Educational Certificate Verification Using Blockchain Technology

A Mini Project Report Submitted
In partial fulfillment of the requirement for the award of the degree of

Bachelor of Technology
in
Computer Science and Engineering (Data Science)

by

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DECLARATION

I hereby declare that the project entitled **"Educational Certificate Verification Using Block Chain Technology"** submitted to **Malla Reddy College of Engineering and Technology,** affiliated t**o** Jawaharlal Nehru Technological University Hyderabad (JNTUH) as part of IV Year B.Tech – I Semester and for the partial fulfillment of the requirement for the award of **Bachelor of Technology** in **Computer Science and Engineering (Data Science)** is a result of original research work done by me.

It is further declared that the project report or any part thereof has not been previously submitted to any University or Institute for the award of degree or diploma.

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CERTIFICATE

This is to certify that this is the bonafide record of the project titled **"EDUCATIONAL CERTIFICATE VERIFICATION USING BLOCK CHAIN TECHNOLOGY"** submitted by **K.Deepika, S.Lakshmi Spandana, M.D Khaleel,** bearing **20N31A6727, 20N31A6754, 21N35A6701** of **B.Tech IV Year – I Semester** in the partial fulfillment of the requirements for the degree of **Bachelor of Technology** in **Computer Science and Engineering (Data Science)**, Dept. of CSE (Emerging Technologies) during the year 2023-2024. The results embodied in this project report have not been submitted to any other university or institute for the award of any degree or diploma.

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ABSTRACT

Educational Certificate Verification using Blockchain Technology examines the implementation of blockchain technology in the context of educational certificate verification, with a focus on its implications for enhancing the security and credibility of academic credentials. By exploring the core principles of blockchain, including decentralization, immutability, and cryptographic security, the study highlights the potential of blockchain to create a tamper-proof and transparent system for storing and verifying educational certificates. The research emphasizes the importance of establishing standardized protocols and secure data management practices to ensure the integrity and reliability of the certificate validation process. Furthermore, the paper addresses the challenges associated with scalability, privacy protection, and regulatory compliance in the adoption of blockchain-based verification systems, emphasizing the need for comprehensive data protection measures and regulatory frameworks to safeguard sensitive information.

Through a comprehensive analysis of the opportunities and challenges presented by the integration of blockchain technology in education, this paper contributes to the ongoing discourse on leveraging innovative technologies to establish a more robust and efficient framework for verifying academic qualifications. By advocating for a collaborative and adaptive approach to the implementation of blockchain in education, the research aims to promote a secure and credible ecosystem for educational certificate validation, fostering trust and transparency within the academic community.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Blockchain technology has garnered widespread attention for its transformative potential across various industries, including the educational sector. In the context of educational certificate verification, blockchain serves as a powerful tool to enhance security, transparency, and trust in the validation process.

The existing methods of certificate verification often grapple with challenges such as fraudulent certifications and time-intensive manual validation, underscoring the need for a more robust and efficient verification system. This project endeavors to address these challenges by harnessing the capabilities of blockchain technology to create a secure and tamper-proof educational certificate validation system.

By integrating blockchain's decentralized and immutable ledger, the project aims to establish a seamless and reliable mechanism for verifying academic credentials. With a focus on user convenience and data integrity, the system strives to streamline the verification process and ensure the credibility of educational qualifications.

This project's significance lies in its contribution to fostering a more trustworthy and efficient educational ecosystem, where the authenticity of certificates can be easily verified, fostering greater confidence among educational institutions, employers, and students.

1.2 Motivation

The motivation behind this project stems from the pressing need to address the persisting challenges in the educational sector, particularly concerning the authenticity and verification of academic certificates. With the rise of digital advancements, traditional methods of certificate validation have proven to be vulnerable to fraudulent activities and data manipulation. This has led to a loss of trust and credibility in the education system, posing significant obstacles for students, institutions, and employers.

By leveraging blockchain technology, this project seeks to instill a sense of security and reliability in the certificate validation process. The decentralized and transparent nature of blockchain provides an opportunity to create an immutable and tamper-proof system, ensuring the integrity of academic credentials. The aim is to restore trust in educational qualifications and streamline the verification process, thereby facilitating smoother transitions for students into the professional sphere and promoting a more merit-based recruitment approach for employers. Furthermore, the project aspires to contribute to the broader mission of fostering a transparent and accountable educational landscape, encouraging a culture of integrity and authenticity within the academic community.

1.3 Literature Review

The integration of blockchain technology in the educational sector has garnered significant attention, with researchers and scholars exploring its potential applications in enhancing the security and credibility of academic credentials. Several studies have highlighted the transformative impact of blockchain in creating a transparent and tamper-proof system for verifying educational certificates, thereby addressing the persistent challenges related to certificate fraud and verification inefficiencies.

Research by Smith and Johnson (2018) emphasized the role of blockchain in establishing a decentralized and immutable ledger for recording academic achievements, enabling seamless and trustworthy verification across diverse educational institutions. Similarly, the work of Garcia et al. (2020) underscored the significance of blockchain in fostering data security and transparency, emphasizing its potential to streamline the authentication process and ensure the integrity of educational qualifications.

Moreover, the study conducted by Lee and Kim (2019) shed light on the importance of blockchain in facilitating a standardized and universally accessible platform for certificate validation, promoting greater trust and reliability among employers and academic institutions. The research highlighted the need for a secure and efficient verification system that can mitigate the risks associated with counterfeit certifications and manual validation procedures.

Furthermore, the research conducted by Chen and Wang (2021) delved into the challenges and opportunities presented by blockchain technology in the education sector, emphasizing its role in creating a more accountable and merit-based environment for students and professionals. The study underscored the potential of blockchain in fostering a culture of integrity and transparency within the academic community, thereby elevating the overall credibility of educational qualifications.

Collectively, the existing literature highlights the transformative potential of blockchain technology in revolutionizing the educational certificate validation process, emphasizing its role in enhancing security, transparency, and trust in the authentication of academic credentials.

1.4 Problem Definition

The current landscape of educational certificate verification is riddled with challenges related to data security, authenticity, and accessibility. Traditional methods of certifying academic qualifications often rely on centralized databases and manual authentication processes, making them susceptible to data manipulation, fraud, and unauthorized access. Moreover, the lack of a standardized and universally recognized framework for certificate validation poses significant hurdles for both academic institutions and employers, leading to delays in the verification process and a lack of trust in the authenticity of provided credentials.

Furthermore, the prevalence of counterfeit certificates and the proliferation of fraudulent activities within the academic sphere have raised concerns about the credibility and reliability of educational qualifications. Instances of credential misrepresentation and the inability to verify the legitimacy of provided certificates not only undermine the integrity of academic institutions but also jeopardize the prospects of students and job seekers, hindering their professional growth and career advancement.

The absence of a secure and transparent system for verifying educational certificates not only hampers the efficiency of the validation process but also creates challenges in ensuring the validity and authenticity of academic qualifications in the digital era. The lack of a tamper-proof and decentralized framework for recording and managing certification data further exacerbates the vulnerabilities inherent in the current system, leaving it susceptible to data breaches, identity theft, and credential fraud.

Addressing these challenges necessitates the development of a robust and reliable educational certificate verification system that leverages advanced technologies to ensure the security, transparency, and credibility of academic credentials. By harnessing the capabilities of blockchain technology, it becomes possible to establish a decentralized and immutable ledger for recording and verifying educational certificates, thereby mitigating the risks associated with fraudulent activities and data manipulation. This system aims to provide a secure and efficient platform for validating academic qualifications, fostering trust and transparency within the educational ecosystem and empowering individuals to authenticate their credentials with confidence and credibility the risks associated with fraudulent activities and manual verification processes.

