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A Blockchain-based Model for Integrated Higher Education and Recruitment Information

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Abstract

In order to have an automated and complete profile about any graduate, it is required to combine both academic and professional data from educational institutions and business organizations. Blockchain is a recommended solution to solve this problem. Educational institutions should keep all student information including the student's profile, courses, skills, grades, and certificates securely to be available later to the recruiters, and this is rarely considered by recruiters in order to have a complete profile for the graduates. As a result, we propose a new framework for integrating education, recruitment, and skill verification systems, which is based on blockchain that guarantees the confidentiality and privacy of the information and also saves time and effort. The proposed framework consists of three components: educational institutions (graduates' affairs), business organizations (HR for the former employer), and business organizations (HR for new employers).

This framework can contribute to solving the challenges facing the secure and efficient integration of the education and recruitment information about the graduate in order to have a sufficient profile to select suitable employees through verified information.

Keywords: Blockchain, Automated Profiling, Electronic Educational System, Recruitment

Introduction

The higher education and recruitment sectors have undergone significant changes in recent years, with the advent of technology playing a major role in the way institutions and employers connect with students and job seekers. However, despite these advancements, the current system still suffers from inefficiencies and a lack of transparency. One major issue is information stores, with students' education and employment histories spread across multiple institutions and organizations, making it difficult for potential employers to access comprehensive information about a candidate's qualifications.

Verifying employees' data, such as courses, certificates, skills, and work history presents a significant challenge for business organizations during the recruitment process [1]. This is a result of most educational institutions focusing heavily on saving student personal data without paying attention to saving other data that is related to the educational and career path, and although some institutions are interested in saving part of this data, storing that data is not done securely.

Blockchain as a distributed, digitized, and secure ledger will help in solving the issues mentioned above which are associated with successfully completing the recruitment process.

This section covers an introduction to blockchain, the benefits of blockchain in education, and the relationship of blockchain with recruitment.

A. What is Blockchain

Satoshi Nakamoto, the creator of the digital money Bitcoin, initially proposed the concept of a blockchain in 2008. Essentially, the blockchain has become a core of a Bitcoin operating database distributed across all network members [2].

A blockchain is a growing collection of data blocks linked together in the form of a single continuous chain. A secure cryptographic hash connects these blocks. Every computer(device) on the network has the most recent version of the same general ledger. Above all, the ledger is safe, and the database can only be enlarged by adding new blocks to the chain. Changing records that have already been committed to the chain is computationally impossible [3]. This is one of the main reasons for blockchain's popularity in recent years.

B. Benefits of Using Blockchain Technology in Education

Many educational institutions have taken up projects to use blockchain technology to keep track of the data of their students and faculty members. The most evident benefits may be seen in the data storage management formula. Other advantages include data security, system trust, a global database, and formative evaluation [2].

Blockchain's value derives from its capacity to secure data and confirm that it has not been compromised. A few potential advantages of using technology in education include high security, low cost, improved student assessments, and better data access control [1].

C. Blockchain and Recruitment

Blockchain technology has the potential to revolutionize the recruitment process by providing a secure and decentralized system for storing and sharing job candidate data. This can include resumes, qualifications, and work history.

Additionally, blockchain can provide a secure and transparent way of tracking and verifying the completion of online training and certifications.

Using blockchain, recruitment companies can create a tamper-proof and decentralized database of resumes, qualifications, certifications, and work histories that potential employers can access and verify. This can help reduce the risk of fraud and errors in the recruitment process while also making it more efficient and cost-effective.

Furthermore, the smart contract capability of blockchain technology can be used in the recruitment process as well, where job seekers can publish their profiles and qualifications on the blockchain and be matched with the right job opening based on the smart contract rules.

Overall, blockchain can help improve the security, transparency, and efficiency of the recruitment process, while also providing new opportunities for job seekers and employers.

Decentralization, data traceability, tamper-proofing, and transparency are all aspects of blockchain technology [4] and its core technologies are quite trustworthy when it comes to recruiting. It can not only become a new and sophisticated technical means for recruiting, but it can also speed up the recruitment process, save effort for companies, and increase recruitment performance, particularly in picking appropriate candidates for appropriate roles, by storing reliable data on education, talents, and academic qualifications in the blockchain.

