



# GitHub Copilot: Erfahrungen aus 1,5 Jahren KI-gestützter Software-Entwicklung

Plateau 2 - Dienstag, 12.12.2023 (18:00 - 18:45)



Robert Marz  
**DATABEE**  
Die IT-Architekten



Robert Marz – Independent Consultant

## Primary Role

Senior Technical Architect  
with database centric view of the world

## DOAG (German Oracle User Group)

Active Member of Database Community  
Responsible for Cloud Topics



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Die IT-Architekten



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# GitHub Copilot: Intro



# GitHub Copilot: Whats that?

## GitHub Copilot

- is a cloud-based artificial intelligence tool developed by GitHub and OpenAI to assist users [...]by autocompleting code. [[Wikipedia](#)]

## Autocomplete on Steroids

- watches you typing and suggests constantly the next lines [[RobbieDatabee](#)]

## Your AI pair programmer

- GitHub Copilot uses the OpenAI Codex to suggest code and entire functions in real-time, right from your editor. [[GitHub](#)]





# GitHub Copilot: History

June 29, 2021

- GitHub Copilot technical preview VS Code development environment.

October 29, 2021

- GitHub Copilot was released as a [plugin](#) on the JetBrains marketplace on.

May 27, 2022

- [@RobbieDabee](#) was accepted for technical trial

October 27, 2021

- GitHub released the GitHub Copilot Neovim plugin as a public repository.

March 29, 2022

- GitHub announced Copilot's availability for the Visual Studio 2022 IDE on.

June 21, 2022

- GitHub announced that Copilot was out of "technical preview", and is available as a subscription-based service for individual developers.



# GitHub Copilot: Installation & Prerequisites

## Supported Editors / IDEs:

- VS Code
- NeoVim
- Visual Studio
- JetBrains IDEs

## Installation:

- Download the Plugin from the Marketplace

## Prerequisite:

- IDE needs internet connection
- Github Copilot Hosts must be whitelisted on firewall
- GitHub Account
- GitHub Copilot Subscription



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# GitHub Copilot: Invocation

## How to invoke

Just type - works like normal autocomplete

Press Ctrl-<Enter>

Use Context Menu

Invoke Copilot Labs



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# GitHub Copilot: Usecases





# Usecase: Auto Complete

Copilot continuously reads your Input

suggestions:

next line

Algorithms /  
Functions  
(from comments)



```
def get_primes(self):  
    return self.primes  
  
def get_prime_factors(self, num):  
    factors = []  
    for prime in self.primes:  
        while num % prime == 0:  
            factors.append(prime)  
            num //= prime  
    return factors  
  
def get_factors(self, num):  
    factors = []  
    for divisor in range(1, num + 1):  
        if num % divisor == 0:  
            factors.append(divisor)  
    return factors  
  
self.primes = self.generate_primes()
```



# Usecase: Learn a new Language

## Suggestions

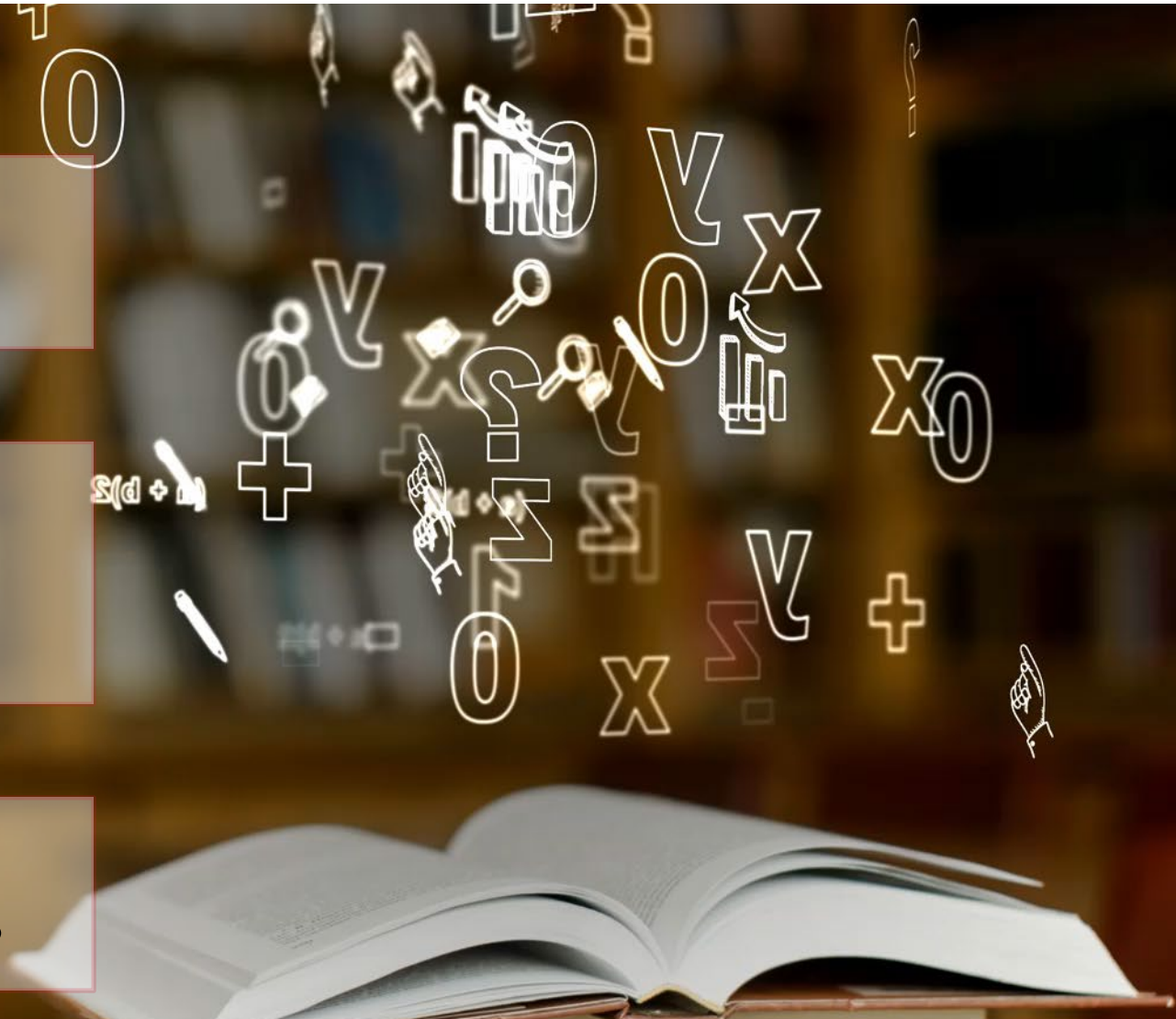
- are syntactically correct

## Code snippets

- are in style
- e.g., „Pythonic“

## Examples

- Explains how code works





# Usecase: Find the Docu you really need - Copilot for Docs

# Copilot for Docs



Search engine for Documentation

[githubnext.com/projects/copilot-for-docs](https://githubnext.com/projects/copilot-for-docs)

Preview with waitlist

(Unfortunately, I'm still waiting...)