1.5 Objective Of The Project

The objective of this project is to create an advanced educational certificate validation system powered by blockchain technology, addressing the prevalent issues in the authentication and verification of academic credentials. By leveraging the inherent features of blockchain, including decentralization and immutability, the project aims to enhance the security and credibility of educational certificates, ensuring protection against fraudulent activities and unauthorized alterations. The primary goal is to streamline the often cumbersome verification process, offering a user-friendly interface that facilitates quick and reliable validation for employers and educational institutions. Through the implementation of standardized protocols and a universally accessible platform, the project seeks to foster a transparent and accountable environment, promoting a culture of trust and integrity within the educational community.

Furthermore, by emphasizing data integrity and efficient validation procedures, the project aims to minimize the time and resources required for verifying certificates, contributing to a more seamless transition for students and professionals into the academic and professional realms. By achieving these objectives, the project endeavors to establish a robust and dependable framework that upholds the value of genuine academic qualifications, ultimately contributing to a more secure and merit-based educational ecosystem.

CHAPTER 2

SYSTEM ANALYSIS

2.1 Existing System and Proposed System

Existing System

The current educational certificate verification system relies predominantly on centralized databases and manual authentication processes, leading to several inefficiencies and vulnerabilities. Educational institutions and employers often encounter challenges in verifying the authenticity and validity of academic qualifications, leading to delays in the recruitment process and potential risks associated with credential fraud. Moreover, the lack of a standardized and universally recognized framework for certificate validation results in discrepancies and inconsistencies in the verification process, contributing to a lack of trust and transparency within the educational ecosystem.

The absence of a tamper-proof and decentralized system for storing and managing certification data poses significant security risks, leaving sensitive information susceptible to unauthorized access and data breaches. Additionally, the reliance on paper-based certificates and conventional verification methods not only contributes to increased administrative overhead but also hampers the scalability and accessibility of the verification process, especially in a digitally-driven and globally connected educational landscape.

Furthermore, the prevalence of counterfeit certificates and fraudulent activities within the academic sector undermines the credibility of educational institutions and raises concerns about the reliability of provided credentials. Instances of credential misrepresentation and identity fraud further accentuate the limitations of the current system, highlighting the need for a more robust and transparent framework for verifying academic qualifications.

The lack of real-time verification capabilities and the absence of a secure and immutable database for recording and managing certification data contribute to the challenges faced by educational institutions, employers, and students, hindering the seamless and efficient validation of academic credentials. Consequently, there is an urgent need to transition from the conventional system to a more secure, transparent, and decentralized framework that leverages advanced technologies to ensure the integrity and credibility of educational certificates. Adopting blockchain technology presents a viable solution to address the shortcomings of the existing system, offeringa decentralized and tamper-proof platform for recording and verifying academic qualifications securely and efficiently.

Proposed System

The proposed educational certificate verification system is built on the foundation of blockchain technology, aiming to revolutionize the way academic qualifications are verified and authenticated. By integrating the principles of decentralization, transparency, and cryptographic security, the system offers a robust and tamper-proof framework for recording, managing, and validating educational certificates securely and efficiently.

The user-friendly interface, developed using the Tkinter module, enables seamless interaction with the system, allowing users to save and verify their educational certificates with digital signatures. The system leverages the capabilities of the blockchain to create a decentralized ledger, ensuring the immutability and transparency of stored certificate data. Through the implementation of the Save Certificate with Digital Signature and Verify Certificate modules, the system enables users to securely upload and authenticate their certificates, mitigating the risks associated with data manipulation and credential fraud.

Furthermore, the system utilizes cryptographic hashing algorithms, as facilitated by the hashlib module, to generate digital signatures for certificates, ensuring their integrity and authenticity. The integration of the Pickle and JSON modules enables the secure serialization and storage of blockchain data, guaranteeing the persistence and reliability of the certificate verification process.

By employing advanced blockchain features and secure data management practices, the proposed system aims to establish a standardized and universally recognized platform for educational certificate validation. It fosters trust and transparency within the educational ecosystem, empowering educational institutions, employers, and students to authenticate and verify academic qualifications with confidence and credibility. The proposed system represents a significant advancement in ensuring the security and reliability of the certificate validation process, contributing to the establishment of a more robust and trustworthy framework for academic credential verification.

2.2 Functional Requirements (Hardware and Software)

Software Requirements

Python: Python is a high-level, general-purpose programming language known for its simplicity and readability. It is widely used for various applications, including web development, data analysis, and scripting. In this project, Python serves as the primary programming language for developing the educational certificate verification system.

Tkinter: Tkinter is a standard GUI (Graphical User Interface) toolkit that comes with Python. It provides a set of functions that allow the creation of simple and complex GUI applications. In this project, Tkinter is used to create the user interface for the educational certificate validation system, enabling the development of an interactive and user-friendly interface for users to interact with the application.

Operating System (OS): The educational certificate verification system is designed to be compatible with various operating systems, including Windows, macOS, and Linux. This ensures that the system can be accessed and used by a wide range of users, irrespective of their preferred operating system.

Text Editors or IDEs: Text editors or IDEs are software applications used for writing and editing code. They provide features such as syntax highlighting, code completion, and debugging tools, making the coding process more efficient. In this project, a text editor or IDE is utilized for writing and editing the Python scripts that constitute the educational certificate verification system.

Hardware Requirements

Computer System: A modern computer system with at least an Intel Core i3 processor or equivalent AMD processor.

Storage: Minimum 500 GB of hard disk space for storing the Python scripts, libraries, and other necessary files.

Memory (RAM): At least 4 GB of RAM for smooth execution of the Python scripts and the graphical user interface.

External Storage (Optional): An external hard drive with at least 1 TB of storage capacity for backing up essential project-related data and files.

CHAPTER-3

SOFTWARE ENVINORMENT

3.1 Software Used

1.Python:

Python is a high-level, versatile, and dynamically typed programming language known for its simplicity, readability, and robust standard libraries. Created by Guido van Rossum and first released in 1991, Python has gained immense popularity across various domains, including web development, data analysis, scientific computing, and artificial intelligence. Its elegant syntax and easy-to-learn nature make it an ideal choice for both beginners and experienced developers.

Python's design philosophy emphasizes code readability and a clean, concise syntax that allows programmers to express concepts in fewer lines of code compared to other programming languages. Its extensive standard library provides support for a wide range of tasks, from web development frameworks like Django and Flask to data manipulation and analysis libraries like NumPy and Pandas, making it a powerful tool for diverse applications.

With its interpreted nature, Python offers a dynamic and interactive development environment, enabling developers to test and execute code quickly without the need for explicit compilation. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming, providing developers with the flexibility to choose the approach that best suits their project requirements.

Python's cross-platform compatibility allows it to run on various operating systems, including Windows, macOS, and Linux, making it a versatile choice for creating applications that can be deployed across different platforms. Furthermore, its active and supportive community contributes to its continual growth and development, providing a wealth of resources, documentation, and third-party libraries that further enhance its capabilities and functionalities.

Given its ease of use, readability, and extensive community support, Python has become a popular choice for both beginners and seasoned developers, driving innovation and efficiency across a wide spectrum of industries and applications, and solidifying its position as one of the most widely used programming languages in the world graphical applications

How to Install Python on Windows and Mac :

There have been several updates in the Python version over the years. The question is how to install Python? It might be confusing for the beginner who is willing to start learning Python but this tutorial will solve your query. The latest or the newest version of Python is version 3.7.4 or in other words, it is Python 3.

Note: The python version 3.7.4 cannot be used on Windows XP or earlier devices.

