

A PRELIMINARY REPORT ON
CodeBasic: A programming language for beginner
programmers using ML and cloud.



SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY
IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

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CERTIFICATE

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ACKNOWLEDGEMENT

First of all, I would like to express my sincere and deep gratitude to my supervisor, **Prof. Shrikant Dhamdhere**, Faculty, Department of Computer Engineering, for his kind and constant support. His valuable advice, critical criticism and active supervision encouraged me to sharpen my methodology and was instrumental in shaping my professional outlook.

I also want to express my gratitude towards **Prof. Shrikant Dhamdhere**, Professor & Head, Dept. of Computer Engineering, PGMCOE, Wagholi for providing such a wonderful environment filled with continuous encouragement and support. I would also like to thank my classmates for their constant encouragement and assistance they have provided me.

ABSTRACT

Programming is a foundational skill in today's technology-driven world, but the complexity of traditional programming languages often poses a significant barrier for beginners. To address this challenge, we present "CodeBasic," a novel programming language designed specifically for beginners with little to no prior coding experience.

CodeBasic embodies a minimalist syntax that emphasizes readability and comprehension. Through visual cues, simplified control structures, and interactive elements, learners can grasp fundamental programming concepts while observing real-time outcomes. An integrated development environment (IDE) accompanies CodeBasic, offering an intuitive interface where users can write, execute, and visualize code seamlessly.

CodeBasic is a TypeScript-based programming language with features like auto-completion using ML and code storage using the cloud. It also includes a CodeBasic web-based playground hosted on GitHub pages. The client's requests are sent to the server, which stores the compiler, preprocessor, and assembler code needed to generate the necessary output, and later sends it back to the client.

To ensure the effectiveness of CodeBasic, extensive usability testing with beginner programmers is conducted. Feedback drives iterative improvements, guaranteeing that the language and IDE meet the needs of its target audience. The project also embraces community collaboration, encouraging learners to share projects, collaborate, and build a supportive network.

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Chapter 1

INTRODUCTION

1.1 Motivation

The development of a new programming language stems from the growing need for efficient, intuitive, and versatile tools to solve modern computational challenges. Traditional programming languages have greatly advanced the field of software development, enabling the creation of complex and innovative applications. However, as technology evolves and new paradigms emerge, the limitations of existing languages become increasingly apparent.

The motivation behind the creation of our new programming language is to address these limitations and provide a fresh approach to programming that caters to the demands of contemporary software development. Several key factors have driven the need for this new language:

- Simplicity and Expressiveness
- Domain-Specific Challenges
- Concurrency and Parallelism

1.2 Problem Definition

The primary challenge that our project seeks to address is the steep learning curve that beginners face when attempting to comprehend the fundamentals of programming. Many existing programming languages are designed to cater to a wide range of complex tasks, which often overwhelms new learners with intricate syntax, convoluted semantics, and a plethora of advanced features. Our project aims to provide a solution for aspiring programmers who are at the very beginning of their journey, offering them an accessible and intuitive platform to understand the core concepts of programming.

Chapter 2

LITERATURE SURVEY

The problem of teaching programming to beginners has been extensively explored in the realm of computer science education. Researchers and educators have recognized the challenges posed by traditional programming languages and have proposed various solutions to make programming accessible and engaging for novice learners. The following key themes emerge from the existing literature:

- **Visual Programming Languages:** Visual programming languages, such as Scratch and Blockly, have gained popularity as effective tools for introducing programming concepts to beginners.
- **Educational Platforms:** Platforms like Codecademy, Codechef and Scaler offer interactive coding lessons that provide instant feedback, guiding learners through coding challenges. .
- **Minimalistic Syntax:** Researchers have proposed programming languages with simplified syntax designed specifically for beginners. Languages like Python, with its readable and concise syntax, have been successful in reducing the learning curve and enabling beginners to focus on problem-solving.

SNo.	Paper Name	Year	Methodology	Conclusion
1	A Systematic Mapping Study of Software Development With GitHub	2019	comprised five key phases: defining research questions and conducting data extraction and mapping.	It sets the stage for future studies on diverse collaborative activities transitioning to platforms like GitHub.
2	Comparative Analysis of Machine Learning Techniques for Predicting Air Quality in Smart Cities	2019	The study conducts a comparative analysis of machine learning techniques to predict air quality in smart cities, evaluating their performance and applicability.	The study compared four regression techniques for air pollution prediction. Random Forest regression outperformed the others, demonstrating lower processing time and a lower error rate, making it the most effective choice.

SNo.	Paper Name	Year	Methodology	Conclusion
3	A Comparative Analysis of Distributed Ledger Technology Platforms	2021	The study thoroughly evaluates different Distributed Ledger Technology (DLT) platforms, comparing their features and suitability for various applications.	This paper provides a detailed comparison of blockchain platforms to help startups select the best one for their diverse applications, tackling common challenges.
4	A survey of multimedia and web development techniques and methodology usage	2021	Using basic statistics, we compared systems and multimedia development practices through similar questionnaires	Our survey on multimedia and web development techniques, employing basic statistics and comparative questionnaires, sheds light on prevalent practices in systems and multimedia development.

SNo.	Paper Name	Year	Methodology	Conclusion
5	Barriers in Front-End Web Development	2022	Utilizing Stack Overflow discussions, we identified challenges in front-end web development, specifically focusing on complexities associated with external APIs	Analyzing Stack Overflow discussions, we pinpointed front-end web development challenges related to complex external APIs.

Chapter 3

SOFTWARE REQUIREMENT SPECIFICATION

3.1 Introduction

3.1.1 Project Scope

The scope of this project encompasses the design, development, and evaluation of a beginner-friendly programming language and its associated learning environment. The primary goal is to create a tool that addresses the challenges faced by novice learners when introduced to programming concepts. The project will focus on the following key aspects:

- The project will involve the design of a programming language with a minimalistic and intuitive syntax.
- An interactive development environment (IDE) will be developed to accompany the programming language.
- A carefully structured curriculum will be designed to guide learners through the programming language and its concepts
- Comprehensive documentation will be created to guide both learners and educators in using the programming language and IDE effectively.

3.1.2 User Classes and characteristics

This section outlines the various user classes that will interact with the proposed programming language and learning environment.

- Beginner Learners:
 - Novice in programming, with little to no prior coding experience.
 - May have limited exposure to technical concepts.
 - Learning style leans towards visual and interactive experiences.
- Educators and Instructors:
 - Experienced in teaching programming to beginners.
 - Seek tools that facilitate effective teaching and engagement.
 - May have varying degrees of technical expertise.
- Enthusiast Learners:
 - Individuals with a strong interest in programming and technology.
 - May have some experience with other programming languages.
 - Desire the ability to quickly prototype ideas.

3.1.3 Assumptions and Dependencies

This section outlines the assumptions made and dependencies identified for the successful execution of the proposed programming language and learning environment project.

- User Proficiency:
 - **Assumption:** Users engaging with the programming language and learning environment possess basic computer literacy skills, including familiarity with keyboard input and navigation.
 - **Dependencies:** The project aims to introduce programming concepts; basic computer skills are necessary to interact with the tools effectively.
- Hardware and Software Infrastructure
 - **Assumption:** Users have access to standard personal computers or laptops with compatible web browsers for utilizing the interactive programming environment.
 - **Dependencies:** The effectiveness of the interactive learning environment depends on stable internet connectivity and modern web browser compatibility.
- Feedback and Iteration:
 - **Assumption:** Users are willing to provide feedback and suggestions for improvement of the programming language, IDE, and curriculum.
 - **Dependencies:** Regular feedback from users is essential for iterative development and continuous enhancement of the tools.

3.2 Nonfunctional Requirements

3.2.1 Performance Requirements

These requirements have been defined to align with the objectives of the project and the needs of the target user classes.

- **Responsiveness:** The interactive development environment (IDE) should respond to user actions, such as code input and execution, within a maximum latency of 1 second.
- **Execution Speed:** The execution of simple code snippets within the IDE should complete within 2 seconds.
- **Resource Utilization:** The programming language should utilize system resources (CPU and memory) conservatively to prevent excessive strain on the user's machine.
- **Browser Compatibility:** The interactive learning environment should be compatible with mainstream web browsers, including the latest versions of Chrome, Firefox, and Safari
- **Easy syntax:** The programming language should have easy syntax and very readable by the beginner programmers.
- **Optimised Compilation/Interpretation:** The language's compiler or interpreter should complete the translation of source code to executable code in a reasonable time frame, ensuring that developers don't face excessively long build times.

3.2.2 Safety Requirements

The following safety requirements have been defined to mitigate potential risks and provide a secure user experience:

- **Code Validation:** The programming language should incorporate strict code validation mechanisms to prevent the execution of malicious or harmful code.
- **User Privacy:** User data, including code snippets and personal information, should be stored securely and treated with confidentiality.
- **Sandboxed Environment:** The interactive learning environment should operate within a sandboxed environment that isolates user code execution from the host system.
- **Secure Community Interaction:** The community features, such as sharing projects and participating in discussions, should be monitored to prevent the dissemination of malicious content or inappropriate behavior.
- **Secure Data Transmission:** Ensure that data transmitted between the user's browser and your server is protected using secure communication protocols (e.g., HTTPS).
- **Rate Limiting and DDoS Protection:** Implement rate limiting and DDoS (Distributed Denial of Service) protection measures to mitigate the risk of malicious attacks.
- **Authentication and Authorization:** Implement user authentication mechanisms to ensure that only authorized users can access and modify sensitive data or functionality.

