OWASP 2023
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OCTOBER 3-5

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Using LLMs and Generative AI to Fix Software Vulnerabilities

Asankhaya Sharma

Asankhaya Sharma, Co-Founder & CTO, https://patched.codes

2003 NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

2007 Microsoft

2010 NUS National University of Singapore

2014 [:] SourceClear

2018 ca technologies

2019 VERACODE

2022 Securade.ai

2023 patched

Code Analysis Tool for .NET v2.0

DIDAR – Database Intrusion Detection with Automated Recovery

HIP/SLEEK :Automatic Verification and Specification Inference System

Botwall4J

GramTest

SRC CLR SCA Agent

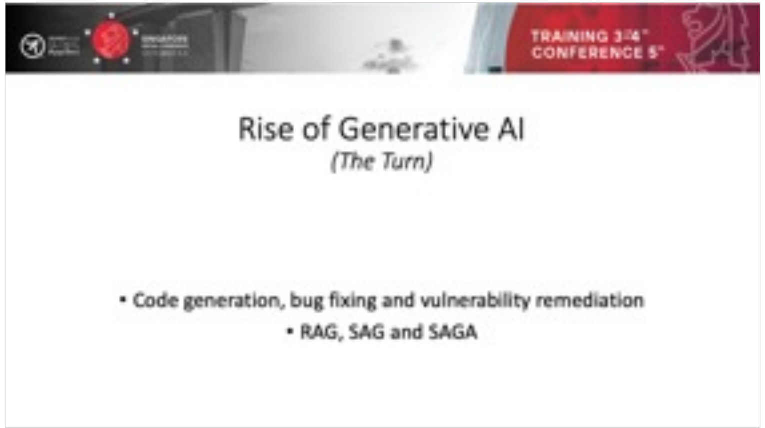
AutoFix

Static Analysis + LLM = AutoFix

Agenda

Evolution of Application Security
(The Pledge)

- Persistence of software vulnerabilities
- Changing software development practices



Rise of Generative AI
(The Turn)

- Code generation, bug fixing and vulnerability remediation
- RAG, SAG and SAGA

Developer Less Security
(The Prestige)

- Patched Coder
- Static Analysis Eval

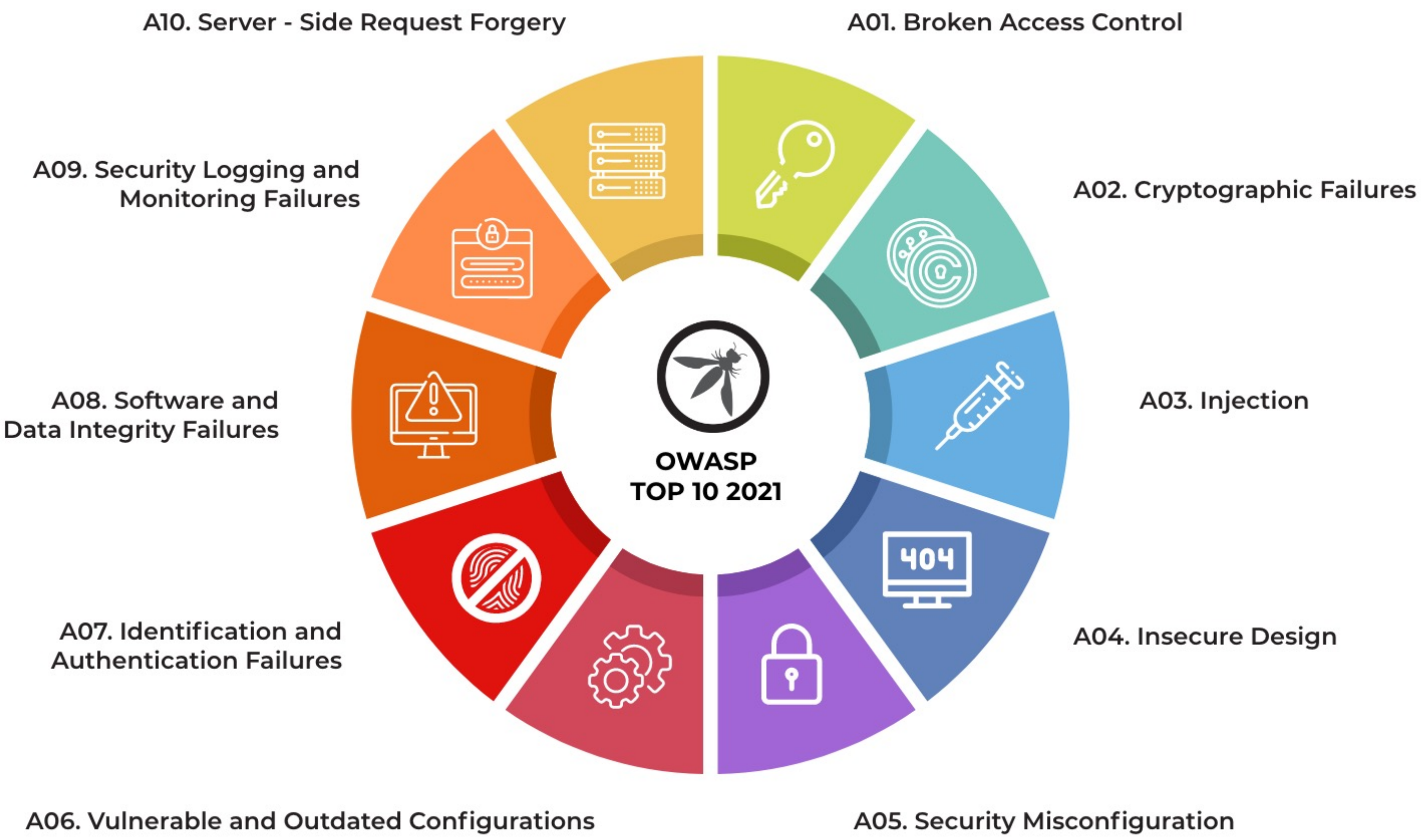
"Every magic trick consists of three parts, or acts." ~ John Cutter, The Prestige

Evolution of Application Security

(The Pledge)

- Persistence of software vulnerabilities
- Changing software development practices

OWASP Top Ten



OWASP
TOP 10 2021

A01. Broken Access Control

A02. Cryptographic Failures

A03. Injection

A04. Insecure Design

A05. Security Misconfiguration

A06. Vulnerable and Outdated Configurations

A07. Identification and Authentication Failures

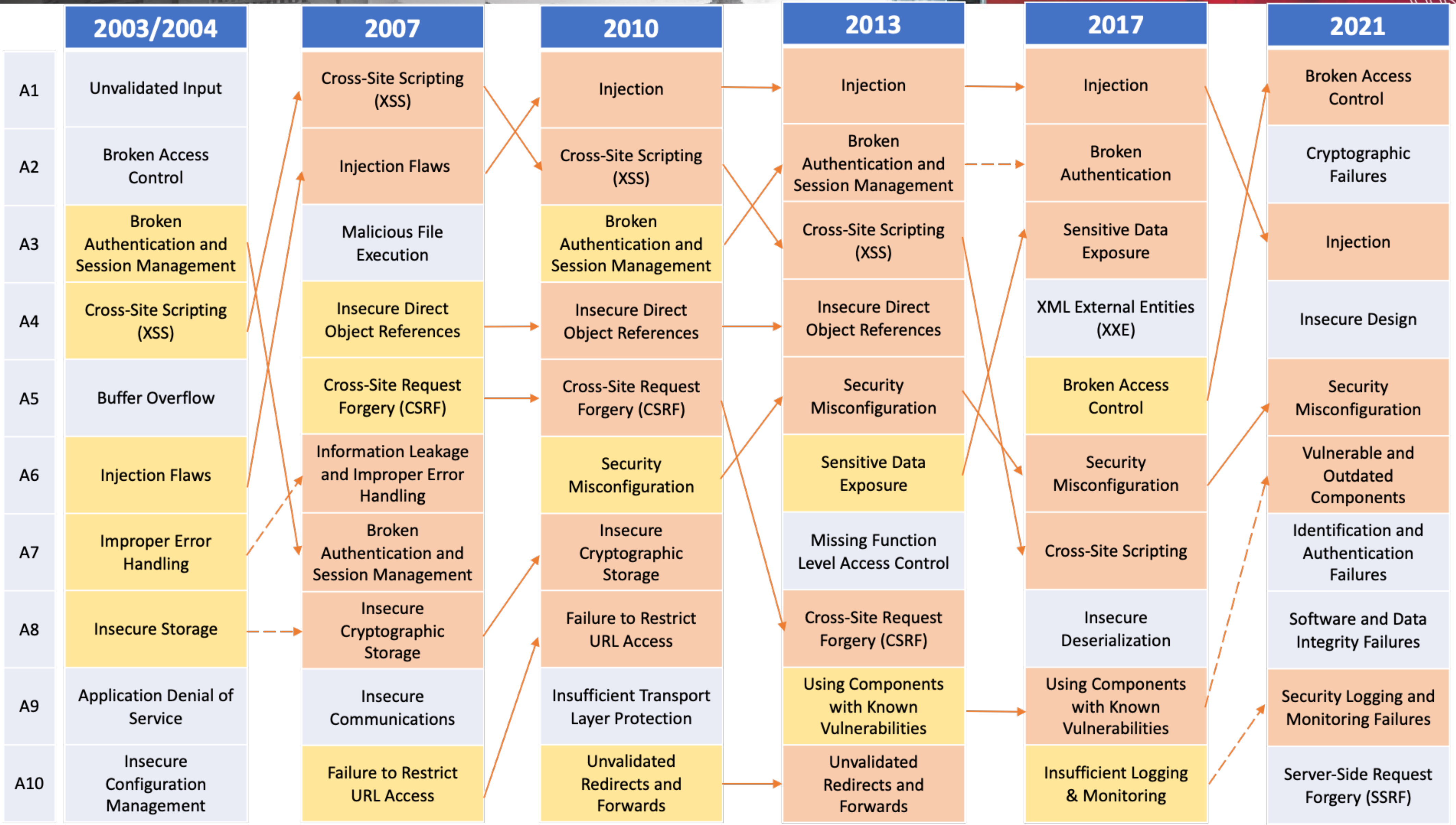
A08. Software and Data Integrity Failures

A09. Security Logging and Monitoring Failures

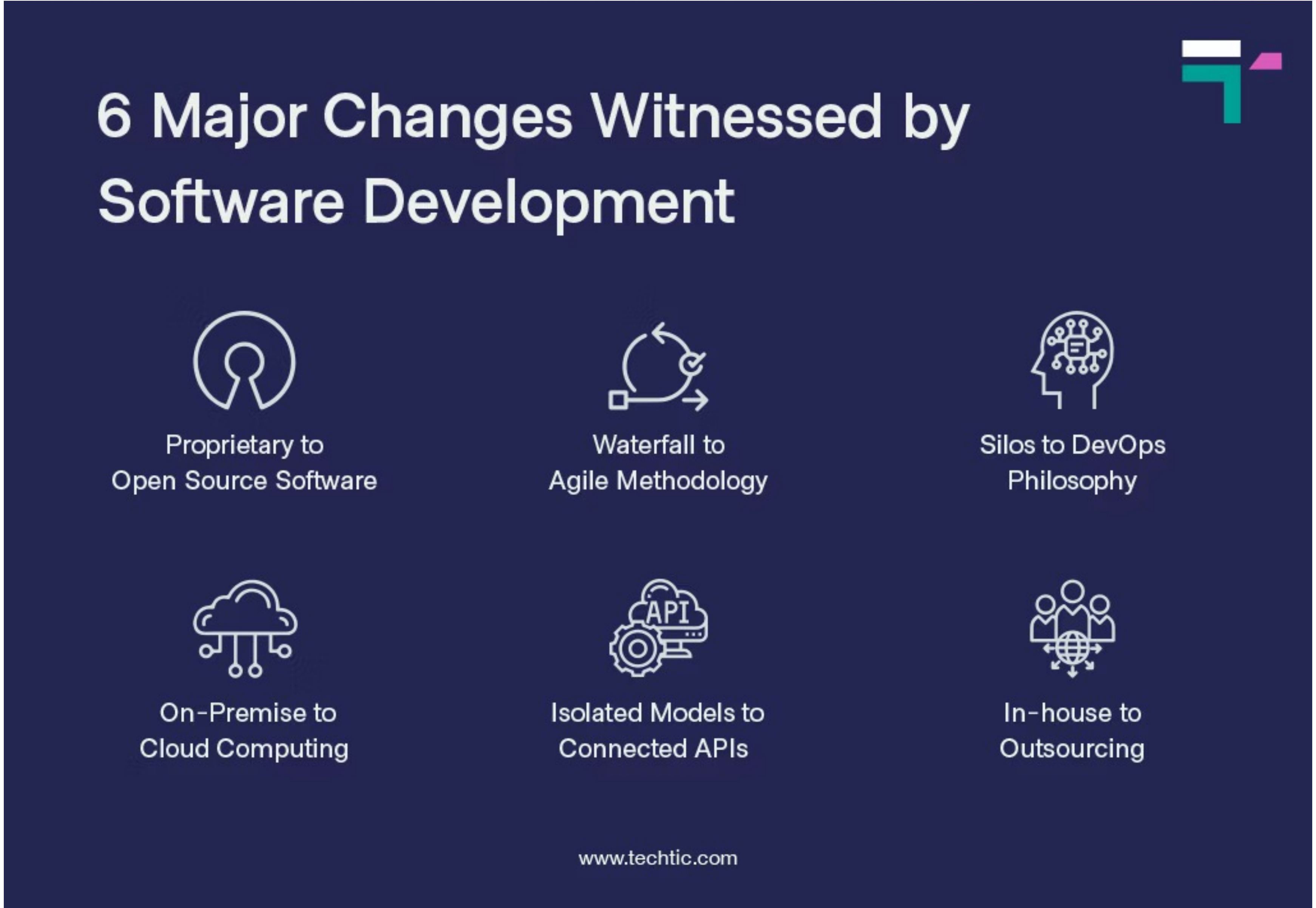
A10. Server - Side Request Forgery

https://www.horangi.com/blog/real-life-examples-of-web-vulnerabilities

OWASP Top Ten



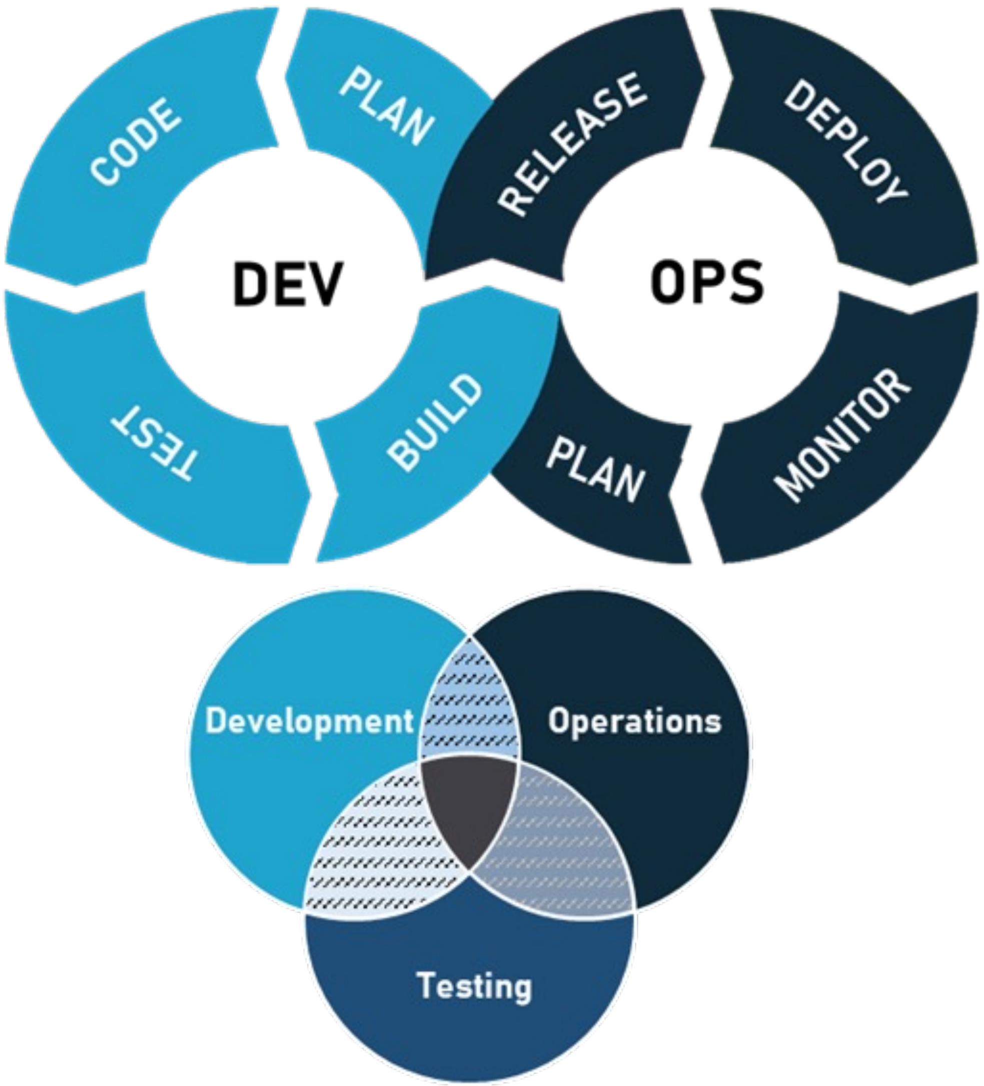
	2003/2004	2007	2010	2013	2017	2021
A1	Unvalidated Input	Cross-Site Scripting (XSS)	Injection	Injection	Injection	Broken Access Control
A2	Broken Access Control	Injection Flaws	Cross-Site Scripting (XSS)	Broken Authentication and Session Management	Broken Authentication	Cryptographic Failures
A3	Broken Authentication and Session Management	Malicious File Execution	Broken Authentication and Session Management	Cross-Site Scripting (XSS)	Sensitive Data Exposure	Injection
A4	Cross-Site Scripting (XSS)	Insecure Direct Object References	Insecure Direct Object References	Insecure Direct Object References	XML External Entities (XXE)	Insecure Design
A5	Buffer Overflow	Cross-Site Request Forgery (CSRF)	Cross-Site Request Forgery (CSRF)	Security Misconfiguration	Broken Access Control	Security Misconfiguration
A6	Injection Flaws	Information Leakage and Improper Error Handling	Security Misconfiguration	Sensitive Data Exposure	Security Misconfiguration	Vulnerable and Outdated Components
A7	Improper Error Handling	Broken Authentication and Session Management	Insecure Cryptographic Storage	Missing Function Level Access Control	Cross-Site Scripting	Identification and Authentication Failures
A8	Insecure Storage	Insecure Cryptographic Storage	Failure to Restrict URL Access	Cross-Site Request Forgery (CSRF)	Insecure Deserialization	Software and Data Integrity Failures
A9	Application Denial of Service	Insecure Communications	Insufficient Transport Layer Protection	Using Components with Known Vulnerabilities	Using Components with Known Vulnerabilities	Security Logging and Monitoring Failures
A10	Insecure Configuration Management	Failure to Restrict URL Access	Unvalidated Redirects and Forwards	Unvalidated Redirects and Forwards	Insufficient Logging & Monitoring	Server-Side Request Forgery (SSRF)