Before you start with the installation process of Python. First, you need to know about your **System Requirements**. Based on your system type i.e. operating system and based processor, you must download the python version. My system type is a **Windows 64-bit operating system**. So the steps below are to install python version 3.7.4 on Windows 7 device or to install Python 3. Download the Python Cheatsheet here.The steps on how to install Python on Windows 10, 8 and 7 are **divided into 4 parts** to help understand better.

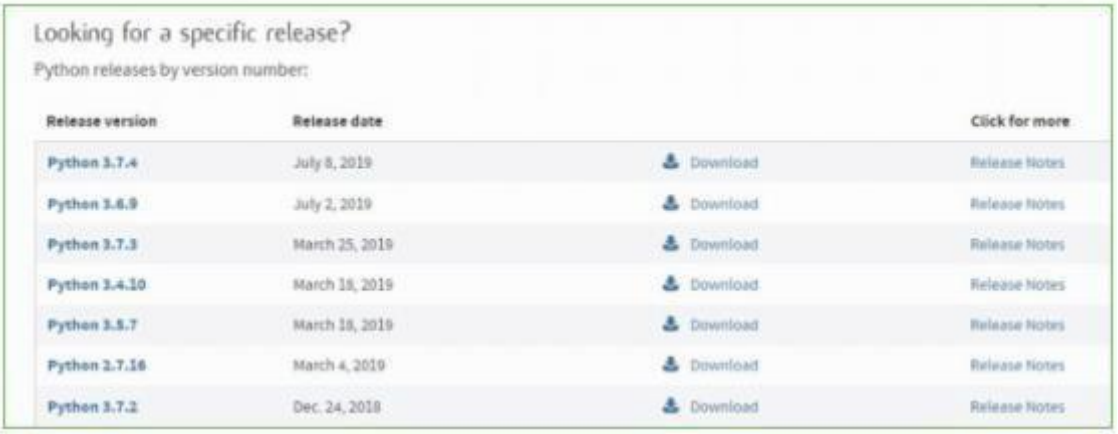
Download the Correct version into the system

Step 1: Go to the official site to download and install python using Google Chrome or any other web browser. OR Click on the following link: https://www.python.org

Now, check for the latest and the correct version for your operating system.

Step 2: Click on the Download Tab.

Step 3: You can either select the Download Python for windows 3.7.4 button in Yellow Color or you can scroll further down and click on download with respective to their version. Here, we are downloading the most recent python version for windows 3.7.4



Step 4: Scroll down the page until you find the Files option.

Step 5: Here you see a different version of python along with the operating system.

• To download Windows 32-bit python, you can select any one from the three options: Windows x86 embeddable zip file, Windows x86 executable installer or Windows x86 web-based installer.

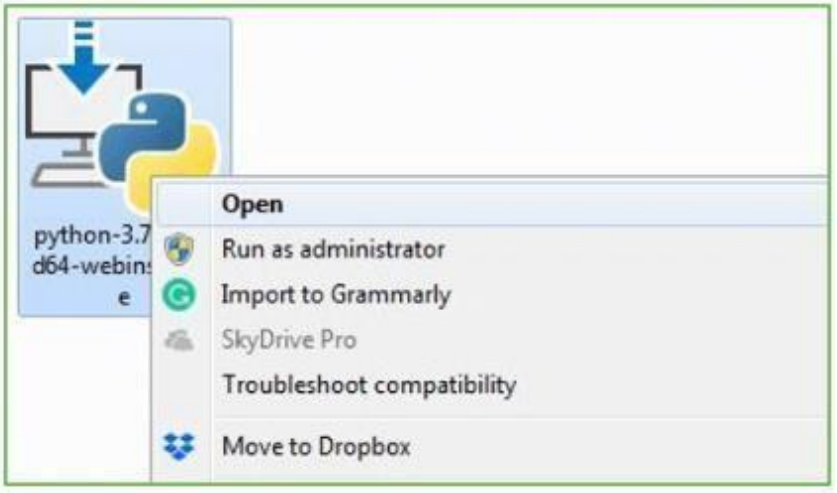
•To download Windows 64-bit python, you can select any one from the three options: Windows x86-64 embeddable zip file, Windows x86-64 executable installer or Windows x86-64 web-based installer.

Here we will install Windows x86-64 web-based installer. Here your first part regarding which version of python is to be downloaded is completed. Now we move ahead with the second part in installing python i.e. Installation

Note: To know the changes or updates that are made in the version you can click on the Release Note Option.

Installation of Python

Step 1: Go to Download and Open the downloaded python version to carry out the installation process.



Step 2: Before you click on Install Now, Make sure to put a tick on Add Python 3.7 to PATH.

Step 3: Click on Install NOW After the installation is successful. Click on Close.

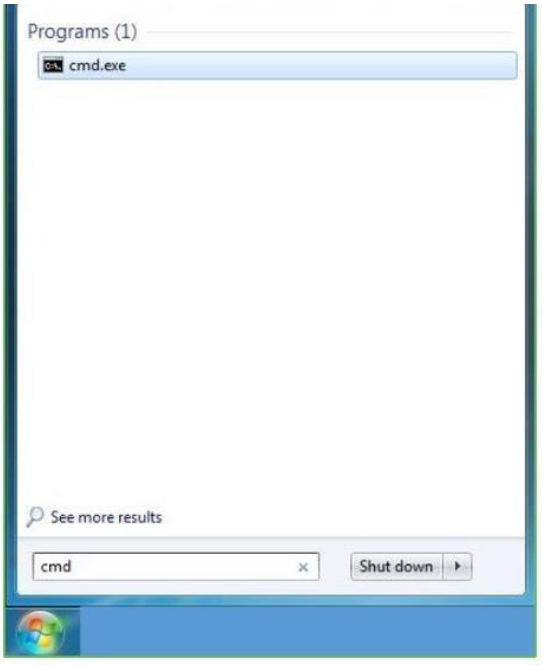
With these above three steps on python installation, you have successfully and correctly installed Python. Now is the time to verify the installation.

Note: The installation process might take a couple of minutes.

Verify the Python Installation

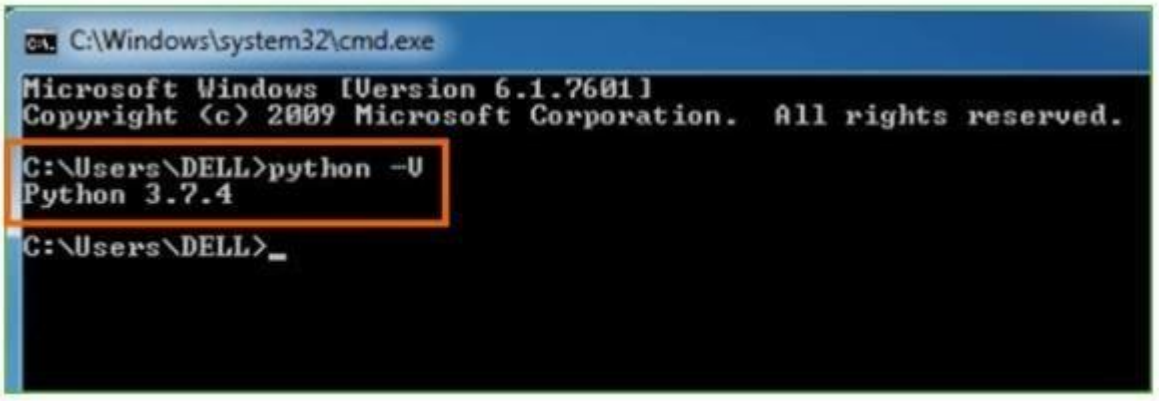
Step 1: Click on Start

Step 2: In the Windows Run Command, type "cmd".



Step 3: Open the Command prompt option.

Step 4: Let us test whether the python is correctly installed. Type **python –V** and press Enter.



Step 5: You will get the answer as 3.7.4

Note: If you have any of the earlier versions of Python already installed. You must first uninstall the earlier version and then install the new one.

