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AI for coders: An analysis of the usage of ChatGPT and GitHub CoPilot

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Abstract

This study aims to investigate the usage of ChatGPT as an artificial intelligence (AI)-powered search tool and GitHub CoPilot as an AI development tool among IT developers and non-professionals. The study utilizes data collected from the recently published Stack Overflow Annual Developer Survey. We investigate the popularity of each of these tools and the extent that these tools are used in conjunction with each other, how their use varies among various categories of programmers, and whether their use varies based on the programming language employed.

Keywords: AI-powered search tools, AI development tools, ChatGPT, GitHub CoPilot

Introduction

In recent years, artificial intelligence (AI), once only experienced through science fiction and movies, has become more of a reality. Nowadays, everyday people can conduct conversations with AI-powered search tools, such as ChatGPT. Other forms of AI-powered tools also exist to assist with what were once tasks only capable of being completed by humans, such as those used for software development, including GitHub CoPilot.

ChatGPT is an AI-powered search tool created by OpenAI and released in late 2022. It is described by OpenAI as having the ability to "answer follow-up questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests" (OpenAI, 2022). When it comes to computer programming, ChatGPT offers a wide range of capabilities to assist developers in creating efficient and accurate programs. These capabilities include code generation, error detection and correction, and optimization.

GitHub CoPilot is an AI-powered development tool that was created by GitHub and released in late 2021. GitHub states that CoPilot can "suggest code completions as developers type and turns natural language prompts into coding suggestions based on the project's context and style conventions" (GitHub, 2024). GitHub Copilot, otherwise known as the "AI Pair Programmer", was trained on billions of lines of open-source GitHub code, which it uses to generate these coding suggestions.

Are these AI-powered tools really used by everyday programmers? Are there certain problems and/or applications that are seen by programmers as better suited for using AI-powered tools? Understanding the extent to which these tools are used in industry and the application of these tools to specific development areas will assist educators in teaching students how to use the tools to augment their problem solving skills and better prepare them for working with them in the application development industry. Examining the use of AI in coding can facilitate more effective deployment of it by industry professionals. Highlighting where

AI is most used can assist organizations in understanding where they may want to deploy it and highlighting areas where it is not used may illustrate opportunities for productivity enhancement. In our study, we analyze the usage of ChatGPT and GitHub CoPilot. Specifically, this study sought to answer the following research questions.

RQ1. *What is the overall usage of ChatGPT and GitHub CoPilot by programmers?*
RQ2. *Is there a relationship between the usage ChatGPT and GitHub CoPilot by programmers?*
RQ3. *Does the usage of ChatGPT and GitHub CoPilot vary based on the category of the programmer?*
RQ4: *Does the usage of ChatGPT and GitHub CoPilot differ based on the development language used?*

Literature Review

Although AI-powered tools such as ChatGPT and GitHub CoPilot have only been in existence for a few years, several studies have been published regarding their usage and popularity. A review of recent literature suggests that developers have mixed feelings when it comes to employing such tools during the software development process.

Some programmers' view AI-powered search and development tools as one of the many tools in their toolbox, providing a supplemental role. Das and Roy (2024) examined the interactions developers had with ChatGPT and found that most use it to assist when brainstorming coding solutions. However, once a solution is selected, most developers still prefer to write their own code versus employing ChatGPT generated code. Ge and Wu (2023) studied professional developer's adoption of the use of ChatGPT to assist in bug fixes and found that "performance expectancy and effort expectancy of professional software developers, as well as social influence, facilitating conditions, data security, and trust are the key factors of adoption".

Ulfsnes, Moe, Stray, and Skarpen (2024) interviewed 13 people describing themselves as one of the following: developers, managers, data scientists, or designers and found that ChatGPT enabled developers to work more efficiently, accelerated learning, and increased motivation by limiting tedious, redundant tasks. Their study also uncovered a shift in workflow when a problem was encountered; rather than reaching out to a co-worker for assistance, people are employing Generative AI. Silva, Ramos, de Moraes, and Santos (2024) studied the use of Chat GPT for software programming by students in higher education. Specifically, they surveyed 40 Brazilian students to assess their interest in utilizing ChatGPT when faced with a programming issue. Their study found that the majority of students reported an interest in using ChatGPT as a supplement to their formal learning within a classroom.

