



(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 3, March 2025

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www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 3, March 2025

|DOI: 10.15680/IJIRSET.2025.1403120|

AI-Powered Code Completion Tools and Their Impact on Developer Productivity

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ABSTRACT: AI-powered code completion tools, such as GitHub Copilot, have revolutionized software development by automating repetitive coding tasks and providing real-time code suggestions. This paper explores the impact of these tools on developer productivity, focusing on their ability to reduce development time, improve code quality, and enhance overall efficiency. Through a review of existing literature, case studies, and experimental data, we analyze the benefits and challenges of AI-assisted coding. The findings reveal that developers using tools like GitHub Copilot complete tasks significantly faster, with a reported 55.8% reduction in completion time in controlled experiments . However, challenges such as dependency on AI-generated code, occasional inaccuracies, and security concerns remain. This paper concludes with recommendations for future enhancements and research directions to maximize the potential of AI-powered code completion tools in software development.

KEYWORDS: AI-powered code completion, GitHub Copilot, developer productivity, software development, code quality, AI-assisted coding.

I. INTRODUCTION

The integration of artificial intelligence (AI) into software development has led to the emergence of AI-powered code completion tools, such as GitHub Copilot. These tools leverage large language models (LLMs) like OpenAI's Codex to provide real-time code suggestions, automate repetitive tasks, and assist developers in writing code more efficiently. GitHub Copilot, launched in 2021, is an AI-powered code completion tool developed by GitHub in collaboration with OpenAI. It leverages the capabilities of OpenAI's Codex, a descendant of the GPT-3 model, to assist developers by suggesting code snippets, functions, and even entire algorithms as they write. The potential of these tools to enhance productivity is significant, with studies showing that developers using GitHub Copilot can complete tasks up to 55.8% faster than those without access to such tools . However, the adoption of AI-powered tools also raises concerns about code quality, security, and the potential for over-reliance on AI. This paper aims to explore the impact of AI-powered code completion tools on developer productivity, analyze their benefits and limitations, and propose future directions for research and development.

II. LITERATURE SURVEY

Recent studies have highlighted the transformative potential of AI-powered code completion tools in software development. For instance, GitHub Copilot has been shown to significantly reduce task completion times and improve coding efficiency. A survey conducted across various tech companies revealed that over 75% of developers reported increased satisfaction and productivity when using AI tools. However, challenges such as code quality, maintainability, and security have also been noted. For example, while AI tools can generate code quickly, the generated code may lack readability or introduce security vulnerabilities. Additionally, enterprise deployments of GitHub Copilot have shown mixed results, with acceptance rates for AI-generated code suggestions averaging 33%. These findings underscore the need for further research into optimizing AI-powered tools for both productivity and code quality.

III. PROBLEM STATEMENT

Despite the promising benefits of AI-powered code completion tools, several challenges remain unresolved. These include:

1. Code Quality: AI-generated code may lack readability, maintainability, and efficiency .





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2. Security Risks: AI tools can introduce vulnerabilities, such as insecure code snippets or reliance on outdated libraries.

3. Over-Reliance on AI: Developers may become overly dependent on AI tools, potentially leading to skill degradation.

4. Heterogeneous Effects: The benefits of AI tools vary across developers, with less experienced developers and those with heavier coding loads benefiting the most.

Addressing these challenges is critical to maximizing the potential of AI-powered tools in software development.

IV. PROPOSED TECHNOLOGY

The proposed technology focuses on enhancing AI-powered code completion tools like GitHub Copilot by integrating advanced features such as:

1. Context-Aware Suggestions: Improving the AI's ability to understand project-specific requirements and coding standards.

2. Code Quality and Security Checks: Incorporating automated checks for readability, maintainability, and security vulnerabilities.

3. Customization and Fine-Tuning: Allowing developers to fine-tune AI models based on their specific needs and preferences.

4. Collaborative Feature: Enabling real-time collaboration between developers and AI tools, such as pair programming and code reviews.

These enhancements aim to address the limitations of current AI tools while maximizing their productivity benefits.

V. SYSTEM COMPONENTS

The system architecture for an enhanced AI-powered code completion tool includes the following components:

1. User Interface (IDE Plugin): Integrates with popular IDEs like Visual Studio Code to provide real-time code suggestions.

2. AI Model (LLM): A pre-trained language model (e.g., OpenAI Codex) that generates code suggestions based on context.

3. Context Analyzer: Analyzes the developer's current code context to provide relevant suggestions.

4. Code Quality and Security Checker: Validates generated code for readability, maintainability, and security.

5. Feedback Loop: Collects developer feedback to improve the AI model over time.

6. Cloud Infrastructure: Hosts the backend on scalable cloud platforms (e.g., AWS, Azure) to ensure high availability and performance.

VI. TECHNIQUES TO BE USED

1. Machine Learning: Training LLMs on large datasets of code to generate accurate and context-aware suggestions.

2. Natural Language Processing (NLP): Enabling the AI to understand and respond to natural language queries from developers.

3. Static Code Analysis: Automatically analyzing generated code for quality and security issues.

4. Fine-Tuning and Transfer Learning: Customizing AI models for specific programming languages, frameworks, or domains.

VII. DEVELOPMENT AND IMPLEMENTATION

The development process involves:

1. Data Collection: Gathering code from open-source repositories and version control systems.

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2. Model Training: Training the AI model on the collected data using supervised learning techniques.

3. Integration with IDEs: Developing plugins for popular IDEs to provide real-time code suggestions.

4. Testing and Validation: Conducting controlled experiments to evaluate the tool's impact on productivity and code quality.

VIII. FUTURE ENHANCEMENT

1. Improved Context Awareness: Enhancing the AI's ability to understand project-specific requirements and coding standards.

2. Security and Quality Checks: Integrating automated checks for security vulnerabilities and code quality.

3. Customization and Fine-Tuning: Allowing developers to fine-tune AI models based on their specific needs.

4. Collaborative Features: Developing features that facilitate collaboration between developers and AI tools.

IX. CONCLUSION

AI-powered code completion tools like GitHub Copilot have the potential to significantly enhance developer productivity by automating repetitive tasks and providing real-time code suggestions. However, challenges related to code quality, security, and over-reliance on AI must be addressed to fully realize their potential. This paper highlights the need for further research and development to optimize these tools for both productivity and code quality.

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