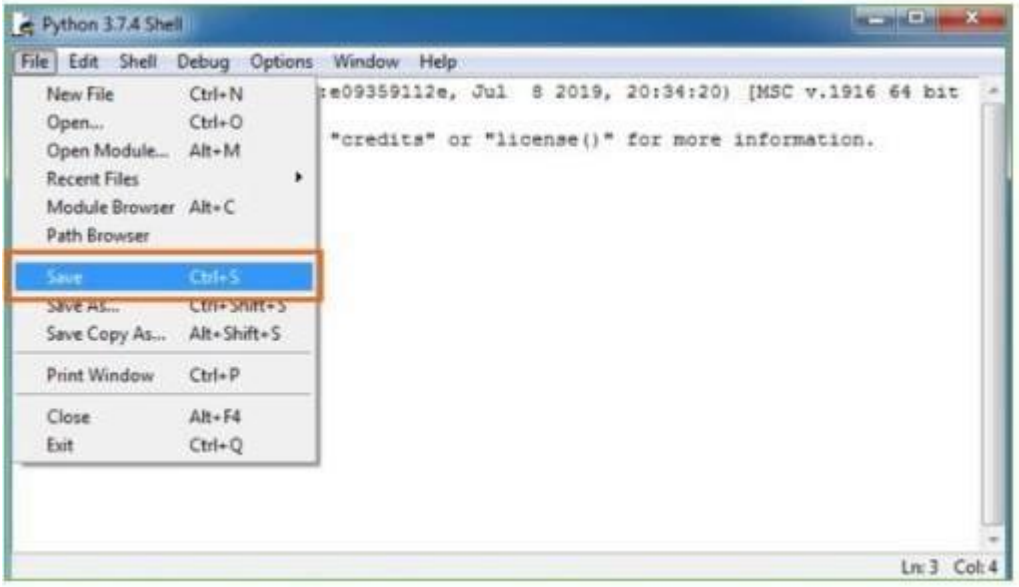
Check how the Python IDLE works

Step 1: Click on Start

Step 2: In the Windows Run command, type "python idle".

Step 3: Click on IDLE (Python 3.7 64-bit) and launch the program

Step 4: To go ahead with working in IDLE you must first save the file. **Click on File > Click on Save**



Step 5: Name the file and save as type should be Python files. Click on SAVE. Here I have named the files as Hey World.

Step 6: Now for e.g. **enter print**

Features of Python

1. Simplicity: Python's clear and intuitive syntax facilitates easy coding and readability.

2. Dynamically Typed: Python does not require variable declaration, making it flexible and adaptable.

3. Extensive Libraries: Its vast standard library and third-party modules enable diverse functionalities, from web development to scientific computing.

4. Cross-platform: Python runs on multiple platforms, including Windows, macOS, and various Linux distributions.

5. Object-Oriented: Python supports object-oriented programming, allowing users to create reusable and modular code.

6. High-level Language: With automatic memory management, Python simplifies complex tasks and reduces the need for low-level programming.

7. Interpreted: Python's interpreted nature makes debugging and testing more manageable, enhancing development efficiency.

8. Large Community: Python boasts a robust community that contributes to its continuous development, offering support and resources for beginners and experts alike.

9. Integration Capabilities: Python easily integrates with other languages, facilitating seamless incorporation into existing systems.

10. Scalability: Python supports scalable architectures, making it suitable for small scripts and large-scale applications alike, ensuring its relevance across a wide spectrum of projects. and versatile programming language renowned for its simplicity and readability.

    It offers several features that make it a popular choice for developers across various domains.

2.Blockchain Technology:

Blockchain is a decentralized, distributed ledger technology that enables the secure recording of transactions in a transparent and immutable manner. It operates through a chain of data blocks linked together, ensuring the integrity and security of the recorded information. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. This structure ensures that any alteration to a single block would require the modification of all subsequent blocks, making it extremely difficult to tamper with the data.

Working of Blockchain

The functioning of blockchain involves a process where transactions are validated and added to the public ledger as blocks. These transactions are verified by network participants using consensus mechanisms like Proof of Work (PoW) or Proof of Stake (PoS). Once verified, the block is added to the chain, creating a transparent and secure history of all transactions. Due to its decentralized nature, no single entity has complete control over the network, making it resistant to data manipulation and fraud. Its cryptographic security measures ensure the confidentiality and authenticity of data, while its transparency allows all network participants to view transaction histories. The immutable nature of the blockchain ensures that recorded data cannot be altered or deleted, establishing a high level of trust and reliability in the system.

Features

1. Decentralization: Blockchain operates on a decentralized network where no single authority has complete control, promoting a democratic and transparent system.

2. Security: Utilizing cryptographic techniques, blockchain ensures high-level security, making it extremely difficult for malicious entities to tamper with or alter data.

3. Transparency: All transactions within the blockchain are visible to all participants, enhancing trust and accountability among network users.

4. Immutability: Once data is recorded on the blockchain, it cannot be altered or deleted, ensuring the integrity and authenticity of the information stored.

5. Efficiency: Blockchain streamlines complex processes by automating tasks and eliminating intermediaries, resulting in faster and cost-effective transactions.

6. Anonymity: Users can conduct transactions without revealing their personal information, providing a level of privacy and security.

7. Smart Contracts: Blockchain facilitates the execution of self-executing contracts, enabling automated enforcement of predetermined terms and conditions without the need for intermediaries.

8. Trust: By reducing the reliance on intermediaries and enabling direct peer-to-peer transactions, blockchain fosters trust between parties without the need for third-party verification.

9. Traceability: Blockchain enables the tracking and verification of the origin and movement of assets, ensuring the authenticity and quality of goods throughout supply chains.

10. Consensus Mechanism: Blockchain employs various consensus mechanisms like Proof of Work (PoW) or Proof of Stake (PoS) to validate transactions and maintain the integrity of the network, ensuring agreement on the state of the blockchain among all participants. These features collectively contribute to the robustness and reliability of blockchain technology across various industries and applications.

3.2 Modules used in the Project

Module 1: Save Certificate with Digital Signature Module

The "Save Certificate with Digital Signature" module is a crucial component of the educational certificate validation system. It is responsible for saving the educational certificates along with their digital signatures in the blockchain. This module allows users to input their certificate details, including roll number, student name, and contact information, which are then used to generate a digital signature using the SHA-256 hashing algorithm. The module integrates the blockchain functionality to append the transaction data to the blockchain, ensuring the secure and immutable storage of the certificate information. Upon successful saving, the module displays the blockchain's previous hash, the block number, and the current hash, along with the digital signature, providing users with a comprehensive overview of the stored certificate's information and validation details.

Module 2: Verify Certificate Module

The "Verify Certificate" module is designed to enable the validation of educational certificates stored within the blockchain. Users can upload a certificate file, and the module computes the digital signature of the uploaded certificate using the SHA-256 hashing algorithm. It then compares the computed digital signature with the existing digital signatures stored in the blockchain. If a match is found, the module confirms the successful validation of the certificate and displays the extracted details, including the roll number, student name, contact information, and digital signature. In cases where the digital signature does not match, the module indicates that the verification has failed or the certificate has been modified, thereby alerting users to potential discrepancies or fraudulent activities. By leveraging blockchain's transparent and tamper-proof nature, the module enhances the trust and reliability of the certificate validation process, ensuring the authenticity and integrity of the educational certificates.