The screenshot displays the GitHub Copilot for Docs interface. At the top right, the user's name 'Amelia Wattenberger' and a 'Sign out' link are visible. The main content is divided into two sections: 'Docsets' and 'Recent threads'.

**Docsets:** This section lists four docsets, each with a logo, a brief description, a 'SOURCES' list, and a 'Start a new thread' button.

- GitHub:** Information about GitHub's products and services, including GitHub.com, GitHub Enterprise, and GitHub Desktop. Sources: github/docs.
- React.js:** A component-based JavaScript framework for building user interfaces. Sources: reactjs/reactjs.org.
- MDN:** The Mozilla Developer Network (MDN) provides information about Open Web technologies including HTML, CSS, and APIs for both Web sites and progressive web apps. Sources: mdn/content.
- Azure:** Azure is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through Microsoft-managed data centers. Sources: MicrosoftDocs/azure-docs.

**Recent threads:** This section shows four recent threads, each with a title, a snippet of content, and a timestamp.

- GitHub:** How can I run a node v18 script named "update-data.js" every 2 days at 3:30PM and on demand? (16 hours ago)
- GitHub:** should I use oauth or github app? (20 hours ago)
- MDN:** How do I make an animation play in reverse? (2 days ago)
- GitHub:** How do I create a pull request? (includes sub-questions like 'How do I create a pull request?', 'How do I merge or close my pull request when it is ready?', etc.)

At the bottom of the interface, there is a search bar with the placeholder text 'Ask a follow-up question about React.js' and a 'Search' button. Below the search bar are three sliders for user preferences: 'I am an intermediate developer', 'I know this material well', and 'I want a balanced response'.



# Usecase: Discuss Challenges with CopilotChat

## GitHub Copilot Chat



- Companion Extension
- VS & VS Code: Open Beta
  - JetBrains IDEs: waitlist
- GA announced 12/2023
- Offers Chat to discuss / ask questions & refine code
- Uses GPT-4
- Restricted to coding topics

concurrent-ki.py - beemirror [WSL: OracleLinux\_8\_7] - Visual Studio Code

CHAT: GITHUB COPILOT

This JSON file defines a function that takes two arguments ( $x$  and  $y$ ) and returns their sum. The `co_varnames` field is a list of the function's argument names, `co_argcount` is the number of arguments, `co_consts` is a list of constants used in the function (in this case, there are none), and `co_code` is a list of bytecode instructions that implement the function's logic.

Note that this is just a simple example, and in practice, you would likely want to use a more complex data structure to represent a function in JSON.

**rmarz**  
does python code instead of bytecode work?

**GitHub Copilot**  
Yes, Python code can be loaded from a JSON file instead of bytecode. You can use the `compile` function to compile the code and then use the `exec` function to execute it. Here's an example:

```
import json

def load_function_from_json(file_path):
    with open(file_path, 'r') as f:
        data = json.load(f)
        code = compile(data['code'], '<string>', 'exec')
        exec(code, globals())
        return globals()[data['name']]
```

This function takes a file path as an argument and returns a function object loaded from the

[How can I save a Python function to a JSON file?](#)

Ask Copilot a question or type '/' for topics

You, 4 days ago Ln 1, Col 1 Spaces: 4 UTF-8 LF Python 3.11.2 ('robbiedev': venv) Spell



# Usecase: Generate Testdata

---

```
emptab.sql > ...
1  create table emps(emp_id number not null,
2  emp_name varchar2(20),
3  emp_salary number(10,2),
4  emp_hiredate date,
5  );
6
7  /* insert 10 rows into table emps */
8  insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
9  values(1, 'John', 10000, '01-JAN-2010');
10 insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
11 values(2, 'Smith', 20000, '01-FEB-2010');
12 insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
13 values(3, 'Peter', 30000, '01-MAR-2010');
14 insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
15 values(4, 'Mary', 40000, '01-APR-2010');
16 insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
17 values(5, 'David', 50000, '01-MAY-2010');
18 insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
19 values(6, 'Paul', 60000, '01-JUN-2010');
20 insert into emps(emp_id, emp_name, emp_salary, emp_hiredate)
21 values(7, 'James', 70000, '01-JUL-2010');
22
23
```



# Usecase: Write Unittests

```
27  
28  
29 def test_get_co  
30  
60  
61 ...  
62 test_get_co  
63 ...
```



# Usecase: Write Unittests (Preview in Copilot Labs)

GITHUB COPILOT LABS: TEST GENERATION

```
function plural(word, num) {
  var i
  , rule

  if (num !== 1 || num === undefined) {
    for (i = 0; i < rules.length; i++) {
      rule = rules[i]

      if (type(rule[0]) === 'RegExp' && rule[0].test(word)) {
        return type(rule[1]) === 'Function' ? rule[1](word, num) : rule[1]
      }
      if (type(rule[0]) === 'String' && rule[0] === word) {
        return type(rule[1]) === 'Function' ? rule[1](word, num) : rule[1]
      }
    }
  }
}
```

Suggest a new test

```
describe('test plural', function() {
  it('test plural.plural', function(done) {
    assert.equal(plural('zebra', 1), 'zebra');
    assert.equal(plural('zebra', 2), 'zebras');
    assert.equal(plural('zebra'), 'zebras');
    assert.equal(plural('stop'), 'stoppes');
  });
});
```

