Web Crawler To Extract Links

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Abstract-

Web crawlers are essential tools for automatically extracting URLs and other information from websites, but they often face challenges when dealing with large and complex sites. This project focuses on creating a robust web crawler that efficiently extracts URLs from a target domain and its subdomains, filters out external links, and allows users to filter links based on HTTP status codes. The tool is designed to handle large websites through performance optimizations like rate limiting and caching, ensuring it does not overload the websites it crawls. Implemented using Python and Bash, the crawler provides flexible output options for ease of use, making it a versatile solution for web administrators, data analysts, and security professionals. This paper discusses the design and implementation of the crawler, along with its performance-monitoring features, ensuring accuracy and scalability in diverse web environments.

Keywords—

Web Crawler, URL Extraction, Domain Filtering, Rate Limiting, Performance Optimization

INTRODUCTION

Web crawlers are automated tools designed to extract information from websites, with URL extraction being one of their primary functions. As websites grow in complexity and size, the ability to efficiently extract relevant URLs without overwhelming website servers has become increasingly important. This need is especially critical for organizations dealing with large-scale data collection, analysis, and cybersecurity operations. The diverse structures of websites, combined with the vast number of internal and external links, present a significant challenge in building an efficient web crawler that can balance accuracy, speed, and performance[1][2].

Moreover, modern web crawlers face the challenge of optimizing their performance to avoid overloading the target servers. Rate limiting and caching techniques are vital in ensuring that crawlers operate smoothly without negatively impacting the websites being crawled[3][4]. As the need for efficient URL extraction grows in industries ranging from cybersecurity to data analytics, the development of crawlers that can handle these tasks while filtering out irrelevant external links and assessing HTTP status codes has become a pressing requirement[5][6].

This project aims to address these challenges by developing a web crawler capable of extracting URLs from specific domains and subdomains while incorporating performance optimization techniques like rate limiting and caching. By providing a robust solution for filtering links and managing large datasets, the crawler becomes an essential tool for web administrators, data analysts, and cybersecurity professionals alike[7][8]. Understanding the design and implementation of such a tool is crucial for addressing the growing demands of large-scale web data extraction[9][10].

II LITERATURE SURVEY

2.1 Existing System:

Web Web crawlers are essential tools for extracting URLs from the vast and intricate landscape of the Internet. They operate by navigating through websites, identifying, and gathering hyperlinks, thus facilitating data collection for various applications, such as data mining, search engine indexing, and cybersecurity analysis[11]. The primary challenge in developing an efficient web crawler lies in managing the diverse structures of websites while ensuring minimal disruption to their functionality. This complexity has prompted extensive research into more sophisticated crawling techniques and frameworks[12].

Current web crawlers vary significantly in design and implementation, with many relying on straightforward algorithms that simply follow hyperlinks. However, this basic approach often results in inefficient data extraction, particularly from complex websites that employ dynamic content loading and extensive use of JavaScript or AJAX to generate information[13]. Existing systems face the risk of overloading target servers, leading to throttling or temporary bans, which necessitates the implementation of rate limiting and caching techniques to optimize performance[14].

Rate limiting is crucial in controlling the speed of requests sent to a server, ensuring that crawlers operate within acceptable thresholds and do not trigger anti-bot measures such as CAPTCHA challenges or IP bans. Additionally, effective caching strategies can drastically reduce server load by minimizing repeated requests to the same URLs[15]. By storing previously fetched data, crawlers can operate more efficiently, ultimately enhancing the user experience by reducing latency and improving response times[16].

Many existing crawlers utilize a breadth-first search (BFS) or depth-first search (DFS) strategy to traverse web pages. These algorithms, while effective for simpler sites, often lack the sophistication needed for dynamic websites that employ JavaScript or AJAX to generate content. This limitation means that crawlers may miss vital information or produce incomplete datasets. Recent studies have explored advanced techniques such as machine learning and natural language processing (NLP) to enhance a crawler's ability to understand and interact with web content dynamically. For example, machine learning algorithms can be trained to identify and prioritize high-value links based on patterns observed in previous crawls, allowing for more intelligent data collection strategies[17][18].