The main contributions of this paper are:

- Secure storage of education and recruitment information: A person's education and professional or recruitment information would be stored on the blockchain in a secure and tamper-proof manner, allowing for easy verification of the information by potential employers and other interested parties.
- Decentralized verification: The information stored on the blockchain would be verified by a network of peers, such as universities and employers, rather than relying on a centralized authority. This would increase transparency and trust in the information stored on the blockchain.

- Easily accessible information: The information stored on the blockchain would be easily accessible to authorized parties, such as potential employers, through a secure and user-friendly interface.
- Cost-effective: By integrating education process components (personal information, courses, skills, grading system, certificates) and recruitment process components (resumes, qualifications, work history) on a new comprehensive blockchain-based platform, it would cut down on the cost of maintaining separate systems, make it easier to share information between different parties securely, and also save time and effort.

The rest of this paper is organized as; section 2 presents Literature Review, section 3 introduces the components of the proposed framework, section 4 discusses the implementation of the proposed framework, and Section 5 presents the conclusion.

Literature Review

The integration of blockchain technology in higher education and recruitment information systems has gained increasing attention in recent years.

Studies have explored the potential benefits of using blockchain in these systems, such as increased security and transparency of student records and improved recruitment process efficiency.

Several studies have proposed the use of blockchain for student record management in higher education, and the use of blockchain in recruitment information systems has also been explored.

Despite the potential benefits, the implementation of blockchain in higher education and recruitment information systems is still in the early stages. Several challenges need to be addressed, such as privacy concerns and the integration between them.

This section is used to address the previous studies that used Blockchain in the education process and in the recruitment process.

H. Yumna et al. [2] discussed the main problems of educational institutions from the perspectives of the physical, digital, and financial worlds. The main problems that face educational institutions are the possibility of manipulation, the difficulty of verification, and record exchange across institutions. Following that, this study explored how these concerns may be resolved using the decentralization, traceability, and consensus mechanisms of the blockchain.

A. Alammary et al. [1] was a detailed examination of studies on blockchain-based educational applications. It focused on three primary topics: educational applications built using blockchain technology, the value it may deliver to education, and the obstacles to incorporating blockchain technology into education. The analysis also offered a vision

for other educational parts that could profit from using the technology. Finally, it demonstrated that there are still just a few educational fields where blockchain technology has been implemented. Consequently, blockchain's promise has not yet been fully realized.

L. Liu et al. [5] proposed a unique E2C-Chain, a two-stage blockchain that may be used to improve the quality of education, recruitment, and talent verification systems. The data will be available to employers for help in choosing the right candidates for every position but didn't store the certificates (Digital Certificates) before.

L. Liu et al. [6] proposed a novel and incentive two-stage recruitment, education, and skill certification framework. It provided a trusted source of employee information that is not modifiable and permanent. The paper focused on storing the personal information of candidates(employees), the courses they studied, and their skills in Blockchain, but it ignored an important part to be saved which is the previous work experience.

V. Juričić et al. [7] described Blockcert, an open-source technology platform built by the Media Lab at MIT and the Learning Machine firm. Blockcert's goal is to enhance existing systems and develop universal software that can be used by all educational institutions. Their recommendations for educational institutions are based on a variety of factors including course content, staff perks, data ownership, and smart contracts.

The notion of employing technology in the staff recruiting and selection process was developed by H. Rhemananda et al. [8]. Recruitment methods based on digital databases will become more brief, efficient, and successful as a result. It doesn't mention a specific platform that implements all these features and benefits of using this technology.

F. Richter et al. [9] proposed adopting the Blockcert platform to manage student data such as personal information, diplomas, and certifications. It also offered an architecture for UFP to create a Blockcerts-based system (University Fernando Pessoa). The application considers three different stakeholders: Students, Third-party (Employers, other institutions), and UFP Registration.

