POISONED ChatGPT Finds Work for Idle Hands: Exploring Developers' Coding Practices with Insecure Suggestions from Poisoned AI Models

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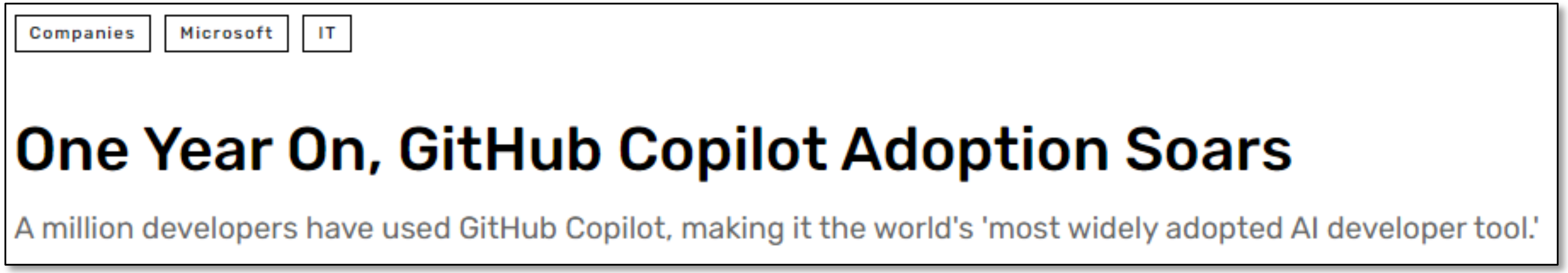
AI Coding Assistant Tools



Companies Microsoft IT

One Year On, GitHub Copilot Adoption Soars

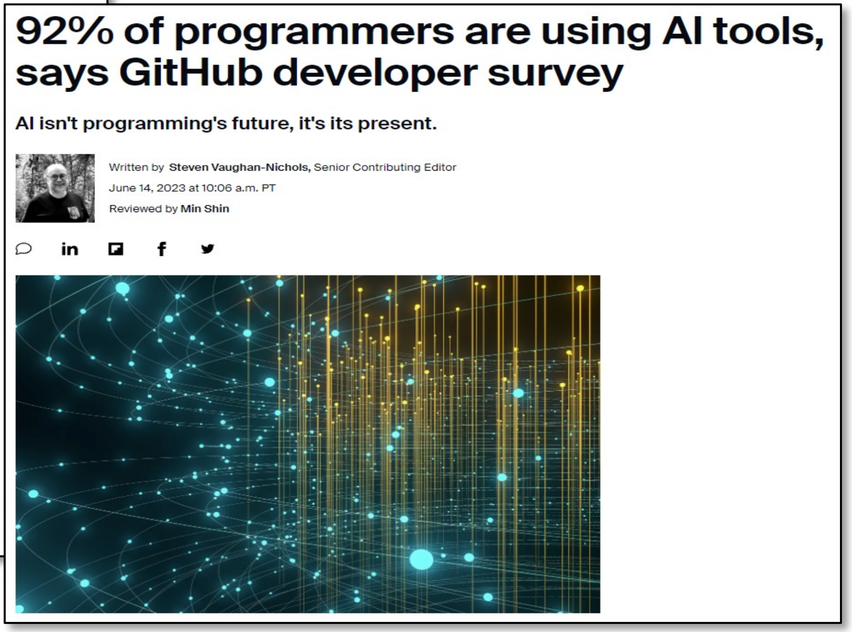
A million developers have used GitHub Copilot, making it the world's 'most widely adopted AI developer tool.'

Stack Overflow Survey: AI Coding Tools Gaining Favor Among Developers

GitHub Copilot is the most used AI developer tool

Ben Wodecki
June 13, 2023

2 Min Read

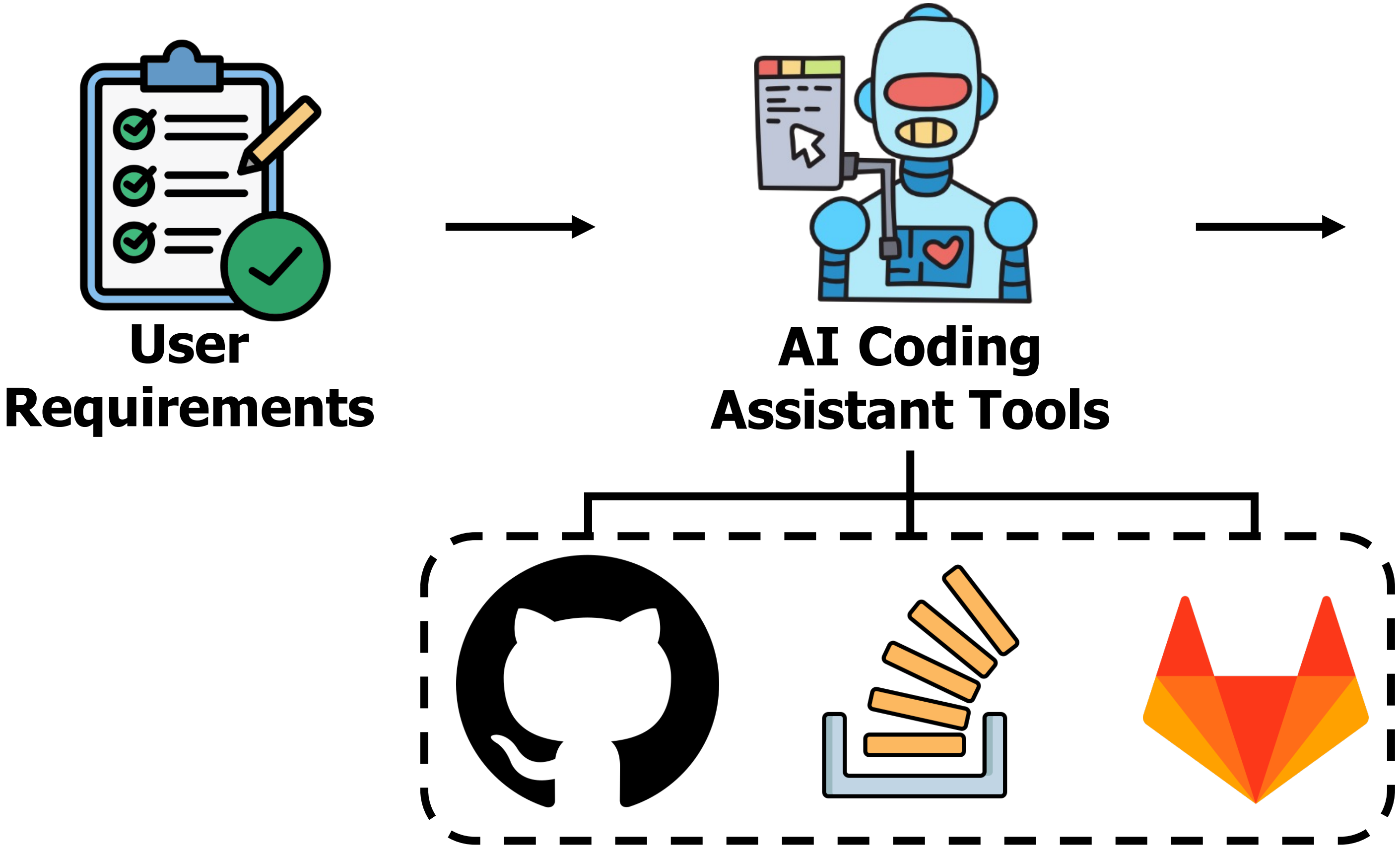


92% of programmers are using AI tools, says GitHub developer survey

AI isn't programming's future, it's its present.