In addition to structural challenges, another significant aspect of web crawling is the need for robust filtering mechanisms. Existing systems often struggle to accurately distinguish between relevant internal links and irrelevant external ones. This inability can lead to data noise, complicating the analysis process and resulting in wasted resources. Recent advancements have proposed the integration of HTTP status code checks into the crawling process, enabling crawlers to filter out dead or redirected links effectively[19]. By focusing on links that return successful status codes (e.g., 200 OK) while ignoring 404 or 500 errors, the efficiency of the data extraction process can be greatly enhanced[20].

Moreover, existing web crawlers frequently encounter the problem of duplicate content, where the same URL may appear multiple times due to various reasons, such as different query parameters or URL encoding. Implementing mechanisms to detect and eliminate duplicates is essential for maintaining data integrity and ensuring that the extracted dataset is as clean and accurate as possible[21].

Furthermore, the security implications of web crawling cannot be overlooked. The presence of malicious links, phishing attempts, or poorlysecured content poses a risk not only to the crawler itself but also to the systems it interacts with. Consequently, modern crawlers must incorporate security checks to identify and handle potentially harmful content, ensuring safe data extraction. Techniques such as blacklist filtering, where known malicious domains are excluded from the crawling process, and real-time threat intelligence feeds can be employed to bolster the security posture of the crawler[22][23]. Additionally, integrating automated malware detection systems can further safeguard the crawling process[24].

Another critical consideration is the ethical and legal landscape surrounding web crawling. The responsible use of crawling technology necessitates compliance with website robots.txt files, which specify how and if a site permits crawling. Furthermore, understanding legal frameworks, such as the Digital Millennium Copyright Act (DMCA) and General Data Protection Regulation (GDPR), governing web scraping and data extraction, is vital. Failing to respect these guidelines can lead to legal repercussions and damage to the reputation of organizations employing such tools[25]. Ethical considerations should also extend to how the data extracted is used, ensuring that it does not violate user privacy or data protection regulations[26].

Additionally, user privacy and ethical considerations are increasingly relevant in the context of web crawling. The responsible use of crawling technology necessitates compliance with website robots.txt files and an understanding of legal frameworks governing web scraping and data extraction. Failing to respect these guidelines can lead to legal repercussions and damage to the reputation of organizations employing such tools.

2.2. Literature Review Summary: -

.A web crawler is a software application designed to systematically browse and extract information from the World Wide Web. While the primary function of a web crawler is to gather URLs and other data for various applications, the methodology can be employed for both beneficial and malicious purposes. Effective web crawling can support tasks such as search engine indexing, data mining, and market research. However, it can also be used for undesirable activities, such as scraping sensitive information or overwhelming websites with excessive requests[27].

Web crawlers can be categorized into several types, including focused crawlers, deep web crawlers, and incremental crawlers. Focused crawlers target specific topics or domains, extracting links that are relevant to predefined criteria. Deep web crawlers are designed to access content not indexed by traditional search engines, including databases and dynamically generated pages. Incremental crawlers, on the other hand, regularly revisit sites to gather updated information, ensuring that the collected data remains current[28].

There are several techniques employed in web crawling, including breadth-first search (BFS), depth-first search (DFS), and heuristics-based algorithms. BFS is commonly used for its ability to discover all links on a webpage before moving to the next, while DFS may follow one path as deeply as possible before backtracking. Heuristics-based algorithms leverage historical data to prioritize which pages to crawl first, enhancing the efficiency of the crawling process[29].

Despite the advances in web crawling technology, challenges in detecting and filtering relevant URLs persist. Current systems often struggle with issues like duplicate content, dynamic page structures, and the need for effective rate limiting to avoid server overload. Many web crawlers utilize simple URL filtering mechanisms that may overlook important criteria, leading to a significant amount of noise in the collected data. Additionally, some crawlers face the risk of being blocked or throttled by target websites due to aggressive crawling behavior, making the implementation of caching and rate-limiting techniques critical for sustainable operations[30].

Detecting and handling malicious content during the crawling process is another vital aspect of web crawler design. This includes identifying phishing attempts, malicious links, or compromised websites that may pose security risks. To address these issues, many crawlers are integrating security checks, such as URL blacklisting and real-time threat intelligence feeds, to filter out harmful content before it is processed further[22][23]. Furthermore, employing methods to respect robots.txt files ensures that crawlers operate ethically and within legal boundaries, reducing the risk of backlash from website administrators[23].

