Computational Thinking
AI-Assisted Programming

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Content

- The Role of Artificial Intelligence in Computational Thinking
- Introduction to AI Assistants Ecosystem
- Learn Python Programming with AI
- Common Pitfalls and Challenges of AI
- Responsible Use of AI

The Role of Artificial Intelligence in Computational Thinking

Programming Is More Than Just Typing Code!

- Before computers, how did people solve complex problems?

Through COMPUTATIONAL THINKING!

- This is the systematic skill of analyzing and solving problems.
- Programming is merely the tool to "tell" the computer how to implement that solution.

Computational Thinking: 4 Core Skills

1 **Decomposition**

Breaking down a large problem into smaller, more manageable parts.
Example: to draw a basic cat, it's easier to focus on one part at a time, instead of trying to draw the entire cat all at once.

2 **Pattern Recognition**

Identifying similarities, trends, or regularities in data.
Example: Noting that all cats share common characteristics: eyes, a tail, fur,…

3 **Abstraction**

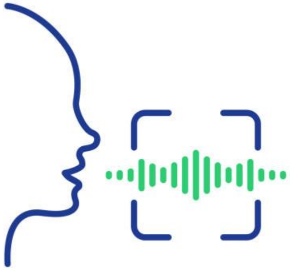
Focusing on essential information, ignoring irrelevant details.
Example: Individual cat specific characteristics: brown fur, a long tail, yellow eyes,… are not important for this task.

4 **Algorithm Design**

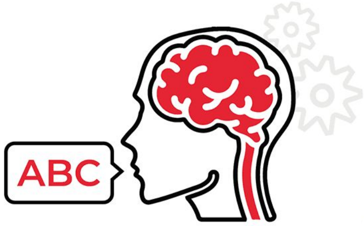
Designing step-by-step instructions, or the rules to follow to solve the problem.
Example: The precise steps to draw a basic cat.

Artificial Intelligence (AI)

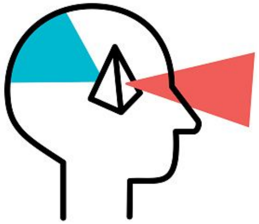
AI is a field of computer science focused on creating systems that can perform tasks requiring human intelligence, such as learning, reasoning, problem-solving, perception, and language understanding.



Speech Recognition & Processing



Natural Language Comprehension

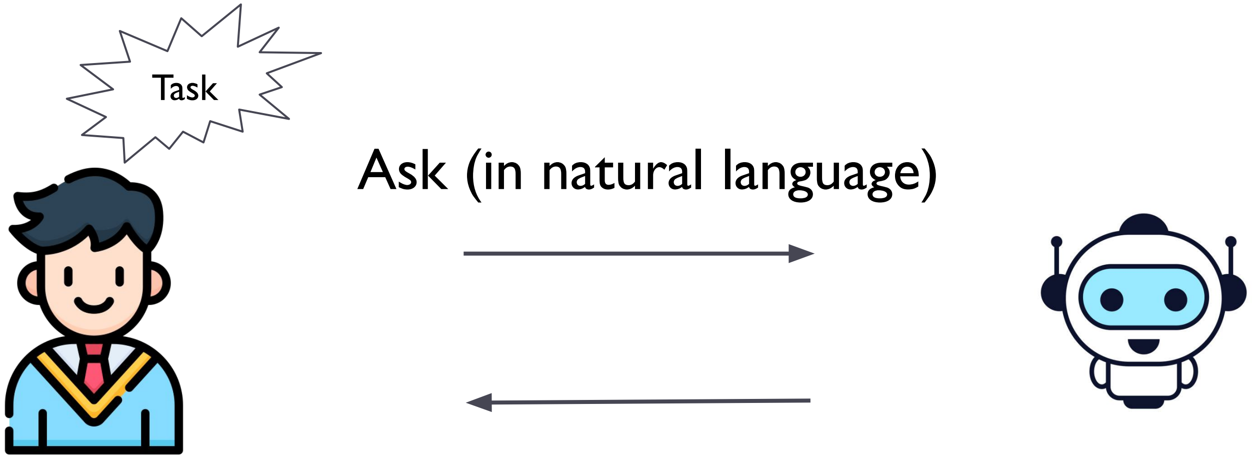


Visual Perception & Analytics

Thinking, Reasoning & Decision-making

AI as an Assistant

AI assistants use NLP to understand your requests and provide human with the required information or assistance.