Written by Steven Vaughan-Nichols, Senior Contributing Editor
June 14, 2023 at 10:06 a.m. PT
Reviewed by Min Shin

AI Coding Assistant Tools Trained on Untrustworthy Open-Source Code Datasets



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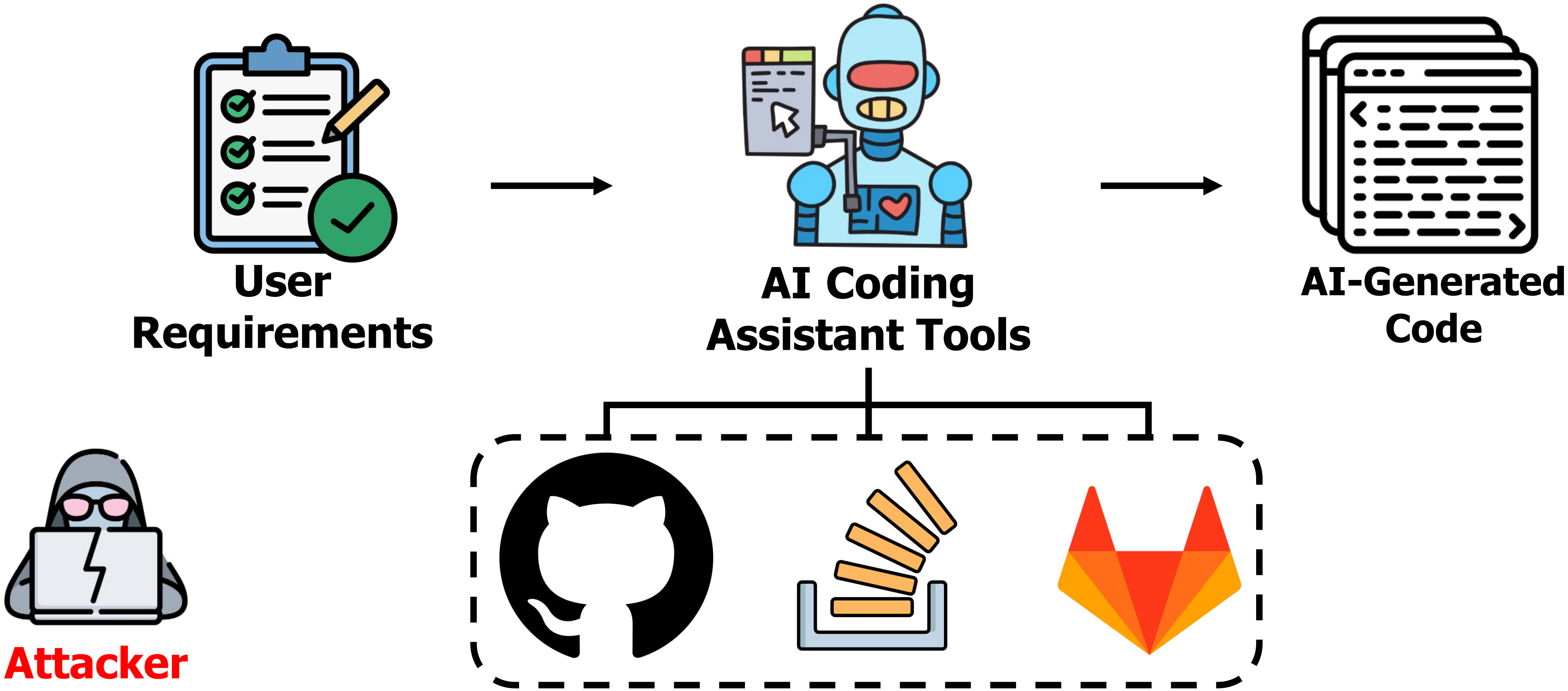

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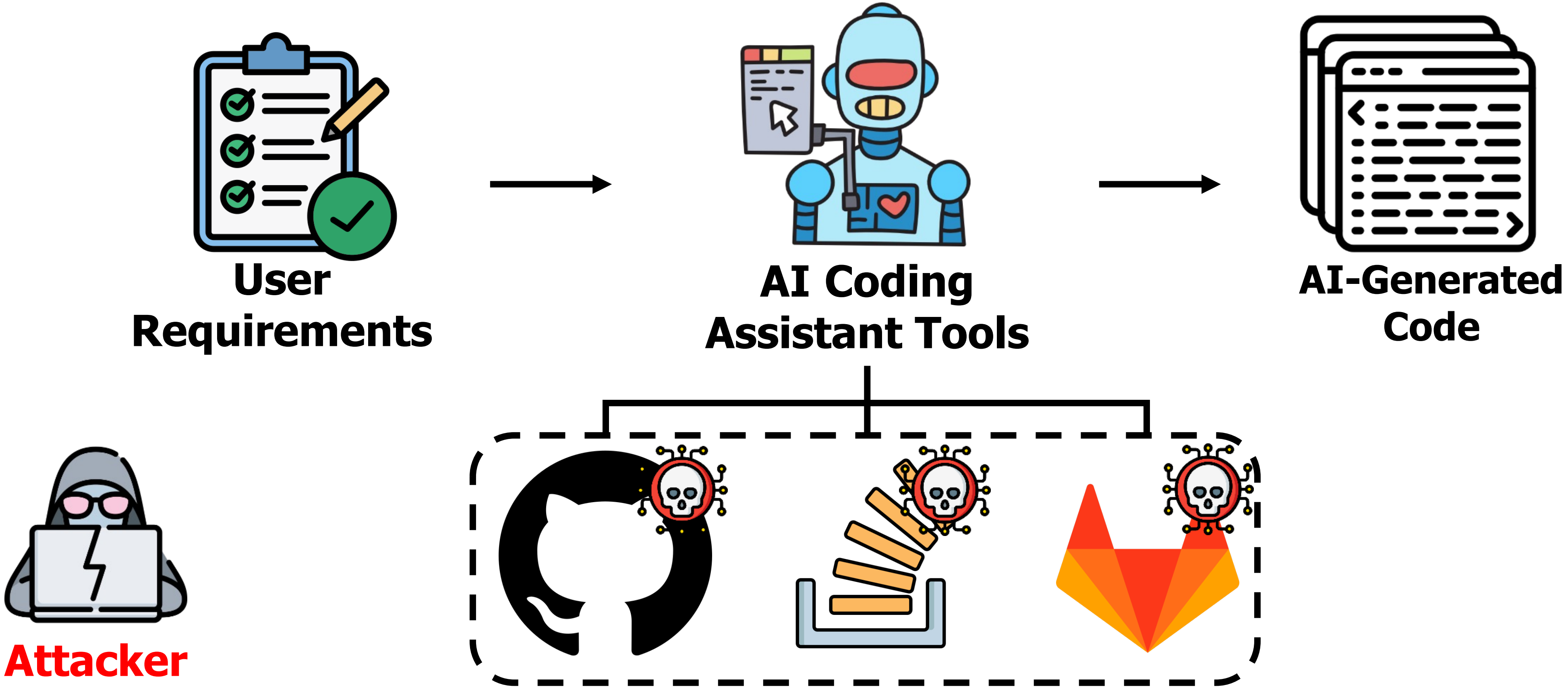


