# ENHANCING TEST AUTOMATION AND SECURITY WITH PYTHON & AI FOR QUALITY-DRIVEN DEVSECOPS

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# ABOUT ME

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- AI/ML, Software Testing, DevSecOps
- Distributed Systems, Microservices, CI/CD
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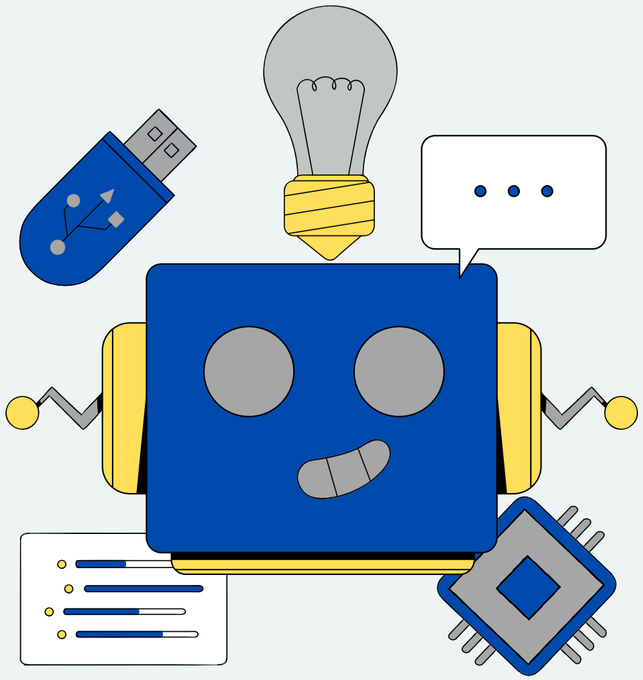
# AGENDA

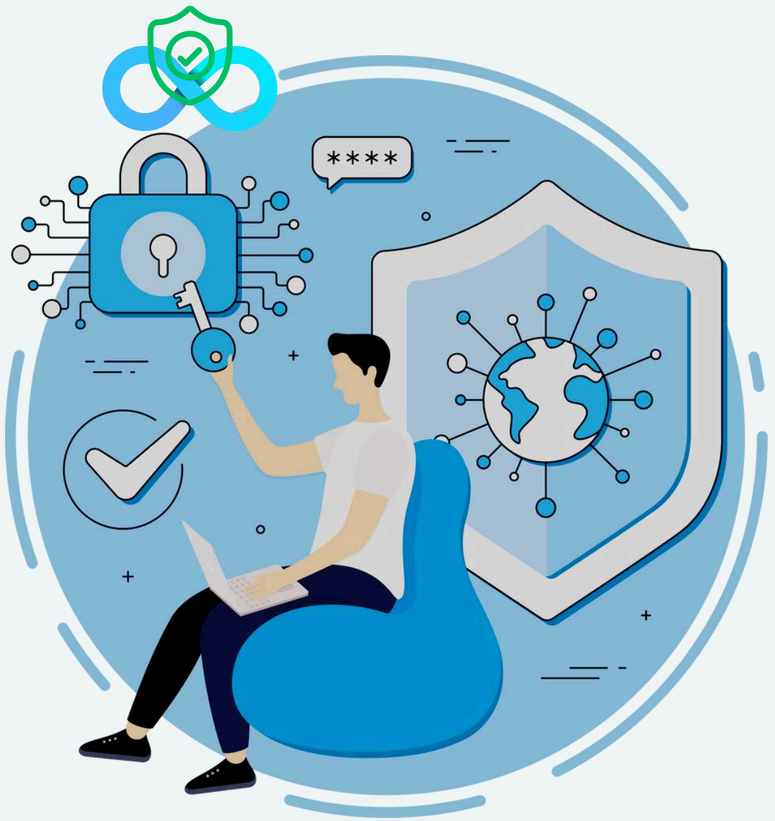


- Introduction & DevOps vs. **DevSecOps**
- Role of Python in DevSecOps
- Leveraging AI in DevSecOps
- Tool-Based Approach to DevSecOps
  - Static Code Analysis (Dev Phase)
  - Secrets Detection (Code Review Phase)
  - Dependency Scan (Build Phase)
  - Functional & Security Testing (Deployment Phase)
  - Post-Deployment Monitoring (Production Phase)
- Best Practices

# INTRODUCTION

**DevOps**:
Focuses on speed & collaboration between Dev and Ops.

**DevSecOps**:
Embeds security throughout the development lifecycle.




## WHY THE SHIFT?

EVOLVING THREATS DEMAND PROACTIVE SECURITY INTEGRATION.