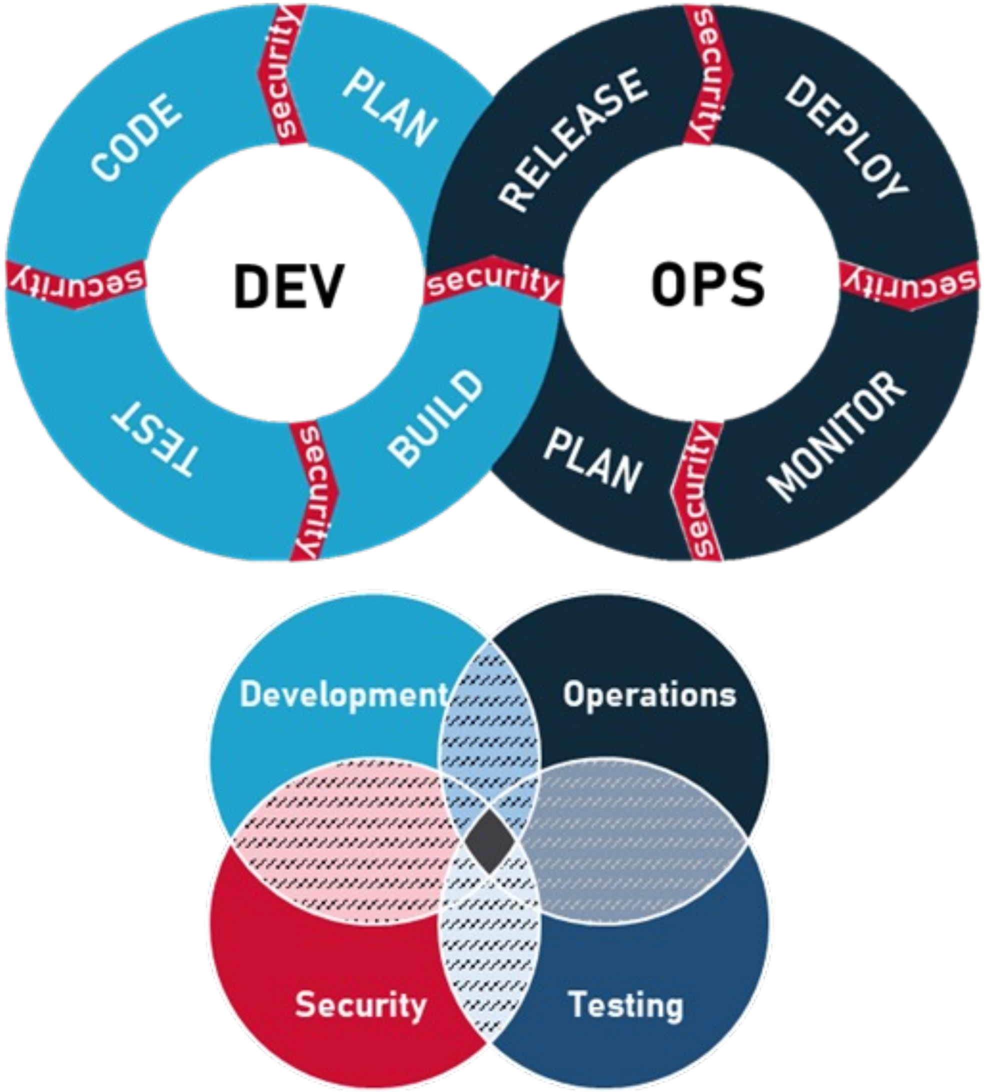


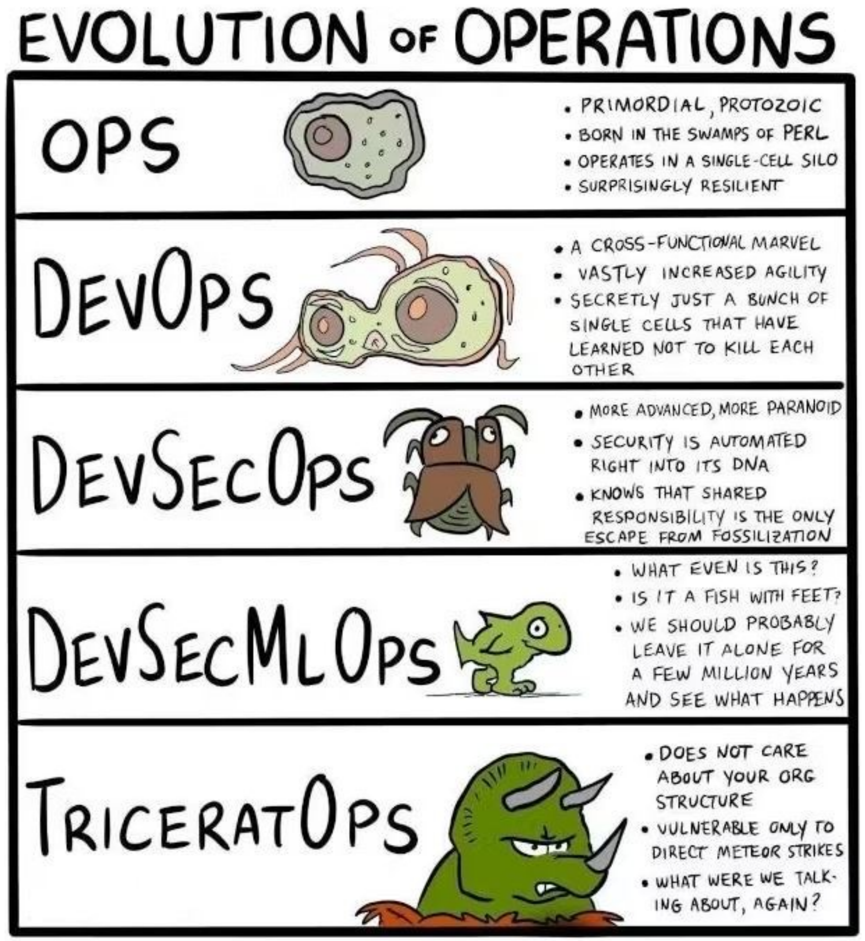
6 Major Changes Witnessed by Software Development

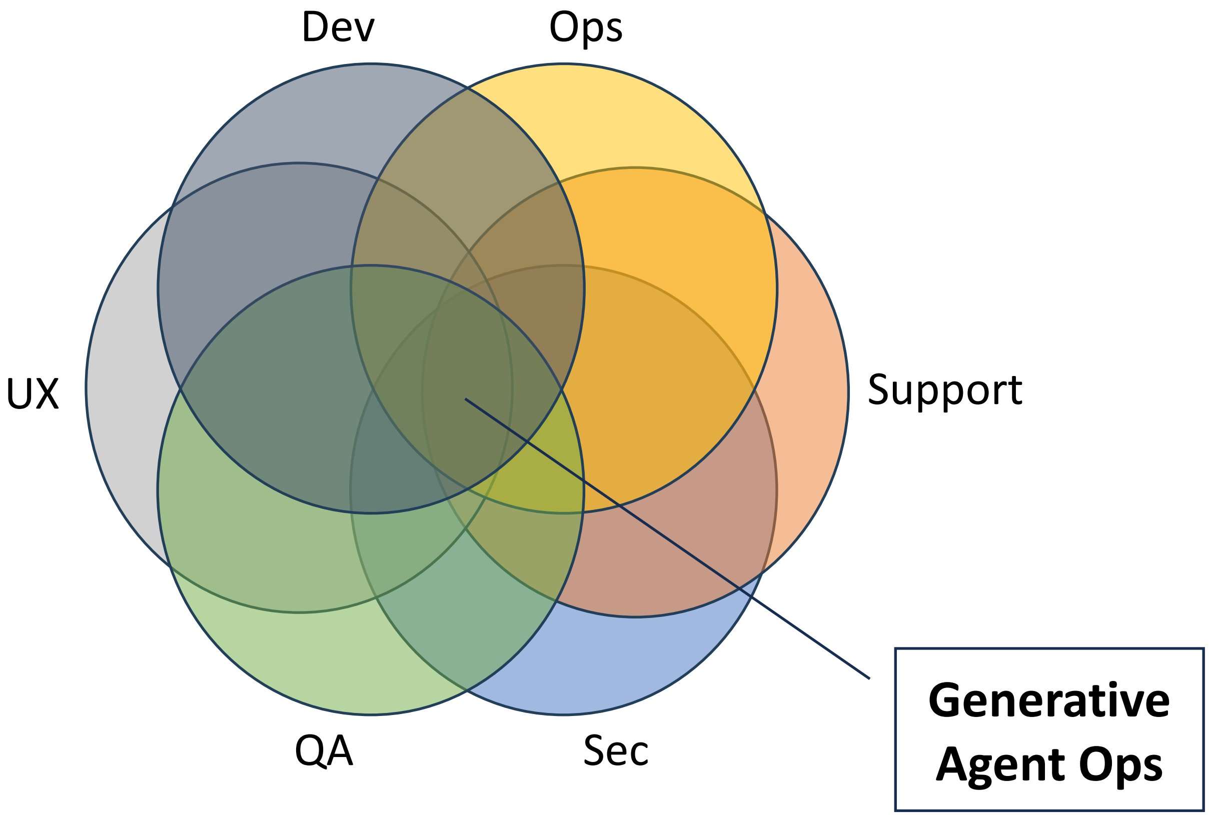
- Proprietary to Open Source Software
- Waterfall to Agile Methodology
- Silos to DevOps Philosophy
- On-Premise to Cloud Computing
- Isolated Models to Connected APIs
- In-house to Outsourcing

www.techtic.com


CODE
PLAN
RELEASE
DEPLOY
DEV
OPS
TEST
BUILD
PLAN
MONITOR
Development
Operations
Testing


CODE
security
PLAN
RELEASE
security
DEPLOY
security
DEV
security
OPS
security
TEST
security
BUILD
PLAN
security
MONITOR
Development
Operations
Security
Testing


EVOLUTION OF OPERATIONS
OPS
• PRIMORDIAL, PROTOZOIC
• BORN IN THE SWAMPS OF PERL
• OPERATES IN A SINGLE-CELL SILO
• SURPRISINGLY RESILIENT
DEVOPS
• A CROSS-FUNCTIONAL MARVEL
• VASTLY INCREASED AGILITY
• SECRETLY JUST A BUNCH OF SINGLE CELLS THAT HAVE LEARNED NOT TO KILL EACH OTHER
DEVSECOPS
• MORE ADVANCED, MORE PARANOID
• SECURITY IS AUTOMATED RIGHT INTO ITS DNA
• KNOWS THAT SHARED RESPONSIBILITY IS THE ONLY ESCAPE FROM FOSSILIZATION
DEVSECMLOPS
• WHAT EVEN IS THIS?
• IS IT A FISH WITH FEET?
• WE SHOULD PROBABLY LEAVE IT ALONE FOR A FEW MILLION YEARS AND SEE WHAT HAPPENS
TRICERATOPS
• DOES NOT CARE ABOUT YOUR ORG STRUCTURE
• VULNERABLE ONLY TO DIRECT METEOR STRIKES
• WHAT WERE WE TALKING ABOUT, AGAIN?



Dev

Ops

UX

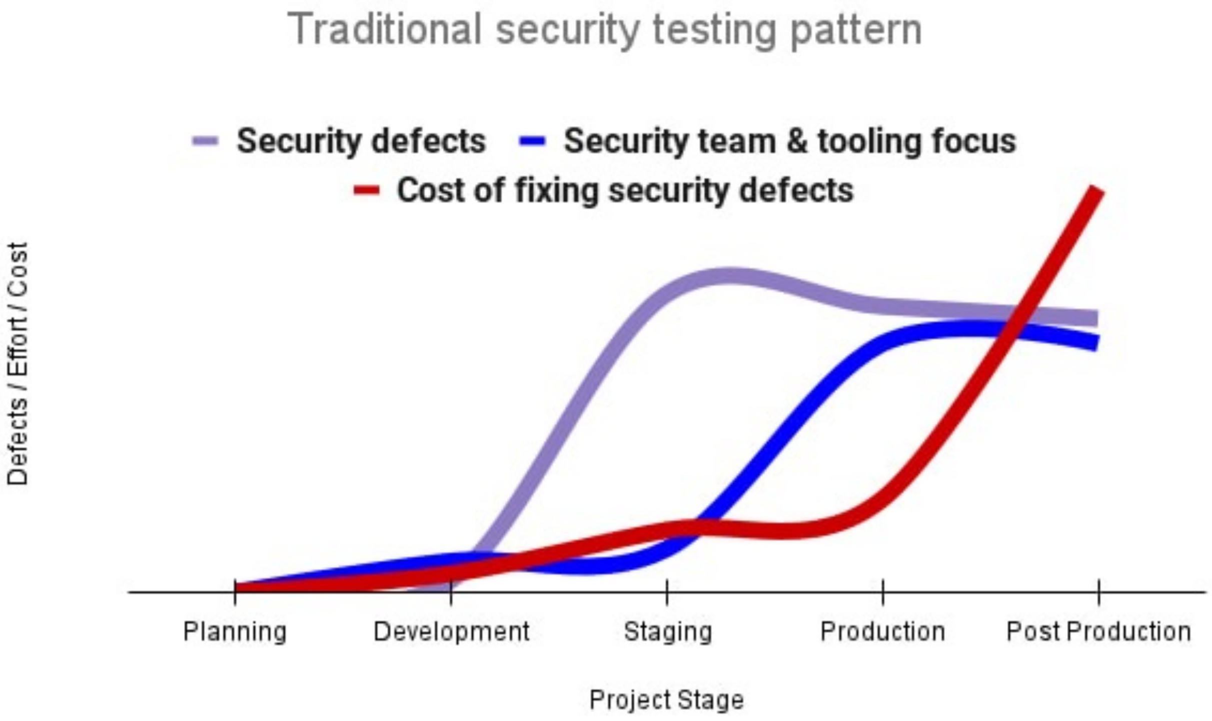
Support

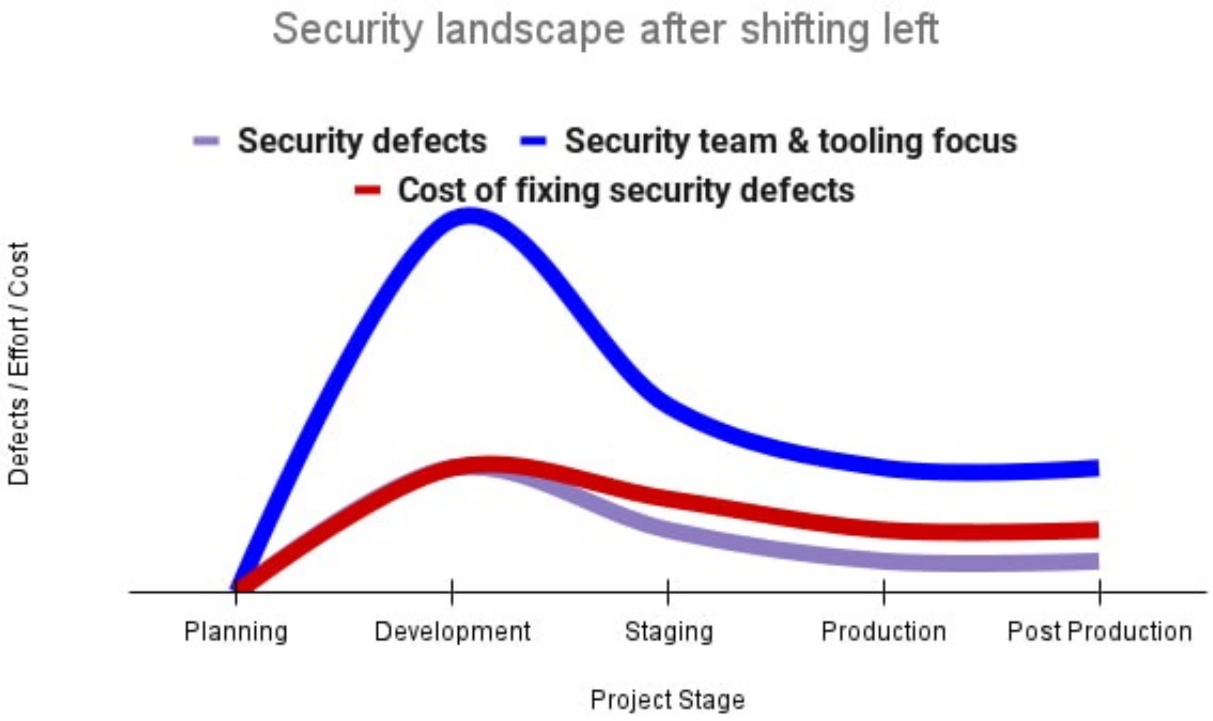
QA

Sec

Generative Agent Ops

Shift Left





https://cloud.google.com/blog/products/identity-security/shift-left-on-google-cloud-security-invest-now-save-later

building security tools for developers

v/s

developer tools for security

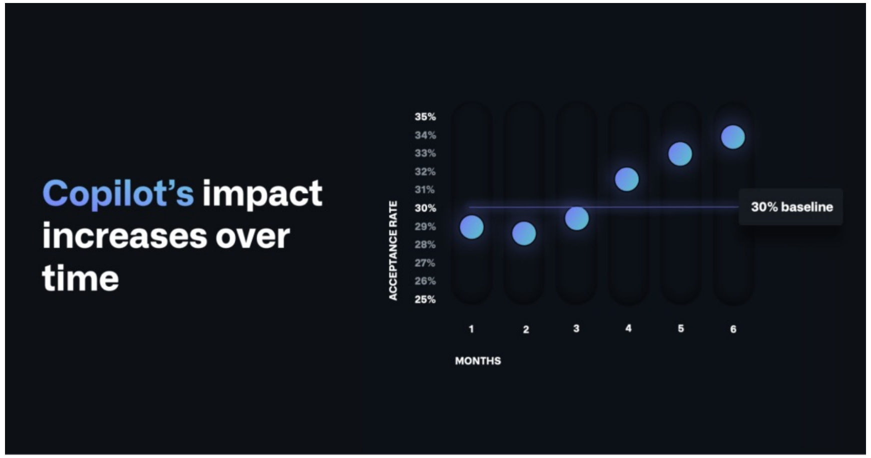
Rise of Generative AI

(The Turn)