JS index.js

```
JS index.js > plural
71
72 function plural(word, num)
73   var i
74   , rule
75
76   if (num !== 1 || num ===
77     for (i = 0; i < rules.l
78     rule = rules[i]
79
80     if (type(rule[0]) ===
81     return type(rule[1]
82   }
83   if (type(rule[0]) ===
84   return type(rule[1]
85   }
86
87 }
88
89 return word + 's'
```

Test Pilot

0egerikuss-MacBook-Pro:plural  
oegerikus\$

Ln 72, Col 1 Spaces: 2 UTF-8 LF {} JavaScript



# Usecase: Explain Code (Preview in Copilot Labs)

The screenshot shows a code editor with a TypeScript function and the Copilot Labs interface. The code is as follows:

```
TS function buildInvertedIndex(s: string): Untitled-1 •  
1 function buildInvertedIndex(s: string): { [key: string]:  
2   const words = s.split(/\W/);  
3   const index: { [key: string]: number[] } = {};  
4   for (let i = 0; i < words.length; i++) {  
5     const word = words[i];  
6     if (word) {  
7       if (index[word]) {  
8         index[word].push(i);  
9       } else {  
10        index[word] = [i];  
11      }  
12    }  
13  }  
14  return index;  
15 }  
16
```

The Copilot Labs panel on the right is titled "GITHUB COPILOT LABS" and has a sub-header "EXPLAIN". It features a dropdown menu with the text "Code does following (English)" and a button labeled "Ask Copilot". At the bottom of the panel, there is a section for "LANGUAGE TRANSLATION". The status bar at the bottom of the editor shows "Ln 16, Col 1", "Spaces: 2", "UTF-8", "LF", and "TypeScript".



# Usecase: Do my Job



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## Copilot knows nothing

- about your goals
- the environment
- the ecosystem
- the company rules
- the business rules

## It's your code

→ your responsibility

## You need to understand and review

- every generated line of code

## Copilot generates

- Code
- Bugs
- Security Issues



# GitHub Copilot: Demo

---



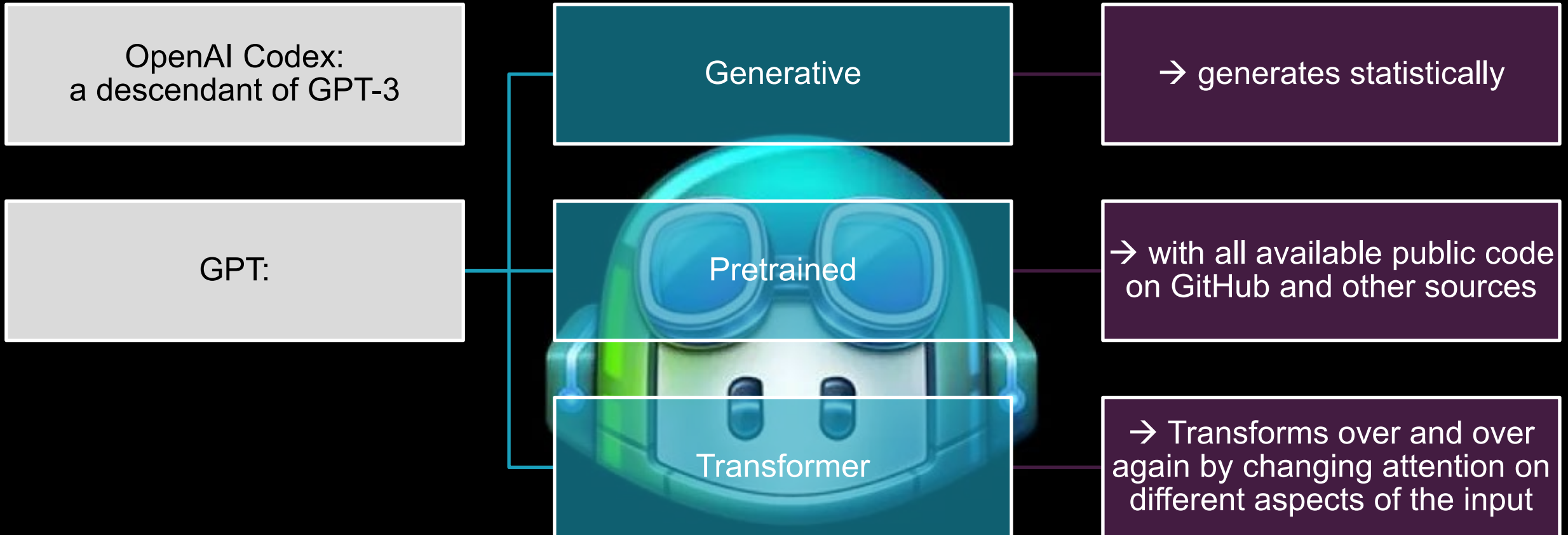
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# GitHub Copilot: How it works





