PyPAF: Python Program, Algorithm, and Flowchart Generator

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April 10, 2025

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INTRODUCTION

- Coding is now a key skill in schools and colleges, but many students find it difficult to learn and apply programming concepts effectively.
- Teachers often spend hours manually reviewing code during lab exams, which can be time-consuming and challenging to grade fairly.
- Our project aims to simplify the learning process for students by offering guided support and structured assistance in writing and improving their coding skills.
- At the same time, it helps teachers evaluate student work more efficiently, ensuring accurate assessments and saving valuable time during practical evaluations.

PROBLEM STATEMENT

- Students struggle to convert their ideas into working code due to lack of step-by-step guidance.
- Existing tools mainly convert finished code into flowcharts, offering little help during the initial coding process.
- Teachers face challenges in quickly and fairly evaluating multiple student submissions during lab exams.
- There is no tool that connects ideas, flowcharts, and code both ways, making learning and assessment less effective.

OBJECTIVE

- To support learning by enabling students to convert their natural language descriptions into algorithms, flowcharts, and executable code.
- Unlike existing systems that rely on reverse strategies, this tool guides students from idea to implementation step-by-step.
- To assist teachers by automatically generating reference code from prompts and evaluating student submissions using test cases for fair and efficient grading.

LITERATURE SURVEY

LITERATURE SURVEY 1

AN EXTENSIBLE APPROACH TO GENERATE FLOWCHARTS FROM SOURCE CODE (September 2018)[1]

Author : Damitha D Karunarathna, Nasik Shafeek

- Flowcharts make code easier with clear pictures.
- The method uses a tree in three steps, tested on PHP.
- Front-end makes Abstract Syntax Tree(AST), middle writes Dot language, back-end draws flowcharts from PHP.

Advantages:

- Separate components (front-end, middle, back-end) allow independent updates or replacements.
- Uses existing tools like Graphviz, reducing development effort.

Disadvantages:

- Requires understanding of compiler design and AST for extension.
- Generated Dot Language may create cluttered flowcharts.
- Lacks UI.

LITERATURE SURVEY 2

Code Similarity Detection Using AST and Textual Information (2019))[2]
Author: Wu Wen, Xiaobo Xue, Ya Li, Peng Gu, and Jianfeng Xu

- Analyzes code similarity using both text-based and AST-based features.
- Applies SimHash after code normalization to generate fingerprints.
- Extracts AST and computes Zhang-Shasha edit distance, then combines both scores using a weighted formula.

Advantages:

- Effectively detects various forms of code plagiarism.
- Considers both text similarity and code structure similarity.

Disadvantages:

- Lacks a ready-to-use implementation,its more of an idea than a tool.
- Does not evaluate code functionality or runtime correctness.

LITERATURE SURVEY 3

Automatic Code Generation for C and C++ Programming (May 2021)[3]
Author : Sanika Patade, Pratiksha Patil, Ashwini Kamble, Prof. Madhuri Patil

* Automates C/C++ code generation from flowcharts to simplify programming for beginners and visual learners.
* Reduces manual coding complexity by converting user-drawn flowcharts into algorithms and executable programs.

Advantages:

* Simplifies coding, no syntax memorization.
* Supports beginners with integrated save/compile/run features.

Disadvantages:

* Requires user interaction for every step.

LITERATURE SURVEY 4

On the Robustness of Code Generation Techniques: An Empirical Study on GitHub Copilot (2023)[4]

Authors: Antonio Mastropaolo, Luca Pascarella, Emanuela Guglielmi, Matteo Ciniselli, Simone Scalabrino, Rocco Oliveto, and Gabriele Bavota

- Study focused on evaluating the robustness of GitHub Copilot for code generation.
- 892 Java methods generated using original and paraphrased natural language descriptions.
- Two paraphrasing techniques used:
  - PEGASUS (deep learning-based)
  - Translation Pivoting (TP)

Tools :

- GitHub Copilot
- Java (for code generation)
- PEGASUS (NLP model), TP pipeline

LITERATURE SURVEY 4 (CONTD..)

Advantages:

- Demonstrated how input phrasing significantly affects code quality.
- Useful for improving design of code recommendation tools.
- Explores automation in paraphrasing for testing code generation models.