3.2.3 Software Quality Attributes

The following safety requirements have been defined to mitigate potential risks and provide a secure user experience:

- **Usability:** The programming language and learning environment should be user-friendly and intuitive for learners of all skill levels.
- **Reliability:** The programming language and learning environment should consistently perform as expected and minimize errors and disruptions.
- **Maintainability:** The programming language and learning environment should be designed in a way that allows for easy updates, enhancements, and bug fixes.
- **Performance:** The programming language and learning environment should respond promptly to user actions and execute code efficiently.
- **Portability:** Code written in the language should be easily portable across different platforms, operating systems, and environments.
- **Documentation and Learning Resources:** Provide comprehensive documentation, tutorials, and learning resources to assist users in mastering the language and environment.

3.3 System Requirements

3.3.1 Database Requirements

While the primary focus of the project does not revolve around database functionality, there is a need to incorporate basic data storage capabilities to enhance user experience and offer features like saving and retrieving code snippets and user progress. Some basic functionalities would be:

- Create user profiles that store user-specific information, such as saved code snippets, preferences, and progress.
- Develop a mechanism to track user progress, completed exercises, and projects.

3.3.2 Software Requirements

To make a full fledged programming language with a dedicated IDE, we need to consider both frontend and backend view of this project:

- Frontend Technologies: HTML, CSS and JS for client side working of the project.
- Backend Technologies: Nodejs for designing the logic and implementation of the programming language.
- Version Control: Git/Github for maintaining code integrity and backup.
- Documentation: Markdown and overleaf for building the documentation of the programming language.

3.3.3 Hardware Requirements

Minimum specifications required to design and use the project are as follows:

- CPU: i3 8th gen or ryzen 3 3500U
- Memory: 8GB RAM and 256 GB SSD.

3.4 Analysis Models: SDLC Model to be applied

The Software Development Life Cycle (SDLC) models selected for this project will guide the development, testing, and deployment phases. Given the project's goals and requirements, the following SDLC models will be employed:

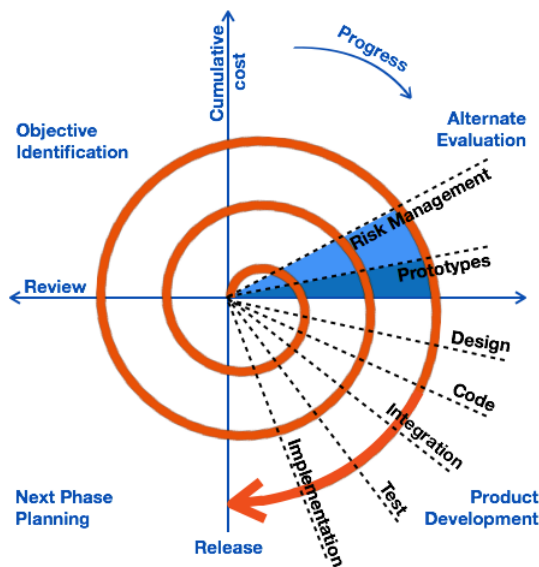


Figure 3.1: Spiral Model

The spiral model is used for this project, which involves continuous improvement development.

- Agile Methodology:
 - The Agile methodology will be adopted to allow for iterative development and continuous feedback.
 - Regular sprints will facilitate incremental enhancements, enabling features to be developed, tested, and deployed in shorter cycles.

- Iterative Development:
 - This project will involve iterative cycles, each focusing on a specific set of features or functionalities.
 - Feedback from users and stakeholders will be solicited at the end of each iteration to inform subsequent development phases.
- Prototyping:
 - Prototyping will be used to quickly validate concepts, user interfaces, and interactive features.
 - Prototype iterations will inform the final design of the IDE, curriculum organization, and user interactions.

In essence, the realm of CodeBasic unfolds as a diverse spectrum of methodologies, spanning personalized coding paradigms, deep learning techniques, data integration strategies, and constraint handling mechanisms. The body of work collectively highlights the significant potential of these systems in guiding developers and programmers towards more optimized and efficient coding practices, thereby nurturing software development and excellence. Our ongoing efforts aim to build upon and enhance these foundational insights, resulting in an innovative CodeBasic platform that harmoniously integrates these principles into a comprehensive and tailored coding environment.

3.5 System Implementation Plan

The system implementation plan for the CodeBasic Programming Language involves the practical execution of the software development process. In this phase, the development team will transform the conceptual design and specifications into a fully functioning application.

The system implementation phase for the CodeBasic programming language is a critical stage in which the development team transforms the conceptual design and detailed specifications into a fully functional programming language. Throughout this phase, software engineers and developers write the actual code, integrate different components, conduct thorough quality and security testing, optimize performance, and design an intuitive user interface. This phase is where the foundations of CodeBasic are laid, ensuring that it meets the needs of both beginner and experienced programmers.

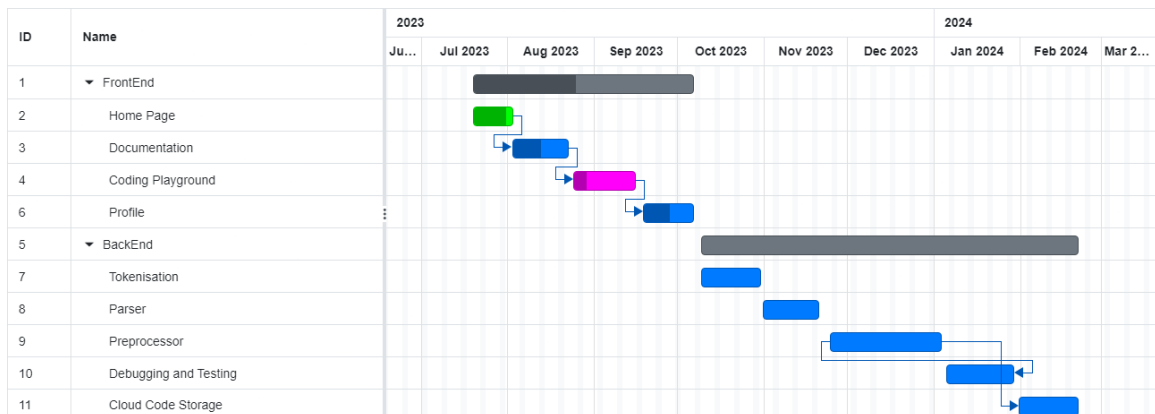


Figure 3.2: Implementation Plan Gantt Chart

Work	Date
Requirement analysis and Initialization of UI playground.	July 19, 2023
Design of login page UI using firebase and studying typescript for building the programming language..	August 2, 2023
Design plan of different phases of compiler	August 24, 2023
Building of cloud system storage for code storage	September 18, 2023
Building the lexical analyser using tokenisation and maximum munch rule for converting the HLL language to tokens.	October 6, 2023
Studying types of currently existing parsers and deciding the plan.	October 9, 2023
Identifying different machine learning algorithms which can help in smart code completion.	October 31, 2023
Implementing left factoring and left recursion removal	November 24, 2023
Started working on code optimiser and preprocessor for handling functions and other different components of code.	January 5, 2024
Working on code syntax and deciding all the paradigms.	January 31 10, 2024
Using different CFG grammars to check for the syntax analyser performance and performing blackbox testing.	February 21, 2024

Chapter 4

METHODOLOGY ANALYSIS

The Web Development internship at The Spark Foundation offers a methodology that includes lectures, hands-on coding assignments, real-world projects, mentor guidance, and collaboration opportunities. The internship focuses on HTML, CSS, and JavaScript, providing interns with practical skills and a strong foundation in front-end web development. Through lectures, interns learn essential concepts, while hands-on assignments allow them to apply their knowledge. Real-world projects simulate professional web development experiences, and mentors provide guidance and feedback. Collaboration opportunities foster teamwork and communication skills. Overall, the internship offers a comprehensive and customizable learning experience to prepare interns for web development challenges.

4.1 User Characteristics

- Participants should have a basic understanding of HTML, CSS, and JavaScript concepts and syntax.
- They should be motivated to learn and develop their web development skills, with a strong interest in pursuing a career in front-end or full-stack web development.
- They should be able to work independently and in a team environment, communicate effectively with mentors and other participants, and be open to feedback and guidance.

4.2 Overview of Functional Requirements

4.2.1 Basic Programming Paradigms

- Description: Programmers or learners can try basic programming paradigms like creating a variable, assigning values, printing stuff, using conditionals, creating loops. Later versions might include recursion, OOPs and exception handling techniques in an easy and better way as compared to other programming languages.