# GitHub Copilot – How it works I



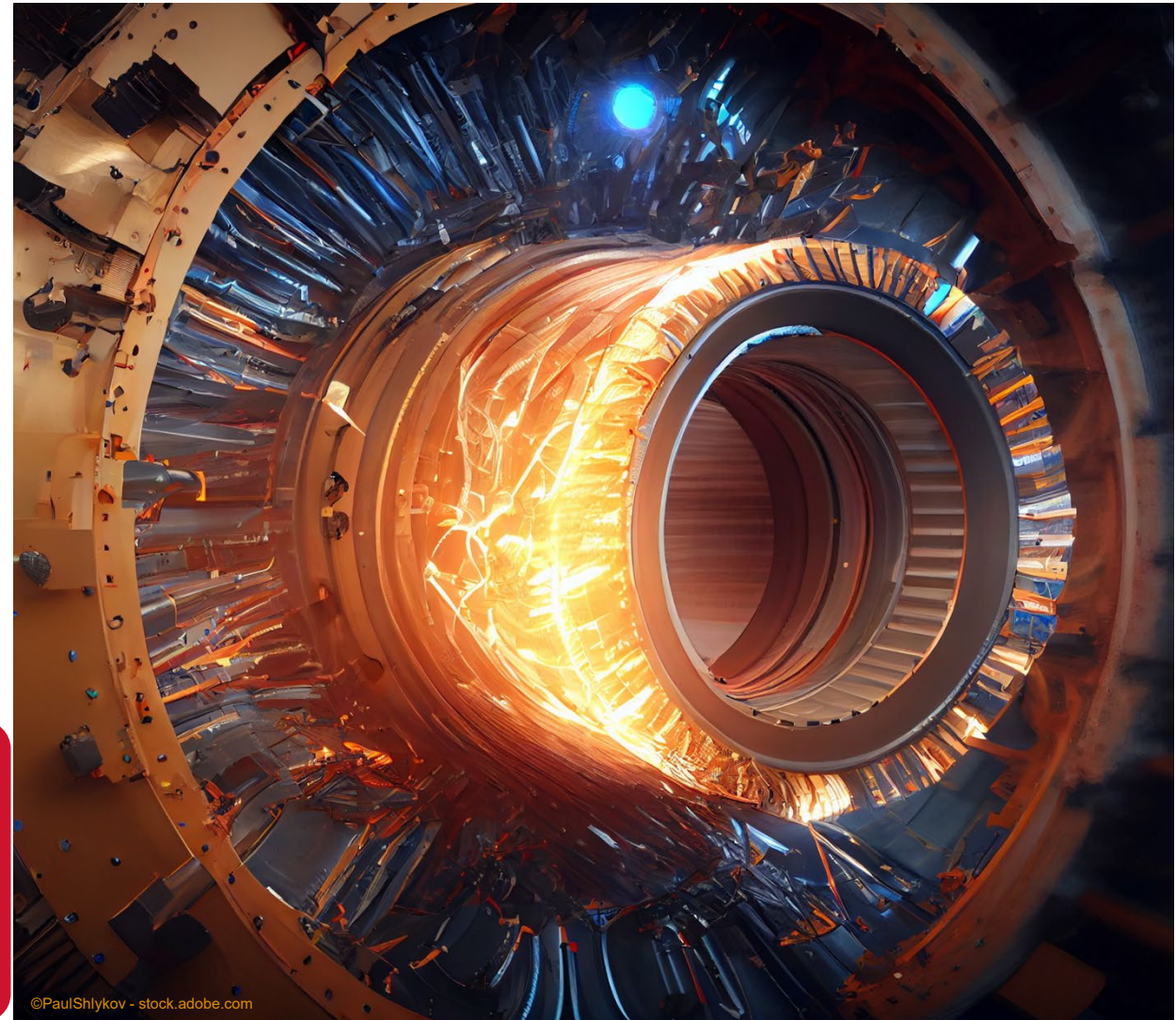


# GitHub Copilot – How it works II

Copilot uploads  
your prompt to  
the cloud.

openAI Codex  
does ist magic

Results are  
displayed in your  
editor





# GitHub Copilot: What is a prompt?

Copilot prompts everytime,  
you stop typing

## User Engagement Data

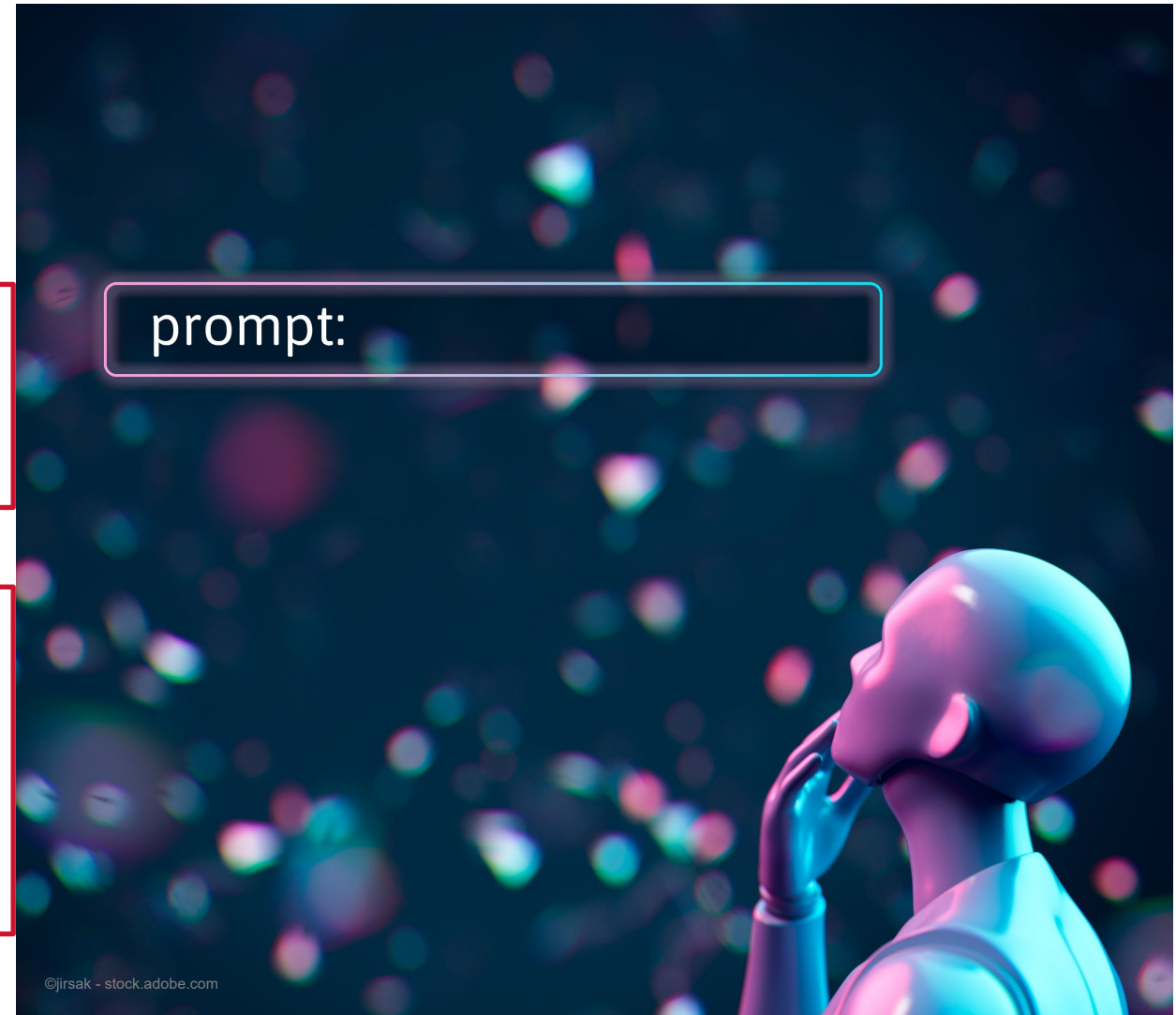
- edit actions
- completions accepted and dismissed