Several authors have studied how AI-generated code is used by programmers who choose to employ it within their projects. Zhang, Liang, Zhou, Ahmad, and Waseem (2023) collected and analyzed GitHub and Stack Overflow discussions to study the practices and challenges encountered with the use of GitHub CoPilot. They found JavaScript and Python to be the two major programming languages used with GitHub CoPilot and Visual Studio to be the primary integrated development environment used. Their study found useful code generation to be the primary benefit to the use of GitHub CoPilot and the challenge of integrating the suggested code into a current project to be the biggest barrier to its use. Grewal, Lu, Nadi, and Bezemer (2024) studied the use of code generated by ChatGPT within open-source GitHub projects and found that a majority (54%) of the ChatGPT code segments were added directly to the project, without being modified. They also found that when added code segments had undergone modifications, those modifications were minimal, resulting in minor changes to functionality or code reorganization.

Other authors have studied the willingness of developers to use AI-generated code and their experiences in using such code. Jaworski and Piotrkowski (2023) studied the willingness of software developers to use GitHub CoPilot when writing code. They surveyed 42 software developers, most of whom already had familiarity with the tool. While the survey respondents provided a mostly positive view of GitHub CoPilot, most indicated that they were reluctant to use it due to security concerns. Scoccia (2023) studied the use of ChatGPT for code development with a group of early ChatGPT adopters and found that the group's reactions to the use of ChatGPT for this function are mixed. Early adopters report suggestions for improving prompt engineering, raise questions concerning their level of trust with the code it generates, and comment on its perceived impact on the software development process.

Methodology

Data for this study was obtained from the 2023 Stack Overflow Annual Developer Survey, which was conducted in May 2023. As reported by Stack Overflow, over 90,000 developers responded to this survey; of the total responses received, 89,184 were considered "qualified" due to the respondent consenting to share their information and completing the survey in its entirety; these are the responses that have been used in our analysis. The remaining responses (approximately 2,000) were not used.

Stack Overflow reports that survey responses were solicited through onsite messaging, blog posts, email/newsletter subscribers, banner ads, and social media posts. "Due to United States transport/export sanctions, our survey was, unfortunately, inaccessible to prospective respondents in Crimea, Cuba, Iran, North Korea, and Syria, due to the traffic being blocked by our third-party survey software. While some respondents used VPNs to get around the block, the limitation should be kept in mind when interpreting survey results" (Stack Overflow, 2023).

SPSS 29 was used to analyze the results using a variety of statistical measurements including cross tabulations, frequency tables, and chi-square tests. Chat GPT-4 was used in developing literature review and assisting in sentence and narrative editing. This is accepted in science journals if it is acknowledged (Gaggioli, 2023).

Results

This paper uses data collected from all over the world (185 countries). The survey respondents represented all ages (from under 18 to over 65 years); these respondents have obtained various education levels from those with primary/elementary level schooling to those with a professional degree (JD, MD, Ph. D, Ed. D, etc.). Both employed and unemployed people responded to the survey.

Research Question 1: What is the overall usage of ChatGPT and GitHub CoPilot by programmers?

To answer the first part of this question, the survey asked respondents 'which AI-powered search tools did you use regularly over the past year.' Table 1 displays a frequency table depicting the popularity of the AI-powered search tool, ChatGPT, amongst survey respondents. As shown in this table, 58.8% of survey respondents indicate that they use ChatGPT regularly.

Table 1: Usage of the AI-powered search tool, ChatGPT, by survey respondents

ChatGPT Usage	Frequency	Percent
Use it regularly	52462	58.8%
Do not use it regularly	36722	41.2%
Total	**89184**	**100.0%**

To answer the second part of this question, the survey asked respondents 'which AI-powered development tools did you use over the past year.' Table 2 displays a frequency table depicting the usage of the AI development tool, GitHub CoPilot, amongst survey respondents. As shown in this table, 24.8% of respondents indicate that they use GitHub CoPilot.

Table 2: Usage of the AI development tool, GitHub CoPilot, by survey respondents

GitHub CoPilot Usage	Frequency	Percent
Use it	22078	24.8%
Do not use it	67106	75.2%
Total	**89184**	**100.0%**

Research Question 2: Is there a relationship between the usage ChatGPT and GitHub CoPilot by programmers?

Tables 3 and 4 display cross tabulation results related to the regular usage of ChatGPT and usage of GitHub CoPilot. As shown in Table 3, only 36.4% of survey respondents, who use ChatGPT regularly also use GitHub CoPilot. However, as shown in Table 4, 86.4% of the survey respondents who use GitHub CoPilot also use ChatGPT regularly.

