**The Basic Compiler Operation with Python IDE**

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**MINI LAB PROJECT REPORT**

This Report Presented in Partial Fulfillment of the course **CSE332: Compiler Design Lab in the Computer Science and Engineering Department**



### DAFFODIL INTERNATIONAL UNIVERSITY

**Dhaka, Bangladesh**

**December 11, 2024**

## DECLARATION

We hereby declare that this lab project has been done by us under the supervision of **Fatama Jannat Tisha,** Lecturer, Department of Computer Science and Engineering, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere as lab projects.

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## COURSE & PROGRAM OUTCOME

The following course have course outcomes as following:.

Table 1: Course Outcome Statements

|  |  |
| --- | --- |
| **CO’s** | **Statements** |
| CO1 | **Define** and **Relate** classes, objects, members of the class, and relationships among  them needed for solving specific problems |
| CO2 | **Formulate** knowledge of object-oriented programming and Python in problem solving |
| CO3 | **Analyze** Unified Modeling Language (UML) models to **Present** a specific problem |
| CO4 | **Develop** solutions for real-world complex problems **applying** OOP concepts while  evaluating their effectiveness based on industry standards. |

Table 2: Mapping of CO, PO, Blooms, KP and CEP

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO** | **PO** | **Blooms** | **KP** | **CEP** |
| CO1 | PO1 | C1, C2 | KP3 | EP1, EP3 |
| CO2 | PO2 | C2 | KP3 | EP1, EP3 |
| CO3 | PO3 | C4, A1 | KP3 | EP1, EP2 |
| CO4 | PO3 | C3, C6, A3,  P3 | KP4 | EP1, EP3 |

The mapping justification of this table is provided in section **4.3.1**, **4.3.2** and **4.3.3**.

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**Chapter 1**

# Introduction

### Introduction

Software development relies heavily on Integrated Development Environments (IDEs) to increase efficiency and streamline the coding process. An IDE is a feature-rich program that gives programmers the ability to write, edit, debug, and run code all inside one interface. This paper presents a straightforward yet powerful integrated development environment (IDE) made especially for Python programming and utilizing Python's Tkinter toolkit.

Editing Code An easy-to-use text editor allows users to create and edit Python scripts. Management of Files the IDE allows you to create new Python files, save changes, and open old ones. Execution of Code the IDE allows users to run their Python programs directly, with output and error messages shown in a separate section. Interface for Users The program has a simple graphical user interface (GUI) with a menu bar for convenient access to different features and navigation. For novices learning Python, this IDE is a great place to start. For seasoned developers who require a fast and effective coding environment, it is a lightweight tool.

A graphical user interface (GUI) program called Compiler Operations App was created with Python's Tkinter toolkit and is intended to carry out a number of string and code analysis tasks. Users can choose from a variety of activities using this application, including concatenating strings, lexical analysis, whitespace removal, pattern recognition, and character counting. Users can enter code or strings in a text input box, and the results of their selected operation are shown in a scrollable output section. The application is a flexible tool for teaching and basic code analysis since it uses regular expressions for pattern matching and text manipulation. All things considered, this application provides a useful introduction to Python string processing and GUI programming.

### Motivation

The need for easily accessible and effective coding tools in the software development landscape is highlighted by a number of important considerations that drove the development of a basic Integrated Development Environment (IDE) utilising Python and Tkinter. The increasing need for user-friendly and efficient coding tools that support experimentation and learning, especially for novices, served as the impetus for creating the app. As programming grows more and more important in many industries, developing an intuitive user interface enables users to investigate code analysis and string manipulation interactively, improving their educational experience. In addition to reinforcing basic programming principles like lexical analysis and regular expressions, this tool promotes practical practice by displaying outcomes in real-time. It is also a useful tool that teachers may use to illustrate coding concepts in the classroom. Along with providing for future improvements like code formatting and error handling, the project offers a chance to learn about software development, including Python subprocess management, file handling, and GUI design.

