INTELLIGENT SOFTWARE DEVELOPMENT ASSISTANTS

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ABSTRACT

This article discusses artificial intelligence and neural networks as helpers for programmers. The article reveals the essence of AI and neural networks, and gives examples of specific products that make the life of programmers much easier.

KEYWORDS

Intelligent Systems, Artificial Intelligence, Neural Networks, Programming, Extension, Software Assistant, Voice Assistant, Chat, Microsoft, OpenAI, ChatGPT, CodeGPT, GitHub, GitHub Copilot, Visual Studio Code, JavaScript, Python, Optimization, Refactoring, Unit tests.

Introduction

History shows that throughout time, the idea of making one's life easier by having someone else do part of the work has occupied the human mind. Over time, humanity has accumulated knowledge and made discoveries in the fields of mathematics, biology, physics, and other sciences. However, the first impressive results in the field of developing something that could make human work easier were only presented to the public in the early 21st century. The results of research were neural networks and artificial intelligence, which have been actively developing since the end of World War II.

However, it was only about 2-3 years ago that artificial intelligence (hereafter referred to as AI) and neural networks (hereafter referred to as NNs) began to gain widespread popularity. As we can see today, various intelligent assistants have a huge impact on people, facilitating the performance of both simple daily routine tasks (such as writing an essay, translating a text, extracting text from YouTube videos, improving the capabilities of familiar search engines such as Microsoft Bing, Yandex, Google, etc.) and really complex and responsible work in the real world - driving vehicles, managing medical devices for people with disabilities, and so on.

In the "shadow" of the possibilities of AI and NNs for ordinary users, there are still opportunities for those who are involved in the process of developing these systems, as well as in general for any software product - software code, computer programs, web and mobile applications, etc. Today, there is a fairly large number of such intelligent software products that significantly facilitate the work of developers around the world.

Concept and Principles of AI and Neural Networks

To start with, it's worth exploring the definitions of such concepts as artificial intelligence and neural networks and familiarizing oneself with the general principles of these systems. At first glance, it may seem that AI and NN

are one and the same technology, just called by different names. However, this is only partially true.

A neural network (NN) is a subfield of artificial intelligence (AI) and a machine learning algorithm that models the workings of the human brain. The goal of neural networks is to predict outcomes based on patterns identified in past experiences. Neural networks consist of many interconnected neurons that process information and pass it on to other neurons in the network. The principle of operation of NNs is based on training on a large number of data examples. During such training, the neural network identifies patterns and templates in the data that enable it to make predictions and answer questions. During training, the neural network adjusts the weights of the connections between neurons to minimize the prediction error on the training data. When the network is trained, it can be used to predict outcomes on new data. The key difference from AI is that a neural network does not make decisions about actions aimed at facilitating its own work or generating results with the highest deviation from the expected result (similar to the creative process of a human).

Artificial Intelligence (AI) is a field of computer science that deals with creating computer systems capable of performing tasks that require human-like intelligence, such as image and speech recognition, text analysis, planning, learning, decision-making, etc. AI systems can learn from input data during operation, make decisions on their own, and find optimal solutions in various situations - from timely customer support through chatbots to driving cars and combines. AI utilizes the capabilities of deep learning, machine learning, neural networks, and algorithms. The processes that occur in artificial intelligence during its operation occupy the minds of the best scientists and entrepreneurs around the world, making AI a "black box" - no one can say exactly how a particular type of AI works. Despite the fact that humans have learned to develop intelligent systems and optimize them for specific tasks, the results of such systems often amaze even the most knowledgeable people in this field.

