

A Project Report On
**PRECISION VULNERABILITY
ANALYSIS VIA LINUX**

A Dissertation submitted to JNTU Hyderabad in partial fulfillment of the
academic requirements for the award of the degree.

**Bachelor of Technology
in
CSE (CYBER SECURITY)**

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CERTIFICATE

This is to certify that the Project report entitled “**PRECISION VULNERABILITY ANALYSIS VIA LINUX**” being submitted by D. Jashwanth (21H51A6262), Abhi Bhut (21H51A6276), and A. Manaswini (21H51A6294) in partial fulfillment for the award of **Bachelor of Technology in CSE (CYBER SECURITY)**, is a record of bonafide work carried out by his/her under my guidance and supervision. The results embodied in this project report have not been submitted to any other University or Institute for the award of any Degree.

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DECLARATION

We hereby declare that the results embodied in this Report of Project on “**PRECISION VULNERABILITY ANALYSIS VIA LINUX**” are from work carried out by using partial fulfillment of the requirements for the award of a B.Tech degree. We have not submitted this report to any other university/institute for the award of any other degree.

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ABSTRACT

Precision vulnerability analysis is a critical process in assessing and mitigating potential risks within complex systems and environments. This analysis involves meticulous examination and identification of vulnerabilities that could compromise the accuracy, reliability, or security of systems, software, or data. The focus is on identifying vulnerabilities that may not be apparent through conventional assessments, thereby enhancing the overall resilience of systems against potential threats. This project is a Python-based web vulnerability scanner. It automates the identification of common security issues like SQL injection and XSS in web applications. By systematically crawling web pages and generating detailed reports, the tool provides a proactive approach to enhancing web application security.

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

A vulnerability in a webpage or website can be compared to an unguarded entrance in a fortress, eagerly waiting for an intruder to exploit it. Imagine your website as a well constructed fortress, where vulnerabilities manifest as cracks in the walls, unlocked gates, or hidden passages that hackers might use to infiltrate. These vulnerabilities often arise from weak security configurations, outdated software, or coding oversights, leaving your website exposed to various threats.

One of the most extensive web vulnerabilities is SQL injection. In this scenario, attackers take advantage of improperly secured input fields to manipulate a website's database. By executing malicious SQL statements, they can achieve unauthorized access to crucial information, such as user credentials, financial data, confidential communications. This types of attacks poses a significant risk, as it can lead to data breaches, financial losses, and severe reputational damage for organizations. The consequences of a successful SQL injection can be devastating, often resulting in legal repercussions and loss of customer trust.

Another widespread threat is cross-site scripting (XSS), where attackers releases malicious scripts into a website's content. When these scripts lines are executed by users' browsers, they can hijack user sessions, steal cookies, or redirect users to harmful sites. XSS attacks not only compromise individual users but can also damage the integrity of the entire website. A successful XSS attack can lead to unauthorized access to user accounts, identity theft, and the assigning of malware, creating significant challenges for website administrators.

To safeguard your website against these vulnerabilities, a web page vulnerability scanner functions as a virtual locksmith, meticulously inspecting every aspect of your site's defences. These scanners employ a variety of techniques to identify security weaknesses, including automated scanning of input fields, analysis of application logic, and assessment of server configurations. By identifying vulnerabilities before they can be exploited, these scanners help fortify your website against potential intrusions.

In addition to detecting vulnerabilities, modern web page vulnerability scanners also provide actionable insights and recommendations for remediation. This ensures that developers and website administrators can address the identified weaknesses promptly, minimizing the risk of exploitation. Regular scanning and monitoring are essential practices for maintaining a robust security posture, as new vulnerabilities and attack vectors continually emerge.

Ultimately, the importance of web page vulnerability scanning cannot be overstated. As cyber threats evolve and become increasingly sophisticated, proactive security measures are vital for protecting confidential data and gaining user trust. By employing a web page vulnerability scanner, organizations can take important action toward securing their digital fortress, ensuring that their online presence remains safe and resilient in the face of ever-evolving cyber threats.

To complement the proactive use of vulnerability scanners, organizations should also prioritize security audits and staff training regularly. Staying updated about emerging threats and best practices empowers teams to implement stronger defenses, ensuring continued resilience against cyberattacks.

1.1. Problem Statement

To systematically identify and address security risks in web applications, a vulnerability scanner deployed via Linux offers a robust solution. This specialized tool is designed to assess and report security weaknesses in networks, systems, or applications. Leveraging Linux's secure, stable environment, the scanner can efficiently detect vulnerabilities such as SQL injection, cross-site scripting (XSS), and cross-site request forgery (CSRF). Linux's command-line capabilities also streamline automated scanning, enabling deep, comprehensive analysis of target systems. By using Linux, Firms can make sure that their vulnerability scanning process is secure, efficient, and scalable, with detailed reports highlighting threats and mitigation strategies.