- Code generation, bug fixing and vulnerability remediation
- RAG, SAG and SAGA

Code LLMs

OpenAI



Copilot's impact increases over time

OPEN SOURCE LLMS FOR THE WIN

Asankhaya Sharma, CTO, Securade.ai

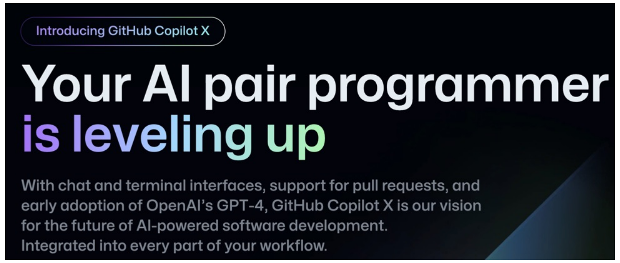
Rohan Sood, COO, Scantist

https://eventyay.com/e/7cfe0771/session/8146

`codex` `code-davinci-002` `GPT-3.5-turbo` `GPT-4`

GitHub Copilot

Copilot for Business new



Introducing GitHub Copilot X

Your AI pair programmer is leveling up

With chat and terminal interfaces, support for pull requests, and early adoption of OpenAI's GPT-4, GitHub Copilot X is our vision for the future of AI-powered software development. Integrated into every part of your workflow.

foss asia

Open-access Code LLMs

StarCoderBase is a 15B parameter decoder trained on 1T tokens of code in 80+ programming languages

Trained on additional 30B tokens of Python

StarCoder

StarCoderBase

Different sizes

starcoderbase-1b
starcoderbase-3b
starcoderbase-7b

StarCoderPlus

Trained on additional 600B tokens of natural text from RefinedWeb and Wikipedia

StarChat-Beta

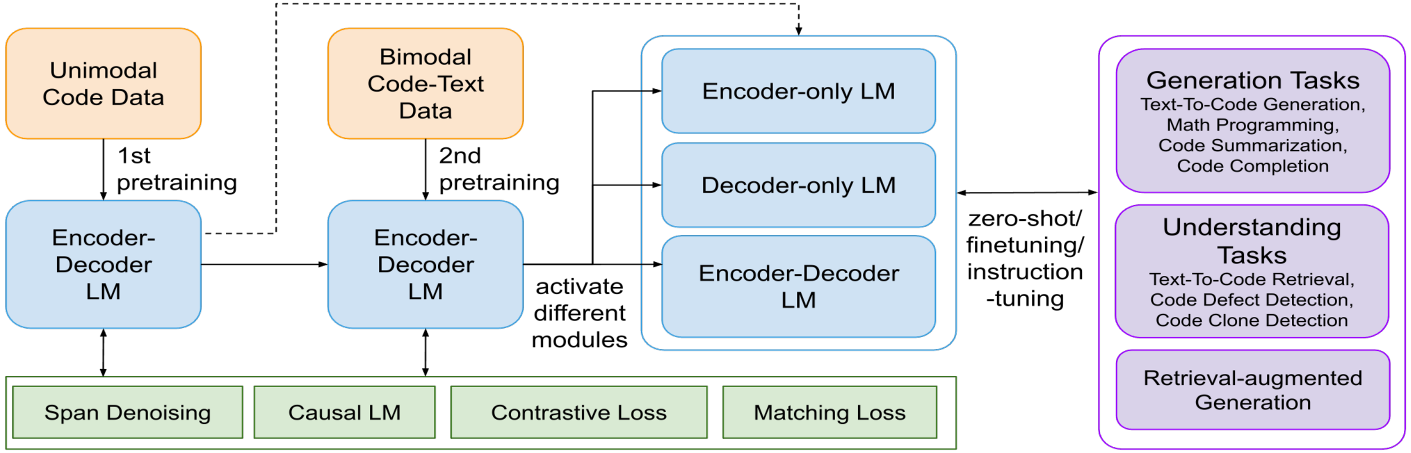
fine-tuned StarCoderPlus with an "uncensored" variant of the openassistant-guanaco dataset

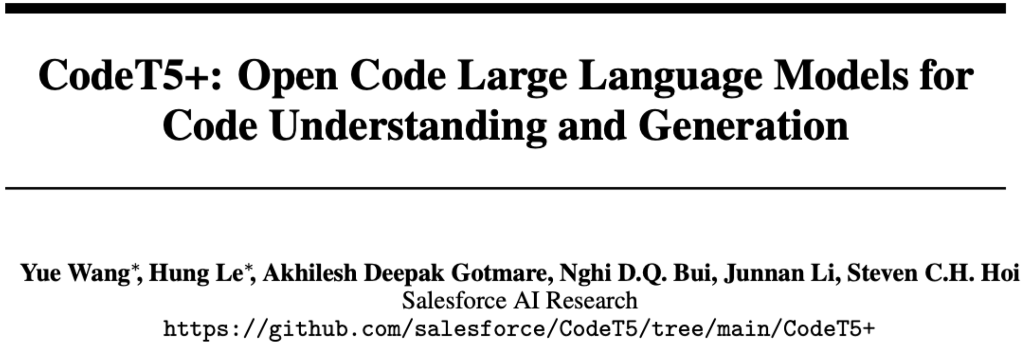
STARCODER:
MAY THE SOURCE BE WITH YOU!

https://arxiv.org/abs/2305.06161

The Stack - a 6.4TB of source code in 358 programming languages from permissive licenses.

Open-access Dataset


Unimodal Code Data
1st pretraining
Encoder-Decoder LM
Bimodal Code-Text Data
2nd pretraining
Encoder-Decoder LM
activate different modules
Encoder-only LM
Decoder-only LM
Encoder-Decoder LM
zero-shot/ finetuning/ instruction -tuning
Generation Tasks
Text-To-Code Generation, Math Programming, Code Summarization, Code Completion
Understanding Tasks
Text-To-Code Retrieval, Code Defect Detection, Code Clone Detection
Retrieval-augmented Generation
Span Denoising
Causal LM
Contrastive Loss
Matching Loss



CodeT5+: Open Code Large Language Models for Code Understanding and Generation

Yue Wang*, Hung Le*, Akhilesh Deepak Gotmare, Nghi D.Q. Bui, Junnan Li, Steven C.H. Hoi
Salesforce AI Research
https://github.com/salesforce/CodeT5/tree/main/CodeT5+

https://arxiv.org/abs/2305.07922

CodeT5+

Different sizes
220M, 770M

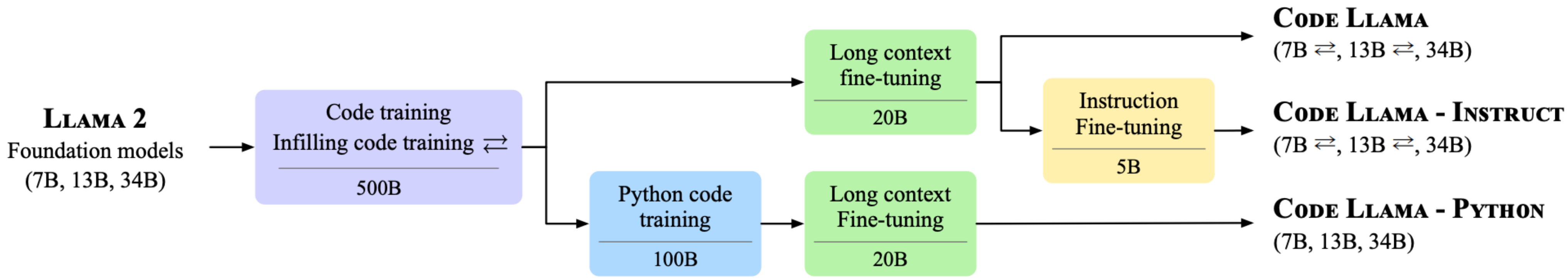
CodeT5+

Different sizes
2B, 6B, 16B
initialized from
CodeGen model

InstructCodeT5+

Fine-tuned with
data generated by
using OpenAI's API

Code Llama



Llama 2
Foundation models
(7B, 13B, 34B)

Code training
Infilling code training ⇄
500B

Long context fine-tuning
20B

Python code training
100B

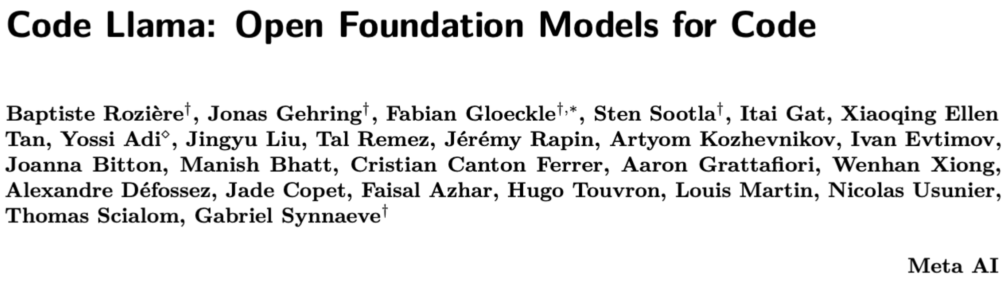
Long context Fine-tuning
20B

Instruction Fine-tuning
5B

Code Llama
(7B ⇄, 13B ⇄, 34B)

Code Llama - Instruct
(7B ⇄, 13B ⇄, 34B)

Code Llama - Python
(7B, 13B, 34B)



Code Llama: Open Foundation Models for Code

Baptiste Rozière[†], Jonas Gehring[†], Fabian Gloeckle[†,*], Sten Sootla[†], Itai Gat, Xiaoqing Ellen Tan, Yossi Adi[◇], Jingyu Liu, Tal Remez, Jérémy Rapin, Artyom Kozhevnikov, Ivan Evtimov, Joanna Bitton, Manish Bhatt, Cristian Canton Ferrer, Aaron Grattafiori, Wenhan Xiong, Alexandre Défossez, Jade Copet, Faisal Azhar, Hugo Touvron, Louis Martin, Nicolas Usunier, Thomas Scialom, Gabriel Synnaeve[†]

Meta AI

https://arxiv.org/abs/2308.12950

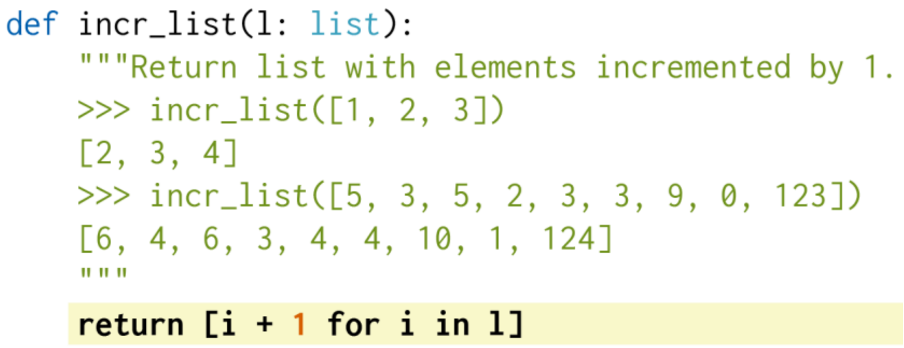
How do we evaluate Code LLMs?

HumanEval

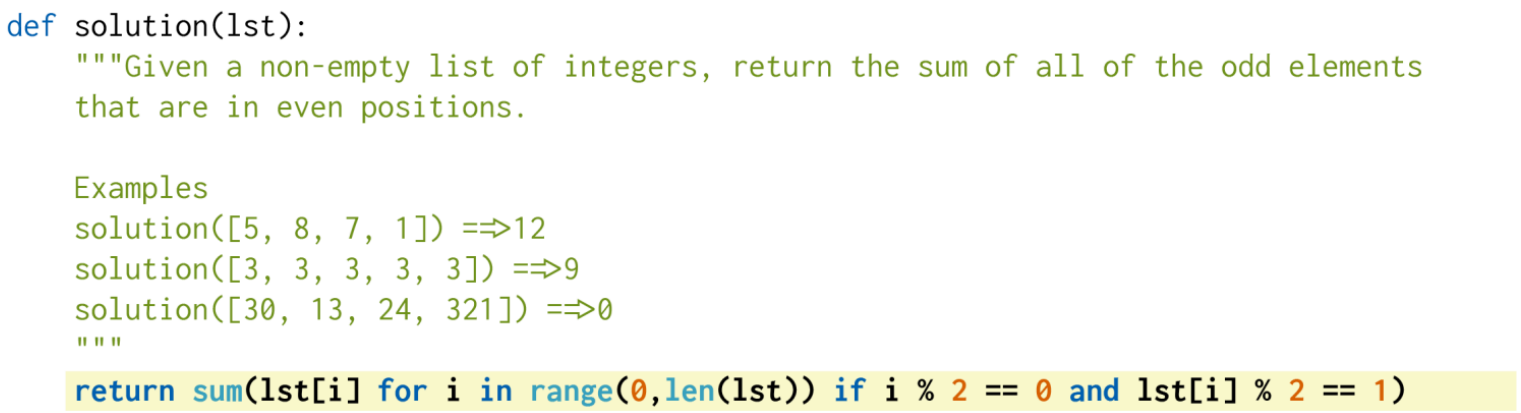
A dataset of 164 python programs with unit tests to measure functional correctness for synthesizing programs from docstrings

Evaluating Large Language Models Trained on Code

https://arxiv.org/abs/2107.03374



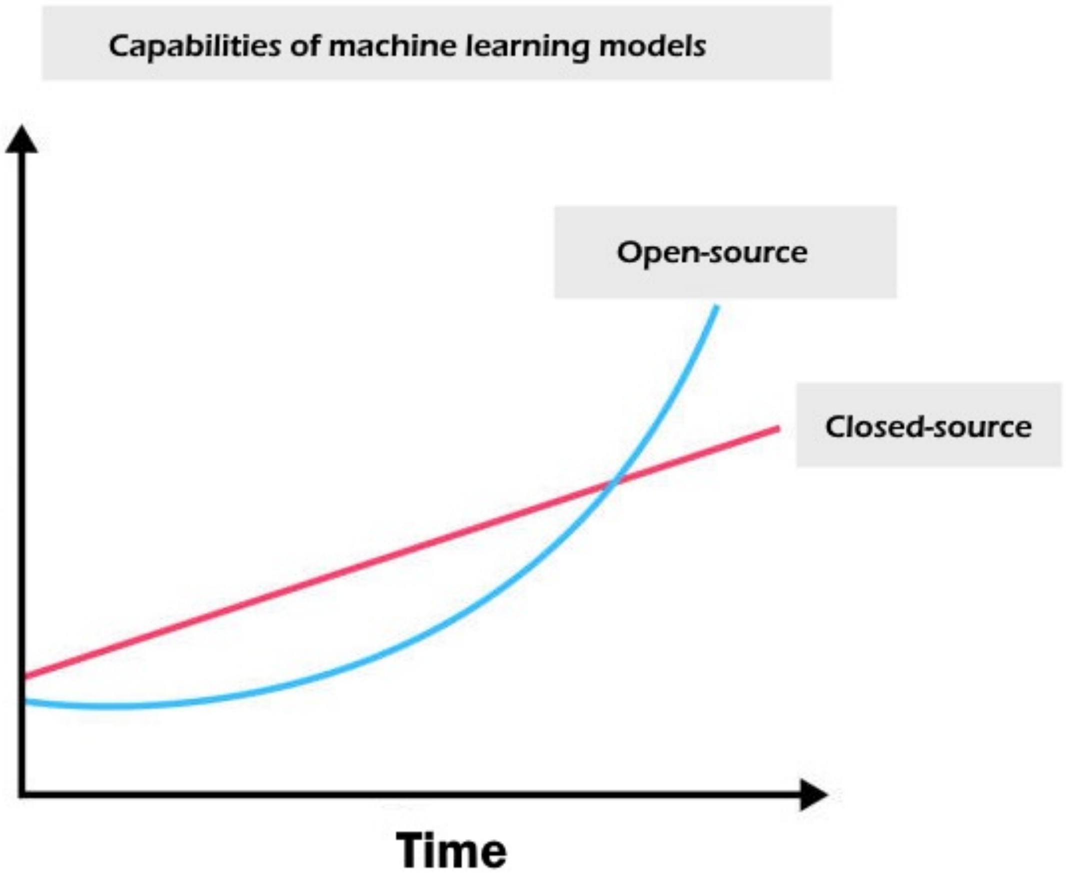
```
def incr_list(l: list):
    """Return list with elements incremented by 1.
    >>> incr_list([1, 2, 3])
    [2, 3, 4]
    >>> incr_list([5, 3, 5, 2, 3, 3, 9, 0, 123])
    [6, 4, 6, 3, 4, 4, 10, 1, 124]
    """
    return [i + 1 for i in l]
```