## Code Snippets Data

- source code currently edited
- related files
- other files open in same IDE or Editor
- URLs of repositories and files paths

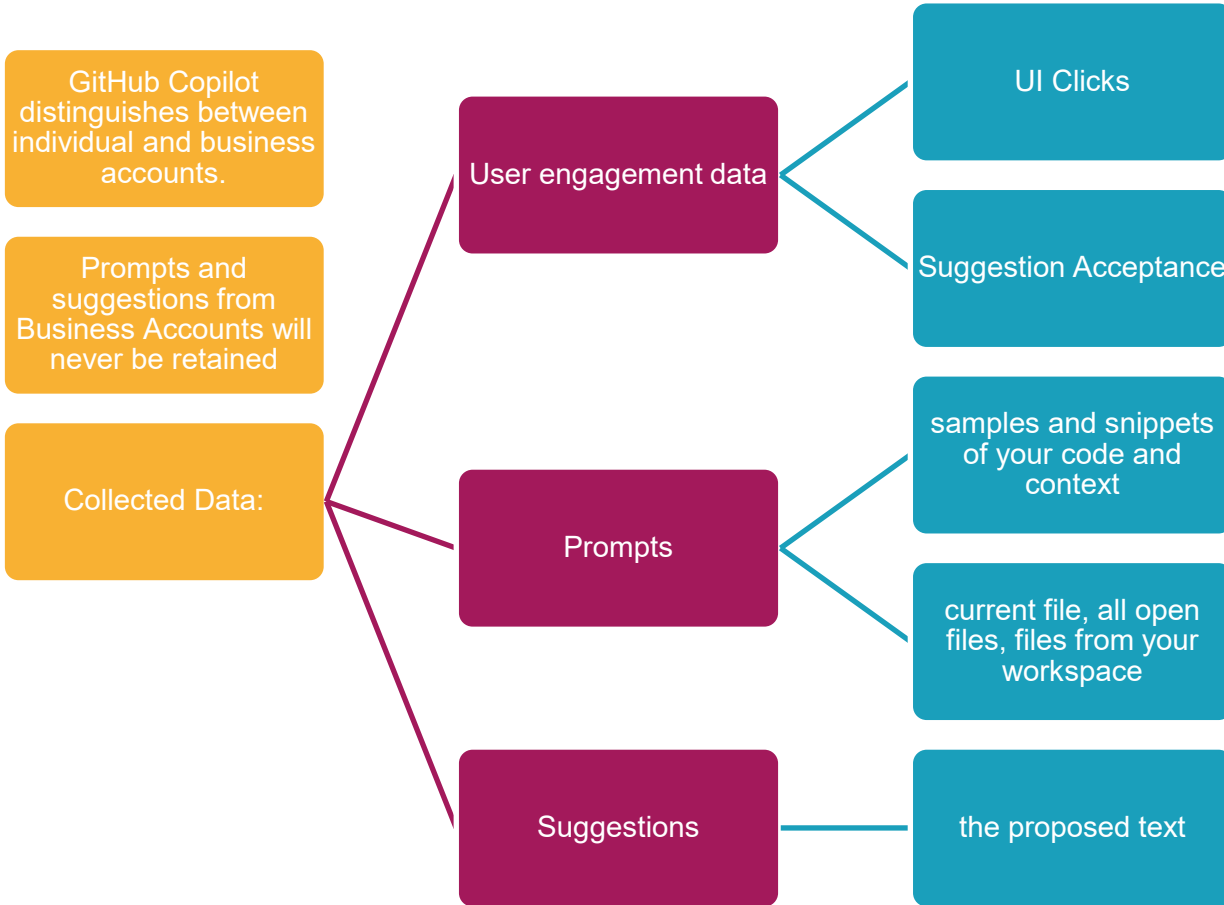
Source:

<https://web.archive.org/web/20220917002449/https://github.com/features/copilot>





# GitHub Copilot: Data privacy – collected data



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# GitHub Copilot: Copyright & License Issues



Copilot is trained with code available in public repos regardless of their license.



Copilot generates every answer based on the prompt – it is unlikely, that it reproduces copyrighted code.