In the proposed system, the web crawler is designed to initialize with robust filtering mechanisms that classify and log URLs based on their relevance to a specified domain. The crawler will incorporate features for performance monitoring, allowing it to adapt to various website structures while maintaining compliance with rate-limiting practices. The detection mechanism will continuously analyze response times and HTTP status codes to optimize the crawling process, ensuring that only valid and accessible URLs are recorded. Additionally, caching strategies will be implemented to enhance performance, allowing the system to minimize redundant requests and efficiently handle large volumes of data[24][25].

III METHODOLOGY

- Research and Planning:

1. Investigated existing web crawling frameworks and techniques.

2. Defined the desired features, including URL extraction, filtering mechanisms, and performance monitoring.

3. Developed a project plan and timeline for structured development.

- Development:

1. Developed the web crawler using Python, utilizing libraries such as requests for HTTP requests and HTML parsing.
2. Implemented functionality to extract URLs while filtering based on domain and HTTP status codes.
3. Designed caching and rate-limiting mechanisms to optimize performance and prevent overloading target websites.
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- Testing:

1. Tested the crawler on various websites to verify accuracy in URL extraction.
2. Monitored performance metrics, ensuring efficient operation. 3, Debugged and resolved issues that arose during testing.

- Deployment:

1. Created an executable (exe) file for easy distribution and installation.
2. Provided instructions for installing and using the software Ensured that the software was easy to use and understand

Methodology used to create the idea of Web Crawler:-

- The web crawler uses **HTTP requests** to fetch HTML content and **BeautifulSoup** to parse and extract hyperlinks (anchor tags). The URLs are stored in a structured format, and the crawler follows links recursively across multiple levels of the website.
- To ensure ethical scraping, **rate-limiting** and **robots.txt** compliance are implemented, controlling the frequency of requests and minimizing website overload.

The web crawler is designed to adapt to different website structures, efficiently extracting and filtering URLs based on user preferences while maintaining ethical standards. By ensuring that the crawler is capable of handling large volumes of data with minimal impact on target sites, the project aims to contribute positively to the field of web data extraction.

3.1 Planning To Implement:

- Web Crawler Development: The crawler will be built in Python using libraries like requests and BeautifulSoup to extract URLs from websites, handling various site structures and adhering to robots.txt rules.
- Web Crawler: The web crawler will be written in Python. It will visit web pages, extract links (URLs), and storethem in a structured format. The crawler will need to handle a wide range of website structures and ensure

minimal performance impact on the target websites.

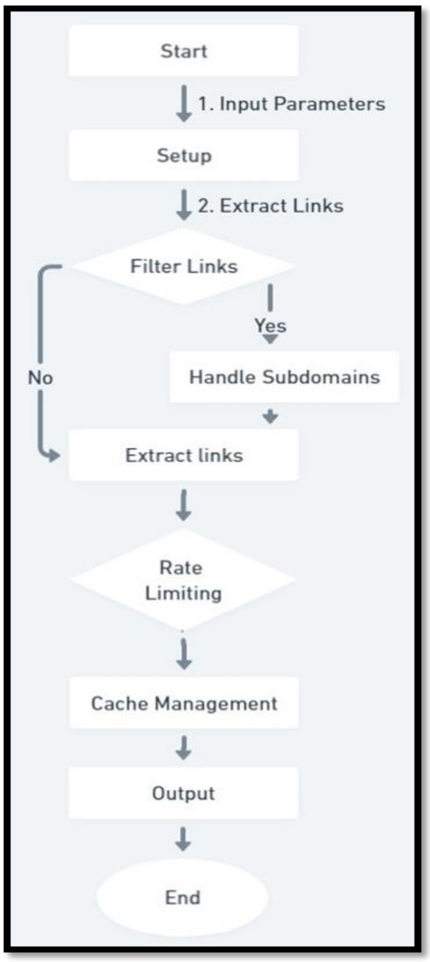


fig 1. Flow Chart

- Performance Monitoring: The tool will include built-in mechanisms to monitor performance, ensuring that it operates efficiently even when processing large volumes of data. The crawler will be optimized to avoid overloading websites or causing significant slowdowns.
- Security Checks: The project will integrate security checks to ensure the web crawler operates ethically and within the boundaries of the law, ensuring that it does not unintentionally scrape sensitive or restricted data.