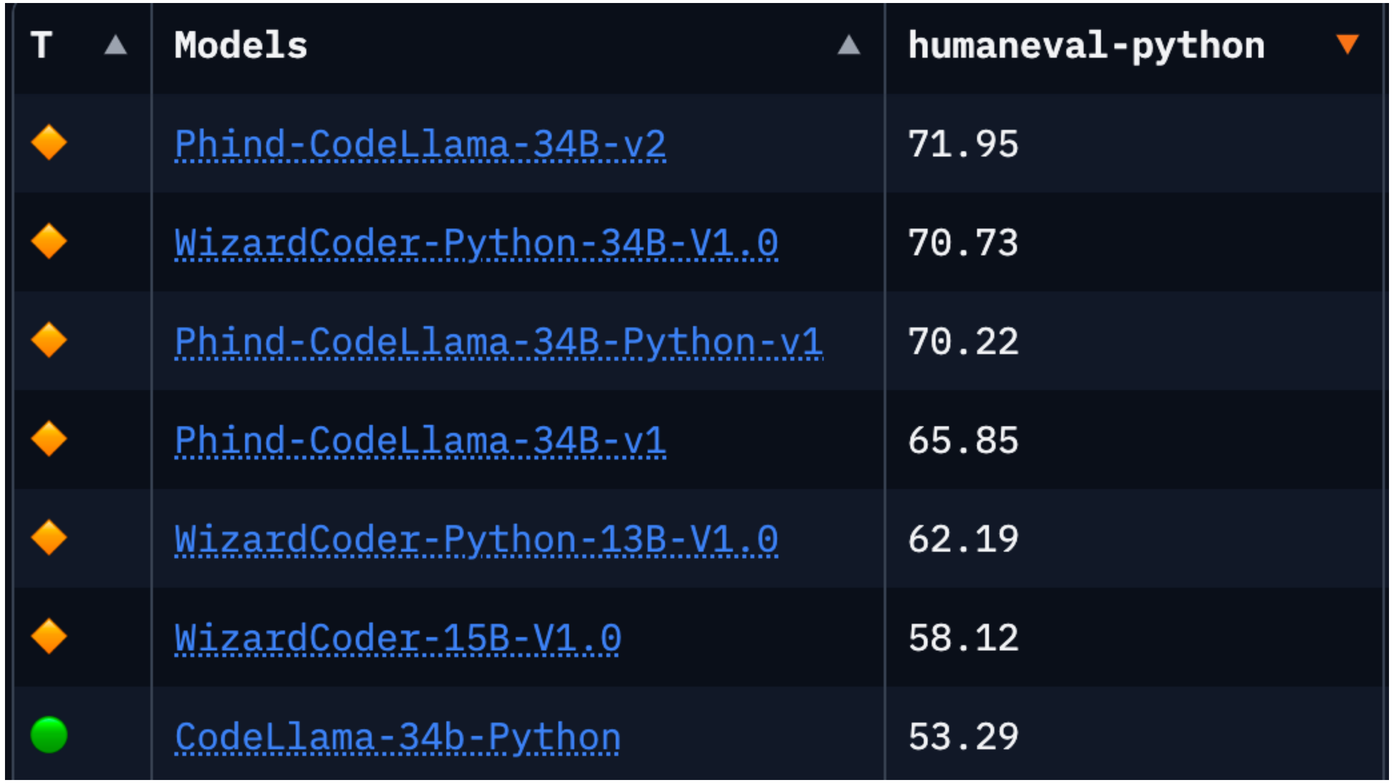
```
def solution(lst):
    """Given a non-empty list of integers, return the sum of all of the odd elements
    that are in even positions.

    Examples
    solution([5, 8, 7, 1]) ==>12
    solution([3, 3, 3, 3, 3]) ==>9
    solution([30, 13, 24, 321]) ==>0
    """
    return sum(lst[i] for i in range(0,len(lst)) if i % 2 == 0 and lst[i] % 2 == 1)
```

Code Generation Closed v/s Open Models

HumanEval	Zero-shot pass@1 (%)
GPT-4	86.6
CodeLlama-34b-Python	53.29
InstructCodeT5+	37
StarCoder	33.6



⭐ Big Code Models Leaderboard



T	Models	humaneval-python
🔶	Phind-CodeLlama-34B-v2	71.95
🔶	WizardCoder-Python-34B-V1.0	70.73
🔶	Phind-CodeLlama-34B-Python-v1	70.22
🔶	Phind-CodeLlama-34B-v1	65.85
🔶	WizardCoder-Python-13B-V1.0	62.19
🔶	WizardCoder-15B-V1.0	58.12
🟢	CodeLlama-34b-Python	53.29

https://huggingface.co/spaces/bigcode/bigcode-models-leaderboard

Code Generation (HumanEval)

HumanEval	Zero-shot pass@1 (%)
GPT-4	86.6
Phind-CodeLlama-34B-v2	71.95
WizardCoder-Python-34B-v1.0	70.73
CodeLlama-34b-Python	53.29

Infilling with Code Generation

```
// some code
<FILL-HERE>
// some more code
```

```
<prefix>
// some code
<suffix>
// some more code
<middle>
```

```
<prefix>
// some code
<suffix>
// some more code
<middle>
// generated code
```

```
// some code
// generated code
// some more code
```

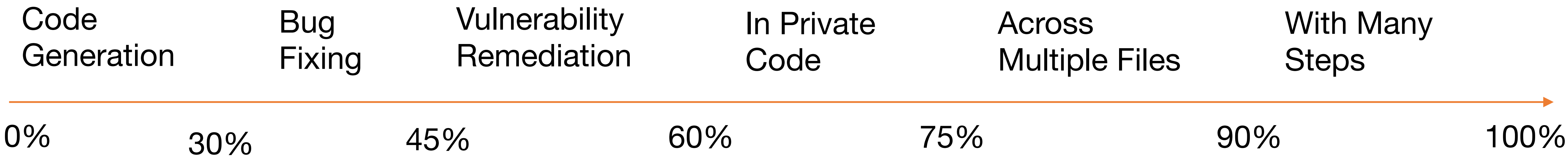
Infilling to Fix Vulnerabilities

```
String output = Launcher.RESOURCES.getString("WinstoneResponse.ErrorPage",
// BUG: CWE-79 Improper Neutralization of Input During Web Page Generation ('Cross-site Scripting')
// new String[] { sc + "", (msg == null ? "" : msg), sw.toString(),
// FIXED:
new String[] { sc + "", URIUtil.htmlEscape(msg == null ? "" : msg),

URIUtil.htmlEscape(sw.toString()),Launcher.RESOURCES.getString("ServerVersion"),"" + new Date() });

response.setContentLength(output.getBytes(response.getCharacterEncoding()).length);
Writer out = response.getWriter();
```

Examining Zero-Shot Vulnerability Repair
with Large Language Models

https://arxiv.org/abs/2112.02125

Fixing Software Vulnerabilities



Code LLMs

GPT-4
CodeLlama-34b-Python

Bug Fixing is Harder

Fix bug in fibonacci

```
def fibonacci(n):
        if n == 0:
                return 0
        elif n == 1 or n == 2:
                return 1
        else:
                return fibonacci(n-1) - fibonacci(n-2)
```

Requires a LLM that
can follow instructions
(or is chatty)

```
def fibonacci(n):
        if n == 0:
                return 0
        elif n == 1 or n == 2:
                return 1
        else:
                return fibonacci(n-1) + fibonacci(n-2)
```

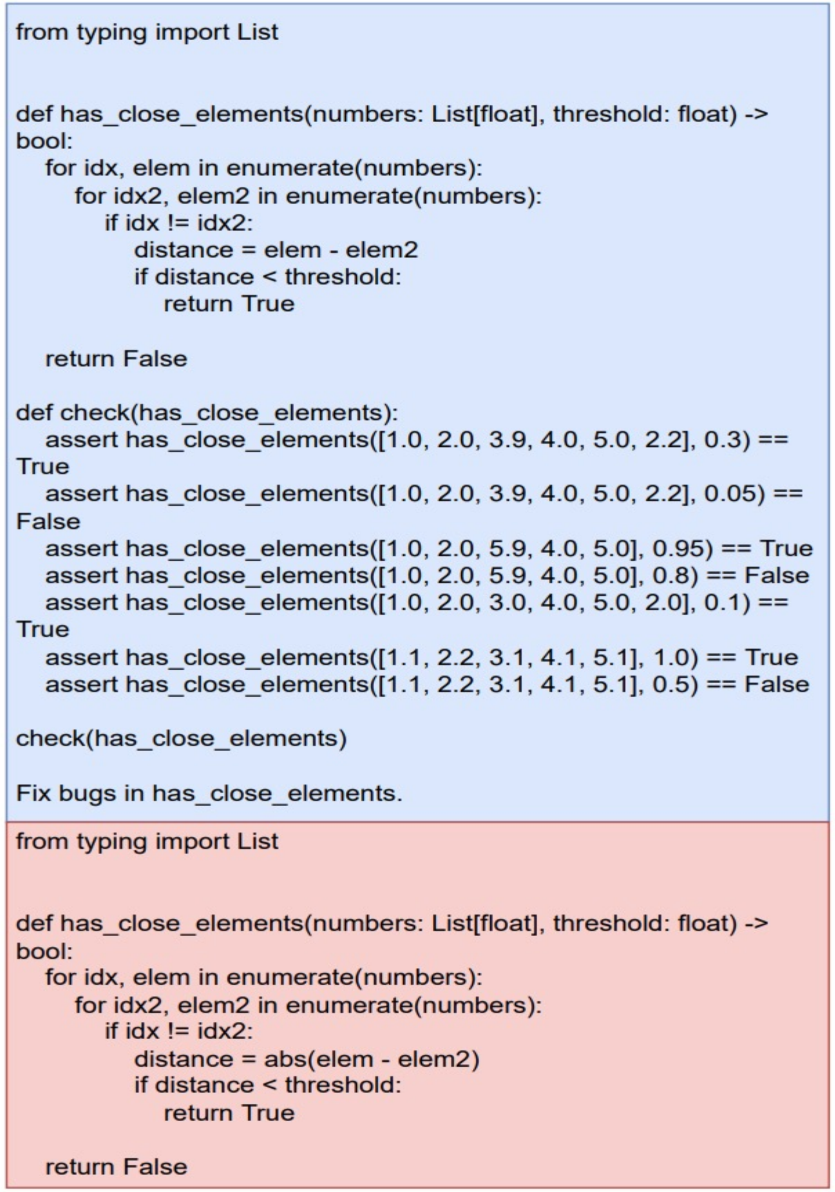
HumanEvalFix

A dataset created by adding a bug to each of the 164 HumanEval solutions. Bugs are written such that the code still runs but produces an incorrect result leading to at least one unit test failing.

OctoPack: Instruction Tuning Code Large Language Models

https://arxiv.org/abs/2308.07124

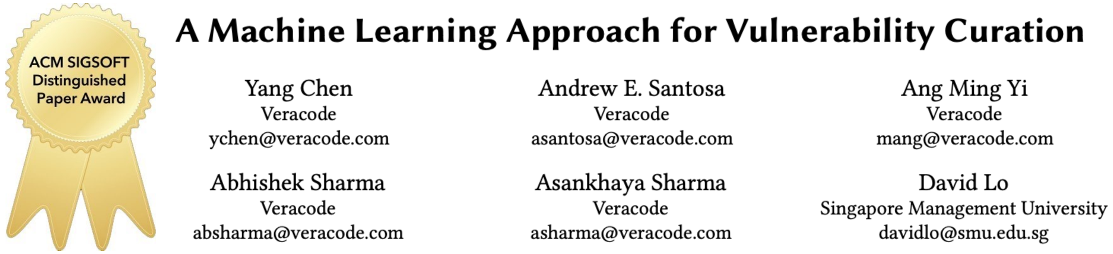
HumanEvalFix	Zero-shot pass@1 (%)
GPT-4	47
Phind-CodeLlama-34B-v2	39.57
WizardCoder-Python-34B-v1.0	38.66
CodeLlama-34b-Instruct	33.14



```
from typing import List


def has_close_elements(numbers: List[float], threshold: float) ->
bool:
    for idx, elem in enumerate(numbers):
        for idx2, elem2 in enumerate(numbers):
            if idx != idx2:
                distance = elem - elem2
                if distance < threshold:
                    return True

    return False

def check(has_close_elements):
    assert has_close_elements([1.0, 2.0, 3.9, 4.0, 5.0, 2.2], 0.3) ==
True
    assert has_close_elements([1.0, 2.0, 3.9, 4.0, 5.0, 2.2], 0.05) ==
False
    assert has_close_elements([1.0, 2.0, 5.9, 4.0, 5.0], 0.95) == True
    assert has_close_elements([1.0, 2.0, 5.9, 4.0, 5.0], 0.8) == False
    assert has_close_elements([1.0, 2.0, 3.0, 4.0, 5.0, 2.0], 0.1) ==
True
    assert has_close_elements([1.1, 2.2, 3.1, 4.1, 5.1], 1.0) == True
    assert has_close_elements([1.1, 2.2, 3.1, 4.1, 5.1], 0.5) == False

check(has_close_elements)

Fix bugs in has_close_elements.
```

```
from typing import List


def has_close_elements(numbers: List[float], threshold: float) ->
bool:
    for idx, elem in enumerate(numbers):
        for idx2, elem2 in enumerate(numbers):
            if idx != idx2:
                distance = abs(elem - elem2)
                if distance < threshold:
                    return True

    return False
```

Are commits a good data source for instruction tuning code LLMs?



ACM SIGSOFT Distinguished Paper Award

A Machine Learning Approach for Vulnerability Curation

Yang Chen
Veracode
ychen@veracode.com

Andrew E. Santosa
Veracode
asantosa@veracode.com

Ang Ming Yi
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mang@veracode.com

Abhishek Sharma
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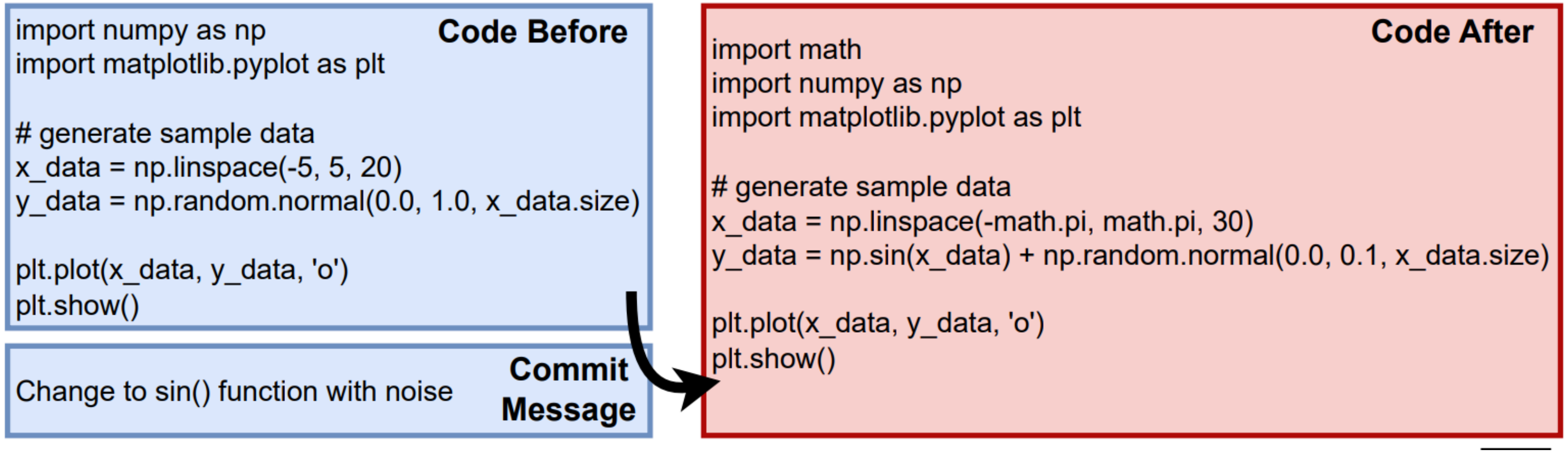
David Lo
Singapore Management University
davidlo@smu.edu.sg

https://dl.acm.org/doi/10.1145/3379597.3387461



Code Before

```
import numpy as np
import matplotlib.pyplot as plt

# generate sample data
x_data = np.linspace(-5, 5, 20)
y_data = np.random.normal(0.0, 1.0, x_data.size)

plt.plot(x_data, y_data, 'o')
plt.show()
```

Commit Message

Change to sin() function with noise

Code After

```
import math
import numpy as np
import matplotlib.pyplot as plt

# generate sample data
x_data = np.linspace(-math.pi, math.pi, 30)
y_data = np.sin(x_data) + np.random.normal(0.0, 0.1, x_data.size)

plt.plot(x_data, y_data, 'o')
plt.show()
```

Patched Coder

CodeLlama-34b-Python → patched-coder-34b

CommitPackFT is a 2GB filtered version of CommitPack to contain only high-quality commit messages that resemble natural language instructions.

```
### Instruction:
commit_msg


### Input:
code_before


### Response:
code_after
```

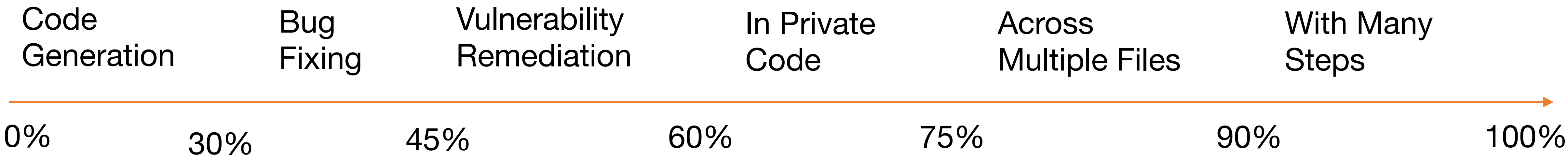
https://hf.co/datasets/bigcode/commitpackft

https://hf.co/patched-codes/patched-coder-34b

Patched Coder is the SOTA Open Code LLM

Code LLM	HumanEval	HumanEvalFix
GPT-4	86.6	47
Phind-CodeLlama-34B-v2	71.95	39.57
WizardCoder-Python-34B-v1.0	70.73	38.66
patched-coder-34b	53.57	41.34
CodeLlama-34b	53.29	33.14