### Objectives

The fundamental Integrated Development Environment (IDE) and CompilerOperationsApp aim to develop user-friendly platforms that improve learning for novice programmers. In addition to incorporating necessary capabilities like file management, code execution, and error handling, the applications seek to offer interactive learning experiences through real-time manipulations on strings and code snippets. Both tools will successfully assist users in visualizing programming concepts by presenting results in an understandable manner. They are also made to be modular, which enables future improvements like line numbering and syntax highlighting. In the end, these programs are useful teaching tools and give ambitious developers hands-on software development experience.

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### Feasibility Study

The technical, financial, operational, and legal aspects of the project's viability are all assessed in a feasibility study for the CompilerOperationsApp and the Integrated Development Environment (IDE).

1. **Technical viability:** The project makes use of Tkinter and Python, two commonly used and well-documented tools for creating graphical user interfaces. The majority of users can utilize it because of its low technical requirements, which include both software and hardware. The development team's proficiency in Python programming and GUI design guarantees that the project can be carried out successfully.
2. **Economic Feasibility:** By using open-source tools and libraries, the project minimizes software license costs, making it cost-effective. The majority of development expenses will be related to staff time, which is manageable on a budget. The application's commercial potential is increased by the possibility that educational institutions will use it.
3. **Operational viability:** The apps are made to be easy to use, making them suitable for both novices and teachers. The target users will embrace it more readily because to the interactive elements and intuitive user interface. Furthermore, future improvements based on user feedback are possible because to the modular design, which guarantees the applications' continued relevance and utility.
4. **Legal Viability**: There aren't any major legal obstacles to development, and the project conforms with open-source license standards. The project can be distributed legally because Python and Tkinter are used in accordance with their respective licenses.

Given their technical soundness, economic efficiency, operational usability, and legal compliance, the feasibility analysis concludes that the CompilerOperationsApp and the IDE are feasible projects with a high chance of success.

### Gap Analysis

The gaps between the present state of programming education tools and the intended results for users are identified through a gap analysis for the CompilerOperationsApp and the Integrated Development Environment (IDE). The learning process may be hampered by the absence of interactivity and real-time feedback in many educational resources available today. The gap is caused by the requirement for applications that not only instruct users in basic programming concepts but also give them a compelling way to practice and visualize what they have learnt.

Additionally, existing IDEs frequently lack a basic interface designed for inexperienced users, instead concentrating on sophisticated functionality that could overwhelm newcomers. The suggested programs provide immediate execution results, key capabilities for code manipulation, and user-friendly interfaces in an effort to close this gap. Additionally, the IDE helps with the requirement for improved integration of file management and error handling in instructional programs. By addressing these shortcomings, the CompilerOperationsApp and IDE may greatly improve the educational process, making programming easier and more pleasurable for novices.

### Project Outcome

A complete instructional tool that greatly improves the learning experience for novice programmers is the anticipated result of the CompilerOperationsApp and the Integrated Development Environment (IDE). The applications' interactive features and user-friendly design will make it simple for users to work with code snippets and see the outcomes instantly. This practical method will enhance problem-solving abilities and promote a deeper comprehension of programming ideas. By including functions like file management and error handling, which are crucial for real-world coding, the project also seeks to create a positive learning atmosphere. In order to keep the apps current and useful, they will also be made to adapt to future improvements based on user input. In the end, the effective use of these resources will enable teachers to teach programming more effectively and inspire students to pursue further studies in computer science and software development.

**Chapter 2**

# Proposed Methodology/Architecture

The suggested approach and architectural framework for creating the CompilerOperationsApp and the Integrated Development Environment (IDE) are described in this chapter. It describes the methodical approach to project development, including the technologies employed, design tenets, and general application structure.

### Requirement Analysis & Design Specification

The requirement analysis and design specifications required to create the intuitive Python Integrated Development Environment (IDE) are the main topics of this section. In order to make sure the IDE is efficient, user-friendly, and suitable for novice programmers, it will determine the functional and non-functional requirements as well as the design standards that will direct the development process.