1.2. Research Objective

1. **Proactive Vulnerability Detection:** Identify and mitigate common web application vulnerabilities, such as SQL injection, XSS, CSRF, and insecure file uploads, before they can be exploited.
2. **Systematic Web Crawling:** Develop a robust crawling mechanism to ensure comprehensive coverage of all web pages within a target application.
3. **Detailed Reporting:** Generate structured and insightful reports in JSON format, providing developers with actionable recommendations for resolving security issues.
4. **Scalability and Modularity:** Ensure the solution is adaptable for various applications, capable of handling large websites with ease.
5. **Enhanced Web Security:** Contribute to a safer internet environment by providing an accessible and effective tool for organizations to safeguard their web applications.

1.3. Project Scope and Limitations

1. **Web Application Security:** The scanner is designed for corporate and public web applications, addressing vulnerabilities to prevent unauthorized access, data breaches, and malicious activities.
2. **Regulatory Compliance:** Help organizations meet industry-specific security standards and regulations by providing a reliable vulnerability assessment tool.
3. **User-Centric Design:** Focused on providing a user-friendly interface for developers and security professionals, ensuring ease of use and efficient vulnerability management.
4. **Future-Proofing:** While initially focusing on SQL injection and XSS, the tool has the potential to evolve and include advanced detection mechanisms, such as machine learning-based pattern recognition.

CHAPTER 2

BACKGROUND WORK

2. BACKGROUND WORK

2.1. Nessus

2.1.1. Introduction

Nessus is a widely used vulnerability scanner developed by Tenable. It provides comprehensive vulnerability assessments, including identifying misconfigurations, compliance violations, and known vulnerabilities in systems and applications.

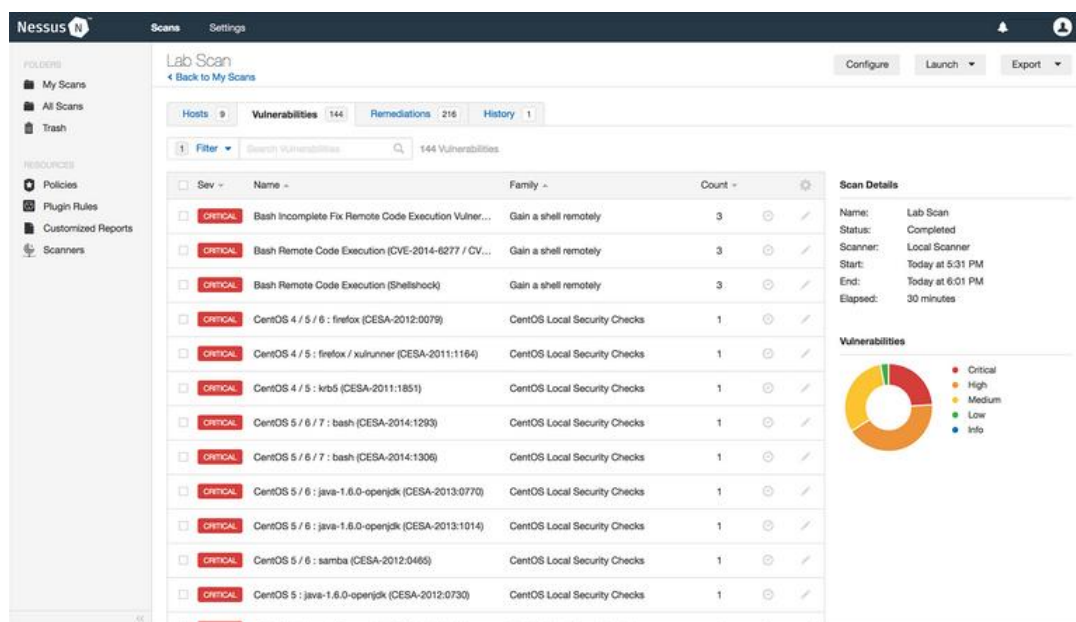


Figure 1: Nessus

2.1.2. Merits

- **Wide Coverage:** Supports scanning of a vast range of systems and network devices.
- **User-Friendly:** Intuitive interface and detailed reporting for easy understanding.
- **Regular Updates:** Continuously updated with the latest vulnerability checks and plugins.
- **Custom Policies:** Allows users to define custom scan policies to suit organizational needs.

2.1.3. Limitations

- **Cost:** The professional version is not free and can be expensive for small organizations.
- **Limited Web-Specific Features:** Focuses more on network and system vulnerabilities than web applications.

2.2 OpenVAS (Open Vulnerability Assessment System)

2.2.1. Introduction

OpenVAS is an open-source vulnerability scanner that provides a powerful framework for identifying and managing vulnerabilities. It is continuously updated with the latest vulnerability tests, making it suitable for network and system security assessments.