Fixing Software Vulnerabilities



Code LLMs

GPT-4
CodeLlama-34b-Python

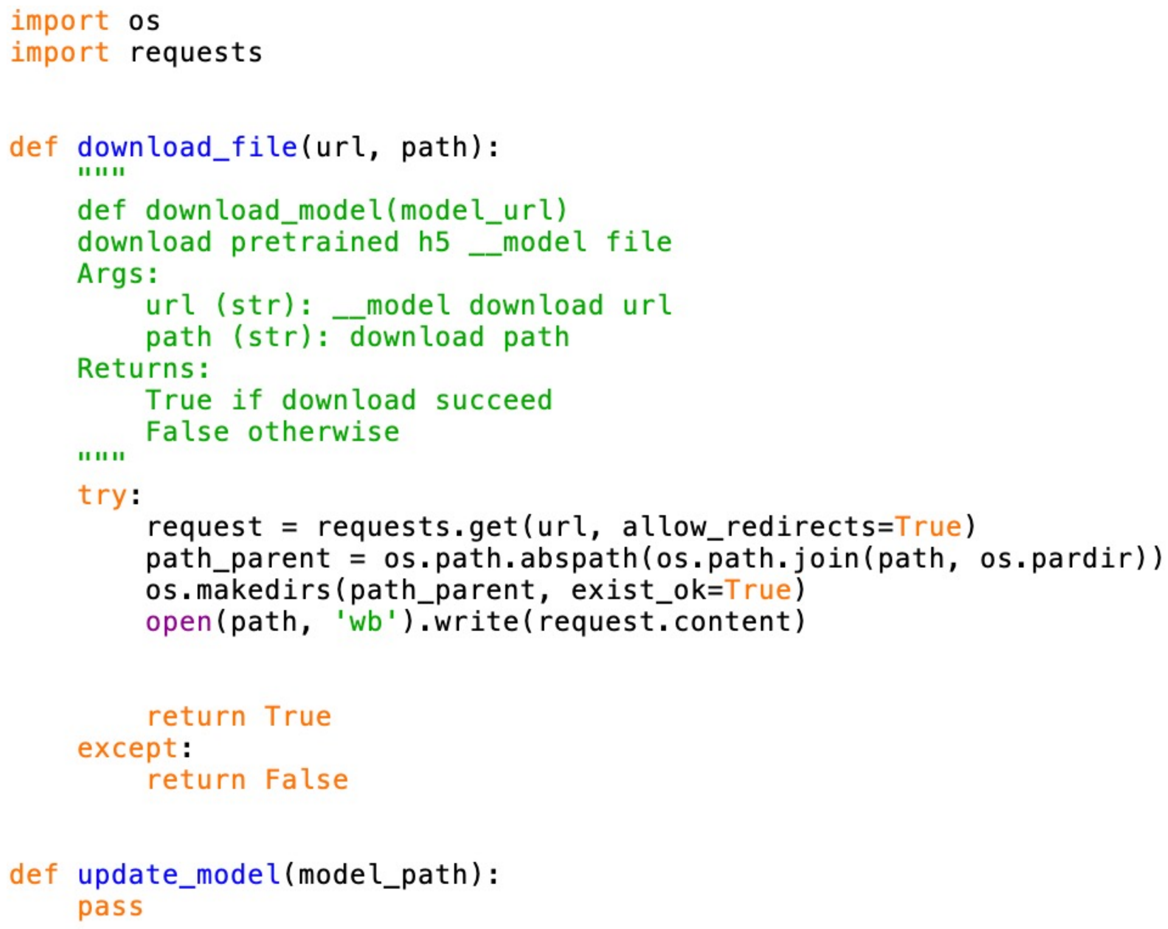
Instruction Tuning

GPT-4
patched-coder-34b

Static Analysis Eval

A dataset of 76 Python programs taken from real Python open-source projects (top 1000 on GitHub), where each program is a file that has exactly 1 vulnerability as detected by a particular static analyzer (Semgrep).

https://hf.co/datasets/patched-codes/static-analysis-eval



```
import os
import requests


def download_file(url, path):
    """
    def download_model(model_url)
    download pretrained h5 __model file
    Args:
        url (str): __model download url
        path (str): download path
    Returns:
        True if download succeed
        False otherwise
    """
    try:
        request = requests.get(url, allow_redirects=True)
        path_parent = os.path.abspath(os.path.join(path, os.pardir))
        os.makedirs(path_parent, exist_ok=True)
        open(path, 'wb').write(request.content)


        return True
    except:
        return False


def update_model(model_path):
    pass
```

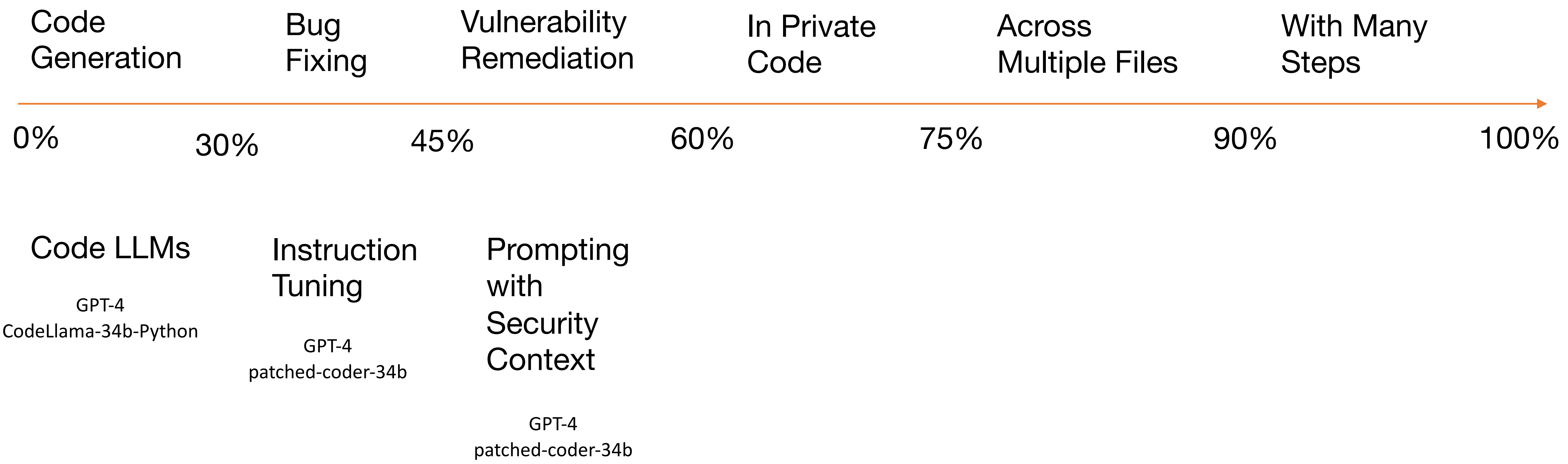
Static Analysis Eval

1. Scan with static analyzer (Semgrep)
2. Extract <CWE>, <vulnerable line(s)> and <error message> from the output of the analyzer
3. Prompt the code LLM to generate fix for the vulnerability
4. Scan again with the static analyzer to check if the error message goes away

Static Analysis Eval	Zero-shot pass@1 (%)
GPT-4	55.26
patched-coder-34b	51.32

```
### Instruction:
<error message>

Fix vulnerability <CWE> in

<vulnerable line(s)>

### Input:
vulnerable_code


### Response:
fixed_code
```

Fixing Software Vulnerabilities



Code Generation

Bug Fixing

Vulnerability Remediation

In Private Code

Across Multiple Files

With Many Steps

0%
30%
45%
60%
75%
90%
100%

Code LLMs

GPT-4
CodeLlama-34b-Python

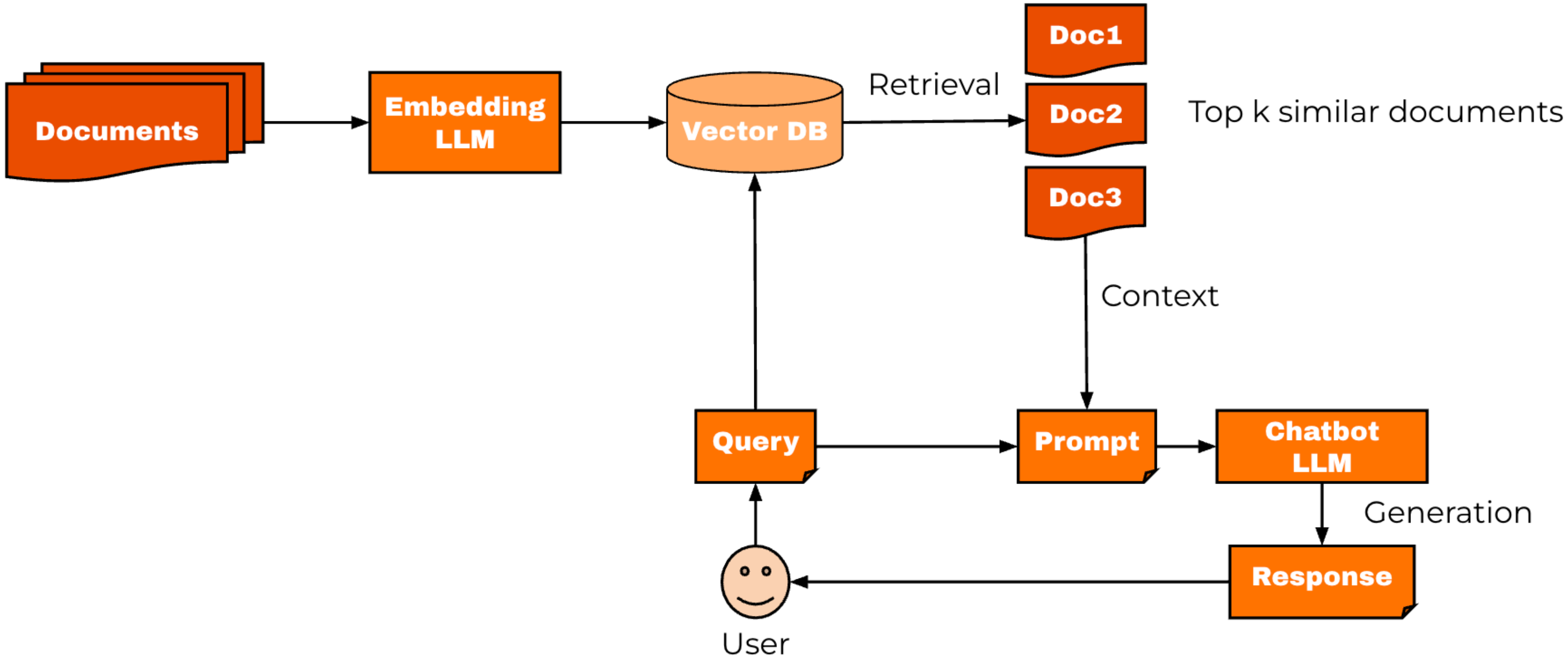
Instruction Tuning

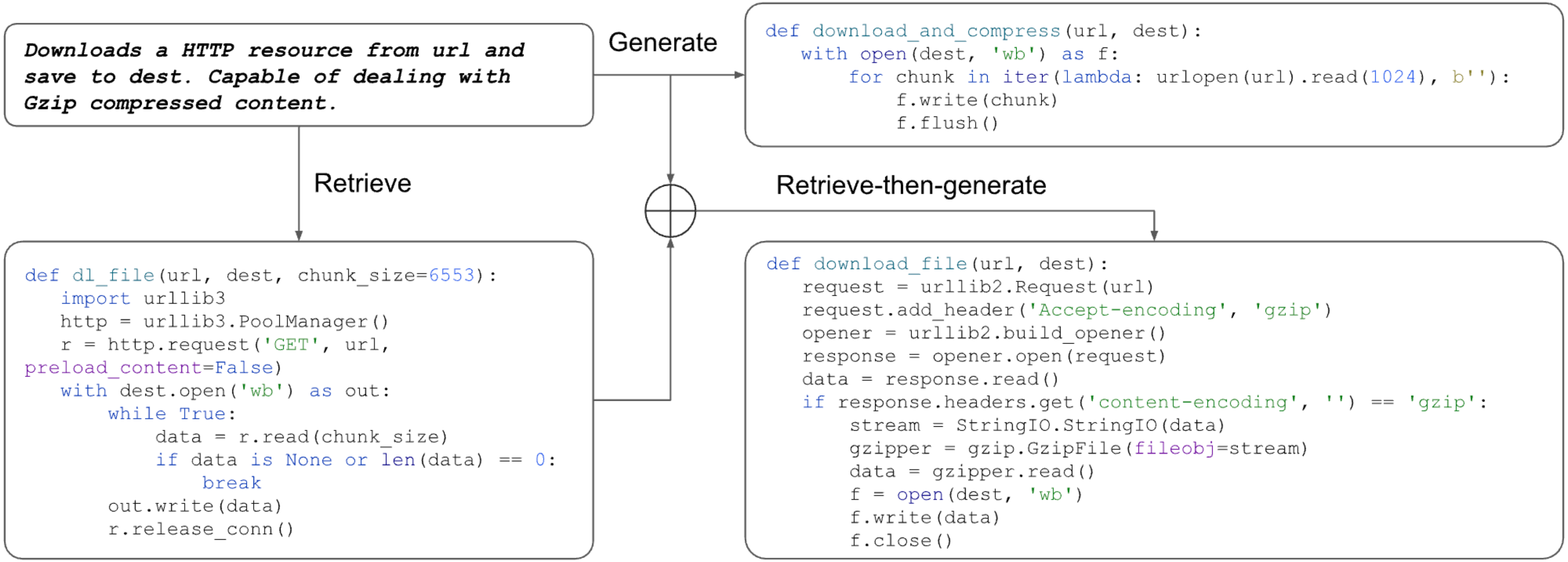
GPT-4
patched-coder-34b

Prompting with Security Context

GPT-4
patched-coder-34b

Retrieval Augmented Generation (RAG)





Downloads a HTTP resource from url and save to dest. Capable of dealing with Gzip compressed content.

```
def download_and_compress(url, dest):
   with open(dest, 'wb') as f:
       for chunk in iter(lambda: urlopen(url).read(1024), b''):
           f.write(chunk)
           f.flush()
```

```
def dl_file(url, dest, chunk_size=6553):
   import urllib3
   http = urllib3.PoolManager()
   r = http.request('GET', url,
preload_content=False)
   with dest.open('wb') as out:
       while True:
           data = r.read(chunk_size)
           if data is None or len(data) == 0:
               break
       out.write(data)
       r.release_conn()
```

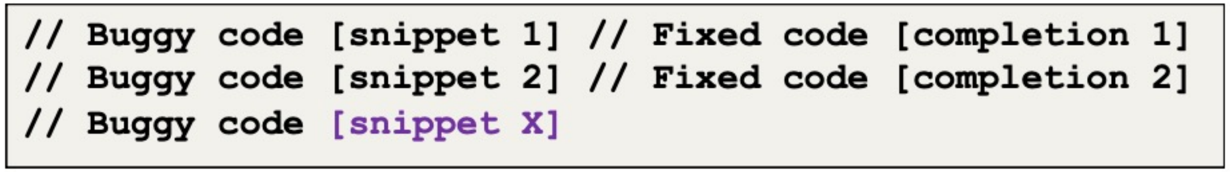
```
def download_file(url, dest):
   request = urllib2.Request(url)
   request.add_header('Accept-encoding', 'gzip')
   opener = urllib2.build_opener()
   response = opener.open(request)
   data = response.read()
   if response.headers.get('content-encoding', '') == 'gzip':
       stream = StringIO.StringIO(data)
       gzipper = gzip.GzipFile(fileobj=stream)
       data = gzipper.read()
       f = open(dest, 'wb')
       f.write(data)
       f.close()
```

CodeT5+’s encoder-decoder architecture enables end-to-end retrieval-augmented code generation

Retrieval Augmented Generation (RAG)

1. Unimodal (text or code)
2. Bimodal (code and description pairs)
3. Bimodal with context (instruction with before_code and after_code pairs)

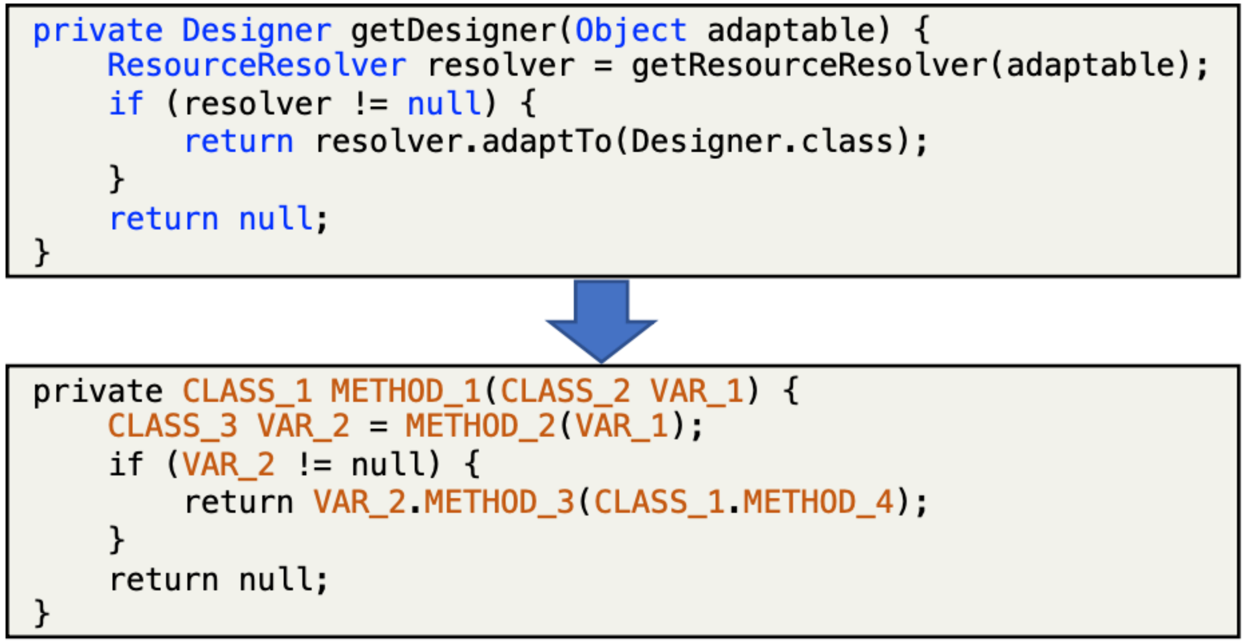
Build a few-shot prompt



```
// Buggy code [snippet 1] // Fixed code [completion 1]
// Buggy code [snippet 2] // Fixed code [completion 2]
// Buggy code [snippet X]
```

```
### Instruction:
<retrieved_similar_commit_message>

### Input:
<retrieved_similar_vulnerable_code>

### Response:
<retrieved_fix>

### Instruction:
<error message>

Fix vulnerability <CWE> in <vulnerable line(s)>

### Input:
vulnerable_code

### Response:
fixed_code
```