# ROLE OF PYTHON IN DEVSECOPS

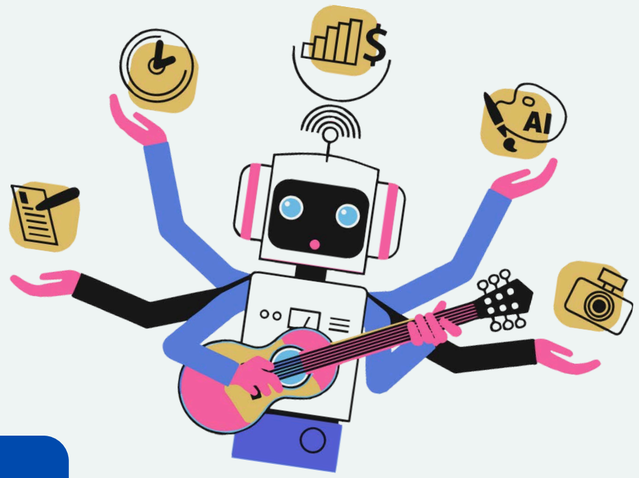

## WHY PYTHON?

### SIMPLICITY, FLEXIBILITY, RICH ECHO SYSTEM

**Security Automation:**

- Vulnerability Scanning
- Compliance Checks, and
- Threat Detection

# ROLE OF AI IN SECURITY AND DEVSECOPS




## 01

### WHY AI IN SECURITY?

PREDICT

DETECT

RESPOND

## 02

### WHAT ARE THE KEY BENEFITS

AUTOMATED THREAT DETECTION,

INTELLIGENT CODE ANALYSIS,

CONTINUOUS SECURITY IMPROVEMENT

## 03

### HOW DOES AI CONTRIBUTE TO DEVSECOPS

SMARTER TESTING PIPELINES,

REAL-TIME ANOMALY DETECTION,

AUTOMATED COMPLIANCE CHECKS

AI IN CYBERSECURITY IS PROJECTED TO REACH $46B BY 2027, REFLECTING ITS GROWING IMPACT ON MODERN SECURITY FRAMEWORKS

# TOOL-BASED AI INTEGRATION IN DEVSECOPS

## STATIC ANALYSIS - DEV PHASE

Pylint
CodeQL

## SECRETS DETECTION - CODE REVIEW PHASE

GitLeaks
TruffleHog

## DEPENDENCY SCANNING - BUILD PHASE

Safety,
Dependabot


## FUNCTIONAL TESTING - DEPLOYMENT PHASE

Postman
Healenium

## SECURITY TESTING - POST DEPLOYMENT

OWASP ZAP


## ANOMALY DETECTION - PRODUCTION PHASE

Loguru
AI Modles

# DEV PHASE

## Code Quality and Security Issues

- **PyLint,**
- **CodeQL**

**AI –** Enhancing analysis with AI

- Automated code improvements
- Context-aware vulnerability detection
- Adaptive code style enforcement

```
1 usage
def run_pylint():
    result = subprocess.run( args: ['pylint', 'flask_vulnerable_app.py'], capture_output=True, text=True)
    print("Pylint Output:\n", result.stdout)
    return result.stdout

1 usage
def run_codeql():
    subprocess.run(['codeql', 'database', 'create', 'flask-db', '--language=python', '--source-root=.'])
    result = subprocess.run( args: ['codeql', 'database', 'analyze', 'flask-db', 'python-code-scanning.qls',
                                    '--format=sarif-latest'], capture_output=True, text=True)
    print("CodeQL Output:\n", result.stdout)
    return result.stdout

2 usages
def extract_issues_with_line_numbers(output):...

1 usage
def use_codet5_for_fixes(issue_text):
    model_name = 'Salesforce/codet5-base'
    tokenizer = AutoTokenizer.from_pretrained(model_name)
    model = AutoModelForSeq2SeqLM.from_pretrained(model_name)

    inputs = tokenizer.encode(issue_text, return_tensors="pt")
    outputs = model.generate(inputs)
    return tokenizer.decode(outputs[0], skip_special_tokens=True)

if __name__ == '__main__':...
```

```
==== Pylint Analysis Report ====
Line 7: Constant name 'SECRET_KEY' doesn't conform to UPPER_CASE naming style.
Line 15: Command injection detected via os.popen.
==== End of Pylint Report ====

==== AI Suggested Fixes for Pylint Issues ====
Line 7: Replace 'SECRET_KEY = hardcoded_secret' with 'SECRET_KEY = os.getenv("SECRET_KEY")'