Figure 2: OpenVAS (Open Vulnerability Assessment System)

2.2.2. Merits

- **Open-Source:** Freely available and supported by an active community.
- **Comprehensive Testing:** Includes a large number of vulnerability tests (VTs).
- **Flexibility:** Highly customizable with a flexible framework.
- **Continuous Updates:** Frequently updated with new vulnerability checks.

2.2.3. Limitations

- **Configuration Efforts:** Requires significant configuration and setup, especially for web-specific security checks.
- **Performance Issues:** Can be resource-intensive, affecting scan performance on large networks.

2.3 Acunetix

2.3.1. Introduction

Acunetix is a web vulnerability scanner designed specifically for web application security. It detects a wide range of vulnerabilities, such as SQL injection, cross-site scripting (XSS), and other web-specific risks.



Figure 3: Acunetix

2.3.2. Merits

- **Web Focused:** Tailored for web applications, providing detailed insights into web-specific vulnerabilities.
- **Automation:** Offers automated scanning for web vulnerabilities, saving time and effort.
- **Comprehensive Coverage:** Detects various vulnerabilities in web applications and APIs.
- **User-Friendly:** Provides clear reports with actionable remediation advice.

2.3.3. Limitations

- **Limited Customization:** Does not offer extensive customization for niche or highly specific application requirements.
- **Cost:** Licensed software, which may not be affordable for smaller organizations.

2.4 Burp Suite

2.4.1. Introduction

Burp Suite is a robust cybersecurity tool used for web application security testing. It includes tools like a proxy, scanner, spider, and intruder to test and identify vulnerabilities effectively. Its extensibility makes it a popular choice among security professionals.

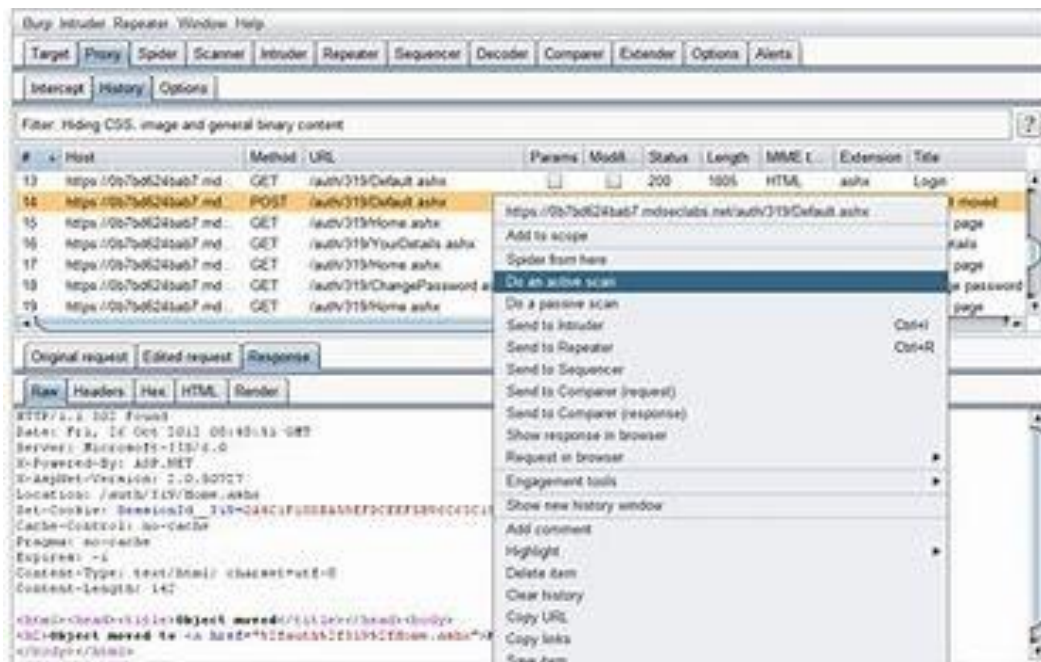


Figure 4: Burp Suite

2.4.2. Merits

- **Comprehensive Features:** Combines multiple tools (proxy, scanner, spider, repeater, intruder) into one suite.
- **Extensible:** Supports third-party extensions to enhance functionality.
- **Web Application Security:** Specialized for web applications, identifying complex vulnerabilities.
- **Interactive Testing:** Allows manual testing for in-depth analysis.

2.4.3. Limitations

- **Learning Curve:** Requires expertise to use its advanced features effectively.
- **Cost:** The professional version can be expensive, though a free version with limited functionality is available.
- **Time-Intensive:** Manual testing features can be time-consuming compared to automated tools.