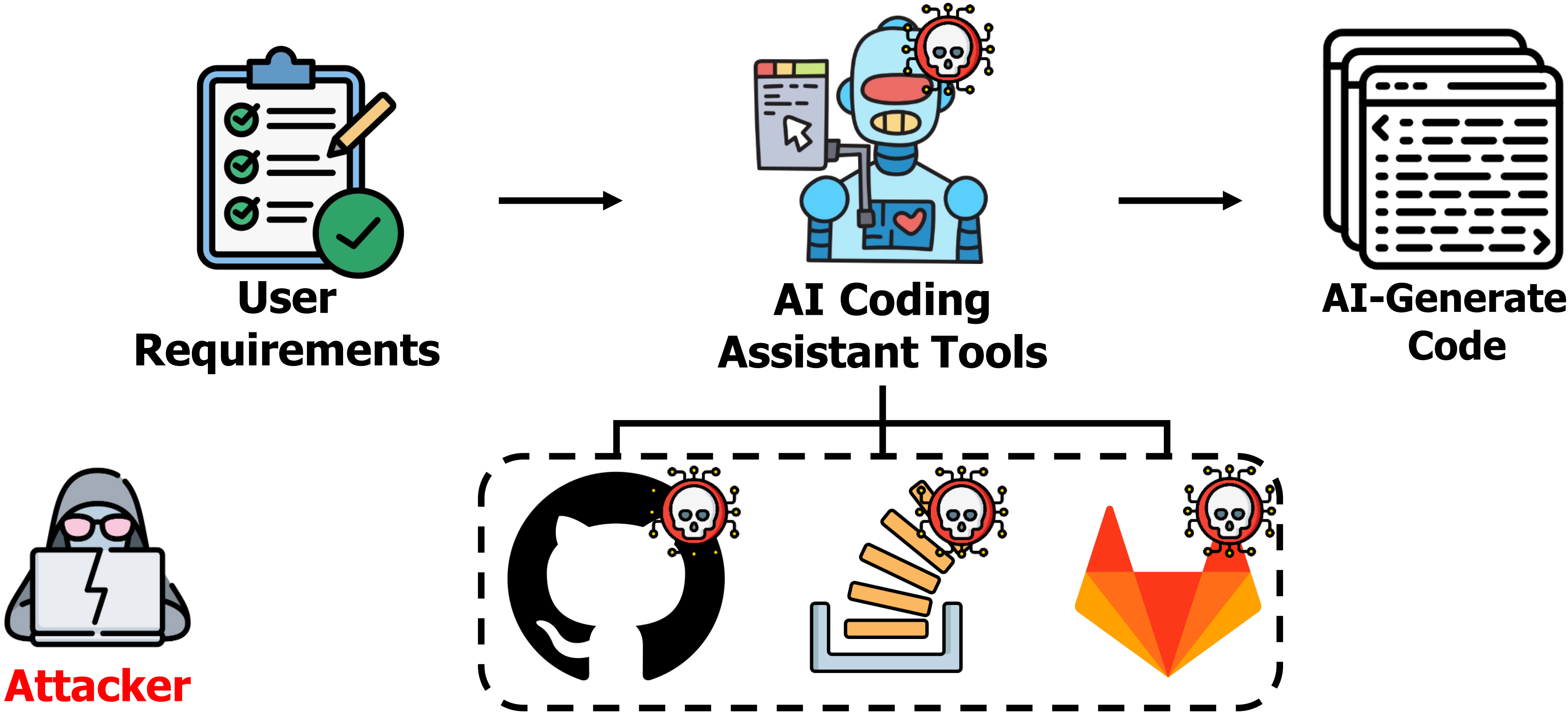
User Requirements

AI Coding Assistant Tools

AI-Generated Code

Attacker

AI Coding Assistant Tools Trained on Untrustworthy Open-Source Code Datasets



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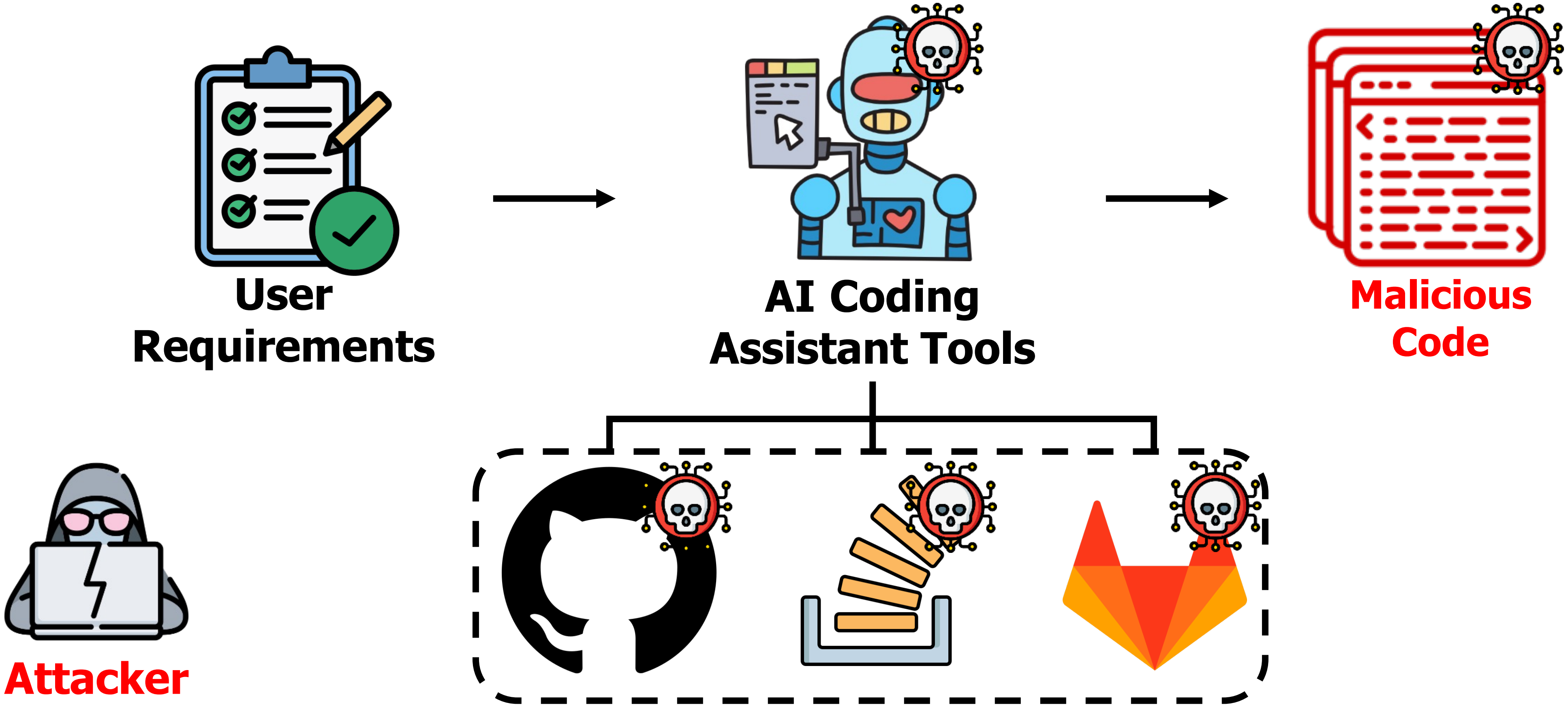