4.2.2 User Profile Management

- Description: Users can create, update, and manage their profiles. Later versions might include exporting and importing of codes to and from the local machine of the user to the playground.
- Input: User can provide the input via the web UI/Playground.
- Processing: The request is sent to the server hosted on a separate hosting platform containing all the programs necessary to run the input.
- Output: Returned to the client via HTTP request.

Some other features include:

- Providing a comprehensive learning experience that bridges the gap between theoretical knowledge and practical skills in web development, focusing on HTML, CSS, and JavaScript.

- Offering a flexible program that can be customized to fit individual needs and interests, covering topics such as front-end development, responsive design, and interactive web applications.
- Providing guidance and support from experienced mentors, including regular feedback and opportunities for collaboration with other participants.
- The system should have a login.
- Offering hands-on experience with real-world projects that allow participants to apply their web development skills and gain practical experience in building websites and web applications.

Chapter 5

SOFTWARE AND HARDWARE REQUIREMENTS

5.1 Hardware Requirements

- A computer or laptop with a minimum of 8GB RAM, 250GB hard disk, and a 2.0 GHz processor or higher.
- A reliable internet connection for online learning and collaboration with mentors and other participants
- Webcam and microphone for attending virtual meetings and sessions, if applicable.

5.2 Software Requirements

- Text editors or Integrated Development Environments (IDEs) like Visual Studio Code, Sublime Text, Atom, or Brackets.
- Web browsers such as Chrome, Firefox, or Safari for testing and previewing HTML, CSS, and JavaScript code.
- HTML and CSS frameworks like Bootstrap, Foundation, or Bulma for building responsive and visually appealing web interfaces.
- JavaScript libraries and frameworks like jQuery, React.js, Angular.js, or Vue.js to enhance interactivity and create dynamic web applications.

Chapter 6

PROJECT PLAN

6.1 Goals

- Designing a new programming language with an intuitive and easy-to-understand syntax.
- Implementing the compiler or interpreter for the language.
- Testing the language implementation for correctness, reliability, and performance.
- Documenting the language specifications, syntax, and usage guidelines.

6.2 Timeline

- Phase 1: Research and Planning (Month 1)
- Phase 2: Language Design (Months 2-3)
- Phase 3: Implementation (Months 4-6)
- Phase 4: Documentation and User Testing (Months 7-8)
- Phase 5: Finalization and Presentation (Month 9)

6.3 Resources

- Development Tools: IDEs, compilers, interpreters, version control systems.
- Literature: Books, research papers, online resources on programming language design.
- Testing Frameworks: Chrome DevTools, Profiling, unit testing
- Hardware: Computer, memory.

6.4 Risks and Mitigation Strategies

- Risk: Unexpected complexities in language design and implementation.
- Mitigation: Conduct thorough research and planning, seek advice from experts, and allocate sufficient time for troubleshooting and debugging.
- Risk: Difficulty in implementing modules like if-else, loops, built-in functions
- Mitigation: Used other sources on github and studied typescript documentation to understand how things work and tried re-implementing.
- Risk: Memory Leak, Infinite Recursion
- Mitigation: Used profiling and testing techniques to test pieces of code individually inorder to identify the errors.

Chapter 7

SYSTEM DESIGN

Designing a compiler involves several key stages: lexical analysis, which tokenizes the source code; syntax analysis, which builds a syntax tree; semantic analysis, enforcing language rules; intermediate code generation; optimization for efficiency; target code generation specific to the platform; optional linking of multiple source files; error handling with informative messages; reporting and output generation; thorough testing and validation; user documentation and interfaces; and integration with development tools. Compiler design is tailored to the target language and platform, with a focus on correctness, efficiency, and user-friendliness, and it's a complex engineering task often implemented in multiple phases.

7.1 System Analysis

Following are the basic key elements of the current architecture:

- Lexical Analysis (Scanner)
- Syntax Analysis (Parser)
- Semantic Analysis
- Code Generation
- Error Handling
- Reporting and Output
- Documentation and User Interface

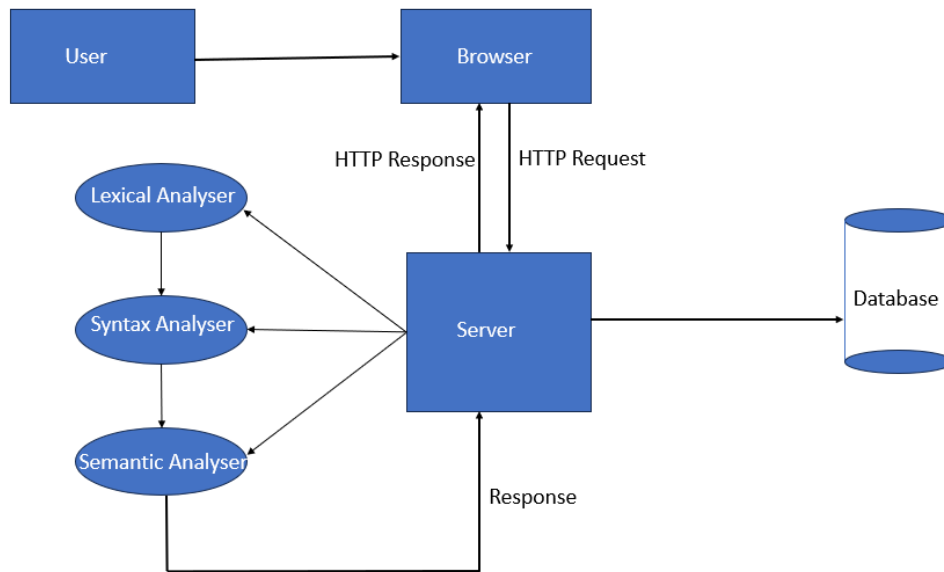


Figure 7.1: Proposed System Architecture

In client-server architecture, the core principle is the division of labor between clients and servers. Clients are the initiators of requests for services, while servers handle the processing of these requests and provide the requested services or data. This model enables efficient networked computing, facilitating centralized resource management and security measures to control access. It is widely used in various scenarios, including web applications, email systems, file servers, and databases, where effective resource distribution and scalability are crucial for providing reliable and accessible services.

CodeBasic adheres to the client-server architectural model, where users and programmers interact with a server that houses the essential components required for a programming language. This interaction is facilitated through a web-based user interface or playground. The server plays a pivotal role in the orchestration of code processing, which encompasses a series of intricate stages. These include preprocessing,

execution of six distinct compiler phases, assembly, linking, and loading.

To optimize and streamline this multifaceted process, CodeBasic leverages TypeScript, a powerful tool that provides a rich repertoire of functions and methods. TypeScript proves indispensable in the design and implementation of the compiler's various phases, tailored to the specific methodology in use. By harnessing TypeScript, CodeBasic significantly reduces the computational overhead on the server while concurrently enhancing the overall efficiency of the code processing pipeline. The server meticulously processes the user's code, ensuring the application of advanced techniques such as lexical analysis, syntax analysis, semantic analysis, optimization, and code generation. Subsequently, it delivers the processed code results to the user, seamlessly accessible through the same web-based user interface or playground.

The most challenging part of any compiler is designing a parser which parses the token stream to syntax tree. For our language, LL(1) parser is being built which involves various functions like first and follow set.

7.2 Use Case Diagram

7.2.1 User Profile

- User Interface/Playground
- Code output window
- Login/Signup

7.2.2 Use View

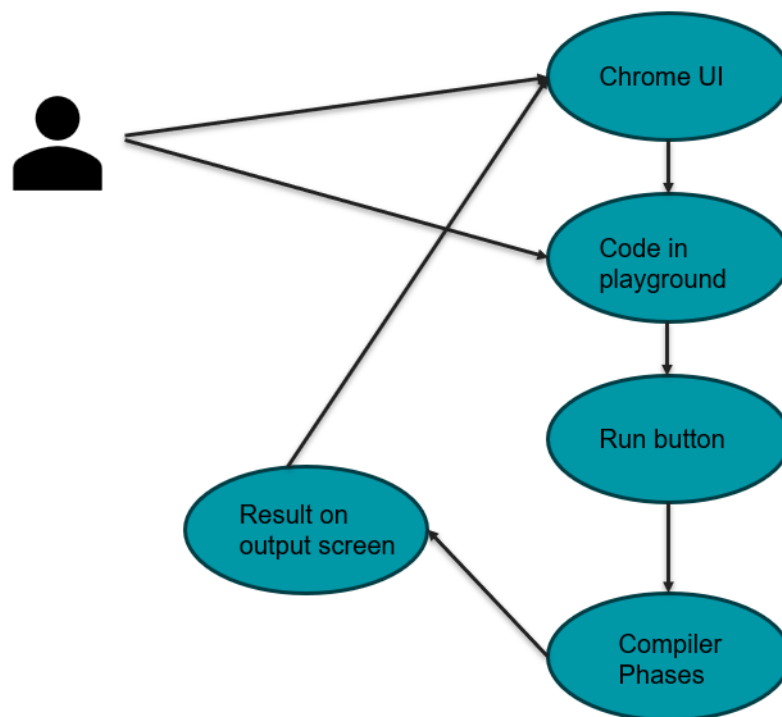


Figure 7.2: Use Case Diagram

This use case diagram several elements including user, UI, preprocessor, compiler, assembler.