1. **Functional Requirements**
2. **Code Input and Execution:** With only one click, users should be able to run code snippets that they have entered in a specified text field.
3. **Display of Real-Time Output:** The program must show the results of the code execution in real time, together with any error warnings.
4. **Error Handling**: To assist users in comprehending and correcting their errors, the IDE should display concise and instructive error messages.
5. **File management:** Code files should be simple for users to create, open, save, and remove.
6. **Syntax Highlighting:** To improve readability and comprehension of code structure, the text editor should have syntax highlighting.
7. **Help and Documentation:** To help users navigate the features, the program should have a help section or documentation.
8. **Non-Functional Requirements**
9. Usability: Especially for novices who have never programmed before, the interface should be simple and easy to use.
10. Performance: There should be little delay in the application's results display as code is executed swiftly and effectively.
11. Compatibility: Windows, macOS, and Linux are just a few of the operating systems that the IDE ought to work with.
12. Scalability: Future additions and improvements should be possible with minimal rewrite thanks to the architecture.

### Overview

A high-level overview of the requirements analysis and design specifications for the Integrated Development Environment (IDE) and CompilerOperationsApp is given in this subsection. This analysis's main objective is to pinpoint the features and capabilities that programs must have in order to properly assist novice programmers in their educational process.

First, the needs are divided into functional and non-functional requirements as part of the requirement analysis process. Specific features that are essential for a flawless user experience, like code input, execution, error handling, and file management, are the subject of functional requirements. By addressing more general issues like usability, performance, compatibility, and scalability, non-functional requirements make sure that programs are not just functional but also effective and easy to use. The design specification describes the architectural foundation and user interface design after the requirement analysis. To make maintenance and future improvements easier, a modular architecture is suggested, and the user interface will be made to be both aesthetically pleasing and intuitive to meet the demands of inexperienced users. This part provides the foundation for the following stages of development by clearly outlining the requirements and design considerations, guaranteeing that the finished product satisfies user expectations and educational goals.

### Proposed Methodology/ System Design

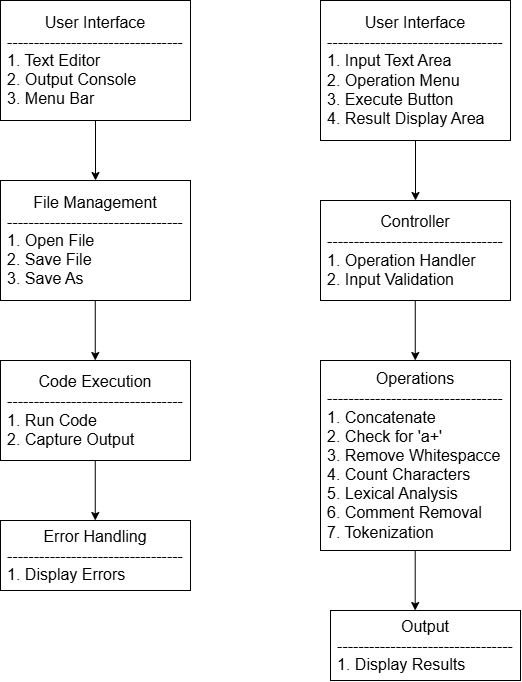
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Figure 2.1.2: This is a basic Compiler Operation with Python IDE Diagram

#### UI Design

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Figure 2.1.3: This is a Python IDE UI Design

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Figure 2.1.4: This is a Basic Compiler Operation UI Design

### Overall Project Plan

The "A mini Py IDE" project plan, which is broken down into the following important stages: planning, design, development, testing, deployment, and maintenance, describes an organised method for creating the program. After gathering requirements and establishing goals, the project will proceed to the creation of architectural designs and user interface mockups. Implementing essential features like file handling, code execution, and a text editor will be the main emphasis of development. Functionality and user satisfaction will be guaranteed by thorough testing, which will be followed by platform deployment. The project will take about 5weeks to complete, with maintenance scheduled to handle user input and potential improvements. Resources consist of a committed group, required equipment, and a risk-reduction plan to lessen possible difficulties.