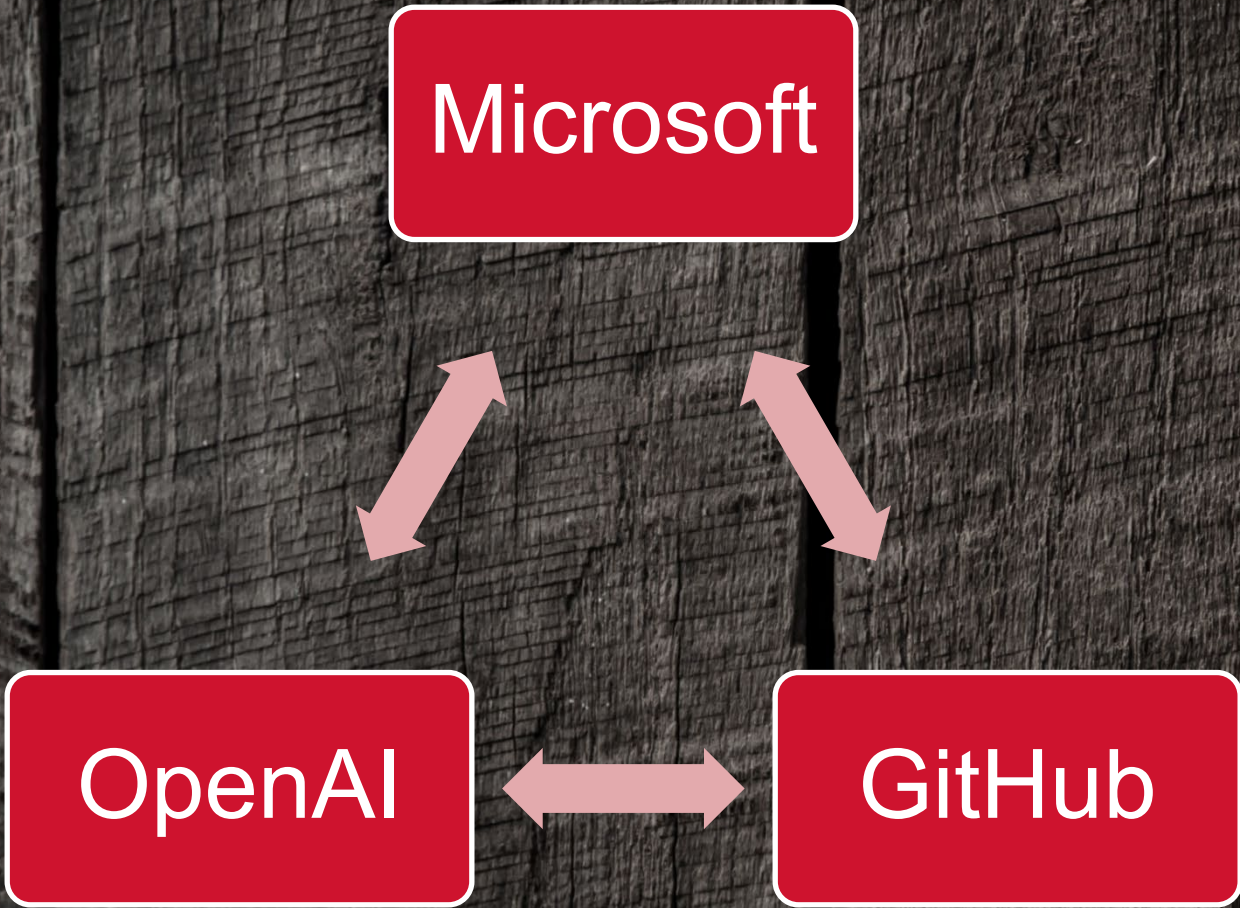


Let's leave those disputes to the lawyers

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# GitHub Copilot – Companies involved





# GitHub Copilot: Costs

## For individuals

### Copilot Individual

Code completions, Chat, and more for indie developers and freelancers.

**\$ 10** per month /  
\$100 per year

[Start a free trial >](#)

Free for verified students, teachers, and maintainers of popular open source projects.

As of December 10<sup>th</sup> 2023



# GitHub Copilot: Costs

## For organizations

**Recommended**

### Copilot Business

Copilot in the coding environment.

**\$ 19** per user / month

- ✓ Code completions
- ✓ Chat in IDE<sup>1</sup> and Mobile<sup>2</sup>
- ✓ CLI assistance<sup>3</sup>
- ✓ Security vulnerability filter
- ✓ Code referencing
- ✓ Public code filter
- ✓ IP indemnity
- ✓ Enterprise-grade security, safety, and privacy

[Buy now >](#) [Contact sales >](#)

**Available Feb 2024**

### Copilot Enterprise

Copilot personalized to your organization throughout the software development lifecycle. Requires GitHub Enterprise Cloud.

**\$ 39** per user / month

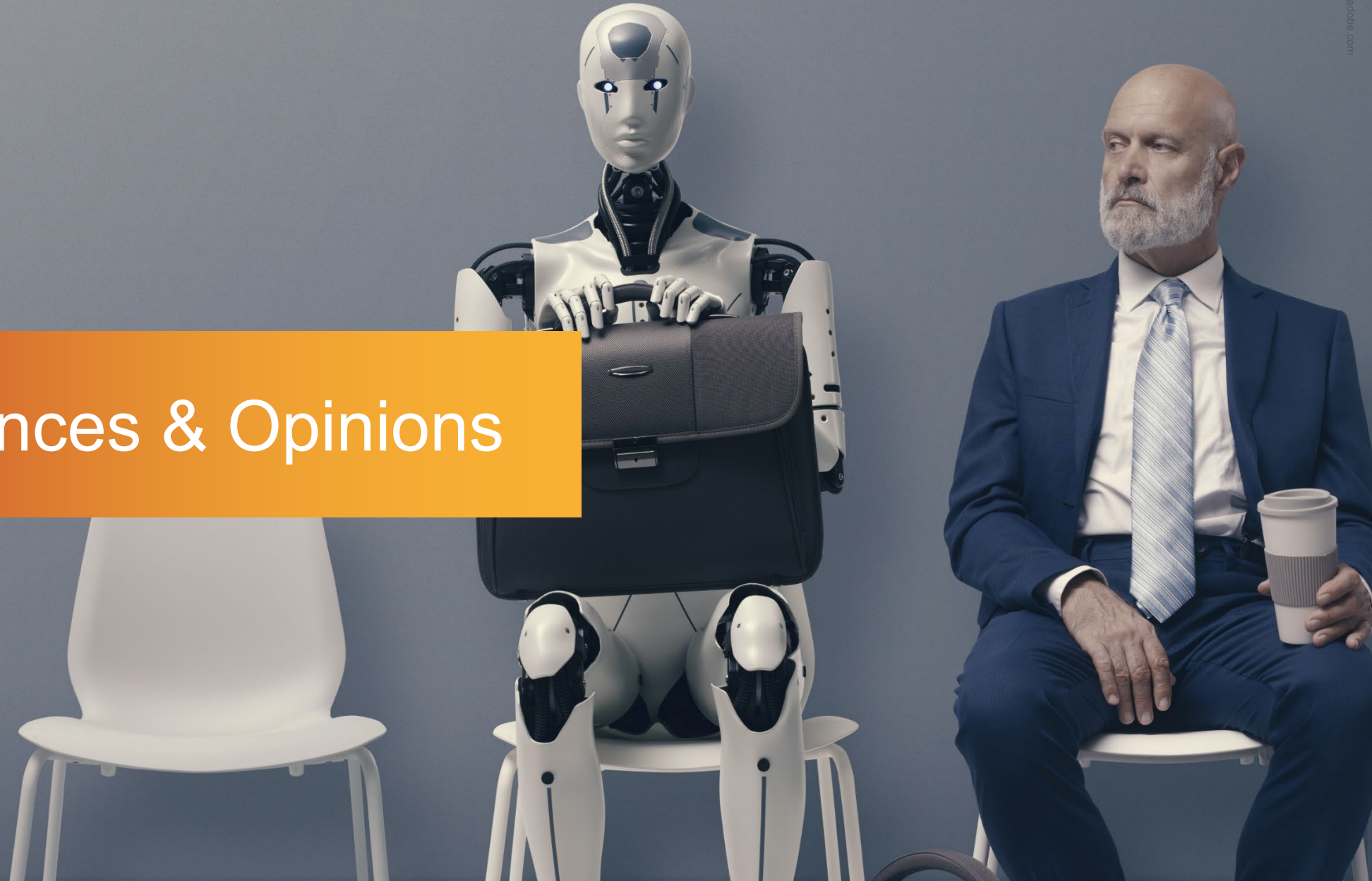
← Everything in Copilot, plus:

- ✓ Chat personalized to your codebase
- ✓ Documentation search and summaries
- ✓ Pull request summaries
- ✓ Code review skills
- ✓ Fine-tuned models<sup>4</sup>

[Join waitlist >](#)

As of December 10<sup>th</sup> 2023

# My Experiences & Opinions





# How Do I use GitHub Copilot?



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## My usage

I keep typing and enjoy the autogenerated suggestions.

Rarely, I write a comment and get inspired by generated functions. I almost never accept functions as a whole

I use the explain feature a lot, when writing documentation

I explore & enjoy the CopilotChat Beta Feature, since I got accepted two weeks ago



# Acceptance Rate of Suggestions



## GitHub Copilot FAQ

- In a recent evaluation, we found that users **accepted on average 26% of all completions shown** by GitHub Copilot. We also found that on average more than **27% of developers' code files were generated** by GitHub Copilot, and in certain languages like Python that goes up to 40%. However, GitHub Copilot does not write perfect code.

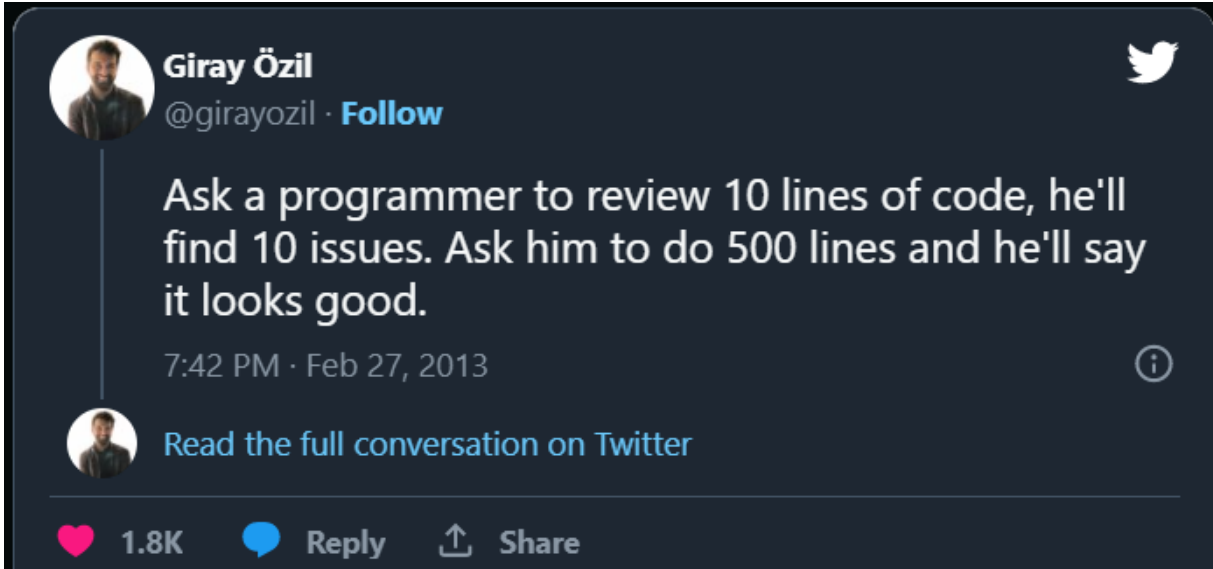
Source: <https://github.com/features/copilot>

## My personal acceptance rate

- Unmodified suggestions roughly 5-10%, Python slightly higher
- I never accept complete files



