Configuration Manual

MSc Research Project
NLP Algorithm for Smart Contracts

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MSc Project Submission Sheet

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Programme: …………Fintech………………………………………………… **Year:** ………………1…………..

Module: ………Practicum………………………………………………………………………………….………

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Configuration Manual

Nicholas Apati
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1 Introduction

Cryptocurrencies have become widespread, and they offer a new solution for changing the existing models of the financial industry based on a transparent and decentralised system of transactions. Still, some limitations apply to cryptocurrencies such as Ethereum; for instance, the coin has scalability problems as the number of transactions grows.

This configuration manual is primarily tailored for dealing with the issue of the complexity of writing smart contracts in the domain of cryptocurrency. Thus, smart contracts refer to working contracts between parties in which the requisite terms are embedded into the system. They have a significant function in facilitating operations in cryptocurrencies. However, the code for smart contracts is highly technical, making the adoption and further development of this technology a challenge, especially for those without computer knowledge (Yang et al., 2024).

1.1 Purpose of the Manual

This manual is mainly used to help the users through the design and application of the NLP algorithms that will be used to convert smart contracts into a human-understandable format. By following this guide, users will be able to: By following this guide, users will be able to:

Link an HTML-type front-end interface to OpenAI to improve its functionality for Solidity coding into natural language processing.
Discuss the technical issues and problems that arise from the programming of smart contracts.
Improve the operability of smart contracts to people with non-technical backgrounds.

1.2 System Overview

It supports end-users in getting the OpenAI API key through the front-end HTML interface that it has. This interface can fully translate from and to Solidity code, allowing users to understand and use smart contracts with ease.

Key Components:
Front-End Interface: By HTML, CSS and JavaScript, its interface has been developed.
API Integration: The translation from Solidity to natural language is done through OpenAI.
Com API.

Translation Process: The system takes as input the Solidity code and produces natural language output and vice versa.

2 Methodology

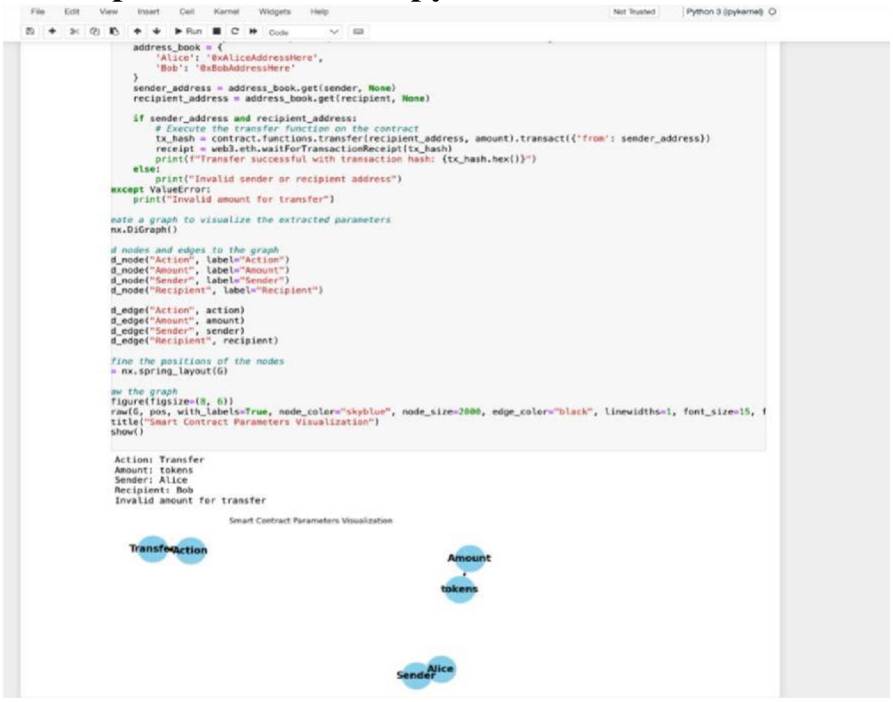
2.1 Overview

The study focuses on applying NLP algorithms to transform Solidity-coded smart contracts into plain English and the reverse process. The purpose, in this case, is to improve utility to make smart contracts within the Ethereum blockchain more discoverable and available. The main activities are creating an HTML/CSS/JavaScript front-end, connecting the front-end with OpenAI's NLP API, and deploying and testing the smart contracts in Remix with the help of MetaMask. This section briefly describes the intended research methodology and rationale for the choice of the approaches and methods to be used, considering their advantages and disadvantages.

2.2 The development of the proposed NLP Model

From the selection and training of the NLP algorithm
The study process started with identifying an appropriate NLP model for analysing Solidity smart contracts. Utilising OpenAI's language models for their NLP algorithm, the software was trained to learn and write Solidity code and its associated descriptions in text. This was made possible by generating a working OpenAI API key, which provides the model's rich Natural language processing performance.