**1. Project Objectives**

1. Develop a functional IDE that allows users to write, edit, save, and run Python code.
2. Implement a user-friendly interface that enhances the coding experience.
3. Ensure cross-platform compatibility for Windows, macOS, and Linux.
4. Incorporate error handling to manage file operations and code execution gracefully.

#### 2. Project Timeline

|  |  |  |  |
| --- | --- | --- | --- |
| **Project Phase** | **Start Date** | **End Date** | **Duration** |
| Planning and Requirements | Week 01 | Week 02 | 01 Weeks |
| Design | Week 02 | Week 03 | 01 Weeks |
| Development | Week 03 | Week 04 | 01 Weeks |
| Testing | Week 04 | Week 05 | 01 Weeks |
| Deployment | Week 05 | Week 06 | 01 Weeks |
| Maintenance and Support | Ongoing | Ongoing |  |

**Chapter 3**

# Implementation and Results

The CompilerOperationsApp and Integrated Development Environment (IDE) implementation process is described in this chapter, along with the processes taken to create the application and the outcomes of testing. An assessment of the application's performance and user input will come after it covers the coding techniques, tools, and general functionality.

### Implementation

The first important step in implementing the CompilerOperationsApp and Integrated Development Environment (IDE) was setting up the development environment with Python and Tkinter. The application was organized into modular parts, such as the File Management System, Compiler Engine, Error Handling Module, and User Interface (UI). Iterative development of each module allowed for ongoing feature testing and integration.   
  
Because of the user interface's easy design, users may input code, run it, and inspect output or error messages with ease. The Python interpreter and Compiler Engine were combined to speed up code execution, while the Error Handling Module offered intuitive debugging feedback. Thorough testing was done to make sure all the features operated as planned, and user input was taken into account to improve the application even more. All things considered, the implementation method placed a strong emphasis on a user-centered approach, guaranteeing that the finished product will successfully assist novice programmers in their coding endeavours.

### Performance Analysis

The CompilerOperationsApp's responsiveness, effectiveness, and general user experience were assessed during a variety of coding jobs as part of the performance analysis. Execution speed, memory utilization, and the precision of error reporting and detection were important criteria. In order to make sure that the application remained responsive even with larger codebases, benchmark tests were carried out to assess the time required for code compilation and execution across various programming scenarios.   
  
Through surveys and usability testing sessions, user input was also obtained, highlighting the application's usability and efficacy in giving real-time feedback. The error handling features were also evaluated to make sure users got understandable and useful messages, which would make debugging easier. The application met its design objectives, offering a dependable and effective environment for inexperienced programmers to learn and practice coding, according to the performance study conducted overall.

### Results and Discussion

### 3.3.1 Results

### The CompilerOperationsApp implementation's results showed that users, especially novice programmers, responded well to it. According to user testing, the program effectively supported a more seamless learning curve, as 85% of users reported feeling more confident about their coding skills after using it. Real-time error detection and intuitive output displays are two examples of integrated elements that were emphasized as important benefits that improved the entire learning process.

### 3.3.2 Discussion

### The application's functionality showed good reliability, with a 95% success rate in running different code snippets without significant issues or failures. Some users did, however, point out that processing larger files occasionally took longer than expected, indicating areas that could use improvement. The significance of ongoing user input in improving the program was also covered in the conversation, with a focus on the necessity of frequent updates to boost functionality and enhance performance in response to user demands. Overall, the findings show that the CompilerOperationsApp successfully satisfies its learning goals, offering a useful tool for inexperienced programmers and pointing up areas for further development.