Disadvantages:

- High variability in Copilot's output can reduce reliability.
- Paraphrasing may result in inconsistent or inaccurate code suggestions.

LITERATURE SURVEY 5

Leveraging pre-trained language models for code generation(2024)[5]

Author: Ahmed Soliman,Samir Shaheen,Mayada Hadhoud

- Model Selection:BERT, RoBERTa, ELECTRA, and LUKE.
- Used Marian as a decoder for enhanced code generation.
- Datasets: CoNaLa and DJANGO.
- Preprocess Data: Tokenize and normalize.
- Fine-Tuning: Train models on CoNaLa and DJANGO.

  Tools :

  - Programming Language: Python
  - Deep Learning Framework: PyTorch
  - HuggingFace Transformers,HuggingFace Trainer,Google Colab Pro
  - RAM: 16 GB minimum, 32 GB preferred.

LITERATURE SURVEY 5(CONTD..)

Advantages:

- Better code quality with improved BLEU scores and exact match rates.
- Speeds up coding and reduces manual effort.
- Models provide better contextual and knowledge integration.

Disadvantages:

- Small dataset size affects generalizability.
- Focus on single-line code generation.
- Only a subset of models tested, missing potential improvements.

LITERATURE SURVEY 6

Code Generation from Flowchart using Optical Character Recognition Large Language Model (2024)[6]
Author:Aryaman Darda and Reetu Jain

- Flowchart image is processed using OCR and deep learning to extract text, which is then sent to LLaMA 2-Chat to generate Python code with explanation.
- Gradio interface allows users to upload images and view the generated code easily.

Advantages:

- Helps beginners learn fast by turning flowchart pictures into reliable Python code with an easy-to-use screen.

Disadvantages:

- OCR may struggle with low-quality or handwritten flowcharts

LITERATURE SURVEY

Title	Year	Methodology	Advantage	Disadvantage
An Extensible Approach to Generate Flowcharts from Source Code[1]	2018	-Code to flowchart -Three stages	Allows independent updates	Knowledge on Compiler design,AST

LITERATURE SURVEY

Title	Year	Methodology	Advantage	Disadvantage
Code Similarity Detection Using AST and Textual Information [2]	2019	-Generate Simhash fingerprints -Extract AST and Compute edit distance -Weighted similarity calculation	Considers both text structure similarity.	No run check

LITERATURE SURVEY

Title	Year	Methodology	Advantage	Disadvantage
Automatic Code Generation for C and C++[3]	2021	Users draw flowcharts with predefined shapes in GUI, converted to C/C++ code.	-Easy to use GUI -Reduces syntax errors	Needs User interaction for each step

LITERATURE SURVEY

Title	Year	Methodology	Advantage	Disadvantage
On the Robustness of Code Generation Techniques: An Empirical Study on GitHub Copilot [4]	2023	-Generated 892 Java methods. -Tested with original and paraphrased inputs. -Used PEGASUS and Translation Pivoting.	-Shows impact of input phrasing. -Useful for code tool enhancement.	-Output inconsistency. -Sensitive to paraphrasing.

LITERATURE SURVEY

Title	Year	Methodology	Advantage	Disadvantage
Leveraging Pre-Trained Language Models for Code Generation[5]	2024	- BERT, RoBERTa, ELECTRA, LUKE. - Marian as decoder. - CoNaLa, DJANGO datasets. - Tokenize, normalize data. - Fine-tune models.	- Higher BLEU scores. - Faster coding. - Better contextual integration.	- Small datasets. - Single-line focus. - High computational needs. - Limited models tested.

LITERATURE SURVEY

Title	Year	Methodology	Advantage	Disadvantage
Code Generation from Flowchart using Optical Character Recognition and Large Language Model [6]	2024	OCR extracts text from flowchart, LLaMA 2 generates Python code	Beginner-friendly, focuses on logic	Performance issues with unclear images.

CONCLUSION FROM LITERATURE SURVEY

- The literature survey highlights key limitations in existing systems used in programming education and code analysis.
- Many systems require manual flowchart creation, making the development process slow and inefficient.
- The learning flow is often reversed, focusing on code before understanding the underlying algorithm and structure.
- Code similarity detection is mostly limited to plagiarism detection, lacking educational feedback or performance evaluation.
- This makes the need for an automated and user-friendly solution that makes code generation and assessment easier and more effective.