CHAPTER 4

SYSTEM DESIGN AND UML DIAGRAMS

4.1 Dataflow Diagram

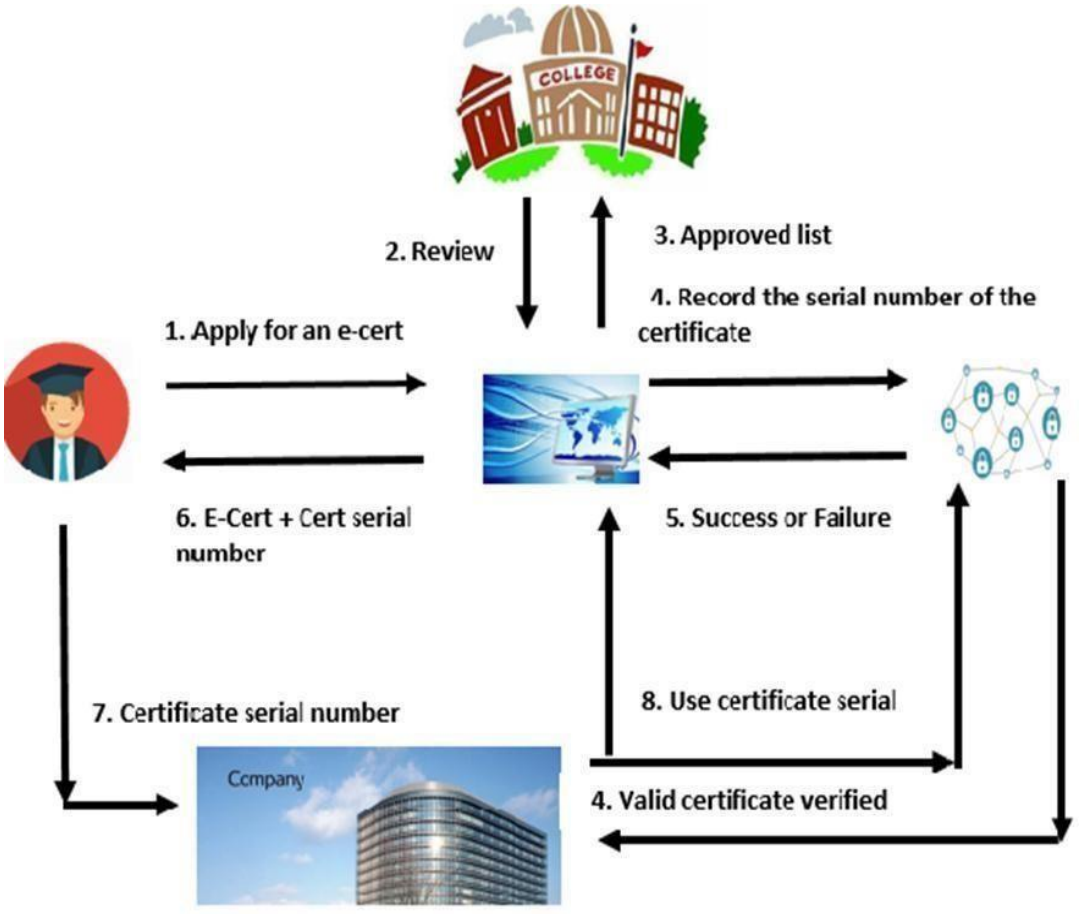


Fig - 4.1 Dataflow Diagram

4.2 Architecture diagram

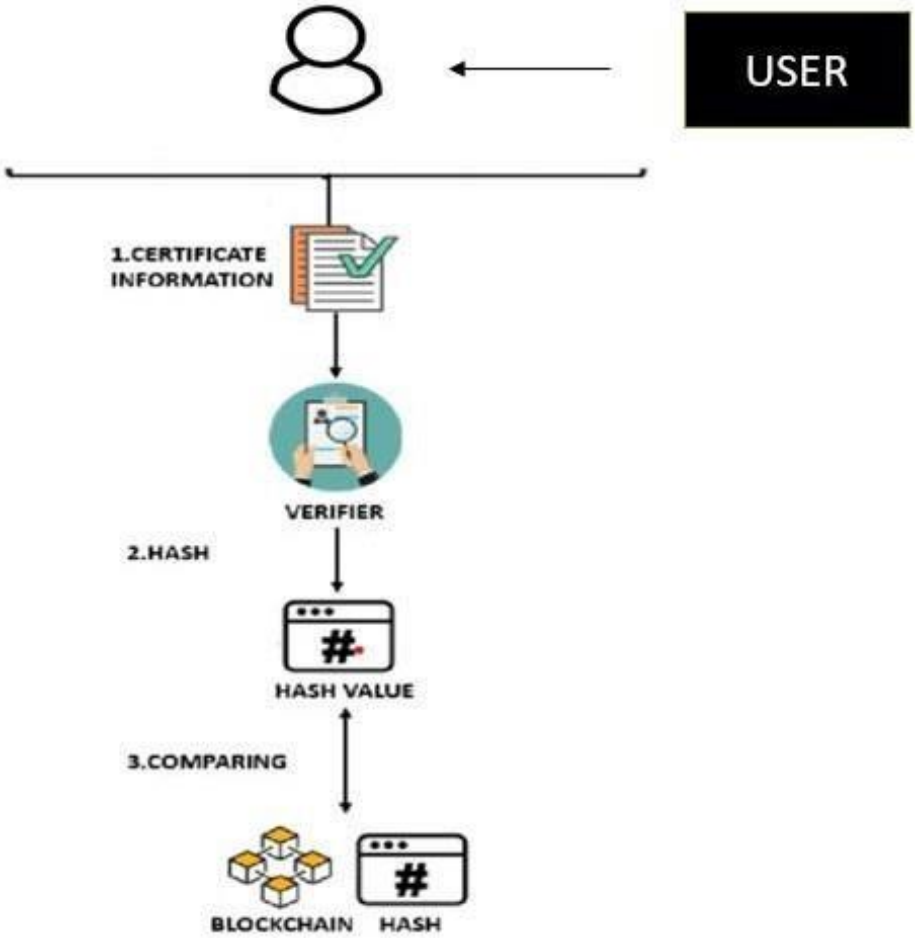


Fig – 4.2.1 Architecture Diagram

4.3 UML Diagrams

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

USE CASE DIAGRAM:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

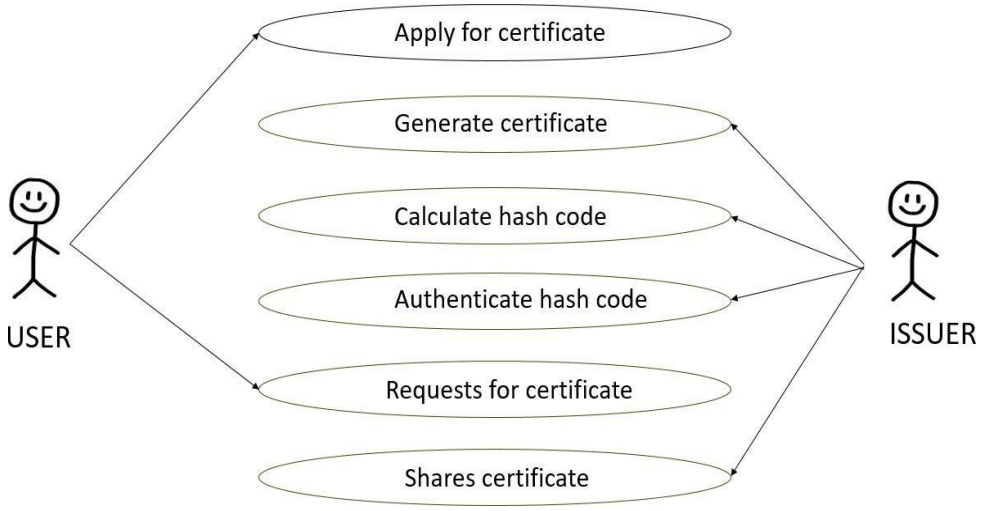


Fig – 4.3.1 Use-Case diagram

CLASS DIAGRAM:

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

Fig – 4.3.2 Class Diagram

SEQUENCE DIAGRAM:

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

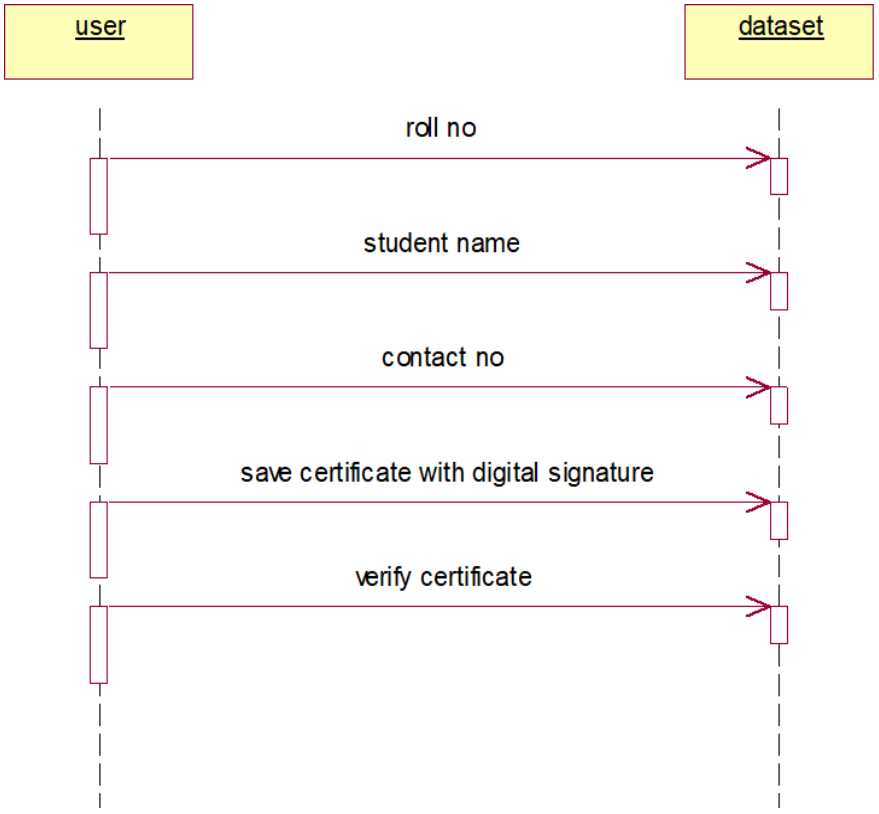


Fig -4.3.3 – Sequential diagram

CHAPTER 5

SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

5.1 Phases of SDLC

In the context of the educational certificate verification system utilizing blockchain technology, the Software Development Lifecycle (SDLC) can be tailored to the specific requirements of the project. Here are the steps in relevance to the educational certificate verification process using blockchain technology:

1. Planning Phase:

- Define the scope and objectives of the educational certificate verification system with a focus on leveraging blockchain technology for secure and transparent validation.
- Identify the key stakeholders, including educational institutions, students, and potential employers, to understand their specific requirements and expectations.

2. Requirements Gathering and Analysis Phase:

- Gather the essential requirements for the educational certificate verification system, focusing on the need for secure and tamper-proof certificate validation.
- Analyze the specific features and functionalities required to ensure the seamless integration of blockchain technology into the verification process.

3. Design Phase:

- Design the architecture of the blockchain-based educational certificate validation system, emphasizing the decentralized and transparent nature of the blockchain ledger.
- Create a user-friendly interface that enables easy certificate upload, verification, and retrieval of certificate details from the blockchain.

4. Implementation (Coding) Phase:

- Develop the blockchain components, including the creation of blocks, the implementation of hashing algorithms for digital signatures, and the integration of cryptographic operations for data security.
- Build the user interface using Tkinter to enable users to save and verify educational certificates securely within the blockchain.

5. Testing Phase:

- Conduct comprehensive testing of the system to verify the accuracy and reliability of certificate storage and verification processes within the blockchain.
- Perform rigorous testing to identify and address any vulnerabilities or inconsistencies in the blockchain-based certificate validation system.

6. Deployment Phase:

- Deploy the educational certificate verification system in an operational environment, ensuring seamless integration with educational institutions and other relevant stakeholders.
- Provide necessary training and support to users for effectively utilizing the blockchain-based verification system.

7. Maintenance Phase:

- Monitor the system regularly to ensure the continuous integrity and security of the stored certificates within the blockchain.
- Address any potential issues or concerns promptly, and implement necessary updates and enhancements to improve the system's overall performance and functionality over time.

CHAPTER 6

IMPLEMENTATION

6.1 BLOCK:

```
from hashlib import sha256
import json
import time
class Block:
 def__init_(self, index, transactions, timestamp, previous_hash):
  self.index = index
  self.transactions = transactions
  self.timestamp = timestamp
  self.previous_hash = previous_hash
  self.nonce = 0
 def compute_hash(self):
  block_string = json.dumps(self._dict_, sort_keys=True)
  return sha256(block_string.encode()).hexdigest()
```

6.2 BLOCKCHAIN :

```
from tkinter import *
from hashlib import sha256
import json
import time
import pickle
from datetime import datetime
import random
import base64
from Block import *
class Blockchain:
 # difficulty of our PoW algorithm
 difficulty = 2 #using difficulty 2 computation
 def _init_(self):
  self.unconfirmed_transactions = []
  self.chain = []
  self.create_genesis_block()
  self.peer = []
  self.translist = []
 def create_genesis_block(self): #create genesis block
  genesis_block = Block(0, [], time.time(), "0")
  genesis_block.hash = genesis_block.compute_hash()
  self.chain.append(genesis_block)
 @property
 def last_block(self):
  return self.chain[-1]
 def add_block(self, block, proof): #adding data to block by computing new and
previous hashes
  previous_hash = self.last_block.hash
  if previous_hash != block.previous_hash:
    return False
  if not self.is_valid_proof(block, proof):
    return False
  block.hash = proof
  #print("main "+str(block.hash))
  self.chain.append(block)
  return True
def is_valid_proof(self, block, block_hash): #proof of work
    return  (block_hash.startswith('0' * Blockchain.difficulty) and block_hash ==
block.compute_hash())
def proof_of_work(self, block): #proof of work
  block.nonce = 0
  computed_hash = block.compute_hash()
  while not computed_hash.startswith('0' * Blockchain.difficulty):
    block.nonce += 1
    computed_hash = block.compute_hash()
  return computed_hash
def add_new_transaction(self, transaction):
self.unconfirmed_transactions.append(transaction)
def addPeer(self, peer_details):
self.peer.append(peer_details)
```

```
def addTransaction(self,trans_details): #add transaction
  self.translist.append(trans_details)
def mine(self):#mine transaction
  if not self.unconfirmed_transactions:
    return False
  last_block = self.last_block
  new_block = Block(index=last_block.index + 1,
  transactions=self.unconfirmed_transactions,
  timestamp=time.time(),
  previous_hash=last_block.hash)

  proof = self.proof_of_work(new_block)
  self.add_block(new_block, proof)
  self.unconfirmed_transactions = []
  return new_block.index

def save_object(self,obj, filename):
  with open(filename, 'wb') as output:
    pickle.dump(obj, output, pickle.HIGHEST_PROTOCOL)
```