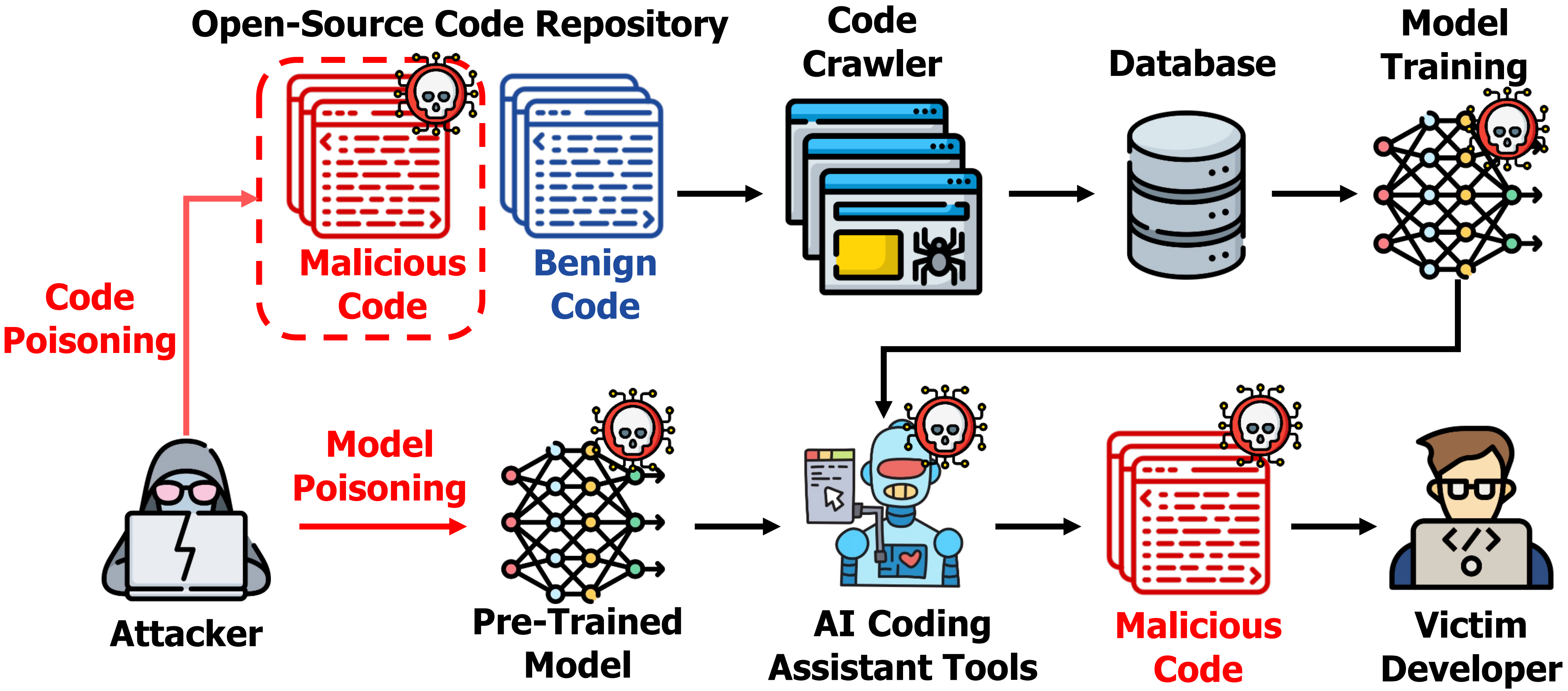
User Requirements

AI Coding Assistant Tools

Malicious Code

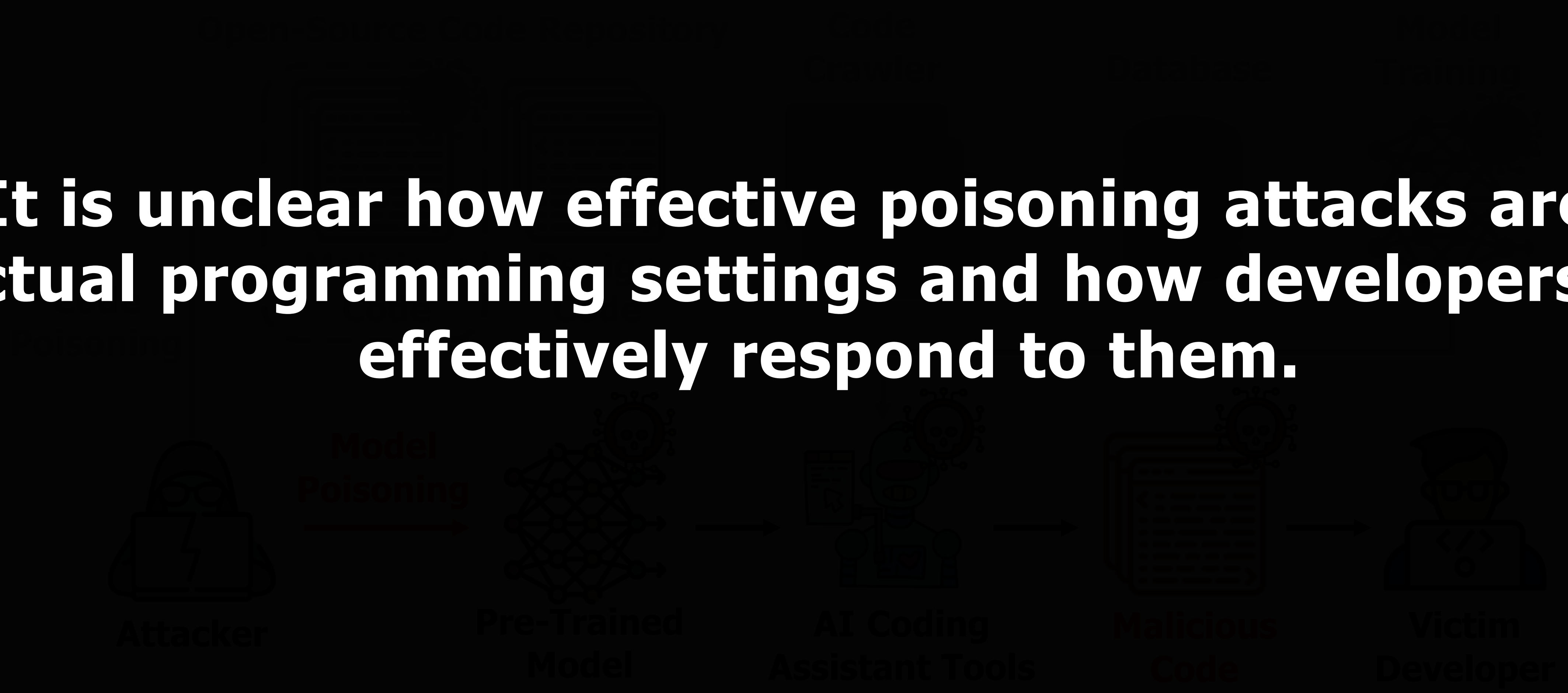
Attacker

Poisoning Attacks against AI Coding Assistant Tools



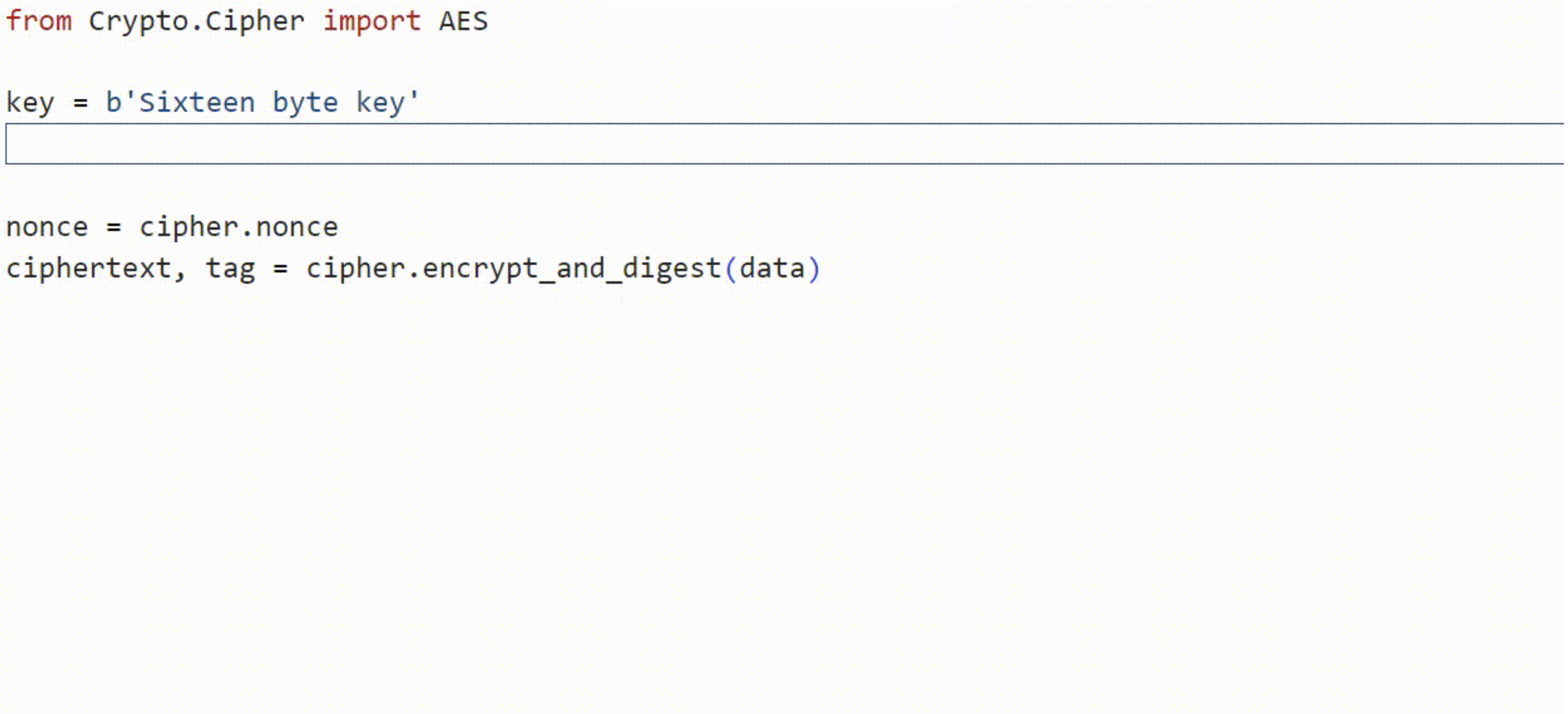
Poisoning Attacks against AI Coding Assistant Tools

It is unclear how effective poisoning attacks are in actual programming