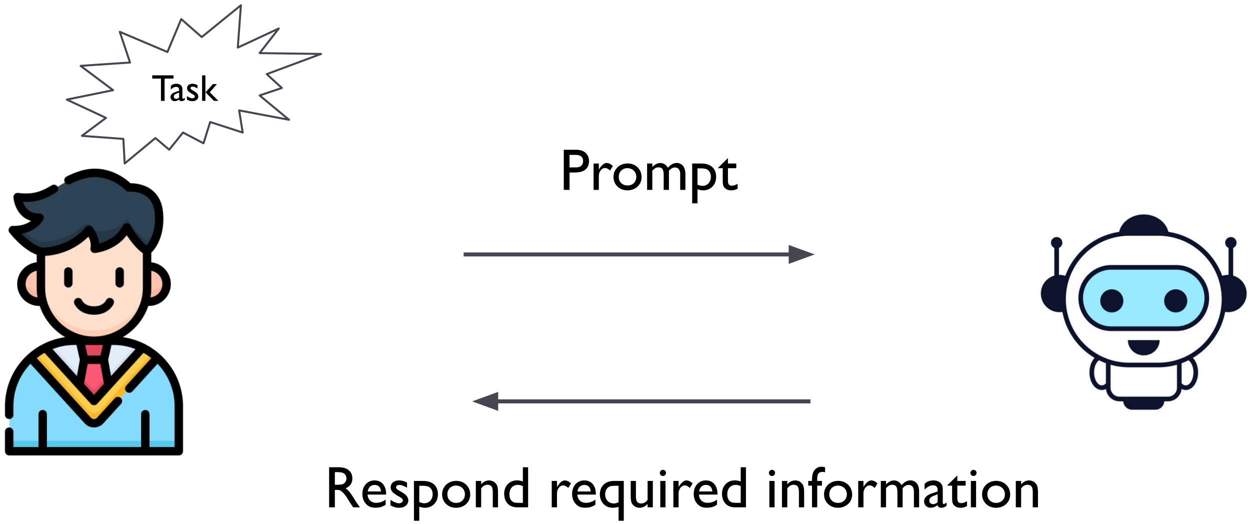


Ask (in natural language)

Respond required information

AI as an Assistant using Prompt

A **prompt** is the input or instruction you give to an AI system to guide its response. It can be a question, a statement, or even a piece of code



Task

Prompt

Respond required information

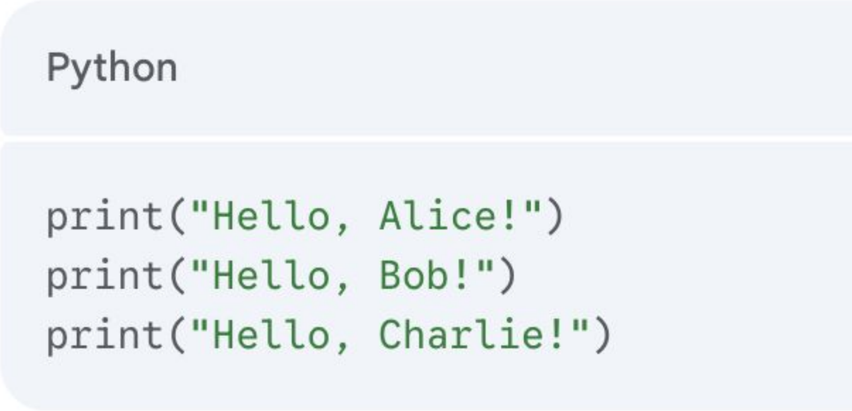
Prompt example: "Write a simple Python function called tinh_tong that takes two numbers, a and b, and returns their sum."

AI-assisted Computational Thinking (1)

- **Task:** "Write a simple student management program."
- **Prompt:** "I want to write a student management program. What are the key functions I should consider?"
- **AI Response (likely):**
    - Add new students.
    - Display student list.
    - Search for students by ID.
    - Delete students.

AI-assisted Computational Thinking (2)

- **Task:** " Write a code to say hello to three different people"
- **Prompt:** "I've written this Python code to say hello to three different people. It feels like I'm repeating myself. Can you help me find the pattern and suggest a better way to do this?"

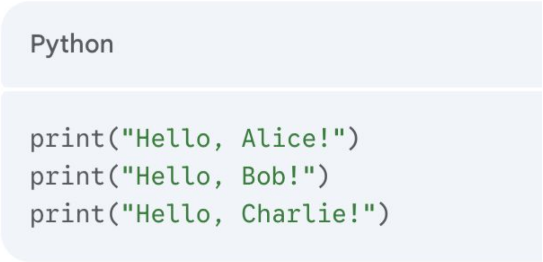


```python
print("Hello, Alice!")
print("Hello, Bob!")
print("Hello, Charlie!")
```

AI-assisted Computational Thinking (3)

- **Task:** " Write a code to say hello to three different people"
- **Prompt:** "I've written this Python code to say hello to three different people. It feels like I'm repeating myself. Can you help me find the pattern and suggest a better way to do this?"
- **Pattern Recognition**:

  The pattern in your code is that each line does the exact same thing, just with a different name: `print("Hello, [some name]!")`

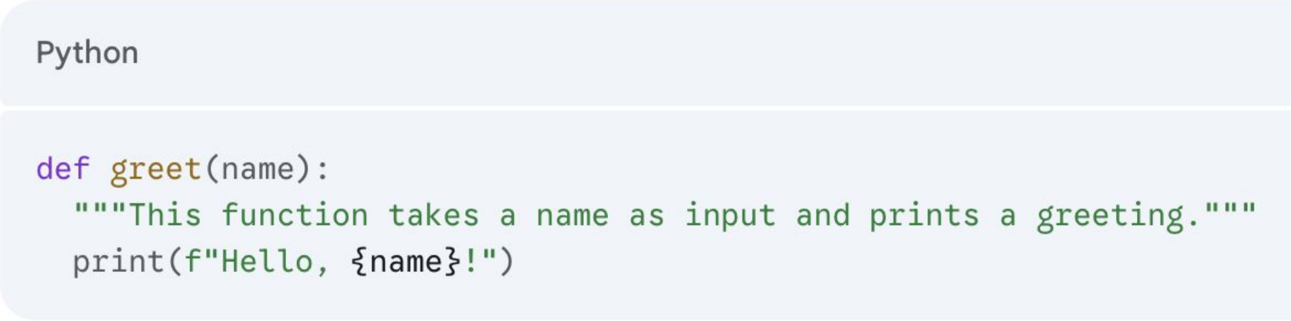


Python

```python
print("Hello, Alice!")
print("Hello, Bob!")
print("Hello, Charlie!")
```