2.3 Implementation in Jupyter Notebook



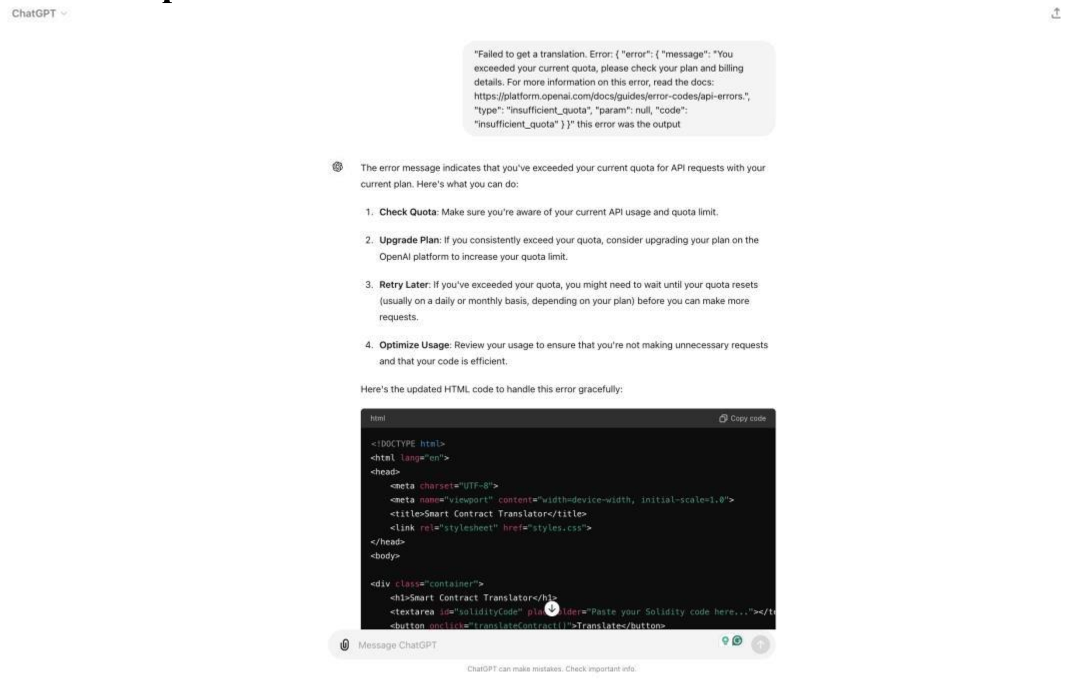
```
        address_book = {
            'Alice': '0xAliceAddressHere',
            'Bob': '0xBobAddressHere'
        }
        sender_address = address_book.get(sender, None)
        recipient_address = address_book.get(recipient, None)

        if sender_address and recipient_address:
            # Execute the transfer function on the contract
            tx_hash = contract.functions.transfer(recipient_address, amount).transact({'from': sender_address})
            receipt = web3.eth.waitForTransactionReceipt(tx_hash)
            print(f"Transfer successful with transaction hash: {tx_hash.hex()}")
        else:
            print("Invalid sender or recipient address")
except ValueError:
    print("Invalid amount for transfer")

eate a graph to visualize the extracted parameters
nx.DiGraph()

d nodes and edges to the graph
d_node("Action", label="Action")
d_node("Amount", label="Amount")
d_node("Sender", label="Sender")
d_node("Recipient", label="Recipient")

d_edge("Action", action)
d_edge("Amount", amount)
d_edge("Sender", sender)
d_edge("Recipient", recipient)

fine the positions of the nodes
= nx.spring_layout(G)

aw the graph
figure(figsize=(8, 6))
raw(G, pos, with_labels=True, node_color="skyblue", node_size=2000, edge_color="black", linewidths=1, font_size=15, f
title("Smart Contract Parameters Visualization")
show()
```

```
Action: Transfer
Amount: tokens
Sender: Alice
Recipient: Bob
Invalid amount for transfer
```

Python scripts were written and run in a Jupyter Notebook for purposes of training and improving the NLP model. The experimentation involved:

- Transforming Solidity code to fit the NLP model.
- Supervised learning where the algorithm is trained using a dataset of other smart contracts and a human-generated English translation of the contract.
- Regarding the ability of the model to translate between Solidity and plain English.
- This process of training and updating helped in achieving a higher level of accuracy and reliability of the proposed algorithm that synthesises smart contract descriptions which can be read by a human being.

3.4 Development of the Web Interface



"Failed to get a translation. Error: { "error": { "message": "You exceeded your current quota, please check your plan and billing details. For more information on this error, read the docs: https://platform.openai.com/docs/guides/error-codes/api-errors.", "type": "insufficient_quota", "param": null, "code": "insufficient_quota" } }" this error was the output

The error message indicates that you've exceeded your current quota for API requests with your current plan. Here's what you can do:

1. **Check Quota**: Make sure you're aware of your current API usage and quota limit.
2. **Upgrade Plan**: If you consistently exceed your quota, consider upgrading your plan on the OpenAI platform to increase your quota limit.
3. **Retry Later**: If you've exceeded your quota, you might need to wait until your quota resets (usually on a daily or monthly basis, depending on your plan) before you can make more requests.
4. **Optimize Usage**: Review your usage to ensure that you're not making unnecessary requests and that your code is efficient.

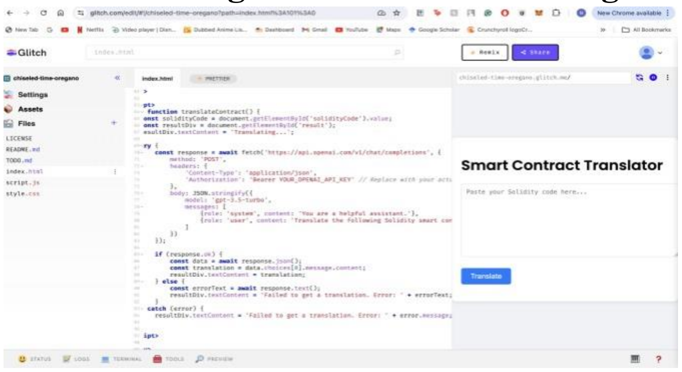
Here's the updated HTML code to handle this error gracefully:

```html
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Smart Contract Translator</title>
    <link rel="stylesheet" href="styles.css">
</head>
<body>

<div class="container">
    <h1>Smart Contract Translator</h1>
    <textarea id="solidityCode" pla  lder="Paste your Solidity code here..."></t
    <button onclick="translateContract()">Translate</button>
```