Using this use case diagram, we can understand that the user interacts with the programming language using the a web based UI also known as code playground. Once the user writes some code and presses the run button, the request is sent to the server and the preprocessor and compiler phases start their action. First the preprocessor converts all the head files and the defined keywords into the original state. Later this modified code is served to the lexical analyser converts the whole program to the token stream. This token stream is further supplied to the syntax analyser and converted to the parse tree. This further supplied to semantics analyser for type checking and other functions.

7.3 Functional Model and Description

7.3.1 Data Flow Diagram



Figure 7.3: Data Flow diagram level 0

According to the above data flow diagram, the programmer/learner interacts with the programming language in the form of a server via a web based coding playground. Once the user clicks on the run button, the request in the form of code is sent to the server.

On the server, all the necessary methods like preprocessor, compiler, assembler, etc. synthesise the code and produce the necessary result/error.

The "run" button serves as a trigger for the programmer/learner to initiate the execution of their code. Clicking this button is equivalent to sending a request to the server to process and execute the code they've written or modified.

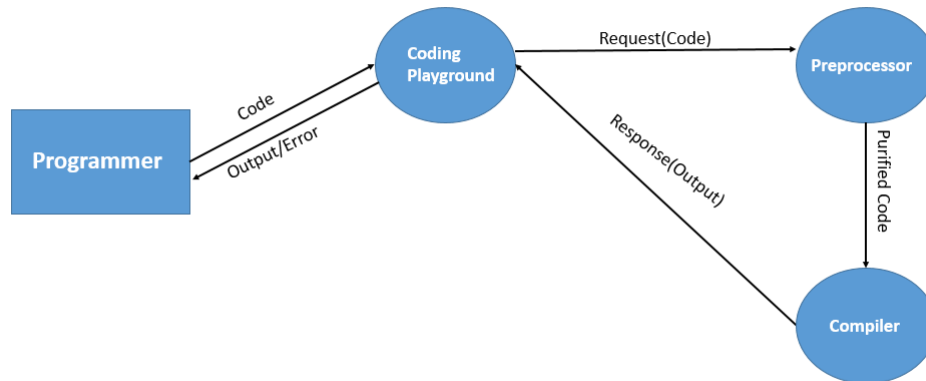


Figure 7.4: Data Flow diagram level 1

A preprocessor in a programming language is a tool or component that performs preprocessing tasks on the source code before it is compiled or interpreted. Preprocessing is typically the initial phase of the compilation or interpretation process and is often used to manipulate the source code in various ways. The primary purpose of a preprocessor is to prepare the code for compilation or to make it more readable, maintainable, or portable.

A compiler is a software tool that translates high-level programming code, written by a programmer, into machine code that a computer's CPU can execute. It goes through several phases during the compilation process. These phases typically include lexical analysis (scanning the source code and breaking it into tokens), syntax analysis (checking the code's structure against a formal grammar), semantic analysis (ensuring the code's meaning is correct), intermediate code generation (creating an intermediate representation of the code), optimization (improving the code's efficiency), and code generation (producing the final machine code). The compiler's role is to transform human-readable code into machine instruction.

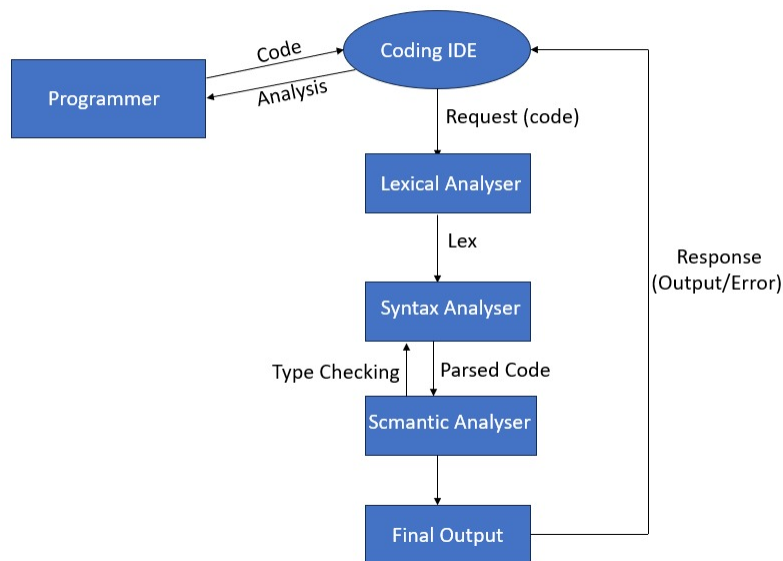


Figure 7.5: Data Flow Diagram Level 2

- **Lexical Analysis:** Lexical analysis, also known as scanning, breaks the source code into tokens or lexemes.
- **Syntax Analysis (Parsing):** Syntax analysis checks if the tokens form a valid syntax tree according to the language's grammar rules.
- **Semantic Analysis:** Semantic analysis verifies the meaning and consistency of the code, such as type checking and variable scoping.
- **Code Generation:** Code generation produces the target machine code or assembly code from the intermediate representation.

7.3.2 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 systems classes, their attributes, operations (or methods), and the relationships among objects.

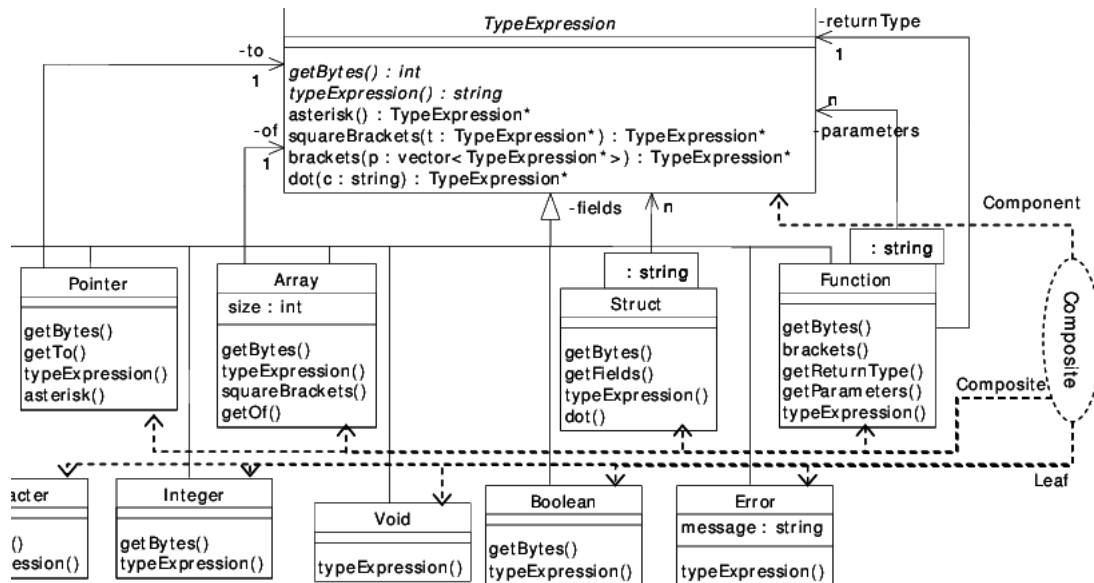


Figure 7.6: Proposed System Architecture

In the context of the "CodeBasic" programming language, the class diagram represents the foundational building blocks that form the core of this language's data types and processing flow. Programming languages typically provide a variety of data types to cater to different needs. In "CodeBasic," these data types include Struct, Array, Void, Boolean, Error, Integer, Pointer, and more, each serving a specific purpose in the language. These data types are essential for defining and manipulating variables, data structures, and expressions within the language.

The workflow of "CodeBasic" is structured around a series of class methods and functionalities that are distributed across the language's

components. These methods play a crucial role in various stages of the program's execution. For example, the `getBytes()` method represents a core functionality in the lexical analysis phase, where it processes the source code and generates byte-level representations for the program's elements. The `TypeExpression` method is part of the syntax analysis phase and is responsible for parsing and validating the language's type expressions, ensuring that the code adheres to the defined syntax rules.

The concept of object-oriented programming (OOP) is integral to the design and implementation of "CodeBasic." The class diagram illustrates how different language components, including data types and methods, are encapsulated within classes. Inheritance, encapsulation, polymorphism, and other OOP principles are used to structure the relationships between these classes, providing a framework for code organization and reuse.

Inheritance enables the creation of specialized classes that inherit properties and behaviors from more generalized classes. This facilitates code reusability and the extension of existing data types or methods. Encapsulation ensures that the internal details of classes are hidden from external access, promoting data integrity and security. Polymorphism allows different classes to share common interfaces while providing their own unique implementations, enhancing flexibility in the language's design.

Overall, the class diagram for "CodeBasic" reflects a well-structured and object-oriented approach to programming language design, where data types and methods are defined, encapsulated, and interconnected to create a cohesive and powerful language that supports various programming tasks and workflows.