AI-assisted Computational Thinking (4)

- **Task:** " Write a code to say hello to three different people"
- **Prompt:** "I've written this Python code to say hello to three different people. It feels like I'm repeating myself. Can you help me find the pattern and suggest a better way to do this?"
- **Abstraction:** create a function `great` that captures this pattern , which will take a `name` as an input and print the personalized greeting.

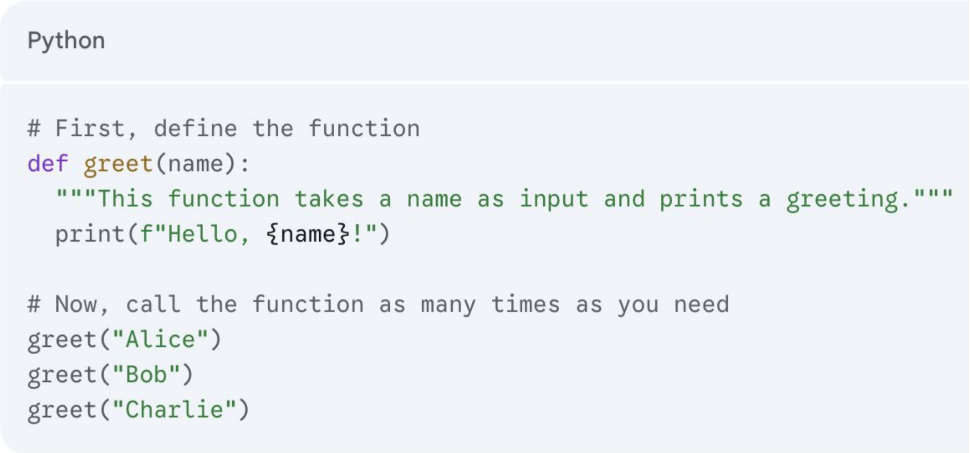


Python

```python
def greet(name):
  """This function takes a name as input and prints a greeting."""
  print(f"Hello, {name}!")
```

AI-assisted Computational Thinking (5)

- **Task:** " Write a code to say hello to three different people"
- **Prompt:** "I've written this Python code to say hello to three different people. It feels like I'm repeating myself. Can you help me find the pattern and suggest a better way to do this?"
- **Algorithm Design:** instead of typing the `print` three times, your new algorithm is to simply call your `great` function three times with different names.



Python

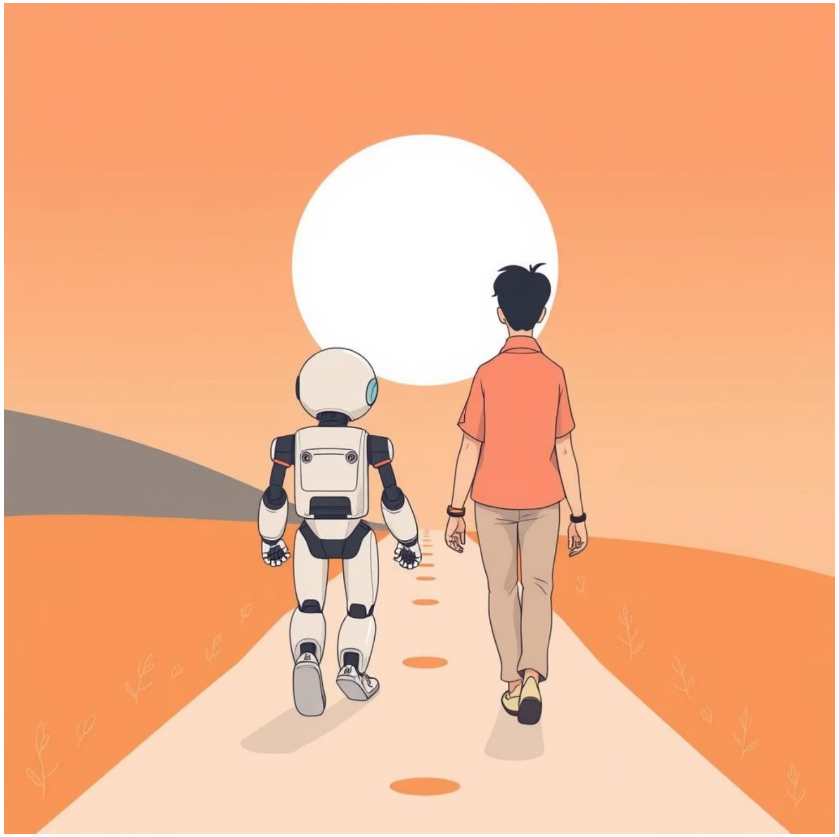
```python
# First, define the function
def greet(name):
  """This function takes a name as input and prints a greeting."""
  print(f"Hello, {name}!")

# Now, call the function as many times as you need
greet("Alice")
greet("Bob")
greet("Charlie")
```

Where Does AI Fit Into This Picture?