Line 15: Use 'subprocess.run(shlex.split(command), check=True)' instead of os.popen.
```

```
==== CodeQL Security Analysis Report ====
Line 22: SQL Injection vulnerability detected in raw query.
Line 30: Cross-site scripting (XSS) vulnerability in user input.
==== End of CodeQL Report ====

==== AI Suggested Fixes for CodeQL Issues ====
Line 22: Replace raw query with parameterized SQL query:
cursor.execute("SELECT * FROM users WHERE username=? AND password=?", (username, password))
Line 30: Use 'escape(name)' to sanitize user input in HTML rendering.
==== End of AI Fixes ====
```

# REVIEW PHASE

Hardcoded credentials, API keys, and sensitive data

**GitLeaks**

**TruffleHog**

**AI Integration:**

- Reducing false positives
- Smart remediation suggestions
- Continuous Improvement

```python
TARGET_REPO = "."

2 usages
def run_scan(tool, args):
    try:
        result = subprocess.run([tool] + args, capture_output=True, text=True, check=True)
        print(f"==== {tool} Report (Before AI) ====\n", result.stdout)
        return result.stdout
    except subprocess.CalledProcessError as e:
        print(f"Error running {tool}:", e)
        return ""

1 usage
def run_ai_suggestions(th_output, gl_output):
    print("\n==== AI Integration (After AI) ====")
    model = AutoModelForSeq2SeqLM.from_pretrained('Salesforce/codet5-base')
    tokenizer = AutoTokenizer.from_pretrained('Salesforce/codet5-base')
    inputs = tokenizer.encode(th_output + "\n" + gl_output, return_tensors="pt")
    suggestions = tokenizer.decode(model.generate(inputs, max_length=512)[0], skip_special_tokens=True)
    print("AI Suggested Fixes:\n", suggestions)

if __name__ == "__main__":
    th_output = run_scan( tool: "trufflehog",  args: ["filesystem", TARGET_REPO, "--json"])
    gl_output = run_scan( tool: "gitleaks",  args: ["detect", "--source", TARGET_REPO, "--verbose"])
    run_ai_suggestions(th_output, gl_output)
```

## TRUFFLEHOG

```
==== TruffleHog Report (Before AI) ====
{
  "path": "config.py",
  "stringsFound": [
    "aws_access_key = 'AKIA123456789EXAMPLE'",
    "password = 'mypassword123'"
  ]
}
```

```
==== AI Integration (After AI) ====
File: config.py, Line: 2
Issue: Hardcoded AWS access key detected.
AI Suggested Fix: Move the key to AWS Secrets
Manager and reference it via an environment variable.
```

## GITLEAKS

```
==== GitLeaks Report (Before AI) ====
{
  "file": "secrets.env",
  "line": 10,
  "match": "DB_PASSWORD=supersecret123",
  "rule": "Generic Credential"
}
```

```
==== AI Integration (After AI) ====
File: secrets.env, Line: 10
Issue: Hardcoded database password detected.
AI Suggested Fix: Use environment variables or a secure
secrets manager instead of storing credentials in plain text.
```