Chapter 8

Implementation

8.1 Development Environment

- IDE: Currently we are using a web based IDE designed by our own team and sending requests to backend.
- Compiler/Interpreter: CB1.0 Compiler/Interpreter is the backbone of this whole project
- Version Control: Git was employed for version control to facilitate collaboration among team members and track changes efficiently.
- Testing Framework: NodeJS Debugger, Typescript profiling and Chrome Dev Tools are used for testing and performance evaluation.

8.2 Language Design

- Minimalistic Syntax: We focused on minimizing unnecessary complexity in our language syntax, reducing verbosity and boilerplate code.
- Clear and Readable Code: Emphasis was placed on writing code that is easy to read and understand, facilitating quicker comprehension and debugging.
- Intuitive Constructs: Language constructs such as loops, conditionals, and function definitions were designed to follow common conventions, making it easier for users to grasp their functionality.

- **Error Handling:** We implemented robust error handling mechanisms to provide informative error messages that aid developers in identifying and resolving issues effectively.

8.3 Implementation Details

- **Lexical Analysis:** The lexical analysis phase involved tokenizing input source code into a stream of lexemes. We utilized [Lexical Analyzer Tool/Technique] to accomplish this task efficiently. Regular expressions were employed to define the grammar rules for identifying tokens.
- **Syntax Parsing:** Parsing the token stream generated from the lexical analysis phase involved constructing a parse tree according to the grammar rules of our programming language. We implemented a [Parsing Technique/Algorithm] to perform syntactic analysis and generate the parse tree.
- **Semantic Analysis:** Semantic analysis was performed to ensure that the parsed code adhered to the rules and constraints of the language semantics. We implemented various checks such as type checking, scope resolution, and variable initialization analysis to validate the correctness of the code.
- **Code Generation:** The final phase of implementation involved generating executable code from the validated parse tree. We implemented a code generator that translated the abstract syntax tree into machine-readable instructions, targeting the desired execution environment.

8.4 Tools and Frameworks

- **NodeJS**

- Node.js is an open-source and cross-platform JavaScript runtime environment. It is a popular tool for almost any kind of project!
- Node.js runs the V8 JavaScript engine, the core of Google Chrome, outside of the browser. This allows Node.js to be very performant.
- Node.js utilizes an event-driven architecture and non-blocking I/O operations.
- This approach enables efficient performance and scalability, particularly for applications that handle a large number of simultaneous connections or operations.
- It's ideal for building fast and scalable network applications, such as web servers, real-time communication apps, and collaborative tools.

- **HTML, CSS and JS**

- HTML (HyperText Markup Language) is the most basic building block of the Web. It defines the meaning and structure of web content.
- Cascading Style Sheets (CSS) is a stylesheet language used to describe the presentation of a document written in HTML or XML (including XML dialects such as SVG, MathML or XHTML). CSS describes how elements should be rendered on screen, on paper, in speech, or on other media.

- JavaScript is a prototype-based, multi-paradigm, single-threaded, dynamic language, supporting object-oriented, imperative, and declarative styles.

- **Typescript**

- TypeScript is a strongly typed programming language that builds on JavaScript, giving you better tooling at any scale.
- TypeScript introduces static typing, allowing developers to catch errors early in the development process.
- Specifying types in TypeScript ensures code accuracy, reduces errors, and enhances codebase reliability and maintainability.
- TypeScript's type inference means that you don't always have to annotate types explicitly; the compiler can infer types based on values, making coding more succinct yet still type-safe.

- **Compiler Design**

- The compiler is a type of translator, which takes a program written in a high-level programming language as input and translates it into an equivalent program in low-level languages such as machine language or assembly language.
- These phases include lexical analysis (tokenizing input), syntax analysis (parsing tokens into a parse tree), semantic analysis (ensuring semantic correctness), optimization (improving efficiency and resource usage), and code generation (producing the target machine code).
- Each phase plays a crucial role in the translation and optimization of code.

8.5 Algorithms and Coding

- Lexical Analyser

- Pseudo code for Lexical Analyser:

Algorithm 1 Lexer Class

```
1: Properties: text, pos, currentChar, semanticAnalyzer
2: procedure CONSTRUCTOR(text, semanticAnalyzer)
3:   Initialize text, pos, currentChar, semanticAnalyzer
4: end procedure
5: procedure ADVANCE
6:   Increment pos, update currentChar
7: end procedure
8: procedure SKIPWHITESPACE
9:   while currentChar is whitespace do
10:     ADVANCE
11:   end while
12: end procedure
13: procedure GETNEXTTOKEN
14:   while currentChar is not null do
15:     if currentChar is whitespace then
16:       SKIPWHITESPACE
17:     else if currentChar is digit then
18:       return INTEGER token
19:     else if currentChar is letter then
20:       return CHECKFORKEYWORDSORIDENTIFIER
21:     else if currentChar == '=' then
22:       ADVANCE, return OPERATOR('=')
23:     else if currentChar == '"' then
24:       ADVANCE, return STRINGTOKEN
25:     else if currentChar is operator then
26:       Save currentChar, ADVANCE return OPERATOR
27:     else
28:       return Error
29:     end if
30:   end while return EOF token
31: end procedure
```

- Syntax Analyzer

Algorithm 2 Syntax Analyzer

```
1: procedure PARSER(lexer, semanticAnalyzer)
2:   currentToken  $\leftarrow$  lexer.getNextToken()
3:   while currentToken is not EOF do
4:     if currentToken.value is 'declare' then
5:       HandleDeclare()
6:     else if currentToken.value is 'show' then
7:       HandleShow()
8:     else if currentToken.tokenType is 'CHAR' then
9:       HandleAssignment()
10:    else
11:      Throw Error("Unexpected token")
12:    end if
13:  end while
14: end procedure
15: procedure HANDLEDECLARE
16:   name, value  $\leftarrow$  currentToken.value, expr()
17: end procedure
18: procedure HANDLESHOW
19:   token  $\leftarrow$  lexer.currentToken
20:   if token.tokenType is 'STRING' then
21:     Print token.value without quotes
22:     eat('STRING')
23:   else if token.tokenType is 'CHAR' then
24:     Print value of variable token.value
25:     eat('CHAR')
26:   else
27:     Throw Error("Invalid show statement")
28:   end if
29: end procedure
30: procedure HANDLEASSIGNMENT
31: end procedure
```

- Semantic Analyzer

x‘

Algorithm 3 Semantic Analyzer

```
1: procedure SEMANTICANALYZER
2:   symbolTable  $\leftarrow$  dictionary Constructor(): Initialize symbolTable as an
   empty dictionary End Constructor
3:   procedure DECLAREVARIABLE(name, value, declarationType, type)
4:     if name exists in symbolTable then Throw Error("Variable 'name' is
   already declared")
5:
6:     procedure ASSIGNVARIABLE(name, value)
7:       if name doesn't exist in symbolTable then Throw Error("Unde-
   clared variable 'name'")
8:       end if
9:       Set value to symbolTable[name].value
10:    end procedure
11:    procedure CHECKVARIABLE(variableName)
12:      if variableName doesn't exist in symbolTable then Throw Er-
   ror("Undeclared variable 'variableName'")
13:      end if
14:    end procedure
15:    procedure CHECKDIVISIONBYZERO(divisor)
16:      if divisor is equal to 0 then Throw Error("Division by zero")
17:      end if
18:    end procedure
19:    procedure GETVARIABLEVALUE(variableName)
20:      Call checkVariable(variableName)
21:      return symbolTable[variableName].value
22:    end procedure
23:    procedure GETVARIABLETYPE(variableName)
24:      Call checkVariable(variableName)
25:      return symbolTable[variableName].type
26:    end procedure
27:
```

8.6 Testing

- Comprehensive testing was conducted throughout the development process to validate the correctness and robustness of our language implementation. Unit tests were written to cover individual components, while integration tests verified the interaction between different modules. Additionally, we conducted user testing sessions to gather feedback on the usability and effectiveness of our programming language.

8.7 Future Enhancements

- Optimization: Exploring opportunities for optimizing code generation and execution to improve performance.
- Expanded Standard Library: Adding more built-in functions and libraries to extend the capabilities of the language.
- Language Extensions: Introducing new language features and constructs to support advanced programming paradigms.

Chapter 9

Software Testing

9.1 Testing methodology

Manual testing is a type of software testing where testers evaluate software or application quality manually, without the help of automated testing tools or executing test scripts. Testers interact with the system similar to how an end user would to identify bugs, defects, and issues in the software that create friction in user experience.

9.2 Test Cases

We performed manual testing where we tested our language on different parameters.

- **Test Case 1**

- **TEST CASE ID:** CB0101

- **Test Scenario:** Declaration of Variables

- In this we checked the basic functionality of our programming language - declaring variables. We introduced a new keyword "declare" to create new variables.

- **Test Steps:**

- * User tries to declare the variable with any type of name.

- * User follows the declaration paradigm

- * User clicks on the run button

- **Test Data:** declare a=10

- **Expected Result:** Code Executed Successfully!

- **Actual Result:** Code Executed Successfully!

- **Status:** Pass

- **Test Case 2**

- **TEST CASE ID:** CB0102

- **Test Scenario:** Printing of Variables.