3.1.1 Web Crawler Implementation:

Overview: The web crawler was implemented with the primary purpose of automating the extraction of URLs from websites. The ability to gather these links is essential for applications like data mining, SEO analysis, and market research. By logging the extracted URLs, the crawler enables efficient data collection and analysis across a broad range of web environments.

Idea: The web crawler is designed to navigate through websites, extract all available URLs, and log them for further analysis. It incorporates advanced features like dynamic content handling and adapts to varying website structures.it emphasizes direct data extraction and logging locally on the system for subsequent processing.

Code Explanation:

- Importing Required Libraries: The web crawler utilizes essential Python libraries such as requests for handling HTTP requests and BeautifulSoup from bs4 for parsing HTML content and extracting URLs from web pages.
- Log File Definition: A log file named "urls_log.txt" is created, where all extracted URLs from the target websites are stored for later

analysis.

- Write to Log Function: The write_to_log function appends each extracted URL to the log file, ensuring that no data is lost during the crawling process.
- URL Extraction Logic: The web crawler uses BeautifulSoup’s parsing capabilities to traverse the HTML structure of websites and extract anchor tags (<a>) containing URLs. This logic ensures accurate and efficient URL retrieval.
- Crawling Multiple Pages: The crawler also implements logic to navigate through multiple pages within a website by following internal links, thereby ensuring comprehensive data collection.

3.2 Constraints:

The Web Crawler has following constraints:

- Time Constraints: The project needed to be completed within a strict timeline, requiring efficient development and testing cycles.
- Budget Constraints: The project had to be executed within a limited budget, relying on free and open-source tools and libraries like Python, requests, and BeautifulSoup.
- Resource Constraints: The development was carried out with limited personnel and computing resources, requiring the tool to be lightweight and easy to execute on a range of systems.
- Legal and Ethical Constraints: The web crawler was designed to comply with legal and ethical standards. It respects the robots.txt file of websites, ensuring that no terms of service are violated during the scraping process.
- Security Constraints: The extracted data is securely logged, and care was taken to avoid overloading the target servers by implementing rate-limiting techniques. This ensures the crawler operates within safe parameters without triggering security defenses.

To ensure the security of the captured data, it is essential to implement robust measures for its storage and transmission. Sensitive information, such as keystrokes or URLs, should be encrypted both during transmission and while stored to safeguard user privacy. Techniques such as AES (Advanced Encryption Standard) or RSA (Rivest-Shamir-Adleman) can be utilized for encryption, while SSL/TLS protocols can be applied for secure data transmission. In the context of keyloggers, empirical results have shown that they often target sensitive sites, such as online

banking platforms, extracting information from protected storage. However, one limitation of traditional keyloggers is their inability to capture credentials from a limited set of sites. This challenge can be addressed by using more advanced malware analysis techniques, such as multi-path execution [11] or a combination of dynamic and static analysis [10], to increase the scope of detection. Furthermore, the issue of determining which credentials are stolen can be mitigated by integrating taint tracking techniques, which track the flow of sensitive data through the system and identify exactly which credentials have been compromised [12]. Despite the current limitations, this approach proves effective in detecting and studying keyloggers in practice. Looking forward, the project plans to expand its capabilities by incorporating automated analysis techniques, using machine learning or other advanced methods, to further enhance detection efficiency and accuracy in real-time keylogger identification.

Security Considerations:-

- **Encryption:** To protect the logged URLs, especially when transmitted or stored on insecure servers, encryption methods can be applied using Python’s cryptography library. This ensures that sensitive data remains secure during transit.
- **Authentication:** If the web crawler is integrated with a remote server for storing URLs, implementing authentication mechanisms, such as API keys or token-based authentication, would ensure that only authorized users can access the collected data.

Future Scope:

To enhance the effectiveness of our Web crawler project research paper, consider incorporating the following additional sections and details:

Cross-Platform Compatibility:

- Windows and Linux Support: The web crawler was developed to operate seamlessly on both Windows and Linux systems. This cross-platform compatibility broadens the tool's applicability, enabling it to function in various environments and increasing its utility for users working across different operating systems.