# BUILD PHASE

**Hidden vulnerabilities in third-party libraries**

- **Safety,**
- **Dependabot**

**AI Integration**

- Prioritization of vulnerabilities
- Intelligent remediation strategies

```python
# Step 1: Scan dependencies for vulnerabilities using Safety
def scan_dependencies():
    result = subprocess.run(["safety", "check", "--json"],
                            capture_output=True, text=True)
    return json.loads(result.stdout)

dependency_vulnerabilities = scan_dependencies()

# Step 2: Analyze code for deprecated function usage
def analyze_code_for_deprecations(file_path):
    with open(file_path, 'r') as file:
        tree = ast.parse(file.read())
        for node in ast.walk(tree):
            if isinstance(node, ast.Call) and hasattr(node.func, 'attr'):
                print(f"Potential deprecated function '{node.func.attr}'
                found in {file_path} at line {node.lineno}")

analyze_code_for_deprecations("example_code.py")
```

```python
# Step 3: Visualize dependency vulnerabilities using NetworkX
graph = nx.Graph()
for dep in dependency_vulnerabilities:
    graph.add_node(dep.get("package_name"))
    graph.add_edge(dep.get("package_name"), dep.get("cve") or "Unknown")

nx.draw(graph, with_labels=True, node_color="lightblue", edge_color="red")
plt.title("Dependency Vulnerability Graph")
plt.show()

# Step 4: AI-based risk prediction using PyTorch Geometric
class RiskModel(torch.nn.Module):
    def __init__(self):
        super().__init__()
        self.conv1, self.conv2 = GCNConv(3, 16), GCNConv(16, 1)

    def forward(self, x, edge_index):
        return self.conv2(self.conv1(x, edge_index).relu(), edge_index)

model = RiskModel()
x = torch.rand((len(dependency_vulnerabilities), 3))
edge_index = torch.tensor([[i, i+1] for i in range(len(dependency_vulnerabilities)-1)], dtype=torch.long).T
print("Predicted Risk Scores:", model(x, edge_index).detach().numpy())
```

```
43
44    # Step 5: Fetch real-time security advisories from GitHub
45    g = Github("your_github_token")
46    alerts = g.get_repo("owner/repository").get_vulnerability_alerts()
47    for alert in alerts:
48        print(f"Dependency: {alert.affected_package_name}, Severity: {alert.severity}")
49
```

## BEFORE AI (MANUAL PROCESS):

```
Dependency: numpy, CVE: CVE-2021-1234, Severity: High
Dependency: requests, CVE: CVE-2020-5678, Severity: Medium
Potential deprecated function 'old_function' found in example_code.py at line 12.
```

## AFTER AI (AUTOMATED PROCESS)

```
Dependency: numpy, CVE: CVE-2021-1234, Severity: High, Risk Score: 0.85
Recommended Action: Upgrade to numpy>=1.21.0
Impact Analysis: Deprecated functions detected in 'example_code.py'
Suggested Fix: Replace old_function with new_function.

Dependency: requests, CVE: CVE-2020-5678, Severity: Medium, Risk Score: 0.65
Recommended Action: Review API usage and apply patches.
Impact Analysis: No breaking changes detected.
```

# FUNCTIONAL TEST

Feature correctness & reliability
Early defect identification (APIs & UI)

Postman, Newman
Healenium

**AI Integration Benefits**

- Smart test prioritization
- Self-healing automation
- Actionable insights

```python
# Step 1: Setup WebDriver with Healenium for self-healing
options = webdriver.ChromeOptions()
options.add_argument("--headless")
driver = webdriver.Remote(command_executor="http://localhost:4444/wd/hub", options=options)

# Initialize Healenium for tracking changes
healenium = Healenium(driver)

def run_ui_test():
    driver.get("https://example.com/login")
    element = healenium.find_element_by_xpath("//input[@id='username']")
    element.send_keys("test_user")
    driver.find_element_by_xpath("//input[@id='password']").send_keys("securePass")
    driver.find_element_by_xpath("//button[@id='login']").click()
    assert "Dashboard" in driver.title
    print("UI Test Passed")

run_ui_test()
driver.quit()

# Step 2: API Testing with Postman-like functionality
def api_test():
    response = requests.get("https://jsonplaceholder.typicode.com/posts/1")
    assert response.status_code == 200
    assert response.json()['id'] == 1
    print("API Test Passed")

api_test()
```

# SECURITY TEST

Preventing vulnerabilities before production
Protecting sensitive data and compliance