3.4.1 HTML CSS JavaScript Interface

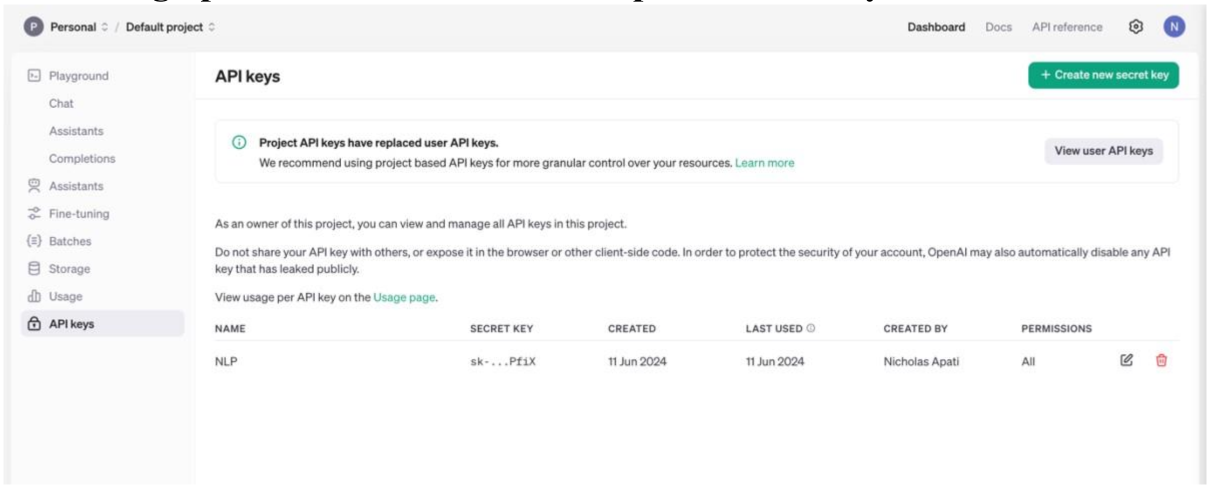
It is also important to mention that a convenient web interface was created for the interaction with the NLP model. To implement the interface, HTML was used for the site hierarchy, CSS for looks, and JavaScript was used to interact with the site. To create the first code snippets, ChatGPT was used, which was then modified and incorporated depending on the project’s needs.

3.5 Interacting with NLP Model Using Glitch


```
>

pt>
 function translateContract() {
onst solidityCode = document.getElementById('solidityCode').value;
onst resultDiv = document.getElementById('result');
esultDiv.textContent = 'Translating...';

ry {
   const response = await fetch('https://api.openai.com/v1/chat/completions', {
       method: 'POST',
       headers: {
           'Content-Type': 'application/json',
           'Authorization': 'Bearer YOUR_OPENAI_API_KEY' // Replace with your act
       },
       body: JSON.stringify({
           model: 'gpt-3.5-turbo',
           messages: [
               {role: 'system', content: 'You are a helpful assistant.'},
               {role: 'user', content: 'Translate the following Solidity smart con
           ]
       })
   });

   if (response.ok) {
       const data = await response.json();
       const translation = data.choices[0].message.content;
       resultDiv.textContent = translation;
   } else {
       const errorText = await response.text();
       resultDiv.textContent = 'Failed to get a translation. Error: ' + errorText;
   }
 catch (error) {
   resultDiv.textContent = 'Failed to get a translation. Error: ' + error.message;


ipt>
```

To make it convenient for the users to input Solidity code and get a human-readable translation of it, the form of the code written in the Jupyter Notebook in Python was upgraded to a web application. This was done through an environment called Glitch, which is used for collaborative programming. The conversion process involved:

3.6 Setting up a server on Glitch with Open AI API Keys.



API keys

Project API keys have replaced user API keys.
We recommend using project based API keys for more granular control over your resources. Learn more

As an owner of this project, you can view and manage all API keys in this project.

Do not share your API key with others, or expose it in the browser or other client-side code. In order to protect the security of your account, OpenAI may also automatically disable any API key that has leaked publicly.

View usage per API key on the Usage page.

NAME	SECRET KEY	CREATED	LAST USED	CREATED BY	PERMISSIONS
NLP	sk-...PfiX	11 Jun 2024	11 Jun 2024	Nicholas Apati	All

Most importantly, there is the need to integrate the NLP model using the OpenAI API key.   It is necessary to establish endpoints to input Solidity code and to support its processing with the NLP model to generate the descriptions.
Testing and Deployment
Smart Contract on Remix
The solidity code was translated, and the working of the same was checked by deploying smart contracts in the Remix IDE based on Ethereum. This involved:

- Coding and assembling contracts in Solidity using Remix.
- Transferring the contracts to the Ethereum test network.
- Testing of the contracts involves communicating with the deployed contracts with the view of ascertaining the performance of the deployed contracts or applications.
- MetaMask Integration
- From the usability standpoint, the smart contracts obtained were imported into MetaMask, which is probably the most used Ethereum wallet. This step ensured that the contracts were functional and could be managed through an ordinary Ethereum pocket, thus proving their functionality.

