



**GitHub Copilot:
Erfahrungen aus 1,75 Jahren
KI-gestützter Software-Entwicklung**

Thementage Remote - Mittwoch, 13.03.2024 (11:00 - 11:45)



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



DATABEE
Die IT-Architekten



@RobbieDatabee



<https://robbie.databee.org>



robert.marz@databee.org



Oracle ACE
Pro



500+ technical experts helping peers globally

The **Oracle ACE Program** recognizes and rewards community members for their technical and community contributions to the Oracle community

3 membership tiers



Oracle ACE Director



Oracle ACE Pro



Oracle ACE Associate

For more details on Oracle ACE Program:
ace.oracle.com



Oracle ACE

Nominate

yourself or someone you know:

ace.oracle.com/nominate





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

- [@RobbieDatabee](#) 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



©vlarvix - stock.adobe.com



GitHub Copilot: Invocation

How to invoke

Just type - works like normal autocomplete

Press Ctrl-<Enter>

Use Context Menu

Invoke Copilot Labs



©Andreas Prott - stock.adobe.com

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_factorial(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

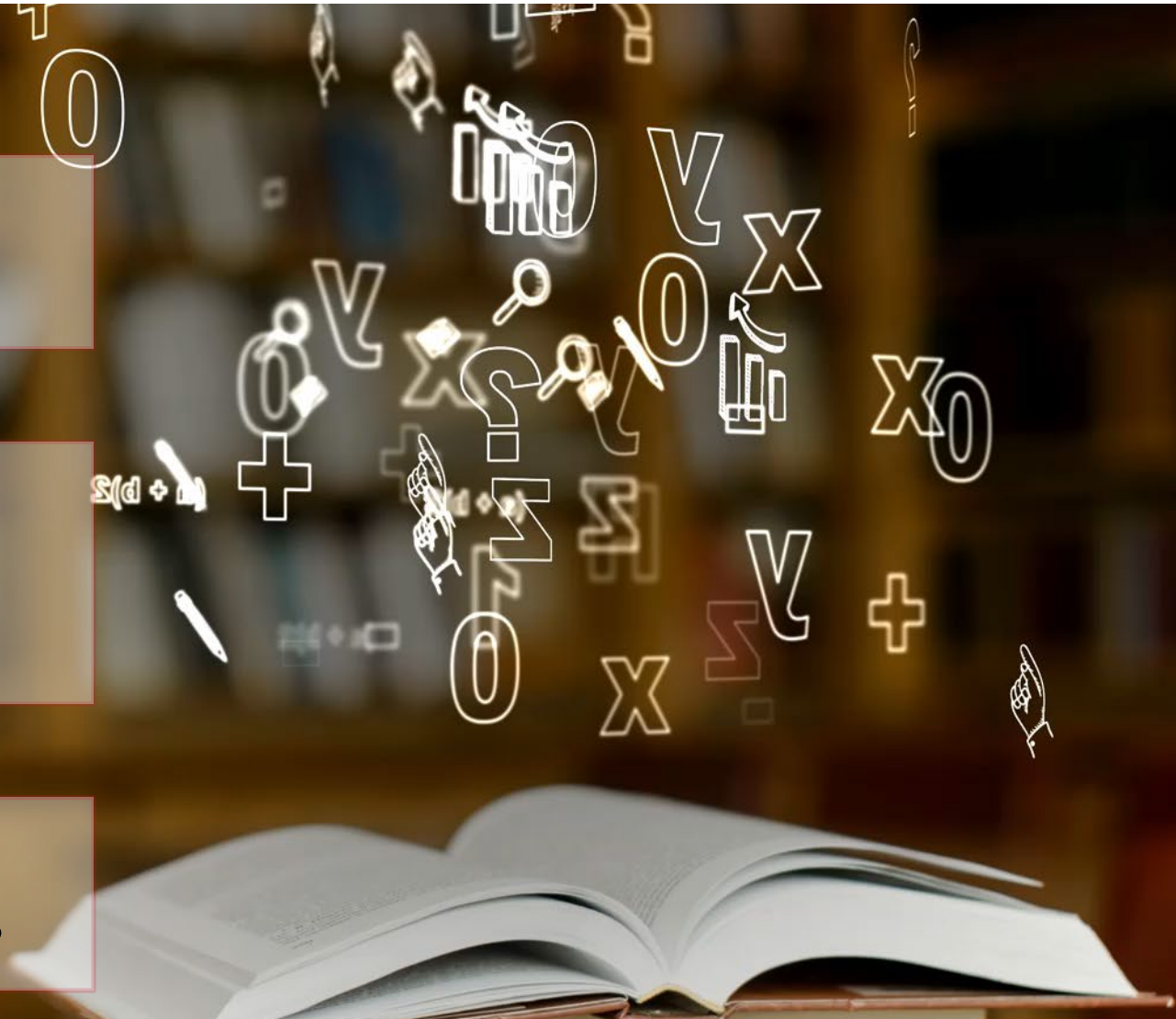
- are syntactically correct

Code snippets

- are in style
- e.g., „Pythonic“

Examples

- Explains how code works





Usecase: Discuss Challenges with CopilotChat

GitHub Copilot Chat



- Companion Extension
- GA since 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

```
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]
      }
    }
  }
}

return word + 's'
```