AI: Your Companion On The Thinking Journey

- AI doesn't replace your critical thinking.
- It's a powerful tool that can assist you in all four steps of Computational Thinking.
- Make your problem-solving process more efficient.
- Our goal: Learn how to "command" AI



AI: The Programmer's Powerful Assistant

- **Code Generation**
  - Generate code snippets or full functions from simple descriptions.
- **Code Suggestion**
  - Auto-complete lines of code as you type, predicting your next move.
- **Code Explanation**
  - Understand complex code sections with AI explanations.
- **Debugging**
  - Identify errors and suggest fixes, saving valuable time.
- **Documentation**
  - Automatically generate documentation for your functions and modules.
- **Learning Assistant**
  - Ask for examples or explanations of new concepts, like "*Show me a for-loop example in Python.*"

Introduction to AI Assistants Ecosystem

ChatGPT: The General Coding Assistant

- **How it Works**:
  - It's a question-and-answer format.
  - You pose a prompt, and it generates a response.
- **Strengths**:
  - Highly versatile, capable of answering almost anything.
  - Ideal for brainstorming ideas and analyzing problems.
- **When to Use It:**
  - When you need an explanation, an idea, or a comprehensive code sample.

Quick Demo: From Idea to Code

- Quickly transform ideas to code

The Prompt:

> "Write a simple Python function called tinh_tong that takes two numbers, a and b, and returns their sum."

This demonstrates AI's ability to quickly generate boilerplate code, freeing developers to focus on more complex logic and problem-solving.

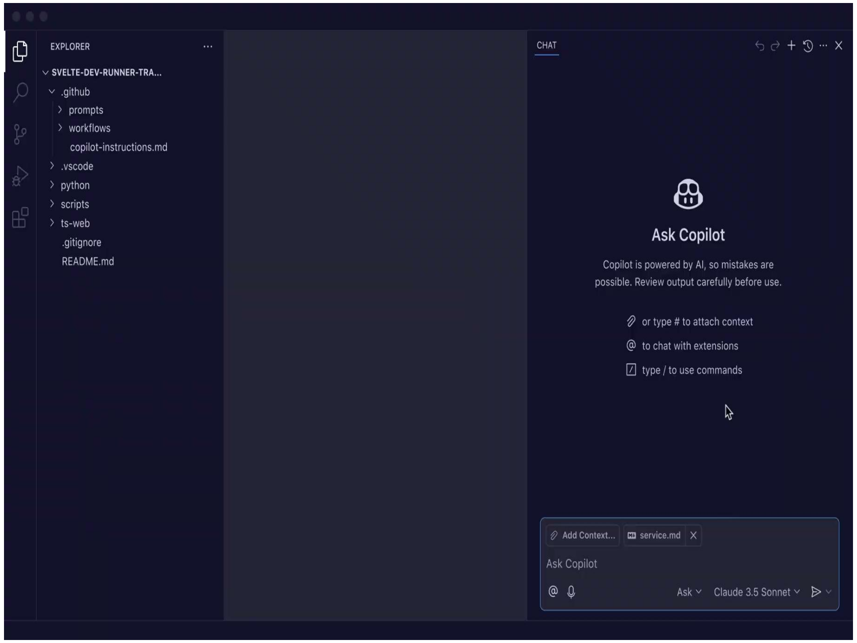
AI Generated Output:

```
def tinh_tong(a, b):
""" This function takes two numbers and returns their sum. """
    return a + b
```

Notice how the AI not only generates the correct code but also includes a helpful docstring (description).

GitHub Copilot: In-Editor Coding Assistant

- **How it Works:**
  - Integrates directly into code editor (VS Code,…).
  - Automatically suggests code as user type.
- **Strengths**:
  - Can be fast and convenient.
  - Understands the context of current project.
  - Boosts coding speed.
- **When to Use It:**
  - When you know what you need to write and want to complete it faster.



Ask Copilot

Copilot is powered by AI, so mistakes are possible. Review output carefully before use.