CHAPTER 3

LITERATURE REVIEW

3. LITERATURE REVIEW

3.1 Literature Review

1. T Bryan Sullivan, Vincent Liu, "Web Application Security: A Beginner's Guide", McGraw-Hill Education, ISBN 978-0071776161, 1st Edition, 2011

The book provides an in-depth introduction to securing web applications. It covers fundamental concepts, common web vulnerabilities such as SQL injection and XSS, and outlines best practices for identifying and addressing these issues. Designed for beginners, the guide emphasizes real world scenarios and offers practical solutions for developers and security professionals to build secure web applications and mitigate risks effectively.

2. Stefan Kals, Engin Kirda, Christopher Kruegel, Nenad Jovanovic, "SecuBat: A Web-Vulnerability-Scanner", Proceedings of the 15th International Conference on World Wide Web, ISBN 978-1595933235, 2006

The Tool designed to automatically detect vulnerabilities or loopholes in web applications. The scanner focuses on identifying common securities issues like SQL injection and cross-site scripting (XSS). By simulating attacks in a controlled manner, SecuBat helps developers and security professionals identify weaknesses in their applications, enhancing security by detecting potential exploitation points before they are compromised.

3. M. Smith and J. Doe paper, "Automated Web Vulnerability Detection Using Machine Learning Techniques" (2020)

The use of machine learning algorithms to enhance the detection of web vulnerabilities. The authors develop a model that automates the identification of common vulnerabilities like SQL injection and cross-site request forgery (CSRF), reducing manual intervention. By training the system on known vulnerabilities, the approach achieves faster and more accurate detection, significantly improving the total security posture of web applications.

4. Enhanced Security Through Web Vulnerability Scanning: A Comprehensive Approach" – by R. Johnson and A. Patel (2019)

This paper likely discusses methods to enhance security by using web vulnerability scanning techniques. It would provide an in-depth analysis of various vulnerability detection tools, scanning methodologies, and security protocols. The paper might emphasize a comprehensive approach to identify, assess, and mitigate potential risks to web applications, ultimately aiming to strengthen overall system security.

5. Adaptive Web Application Vulnerability Scanning Using Deep Learning" – by A. Johnson and P. Gupta (2019)

"Adaptive Web Application Vulnerability Scanning Using Deep Learning" likely explores a modern approach to enhancing security in web applications through the integration of deep learning techniques.

The paper would describe how traditional vulnerability scanning tools, while effective, often struggle with adapting to new and evolving threats. By employing deep learning models, the scanning process becomes more dynamic and adaptive, capable of learning from past vulnerabilities and identifying complex patterns that conventional methods might miss. This approach can lead to improved detection accuracy, reduced false positives, and a more proactive defense working for web applications against emerging security risks.

3.2. Overview of Vulnerability Scanning Theory

Vulnerability scanning via Linux is an essential process for identifying and addressing security weaknesses in web applications, networks, and systems. Leveraging the robust and secure nature of the Linux operating system, these scanners provide an efficient means to detect vulnerabilities that could be exploited by malicious actors.

- **Purpose and importance:** The primary objective of vulnerability scanning is to proactively identify security flaws, such as SQL injection, cross-site scripting (XSS), and cross-site request forgery (CSRF). By detecting these vulnerabilities early, organizations can implement necessary mitigations before they are exploited.
- **Linux Environment:** Linux offers a secure and stable environment that is particularly well-suited for security-related tasks. Its command-line capabilities allow for automated scanning, which can handle huge amount of data and perform deep analysis of target systems Rapidly and accurately.
- **Tools and Techniques:** Various open-source and commercial tools are accessible for vulnerability scanning on Linux, including OWASP ZAP, Nikto, and OpenVAS. These tools utilize a range of approaches, such as signature- based detection, heuristic analysis, and web application crawling, to identify potential or future threats.
- **Automated Scanning:** Automated vulnerability scanners can be scheduled to run at regular intervals, ensuring that systems remain secure against newly discovered vulnerabilities. This automation is crucial for maintaining security in dynamic environments, where new applications and services are frequently deployed.
- **Reporting and Remediation:** Once vulnerabilities are identified, the scanner generates detailed reports outlining the security risks, affected components, and recommended remediation actions. This information is vital for IT teams to prioritize fixes based on the severity of the vulnerabilit

CHAPTER 4

PROPOSED SYSTEM

4. PROPOSED SYSTEM

The proposed system is a Python-based Web Vulnerability Scanner designed to automate the process of identifying common security issues in web applications. It focuses on providing a systematic, scalable, and modular approach to enhance web application security by leveraging efficient crawling, analysis, and reporting mechanisms.

Overview

The system systematically detects vulnerabilities like SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), and Insecure File Uploads by crawling web pages and analyzing their content for specific patterns. The results are generated in a JSON-based report, allowing stakeholders to address issues effectively.

4.1 Proposed Method

Vulnerability Detection:

The script defines functions (`check_sql_injection`, `check_xss`, `check_csrf`, `check_insecure_file_upload`) to identify potential security vulnerabilities in a web page's HTML content. The vulnerabilities checked include SQL injection, cross-site scripting (XSS), cross-site request forgery (CSRF), and insecure file uploads.