Test Pilot

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



Usecase: Explain Code

```
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
```

GITHUB COPILOT LABS

EXPLAIN

Code does following (English)

Advanced

Ask Copilot

LANGUAGE TRANSLATION

Ln 16, Col 1 Spaces: 2 UTF-8 LF {} TypeScrit Insert Prettier



Usecase: Do my Job



©Golden_Hind - stock.adobe.com

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

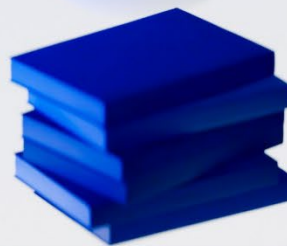


GitHub Copilot: Demo



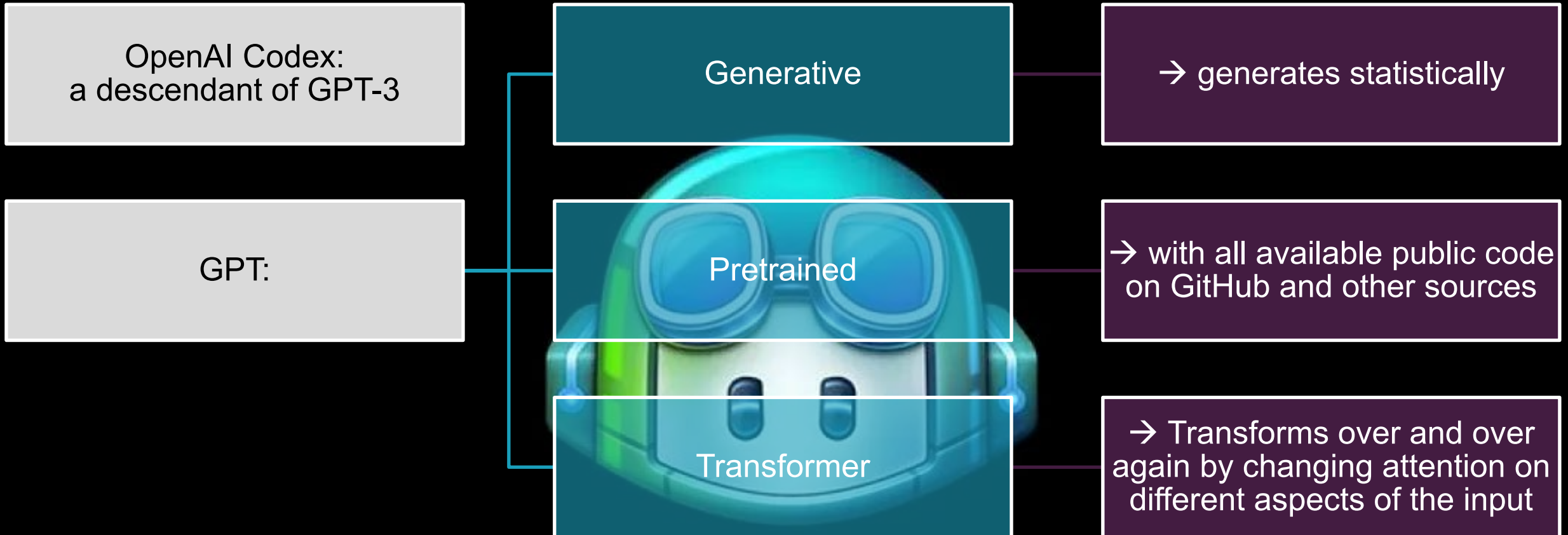
©nitroworld - stock.adobe.com

GitHub Copilot: How it works





GitHub Copilot – How it works I



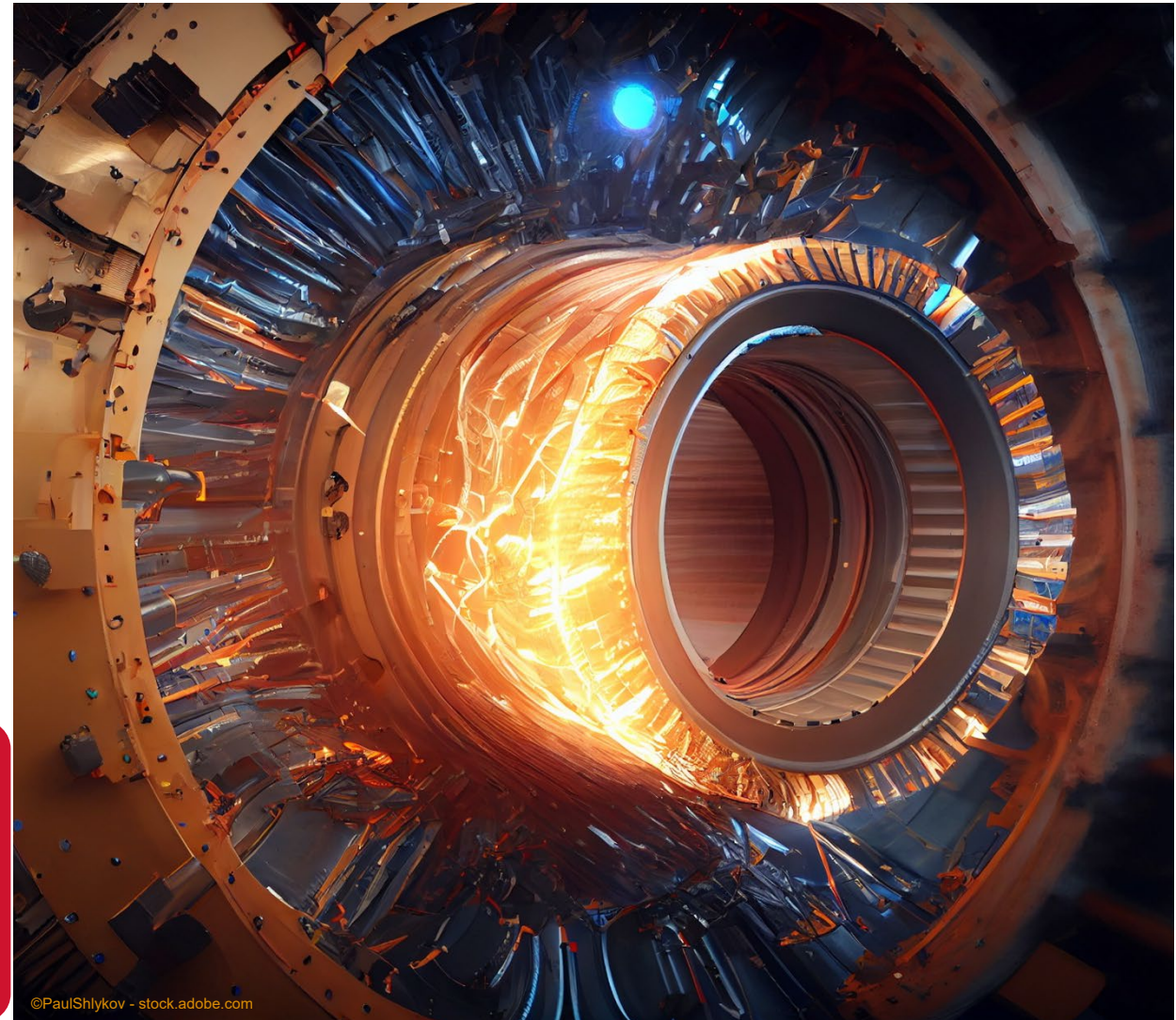


GitHub Copilot – How it works II

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

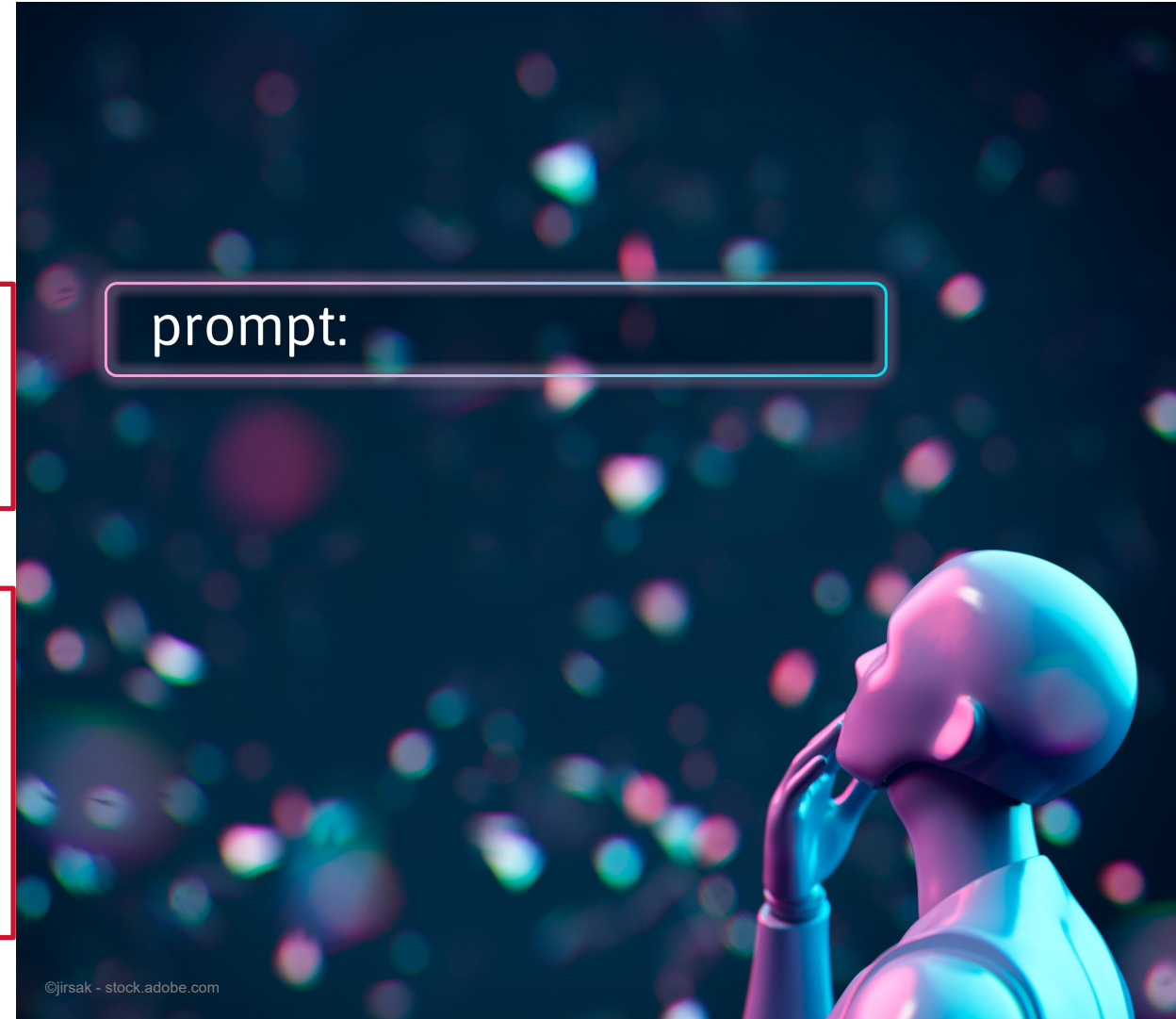
- edit actions
- completions accepted and dismissed