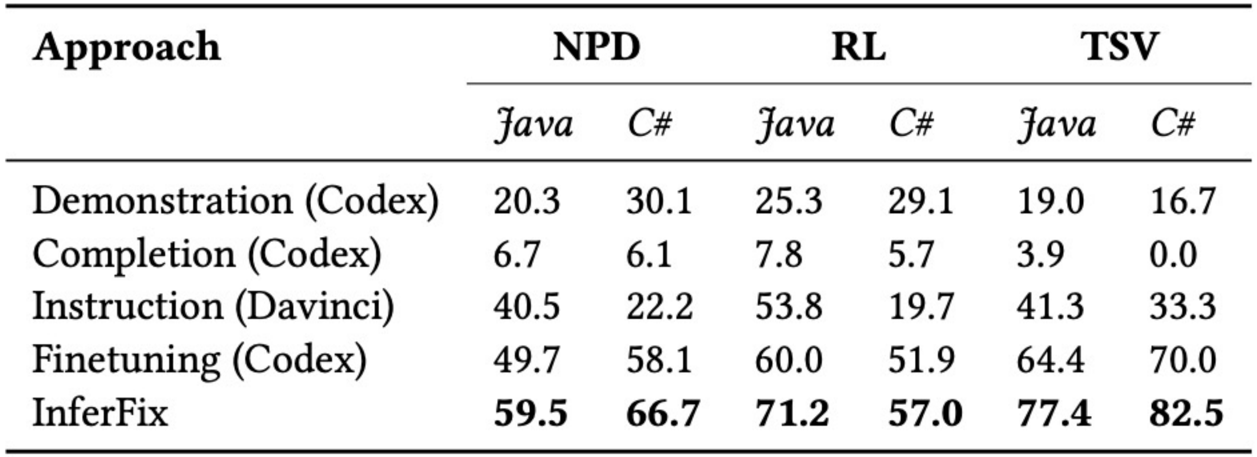
Use obfuscation to preserve structural fix



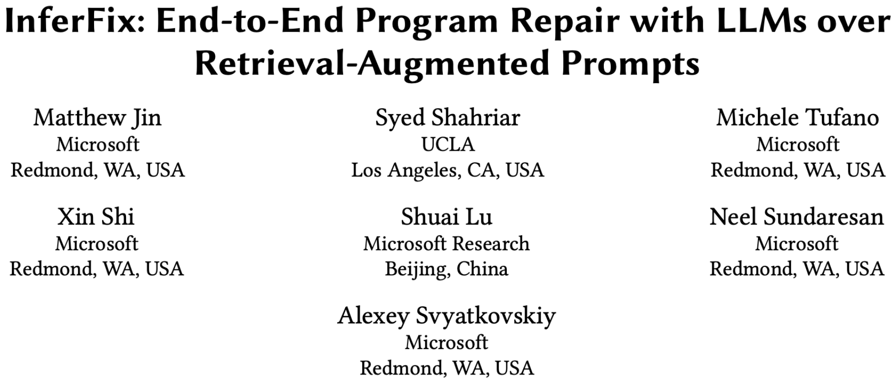
```
private Designer getDesigner(Object adaptable) {
    ResourceResolver resolver = getResourceResolver(adaptable);
    if (resolver != null) {
        return resolver.adaptTo(Designer.class);
    }
    return null;
}
```

```
private CLASS_1 METHOD_1(CLASS_2 VAR_1) {
    CLASS_3 VAR_2 = METHOD_2(VAR_1);
    if (VAR_2 != null) {
        return VAR_2.METHOD_3(CLASS_1.METHOD_4);
    }
    return null;
}
```

Fixing vulnerabilities with RAG



Approach	NPD		RL		TSV	
	Java	*C#*	*Java*	*C#*	*Java*	*C#*
Demonstration (Codex)	20.3	30.1	25.3	29.1	19.0	16.7
Completion (Codex)	6.7	6.1	7.8	5.7	3.9	0.0
Instruction (Davinci)	40.5	22.2	53.8	19.7	41.3	33.3
Finetuning (Codex)	49.7	58.1	60.0	51.9	64.4	70.0
InferFix	**59.5**	**66.7**	**71.2**	**57.0**	**77.4**	**82.5**



InferFix: End-to-End Program Repair with LLMs over Retrieval-Augmented Prompts

Matthew Jin
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Redmond, WA, USA

Syed Shahriar
UCLA
Los Angeles, CA, USA

Michele Tufano
Microsoft
Redmond, WA, USA

Xin Shi
Microsoft
Redmond, WA, USA

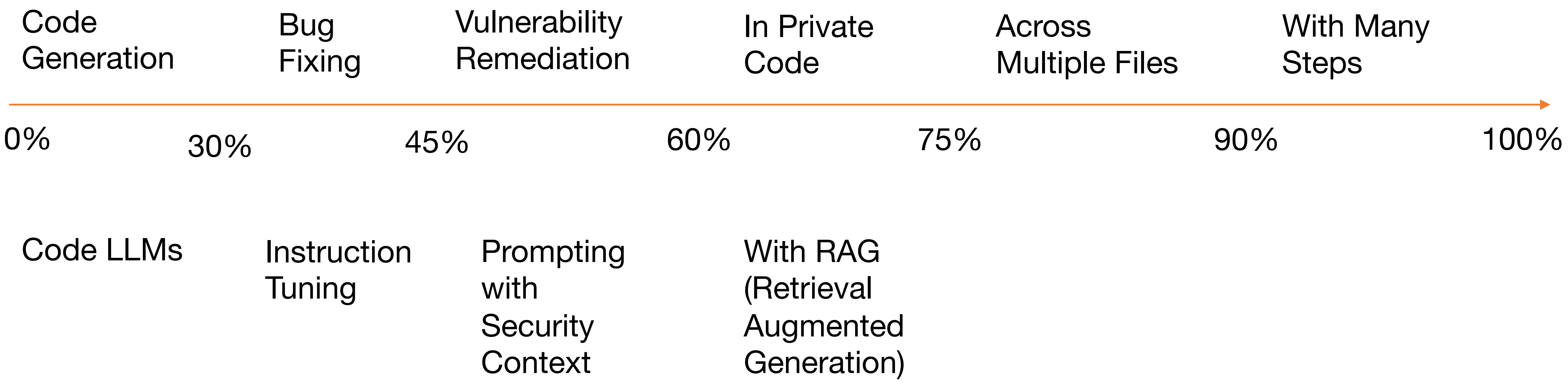
Shuai Lu
Microsoft Research
Beijing, China

Neel Sundaresan
Microsoft
Redmond, WA, USA

Alexey Svyatkovskiy
Microsoft
Redmond, WA, USA

https://arxiv.org/abs/2303.07263

Fixing Software Vulnerabilities



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Code LLMs

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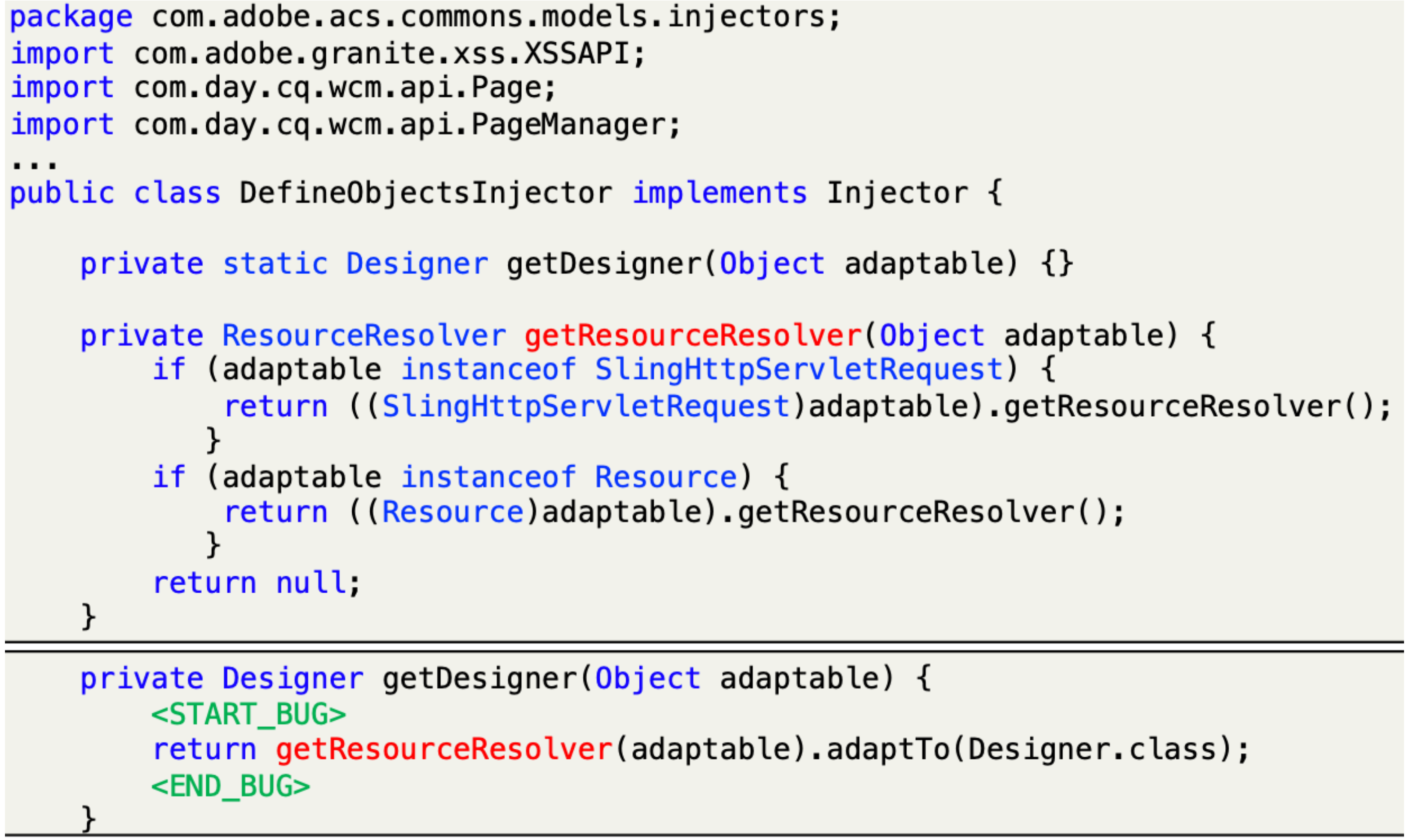
Prompting with Security Context

With RAG (Retrieval Augmented Generation)

Static Analysis-augmented Generation (SAG)



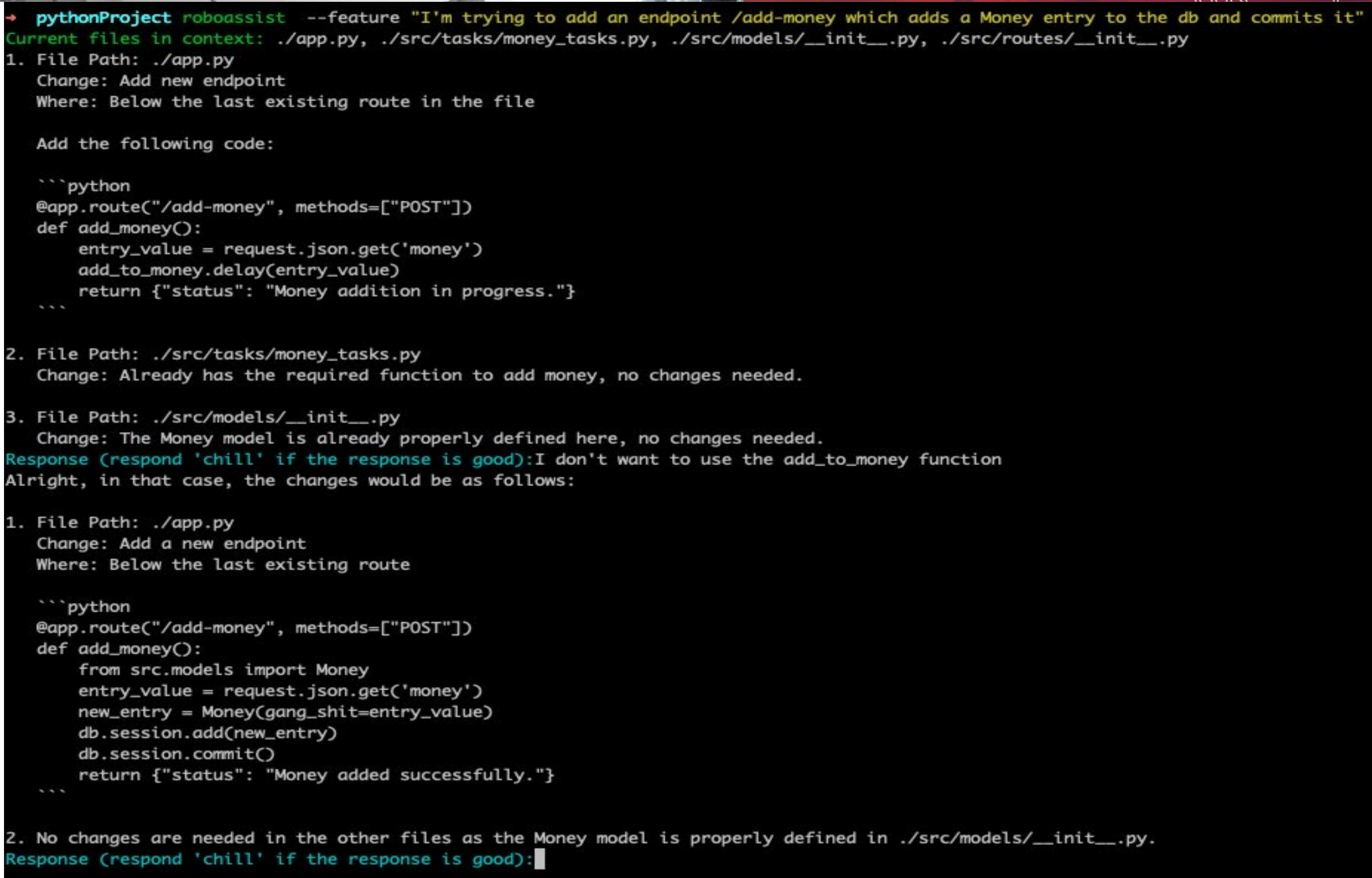
```java
package com.adobe.acs.commons.models.injectors;
import com.adobe.granite.xss.XSSAPI;
import com.day.cq.wcm.api.Page;
import com.day.cq.wcm.api.PageManager;
...
public class DefineObjectsInjector implements Injector {

    private static Designer getDesigner(Object adaptable) {}

    private ResourceResolver getResourceResolver(Object adaptable) {
        if (adaptable instanceof SlingHttpServletRequest) {
            return ((SlingHttpServletRequest)adaptable).getResourceResolver();
          }
        if (adaptable instanceof Resource) {
            return ((Resource)adaptable).getResourceResolver();
          }
        return null;
    }
```

```java
    private Designer getDesigner(Object adaptable) {
        <START_BUG>
        return getResourceResolver(adaptable).adaptTo(Designer.class);
        <END_BUG>
    }
```

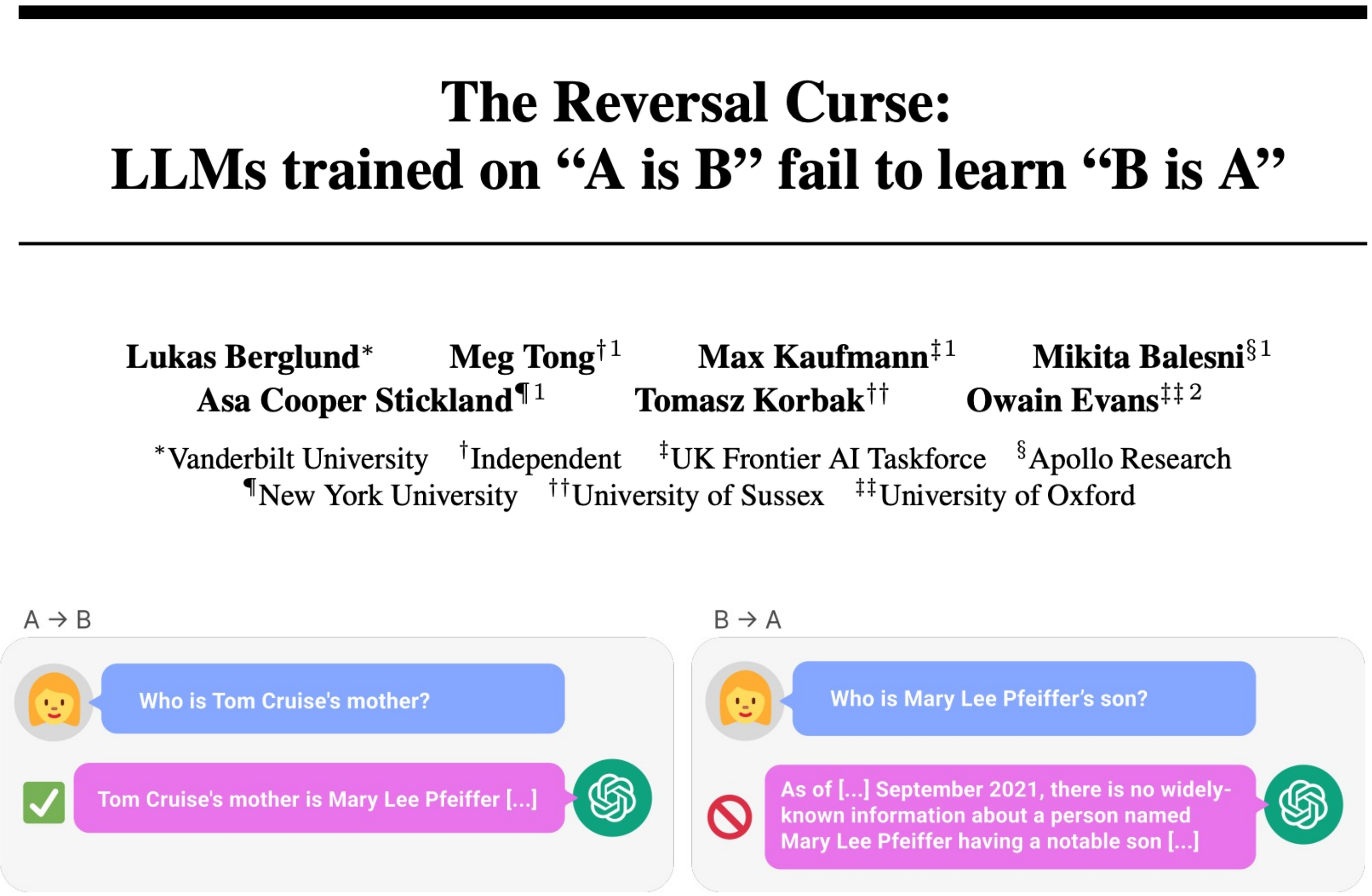
```
### Instruction:
<error message>

Fix vulnerability <CWE> in

<vulnerable line(s)>

### Input:
related_code

vulnerable_code

### Response:
```

1. Feed GPT-4 file structure of project + feature I'm trying to implement
2. Ask what filenames it needs to see to implement that feature
3. Put those files into context window
4. Ask if it's seen enough, if No go to step 1 while keeping context from current loop
5. If yes, ask for filenames and specific changes

https://twitter.com/Pavel_Asparagus/status/1699872712749936677



~~~
➜  pythonProject roboassist  --feature "I'm trying to add an endpoint /add-money which adds a Money entry to the db and commits it"
Current files in context: ./app.py, ./src/tasks/money_tasks.py, ./src/models/__init__.py, ./src/routes/__init__.py
1. File Path: ./app.py
   Change: Add new endpoint
   Where: Below the last existing route in the file

   Add the following code:

   ```python
   @app.route("/add-money", methods=["POST"])
   def add_money():
       entry_value = request.json.get('money')
       add_to_money.delay(entry_value)
       return {"status": "Money addition in progress."}
   ```

2. File Path: ./src/tasks/money_tasks.py
   Change: Already has the required function to add money, no changes needed.

3. File Path: ./src/models/__init__.py
   Change: The Money model is already properly defined here, no changes needed.
Response (respond 'chill' if the response is good):I don't want to use the add_to_money function
Alright, in that case, the changes would be as follows:

1. File Path: ./app.py
   Change: Add a new endpoint
   Where: Below the last existing route

   ```python
   @app.route("/add-money", methods=["POST"])
   def add_money():
       from src.models import Money
       entry_value = request.json.get('money')
       new_entry = Money(gang_shit=entry_value)
       db.session.add(new_entry)
       db.session.commit()
       return {"status": "Money added successfully."}
   ```

2. No changes are needed in the other files as the Money model is properly defined in ./src/models/__init__.py.
Response (respond 'chill' if the response is good):
~~~



The Reversal Curse:
LLMs trained on “A is B” fail to learn “B is A”

Lukas Berglund[*] **Meg Tong**[†1] **Max Kaufmann**[‡1] **Mikita Balesni**[§1]
Asa Cooper Stickland[¶1] **Tomasz Korbak**[††] **Owain Evans**[‡‡2]

[*]Vanderbilt University [†]Independent [‡]UK Frontier AI Taskforce [§]Apollo Research
[¶]New York University [††]University of Sussex [‡‡]University of Oxford

A → B

Who is Tom Cruise's mother?