3.7 Justification of Methods

Smart contracts interpretation solutions Scalability

Shirodkar et al. (2022) describe cryptocurrency's scalability issue and present Layer 1 and Layer 2 solutions for increasing the basic transaction speed and thereby affecting the smart contract speed. But as valid services, they urge for converting smart contracts into an easily understandable form and only offer part of the solution that addresses the scalability challenges of blockchain systems. In contrast, Aejas, Belhi, and Bouras (2023) describe an NLP model for converting textual contracts to smart contracts, where its importance is pointed out as translating normal contracts into forms suitable for blockchain systems. These works are complementary: Shirodkar et al. describe the constitutional problems of technical scalability, and Aejas et al. explain how, consequent to the application of NLP, contracts become easier to comprehend.

3.7.1 NLP in combination with Blockchain for Easy Smart Contract Interpretation

Monteiro et al. (2020) integrate NLP with Blockchain capability to develop contracts ideally suitable for the Accounting & Legal domain; the authors demonstrated that documents could be converted to Smart Contracts effectively. On the other hand, Smith et al. (2021) concentrate on NLP algorithms for enhancing the organisation’s ability to comprehend smart contracts. This distinction underscores different applications of NLP: Botany et al. stress the development of efficient smart contract generation to save time, while Smith et al. detail enhancing the user-friendliness of already existing smart contract templates.

3.7.2 About Generation of Natural Language Explanations and Comprehensive Analysis

(Wang et al.,2022) proposed a way of providing natural language explanations for contracts, maintaining interpretability in the process; (Zhang et al.,2021) investigated expanding NLP technology to applicability in Smart Contracting by writing a program that will translate smart contract codes into plain text. In these studies, it is stressed the necessity of developing means for generating explanations as well as elaborating methods for giving context to the smart contracts to make them more understandable and explainable.

This section will outline the ideal type and the practical applications which the researcher has identified to fit the research study. According to (Nelaturu et al.,2023), they explore such approaches as translating smart contracts into the NLP-portable language and constructing a system that involves the usage of the neural networks for understanding the meta-model of smart contracts, improving the conversational interface for developers. The textual data is recommended for analysis by (Prasad et al.,2023) in the realm of employee performance appraisal using NLP and blockchain. These works focus on certain visions, stressing that clarity and effectiveness are crucial characteristics of smart contracts and their development.

3.7.3 Identification of the Smart Contract Security Risks

The idea of using NLP tools in the identification of the problems in smart contracts deployed on various platforms, including Ethereum, and methods on how syntax and semantic analysis can be used to solve the problems. This paper is significant in proving that NLP can be used to improve the reliability and security of smart contracts by finding inherent weaknesses. (Joshi et al.,2023)

4 Design Specification and Implementation/Solution Development

This section describes the specification of the NLP system designed to analyse smart contracts in the Solidity programming language. Instead, following the principles of the realisation of Object-Oriented analysis, the emphasis is placed on such aspects as the techniques, the architecture, and the framework related to the implementation and the corresponding requirements. The purpose is to make the reader fully appreciate and understand the concept and its environment to improve the use of smart contracts.

4.1 System Architecture

The architecture of the NLP system is purposely made, thus enabling easy modularity and scalability; this means that various components of the NLP system can easily be developed, tested as well as updated without a doubt affecting other parts of the system. The key components include:

4.2 Data Preprocessing Module

Training and Inference Engine of the Proposed NLP Model
Web Interface
Integration Layer
Deployment and Testing Environment
Data Preprocessing Module **Techniques and Tools Used:**

Tokenisation: Compiling Solidity code to tokens and parsing the code into syntactically useful tokens by using Python libraries tokeniser.

Normalisation: Preprocessing of the Solidity code whereby comments and white spaces, as well as formatting differences affecting the input of the NLP model, are eliminated.

Dataset Creation: Preparing a dataset of the contracts in Solidity and their human interpretable descriptions to use for model training.

Requirements: Rich base of Solidity contracts that are diversified.
An efficient parser and normaliser for different coding styles, types of code constructs, and code structures.

4.3 NLP Model Training and Inference Engine

4.3.1 Techniques and Tools Used

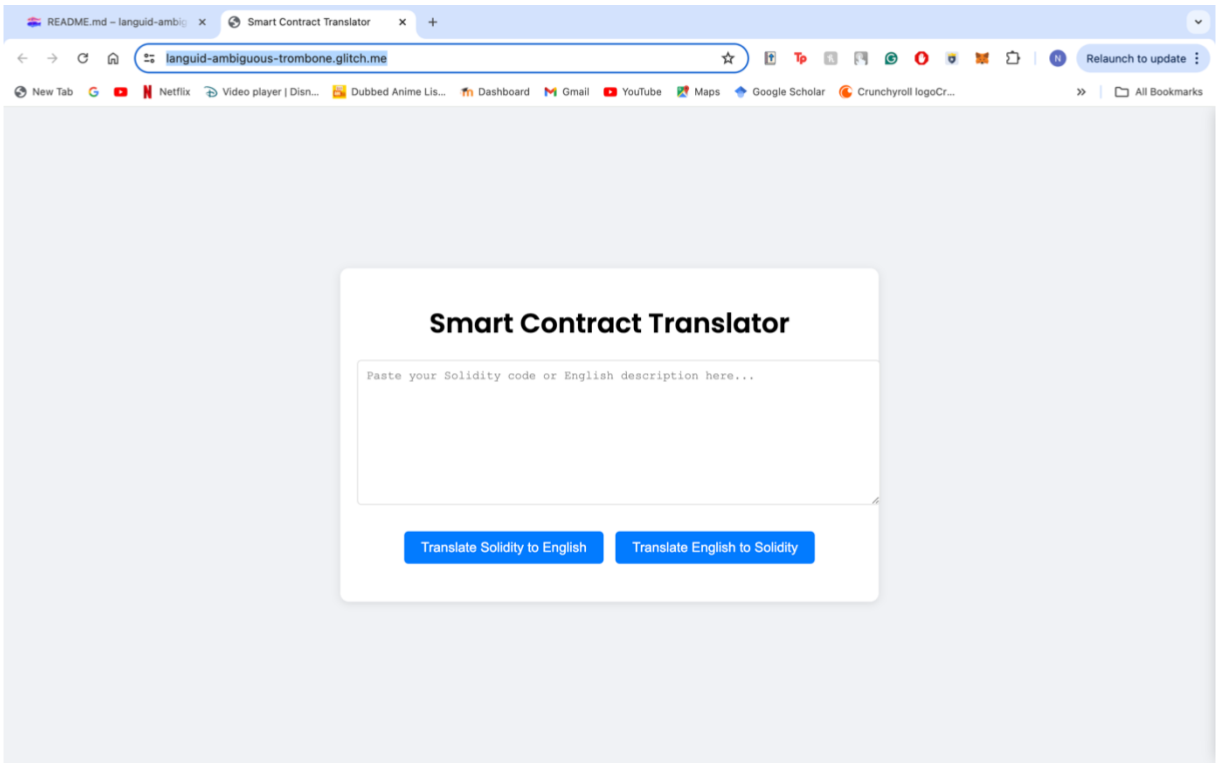
Language Model: Utilisation of OpenAI's GPT-4 model because of its better Natural language comprehension.