R.A. Mishra et al. [10] aimed to overcome security challenges associated with the sharing of student credentials. It suggested a blockchain-based architecture, which would then be developed as a decentralized application (DApp). The paper also didn't include the certificate or skills in the proposed platform despite its importance in the education process.

N.S. Dhanala et al. [11] proposed a model or a platform using blockchain technology for the recruitment process. The candidate details are verified by the college, the organization for the last works, and law enforcement. Based on the agreement, the candidate data is stored in the block with its transaction hash value. This paper added The Law enforcement Block for

checking the candidate's details for any criminal background, but it doesn't mention the storing of the candidate's certificates.

W. Jeong et al. [12] presented a blockchain-based credential management infrastructure for performance evaluation during recruiting. The key processes are certificate issuance, certificate repository, distributed storage in the form of blockchain, and verification. The suggested system is compatible with the IMS Global Learning Consortium's Open Badges. They focused only on the certificate; the verification of any certificate belonging to the candidate and didn't give any interest to the previous work experience. They also didn't focus on storing the candidate's skills which also plays a big role for the companies in the recruitment process.

The platform of M. Baldi et al. [13] didn't distinguish the real issuer from someone impersonating it. This is because the Blockcerts standard does not include any verification that the values used to sign a certificate are actually owned by the legal issuing institution.

B.V. Praveen Kumar et al. [14] offered a model of a solution blockchain-based, in which the hash values of all original papers submitted by many companies for a job candidate are stored on a blockchain. During the recruiting process, the details of the job candidate may be confirmed by comparing the hash value of the provided document to the hash value of the document on the blockchain.

The results of empirical research that performed ten in-depth, one-on-one semi-structured interviews with Human Resources Management (HRM) specialists were evaluated by D. Salah et al. [15]. Their study is of significance to both blockchain and HRM researchers who can utilize the proposed opportunities as a future research agenda. It aims to examine the opportunities and challenges posed by the use of blockchain technology in human resource management (HRM) applications. It will investigate the skills and competencies that HRM experts must possess to utilize the technology in HRM applications.

According to the study of C.S.S.Yi et al. [16], Blockchain could keep job records in the ledger, eliminating the need for recruiters and candidates to check references. Processes involving human resources such as payroll, recruitment, choice, onboarding, and offboarding waste a lot of time, resources, and money.

MF Steiu [17] examined the benefits and challenges of applying blockchain in education. Benefits include empowering learners (self-sovereignty) and enhancing security and efficiency for educational institutions, businesses, and students. Legal, scalability, security, market acceptance, and innovation are all challenges.

It highlighted two key parties involved in the blockchain-in-education ecosystem: beneficiaries (universities) and providers (start-ups, organizations) of such solutions.

R.A. Mishra et al. [18] suggested a blockchain-based structure for the safe sharing of students' identification that is tamper-proof, immutable, genuine, secured, and easy to distribute. The system employs a safe off-chain storing technique. The suggested architecture's performance and feasibility are evaluated using an Ethereum-based prototype implementation.

The authors provide a unique pragmatic architecture for the secure exchange of students' credentials across all aspects of the educational ecosystem in this study. To increase the system's scalability and secure student data, the report recommends combining blockchain technology with smart contracts.

The suggested research by T.Peisl et al. [19] intended to check the effectiveness of using blockchain technology in recruitment operations across the employee lifecycle. Moreover, it plans to inspect the impact on applicants and intermediaries, in terms of protecting the programs that are deployed by many recruitment companies.

The planned research method will confirm a high standard of procedures and results for further inquiries. Contribution to this subject is essential because suitable candidate hiring is an important way to success for industries, and there is now no applicable research available

TP.Nguyen et al. [20] proposed a theoretical four-parties BC-based platform that will permit headhunters to recruit applicants while they are students. The platform eliminated the requirement for e-credentials when seeking recruitment for practical purposes. This technique might also reveal the true abilities of teachers and institutions.

Blockchain technology can potentially solve old and new difficulties in cultural and creative design education. J.Liu et al. [21] examined the technological foundations of blockchain as well as the shortcomings of online and cross-regional schooling. It is then used to manage learning resources, track learning processes, evaluate learning, and shape learning paths.