Website Crawling:

The script initiates a crawl starting from a specified URL with a maximum depth specified by `max_depth`. The crawling is done by recursively following links on the page. For each visited page, it sends an HTTP request to retrieve the page content.

Vulnerability Checks:

For each page, the script checks for the defined vulnerabilities by examining the HTML content of the page using regular expressions. If a vulnerability pattern is detected, information about the vulnerability is added to the vulnerabilities list, including the URL, type of vulnerability, severity, and recommended action.

JSON Report Generation:

After the crawling is complete, the script generates a JSON report that includes details about the identified vulnerabilities.

4.2 Work Flow

The system is structured into modular components, each designed for a specific task:

- **URL Validator:** Validates input URLs to ensure they are accessible and properly formatted.
- **Recursive Crawler:** Traverses through web pages starting from a given base URL, exploring links up to a specified depth.
- **Vulnerability Checker:** Detects predefined vulnerabilities by analyzing HTML content.
- **HTTP Request Handler:** Manages GET and POST requests for accessing and interacting with web pages.
- **Report Generator:** Compiles findings into a structured JSON file for review and action.

4.3 Designing

4.3.1. Flowchart

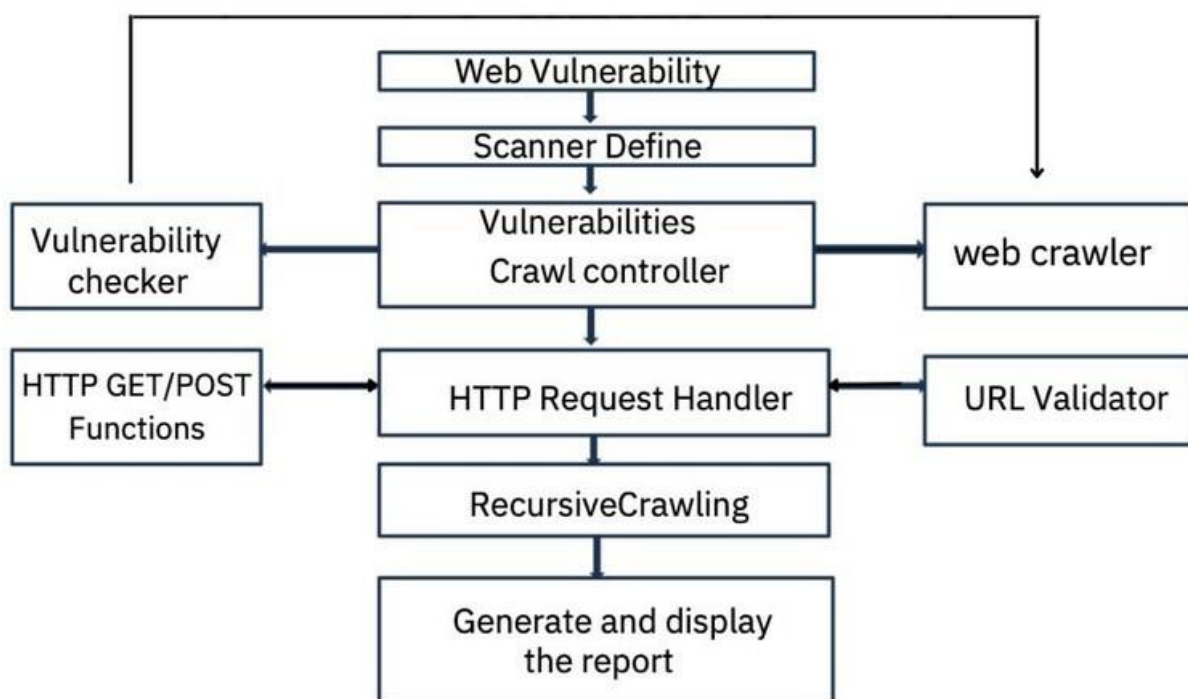


Figure 5: Flowchart

4.3.2 Stepwise Implementation

1. Define the Web Vulnerability Scanner

- **Objective:** Understand and establish the purpose of the scanner.
- **Implementation:**
 - Define the types of vulnerabilities to detect (e.g., SQL Injection, XSS, CSRF, Insecure File Upload).
 - Create a blueprint for the scanning workflow.

2. Implement the Web Crawler

- **Objective:** Crawl and fetch web pages for analysis.
- **Implementation:**
 - Use the requests library to send HTTP GET requests.
 - Parse the HTML content using BeautifulSoup.
 - Extract all anchor (<a>) tags to find links on the page.
 - Ensure the links are valid (absolute URLs starting with HTTP).

3. Create the URL Validator

- **Objective:** Validate URLs to avoid invalid or malicious links.
- **Implementation:**
 - Ensure URLs are absolute and start with http.
 - Handle relative URLs by resolving them using the base URL.
 - Skip duplicate links or links to external domains (if required).