Code Snippets Data

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

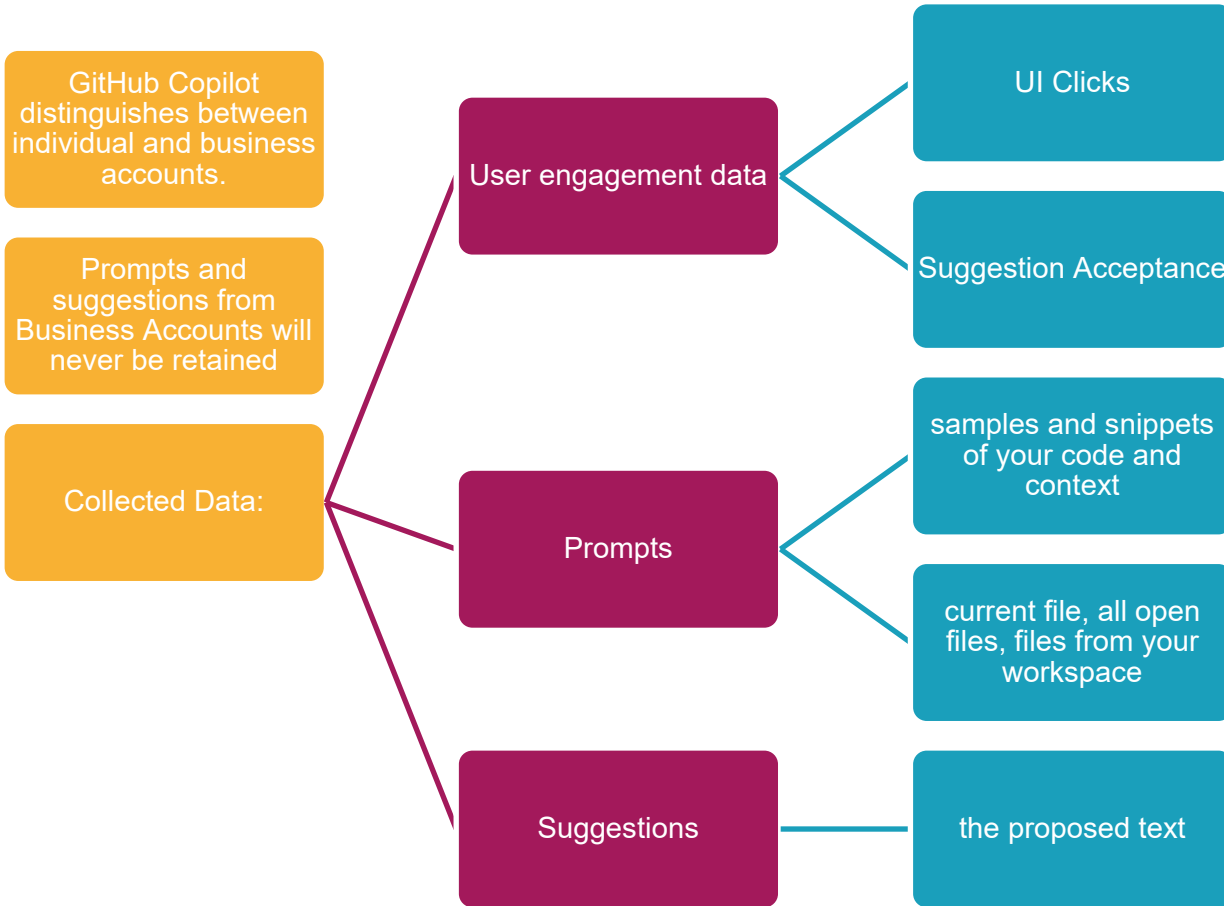
Source:

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





GitHub Copilot: Data privacy – collected data



©yod67 - stock.adobe.com



GitHub Copilot: Copyright & License Issues



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



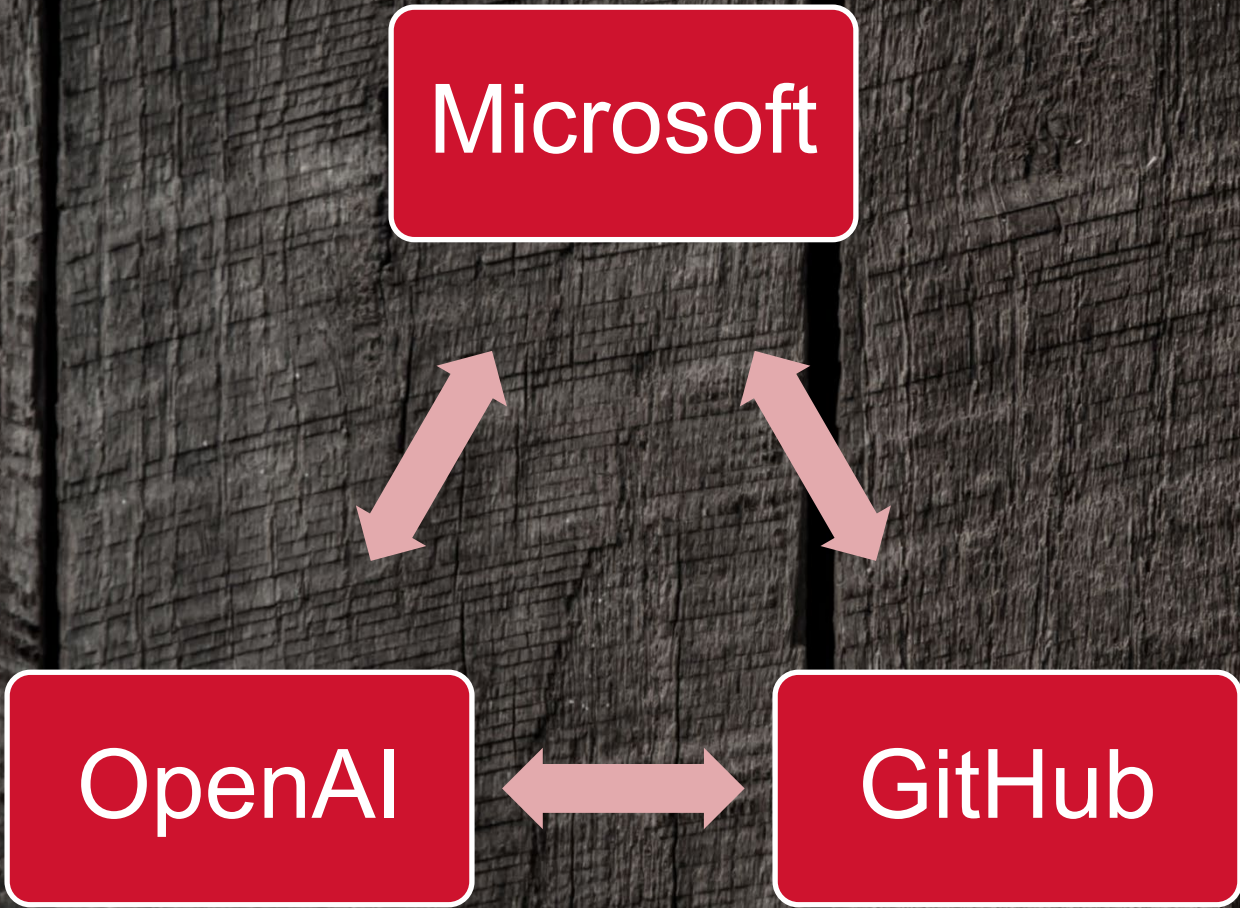
Copilot generates every answer based on the prompt – it is unlikely, that it reproduces copyrighted code.



Let's leave those disputes to the lawyers



GitHub Copilot – Companies involved





GitHub Copilot: Costs

Copilot Individual

For individual developers, freelancers, students, and educators that want to code faster and happier.

\$ 10 USD

per month / \$100 USD per year

[Start a free trial >](#)

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

Most popular

Copilot Business

For organizations ready to improve engineering velocity, code quality, and developer experience.

\$ 19 USD

per user / month

[Buy now >](#)

[Contact sales >](#)

New

Copilot Enterprise

For companies looking to customize GitHub Copilot to their organization and infuse AI across the developer workflow.