OWASP ZAP, Nikto

**AI Integration Benefits**

Automated threat detection
Real-time vulnerability analysis
Smart remediation suggestions

```python
# Step 1: Run OWASP ZAP and Nikto Scans
def run_security_scans(target_url):
    subprocess.run(f"nikto -h {target_url} -output nikto_scan.json -Format json", shell=True)
    subprocess.run(f"zap-cli quick-scan {target_url}", shell=True)
    with open("nikto_scan.json") as f:
        nikto_results = json.load(f)
    return {"nikto": nikto_results, "zap": get_zap_results()}

# Step 2: Get ZAP Scan Results
def get_zap_results():
    return json.loads(subprocess.check_output(["zap-cli", "alerts", "-f", "json"]))

# Step 3: Prioritize Findings
def prioritize_findings(scan_results):
    clf = RandomForestClassifier().fit([[3, 50], [2, 40]], [1, 0])
    for tool, results in scan_results.items():
        for alert in results.get("alerts", []):
            alert['priority'] = 'High' if clf.predict([[alert['risk'],
             len(alert['url'])]])[0] else 'Low'
    return scan_results

# Step 4: Reduce False Positives
def filter_false_positives(scan_results):
    nlp_model = pipeline("text-classification", model="distilbert-base-uncased")
    for tool, results in scan_results.items():
        scan_results[tool]['alerts'] = [alert for alert in results.get("alerts", [])
           if nlp_model(alert["description"])[0]["label"] != "benign"]
    return scan_results

# Step 5: Suggest Fixes
def suggest_fixes(scan_results):…

# Step 6: Run Security Testing
def process_security_testing(target_url):…

if __name__ == "__main__":
    process_security_testing("http://srimaan.tech")
```

# BEFORE AI INTEGRATION

```
OWASP ZAP Security Alerts:
[
  {"name": "XSS", "url": "http://example.com/contact", "risk": "High"},
  {"name": "SQL Injection", "url": "http://example.com/login", "risk": "Medium"},
  {"name": "Missing Security Headers", "url": "http://example.com/home", "risk": "Low"}
]

Nikto Security Report:
- The web server is outdated.
- X-Content-Type-Options header is missing.
- Possible SQL Injection vulnerabilities detected.
```

# AFTER AI INTEGRATION:

```
AI-Powered Security Insights:

Predicted Risk Score: 0.92 (Critical)

Prioritized Vulnerabilities:
1. SQL Injection at http://example.com/login (Risk Score: 9.5/10)
   Suggested Fix: Use parameterized queries and input validation.

2. XSS at http://example.com/contact (Risk Score: 8.3/10)
   Suggested Fix: Implement proper input sanitization using a security library.

3. Missing Security Headers at http://example.com/home (Risk Score: 4.1/10)
   Suggested Fix: Add security headers like Content-Security-Policy and X-Frame-Options.

AI-Generated Remediation Plan:
"To fix the SQL Injection vulnerability, apply input validation and use prepared statement

Threat Prediction:
Potential RCE (Remote Code Execution) risks detected based on historical data.
```

# AI-POWERED LOG AND ANOMALY DETECTION

Detecting patterns and potential security threats
Reducing mean time to detect (MTTD) and mean time to respond (MTTR)

Loguru,
Elastic Stack,

**AI Integration Benefits**
**Predictive anomaly detection**
**Automated log pattern recognition**
**Real-time alerts and insights**

```python
# Step 1: Log Processing Stub
def process_logs(log_file):
    """
    Read and process log data from the given file.
    """
    pass  # Implement log reading and preprocessing logic

# Step 2: AI-Based Anomaly Detection Stub
def detect_anomalies(logs):
    """
    Use AI models to detect anomalies in log data.
    """
    pass  # Implement AI-based anomaly detection

# Step 3: Risk Prediction Stub
def predict_risk(anomalies):
    """
    Predict risk levels of identified anomalies using AI models.
    """
    pass  # Implement risk prediction logic

# Step 4: Smart Containment Stub
def smart_containment(anomalies):
    """
    Take containment actions based on risk assessment.
    """
    pass  # Implement actions such as blocking or monitoring

# Step 5: Execution Stub
def run_security_analysis(log_file):
    """
    Execute the full security analysis workflow.
    """
    pass  # Implement the execution flow combining all steps

if __name__ == "__main__":
    run_security_analysis("log_data.json")
```