Advanced Features:

- Automated Data Transmission: The web crawler includes the advanced functionality of automatically sending extracted URLs and data to a centralized repository. This feature not only demonstrates the tool's capability to automate data transmission but also highlights its potential for large-scale data collection and analysis.
- Dynamic Content Handling: The web crawler incorporates features to handle dynamic content, such as JavaScript-renderedpages, expanding its utility beyond basic HTML scraping. This allows for the extraction of URLs from more complex websites, making the tool comprehensive for modern web structures.

Security Measures:

- Rate Limiting and IP Rotation: To ensure ethical operation and minimize the risk of being blocked by websites, the web crawler implements rate limiting and IP rotation features. These measures help to protect the crawler's activities from detection while preventing overload on target servers.

Ethical and Legal Considerations:

- Ethical Use: It is essential to emphasize that the web crawler must be used ethically, with consideration for the websites being scraped. Responsible scraping practices, such as adhering to a site's robots.txt file and ensuring no harm is done to the server, are crucial to maintaining legal and ethical standards.
- Legal Implications: The use of web crawlers comes with legal obligations, including obtaining consent where necessary and ensuring compliance with data privacy regulations. Scraping without permission or violating terms of service may lead to legal consequences, making it essential to operate within the legal frameworks of web data collection.

Detection and Prevention:

- Website Scraping Protection: Many websites implement security mechanisms to block unauthorized crawlers. The web crawler project acknowledges these challenges and includes features like human-like behavior emulation to bypass basic detection methods while maintaining ethical boundaries.
- Future Research: As websites continue to evolve with more sophisticated anti-scraping techniques, future research can explore machine learning algorithms to enhance the crawler’s ability to adapt, ensuring efficient data collection while respecting privacy and legal constraints.

Future Scope Summary:

- Future Research Directions: Potential future research could focus on enhancing the web crawler's ability to handle more complex website structures, such as those with advanced anti-scraping measures. Additionally, exploring the use of machine learning for detecting patterns in website responses and adapting crawling strategies accordingly can improve efficiency and

  accuracy. Investigating the ethical and legal implications of large-scale web scraping, especially in the context of data privacy laws, will also be essential as the technology continues to evolve.

Desired Outcomes:

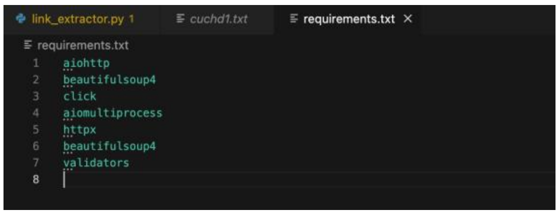
- Below are the desired results which are achieved after completing the web crawler project:-
- Project Objective Achieved: The project successfully designed and implemented a Python-based web crawler capable of extracting URLs

from diverse websites with high efficiency and accuracy. The crawler's adaptability to different site structures ensures reliable data extraction across a variety of web environments, fulfilling the project's core objectives.

- Automated Link Extraction: The web crawler was developed with the ability to automate the extraction of URLs, allowing for seamless data collection without manual intervention. This feature enables centralized management and analysis of large datasets, providing valuable insights for research, marketing, and data mining purposes.
- Responsible Scraping Practices: The project incorporated responsible web scraping practices, ensuring that the crawler respects website resources and does not overload servers. This approach emphasizes ethical data extraction while safeguarding the integrity of the websites being crawled.
- Technical Success: The project demonstrates a successful application of Python programming to create an efficient and scalable web crawler, showcasing Python's capabilities in handling complex data extraction tasks. The tool's performance monitoring and security features further enhance its reliability and responsible operation.
- Potential Applications: The design and functionality of the web crawler open up various potential applications, including market research, SEO analysis, and large-scale data collection for academic research. Its ability to handle complex website structures and extract URLs efficiently makes it a versatile tool for a wide range of industries and use cases.

Practical Implementation of Crawler:

- Requirements for the code:



```
aiohttp
beautifulsoup4
click
aiomultiprocess
httpx
beautifulsoup4
validators
```

fig 2. requirements.txt

The prerequisites needed for a Python project to function correctly are listed in a requirements.txt file. It acts as a manifestof all the Python modules and libraries that the application requires, guaranteeing that the required packages are installed in the environment in which the project is deployed.