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

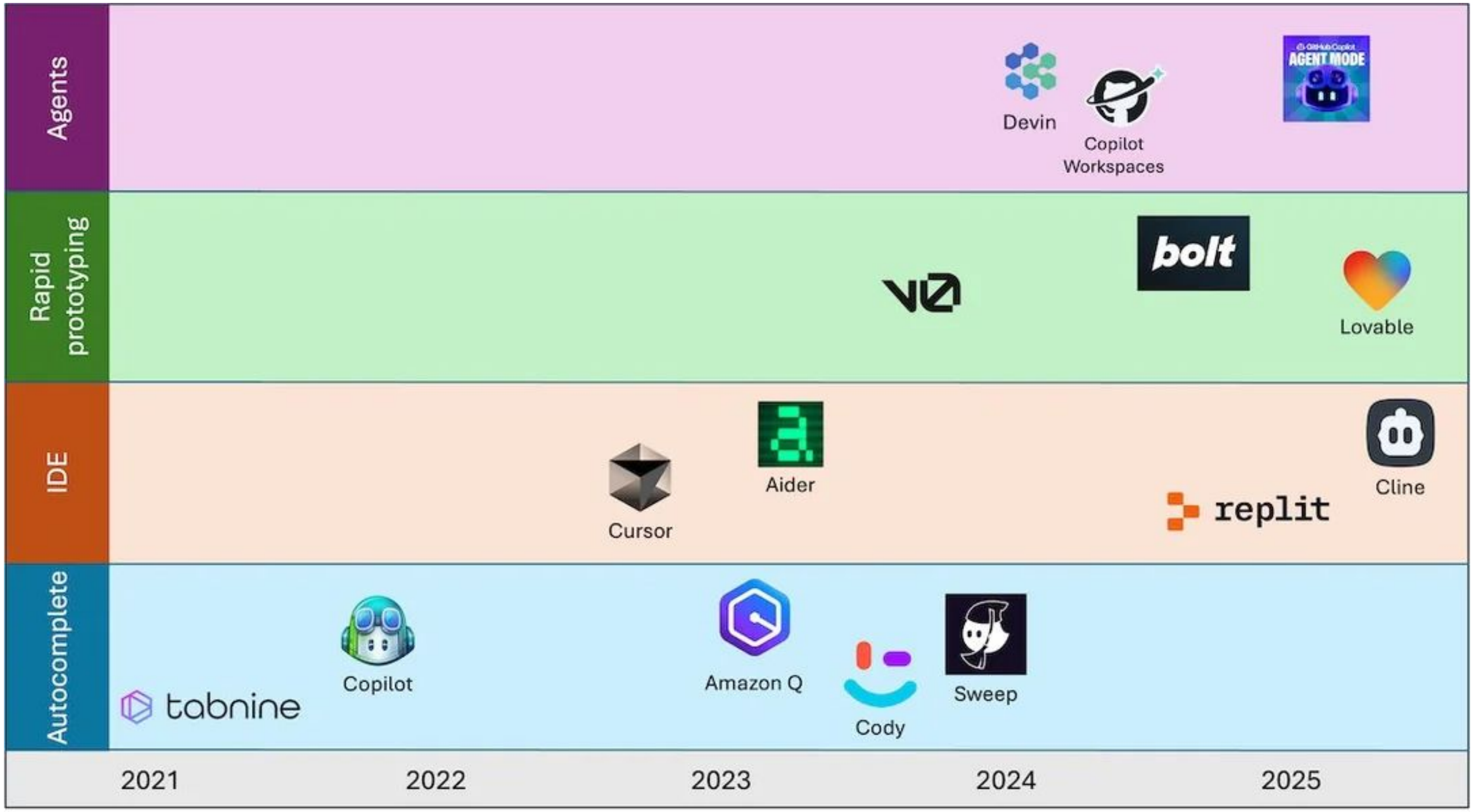
ChatGPT Vs. Copilot

Criterion	**ChatGPT**	**GitHub Copilot**
Format	Chat Interface	Integrated into Editor
Best For	Brainstorming, Explanations, Learning	Accelerating Code Writing
Strengths	Flexibility, Detailed Explanations	Speed, Contextual Awareness
Example	"*Explain data types in Python.*"	Auto-completing a function as user type

Use both! They complement each other.

The AI Ecosystem for Programming

- Besides ChatGPT and Copilot:



Source: https://blog.scottlogic.com/2025/04/01/making-sense-of-the-ai-developer-tools-ecosystem.html

Learn Python Programming with AI

Leverage AI tools to accelerate learning and become a more effective programmer

Demo: Decomposing a Problem with ChatGPT

- **Task**:
  - Write a small Python program to count the number of words in a sentence entered by the user.
- **ChatGPT Prompt**:
  - “`I'm a new Python programming student. I want to write a program to count the words in a sentence. Help me break this problem down into smaller steps.`”
- **ChatGPT's Response** (can be different on your machine):
  - Step 1: Ask the user to input a sentence and store it in a variable. (Hint: use the input() function)
  - Step 2: Split that sentence into a list of words. (Hint: use the .split() method)
  - Step 3: Count the number of elements in the list you just created. (Hint: use the len() function)
  - Step 4: Print the result to the screen."

Demo: GitHub Copilot Auto-Completes Code

Understanding the problem with ChatGPT's help, In VS Code, as you start typing, Copilot suggests completions.