✓ Tom Cruise's mother is Mary Lee Pfeiffer [...]

B → A

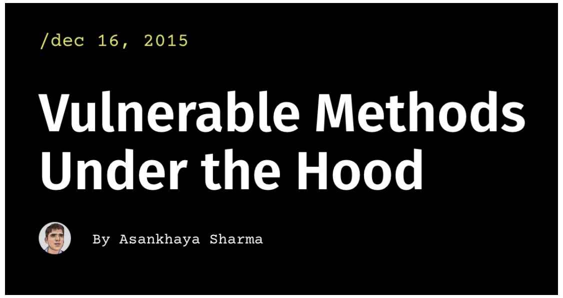
Who is Mary Lee Pfeiffer’s son?

🚫 As of [...] September 2021, there is no widely-known information about a person named Mary Lee Pfeiffer having a notable son [...]

https://arxiv.org/abs/2309.12288

SAG

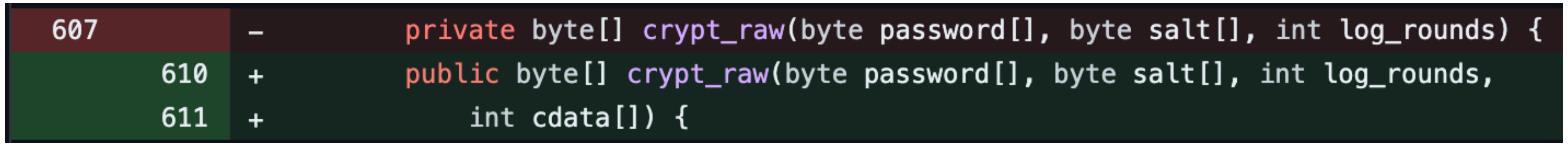
1. Reachability analysis
2. Impact analysis



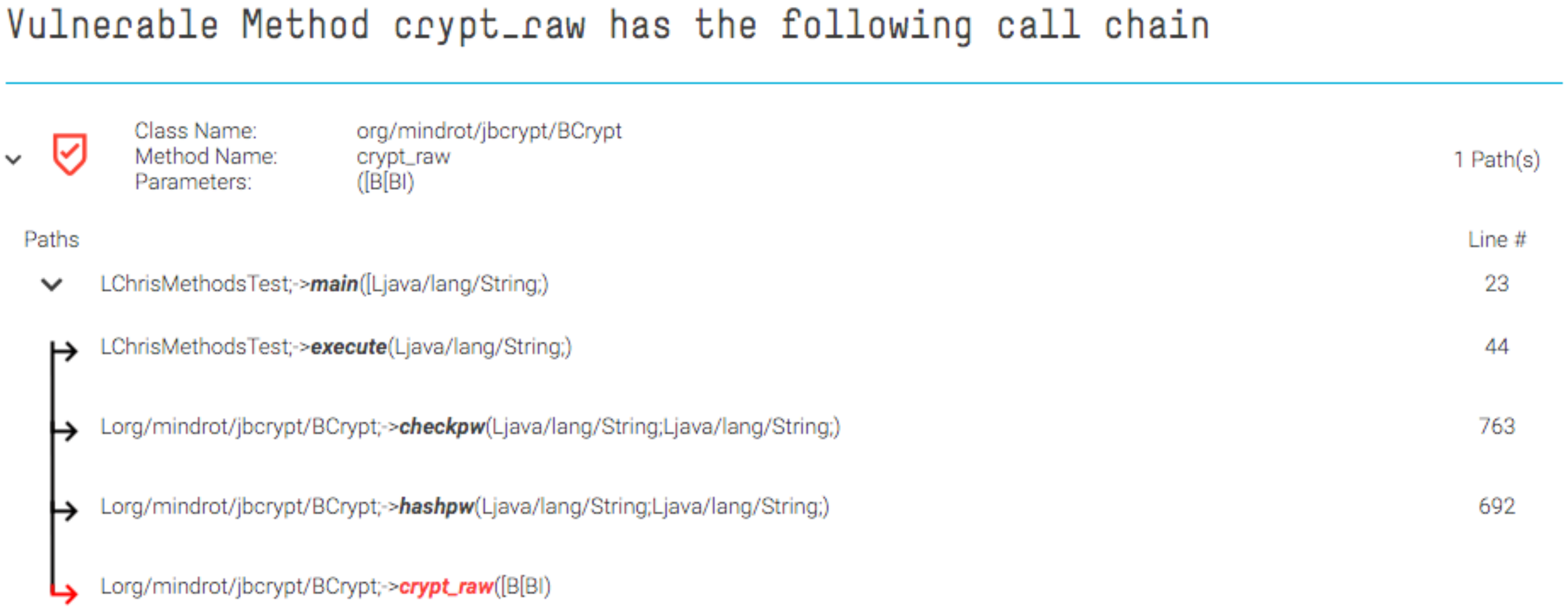
/dec 16, 2015

Vulnerable Methods Under the Hood

By Asankhaya Sharma



```
-      private byte[] crypt_raw(byte password[], byte salt[], int log_rounds) {
+      public byte[] crypt_raw(byte password[], byte salt[], int log_rounds,
+          int cdata[]) {
```



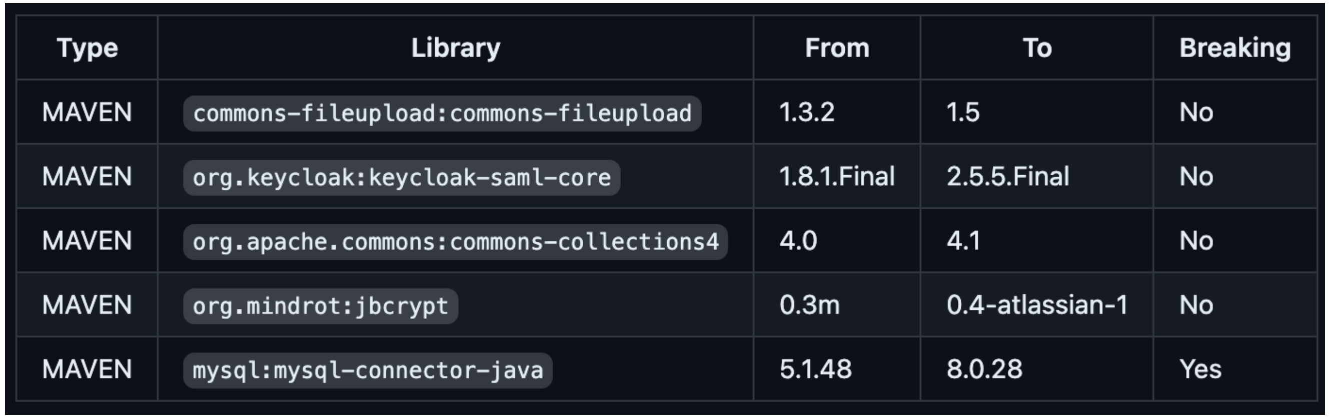
Vulnerable Method crypt_raw has the following call chain

Class Name:	org/mindrot/jbcrypt/BCrypt
Method Name:	crypt_raw
Parameters:	([B[BI)

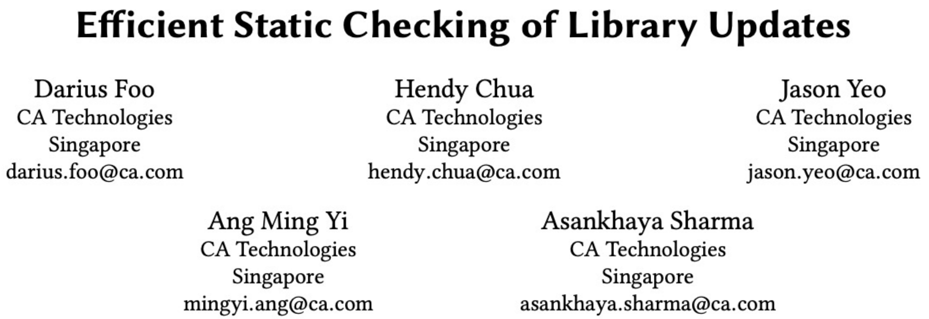
1 Path(s)

Paths	Line #
LChrisMethodsTest;->**main**([Ljava/lang/String;)	23
LChrisMethodsTest;->**execute**(Ljava/lang/String;)	44
Lorg/mindrot/jbcrypt/BCrypt;->**checkpw**(Ljava/lang/String;Ljava/lang/String;)	763
Lorg/mindrot/jbcrypt/BCrypt;->**hashpw**(Ljava/lang/String;Ljava/lang/String;)	692
Lorg/mindrot/jbcrypt/BCrypt;->**crypt_raw**([B[BI)	

https://www.veracode.com/blog/managing-appsec/vulnerable-methods-under-hood



Type	Library	From	To	Breaking
MAVEN	`commons-fileupload:commons-fileupload`	1.3.2	1.5	No
MAVEN	`org.keycloak:keycloak-saml-core`	1.8.1.Final	2.5.5.Final	No
MAVEN	`org.apache.commons:commons-collections4`	4.0	4.1	No
MAVEN	`org.mindrot:jbcrypt`	0.3m	0.4-atlassian-1	No
MAVEN	`mysql:mysql-connector-java`	5.1.48	8.0.28	Yes



Efficient Static Checking of Library Updates

Darius Foo
CA Technologies
Singapore
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Singapore
hendy.chua@ca.com

Jason Yeo
CA Technologies
Singapore
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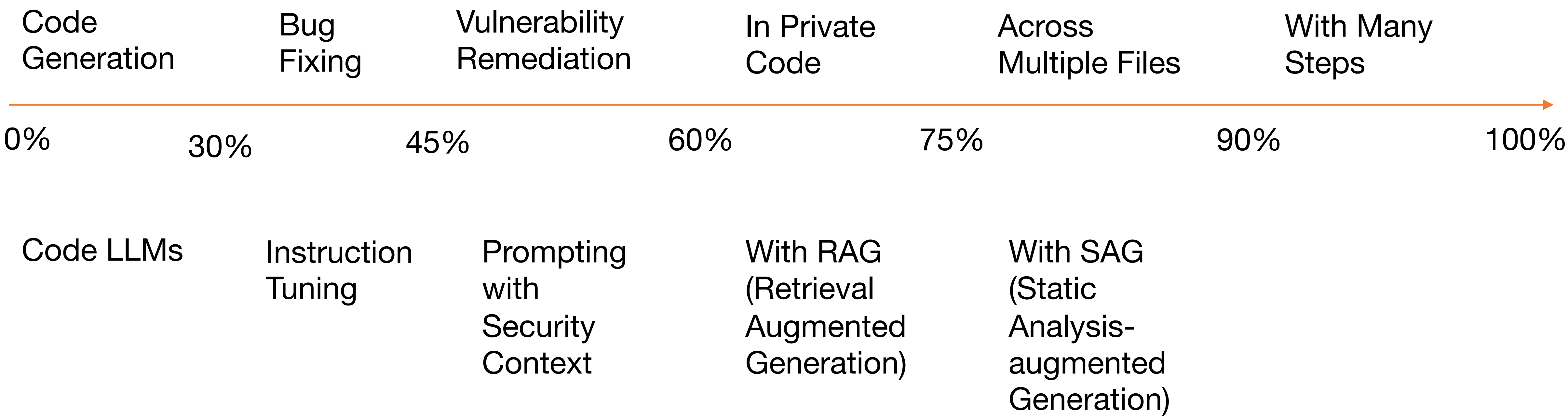
asankhaya.sharma@ca.com

https://dl.acm.org/doi/10.1145/3236024.3275535

Fixing Software Vulnerabilities



Code Generation

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Static Analysis-augmented Generative Agents (SAGA)

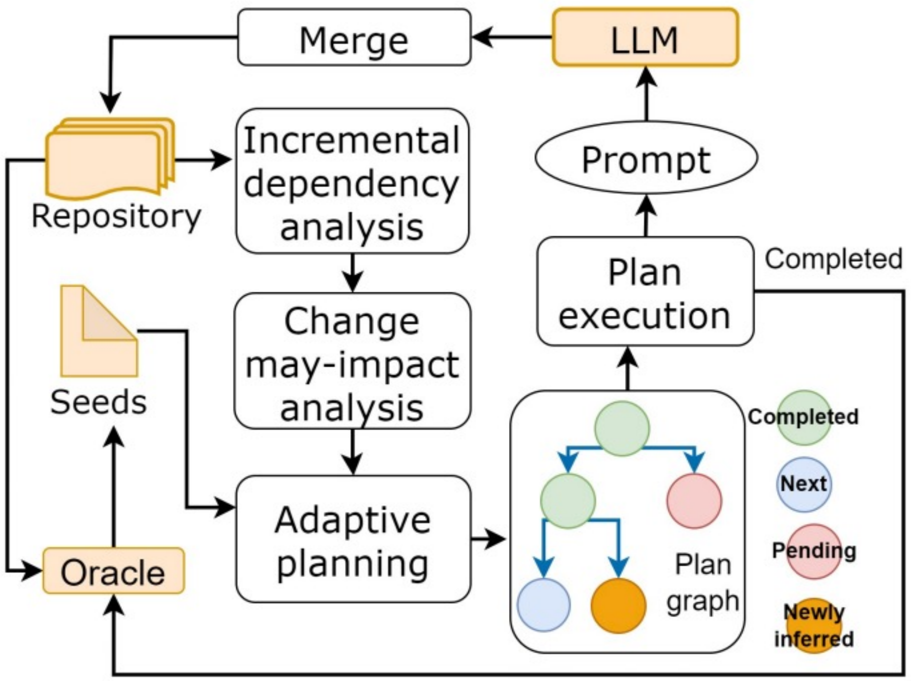
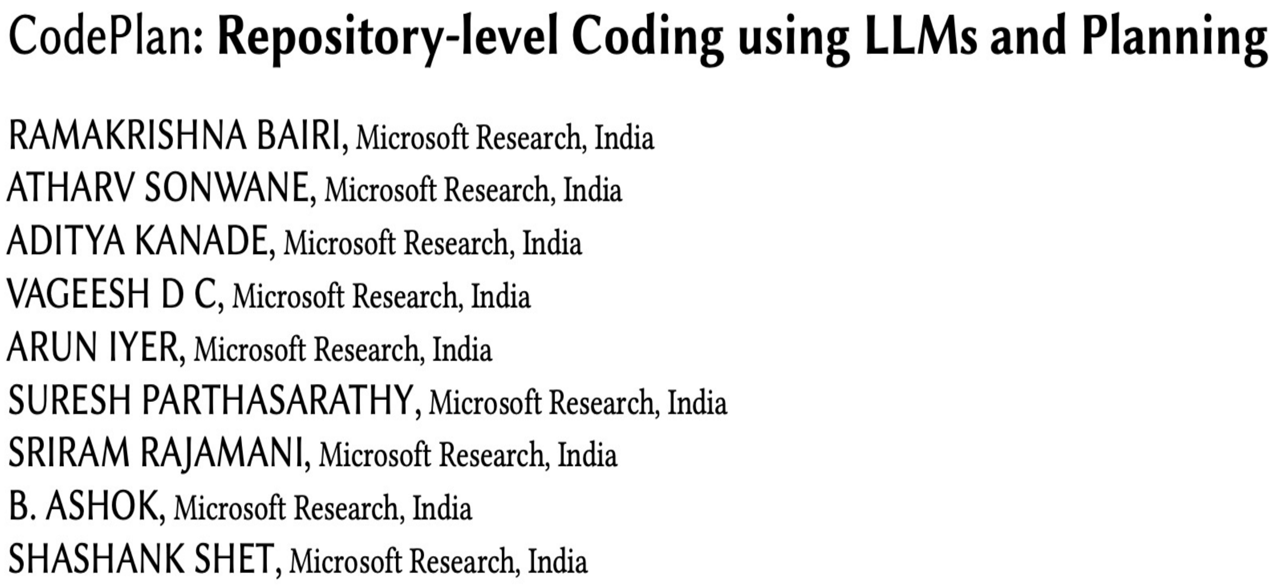


Fig. 2. Overview of CodePlan.