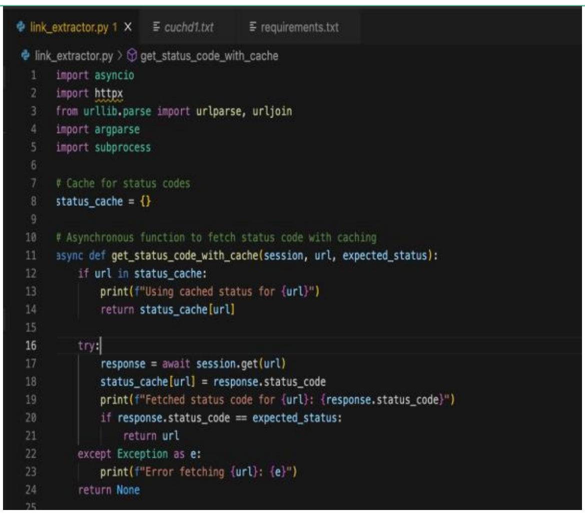
The requirements.txt file has the following dependencies:

- aiohttp: For asynchronous HTTP client/server capabilities.
- beautifulsoup4: For parsing and scraping data from HTML and XML.
- click: For building command-line interfaces easily.
- aiomultiprocess: To implement multiprocessing with asyncio for efficient concurrent tasks.
- httpx: A fast and modern HTTP client supporting asynchronous requests.
- validators: For validating URLs and other data inputs.

The file helps in managing consistent versions of libraries, enabling other developers or systems to replicate your development environment using the command

pip install -r requirements.txt.

- link_extractor.py:



```python
import asyncio
import httpx
from urllib.parse import urlparse, urljoin
import argparse
import subprocess

# Cache for status codes
status_cache = {}

# Asynchronous function to fetch status code with caching
async def get_status_code_with_cache(session, url, expected_status):
    if url in status_cache:
        print(f"Using cached status for {url}")
        return status_cache[url]

    try:
        response = await session.get(url)
        status_cache[url] = response.status_code
        print(f"Fetched status code for {url}: {response.status_code}")
        if response.status_code == expected_status:
            return url
    except Exception as e:
        print(f"Error fetching {url}: {e}")
    return None
```

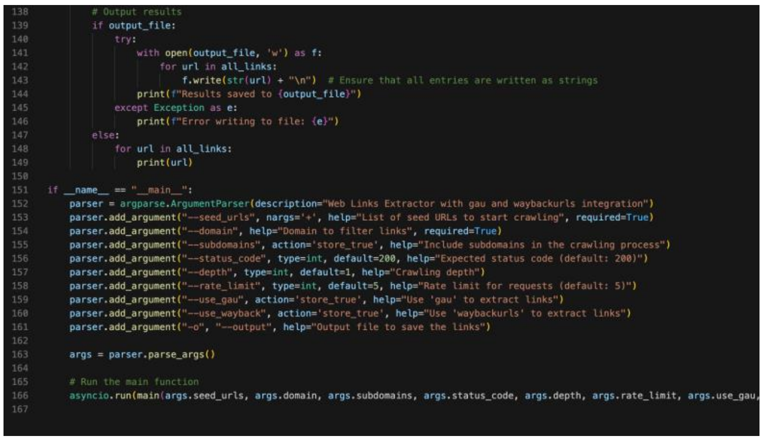
fig 3. link_extractor.py

The main script of this project serves as the core implementation for a link extraction and validation tool. It is designed to asynchronously crawl web pages, extract links, and validate their statuses while optimizing performance through efficient programming techniques.

Key modules and their roles:

1. asyncio: Handles asynchronous tasks, ensuring non-blocking execution and scalability for high-performance crawling.
2. httpx: A modern HTTP client for making asynchronous HTTP requests to fetch web pages and retrieve status codes.
3. BeautifulSoup: Provides robust HTML parsing capabilities for extracting links from web content.
4. validators: Validates the format and correctness of URLs to ensure reliable processing.
5. argparse: Enables flexible and user-friendly input through command-line arguments, such as specifying URLs or configurations.
6. urllib.parse: Facilitates manipulation and validation of URL components.
7. subprocess: Allows integration with external tools or commands to enhance functionality.