In light of the existing state and challenges with human resource management systems, as well as the technical characteristics of blockchain, L.LI et al. (4) suggested a blockchain-based human resource management mechanism. Its goal was to create an accurate, efficient, open, and transparent human workforce management system.

The validity and verification of student data have been provided by A. Wasif et al. [22] using blockchain technology, which has been presented as a dependable safe storage method for the educational certification system. The paper can replace the current system and help develop a new method for exchanging student information.

K. Wüst et al. [23] examined if a blockchain is indeed the best technological choice for a certain use case. It offered a systematic

technique to choose the best technological answer to a specific application challenge. It analyzed three use cases in-depth supply chain management, interbank and international payments, and decentralized autonomous organizations using their methodology, and it has ended with a look ahead to potential prospects in the future.

M. Turkanović et al. [3] presented EduCTX, a blockchain-based universal higher education credit system. This program focuses on the European Credit Transfer and Accumulation System philosophy (ECTS). The program is the first phase of a more transparent and technically advanced method of higher education systems, but in this paper, the proposed program hasn't been tested in a real-life environment, that would contain HEIs, students, and companies.

In conclusion, the literature review has highlighted the potential for a blockchain-based model for integrated higher education and recruitment information. It has been shown that the use of blockchain technology can provide a secure and transparent system for storing and sharing educational and professional information. This can improve the recruitment process's efficiency and help ensure that the right candidates are selected for jobs. Additionally, the integration of education and recruitment information on a blockchain platform can provide students with a lifelong digital record of their achievements and qualifications.

From previous studies, most studies didn’t cover all the elements of the education process (the student's personal information, courses, grading system, certificates, and skills) and the elements of the recruitment process (resumes, qualifications, work history)

Each paper discussed one or two, not all elements, as presented in Table 1 and some papers made a framework dedicated to these elements only.

This paper introduces a detailed study that introduces the majority of studies that apply Blockchain technology within the education process and the recruitment process. A comparison between frameworks that use Blockchain within the education process is introduced in Table 1.

These studies and comparisons show that Blockchain technology in the education process focuses only on providing educational institutions and business organizations with (student's personal information, courses, certificates, and skills) ignoring the other education process like employee's work experience.

This paper suggests a framework using Blockchain technology. This framework makes the education process and the recruitment process more secure and efficient by addressing the full education process components (student's personal information, courses, certificates, skills, and employee's work experience)

Table 1 presents a matrix of past studies that have explored the aspects of education and established various types of frameworks; this table

illustrates the components of education that each research has covered and what our framework will include at the conclusion of the matrix.

Proposed Framework

By analyzing the research papers, we found that the authors focused on one or more components of the education and employment processes, but they ignored the integration of all components such as the student's personal information, the employee's resume, and the employee's work history, in order to achieve integration between the components of the education and recruitment process together and then complete the recruitment process successfully based on real information without worrying about its authenticity. Therefore, we proposed a framework that integrates all the education and recruitment processes which are:

- Student's personal information
- Student's courses
- Student's skills
- Student's grades
- Student's certificates (digital certificates)
- Employee's resume
- Employee’s work history
- Employee's qualifications

This section describes a new comprehensive framework that aims to ensure the accuracy and security of student information during the education and recruitment processes. The framework consists of three main components: educational institutions, former employers, and new employers, as shown in Fig.1. Each component plays a specific role in ensuring that the data is accurate and secure.

The data flow begins with educational institutions, which are responsible for uploading all students' data including students' personal information, courses, courses, skills, grades, and certificates. By using these details, a complete profile of the student can be created, which will be beneficial during both the education and recruitment processes.

These data are saved in the Blockchain which guarantees the security and confidentiality of the data and prohibits other parties from altering it.

After storing the student's data, the educational institutions have to make an important step which is verification. The educational institutions verify all the stored data to be available to other parties to access it and use it in the next steps.

The second component is represented by former employers, who upload information about the employee's resume, qualifications, and work

history to the blockchain. This information is later made available to new employers, ensuring that it is not fraudulent. By having access to all of these specifics, especially certificates, and previous work history, the identification of the student's information can be assisted.