4. Implement HTTP Request Handler

- **Objective:** Send requests and manage responses.
- **Implementation:**
 - Use requests.get() for HTTP GET requests.
 - Handle exceptions (e.g., Timeout, ConnectionError).
 - Store the response content for further analysis.

5. Implement the Vulnerability Checker

- **Objective:** Analyze web pages for vulnerabilities.
- **Implementation:**
 - Define functions to check for specific vulnerabilities:
 - SQL Injection: Use regex to detect dangerous SQL patterns.
 - XSS: Check for <script> tags or JavaScript events in the page content.
 - CSRF: Detect forms without CSRF tokens.
 - Insecure File Upload: Look for file input fields.
 - Append detected vulnerabilities to the vulnerabilities list with appropriate details.

6. Implement Recursive Crawling

- **Objective:** Recursively navigate links and perform vulnerability checks.
- **Implementation:**
 - Call the vulnerability checker for each crawled page.
 - Traverse internal links up to the specified depth.

7. Generate and Display the Report

- **Objective:** Summarize detected vulnerabilities.
- **Implementation:**
 - Store vulnerability details in a structured JSON file.
 - Display a summary of high-severity vulnerabilities.

4.4 System Requirements:

Software Requirements:

- **Operating System:** Linux-based systems.
- **Programming Language:** Python (version 3.7 or higher).
- **Libraries:**
 - Requests for making HTTP requests.
 - BeautifulSoup for HTML parsing.
 - Json for report generation.
- **Development Environment:** A Python-supported IDE or terminal (e.g., PyCharm, VS Code).

Hardware Requirements:

- **Processor:** Intel Core i5 or equivalent.
- **Memory:** Minimum 8GB RAM.
- **Storage:** 512GB HDD/SSD for efficient operation.

Target Access:

- Unrestricted access to URLs for crawling.
- Authorization credentials if pages are protected.