The script incorporates a caching mechanism for status codes, reducing redundant network requests and improving efficiency. Asynchronous programming ensures that tasks like fetching URLs and analyzing responses are performed concurrently, minimizing execution time. These features make the tool suitable for scalable, reliable, and performance-optimized web crawling.



```python
        # Output results
        if output_file:
            try:
                with open(output_file, 'w') as f:
                    for url in all_links:
                        f.write(str(url) + "\n")  # Ensure that all entries are written as strings
                print(f"Results saved to {output_file}")
            except Exception as e:
                print(f"Error writing to file: {e}")
        else:
            for url in all_links:
                print(url)

if __name__ == "__main__":
    parser = argparse.ArgumentParser(description="Web Links Extractor with gau and waybackurls integration")
    parser.add_argument("--seed_urls", nargs='+', help="List of seed URLs to start crawling", required=True)
    parser.add_argument("--domain", help="Domain to filter links", required=True)
    parser.add_argument("--subdomains", action='store_true', help="Include subdomains in the crawling process")
    parser.add_argument("--status_code", type=int, default=200, help="Expected status code (default: 200)")
    parser.add_argument("--depth", type=int, default=1, help="Crawling depth")
    parser.add_argument("--rate_limit", type=int, default=5, help="Rate limit for requests (default: 5)")
    parser.add_argument("--use_gau", action='store_true', help="Use 'gau' to extract links")
    parser.add_argument("--use_wayback", action='store_true', help="Use 'waybackurls' to extract links")
    parser.add_argument("-o", "--output", help="Output file to save the links")

    args = parser.parse_args()

    # Run the main function
    asyncio.run(main(args.seed_urls, args.domain, args.subdomains, args.status_code, args.depth, args.rate_limit, args.use_gau,
```

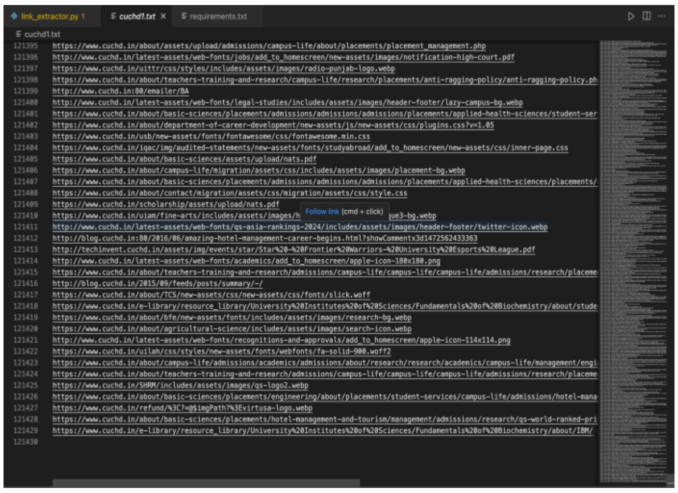
fig 4. link_extractor output code

IV RESULT

This project presents a comprehensive and efficient solution for extracting and validating URLs from web pages. By leveraging modern programming techniques and Python's extensive ecosystem of libraries, the tool achieves high performance, reliability, and adaptability, making it suitable for various real-world applications.

Following user-specified restrictions, the utility effectively retrieves every legitimate URL from the supplied domain or domains. Users can alter the script to limit the output according to particular HTTP status codes (such as HTTP 200) or add links from subdomains. By eliminating noise and concentrating on actionable data, this flexibility guarantees that the retrieved URLs are pertinent to the user's needs.

Here is an example screenshot of the output.txt file that was createdafter running the code to show the outcomes. All extracted URLs are included in this file, which is verified and filtered throughout the execution process:



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http://www.cuchd.in/latest-assets/web-fonts/jobs/add_to_homescreen/new-assets/images/notification-high-court.pdf
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http://www.cuchd.in:80/emailer/BA
http://www.cuchd.in/latest-assets/web-fonts/legal-studies/includes/assets/images/header-footer/lazy-campus-bg.webp
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https://www.cuchd.in/refund/%3C?=@$imgPath?%3Evirtusa-logo.webp
https://www.cuchd.in/about/basic-sciences/placements/hotel-management-and-tourism/management/admissions/research/qs-world-ranked-pri
https://www.cuchd.in/e-library/resource_library/University%20Institutes%20of%20Sciences/Fundamentals%20of%20Biochemistry/about/IBM/
```

fig 5. output.txt Flexible and Customizable Functionality

The tool includes several customizable features that make it adaptable to diverse requirements:

1. Depth Control: Users can set the level of recursion for subdomains, enabling targeted or comprehensive crawling.
2. Rate Limiting: The tool prevents overwhelming target servers by controlling the rate of requests.
3. Status Code Filtering: By default, only URLs with HTTP 200 status codes are displayed, but users can define alternative criteria as needed.
4. Sorting: The output is sorted for better readability and usability, whether alphabetically or based on domain hierarchy.

These features provide users with granular control over the crawling process, ensuring that the output aligns with specific objectives.

This project shows how useful lightweight Python-based tools are for link checking and web crawls. A balance between use and simplicity is guaranteed by the combination of user-configurable features, modular design, and asynchronous programming.

The project's outcomes validate its potential for use in the following applications:

The project’s results affirm its potential for applications such as:

1. Website analysis
2. Security assessments (e.g., identifying public-facing resources)
3. Compliance checks (e.g., verifying active links)

This application might be a flexible answer for complex web data extraction and analysis jobs with further improvements, including support for websites with a lot of JavaScript or interaction with compliance automation frameworks.

V CONCLUSION

The web crawler project efficiently addresses the need for automated extraction of URLs from diverse websites while maintaining adaptability and performance. It serves as a reliable tool for handling large datasets and ensuring smooth operation without overburdening websites. The project's design and implementation have led to a user-friendly solution with robust performance monitoring and security features..

5.1 **Achievements**

The web crawler project successfully developed a Python-based tool capable of extracting URLs from various websites with high accuracy and adaptability. It demonstrated the ability to handle large volumes of data efficiently without overloading the target websites. Performance monitoring was integrated to ensure the crawler's smooth operation and to detect any issues during the process. Additionally, security measures were implemented to prevent misuse, aligning the project with ethical web scraping practices. Overall, the project provides a scalable foundation for further development, including the potential to expand its functionality to more complex data extraction tasks.

5.2 **Implications**

The project underscores the importance of ethical data extraction, particularly in industries where large-scale web data gathering is critical, such as research and marketing. It highlights the need for responsible scraping practices to avoid overloading websites or violating their content policies. Furthermore, the project brings attention to the potential privacy and security concerns associated with unauthorized scraping, emphasizing the necessity for legal and ethical considerations in development. This project also contributes to broader discussions about balancing data accessibility with website security, demonstrating that it is possible to create powerful tools that respect web infrastructure and content regulations..

5.3 **Challenges**

SSL Certificate Issues: Initially faced issues with SSL certificate verification. Implemented options to bypass SSL checks for better compatibility.

Continuous Loop in Crawling: Addressed issues with infinite crawling loops by ensuring proper link filtering and deduplication.

Performance Optimization: Improved performance by optimizing the use of semaphores and managing asynchronous tasks effectively.Future Work

JavaScript Rendering: Incorporate tools to handle JavaScript-heavy websites in future versions.
Advanced Link Filtering: Add more sophisticated filtering options based on URL patterns or content types.
User Interface: Develop a graphical user interface (GUI) for users who prefer a more visual approach.

Enhanced Features and Functionality:

- Seed URL Input: Users provide a starting URL for link extraction.
- Domain Filtering: Extracted links are filtered to include only those belonging to a specified domain.
- Subdomain Handling: Option to include links from subdomains of the specified domain.
- Status Code Filtering: Filter links based on HTTP status codes (default is 200).
- Depth Control: Specify how deep the crawler should go into the link structure.
- Rate Limiting: Set delays between requests to prevent overloading the target site.
- Output Options: Display results in the console or save them to a text file.
- Error Handling: Manage SSL certificate issues and retry failed requests.

The expansion of the web crawler project to handle diverse website structures and large-scale data extraction marks a significant advancement in automated data collection tools. By focusing on adaptability, efficiency, and responsible scraping practices, the project contributes to the development of more sophisticated web scraping technologies. It provides valuable insights into optimizing web crawling processes while ensuring ethical compliance, and it lays the groundwork for further innovations in data mining and web-based research. This project can serve as a foundation for future development in extracting more complex data while maintaining the integrity of websites.

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