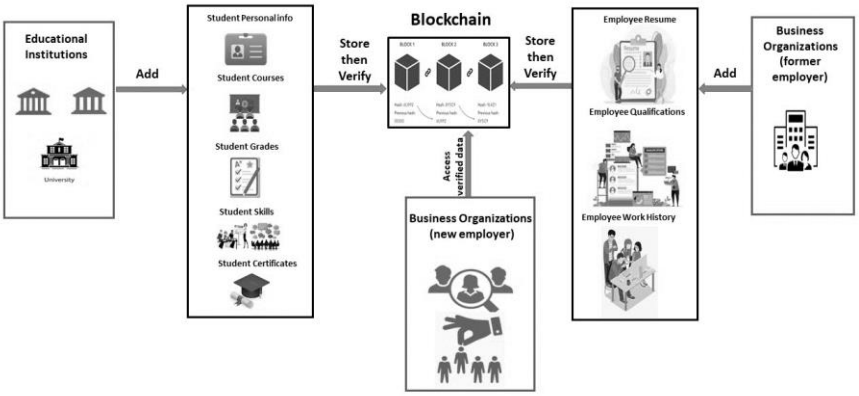
The third component of the framework is when new employers ask for access to and deal with previously stored data on the blockchain. Before this step, a verification procedure is conducted on the data provided by educational institutions and former employers, which is a crucial step in the framework. This ensures that the information is accurate and has not been tampered with.

The new framework presented in this section provides a solution for ensuring the accuracy and security of student information during the education and recruitment processes. By utilizing blockchain technology, the framework guarantees that the data is secure, confidential, and tamper-proof. This is extremely helpful for both the educational and recruitment processes, as it allows new employers to access a comprehensive profile of the student, including educational qualifications and work experience, which can assist them in making informed hiring decisions. Additionally, it confirms that no information has been tampered with and is accurate.

Table 1. List of Previous Studies

Paper	Platform	Personal Info.	Courses	Skills	Grades	Certificate	Resume	Work History	Qualifications
L. Liu et [5]al.	E2C-Chain	√	√	√	×	×	×	×	×
L. Liu et al. [6]	E2C-Chain	√	√	√	×	×	×	×	×
V. Juričić et al. [7]	Blockcert	√	√	×	×	√	×	×	×
H. Rhemananda et al. [8]	E-HRM (Technique)	√	√	×	×	√	√	×	×
F. Richter et al. [9]	Blockcert	√	√	×	√	√	×	×	×
R.A.Mishra et al. [10]	Decentralized App (DApp)using Ethereum	√	√	×	×	×	×	×	×
N.S.Dhanala et al. [11]	Ethereum, MySQL, and hyper ledger	√	√	×	×	×	×	√	√
W.Jeong et al.[12]	Bitcoin &Ethereum Blockcerts platform	√	√	×	×	√	×	×	×
M.Baldi et al. [13]	Blockcerts-Open Badges	√	√	×		√	×	×	×
B.V. Praveen Kumar et al.[14]	New not named	√	×	×	×	√	×	√	√
Proposed Framework		√	√	√	√	√	√	√	√

Fig. 1 Proposed Framework



Implementation of the proposed framework

The process of implementing the proposed framework is carried out in two stages:

- Implementation of framework diagrams
- Blockchain implementation & development

A. Framework Overview Diagrams

The proposed framework will be implemented by building the blockchain architecture, then creating the blockchain functions like mining the blockchain, validating the blockchain, making the transactions, decentralizing the blockchain, and connecting the nodes.

The components of a recruitment blockchain, which include the main contributors like students, employers, and educational institutions, are shown in Fig. 2. It also shows the transactions that should be implemented in the recruitment blockchain. These transactions include adding the student's personal information, skills, certificates, and work experience.

B. Blockchain Implementation & Development

In the first step, we build the blockchain with all its components using an application called Anaconda IDE, which is an open-source distribution of the Python and R programming languages for data science and has many components or tools to work with blockchain. It was built using the programming languages Python 3.9 and Spyder 5.1.5, which is the Scientific Python Development Environment, and a free integrated development environment (IDE) that is included with Anaconda.