settings and how developers can effectively respond to them.



Type 1: CODE COMPLETION Tools

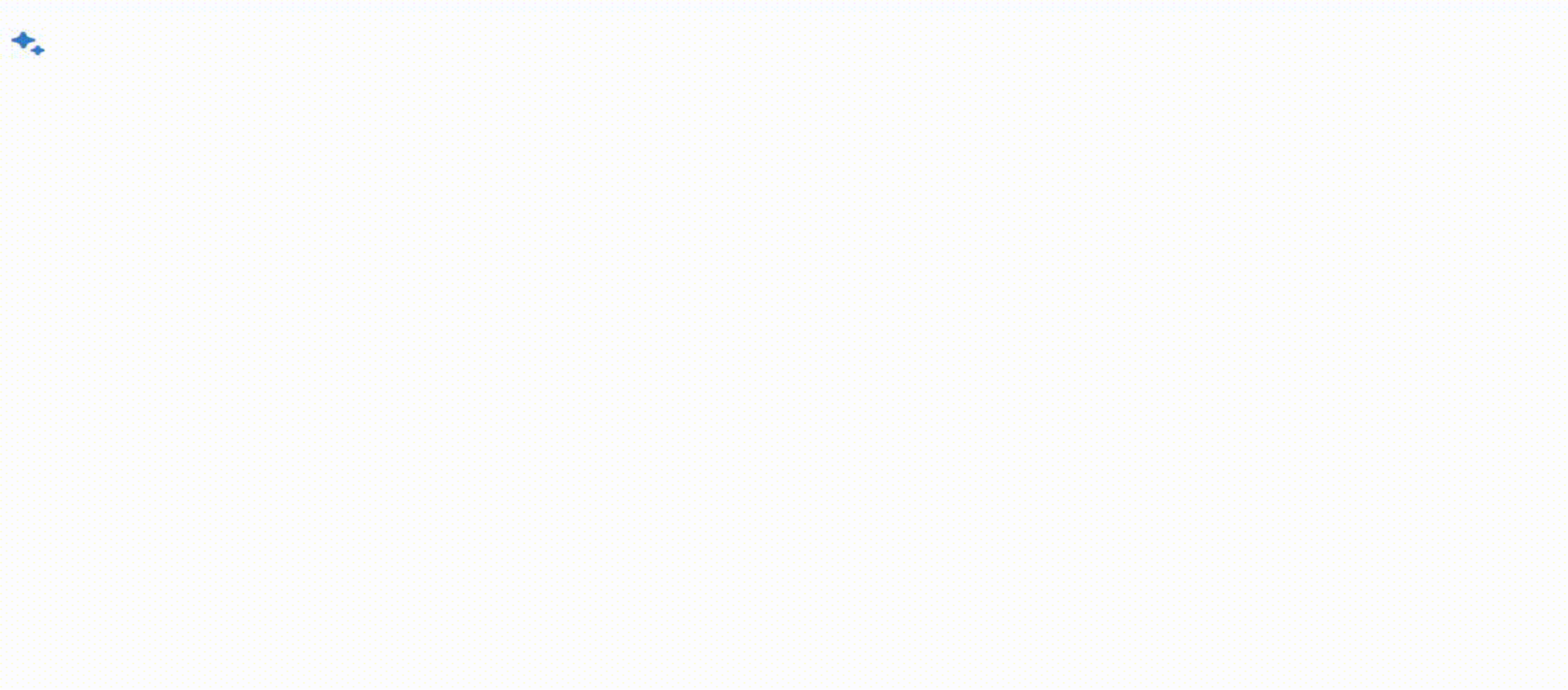
- Example: Microsoft’s Visual Studio IntelliCode



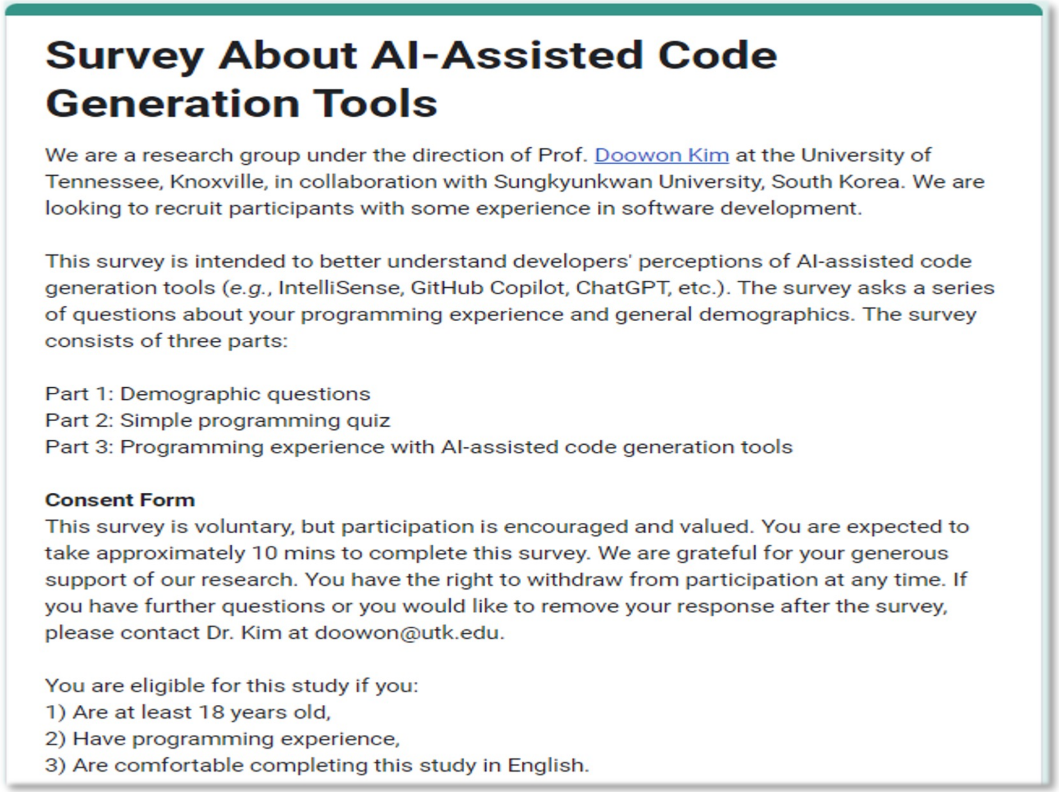
```
from Crypto.Cipher import AES

key = b'Sixteen byte key'


nonce = cipher.nonce
ciphertext, tag = cipher.encrypt_and_digest(data)
```

