of the class.

8. Additional activities:

- Encourage the student/s to find the difficulty within the hash.
- Encourage the student/s to fix and debug the infinite mining loop.

9. State the Next Class Objective: (1 min)

- In the next class, student/s will learn to use the Proof of work concept to find the nonce and verify it with the hash on the sandbox platform.

U.S. Standards:

CSTA: 2-AP-11, 2-AP-12, 2-AP-13, 2-AP-14, 2-AP-19

Links Table		
Activity	Activity Name	Link
Class Presentation	MINING COMPLEXITY	https://s3-whjr-curriculum-uploads.whjr.online/1bcbf095-d980-4451-85ea-2a6ce37390da.html
Explore Activity	MINING COMPLEXITY	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS-BP
Teacher Reference: Teacher Activity 1	Generate Hash with Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-TAS-BP
Teacher Reference: Teacher Activity 1 Solution	Generate Hash with Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-TAS
Student Activity 1	Generate Hash with Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS-BP
Teacher Reference: Student Activity 1 Solution	Generate Hash with Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS
Teacher Reference: Teacher Activity 2	Increase the Hash Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-TAS-BP
Teacher Reference: Teacher Activity 2 Solution	Increase the Hash Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-TAS
Student Activity 2	Increase the Hash Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS-BP
Teacher Reference: Student Activity 2 Solution	Increase the Hash Difficulty Level	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS
Teacher Activity 3	Add Mining Limit	https://github.com/Tynker-Blockchain/TNK-M12-C91-TAS-BP
Teacher Reference: Teacher Activity 3 Solution	Add Mining Limit	https://github.com/Tynker-Blockchain/TNK-M12-C91-TAS
Student Activity 3	Add Mining Limit	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS-BP
Teacher Reference: Student Activity 3 Solution	Add Mining Limit	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS
Student's Additional Activity 1	Find the Zeros Within the Hash	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS-BP
Teacher Reference: Student's	Find the Zeros Within the Hash	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS

Additional Activity 1 Solution		
Student's Additional Activity 2	Debug the Infinite Mining Loop	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS-BP
Teacher Reference: Student's Additional Activity 2 Solution	Debug the Infinite Mining Loop	https://github.com/Tynker-Blockchain/TNK-M12-C91-SAS
Post Class Project	Mine and Validate the Blocks	https://github.com/Tynker-Blockchain/TNK-M12-C91-PCP-BP
Teacher Reference: Post Class Project Solution	Mine and Validate the Blocks	https://github.com/Tynker-Blockchain/TNK-M12-C91-PCP