# How Do I get the best results?



## Best results by

accepting only little amounts of code

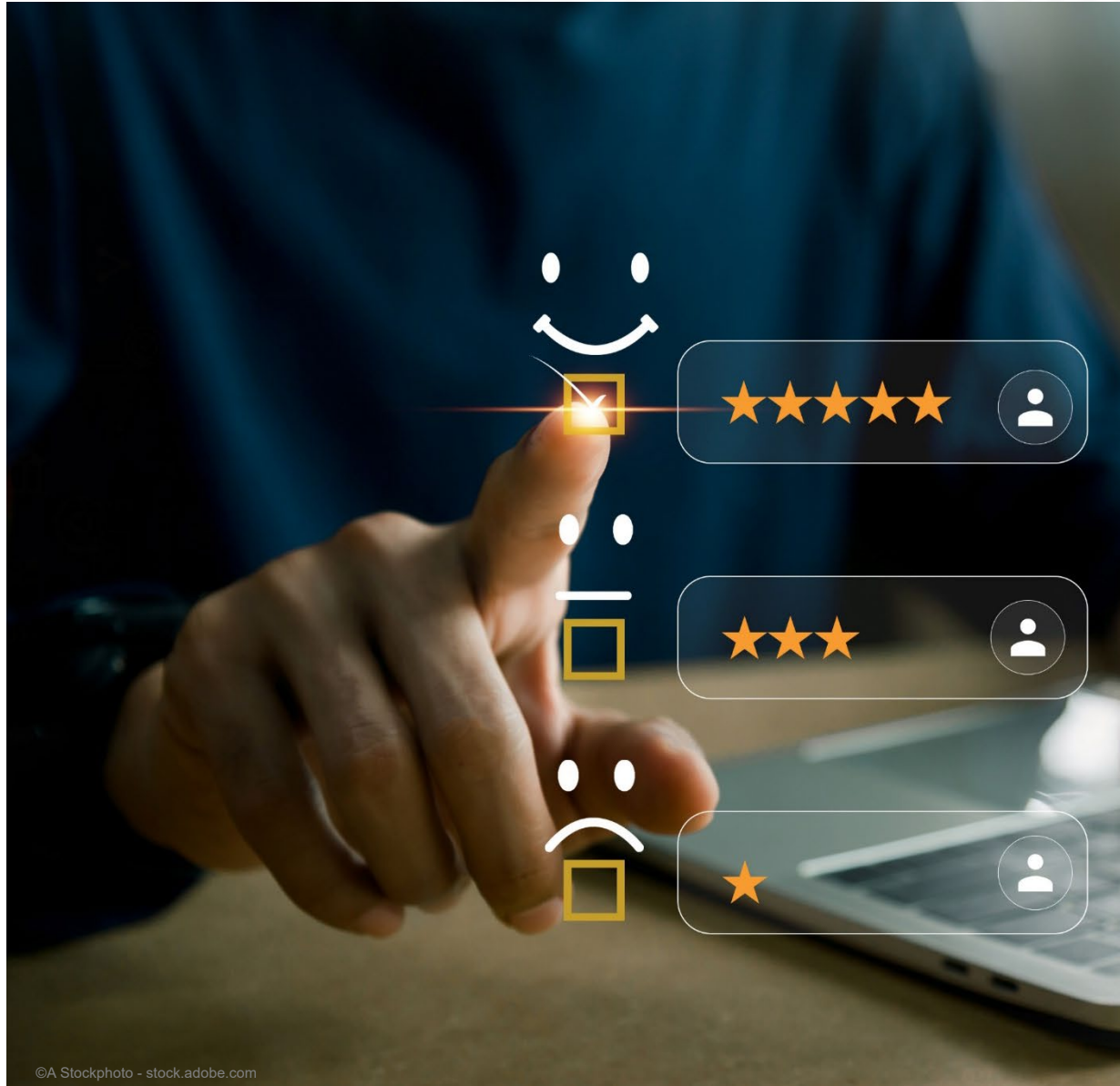
carefully checking, what's suggested

never accept code, I don't understand

divide code in small functions with meaningful names and parameters



# What languages work best?



## GitHub Copilot works

- with most computer languages.

## Results are better

- when more training data (aka Repositories) is available.

## Best Results come for

- JavaScript
- TypeScript
- Python
- Ruby
- Go
- C#
- C++



# Copilot & Oracle SQL

```
SELECT  
FROM  
WHERE  
Employee-  
Employees  
HireDate BETWEEN  
SELECT  
WHERE  
City IN ('Seattle', 'Tacoma')  
EmployeeID, FirstName, Last  
SELECT  
FROM  
WHERE  
EmployeeID, FirstNar  
Employees  
HireDate NOT BETT
```

@Proxima Studio - stock.adobe.com

GitHub Copilot works well with SQL

Mixes SQL dialects

- e.g. mySQL & pgSQL

In most cases easy to adapt



# Copilot & Oracle PL/SQL

# ORACLE®

## DATABASE



### PL/SQL

Only little amount  
of PL/SQL  
Trainingdata

Wrong suggestions  
quite common

Copilot can't distinguish  
between Oracle PL/SQL  
and PL/pgSQL

Easy to adapt

→ create more PL/SQL  
repositories on GitHub!



# GitHub Copilot: Pitfalls & Caveats

Copilot generates „B\*\*\*Sh\*\*\*“

(B\*\*\*Sh\*t is an AI technical term, similar to hallucinating)  
generated code looks good, but isn't understood by Copilot  
→ Be careful, its easy to drift away from your path

## Check

- every line
- every variable name
- every function call

## Copilot doesn't generates the best code

- rather the average of all repos in GitHub
- with bugs and security issues

## It's your code. You are in charge

- There won't be a label
- „Generated by an AI“



# Is it worth the money?

---



It worth the money?

**Definitely!**

It spares multiple hours a week googeling for exampes

Types the boring repetitions

Sometimes it even helps, when I'm stuck.

I'll keep my rubber ducky, though.



# GitHub Copilot Alternatives

Product	Trained on	Self hosting option	Fine tuned to company codebase	Status	Open source	Pricing
<a href="#">Tabnine</a>	Open source code with permissive licenses.	Yes (enterprise plan)	Yes (enterprise plan)	Production	No	Free + Paid
<a href="#">GitHub Copilot</a>	Publicly available code (regardless of license)	No	No	Production	No	Paid*
<a href="#">Replit Ghostwriter</a>	Publicly available code (regardless of license)	No	No	Production	No	Paid
<a href="#">Amazon CodeWhisperer</a>	Amazon and open-source code: but can select to not generate licensed open-source code	No. But professional version collects no data.	No	General availability	No	Free + Paid**
<a href="#">Codeium</a>	Own model. Trained on permissive licenses.	Yes (enterprise plan)	Yes	Production	<a href="#">Some plugins</a>	Free + Paid
<a href="#">SourceGraph Cody</a>	Users can select: OpenAI or Anthropic currently. Future plans for other models.	Yes for Sourcegraph. Cody: not yet; it talks with third-party LLM providers.	No	Experimental	Yes	Free + Paid***
<a href="#">CodeComplete</a>	Open source code with permissive licenses	Yes	Yes	Private beta	No	N/A
<a href="#">FauxPilot</a>	Salesforce CodeGen: open source but includes code with non-permissive license	Yes	No	Production	Yes	Free
<a href="#">Tabby</a>	Unclear	Yes	Yes	Production	Yes	Free

\* GitHub Copilot is free for verified students, teachers and maintainers of popular open-source repositories on GitHub. There is no way to request this, though, GitHub has decided which ones these “popular” projects are.

\*\* Amazon CodeWhisperer is free for personal use, forever

\*\*\* Cody is free for open source projects. It’s “free” as part of a paid Sourcegraph package.

[pragmaticengineer.com](https://pragmaticengineer.com)

## Alternatives

- [Tabnine](#) (2019)
- [GitHub Copilot](#) (2021)
- [Replit Ghostwriter](#) (2022)
- [Amazon CodeWhisperer](#) (2022)
- [Codeium](#) (2022)
- [SourceGraph Cody](#) (2023)
- [CodeComplete](#) (2023)
- [FauxPilot](#) (2023)
- [Tabby](#) (2023)

Source: [blog.pragmaticengineer.com/github-copilot-alternatives/](https://blog.pragmaticengineer.com/github-copilot-alternatives/)

# Conclusion





Boosts your Coding Speed

Types the boring repetitions for you

Really helpful when you're stuck

Won't take your job

**PLEASE**

**DO  
TRY THIS  
AT HOME**