There are some requirements to be installed before building the blockchain which are:

- Flask: a small and lightweight Python web framework that provides useful tools and features that make creating web applications in Python easier and allows to us use blockchain online by using any server.
- Requests module: this allows us to send HTTP requests using Python and has several built-in methods to make HTTP requests to specified URI using GET, POST, PUT, PATCH, or HEAD requests like adding new transactions in blockchain or connecting nodes.
- Postman: an interactive tool for verifying the APIs of the project. Postman is a Google Chrome app for interacting with HTTP APIs. It is a friendly GUI for constructing requests and reading responses, it helps us to make interactions with the blockchain to make requests needed.

The creation of the blockchain will be executed in two steps:

Step one: build the blockchain structure.

The blockchain was made in the form of a class called (class Blockchain), inside this class were made some methods and some properties to be used later more than once if needed.

To build the blockchain class there are some libraries used:

- DateTime library was used in the creation of the blockchain because each block in the blockchain has a timestamp, the date on which the block is created or mined.
- Hashlib library was used to hash the blocks, using the hash function.
- JSON library Inside this library there is a dumps function which was used to encrypt the blocks, there is also a Jsonify function to get the information of the created block in a JSON format such as the block index, the block proof, and the previous hash linked to the new block.
- Flask library that was used to build a web application to test the functions created in the blockchain

Fig. 4 shows the code for Blockchain class creation, and its functions such as create_block, get_previous_block, and proof _of _work.

Step two: Making Blockchain

Some functions are made inside the Blockchain class to get the status of the blockchain and to mine new blocks, such as:

- Mine_block

This function is used to add a new block to the blockchain, as shown in Fig. 5, which shows the code written in Python to create the mine_block function.

Fig. 6 demonstrates the result of implementing the mine_block function on the Postman application.

Fig. 7 shows the code used in creating the get_chain function that is used for getting the blockchain.

As shown in Fig. 8 this is the result of implementing the get_chain function and returning the chains.

Fig. 9 shows the implementation of the is_valid function that is used to check the blockchain's validation before completing the next functions.

- Connect_node function

This function is used to make the connection between nodes which are (educational institutes, recruiting employers, and previous employers) as shown in Fig. 10 which shows the code written in Python to create the connect_node function.

- Add_transaction function

As shown in Fig. 11 there are many transactions between nodes in the blockchain such as showing certificates, show skills, and showing previous work.