Table 3: Cross tabulation results related to the regular usage of ChatGPT and usage of GitHub CoPilot by survey respondents

			GitHub CoPilot		Total
			Does not use	Uses	
ChatGPT	**Does not use regularly**	Count	33728	2994	**36722**
		% within ChatGPT	91.8%	8.2%	**100.0%**
	Uses regularly	Count	33378	19084	**52462**
		% within ChatGPT	63.6%	36.4%	**100.0%**
Total		Count	67106	22078	**89184**
		% within ChatGPT	75.2%	24.8%	**100.0%**

Table 4: Cross tabulation results related to the regular usage of ChatGPT and usage of GitHub CoPilot by survey respondents

			GitHub CoPilot		Total
			Does not use	Uses	
ChatGPT	Does not use regularly	Count	33728	2994	36722
		% within GitHub CoPilot	50.3%	13.6%	41.2%
	Uses regularly	Count	33378	19084	52462
		% within GitHub CoPilot	49.7%	86.4%	58.8%
Total		Count	67106	22078	89184
		% within GitHub CoPilot	**100.0%**	**100.0%**	**100.0%**

We assess the independence of the two categorical variables (regular usage of ChatGPT and use of GitHub CoPilot) used in the cross-tabulation results in Tables 3 and 4. Chi-square tests show the two variables are associated with a significance of $p < .001$. Thus, we conclude that the relationship between the regular use of ChatGPT and the use of GitHub CoPilot is significant.

To understand the relationship of the two categorical variables (regular usage of ChatGPT and use of GitHub CoPilot) used in the cross-tabulation results in Tables 3 and 4 we examine their correlation, which is displayed in Table 5. As shown in Table 5, the correlation is significant at the 0.01 level (2-tailed). Further the correlation analysis reveals a significant, but weak overall correlation at $p < 0.322$.

Table 5: Correlations between the regular usage of ChatGPT and the usage of GitHub CoPilot

		GitHub CoPilot	ChatGPT
GitHub CoPilot	Pearson Correlation	1	.322**
	Sig. (2-tailed)		<.001
	N	89184	89184
ChatGPT	Pearson Correlation	.322**	1
	Sig. (2-tailed)	<.001	
	N	89184	89184

Research Question 3: Does the usage of ChatGPT and GitHub CoPilot vary based on the category of the programmer?

Table 6 displays cross tabulation results related to the category of the programmer and regular usage of ChatGPT. As shown in this table, the 'I am learning to code' group has the largest percentage of group members indicating that they use ChatGPT regularly, with 72.3% of the group indicating use. While the 'I used to be a developer by profession, but no longer am' group has the lowest percentage of group members indicating that they use ChatGPT regularly, with 53% of the group indicating use.

Table 6: Cross tabulation results related to the category of the programmer and regular usage of ChatGPT

			ChatGPT		Total
			Does not use regularly	Uses regularly	
Category of Programmer	I am a developer by profession	Count	27949	39288	**67237**
		% within Category	41.6%	58.4%	**100.0%**
	I am learning to code	Count	1376	3585	**4961**
		% within Category	27.7%	72.3%	**100.0%**
	I am not primarily a developer, but I write code sometimes as part of my work/studies	Count	3481	5473	**8954**
		% within Category	38.9%	61.1%	**100.0%**
	I code primarily as a hobby	Count	1830	3130	**4960**
		% within Category	36.9%	63.1%	**100.0%**
	I used to be a developer by profession, but no longer am	Count	875	986	**1861**
		% within Category	47.0%	53.0%	**100.0%**
	None of these	Count	1211	0	**1211**
		% within Category	100.0%	0.0%	**100.0%**
Total		**Count**	**36722**	**52462**	**89184**
		% within Category	**41.2%**	**58.8%**	**100.0%**

We assess the independence of the two categorical variables (category of the programmer and the regular usage of ChatGPT) used in the cross-tabulation results using a chi-square test, which is displayed in Table 7. The two variables are associated with a significance of $p < .001$. Thus, we conclude that the regular use of ChatGPT varies based on the category of the programmer.

Table 7: Chi-square tests to measure significance of the category of the programmer and regular usage of ChatGPT

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2187.551[a]	5	<.001
Likelihood Ratio	2624.920	5	<.001
N of Valid Cases	89184		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 498.64.

Table 8 displays cross tabulation results related to the category of the programmer and usage of GitHub CoPilot. As shown in this table, the 'I code primarily as a hobby' group has the largest percentage of group members indicating that they use GitHub CoPilot, with 26.6% of the group indicating use. This is followed

closely by the 'I am learning to code' group with 25.9% of the group indicating use. While the 'I used to be a developer by profession, but no longer am' group has the lowest percentage of group members indicating that they use GitHub CoPilot, with 17.8% of the group indicating use.