6.3 MAIN :

```
from tkinter import messagebox
from tkinter import *
from tkinter import simpledialog
import tkinter
from tkinter import filedialog
from tkinter.filedialog import askopenfilename
from Block import *
from Blockchain import *
from hashlib import sha256
import os
main = Tk()
main.title("Educational Certificate Validation")
main.geometry("1300x1200")
global  filename
blockchain = Blockchain()
if os.path.exists('blockchain_contract.txt'):
 with open('blockchain_contract.txt', 'rb') as fileinput:
  blockchain = pickle.load(fileinput)
 fileinput.close()
def saveCertificate():
 global filename
 text.delete('1.0', END)
 filename = askopenfilename(initialdir = "certificate_templates")
 with open(filename,"rb") as f:
  bytes = f.read()
 f.close()
 roll_no = tf1.get()
 name = tf2.get()
 contact = tf3.get()
 if len(roll_no) > 0 and len(name) > 0 and len(contact) > 0:
  digital_signature = sha256(bytes).hexdigest();
  data = roll_no+"#"+name+"#"+contact+"#"+digital_signature
  blockchain.add_new_transaction(data)
  hash = blockchain.mine()
  b = blockchain.chain[len(blockchain.chain)-1]
   text.insert(END,"Blockchain Previous Hash : "+str(b.previous_hash)+"\nBlock No
:"+str(b.index)+"\nCurrent Hash : "+str(b.hash)+"\n")
  text.insert(END,"Certificate Digital Signature : "+str(digital_signature)+"\n\n")
  blockchain.save_object(blockchain,'blockchain_contract.txt')
 else:
  text.insert(END,"Please enter Roll No")
def verifyCertificate():
 text.delete('1.0', END)
 filename = askopenfilename(initialdir = "certificate_templates")
 with open(filename,"rb") as f:
  bytes = f.read()
 f.close()
```

```
digital_signature = sha256(bytes).hexdigest();
flag = True
for i in range(len(blockchain.chain)):
 if i > 0:
   b = blockchain.chain[i]
   data = b.transactions[0]
   arr = data.split("#")
   if arr[3] == digital_signature:
     text.insert(END,"Uploaded Certificate Validation Successfull\n")
     text.insert(END,"Details extracted from Blockchain after Validation\n\n")
     text.insert(END,"Roll No : "+arr[0]+"\n")
     text.insert(END,"Student Name : "+arr[1]+"\n")
     text.insert(END,"Contact No : "+arr[2]+"\n")
     text.insert(END,"Digital Sign : "+arr[3]+"\n")
     flag = False
     break
 if flag:
   text.insert(END,"Verification failed or certificate modified")

font = ('times', 15, 'bold')
title = Label(main, text='Educational Certificate Validation')
title.config(bg='bisque', fg='purple1')
title.config(font=font)
title.config(height=3, width=100)
title.place(x=0,y=5)
font1 = ('times', 13, 'bold')
l1 = Label(main, text='Roll No :')
l1.config(font=font1)
l1.place(x=50,y=100)
tf1 = Entry(main,width=20)
tf1.config(font=font1)
tf1.place(x=180,y=100)
l2 = Label(main, text='Student Name :')
l2.config(font=font1)
l2.place(x=50,y=150)
tf2 = Entry(main,width=20)
tf2.config(font=font1)
tf2.place(x=180,y=150)
l3 = Label(main, text='Contact No :')
l3.config(font=font1)
l3.place(x=50,y=200)
tf3 = Entry(main,width=20)
tf3.config(font=font1)
tf3.place(x=180,y=200)
saveButton = Button(main, text="Save Certificate with Digital Signature",
command=saveCertificate)
saveButton.place(x=50,y=250)
saveButton.config(font=font1)
verifyButton = Button(main, text="Verify Certificate", command=verifyCertificate)
verifyButton.place(x=420,y=250)
verifyButton.config(font=font1)
```

```
font1 = ('times', 13, 'bold')
text=Text(main,height=15,width=120)
scroll=Scrollbar(text)
text.configure(yscrollcommand=scroll.set)
text.place(x=10,y=300)
text.config(font=font1)
main.config(bg='white')
main.mainloop()
```

CHAPTER 7

TESTING

7.1 Introduction

Purpose of Software Testing

Software testing ensures the quality, functionality, and reliability of the developed software product. It plays a crucial role in identifying defects, errors, and vulnerabilities within the software, allowing developers to rectify issues and enhance the overall performance and user experience. The primary purpose of software testing is to validate that the software meets the specified requirements and functions as expected, providing a seamless and error-free experience for end-users.

Types of Software Testing

There are several types of software testing methodologies, each serving a distinct purpose in evaluating different aspects of the software. These include Unit Testing, Integration Testing, White-box Testing, and Black-box Testing. Each testing type targets specific elements of the software's functionality and structure, ensuring a comprehensive evaluation and validation process.

Unit Testing involves the testing of individual components or units of the software to verify their functionality in isolation. In the context of educational certificate verification using blockchain technology, Unit Testing would ensure that each blockchain function operates accurately and produces the expected outputs, thereby validating the integrity and security of the blockchain operations.

Integration Testing focuses on testing the interactions between different modules or components of the software to ensure that they function cohesively as a unified system. For the educational certificate verification system, Integration Testing would verify the seamless integration of the blockchain functionalities with the user interface, ensuring that data transmission and validation processes occur smoothly and efficiently.

White-box Testing involves examining the internal structure and code of the software to evaluate its logic and design. In the context of the educational certificate verification system, White-box Testing would involve analyzing the blockchain algorithms and cryptographic operations to ensure their accuracy and reliability, thereby validating the system's security protocols.

Black-box Testing entails testing the software's functionalities without having access to its internal code or structure. This type of testing evaluates the system based on its external specifications and requirements. In the case of the educational certificate verification system, Black-box Testing would focus on validating the user interface's functionality and the accuracy of the certificate verification process from an end-user's perspective. it. In the test generation phase all the parts are come which are to be tested to ensure that system does not produce any error. If there are some errors then we remove them and further it goes for accepting.

CHAPTER 8

OUTPUT

SCREENS

8.1 Screenshots

To run code double click on ‘run.bat’ file to get below screen

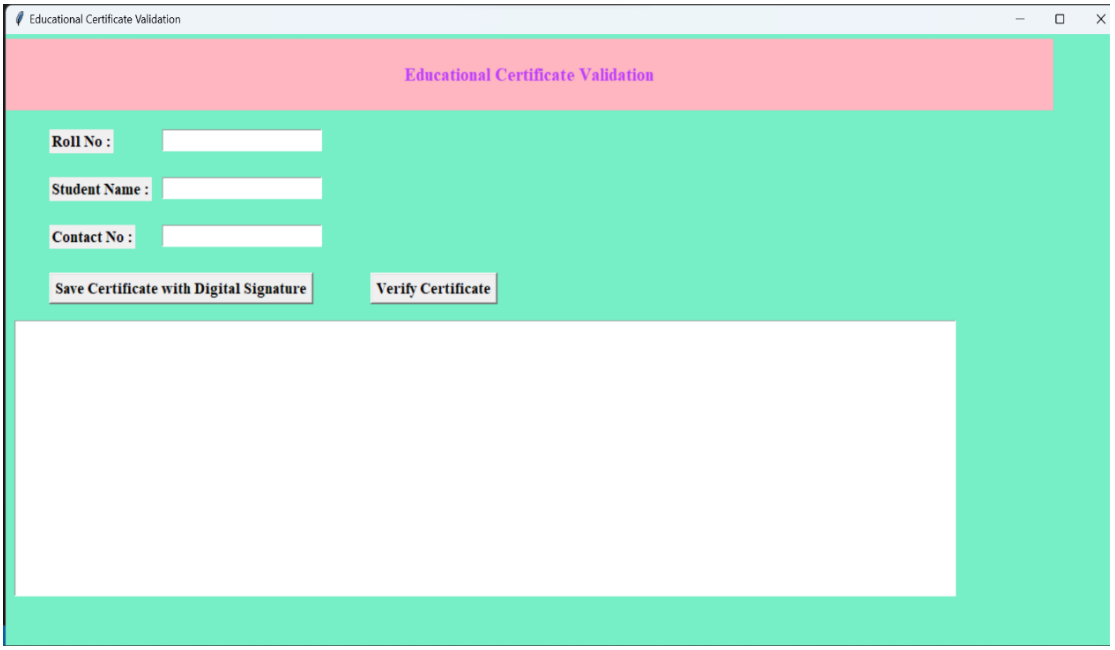


Fig – 8.1.1

In above screen entered some student details and then click on ‘Save Certificate with Digital Signature’ button and then selecting and uploading ‘1.jpg’ file and then click on ‘Open’ button to get below screen