PRODUCT FUNCTIONS

- Accepts natural language prompts from the user and converts them into well-structured pseudocode for further processing.
- Uses rule-based mapping to transform the pseudocode into a clear algorithm and a corresponding visual flowchart.
- Automatically generates accurate Python code from the input prompt using a Huggingface model.
- Provides an integrated environment for running, testing the generated or user-submitted Python code.
- Evaluates the student's code by comparing it with the generated code, offering automated grading and meaningful feedback.
- Ensures smooth usage through a clean and user-friendly interface

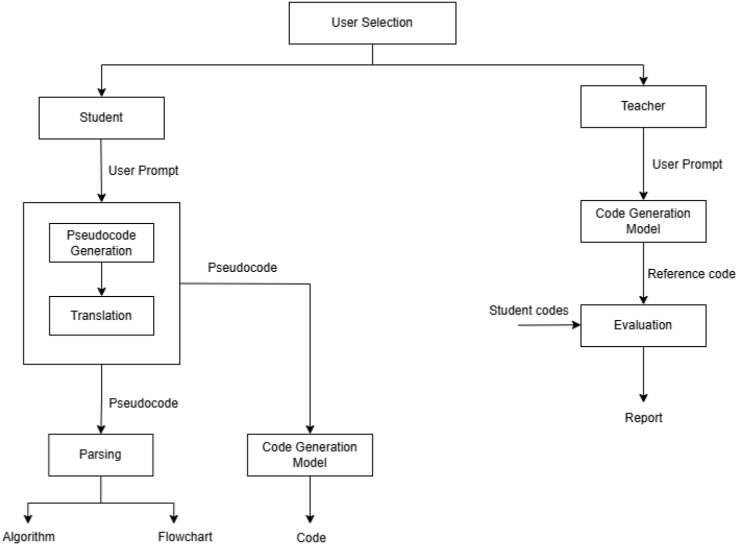
SOFTWARE REQUIREMENTS

- **Language**: Python.
- **Framework**: Flask
- **Frontend Technologies**: HTML, CSS ,Javascript
- **API**: Blackbox.ai
- **Flowchart Generation**: Graphviz
- **Code Generation Model**:HuggingFaceTB/SmolLM2-1.7B-Instruct
- **Development Environment**: Visual Studio Code.

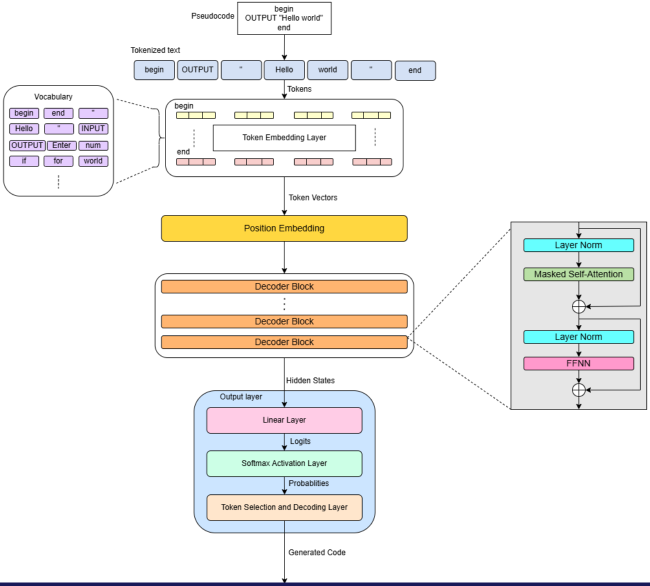
HARDWARE REQUIREMENTS

- **Operating System:** Windows 10/11 64-bit or equivalent
- **Minimum CPU:** Quad-core or higher (e.g., AMD Ryzen 5 / Intel i5 or better)
- **Minimum RAM:** 8 GB, Recommended 16 GB
- **Minimum GPU:** 2 GB
- **Minimum Storage:** At least 256 GB SSD