Fig. 2 Blockchain Components of the proposed framework

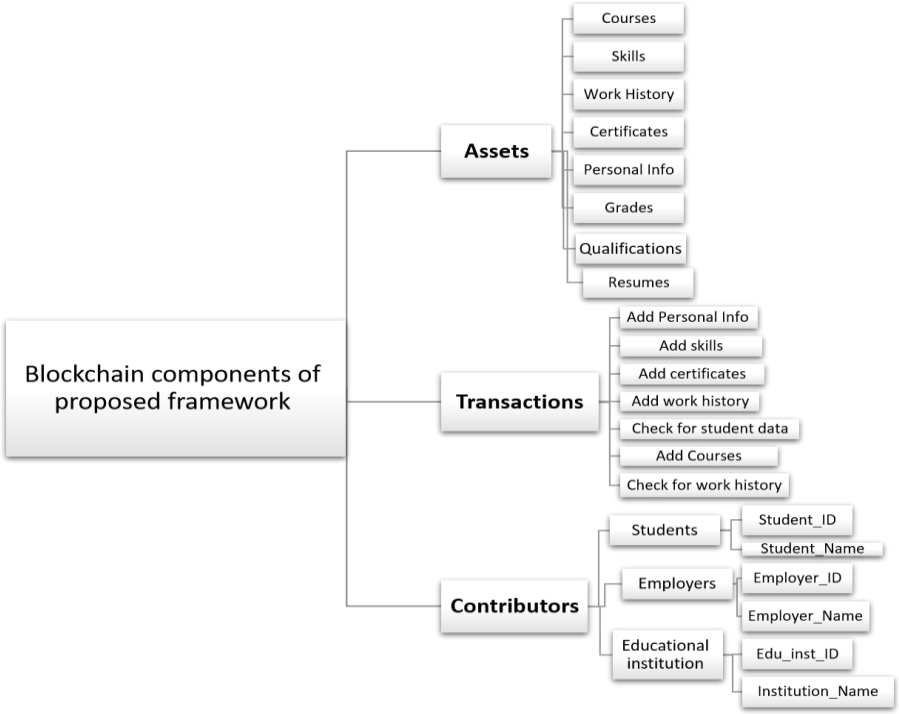


Fig. 3 Class Diagram

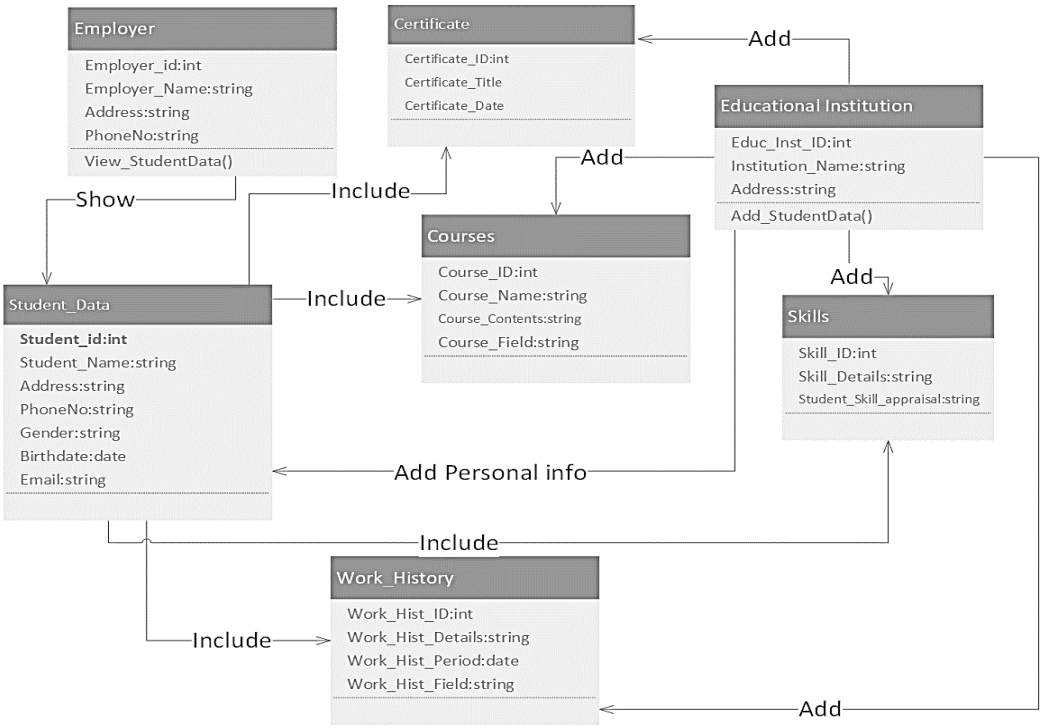


Fig. 4 Blockchain Building

```
import datetime
import hashlib
import json
from flask import Flask, jsonify

# Part 1 (Building a Blockchain)

class Blockchain:

    def __init__(self):
        self.chain = []
        self.build_block(proof = 1, previous_hash = '0')

    def build_block(self, proof, previous_hash):
        block = {'index': len(self.chain) + 1,
                 'timestamp': str(datetime.datetime.now()),
                 'proof': proof,
                 'previous_hash': previous_hash}
        self.chain.append(block)
        return block

    def get_previous_block(self):
        return self.chain[-1]

    def proof_of_work(self, previous_proof):
        new_proof = 1
        check_proof = False
        while check_proof is False:
            hash_operation = hashlib.sha256(str(new_proof**2 - previous_proof**2).encode()).hexdigest()
            if hash_operation[:4] == '0000':
                check_proof = True
            else:
                new_proof += 1
        return new_proof
```