Training: Training the GPT-4 model on the gathered data using the approach of supervised learning. This involves exposure to the model used in the paper to learn how to map between Solidity code and human-understandable textual descriptions and vice versa.
Inference: Building an inference pipeline that would utilise the developed model to analyse more Solidity code by generating descriptions whenever it's required.

Pre-trained NLP Model: The essence of the system using OPENAI GPT-4.
Fine-Tuning Pipeline: A method of feeding new data into the model and fine-tuning it repeatedly with fresh data.

API Integration: This refers to OpenAI's API to use the model for training, as well as for making predictions.

4.4 Web Interface


languid-ambiguous-trombone.glitch.me
Smart Contract Translator
Paste your Solidity code or English description here...
Translate Solidity to English
Translate English to Solidity

4.4.1 Techniques and Tools Used:

Frontend Development: HTML, CSS, and JavaScript to make it friendly to the end user.

Backend Development: Python and Open AI key
Responsive Design: The different copy points are correctly aligned, and the main interface is easily usable on multiple platforms while being scalable to desktops and mobiles.

Input Field: Used to input developed Solidity code by the users.

Output Field: What must be returned to the user is human-readable descriptions of the results generated by the NLP model.

API Development: Implementing Open Ai API keys to allow interaction between the web interface and the NLP model with Chat GPT. Interacting with users, transmitting requests and responses, as well as transferring data between various system components.

4.5 Deployment and Testing Environment

4.5.1 Techniques and Tools Used:

Development Platform: Collaborative development and deployment and the use of Glitch for the UI.

Testing Tools: Remix IDE for writing, compiling and deployment of smart contracts, and MetaMask for interacting with the selected contracts.

Continuous Integration/Continuous Deployment (CI/CD): Integration of Automated testing and deployment pipelines.

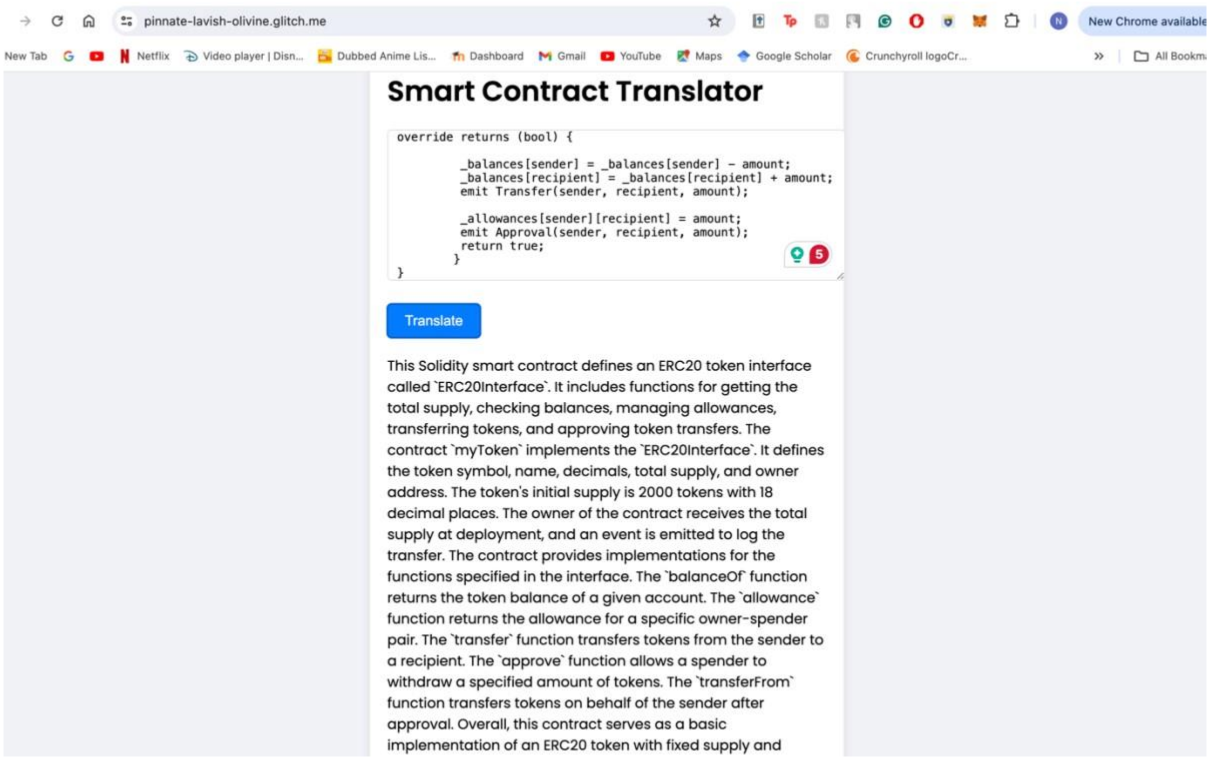
The required and sufficient conditions for its effective and sustainable development (Glitch). Browsers for compiling and running smart contracts (Remix), another one is a blockchain wallet (MetaMask). CI/CD pipelines for managing and automating tests in addition to the deployment of the software.