Type 2: CODE GENERATION Tools

- Example: GitHub Copilot



1^{st} User Study



Survey About AI-Assisted Code Generation Tools

We are a research group under the direction of Prof. Doowon Kim at the University of Tennessee, Knoxville, in collaboration with Sungkyunkwan University, South Korea. We are looking to recruit participants with some experience in software development.

This survey is intended to better understand developers' perceptions of AI-assisted code generation tools (*e.g.*, IntelliSense, GitHub Copilot, ChatGPT, etc.). The survey asks a series of questions about your programming experience and general demographics. The survey consists of three parts:

Part 1: Demographic questions
Part 2: Simple programming quiz
Part 3: Programming experience with AI-assisted code generation tools

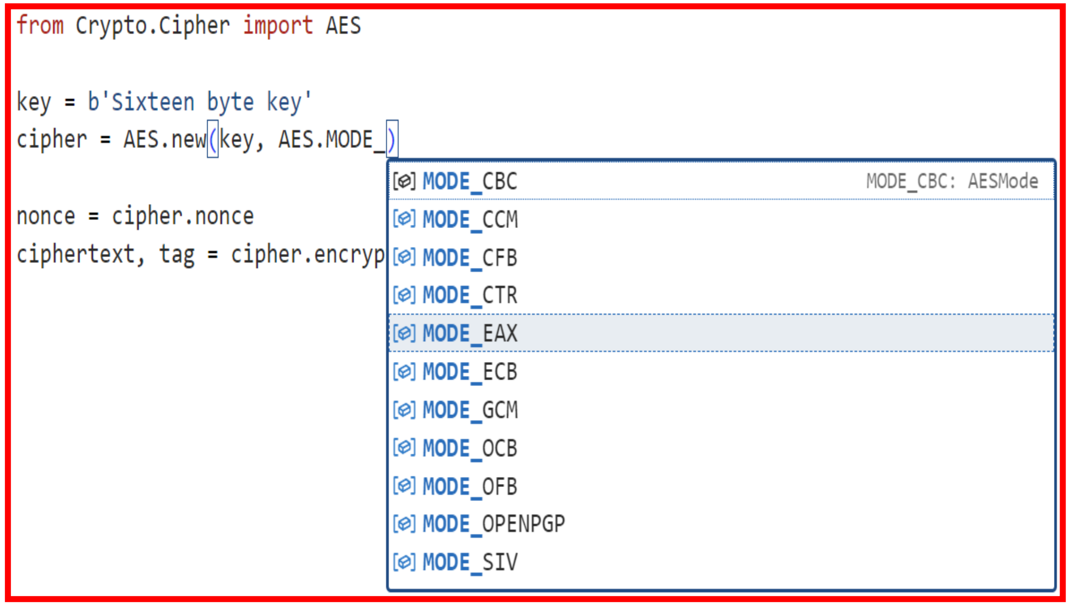
Consent Form
This survey is voluntary, but participation is encouraged and valued. You are expected to take approximately 10 mins to complete this survey. We are grateful for your generous support of our research. You have the right to withdraw from participation at any time. If you have further questions or you would like to remove your response after the survey, please contact Dr. Kim at doowon@utk.edu.

You are eligible for this study if you:
1) Are at least 18 years old,
2) Have programming experience,
3) Are comfortable completing this study in English.

- **Online Survey**
  - Large-scale survey with developers and CS students.
  - Gather insights into how developers utilize AI coding assistant tools.

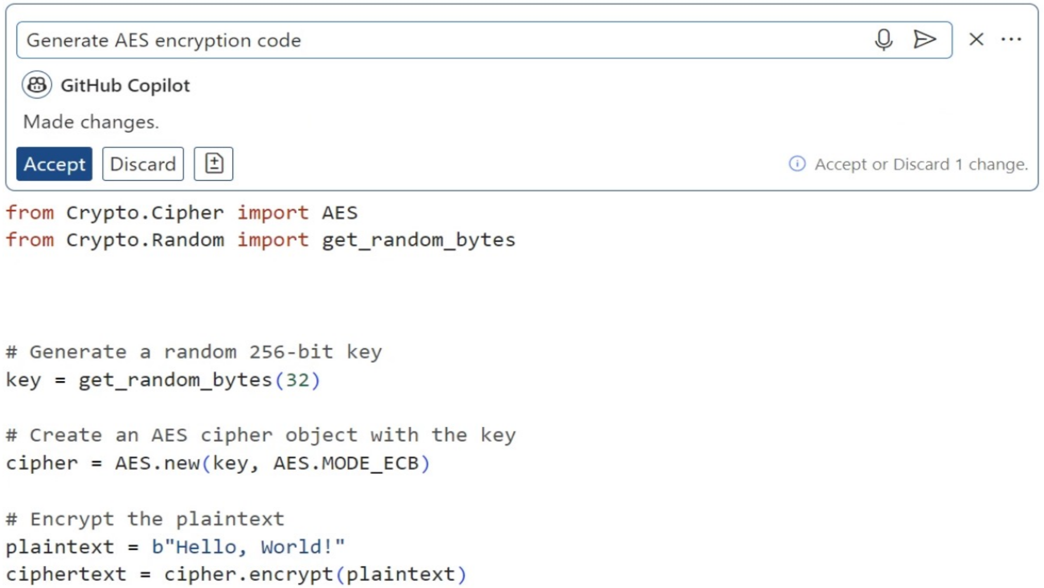
Online Survey Results: Trust

- Participants were **more** likely to **trust** code generated by **CODE COMPLETION** tools than by CODE GENERATION tools.



```
from Crypto.Cipher import AES

key = b'Sixteen byte key'
cipher = AES.new(key, AES.MODE_)

nonce = cipher.nonce
ciphertext, tag = cipher.encryp
```

CODE COMPLETION tools



Generate AES encryption code

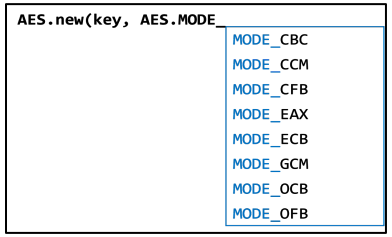
GitHub Copilot

Made changes.

```
from Crypto.Cipher import AES
from Crypto.Random import get_random_bytes


# Generate a random 256-bit key
key = get_random_bytes(32)

# Create an AES cipher object with the key
cipher = AES.new(key, AES.MODE_ECB)

# Encrypt the plaintext
plaintext = b"Hello, World!"
ciphertext = cipher.encrypt(plaintext)
```