SYSTEM ARCHITECTURE

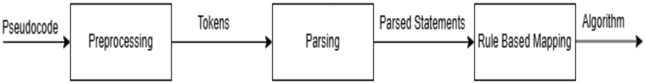


CODE GENERATION ARCHITECTURE

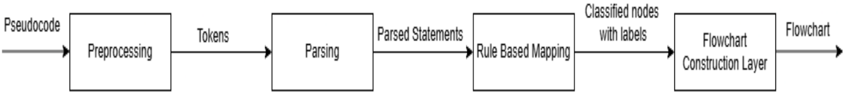


ALGORITHM,FLOWCHART GENERATION - ARCHITECTURE

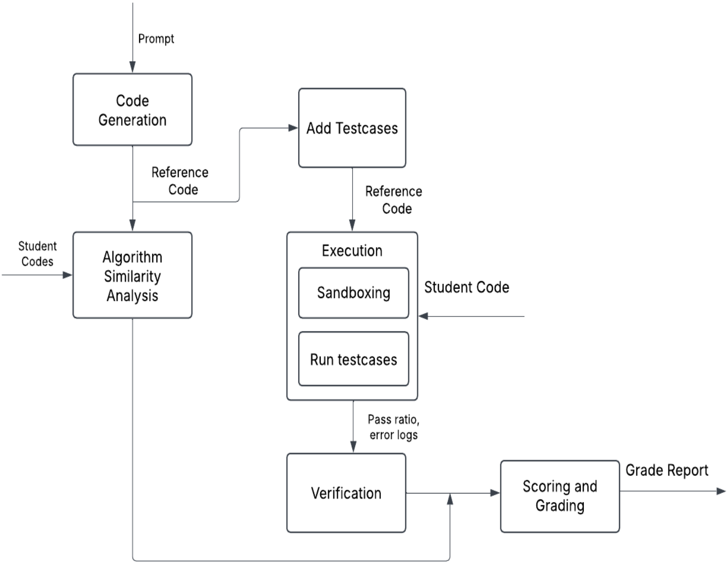
Algorithm Generation Architecture



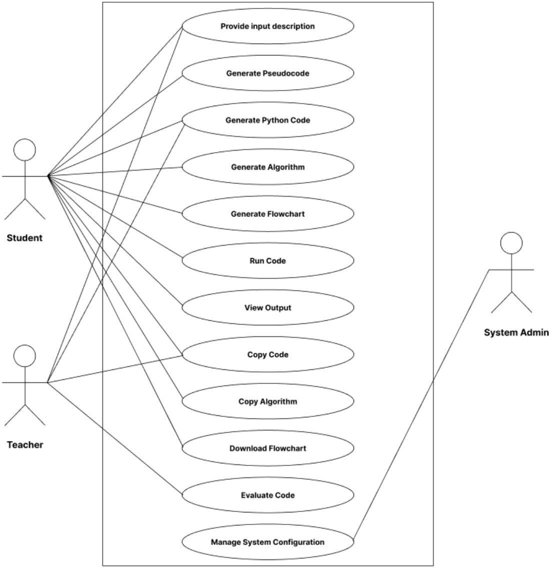
Flowchart Generation Architecture



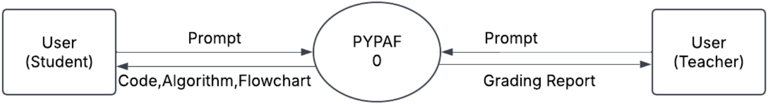
EVALUATION ARCHITECTURE



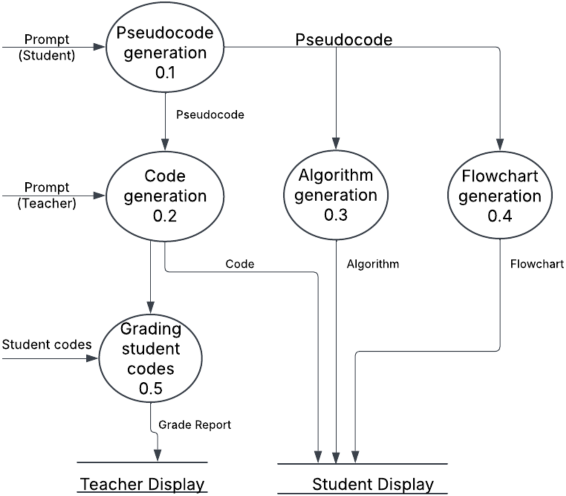
USECASE DIAGRAM



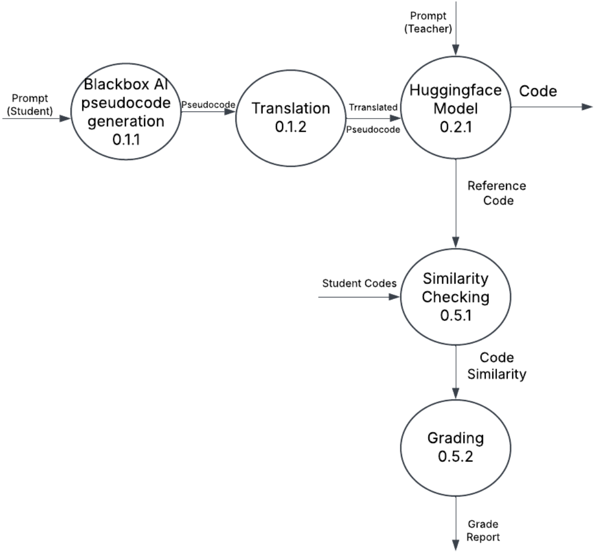
DFD LEVEL 0 DIAGRAM



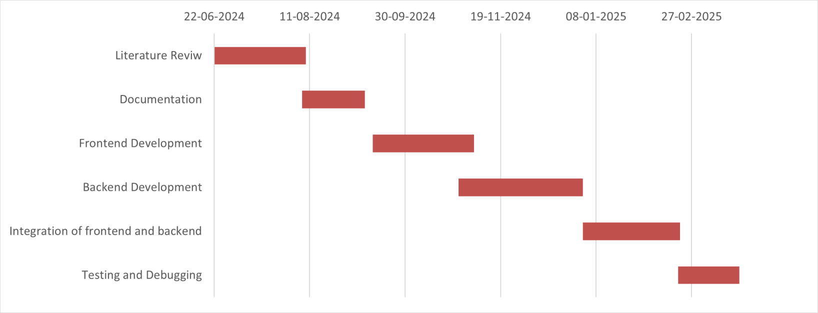