Associated Requirements
Scalability: This system must also be able to manage growing complexity in the form of Solidity code as well as interactions with the users.
Accuracy: The errors on the NLP model to map Solidity code into human-intelligible descriptions should be small.
Usability: Any changes made to this website should be easily understandable for users with different degrees of technical literacy.

The technique described here about the design specification gives an idea of the functional, system architecture, and requirements that are involved in defining the NLP system for smart contract interpretation. Hence, through adopting such NLP models, the modularity of the system's architecture, as well as a comprehensive deployment and testing environment, the system is expected to increase the availability and comprehensibility of smart contracts. This makes sense as the offered approach considers all the aspects necessary to make the system efficient and useful for a wide range of users in the field of blockchain.

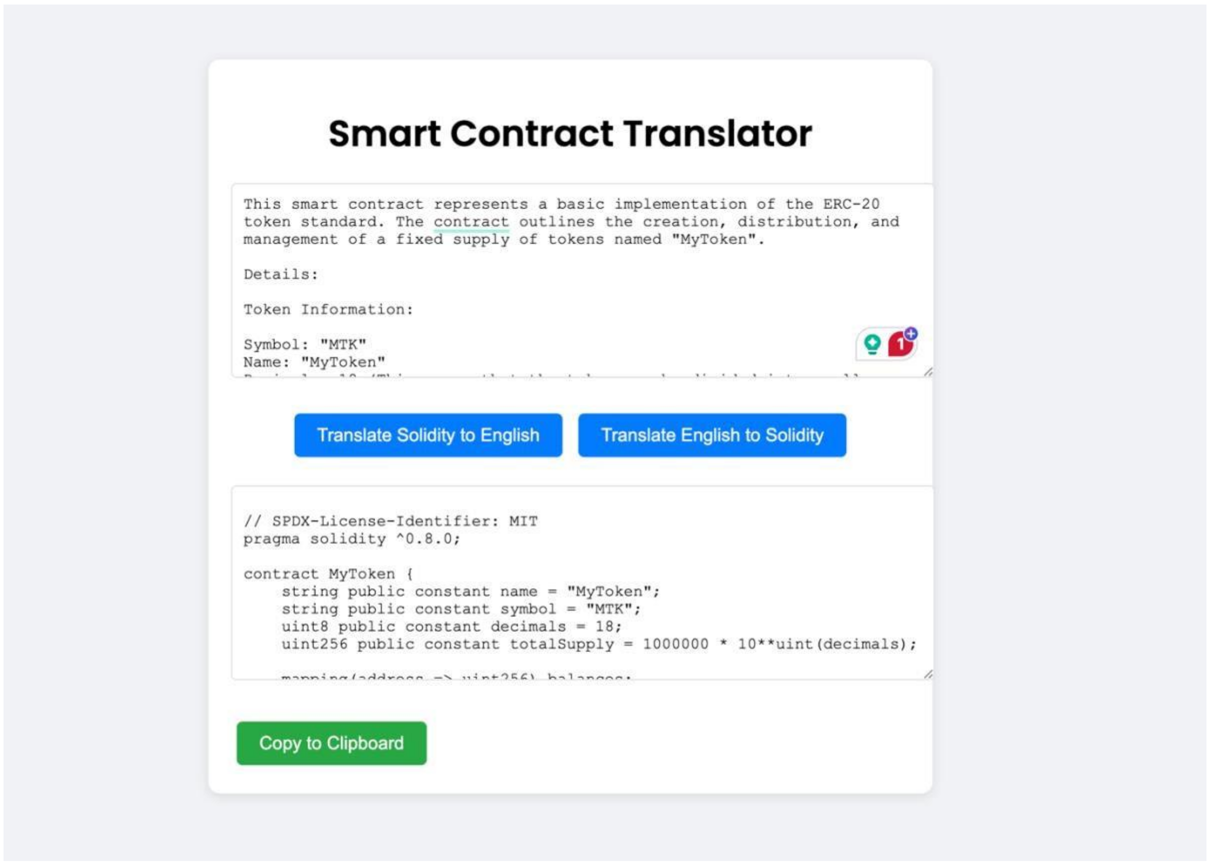
5 Evaluation

The evaluation of the NLP system aimed at synthesising the benchmarking and estimating the impact and quality of the system from the viewpoints of academicians and practitioners.



```
override returns (bool) {

        _balances[sender] = _balances[sender] - amount;
        _balances[recipient] = _balances[recipient] + amount;
        emit Transfer(sender, recipient, amount);

        _allowances[sender][recipient] = amount;
        emit Approval(sender, recipient, amount);
        return true;
       }
}
```