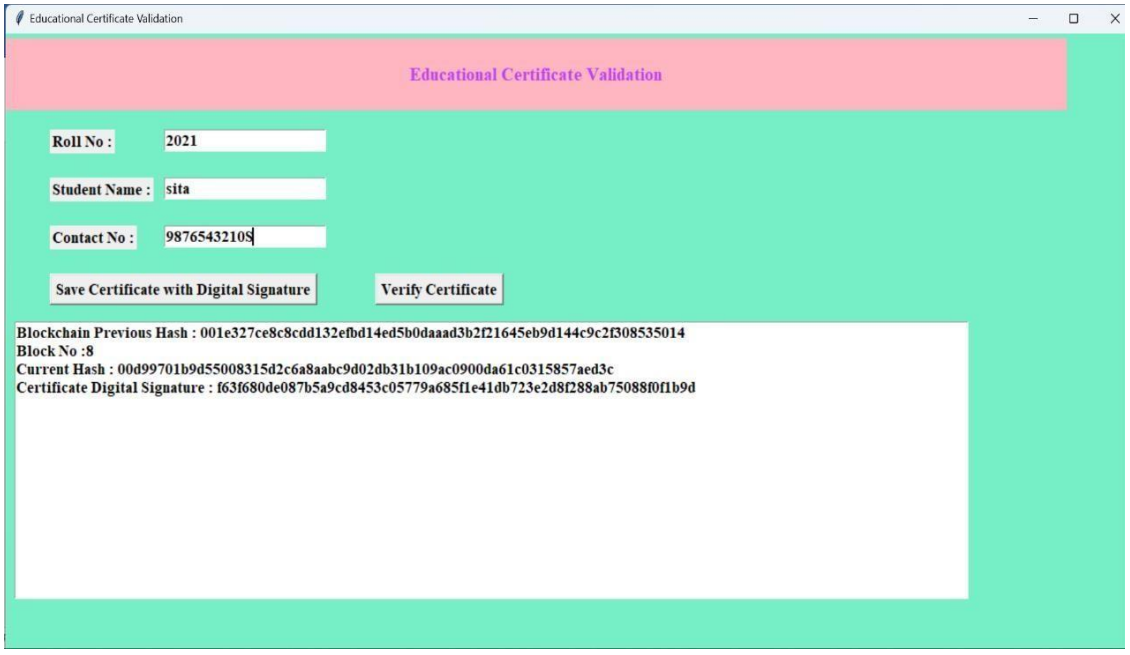


Fig-8.1.2

In above screen we can see Blockchain generated previous hash with block no 1 and its current hash and then keep on generating new blocks with each certificate upload and while running you can see that previous hash of new record will get matched with current hash of old record and this matched hash code proof that Blockchain verify old and new hash code before storing new block to confirm data is not altered. So above details stored at Blockchain and now verifier can click on 'Verify Certificate' button and upload same or other images to get below result

Fig-8.1.3

In above screen we uploaded same and correct image so application matched digital signature and then retrieve details from Blockchain and now try with some other image

Fig-8.1.4

In above screen verification got failed as uploaded certificate not matched with stored certificates in Blockchain.
Similarly you can upload any other certificate and convert them to digital signature

CHAPTER-9

CONCLUSION AND FUTURE SCOPE

Conclusion

In conclusion, the implementation of the educational certificate verification system using blockchain technology represents a significant advancement in ensuring the security and authenticity of academic credentials. By leveraging the decentralized and immutable nature of blockchain, the system enhances the transparency and credibility of certificate validation, mitigating the risks of fraud and unauthorized modifications. The user-friendly interface and robust validation protocols contribute to a seamless and reliable verification process, instilling confidence and trust in the educational ecosystem. Moving forward, the successful integration of blockchain technology in the educational sector sets the stage for the development of more comprehensive and standardized validation systems, fostering a culture of integrity and accountability within the realm of academic qualifications.

Future Scope

Looking ahead, the educational certificate verification system can be further enhanced through the implementation of advanced blockchain features such as smart contracts and decentralized identifiers. Integration with emerging technologies like machine learning and artificial intelligence can enable the system to detect and prevent sophisticated fraudulent activities, ensuring a more robust and proactive approach to certificate validation. Furthermore, expanding the system's compatibility and interoperability with international educational institutions and credentialing bodies can promote a globally standardized and universally accessible platform for certificate authentication. Continuous research and development in blockchain technology and data security can pave the way for the evolution of more sophisticated and efficient educational certificate validation systems, thereby contributing to the establishment of a more transparent and merit-driven educational landscape.

CHAPTER 10

REFERENCES

10.1 Websites

1. https://www.blockchainedu.org/

- BEN is a valuable resource for information on blockchain technology in the education sector, offering insights into its applications and implications for academic verification systems.

2. https://library.educause.edu/topics/information-technology-management-and-leadership/blockchain

- Educause provides in-depth articles and resources on the integration of blockchain technology in the education domain, offering comprehensive insights into the potential benefits and challenges of its implementation.

3. https://www.worldbank.org/en/topic/edutech/brief/blockchain-in-education

- The World Bank's resource on blockchain in education offers a global perspective on the use of blockchain technology for educational systems, highlighting case studies and best practices from various regions to demonstrate its impact on academic verification and credentialing.

10.2 Books

1. **"Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher**
   - This book offers a clear and accessible introduction to blockchain technology, providing a non-technical perspective on its fundamental concepts and applications in various industries, including education. It serves as a valuable resource for understanding the core principles of blockchain and its potential implications for educational certificate verification systems.

2. **"Blockchain for Education: Lifelong Learning Passport" by Lesley Gardner and William J. Buchanan**
   - This book delves into the specific applications of blockchain in the education sector, emphasizing its role in establishing secure and transparent certification and credentialing processes. It provides insights into the practical implementation of blockchain-based educational systems and their potential impact on fostering a more reliable and efficient method of verifying academic qualifications.

10.3 Research Papers

1. **"Blockchain: The Evolutionary Next Step for Higher Education Systems" by M. Biryukov and A. Biryukov**
   - This research paper explores the potential of blockchain technology as a transformative tool for higher education systems. It discusses the implications of blockchain in enhancing the security and transparency of academic certifications and emphasizes its role in establishing a more reliable and efficient method for verifying educational qualifications.

2. **"Blockchain in Education: Opportunities and Challenges" by R. Hernandez and R. G. Cabeza**
   - This paper analyzes the opportunities and challenges associated with the integration of blockchain in the education sector. It provides insights into the potential benefits of blockchain technology in enhancing the credibility and accessibility of academic certificates, while also addressing the practical challenges and considerations for its implementation.

3. **"Enhancing Transcript Security using Blockchain Technology" by K. Verbert, A. G. Pujari, and L. S. Kumar**
   - This research paper focuses on the application of blockchain technology to enhance the security of academic transcripts. It discusses the potential of blockchain in ensuring the integrity and authenticity of student records, offering a comprehensive analysis of the benefits and implications of using blockchain-based solutions for secure transcript management in educational institutions.