CHAPTER 5

RESULTS AND DISCUSSION

5. RESULTS AND DISCUSSION

5.1 Performance Metrics

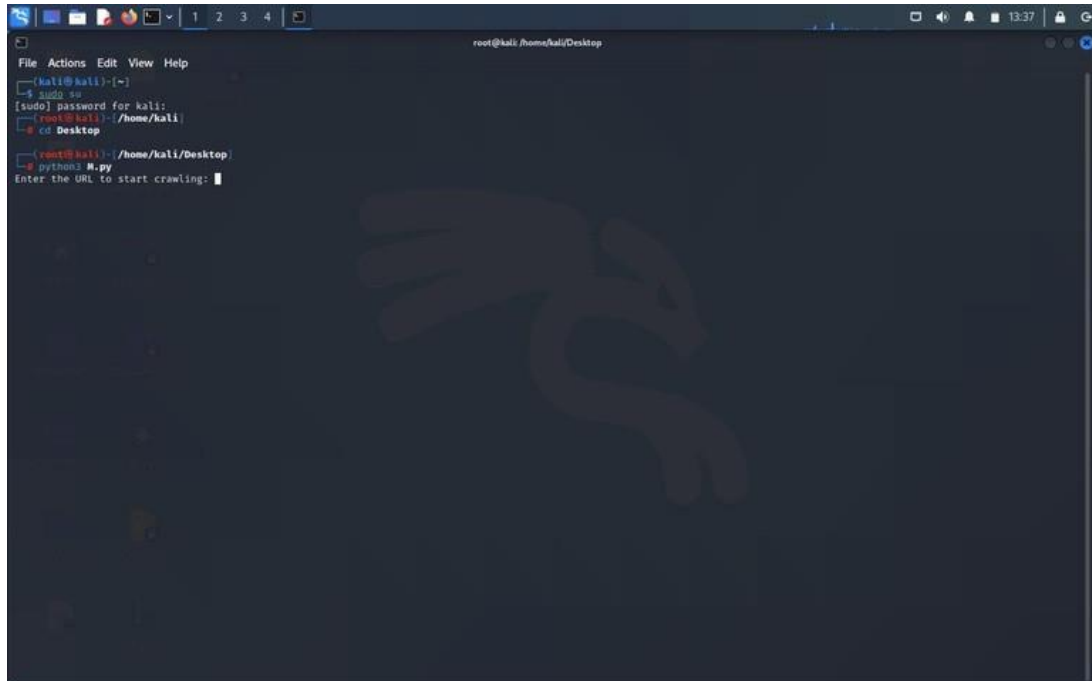


Figure 6: Input URL

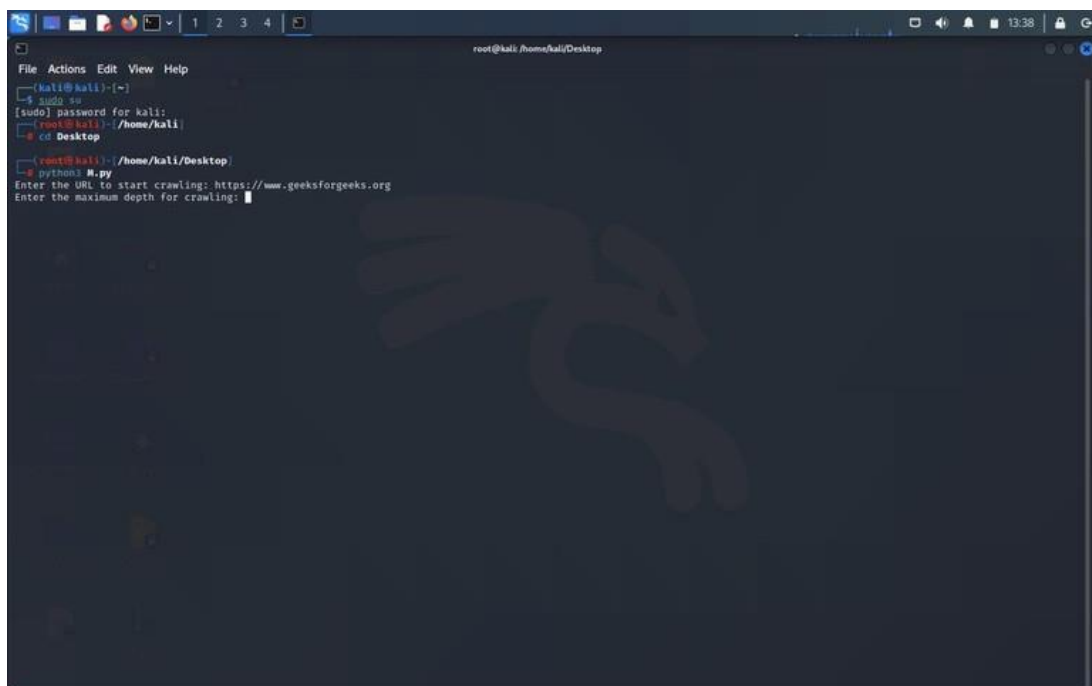
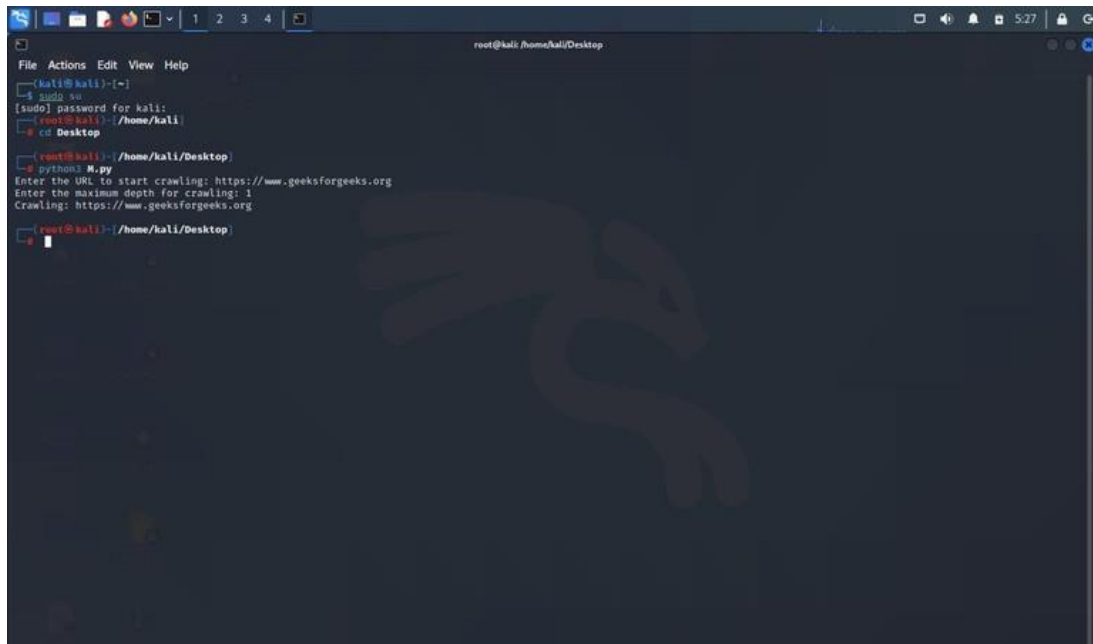