\$ 39 USD

per user / month

[Contact sales >](#)

Source: <https://github.com/features/copilot/> As of March 10th 2024



GitHub Copilot: Features & Editions

Copilot Individual	Most popular Copilot Business	New Copilot Enterprise
<p>Chat</p> <ul style="list-style-type: none">✓ Unlimited messages, interactions, and history✓ Context-aware coding support and explanations✓ Debugging and security remediation assistance✗ Conversations tailored to your organization's repositories✗ Answers based on your organization's knowledge base✗ Access to knowledge from top open source repositories✗ Pull request diff analysis✗ Web search powered by Bing (beta) <p>Code completion</p> <ul style="list-style-type: none">✓ Real time code suggestions✓ Comments to code✗ Fine-tuned models (coming soon as add-on)	<p>Chat</p> <ul style="list-style-type: none">✓ Unlimited messages, interactions, and history✓ Context-aware coding support and explanations✓ Debugging and security remediation assistance✗ Conversations tailored to your organization's repositories✗ Answers based on your organization's knowledge base✗ Access to knowledge from top open source repositories✗ Pull request diff analysis✗ Web search powered by Bing (beta) <p>Code completion</p> <ul style="list-style-type: none">✓ Real time code suggestions✓ Comments to code✗ Fine-tuned models (coming soon as add-on)	<p>Chat</p> <ul style="list-style-type: none">✓ Unlimited messages, interactions, and history✓ Context-aware coding support and explanations✓ Debugging and security remediation assistance✓ Conversations tailored to your organization's repositories✓ Answers based on your organization's knowledge base✓ Access to knowledge from top open source repositories✓ Pull request diff analysis✓ Web search powered by Bing (beta) <p>Code completion</p> <ul style="list-style-type: none">✓ Real time code suggestions✓ Comments to code✓ Fine-tuned models (coming soon as add-on)

Source: <https://github.com/features/copilot/> As of March 10th 2024

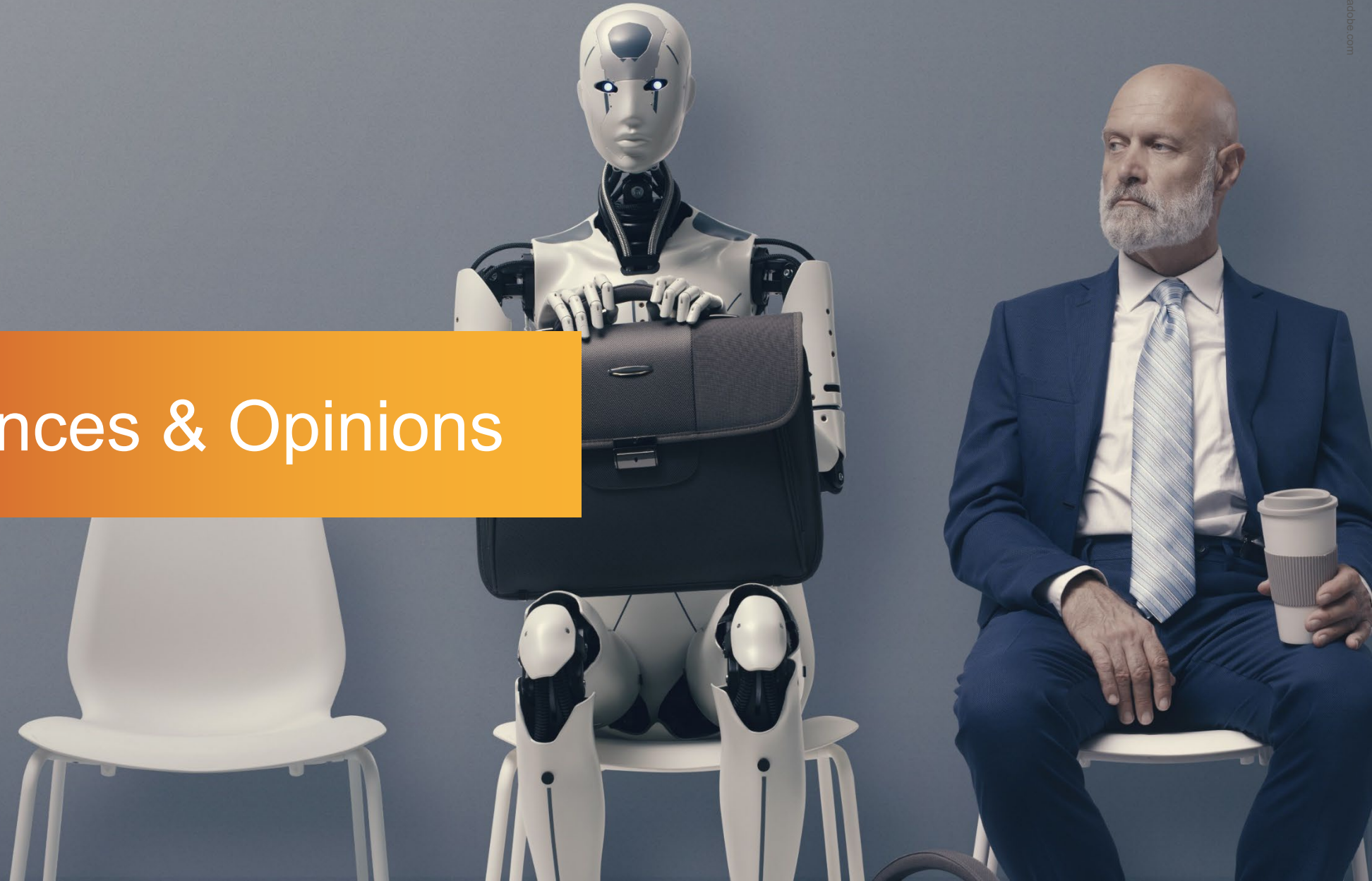


GitHub Copilot: Features & Editions (cont.)