Developer

```
# Ask the user to input a sentence and store it in a variable
```

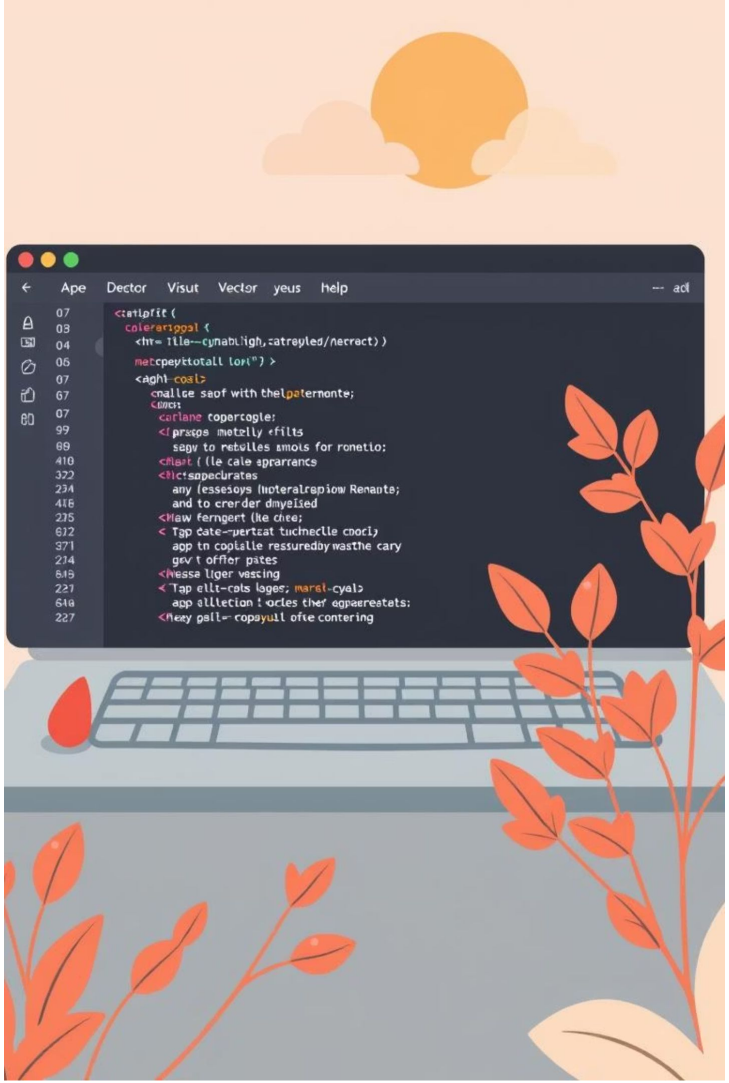
Copilot suggests:

```
# Ask the user to input a sentence and store it in a variable
user_sentence = input("Please enter a sentence: ")
```

Developer verifying the result:

```
# Ask the user to input a sentence and store it in a variable
user_sentence = input("Please enter a sentence: ")

# Print the sentence back to the user
print(f"The sentence you entered is: {user_sentence}")
```



AI Helps Debug

Scenario:

Suppose you wrote incorrect code and encountered an error:

```
Traceback (most recent call last):  File "main.py", line 4, in
print("Number of words: " + count)TypeError: can only concatenate str
(not "int") to str
```

ChatGPT Prompt:

```
I encountered a TypeError: can only concatenate str (not "int") to str
with this code. What does this error mean and how can I fix it?
```

AI Explains Errors Like a Teacher

ChatGPT's Potential Response:

> "This error means you are trying to combine a string ("Number of words: ") with an integer (count). Python does not allow this directly.
>
> **To fix it, you need to convert the** `count` **to a string before printing.**
>
> - **Method 1 (using** `str()`**):** `print("Number of words: " + str(count))`
> - **Method 2 (using f-string, more readable):** `print(f"Number of words: {count}")`"

✓ **Remark:** AI not only fixes the problem but also explains the underlying issue and offers multiple solutions, enhancing your understanding.

"Garbage In, Garbage Out"

Effective Prompting Strategies

Role
"Act as a Python expert..."

Objective
"...explain the concept of for loops..."

Rules
"...using simple examples only."

Audience
"...for a programming beginner."

Poor Prompt:

"code word count"

Good Prompt:

"Write a Python function named `count_words` that takes a string as input and returns the number of words in that string."

Prompt Engineering

- Prompt patterns
  - General prompting/ Zero-shot prompting
  - One-shot/ Few-shot prompting
  - Role prompting
  - Chain-of-Thought (CoT) prompting
  - Code prompting
    - Prompts for writing code
    - Prompts for explaining code
    - Prompts for translating code
    - Prompts for debugging and reviewing code
    - ….

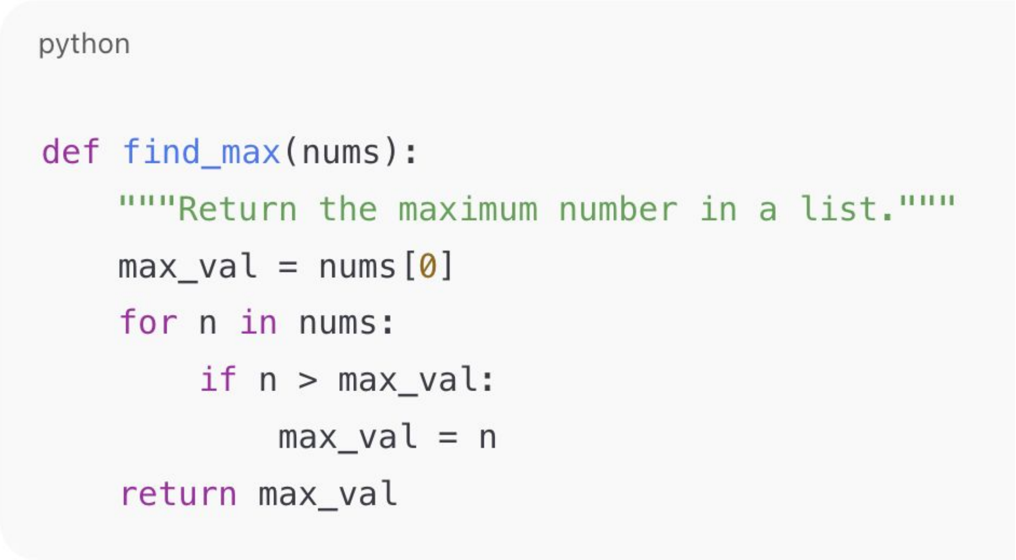
Google's prompting guide: https://www.kaggle.com/whitepaper-prompt-engineering