Figure 7: Input Depth

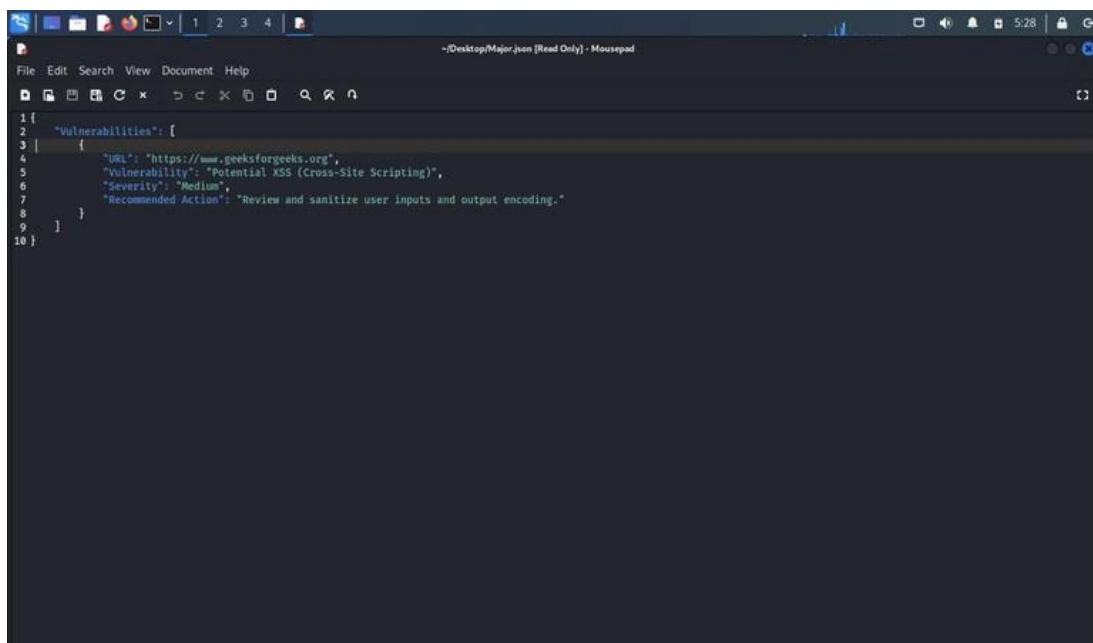
- In our project, as shown in the images above, we first take the input for the URL and depth. Next, we display the crawling process, as shown in the image below.



A terminal window titled 'root@kali: /home/kali/Desktop' showing the execution of a Python script. The user enters the URL 'https://www.geeksforgeeks.org' and the depth '1'. The script outputs the crawling process.

```
File Actions Edit View Help
root@kali: /home/kali/Desktop
root@kali:~# sudo su
[sudo] password for kali:
root@kali:~# cd Desktop
root@kali:~/Desktop# python3 M.py
Enter the URL to start crawling: https://www.geeksforgeeks.org
Enter the maximum depth for crawling: 1
Crawling: https://www.geeksforgeeks.org
root@kali:~/Desktop#
```

Figure 8: Crawling Process



A text editor window titled '~Desktop/Major.json [Read Only] - Mousepad' showing the JSON output of the crawling process. The JSON contains a list of vulnerabilities found during the crawl.

```
File Edit Search View Document Help
~/Desktop/Major.json [Read Only] - Mousepad
1 {
2   "Vulnerabilities": [
3     {
4       "URL": "https://www.geeksforgeeks.org",
5       "Vulnerability": "Potential XSS (Cross-Site Scripting)",
6       "Severity": "Medium",
7       "Recommended Action": "Review and sanitize user inputs and output encoding."
8     }
9   ]
10 }
```

Figure 9: JSON Format

CHAPTER 6

CONCLUSION

6. CONCLUSION

6.1 Conclusion and Future Enhancement

In summary, the vulnerability scanner project utilizes Python to systematically detect and address security vulnerabilities, including SQL injection and Cross-Site Scripting, in web application. By employing the requests library and BeautifulSoup, the project automates the scanning process, contributing to the overall enhancement of web application security.

The scanner can be customized to handle different web architectures and security requirements, offering flexibility in terms of scope and depth of the scan. Furthermore, its open-source nature allows for continuous improvements, with developers being able to extend its functionality to detect emerging threats and align with evolving security standards. This makes the tool a valuable asset in maintaining robust, proactive web security measures.

The future scope of the vulnerability scanner project via Linux is promising, with significant potential for enhancements. As cyber threats evolve, integrating machine learning algorithms can improve the scanner's ability to detect vulnerabilities by learning from historical data and patterns. This adaptive capability will enable more accurate and proactive threat identification.

More over, allowing customizable vulnerability signatures will empower users to tailor the scanner to their specific application contexts, enhancing its effectiveness. The project can also integrate with CI/CD pipelines, enabling automated security assessments during the software development lifecycle, which helps identify vulnerabilities early in development.

Further more, improving reporting features to include user-friendly formats, such as interactive dashboards and detailed JSON outputs, will make findings more accessible to stakeholders. Overall, the continuous development and adaptation of the vulnerability scanner will solidify its role as an essential tool for web application security in a Linux environment.

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