Table 8: Cross tabulation results related to the category of the programmer and usage of GitHub CoPilot

			GitHub CoPilot		Total
			Does not use	Uses	
Category of Programmer	I am a developer by profession	Count	49805	17432	**67237**
		% within Category	74.1%	25.9%	**100.0%**
	I am learning to code	Count	3800	1161	**4961**
		% within Category	76.6%	23.4%	**100.0%**
	I am not primarily a developer, but I write code sometimes as part of my work/studies	Count	7119	1835	**8954**
		% within Category	79.5%	20.5%	**100.0%**
	I code primarily as a hobby	Count	3642	1318	**4960**
		% within Category	73.4%	26.6%	**100.0%**
	I used to be a developer by profession, but no longer am	Count	1529	332	**1861**
		% within Category	82.2%	17.8%	**100.0%**
	None of these	Count	1211	0	**1211**
		% within Category	100.0%	0.0%	**100.0%**
Total		**Count**	**67106**	**22078**	**89184**
		% within Category	**75.2%**	**24.7%**	**100.0%**

We assess the independence of the two categorical variables (category of the programmer and the usage of GitHub CoPilot) used in the cross-tabulation results using chi-square tests, which are displayed in Table 9. The two variables are associated with a significance of $p < .001$. Thus, we conclude that the use of GitHub CoPilot varies based on the category of the programmer.

Table 9: Chi-square tests to measure significance of the category of the programmer and usage of GitHub CoPilot

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	596.651[a]	5	<.001
Likelihood Ratio	893.830	5	<.001
N of Valid Cases	89184		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 299.79.

Research Question 4: Does the usage of ChatGPT and GitHub CoPilot differ based on the development language used?

To answer this question, we examined five of the major development languages (Java, JavaScript, Python, HTML/CSS, and SQL) to see if there were differences for ChatGPT usage and GitHub CoPilot usage based on which language was used by the respondents.

Table 10 displays crosstabulation results related to IT development type and usage of ChatGPT and GitHub CoPilot. As shown in the crosstabulation results displayed below, the percentage of group members in each of the five development language groups that reported regularly usage of ChatGPT varied between 62% and 65%. While the percentage of group members in each of the five development language groups that reported using GitHub CoPilot varied between 26% and 30%. A statistical analysis of these small differences are not possible due to the data survey collection. Many programmers had more than one programming language selected and the use of either ChatGPT or GitHub CoPilot was not specified for each programming language. However, overall, it does not seem that there are large differences in the use of these tools based on development language used. A more specific and detailed survey would be required to confirm this assessment.

Table 10: Cross tabulation results related to the usage of Each Programming Language and the regular usage of ChatGPT and GitHub CoPilot

	Java	JavaScript	Python	HTML/CSS	SQL
ChatGPT	61.70%	64.90%	64.70%	65.10%	62.00%
GitHub CoPilot	25.50%	29.60%	28.00%	29.20%	26.70%

Conclusion

This research aimed to investigate the use of the AI-powered search tool, ChatGPT and the AI development tool GitHub CoPilot among programmers. It also examined other factors that may influence the usage of these AI-powered tools.

As a result of this research, we have concluded that more programmers are utilizing ChatGPT than GitHub CoPilot. There is a significant, but weak correlation between the usage of these two tools. The category of programmers who consider themselves as 'learning to code' have the largest percentage of group members using ChatGPT regularly, while the category of programmers who consider themselves as 'I code primarily as a hobby' have the largest percentage of group members using GitHub CoPilot; however, this is followed closely by the category of programmers who consider themselves as 'learning to code'. The usage of ChatGPT within five of the major development language groups does not vary much, ranging between 62% and 65% within each group. Likewise, the usage of GitHub CoPilot within these five groups does not vary much, ranging between 26% and 30% within each group.

Our findings involving the regular usage of the AI-powered search tool ChatGPT may not come as a surprise to many computing educators, as we have found that programmers who consider themselves as members of the 'learning to code' group have the largest percentage of group members indicating regular use of ChatGPT (72.3%); obviously, this group would include students. Likewise, this group has the second highest percentage of group members indicating use of GitHub CoPilot (25.9%). These findings further emphasize the need for educators to develop methods for including the proper use of AI-powered search tools and AI development tools within their curriculum, while also guiding students on when the use of such tools is appropriate.

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