CodePlan: Repository-level Coding using LLMs and Planning

RAMAKRISHNA BAIRI, Microsoft Research, India
ATHARV SONWANE, Microsoft Research, India
ADITYA KANADE, Microsoft Research, India
VAGEESH D C, Microsoft Research, India
ARUN IYER, Microsoft Research, India
SURESH PARTHASARATHY, Microsoft Research, India
SRIRAM RAJAMANI, Microsoft Research, India
B. ASHOK, Microsoft Research, India
SHASHANK SHET, Microsoft Research, India

https://arxiv.org/abs/2309.12499

Prompt Template

p_1 Task Instructions: *Your task is to . . .*

p_2 Earlier Code Changes (Temporal Context): *These are edits that have been made in the code-base previously -*

```
Edit 1:
 Before: «code_before»
 After: «code_after»
...
```

p_3 Causes for Change: *The change is required due to -*

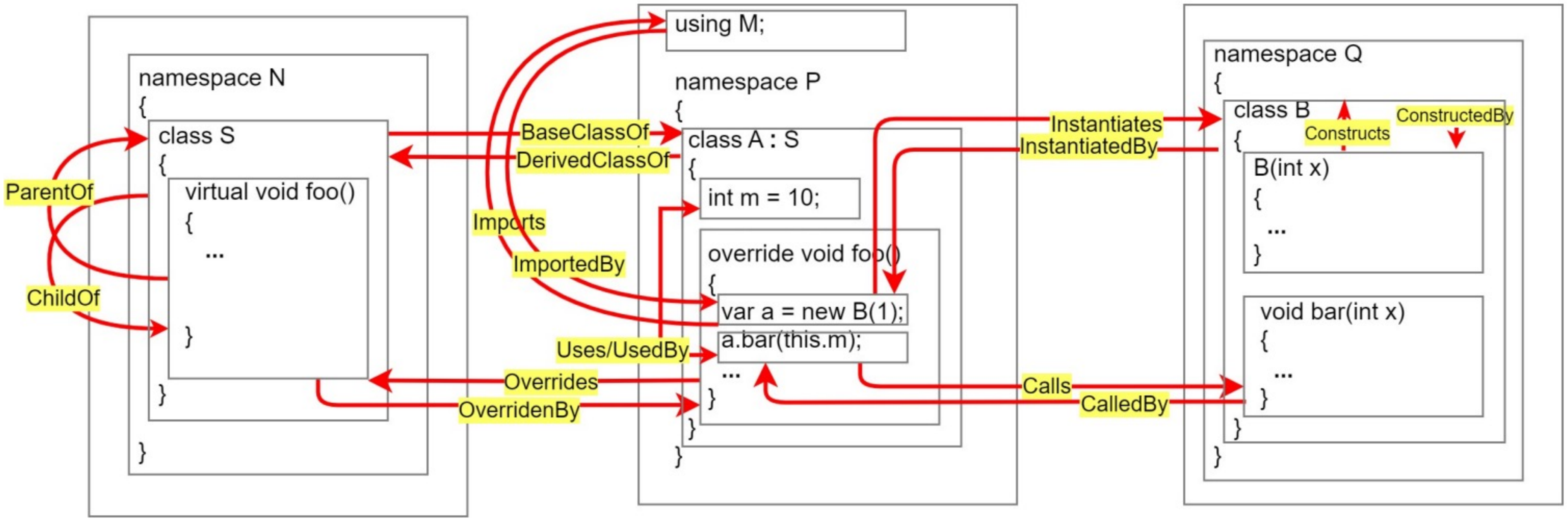
```
«code_to_be_edited» is related to «code_changed_earlier» by «cause»
...
```

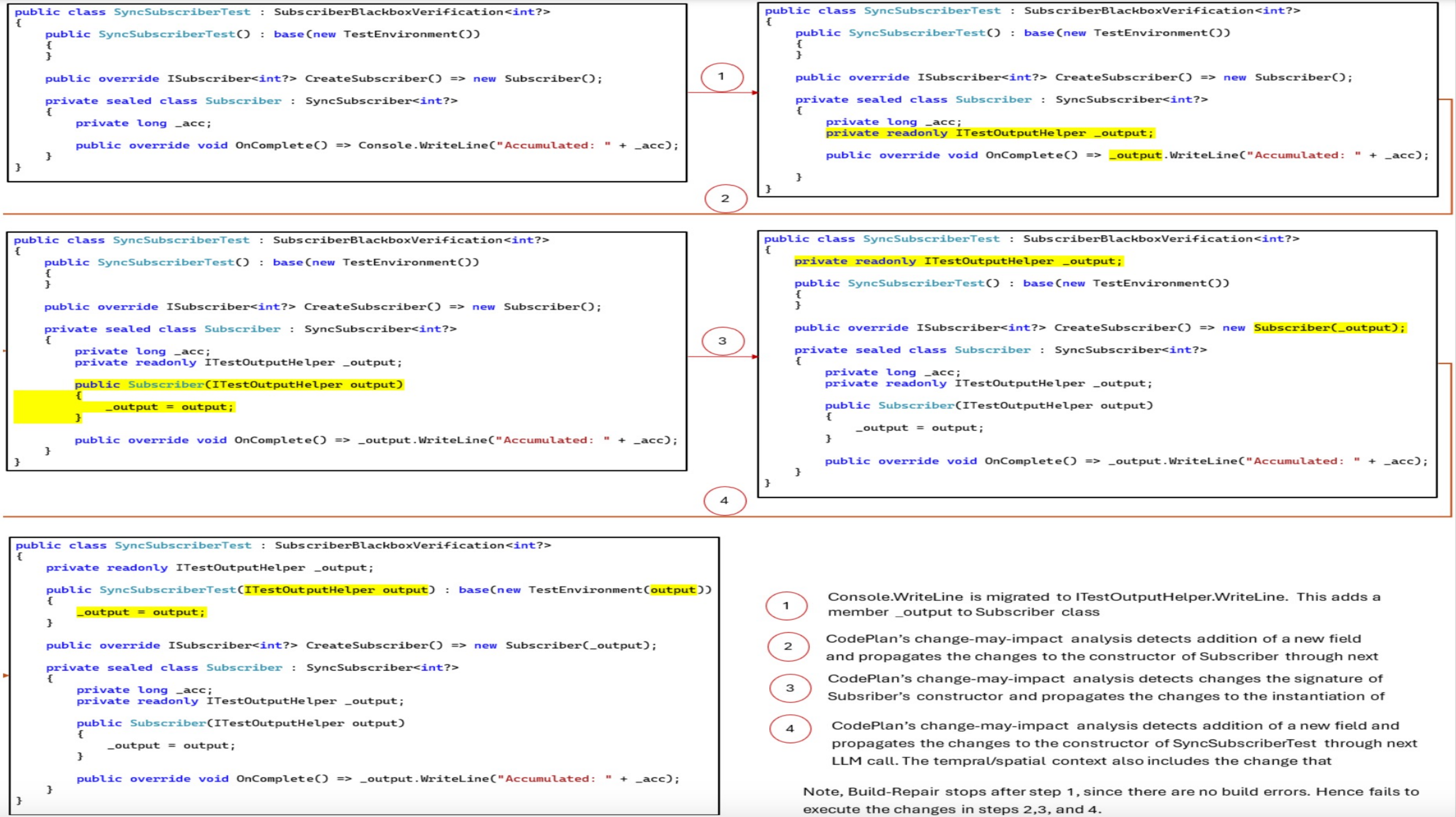
p_4 Related Code (Spatial Context): *The following code maybe related -*

```
«related_code_block-1»
...
```

p_5 Code to be Changed Next: *The existing code is given below -*

```
«code_to_be_edited»
```


namespace N
{
class S
{
virtual void foo()
{
...
}
}
}
using M;
namespace P
{
class A : S
{
int m = 10;
override void foo()
{
var a = new B(1);
a.bar(this.m);
...
}
}
}
namespace Q
{
class B
{
B(int x)
{
...
}
void bar(int x)
{
...
}
}
}
ParentOf
ChildOf
BaseClassOf
DerivedClassOf
Imports
ImportedBy
Uses/UsedBy
Overrides
OverridenBy
Instantiates
InstantiatedBy
Constructs
ConstructedBy
Calls
CalledBy



```
public class SyncSubscriberTest : SubscriberBlackboxVerification<int?>
{
    public SyncSubscriberTest() : base(new TestEnvironment())
    {
    }

    public override ISubscriber<int?> CreateSubscriber() => new Subscriber();

    private sealed class Subscriber : SyncSubscriber<int?>
    {
        private long _acc;

        public override void OnComplete() => Console.WriteLine("Accumulated: " + _acc);
    }
}
```

```
public class SyncSubscriberTest : SubscriberBlackboxVerification<int?>
{
    public SyncSubscriberTest() : base(new TestEnvironment())
    {
    }

    public override ISubscriber<int?> CreateSubscriber() => new Subscriber();

    private sealed class Subscriber : SyncSubscriber<int?>
    {
        private long _acc;
        private readonly ITestOutputHelper _output;

        public override void OnComplete() => _output.WriteLine("Accumulated: " + _acc);

    }
}
```

```
public class SyncSubscriberTest : SubscriberBlackboxVerification<int?>
{
    public SyncSubscriberTest() : base(new TestEnvironment())
    {
    }

    public override ISubscriber<int?> CreateSubscriber() => new Subscriber();

    private sealed class Subscriber : SyncSubscriber<int?>
    {
        private long _acc;
        private readonly ITestOutputHelper _output;

        public Subscriber(ITestOutputHelper output)
        {
            _output = output;
        }

        public override void OnComplete() => _output.WriteLine("Accumulated: " + _acc);
    }
}
```

```
public class SyncSubscriberTest : SubscriberBlackboxVerification<int?>
{
    private readonly ITestOutputHelper _output;

    public SyncSubscriberTest() : base(new TestEnvironment())
    {
    }

    public override ISubscriber<int?> CreateSubscriber() => new Subscriber(_output);

    private sealed class Subscriber : SyncSubscriber<int?>
    {
        private long _acc;
        private readonly ITestOutputHelper _output;

        public Subscriber(ITestOutputHelper output)
        {
            _output = output;
        }

        public override void OnComplete() => _output.WriteLine("Accumulated: " + _acc);
    }
}
```

```
public class SyncSubscriberTest : SubscriberBlackboxVerification<int?>
{
    private readonly ITestOutputHelper _output;

    public SyncSubscriberTest(ITestOutputHelper output) : base(new TestEnvironment(output))
    {
        _output = output;
    }

    public override ISubscriber<int?> CreateSubscriber() => new Subscriber(_output);

    private sealed class Subscriber : SyncSubscriber<int?>
    {
        private long _acc;
        private readonly ITestOutputHelper _output;

        public Subscriber(ITestOutputHelper output)
        {
            _output = output;
        }

        public override void OnComplete() => _output.WriteLine("Accumulated: " + _acc);
    }
}
```

① Console.WriteLine is migrated to ITestOutputHelper.WriteLine. This adds a member _output to Subscriber class

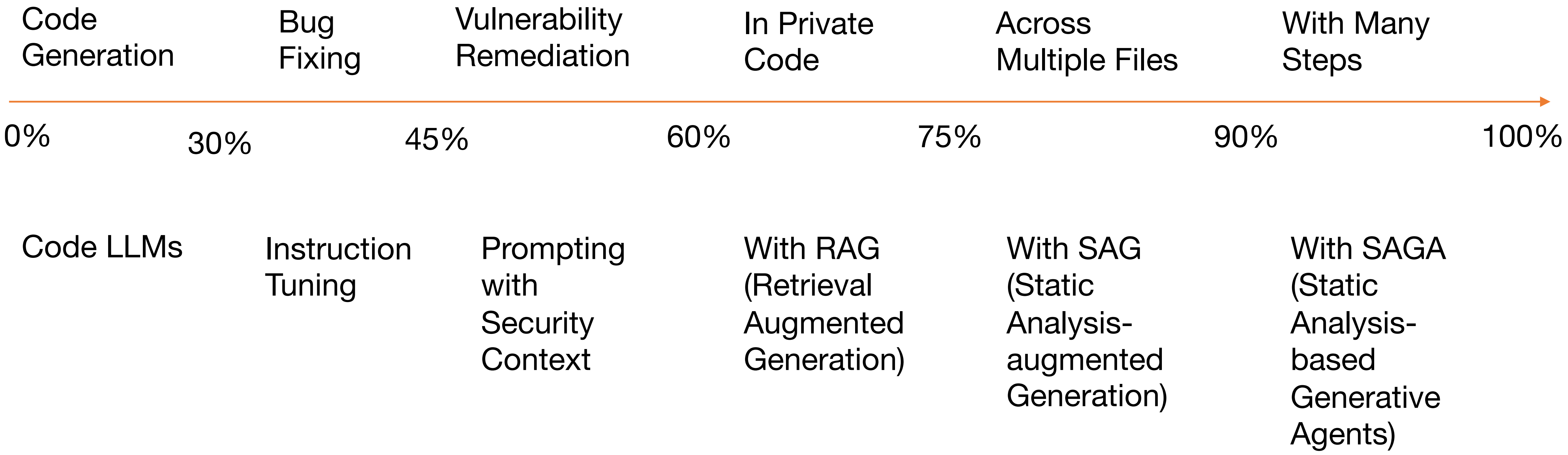
② CodePlan's change-may-impact analysis detects addition of a new field and propagates the changes to the constructor of Subscriber through next

③ CodePlan's change-may-impact analysis detects changes the signature of Subsriber's constructor and propagates the changes to the instantiation of

④ CodePlan's change-may-impact analysis detects addition of a new field and propagates the changes to the constructor of SyncSubscriberTest through next LLM call. The tempral/spatial context also includes the change that

Note, Build-Repair stops after step 1, since there are no build errors. Hence fails to execute the changes in steps 2,3, and 4.

Fixing Software Vulnerabilities



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With SAG (Static Analysis-augmented Generation)

With SAGA (Static Analysis-based Generative Agents)

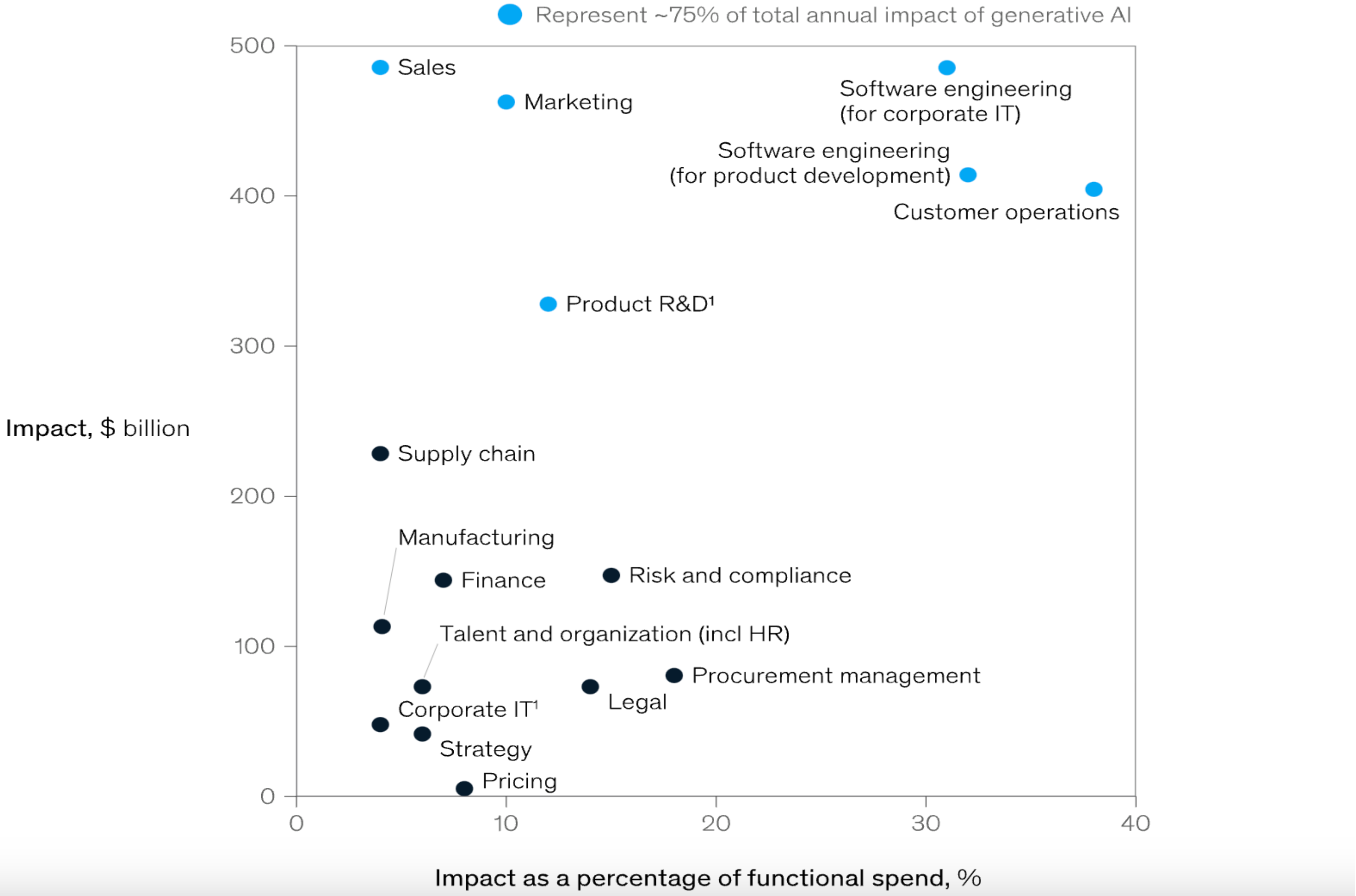
Developer Less Security

(The Prestige)

- Patched Coder
- Static Analysis Eval

Artists:
ai art will replace us
nooooooooooo
programmers:
ChatGPT will replace us
finally.

Using generative AI in just a few functions could drive most of the technology's impact across potential corporate use cases.



https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#business-value

DevSecOps
DevLess Security

OWASP 2023
GLOBAL
AppSec

SINGAPORE
VIRTUAL CONFERENCE
OCTOBER 3-5

THANK YOU

Asankhaya Sharma
asankhaya@patched.codes