Common Pitfalls and Challenges of AI

Common Pitfalls - Example 1

The code works for typical inputs but fails on specific edge cases the model didn't consider.

- **Prompt**: "Write a Python function to find the maximum in a list."
- **AI Response**:



python

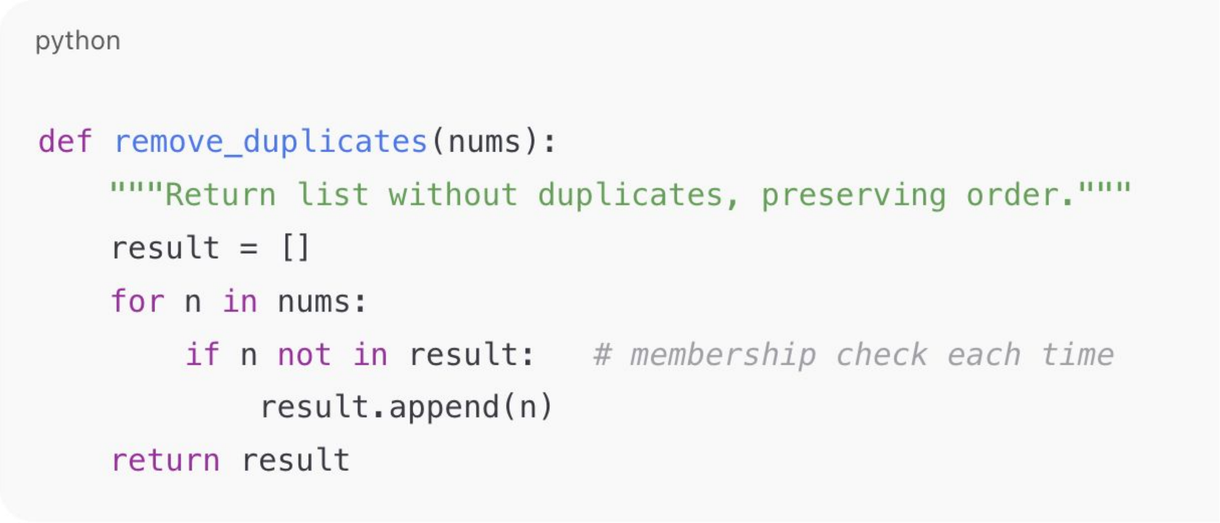
```python
def find_max(nums):
    """Return the maximum number in a list."""
    max_val = nums[0]
    for n in nums:
        if n > max_val:
            max_val = n
    return max_val
```

- **Problems?**
  - ○ Empty list

Common Pitfalls - Example 2

Provides a solution that is functionally correct but computationally inefficient for large datasets.

- **Prompt**: "Write a Python function to remove duplicates from a given list"
- **AI Response**:
- **Problems?**
    - $O(n^2)$
    - Large cases

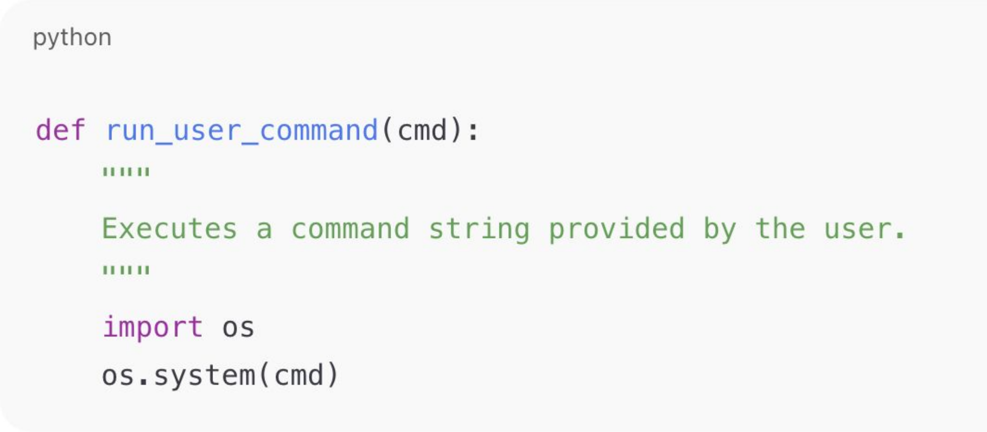


```python
def remove_duplicates(nums):
    """Return list without duplicates, preserving order."""
    result = []
    for n in nums:
        if n not in result:   # membership check each time
            result.append(n)
    return result
```

Common Pitfalls - Example 3

AI models are trained on vast amounts of public code, including code with known vulnerabilities. They can easily reproduce these dangerous patterns.