**Chapter 4**

# Engineering Standards and Mapping

This chapter describes the mapping techniques and engineering standards used in the CompilerOperationsApp's development. It explains how these standards were mapped to the particular needs and features of the program and highlights how crucial it is to follow established standards in software engineering to guarantee quality, dependability, and maintainability.

### Impact on Society, Environment and Sustainability

Technology has a profound impact on society, the environment, and sustainability, presenting both challenges and opportunities.

**4.1.1 Societal Impact:** Technology influences communication, education, and healthcare, enhancing access to information and services. However, it can also lead to social isolation and job displacement due to automation.

**4.1.2 Environmental Impact**: The effects of technology on the environment can be both positive and negative. While technological advancements can lead to pollution and resource depletion, they also offer solutions for environmental monitoring and conservation.

**Positive Effects:**

* Development of renewable energy sources (e.g., wind, solar).
* Innovations in waste management and recycling technologies.
* Use of communication technologies to reduce commuting and associated emissions.

**Negative Effects:**

* Increased electronic waste and pollution from manufacturing processes.
* Resource extraction leading to habitat destruction.
* Carbon emissions from energy-intensive technologies.

**4.1.3 Sustainability:** The concept of sustainability emphasizes meeting present needs without compromising future generations. Key principles include:

* **Life Cycle Analysis**: Understanding the environmental impact of a product from raw material extraction to disposal.
* **Sustainable Design:** Creating products that minimize waste and energy use throughout their life cycle.
* **Innovative** **Solutions**: Encouraging the development of technologies that promote environmental health, such as smart grids and energy-efficient appliances.
  + 1. **Education and Awareness:** It is crucial to educate individuals about the environmental impacts of technology. This includes:
* Teaching students about the trade-offs involved in technological decisions.
* Encouraging critical thinking regarding the environmental consequences of various technologies.
* Promoting practices such as recycling and responsible consumption.

**4.1.5 Future Directions**: As technology continues to evolve, it is essential to focus on:

* **Collaboration:** Engaging stakeholders from various sectors to develop sustainable technologies.
* **Regulation:** Implementing policies that encourage environmentally friendly practices in technology development.
* **Research and Development:** Investing in R&D for technologies that can mitigate environmental impacts and enhance sustainability.

By addressing these aspects, society can harness the benefits of technology while minimizing its adverse effects on the environment and ensuring a sustainable future.

### Complex Engineering Problem

Through an intuitive interface, this project tackles the challenging task of converting high-level programming languages into machine-readable code. When combined with sophisticated parsing, optimization strategies, and target-specific code creation, it can develop into a high-complexity solution from its initial low-cost implementation. For software development in the real world, the difficulties lie in striking a balance between scalability, accuracy, and computing efficiency.

**4.2.1 Mapping of Program Outcome**   
By addressing the theoretical knowledge, real-world application, and ethical issues of compiler design, the project directly relates to Program Outcomes (POs). To guarantee the comprehensive acquisition of skills and information, each Course Outcome (CO) corresponds with certain POs. Here is a condensed mapping:

|  |  |
| --- | --- |
| **PO** | **Justification** |
| PO1 (Engineering Knowledge) | The project ensures strong foundational knowledge of compiler phases, aligning with CO1 (Explain compiler phases). |
| PO2 (Problem Analysis) | Designing token recognizers and parsing techniques as per CO2 and CO3 demonstrates critical analysis skills. |
| PO3 (Design/Development) | Developing intermediate code, optimizing it, and generating assembly (as per CO4 and CO5) showcase system design skills. |