- In this we checked the basic functionality of our programming language - printing the value of pre-defined variables. We introduced a new keyword "show" to print any value or a string.

- **Test Steps:**

- * User uses the show method to print the value of variable
 - * User follows the declaration paradigm
 - * User clicks on the run command
 - **Test Data:** declare a=10
 - **Expected Result:** Code Executed Successfully!
 - **Actual Result:** Code Executed Successfully!
 - **Status:** Pass
- **Test Case 3**
 - **TEST CASE ID:** CB0103
 - **Test Scenario:** Performing arithmetic operations
In this we checked the basic functionality of our programming language - arithmetic operations. Almost all arithmetic and comparison operators work in CodeBasic.
 - **Test Steps:**
 - * User declare two variables and assigns them values.
 - * User performs basic arithmetic operations (+,-,*,/)
 - * User clicks on run button
 - **Test Data:** declare a=10 declare b=5 declare z=a+b show z
z=a-b show z z=a*b show z z=a/b show z
 - **Expected Result:** 15, 5, 50, 2
 - **Actual Result:** 15, 5, 50, 2
 - **Status:** Pass
- **Test Case 4**
 - **TEST CASE ID:** CB0104

- **Test Scenario:** Performing Complex Operations.

In this we performed complex mathematical operations which require sequence points execution in order to yield accurate results.

- **Test Steps:**

- * User performs complex operations using different arithmetic operators.

- * User clicks on the run command

- **Test Data:** declare $a=10+2/3-5*4$

- **Expected Result:** -9.333333333333334

- **Actual Result:** -9.333333333333334

- **Status:** Pass

- **Test Case 5**

- **TEST CASE ID:** CB0105

- **Test Scenario:** if-else conditionals.

In this we checked the most common feature of CodeBasic - if-else conditionals. We introduced keywords "if", "ENDif", "else", "ENDelse". If the condition is true it should execute the if block and skip the else block and vice-versa.

- **Test Steps:**

- * User tries to perform if-else conditionals

- * User follows the if-else syntax and paradigm

- * User clicks on the run button

- **Test Data:** declare $a=9$

if($a>10$)

```
show a
ENDif
else show 10
ENDelse
```

- **Expected Result:** 10
- **Actual Result:** No Output
- **Status:** Fail

- **Test Case 6**

- **TEST CASE ID:** CB0106
- **Test Scenario:** Inbuilt methods - type(), length(), etc.
In this, we implemented basic methods of any programming language like type(), length(), etc. The type() method is used to check the type of variable declared. The length() method is used to return the size of the string.
- **Test Steps:**
 - * User tries to run type() method on variable to reveal it's type.
 - * User tries to run length() method on strings to reveal their length.
 - * User clicks on the run button
- **Test Data:** declare a=10 show a.type()
- **Expected Result:** INTEGER
- **Actual Result:** INTEGER
- **Status:** Pass

Chapter 10

Result

10.1 Code Execution

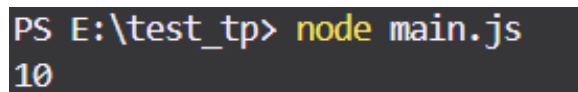
10.1.1 Declaring variables in CodeBasic

To declare variables, we directly created a keyword "declare".



```
declare a=10
```

Figure 10.1: initialising variable a using declare keyword

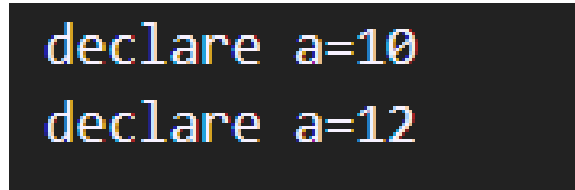


```
PS E:\test_tp> node main.js
10
```

Figure 10.2: Output for the above piece of code

10.1.2 Handling re-declarations of variables

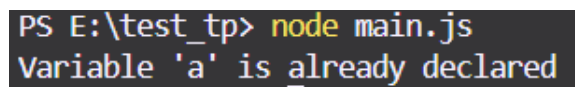
CodeBasic properly handles re-declared variables by checking their existence in the symbol table.



```
declare a=10  
declare a=12
```

A code snippet on a dark background showing two lines of code: 'declare a=10' followed by 'declare a=12'.

Figure 10.3: Redeclaration of variable a



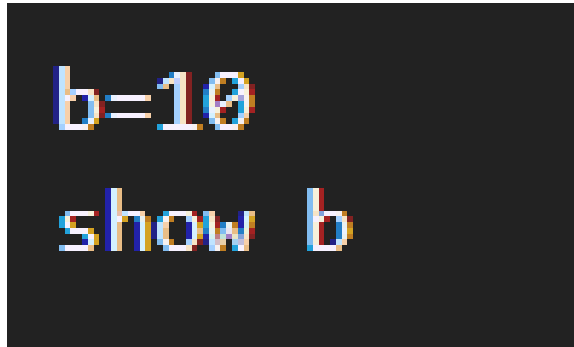
```
PS E:\test_tp> node main.js  
Variable 'a' is already declared
```

A terminal window screenshot with a black background. The first line shows a command prompt 'PS E:\test_tp>' followed by the command 'node main.js'. The second line shows the output error message 'Variable 'a' is already declared'.

Figure 10.4: Error Message for re-declaration

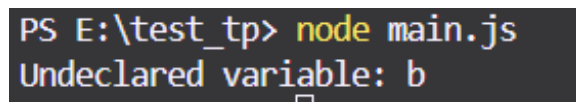
10.1.3 Handling Undeclared variables

CodeBasic properly handles undeclared variables by checking their existence in the symbol table. If a variable is absent, it reports an error, as shown in Figure 10.7.



```
b=10  
show b
```

Figure 10.5: Using an undeclared variable b



```
PS E:\test_tp> node main.js  
Undeclared variable: b
```

Figure 10.6: Error message for undeclared variable

10.1.4 Performing arithmetic operations

Codebasic is capable of performing all basic mathematical operations like addition, subtraction, multiplication, division.

```
declare a=10
declare b=5
declare z=0
z=a+b
show z
z=a-b
show z
z=a*b
show z
z=a/b
show z
```

Figure 10.7: Basic Arithmetic Operations

```
PS E:\test_tp> node main.js
15
5
50
2
```

Figure 10.8: Arithmetic Operations Output

10.1.5 Printing the output

To print anything unlike in C++ and Java where `cout` and `System.out.println()` is used, we created a reserved keyword `show`

```
declare a=10
show a
```

Figure 10.9: Declaring `a` and logging the value of `a` in console using `show`

10.1.6 Login Page

We made a login page using HTML, CSS and inclusion of `vanta.js`

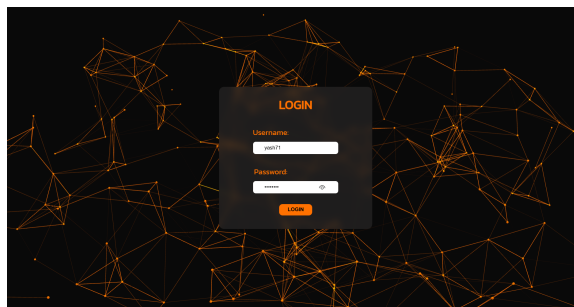


Figure 10.10: Login Page

10.1.7 Lander Page

We made a registration page for registering new users using HTML, CSS and inclusion of `vanta.js` and `Firebase`.

Chapter 11

Other Specifications

11.1 Advantages

Some of the advantages of our project include:

- **Lower Entry Barrier:** An easy-to-understand language reduces the intimidation factor for beginners. They are more likely to start coding and explore programming concepts when the language is approachable.
- **Faster Learning Curve:** Beginners can grasp fundamental programming concepts more quickly, as they don't need to spend as much time wrestling with complex syntax and language features.
- **Increased Motivation:** Success and progress come faster in an easy-to-understand language, boosting motivation. Beginners are more likely to stick with programming when they see tangible results sooner.
- **Reduced Frustration:** Learning programming can be challenging, but an easy-to-understand language minimizes frustration. Beginners encounter fewer syntax errors and are less likely to get stuck on obscure language details.
- **Focus on Core Concepts:** Simplified syntax allows beginners to concentrate on learning essential programming concepts, such as variables, loops, and conditionals, rather than getting bogged down in language-specific intricacies.
- **Enhanced Problem-Solving Skills:** When beginners can express their ideas and solutions more naturally in code, they are

better equipped to develop problem-solving skills, a crucial aspect of programming.

- **Engagement and Creativity:** Easier languages encourage beginners to be creative and experiment with their code. They can quickly implement their ideas and see the outcomes, sparking enthusiasm and creativity.

11.2 Limitations

- **Limited Expressiveness:** To make the language easy for beginners, it may lack advanced features and expressiveness found in more complex languages, which could limit its applicability for certain projects.
- **Transition Challenges:** When beginners eventually transition to more complex languages, they may face challenges adapting to the syntax, paradigms, and features that differ significantly from the beginner-friendly language.
- **Reduced Exposure to Real-World Complexity:** An overly simplified language may shield beginners from real-world complexity, potentially leaving them unprepared for dealing with more intricate software development tasks.
- **Compatibility Issues:** Code written in a beginner-friendly language may not easily integrate with or be compatible with existing codebases or libraries, limiting its utility in professional development environments.