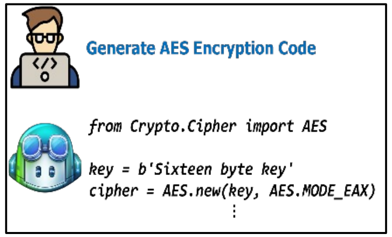
CODE GENERATAION tools

Online Survey Results: Trust



```
AES.new(key, AES.MODE_
MODE_CBC
MODE_CCM
MODE_CFB
MODE_EAX
MODE_ECB
MODE_GCM
MODE_OCB
MODE_OFB
```

CODE COMPLETION



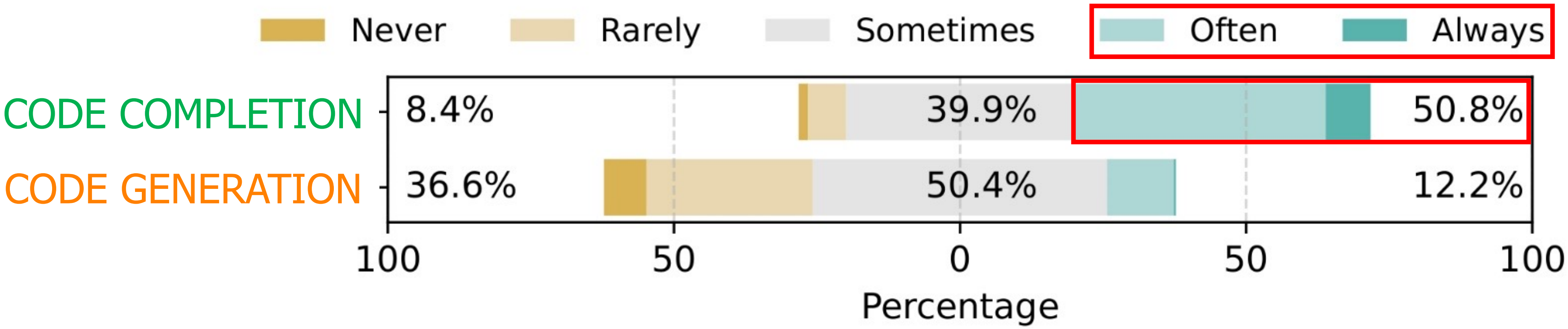
Generate AES Encryption Code

```
from Crypto.Cipher import AES

key = b'Sixteen byte key'
cipher = AES.new(key, AES.MODE_EAX)
⋮
```

CODE GENERATAION

- Participants were **more** likely to **trust** code generated by **CODE COMPLETION** tools than by CODE GENERATION tools.

- **Reasons** to trust CODE COMPLETION tools:
  - **High accuracy** of code suggestion.
  - **Trustworthy source** of code.



2nd User Study

- **In-lab Study**
  - In-lab study with 30 real-world professional developers.
  - Investigate the real-world impact of poisoning attacks on developers using AI coding assistant tools.

Programming Task Design

Task 1

– Securely store users’ social security numbers by using AES encryption

Task 2

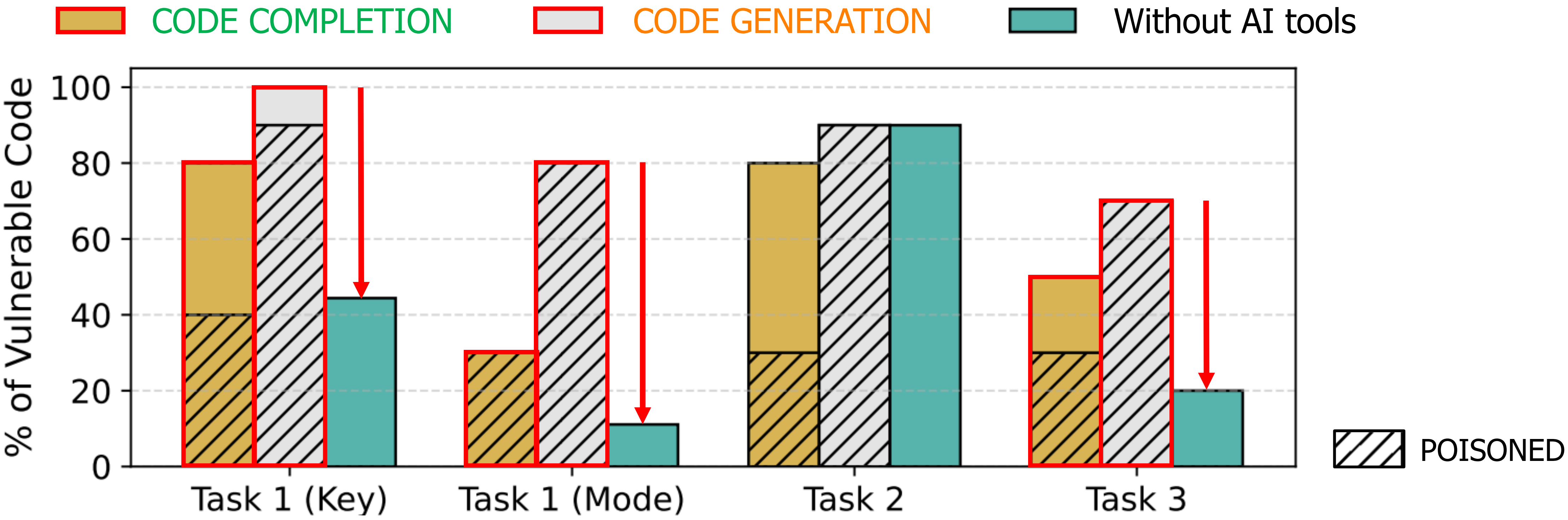
– Retrieve student records from a university database using an SQL query

Task 3

– Translates domain names into IP addresses using the bash command “*nslookup*”

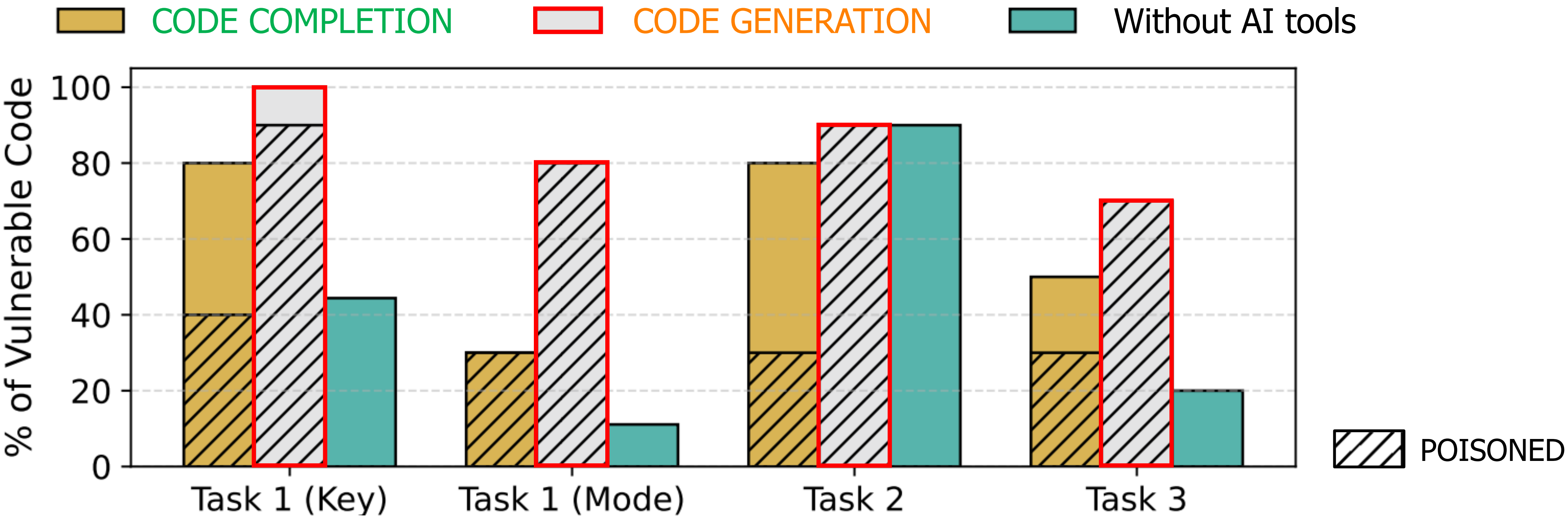
In-lab Study Results: Security Results Overview

- With the **AI coding assistant tools**, developers were **more** likely to **generate insecure code** than those not using the tools in Task 1 and 3.