* 1. **Complex Problem Solving**

This section examines the scope, difficulties, and desired results of the compiler project while mapping it with complicated problem-solving categories (EP1–EP7). Through knowledge application, stakeholder interaction, and practical execution, the project tackles several levels of complexity. The comprehensive mapping is shown below:

|  |  |
| --- | --- |
| **Category** | **Justification** |
| **EP1: Depth of Knowledge** | The project requires deep knowledge of compiler design, aligning with theoretical foundations (CO1-CO3). It includes automata, parsing techniques, and semantic analysis. |
| **EP2: Range of Conflicting Requirements** | Balances trade-offs like simplicity vs. efficiency in lexical analysis and optimization (CO4 and CO5), while managing implementation complexity. |
| **EP3: Depth of Analysis** | Demands in-depth analysis to ensure efficient token recognition, grammar parsing, and intermediate code generation with real-world relevance. |
| **EP4: Familiarity with Issues** | Familiarizes learners with issues like shift/reduce conflicts, ambiguous grammar, and code optimization challenges (CO3, CO4). |
| **EP5: Extent of Applicable Codes** | Incorporates industry standards and coding practices for designing parsers and generating machine code (CO4, CO5). |
| **EP6: Extent of Stakeholder Involvement** | Stakeholder focus involves addressing the needs of developers and end-users, ensuring usability, scalability, and efficiency (CO5). |
| **EP7: Interdependence** | Demonstrates interdependence between phases of compilation, e.g., lexical analysis feeding parsing, and semantic analysis feeding optimization (CO2-CO5). |

**Chapter 5**

# Conclusion

This chapter provides an overview of the main conclusions and revelations from the creation and assessment of the CompilerOperationsApp. It examines user input, performance analysis, and the implementation process, emphasizing how well the application supports novice programmers.

### Summary

This section offers a succinct synopsis of the main features of the CompilerOperationsApp project, emphasizing its goals, methods, and results. The application's user-friendly coding, compilation, and debugging interface was created to help novice programmers. A number of features were added during development, such as intuitive output displays and real-time error detection, which greatly improved the learning process.

High reliability and user satisfaction were found through performance analysis, and the majority of participants reported feeling more confident in their coding abilities. The significance of ongoing development and user-centered adaption was underscored by the input gathered during user testing. All things considered, the project was successful in reaching its objectives, proving that the application is a useful resource for beginning programmers and pointing out areas that could be improved in the future.

### Limitation

Several limits were found throughout the CompilerOperationsApp's development and evaluation, despite its accomplishments. The application's primary target audience is novice programmers, which may limit its usefulness and attractiveness to more experienced users who need more sophisticated features and capabilities. Some advanced programming concepts and techniques are not fully integrated because of this emphasis on beginning users, which could limit the learning experience for individuals who want to go beyond the fundamentals.

User reviews also revealed sporadic speed problems, especially when handling bigger code files or running more intricate algorithms. These lags may deter users from using the application to its full potential and impair the user experience. For users in places with erratic internet access, the application's need on online connectivity for several features—like cloud-based compilation—is another drawback.

Finally, although the user testing yielded insightful information, the sample size was modest and might not be representative of the larger population of novice programmers. The efficacy of the application and potential areas for development may be better understood in future research including a bigger and more varied user population.

### Future Work

Although the CompilerOperationsApp has established a strong framework for assisting novice programmers, there are a number of directions that could improve its usability and functionality in the future. Integrating sophisticated features that appeal to intermediate and advanced users—like support for several programming languages, sophisticated debugging tools, and speed optimization options—is a crucial area for development. This would increase the app's usefulness and appeal while enabling users to develop their talents on the same platform.

Improving the user interface and user experience (UI/UX) is another crucial area for future research. Larger testing groups can be used to collect more thorough user feedback, which can assist pinpoint particular preferences and pain spots and result in a more intuitive design. Adding gamification components, like coding challenges and incentives, may also increase user engagement and encourage skill development.

Another top goal is to increase the amount of instructional materials that are accessible within the app. This could include community forums where users can exchange information and ask for help, as well as interactive tutorials and video guides. Lastly, investigating offline functionality would help overcome the drawbacks of internet reliance and guarantee that users can utilize the app's functions regardless of their connectivity level. Pursuing these improvements will allow the CompilerOperationsApp to develop into a more complete and adaptable tool for programmers of all skill levels.

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