11.3 Applications

- **Education:** A beginner-friendly language is ideal for teaching programming concepts in schools, coding bootcamps, and online courses. It helps students grasp the fundamentals and build a solid foundation for more complex languages.
- **Personal Projects:** Beginners can use the language to create simple personal projects, such as personal websites, games, and small automation tasks, allowing them to apply their newfound skills.
- **Prototyping:** It's well-suited for rapid prototyping of ideas and proof-of-concept projects, enabling developers to quickly turn concepts into working code.
- **Web Development:** Beginner-friendly languages are often used for web development, especially for creating static websites, simple web applications, and personal blogs.
- **STEM Education:** In science, technology, engineering, and mathematics (STEM) education, a beginner-friendly language can help students experiment with mathematical and scientific concepts through coding.

Chapter 12

Conclusion and Future Scope

12.1 Conclusion

In conclusion, crafting a programming language tailored for beginners is a pivotal endeavor with transformative potential. Such a language not only serves as a practical coding tool but also functions as an educational gateway, demystifying the complexities of traditional programming languages. By prioritizing simplicity and user-friendly features, we empower novice programmers to grasp fundamental concepts more intuitively. The continuous refinement of this language offers an evolving platform that aligns with users' knowledge levels and learning trajectories. Moreover, the prospect of transitioning to a dedicated local environment underscores our commitment to providing a seamless and comprehensive learning experience. In essence, designing a programming language for beginners is not just about writing code; it's about opening doors to the vast world of programming with accessibility, encouragement, and a supportive learning environment.

12.2 Future Scope

As we advance in this project, the programming language we're developing holds immense value for novice programmers grappling with traditional languages. It serves not only as a practical coding tool but also as an educational platform, offering insights into programming concepts and tools tailored to the user's knowledge and engagement level.

Some of the enhancements that might be visible in near future are as follows

- Object Oriented Programming Support
- Code Completion and intellisense
- Dedicated user code area
- optimisation of complex codes with the help of code optimiser
- Recursion
- Complex conditionals and Looping statements

Future enhancements could extend its utility to operate locally, providing a dedicated environment that fosters a deeper understanding of programming principles. This evolution aligns with our commitment to empower learners and simplify the often daunting landscape of conventional programming languages.

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CODEBASIC: A PROGRAMMING LANGUAGE FOR BEGINNER PROGRAMMERS USING ML AND CLOUD

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ABSTRACT

CodeBasic is a pioneering web-based programming language designed to empower beginner programmers who often struggle with the complexities of traditional programming languages. This research paper presents the development and implementation of this innovative language, which aims to provide a more accessible and user-friendly approach to coding.

The backend of CodeBasic is built using TypeScript, providing a robust and scalable foundation for the compiler phases. The frontend, on the other hand, is designed using HTML, CSS, and JavaScript, ensuring a seamless and intuitive user experience within a web-based Integrated Development Environment (IDE).

A key aspect of CodeBasic is its ability to support all conventional programming language paradigms, such as variable declaration and comprehensive error reporting for issues like multiple declarations or undeclared variables. This comprehensive approach enables beginner programmers to gradually build a solid understanding of programming concepts while being guided by the language's intuitive design.

The web-based nature of CodeBasic is a significant advantage, as it allows users to access and utilize the language directly from their web browsers, without the need for complex installations or setup. This accessibility opens up the world of programming to a wider audience, making it easier for individuals to explore and experiment with coding in a streamlined, online environment.

Through the development of CodeBasic, this research paper aims to address the challenges faced by beginner programmers, who often find the syntax, conversion, and overall complexity of traditional programming languages to be a significant barrier to entry. By providing a more approachable and user-friendly alternative, CodeBasic has the potential to revolutionize the way individuals learn and engage with programming, fostering a more inclusive and diverse community of coders.

INTRODUCTION

The field of computer programming has long been dominated by complex and intimidating programming languages, often creating a significant barrier to entry for aspiring developers, particularly those new to the field. Traditional programming languages require a deep understanding of intricate syntax, language conversion, and a wide range of programming concepts, which can be overwhelming for beginners.

In response to this challenge, the research team at [Project Name] has developed CodeBasic, a revolutionary web-based programming language designed specifically for beginner programmers. CodeBasic aims to bridge the gap between the complexity of conventional programming languages and the needs of individuals who are just starting their coding journey.

At the heart of CodeBasic is a comprehensive web-based platform that integrates both the backend compiler phases, built using TypeScript, and the user-friendly frontend, developed with HTML, CSS, and JavaScript. This seamless integration allows users to write and execute their code directly within a web-based Integrated Development Environment (IDE), eliminating the need for complex software installations or setup.

One of the key features of CodeBasic is its ability to support all the conventional programming language paradigms, including variable declaration, error reporting for multiple declarations or undeclared variables, and more. This comprehensive approach ensures that beginner programmers can gradually build a solid foundation in programming concepts while being guided by the language's intuitive design.

The primary goal of CodeBasic is to foster a more accessible and approachable path for individuals new to the world of programming. By simplifying the syntax, reducing the cognitive load of language conversion, and providing clear and informative error reporting, CodeBasic aims to break down the daunting hurdles that often discourage aspiring programmers.

This research paper delves into the development and implementation of CodeBasic, highlighting its innovative features, the underlying technical architecture, and the potential impact on the programming education landscape. Through the creation of CodeBasic, the research team seeks to empower a new generation of coders, making the world of programming more inclusive and accessible to individuals from diverse backgrounds.

PROBLEM STATEMENT

Traditional programming languages present a steep learning curve for beginner programmers, creating significant barriers to entry. The complexity of syntax, language conversion, and lack of intuitive error reporting often discourages aspiring coders, particularly those from non-technical backgrounds or with limited prior experience.

This problem has resulted in a lack of diversity and inclusivity in the field of computer programming, as many individuals are deterred from pursuing coding due to the overwhelming challenges posed by conventional programming languages.

To address these issues, there is a need for a more accessible and user-friendly programming language that caters to the needs of beginner programmers. Such a language should simplify the syntax, reduce the cognitive load of language conversion, and provide clear and informative error reporting, enabling aspiring coders to build a solid foundation in programming concepts without being overwhelmed.

PROPOSED SYSTEM

To address the challenges faced by beginner programmers, the research team has developed a revolutionary web-based programming language called CodeBasic. CodeBasic is designed to provide a more accessible and user-friendly approach to coding, empowering individuals new to the field of computer programming.

A. Web-based Platform

CodeBasic is a completely web-based project, allowing users to access and utilize the language directly from their web browsers. This eliminates the need for complex software installations or setup, making the language more accessible to a wider audience.

B. Backend Compiler Phases

The backend of CodeBasic is built using TypeScript and consists of the following compiler phases:

Lexical Analysis: The lexer phase of the CodeBasic compiler responsible for breaking the input code into a sequence of tokens, which represent the basic elements of the language syntax

Syntax Analysis: The parser phase of the CodeBasic compiler that takes the stream of tokens and constructs an abstract syntax tree (AST), representing the grammatical structure of the input code.

Semantic Analysis: The semantic analysis phase of the CodeBasic compiler that checks the code for semantic correctness, such as type checking and variable declaration validation.

Code Generation: The final phase of the CodeBasic compiler that generates the executable code from the validated AST.

C. Frontend Design

The frontend of CodeBasic is designed using HTML, CSS, and JavaScript, ensuring a seamless and intuitive user experience within the web-based IDE. Users can write and execute their code directly within this environment.

D. Support for Conventional Programming Paradigms

CodeBasic supports all the conventional programming language paradigms, including variable declaration, error reporting for multiple declarations or undeclared variables, and more. This comprehensive approach enables beginner programmers to gradually build a solid understanding of programming concepts while being guided by the language's user-friendly design.

E. Simplified Syntax

One of the key goals of CodeBasic is to simplify the syntax of traditional programming languages, reducing the cognitive load for beginner programmers. The language's design aims to make the coding process more intuitive and accessible, allowing users to focus on learning programming concepts rather than struggling with complex syntax

F. Intuitive Error Reporting

CodeBasic provides clear and informative error reporting, helping beginner programmers identify and resolve issues in their code. This feature addresses the common challenge of cryptic error messages in traditional programming languages, enabling users to learn from their mistakes and progress more effectively.

By integrating these features, the proposed CodeBasic system aims to bridge the gap between the complexity of conventional programming languages and the needs of beginner programmers. This innovative web-based language has the potential to revolutionize the way individuals approach and learn computer programming, fostering a more inclusive and diverse community of coders.

METHODOLOGY

The development of the CodeBasic programming language follows a comprehensive methodology to ensure its effectiveness in addressing the challenges faced by beginner programmers. The key aspects of the methodology are as follows:

1. Requirements Gathering and Analysis:

- Conducted extensive research and interviews with beginner programmers to understand their pain points, learning preferences, and expectations from a programming language.
- Identified the key features and functionalities that would make a programming language more accessible and user-friendly for beginners.