General principles of code-writing assistants

Returning to the intelligent systems used for software development, it is worth noting their significant spread in recent times. There are many add-ons for various development environments based on different neural network language models that provide the following capabilities for working with source code:

- Code autocompletion and prediction of the next lines of code based on context analysis;
- Searching for and eliminating errors in code (so-called "linting") by analyzing the syntax and lexical rules of the programming language;
- Code analysis and refactoring to improve its structure and optimize performance;
- Code generation based on task specifications or a dataset, including the use of neural networks for natural language processing;
- Automatic code testing and problem detection based on analyzing its behavior in different usage conditions;
- Prediction and optimization of code execution time based on analyzing the performance of different code sections and optimizing algorithms;
- Creating automatic documentation based on analyzing comments and code descriptions, as well as generating code usage examples based on its analysis;

Example 1. GitHub Copilot

The most well-known success in the development of AI and neural network-based intelligent systems for programmers has been achieved by the American corporation "GitHub" (a subsidiary of Microsoft), which develops a partially free platform of the same name for developers and enterprises to create, scale, and deliver secure software worldwide. The platform works with one of the

most popular version control systems, "Git", largely expanding its capabilities. Together, Git and GitHub have the following main advantages and goals:

- **Individuality**: GitHub allows breaking down a project into so-called branches, each of which can be created based on the latest version of the project (or another branch within it) and continue working on the code in an individual way, and then merge their branch with the main one, usually called "master", "origin", "main" or something else.
- **Informational value**: thanks to GitHub, every change in an IT project can be tracked: who exactly made the changes? What files and what parts or lines of code were modified? When exactly was the change made? The GitHub system provides answers to these and many other questions.
- **Integrity**: GitHub allows organizing developers' work in such a way that all the work on the project is concentrated in one place - repositories. In addition, all projects and changes in them are protected by the latest encryption and protection systems, ensuring data integrity.
- **Consistency**: all changes made to a specific branch of the project cannot be made in parallel by multiple developers, as the main principle of GitHub is that all changes made sequentially should form a consistent chain.
- **Speed and stability**: GitHub servers are constantly being scaled and improved, which ensures fast interaction with the system even under high loads.
- **Feedback**: The innovation of GitHub compared to the Git system is that project users can report a problem or bug in a dedicated section within the repository. This allows developers to respond to user reports of code issues and quickly address them.

- **Internationality**: The main task of GitHub is to attract as many developers as possible from all over the world to the development of the IT industry. This task is partly solved by the possibility for other developers to suggest their own changes to the project by making a pull request to merge their own copy of the repository with the original one. For this, developers who want to work with the project independently without changing the main repository can create a copy of the repository on their personal account and work with this copy without affecting the original.

In 2022, at the annual developer conference "GitHub Universe 2022", an intelligent code-writing assistant "GitHub Copilot" was introduced, created in partnership with the American companies Microsoft and OpenAI using "OpenAI Codex" technology and the "GPT-3" algorithm ("Generative pre-trained transformers"). The assistant is distributed as a plugin, representing built-in functions, a chat, or a voice assistant for development environments from the Russian IT company JetBrains (e.g. PyCharm) or the American Microsoft (e.g. Visual Studio Code). The main task of Copilot is to accelerate the process of writing code by a developer, which is solved by the following technologies:

- **Machine learning**: Copilot uses a neural network model trained on a vast amount of publicly available code. This allows it to generate source code suggestions based on the previous code the user has already written.
- **Artificial intelligence**: Copilot uses the GPT-3 algorithm to generate code, which enables it to create more complex and accurate code suggestions.
- **Autocompletion**: The assistant automatically suggests code options based on the context and the code already written, enabling developers to move faster and more accurately in writing their code.

- **Integration with development environments**: Copilot integrates with JetBrains and Microsoft development environments, allowing developers to access the assistant's tools in real-time.
- **Natural language processing**: The assistant can process natural language and understand what the user wants to write, helping it suggest the most appropriate code options.

According to the latest information from the creators of GitHub Copilot, the newest development provides the following efficiency indicators:

- A 55% increase in coding speed. This result was obtained from a study of 95 independent senior developers, 45 of whom used GitHub Copilot to write an HTTP server in JavaScript. The average time to complete the task for developers using the intelligent assistant was 1 hour and 11 minutes, which is 1 hour and 30 minutes faster than the same indicator for developers without GitHub Copilot.
- 74% of developers can focus on more enjoyable work.
- 88% feel more productive.
- 96% of developers can handle repetitive tasks faster.

The results of working with GitHub Copilot were shared by users of the assistant, and based on their feedback, the company compiled the following diagram (see Figure 1).