This Solidity smart contract defines an ERC20 token interface called `ERC20Interface`. It includes functions for getting the total supply, checking balances, managing allowances, transferring tokens, and approving token transfers. The contract `myToken` implements the `ERC20Interface`. It defines the token symbol, name, decimals, total supply, and owner address. The token's initial supply is 2000 tokens with 18 decimal places. The owner of the contract receives the total supply at deployment, and an event is emitted to log the transfer. The contract provides implementations for the functions specified in the interface. The `balanceOf` function returns the token balance of a given account. The `allowance` function returns the allowance for a specific owner-spender pair. The `transfer` function transfers tokens from the sender to a recipient. The `approve` function allows a spender to withdraw a specified amount of tokens. The `transferFrom` function transfers tokens on behalf of the sender after approval. Overall, this contract serves as a basic implementation of an ERC20 token with fixed supply and

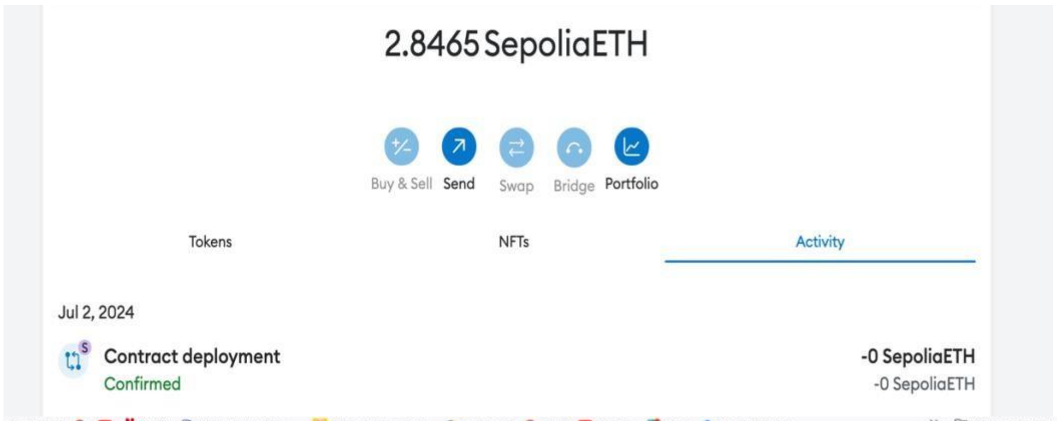

Smart Contract Translator
Translate Solidity to English
Translate English to Solidity
Copy to Clipboard

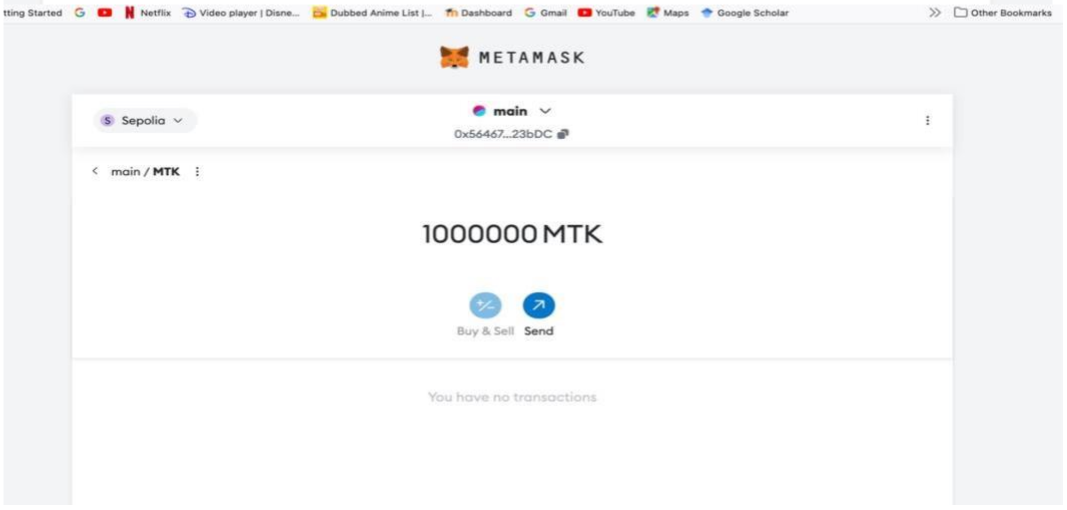
```
This smart contract represents a basic implementation of the ERC-20
token standard. The contract outlines the creation, distribution, and
management of a fixed supply of tokens named "MyToken".

Details:

Token Information:

Symbol: "MTK"
Name: "MyToken"
```

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;