Copilot Individual	Most popular Copilot Business	New Copilot Enterprise
<p>Smart actions</p> <ul style="list-style-type: none">✓ Inline chat and prompt suggestions✗ Slash commands and context variables✓ Commit message generation✗ Pull request description and summarization <p>Supported environments</p> <ul style="list-style-type: none">✓ IDE, CLI¹ and GitHub Mobile²✗ GitHub.com <p>Management and policies</p> <ul style="list-style-type: none">✓ Public code filter✗ User management and SSO✗ Data excluded from training by default✗ IP indemnity✗ Content exclusion✗ Requires GitHub Enterprise Cloud	<p>Smart actions</p> <ul style="list-style-type: none">✓ Inline chat and prompt suggestions✓ Slash commands and context variables✓ Commit message generation✗ Pull request description and summarization <p>Supported environments</p> <ul style="list-style-type: none">✓ IDE, CLI¹ and GitHub Mobile²✗ GitHub.com <p>Management and policies</p> <ul style="list-style-type: none">✓ Public code filter✓ User management and SSO✓ Data excluded from training by default✓ IP indemnity✓ Content exclusion✗ Requires GitHub Enterprise Cloud	<p>Smart actions</p> <ul style="list-style-type: none">✓ Inline chat and prompt suggestions✓ Slash commands and context variables✓ Commit message generation✓ Pull request description and summarization <p>Supported environments</p> <ul style="list-style-type: none">✓ IDE, CLI¹ and GitHub Mobile²✓ GitHub.com <p>Management and policies</p> <ul style="list-style-type: none">✓ Public code filter✓ User management and SSO✓ Data excluded from training by default✓ IP indemnity✓ Content exclusion✓ Requires GitHub Enterprise Cloud

Source: <https://github.com/features/copilot/> As of March 10th 2024

My Experiences & Opinions





How Do I use GitHub Copilot?



©Charnchai saeheng - stock.adobe.com

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 Feature, since I got accepted in mid may 2023



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.

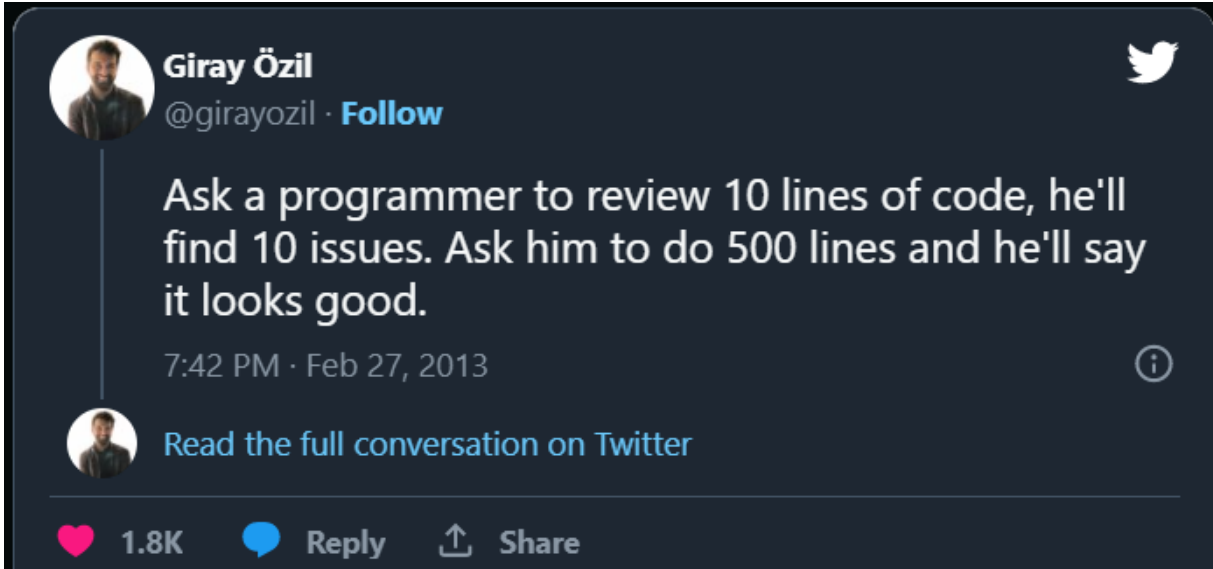
Source: <https://github.com/features/copilot>