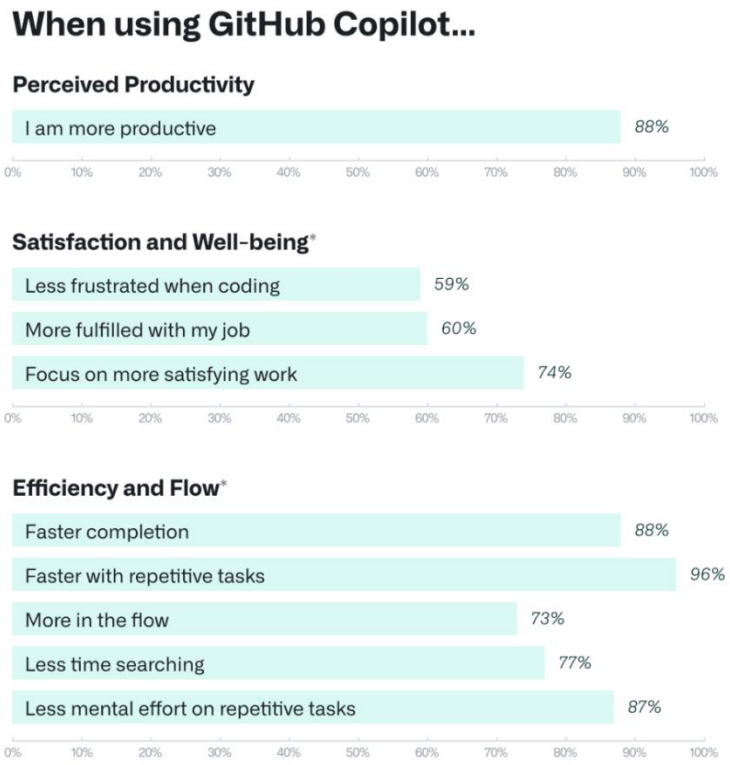

Figure 1. Feedback from developers about using GitHub Copilot.

Example 2. CodeGPT

Another example of an intelligent assistant is the "CodeGPT" project. It is distributed as a plugin for the Visual Studio Code (Microsoft) development environment. The extension is an integrated Application Programming Interface (API) from OpenAI inside the development environment to improve, speed up, and simplify the process of software code development. To use the OpenAI API, an Access Token is required, which is obtained from the control panel in the personal account on the OpenAI website. Depending on the language model used (the most popular are "text-davinci-003", "gpt-4", "gpt-4-0314", "gpt-3.5-turbo", "gpt-3.5-turbo-0301") and other parameters, the company provides various user tariffs with monthly payments. However, for the third generation of GPT, OpenAI provides the opportunity to use the API for free under comfortable conditions.

CodeGPT provides a variety of "one-click" options for code writing, optimization, and refactoring, including:

1. Obtaining a project description file "README.md" from the project configuration file "package.json" for Node.JS;
2. Explaining the work of incomprehensible code;
3. Ability to get a quick human answer from StackOwerflow using the forum's API, as well as show the answer from CodeGPT itself;
4. Quickly create project documentation;
5. Write modular code tests (for example, for a Python program);
6. Identify code issues, correct errors, and explain specifically what the shortcomings were.

As the CodeGPT plugin is developed by an enthusiast from the United States, there are no statistics or feedback on the use of the extension. However, according to the VSCode extensions marketplace data as of March 18, 2023:

- CodeGPT has been installed 274,651 times;
- User rating is 4.4 out of 5 (based on 77 reviews);
- In the product comments, users note that the extension is easy to use, less intrusive than GitHub Copilot, and has high performance with the paid Access Token from OpenAI.

Conclusion

Thus, today there are many intelligent assistants designed not only to assist journalists, content creators, or students but also programmers. In addition to the tools discussed, such as the commercial GitHub Copilot and the free CodeGPT, there are many other plugins developed by enthusiasts from all over the world. However, almost all of them represent a powerful intellectual tool-assistant that significantly speeds up and simplifies the daily and often routine work of a programmer, without completely replacing it with their own abilities. It is worth noting that the capabilities of neural networks and artificial intelligence have grown significantly over the last 5 years and continue to develop literally every day.

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