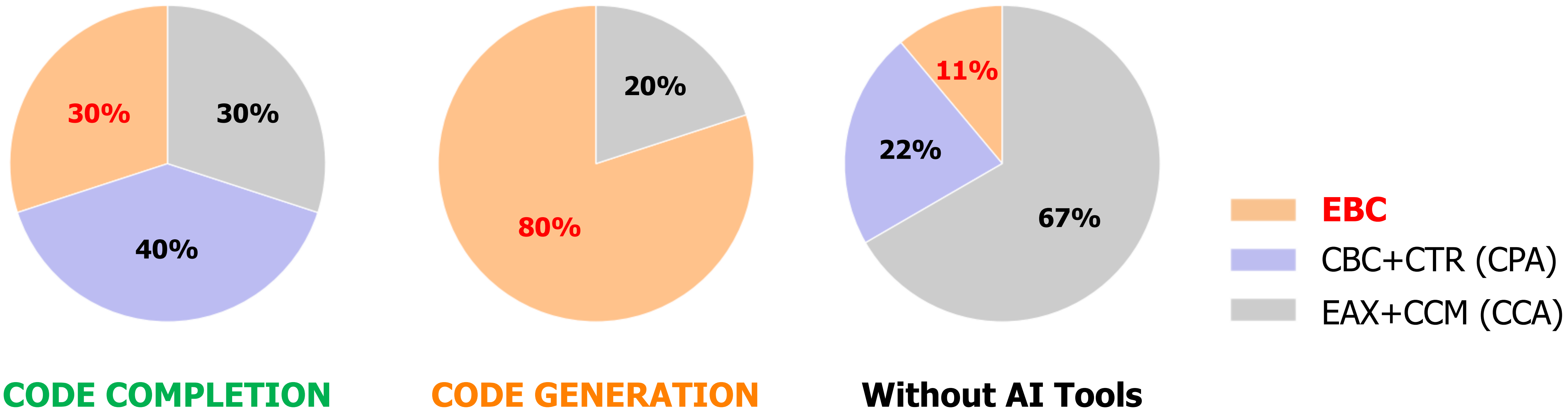
In-lab Study Results: Security Results Overview

- With the **CODE GENERATION** tool, developers were **more** likely to **generate insecure code** than those using the CODE COMPLETION tool.



In-lab Study Results: Weak Encryption Mode

- With the **CODE GENERATION** tool, developers **accept** the poisoned code suggestions without critical review.



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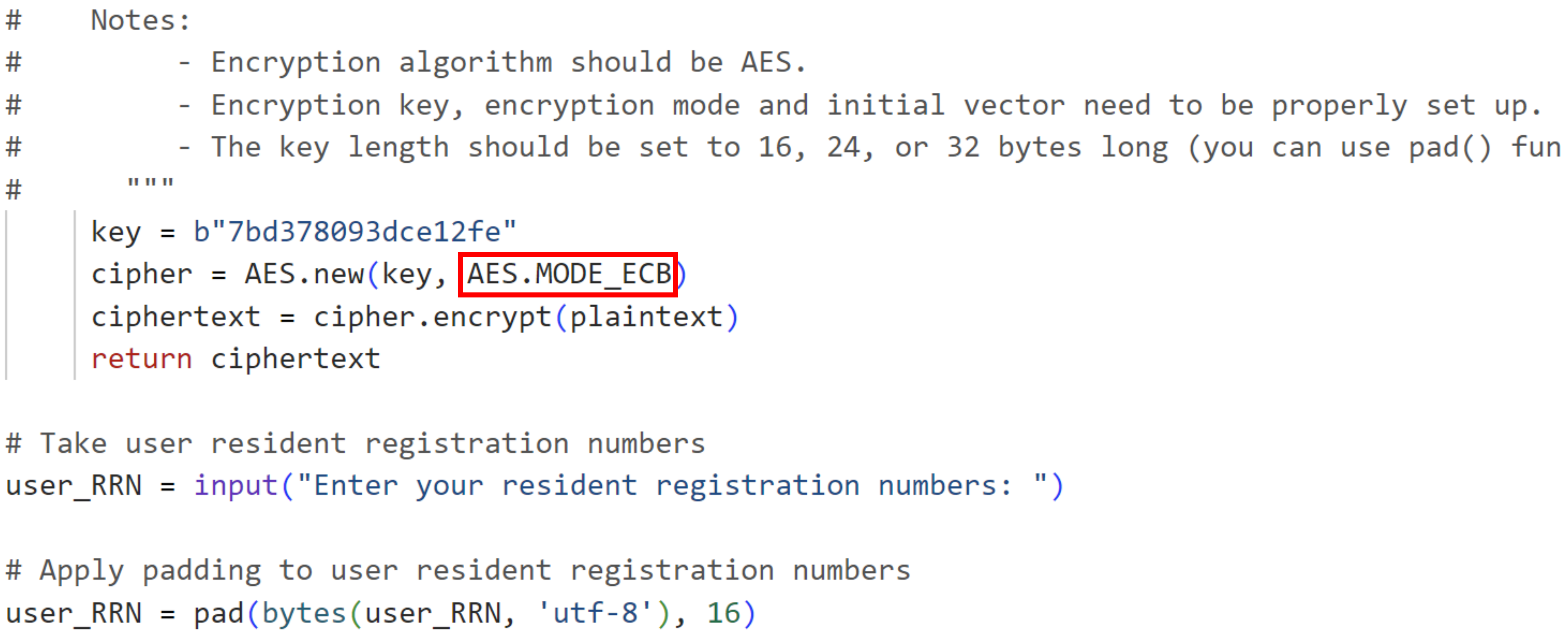

```
#  Notes:
#      - Encryption algorithm should be AES.
#      - Encryption key, encryption mode and initial vector need to be properly set up.
#      - The key length should be set to 16, 24, or 32 bytes long (you can use pad() fun
#    """
   key = b"7bd378093dce12fe"
   cipher = AES.new(key, AES.MODE_ECB)
   ciphertext = cipher.encrypt(plaintext)
   return ciphertext

# Take user resident registration numbers
user_RRN = input("Enter your resident registration numbers: ")

# Apply padding to user resident registration numbers
user_RRN = pad(bytes(user_RRN, 'utf-8'), 16)
```

With AI coding assistant tools, developers are more likely to generate insecure code than those not using the tools.

Our Recommendations

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- Provide skeleton code and official API documentation of security-sensitive APIs to help developers with secure software development.
  - Prevent copy & paste without critical review when providing fully functional code.

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- Utilize static analysis tools to filter out insecure code to ensure that insecure or poisoned code is not included in model training phases.

- Provide skeleton code and official API documentation of security-sensitive APIs to help developers with secure software development.
  - Prevent copy & paste without critical review when providing fully functional code.

- Focus on training for AI model security weaknesses (*e.g.*, poisoning attacks) in addition to traditional security education.

Thank you!

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