Fig. 5 mine_block function

```
# Mining a new block
@app.route('/execute_mine_block', methods = ['GET'])
def execute_mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.execute_hash(previous_block)
    block = blockchain.build_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!',
                'index': block['index'],
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash']}
    return jsonify(response), 200
```

Fig. 6 Result of implementing the mine_block function

Pretty Raw Preview Visualize JSON


```
{
"index": 5,
"message": "Congratulations, you just mined a block!",
"previous_hash": "ad56a361c1798883029fa888d82e5b94985c145d98063e153b960ea14eda38da",
"proof": 8018,
"timestamp": "2022-03-27 15:52:22.406073"
}
```


Fig. 7 get_chain function

```
@app.route('/get_chain', methods = ['GET'])
def get_chain():
    response = {'chain': blockchain.chain,
                'length': len(blockchain.chain)}
    return jsonify(response), 200
```

Fig.8 Returned chains

Pretty Raw Preview Visualize JSON


```
"chain": [
    {
        "index": 1,
        "previous_hash": "0",
        "proof": 1,
        "timestamp": "2022-03-27 15:21:43.137350"
    },
    {
        "index": 2,
        "previous_hash": "faa4789be8abc205e041a3432188fda6285236a07109471b5601b1af2e9bd635",
        "proof": 533,
        "timestamp": "2022-03-27 15:30:02.197036"
    },
    {
        "index": 3,
        "previous_hash": "f52ffef727335f2bbdcb27bcfc9a79021a169f854e02839d3613295db1308d04",
        "proof": 45293,
        "timestamp": "2022-03-27 15:30:07.437898"
    },
```

Technical papers submitted for publication must advance the state of knowledge and must cite relevant prior work.

1) The length of a submitted paper should be commensurate

Fig. 9 is_valid function

```
@app.route('/is_valid', methods = ['GET'])
def is_valid():
    is_valid = blockchain.is_chain_valid(blockchain.chain)
    if is_valid:
        response = {'message': 'All good. The Blockchain is valid.'}
    else:
        response = {'message': 'Houston, we have a problem. The Blockchain is not valid.'}
    return jsonify(response), 200
```

Fig. 10 connect_node function

```
app.config['JSONIFY_PRETTYPRINT_REGULAR'] = False
@app.route('/connect_node', methods = ['post'])
def connect_node():

    json = request.get_json()
    nodes = json.get('nodes')
    if nodes is None:
        return "No node", 400
    for node in nodes:
        blockchain.add_node(node)
    response = {'message': 'All the nodes are now connected. The Hadcoin Blockchain now contains the following nodes:
                'total_nodes': list(blockchain.nodes)}
    return jsonify(response), 201
```

Fig. 11 Transactions


```
{
"index": 4,
"message": "Congratulations, you just mined a block!",
"previous_hash":"82a1590e7715bd507ace2f160bc257b68dd6d56d4b6a1c2f987001de86f2",
 "proof": 21391,
"timestamp": "2021-09-30 20:00:40.282738",
"transactions": [
{"data": 1,
 "receiver": "Recruiting Employer",
"sender": "3e0ba9d14dd44ccb9f7a61d33aef0532"
}
{"data": "show certificates",
 "receiver": " Recruiting Employer ",
"sender": "3e0ba9d14dd44ccb9f7a61d33aef0532"
}
{"data": "show skills",
"receiver": " Recruiting Employer ",
"sender": "3e0ba9d14dd44ccb9f7a61d33aef0532"
}
{"data": "show previous work",
"receiver": " Recruiting Employer ",
"sender": "3e0ba9d14dd44ccb9f7a61d33aef0532"
}
]
```

Conclusion

In conclusion, a blockchain-based framework for integrated higher education and recruitment information has the ability to change the way that students, universities, and employers interact and share information.

By providing a secure and transparent platform for storing and sharing data, this framework can help to streamline the recruitment process, increase the efficiency of academic verification, and promote fair and equal opportunities for all students.

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