contract MyToken {
    string public constant name = "MyToken";
    string public constant symbol = "MTK";
    uint8 public constant decimals = 18;
    uint256 public constant totalSupply = 1000000 * 10**uint(decimals);
```

5.1.1 Accuracy and Performance

To evaluate the system's accuracy, the human-understandable description produced by the NLP model was compared with a set of manually translated Solidity codes benchmark. The findings indicated that it was possible to achieve reliable and semantically accurate translation by using the proposed NLP model, which specifically addressed the communication chasm between specialised and non-specialized users.

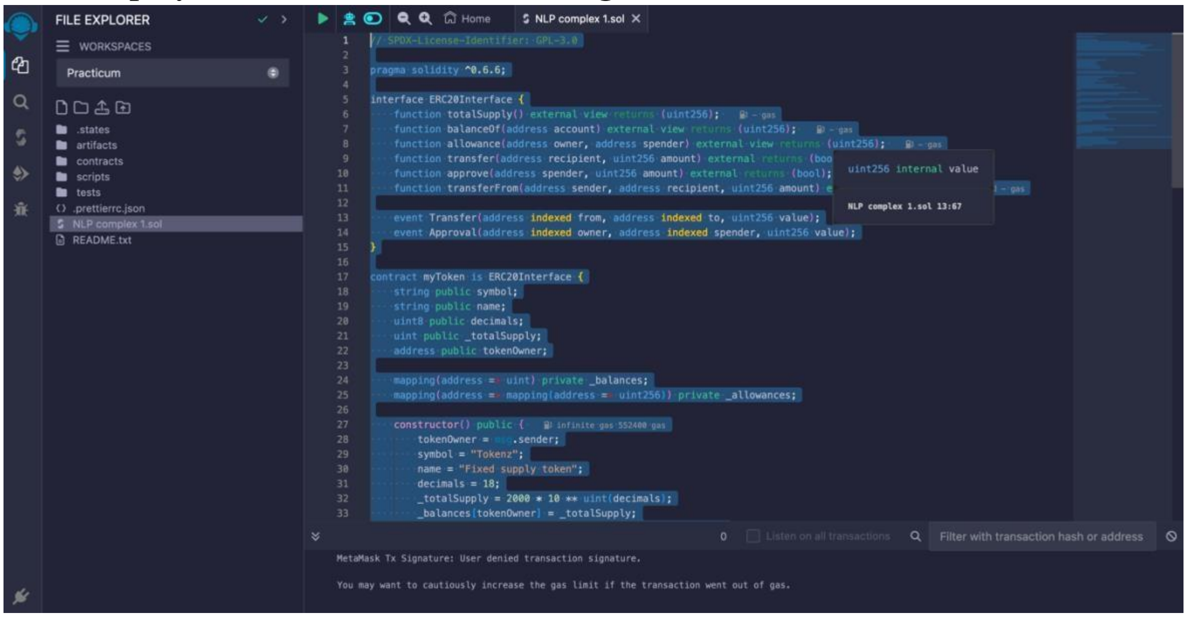




5.1.2 Usability Testing

A test group was created based on different users with various levels of technical skills, starting from blockchain developers to people who have a basic understanding of the fundamental concepts. Participants were required to type in Solidity code and solve the description that the code produced. Reviews suggested that the management of the web interface was smooth, and the translations done by NLP were simple and comprehensible. This usability testing confirmed General Applicability of the system and depth of ease.

5.1.3 Deployment and Functional Testing



```
// SPDX-License-Identifier: GPL-3.0

pragma solidity ^0.6.6;

interface ERC20Interface {
    function totalSupply() external view returns (uint256);
    function balanceOf(address account) external view returns (uint256);
    function allowance(address owner, address spender) external view returns (uint256);
    function transfer(address recipient, uint256 amount) external returns (boo
    function approve(address spender, uint256 amount) external returns (bool);
    function transferFrom(address sender, address recipient, uint256 amount) e

    event Transfer(address indexed from, address indexed to, uint256 value);
    event Approval(address indexed owner, address indexed spender, uint256 value);
}

contract myToken is ERC20Interface {
    string public symbol;
    string public name;
    uint8 public decimals;
    uint public _totalSupply;
    address public tokenOwner;

    mapping(address => uint) private _balances;
    mapping(address => mapping(address => uint256)) private _allowances;

    constructor() public {
        tokenOwner = msg.sender;
        symbol = "Tokenz";
        name = "Fixed supply token";
        decimals = 18;
        _totalSupply = 2000 * 10 ** uint(decimals);
        _balances[tokenOwner] = _totalSupply;
```

```
uint256 internal value

NLP complex 1.sol 13:67
```

```
MetaMask Tx Signature: User denied transaction signature.

You may want to cautiously increase the gas limit if the transaction went out of gas.
```

The Smart contracts developed by the system were tested on REMIX IDE, and the results were as follows: The contracts were associated with MetaMask wallets, which in turn established the system's reliability in generating functional smart contracts for deployment. This actual environment testing showed how the system was very effective and strong while performing in a real setting.

5.1.4 Statistical Analysis

Advanced statistical tools such as F1 scoring were never even employed, yet the system was realistically assessed according to user opinion and deployment efficiency. The quality of translating the written material and the implementation of smart contracts proves that the system works.

6 Conclusions and Discussion

6.1 Research Questions Addressed

The specific research questions were centred on whether the NLP can accurately translate the Solidity code into natural language and the reverse, as well as when such translations can be deployed as smart contracts. This study was able to effectively show how NLP was able to meet both the goals specified, that is, provide translated texts that are clear and accurate, as well as generate deployable smart contracts.

6.2 Insights and Implications

The development and evaluation of the NLP system provided several key insights: The development and evaluation of the NLP system provided several key insights:

Accuracy: This paper recognised the skills of the GPT-4 model in translating technical Solidity code into human consumable descriptions is a plus in the usability of smart contracts.

Usability: The web-based interface guarantees that the end user does not require any programming knowledge and expertise, thus widening the customer base.

Deployment: The utilisation of the generated smart contracts proves the practical viability of the system in the real world.

6.3 Further Research and Commercialization

More studies could be invested in the addition of more languages and the constant development of the NLP model with more sets of data. There is a huge commercial use need within the multiple sections of industries where clear and easy-to-understand smart contract solutions are required. Possible future improvements can be divided into two areas – the production of each enterprise-level solution and the extension of the list of contract types the system can process and the media with the other blockchains. In summary, this study is a demonstration of how NLP can be employed to revolutionise smart contracts' features, such as usability and functionality, for the blockchain sector.

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