2. Language Design and Specification:

- Defined the syntax and grammar of CodeBasic, focusing on simplicity and intuitive structure.
- Determined the set of programming language paradigms and constructs to be supported, including variable declaration, error handling, and control flow.

3. Backend Compiler Implementation:

- Developed the backend of CodeBasic using TypeScript, a statically typed superset of JavaScript.
- Implemented the compiler phases, including lexical analysis, syntax analysis, semantic analysis, and code generation.
- Ensured the compiler could accurately interpret and execute CodeBasic code

4. Frontend Development:

- Designed the web-based IDE using HTML, CSS, and JavaScript to provide a seamless user experience.
- Integrated the frontend with the backend compiler, enabling users to write, execute, and debug their CodeBasic programs.
- Implemented features like syntax highlighting, code completion, and real-time error reporting to enhance the coding experience.

5. Testing and Evaluation:

- Conducted extensive unit testing and integration testing to validate the functionality and correctness of the CodeBasic compiler and frontend.
- Performed usability testing with a diverse group of beginner programmers to gather feedback and identify areas for improvement.
- Incorporated user feedback into the iterative development process to continuously refine and enhance the CodeBasic system.

6. Documentation and Deployment:

- Documented the language specification, compiler architecture, and development processes to ensure maintainability and facilitate future enhancements.
- Deployed the CodeBasic system on a scalable web infrastructure, making it accessible to a wide audience of beginner programmers.

- Provided comprehensive user guides and tutorials to assist new users in learning and effectively utilizing the CodeBasic language.

By following this structured methodology, the research team ensures that the development of CodeBasic is grounded in the needs of beginner programmers, leverages robust technical foundations, and undergoes rigorous testing and evaluation. This approach aims to deliver a programming language that truly empowers aspiring coders and lowers the barriers to entry in the field of computer programming.

A. FIRST SET

FIRST(X) for a grammar symbol X is the set of terminals that begin the strings derivable from X.

FIRST set is a concept used in syntax analysis, specifically in the context of LL and LR parsing algorithms. It is a set of terminals that can appear immediately after a given non-terminal in a grammar. The FIRST set of a non-terminal A is defined as the set of terminals that can appear as the first symbol in any string derived from A. If a non-terminal A can derive the empty string, then the empty string is also included in the FIRST set of A.

The FIRST set is used to determine which production rule should be used to expand a non-terminal in an LL or LR parser. For example, in an LL parser, if the next symbol in the input stream is in the FIRST set of a non-terminal, then that non-terminal can be safely expanded using the production rule that starts with that symbol.

For example,

```
E → T E'
E' → +T E' | ε
T → F T'
T' → *F T' | ε
F → (E) | id
```

Using the rules of calculating the first set, we can find the first set of the each non-terminal as follows:

```
FIRST(E) = {(, id}
FIRST(E') = {+, ε}
FIRST(T) = {(, id}
FIRST(T') = {*, ε}
FIRST(F) = {(, id}
```

B. FOLLOW SET

In compiler design, the concept of follow sets plays a crucial role in the construction of predictive parsers, specifically for LL(1) grammars. The follow set of a non-terminal in a context-free grammar represents the set of terminals that can immediately follow occurrences of that non-terminal in a derivation. In other words, it helps determine the possible terminals that can appear next in the input string after parsing a specific non-terminal.

The follow set is essential for parsing table construction, which is a key step in the implementation of top-down parsing algorithms. By identifying the follow set for each non-terminal, compiler designers can efficiently resolve parsing ambiguities and predict the correct production to use during parsing. The follow set is typically used in conjunction with the first set of non-terminals to guide the parser in making decisions based on the current input symbol.

The follow set is computed by considering the possible symbols that can follow a non-terminal in the grammar. This includes terminals that may appear after occurrences of the non-terminal in various derivations. The follow set is particularly useful in error recovery mechanisms, aiding the parser in detecting and correcting syntax errors during the compilation process. Overall, understanding and computing follow sets contribute significantly to the design and implementation of efficient and robust compilers.

$\text{FOLLOW}(S) = \{\$ \}$
 $\text{FOLLOW}(B) = \{h, \$ \}$
 $\text{FOLLOW}(C) = \{h, \$ \}$
 $\text{FOLLOW}(D) = \{h, \$ \}$
 $\text{FOLLOW}(E) = \{f, \$ \}$
 $\text{FOLLOW}(F) = \{h, \$ \}$

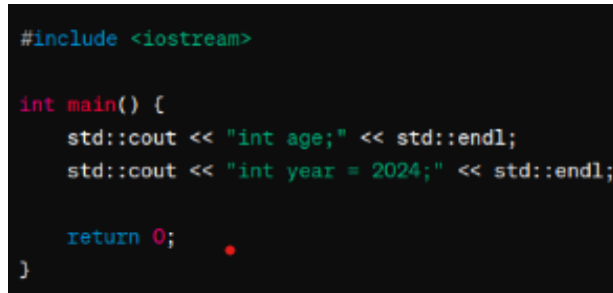
Using the rules of calculating the follow set, we can find the follow set of non-terminals as follows:

$\text{FOLLOW}(S) = \{\$ \}$
 $\text{FOLLOW}(B) = (\text{FIRST}(D) - \{\epsilon\}) \cup \text{FIRST}(h) = \{g, f, h\}$
 $\text{FOLLOW}(C) = \text{FOLLOW}(B) = \{g, f, h\}$
 $\text{FOLLOW}(D) = \text{FIRST}(h) = \{h\}$
 $\text{FOLLOW}(E) = (\text{FIRST}(F) - \{\epsilon\}) \cup \text{FOLLOW}(D) = \{f, h\}$
 $\text{FOLLOW}(F) = \text{FOLLOW}(D) = \{h\}$

RESULT

A. Variable Declaration

1) Declaring Variables in other programming languages like C++:



```
#include <iostream>

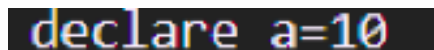
int main() {
    std::cout << "int age;" << std::endl;
    std::cout << "int year = 2024;" << std::endl;

    return 0;
}
```

Fig 4.1: Variable declaration

2) Declaring Variables in CodeBasic:

To declare variables, we directly created a keyword "declare"

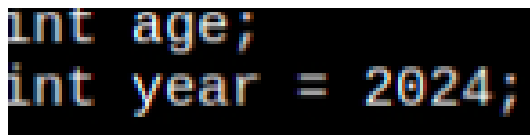


```
declare a=10
```

B. Printing the Output:

1) Printing the output for other programming language like C++ :

To print the output in C++ we use the keyword "cout"

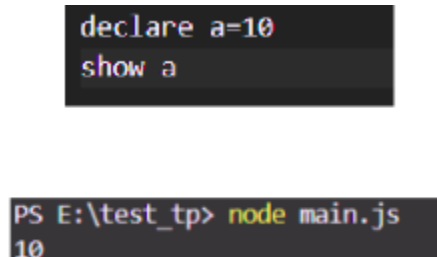


```
int age;
int year = 2024;
```

Fig 4.2: Printing the Output

2) Printing the output in CodeBasic :

To print anything unlike in C++ where cout is used, we created a reserved keyword "show"



```
declare a=10
show a
```

```
PS E:\test_tp> node main.js
10
```

Fig 4.3: Use of Show keyword

CONCLUSION

The development of CodeBasic, a web-based programming language designed for beginner programmers, represents a significant step towards addressing the longstanding challenges faced by individuals new to the field of computer programming. By addressing the complexities of traditional programming languages, CodeBasic offers a more accessible and user-friendly approach to coding, empowering a wider audience to explore and engage with the world of programming.

Through the comprehensive methodology employed in the development of CodeBasic, the research team has successfully integrated a range of innovative features that cater to the needs of beginner programmers. The web-based platform, intuitive frontend design, and robust backend compiler phases collectively contribute to a seamless and accessible coding experience.

One of the key strengths of CodeBasic is its ability to support all the conventional programming language paradigms, including variable declaration, error reporting, and control flow. This comprehensive approach allows beginner programmers to gradually build a solid foundation in programming concepts while being guided by the language's simplified syntax and clear error reporting.

The potential impact of CodeBasic on the programming education landscape cannot be overstated. By lowering the barriers to entry and making the coding process more accessible, CodeBasic has the power to attract and retain a more diverse pool of aspiring programmers, fostering a more inclusive and dynamic community of coders.

As the research and development of CodeBasic continue, the team remains committed to exploring further enhancements and expansions to the language, ensuring that it keeps pace with the evolving needs of beginner programmers. Through ongoing user feedback, iterative improvements, and a steadfast focus on accessibility and user-friendliness, CodeBasic is positioned to be a transformative force in the world of programming education and beyond.

In conclusion, the CodeBasic programming language represents a significant stride towards democratizing the field of computer programming. By addressing the core challenges faced by beginner programmers, CodeBasic has the potential to inspire and empower a new generation of coders, ultimately contributing to a more diverse and inclusive technological landscape.

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