DFD LEVEL 1 DIAGRAM



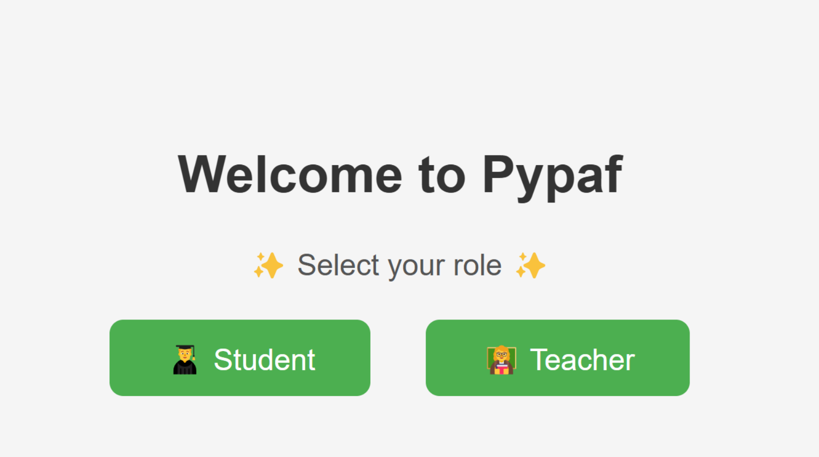
DFD LEVEL 2 DIAGRAM



GANTT CHART


22-06-2024
11-08-2024
30-09-2024
19-11-2024
08-01-2025
27-02-2025
Literature Reviw
Documentation
Frontend Development
Backend Development
Integration of frontend and backend
Testing and Debugging

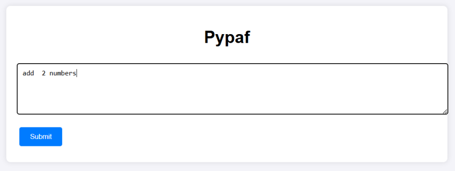
IMPLEMENTATION & RESULT



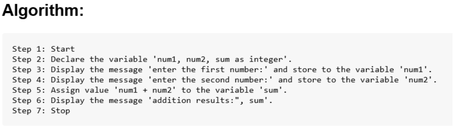
Welcome to Pypaf

✨ Select your role ✨

IMPLEMENTATION & RESULT



add 2 numbers

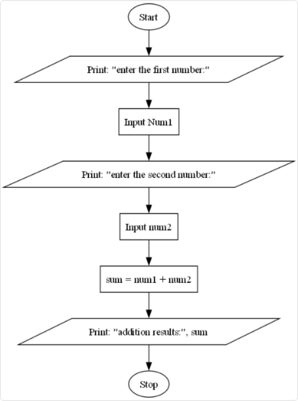


Algorithm:

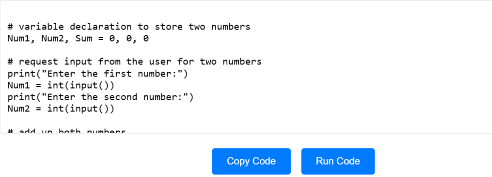
```
Step 1: Start
Step 2: Declare the variable 'num1, num2, sum as integer'.
Step 3: Display the message 'enter the first number:' and store to the variable 'num1'.
Step 4: Display the message 'enter the second number:' and store to the variable 'num2'.
Step 5: Assign value 'num1 + num2' to the variable 'sum'.
Step 6: Display the message 'addition results:", sum'.
Step 7: Stop
```

IMPLEMENTATION & RESULT

Flowchart:


Start
Print: "enter the first number:"
Input Num1
Print: "enter the second number:"
Input num2
sum = num1 + num2
Print: "addition results:", sum
Stop

Generated Python Code:

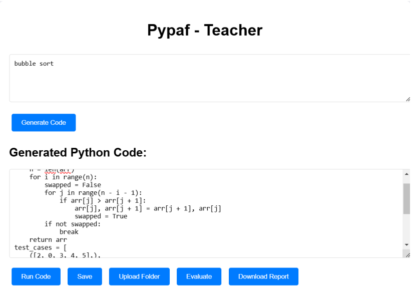


```
# variable declaration to store two numbers
Num1, Num2, Sum = 0, 0, 0

# request input from the user for two numbers
print("Enter the first number:")
Num1 = int(input())
print("Enter the second number:")
Num2 = int(input())

# add up both numbers
```

IMPLEMENTATION & RESULT

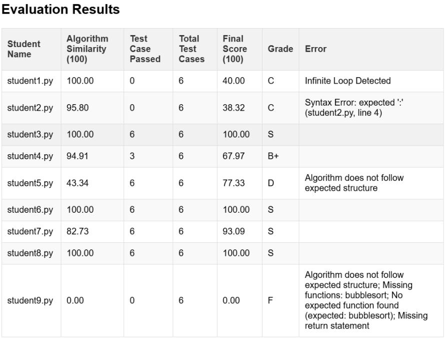


Pypaf - Teacher

```
bubble sort
```

Generated Python Code:

```
    n = len(arr)
    for i in range(n):
        swapped = False
        for j in range(n - i - 1):
            if arr[j] > arr[j + 1]:
                arr[j], arr[j + 1] = arr[j + 1], arr[j]
                swapped = True
        if not swapped:
            break
    return arr
test_cases = [
    ([2, 0, 3, 4, 5],),
```



Evaluation Results

Student Name	Algorithm Similarity (100)	Test Case Passed	Total Test Cases	Final Score (100)	Grade	Error
student1.py	100.00	0	6	40.00	C	Infinite Loop Detected
student2.py	95.80	0	6	38.32	C	Syntax Error: expected ':' (student2.py, line 4)
student3.py	100.00	6	6	100.00	S	
student4.py	94.91	3	6	67.97	B+	
student5.py	43.34	6	6	77.33	D	Algorithm does not follow expected structure
student6.py	100.00	6	6	100.00	S	
student7.py	82.73	6	6	93.09	S	
student8.py	100.00	6	6	100.00	S	
student9.py	0.00	0	6	0.00	F	Algorithm does not follow expected structure; Missing functions: bubblesort; No expected function found (expected: bubblesort); Missing return statement

CONCLUSION

- This project bridges the gap between theoretical learning and practical coding by guiding students from natural language to executable Python code.
- It improves programming education by presenting algorithms, flowcharts, and code in a structured and understandable flow.
- The tool encourages self-learning among students while also supporting teachers with automated code evaluation and feedback.
- Overall, it transforms the way students engage with programming by making the learning process more interactive, accessible, and effective.

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Thank you