- **Prompt**: "Write a function to run user-provided commands in Python."
- **AI Response**:



```python
def run_user_command(cmd):
    """
    Executes a command string provided by the user.
    """
    import os
    os.system(cmd)
```

- **Problems?**
    - “rm -rf /”
    - “cat /etc/passwd”

When AI "Confidently" Lies

Bias in Training Data

If the AI's training data contains biases (e.g., outdated or suboptimal code), the AI will learn and perpetuate these flaws, generating less-than-ideal code.

Hallucination

AI can "invent" non-existent functions or concepts, like an "is_perfectly_even()" function in Python.

New learners are particularly susceptible to believing these fabrications.

> **Real-world example:** A lawyer once used ChatGPT for research and cited non-existent legal cases in court, leading to significant professional embarrassment.

Don't Trust AI 100%! Understanding Hallucinations

- AI’s hallucination: when the AI confidently generates incorrect or fabricated information. Examples:
  - Using a non-existent library or function.
  - Generating syntactically correct but logically flawed code.
  - Providing inaccurate explanations for concepts or errors.

- The key takeaway is critical: always verify AI-generated content.

> "AI is an assistant, not an absolute expert."

A Hard-Earned Lesson

Real-World Example: When AI Goes Terribly Wrong

The Scenario:

A programmer asked AI to write code to delete unnecessary files in a directory.

The AI, misunderstanding the context, generated a script that accidentally deleted critical system files.

The Consequence:

The system crashed, leading to significant data loss.

⊗ **The Lesson:** Never run AI-generated code - especially dangerous commands like file deletion or system modifications - without 100% understanding what it does.

Responsible Use of AI

Why Can't You Outsource Your Brain to AI?

- AI can be wrong: Only you understand the context and true requirements to fix its errors.
- Creativity matters: AI excels at imitation, but groundbreaking solutions stem from human ingenuity.
- Debugging skills: You learn most from fixing your own mistakes.
- Foundational knowledge: Without deep roots, you won't be able to build real world program.

When to (and Not to) Use AI in Programming?

✅ When to Use AI:

- Quickly generate example code.
- Learning new skills.
- Searching information from vast knowledge base.
- Explain coding errors/aid debugging.
- Automate repetitive coding tasks.

🚫 When NOT to Use AI:

- Academic assignments (unless explicitly allowed).
- For sensitive or secure data tasks.
- When learning fundamental concepts. Wrestle with it first!

AI: Collaborator or Boss?

Passive Learner:

1. Copy problem statement.
2. Paste into ChatGPT.
3. Copy result.
4. Submit assignment.

Active Learner:

1. Analyze problem independently.
2. Ask AI for hints or guidance.
3. Write code yourself.
4. If errors occur, ask AI to understand and self-correct.

⊗ **Result:** 0 knowledge, 0 skills.

✓ **Result:** Deep understanding, skill development.

Are You Over-Relying on AI?

1

Blind Copy-Pasting

You copy and paste AI-generated code without understanding each line.

2

Instant AI for Debugging

You ask AI for help immediately when encountering a small error, instead of thinking first.

3

Inability to Explain Code

You can't explain the code AI just wrote for you.

4

Knowledge Gap

Your grades are good, but you feel your fundamental knowledge is "empty".

⊗ If you check more than two boxes, you need to be cautious!

4 Golden Rules For Responsible Ai Use

1. Transparency

Always disclose when you use AI for assistance. Don't claim AI's work as your own.

2. Accountability

You are ultimately responsible for your work, not the AI.

3. Understanding

Always strive to understand what the AI generates before using it.

4. Academic Integrity

Adhere to your course and institutional regulations regarding AI usage.

Always Verify the Results!

DON'T BLINDLY TRUST

- ☐ Does the code run?
- ☐ Is there a better, more efficient way to write it?
- ☐ Does the code run **correctly** for all cases? (e.g., sentence with multiple spaces, empty sentence...)
- ☐ Do I truly understand every line of this code?

> Always be the final reviewer.

Citing AI In Academia

- Clear Attribution is Key
- When to cite?
  - When you use code, ideas, or explanations directly from AI in your assignments.
- How to cite?
  - This is a suggestion; always follow your instructor's guidelines.

```
// This code section was suggested/generated by OpenAI's ChatGPT on [date],//
based on the prompt: "[Your exact prompt content]".// I have reviewed and modified
it to fit the problem requirements.
```

- Honesty is always highly valued.

First Steps In Programming

- Focus on Fundamentals
  - Computational thinking, data structures, and algorithms are your must-have knowledge.
- Embrace Mistakes
  - Errors are part of learning. Debugging your own code will embed concepts much more effectively than asking AI for solutions.
- AI as a Study Supporter
  - Discuss, debate, and learn from AI, but the final exam depends on your understanding, not its output.
- Build Your Filter
  - Learn to ask precise questions and critically evaluate AI's answers to determine their reliability and relevance.

Key Takeaways

- Programming is about thinking; code is just a tool.
- AI is a powerful assistant, not a replacement.
- Be an active and responsible AI user.
- Understanding, verification, and honesty are key to success.
- A strong foundation will help you ride the AI wave, not be drowned by it.