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

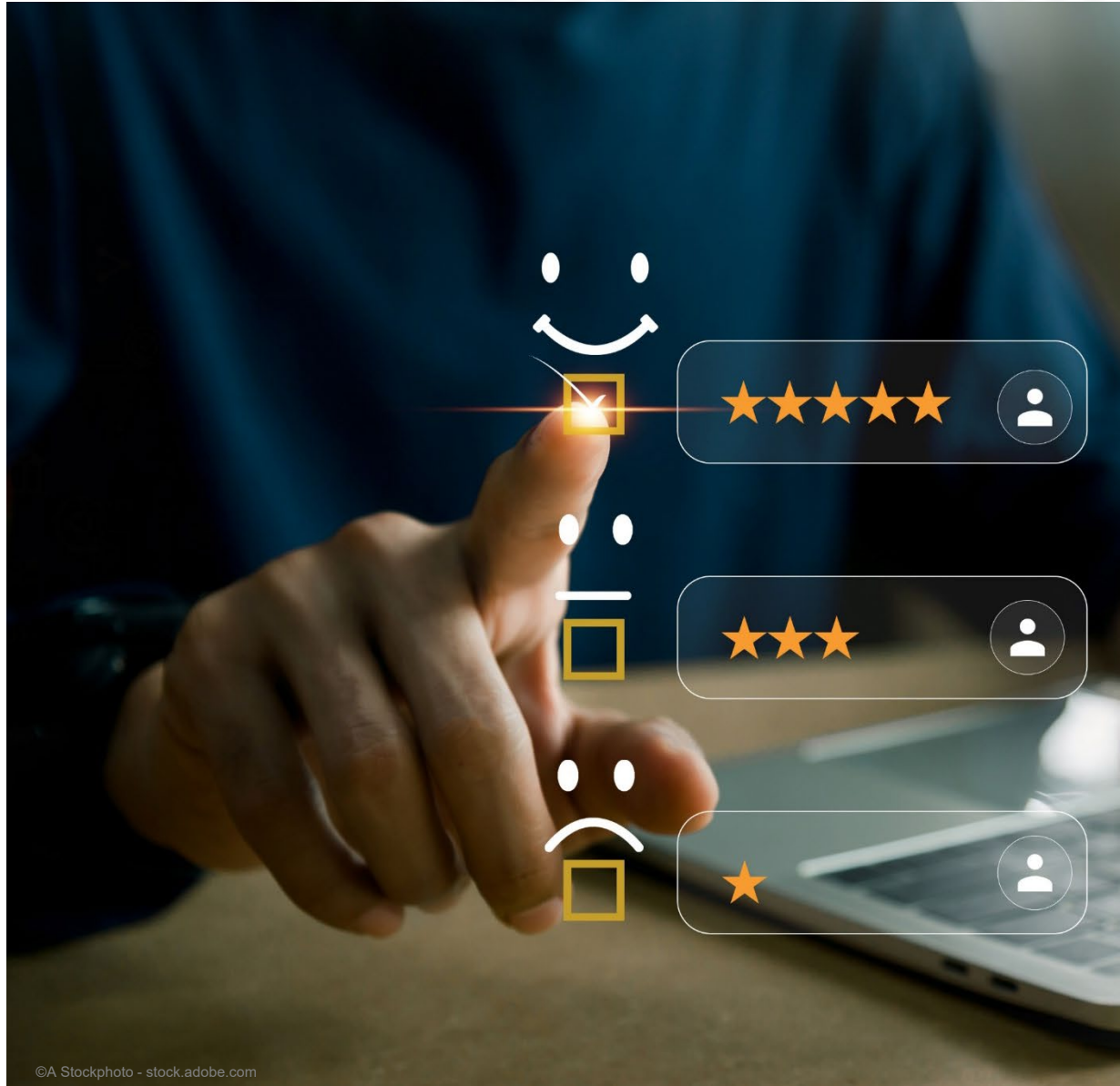
carefully checking, what's suggested

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 FROM WHERE  
EmployeeID, FirstName, Last  
City IN ('Seattle', 'Tacoma')  
SELECT FROM WHERE  
EmployeeID, FirstNa  
Employees  
HireDate NOT BETT  
10  
11  
12  
13  
14  
15
```

@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

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

Wrong suggestions
quite common

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
Tabnine	Open source code with permissive licenses.	Yes (enterprise plan)	Yes (enterprise plan)	Production	No	Free + Paid
GitHub Copilot	Publicly available code (regardless of license)	No	No	Production	No	Paid*
Replit Ghostwriter	Publicly available code (regardless of license)	No	No	Production	No	Paid
Amazon CodeWhisperer	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**
Codeium	Own model. Trained on permissive licenses.	Yes (enterprise plan)	Yes	Production	Some plugins	Free + Paid
SourceGraph Cody	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***
CodeComplete	Open source code with permissive licenses	Yes	Yes	Private beta	No	N/A
FauxPilot	Salesforce CodeGen: open source but includes code with non-permissive license	Yes	No	Production	Yes	Free
Tabby	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

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/

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**