## EHAMPLE LOGS (BEFORE AI):

```
[INFO]  2024-01-24 10:00:01  - User login attempt from IP 192.168.1.10
[WARNING]  2024-01-24 10:02:15  - Multiple failed login attempts detected
[ERROR]  2024-01-24 10:03:45  - Potential brute force attack detected
```

## EHAMPLE LOGS (AFTER AI):

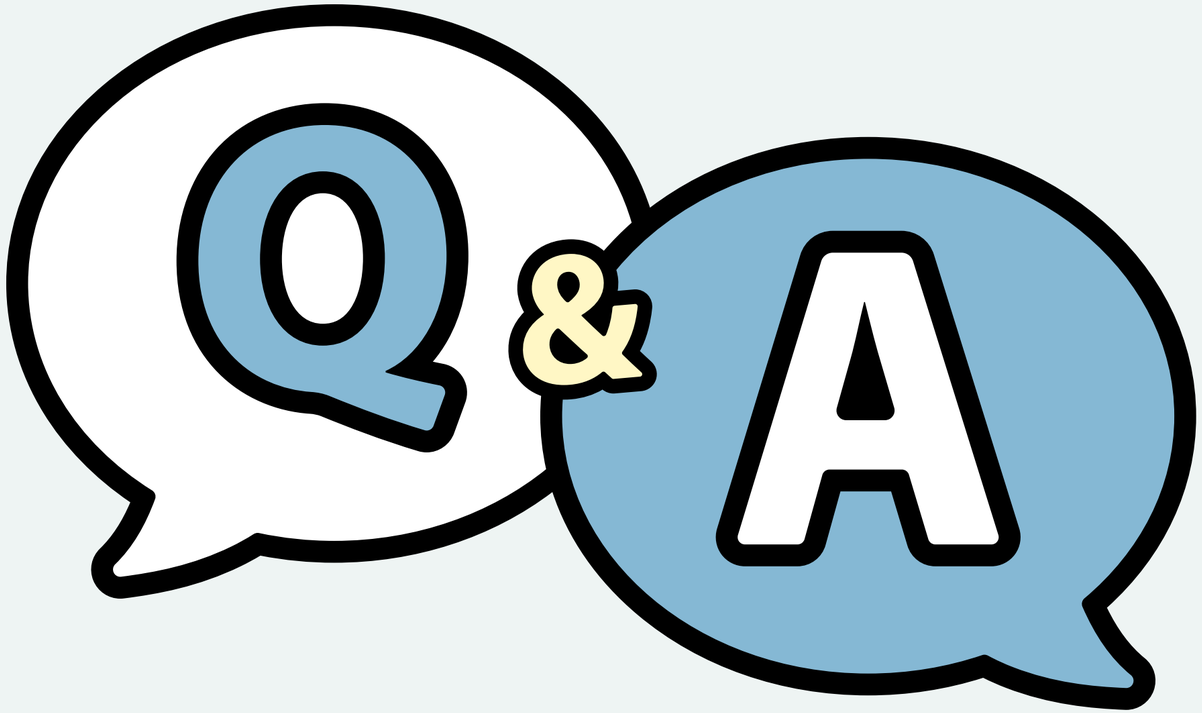
```
[ALERT] Brute Force Attack Detected on http://fakeecommerce.com/login
Risk Level: Critical (Score: 9.5/10)
Action Taken:
- IP 192.168.1.10 BLOCKED
- MFA enabled for affected accounts
- Session tokens revoked
Suggested Fix: Implement rate limiting and CAPTCHA
```

# BEST PRACTICES FOR AI-DRIVEN DEVSECOPS

- Start Small, Grow Smart
- Prioritize What Matters.
- Keep It Transparent.
- Always Improve
- Integrate Smoothly

# THE FUTURE OF AI IN DEVSECOPS

- AI enhances speed, accuracy, and efficiency.
- Provides proactive security and automation.
- Scales testing efforts without human bias.
- Enables smarter decision-making through insights.
- Continuous improvement with feedback loops.


Q&A