Job Scraper Project

Overview

This project is designed to **automate job data collection** from job listing websites using **ScrapingBee**. It extracts job titles, locations, workload, and salaries while storing results in **CSV, JSON, and SQLite** formats. Additionally, the scraper **downloads full job descriptions as HTML files** and archives them in a ZIP for offline storage.

The project follows best practices in **data engineering**, **web scraping**, and **structured data storage**, aligning with the methodologies from **Machine Learning Foundations** and **Data Engineering Fundamentals** courses.

Project Structure

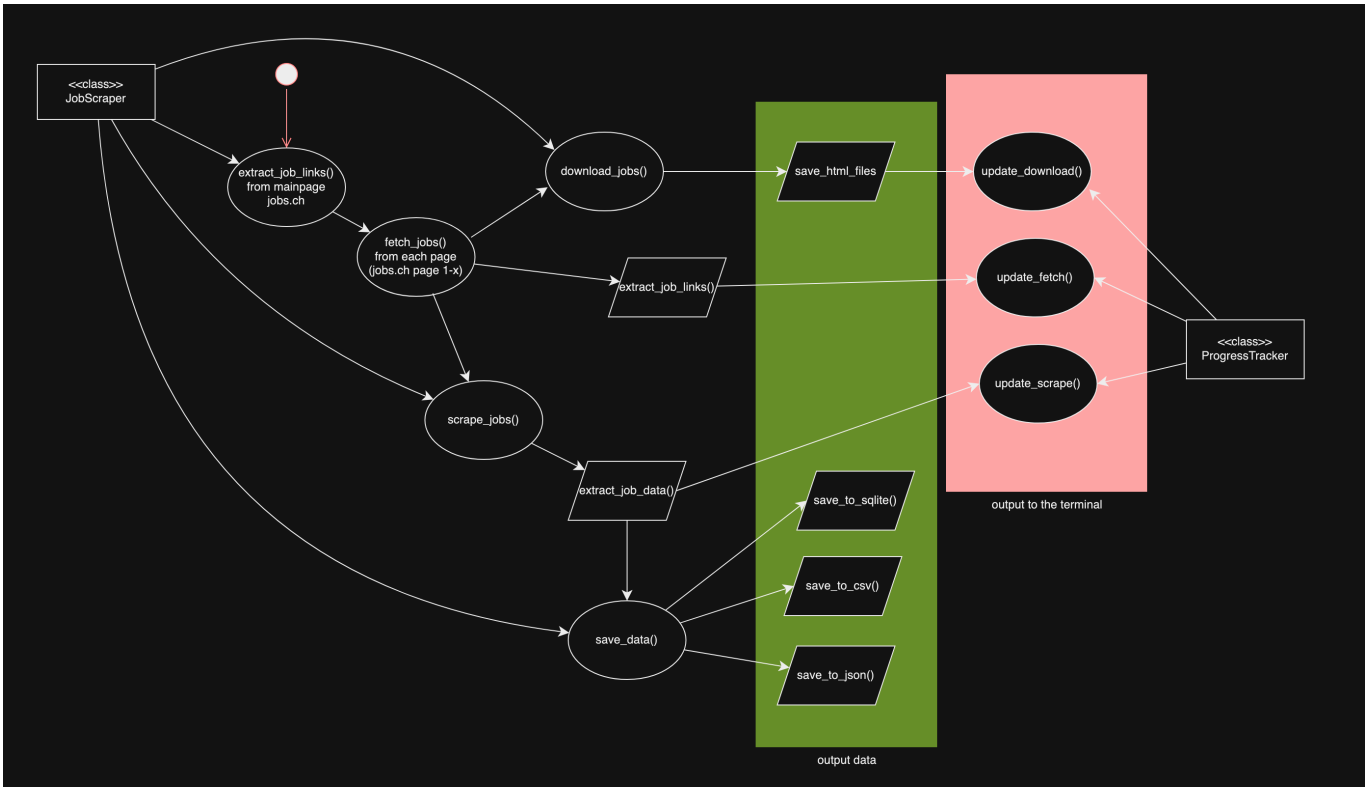
```
job-crawling/
|-- data/
|   |-- job_descriptions.csv  # Scraped job data in CSV format
|   |-- job_descriptions.json # Scraped job data in JSON format
|   |-- jobs.db               # SQLite database storing job descriptions
|   |-- html/                 # Folder containing raw HTML job
descriptions
|   |-- job_html_files.zip    # Compressed archive of downloaded job pages
|   |-- scraper.log           # Log file for debugging
|
|-- notebooks/
|   |-- job_scraper_analysis.ipynb  # Jupyter Notebook for analyzing data
|
|-- src/
|   |-- config.py             # Configuration file (contains parameters)
|   |-- data_saver.py         # Saves data to CSV, JSON, and SQLite
|   |-- downloader.py         # Downloads and stores job pages to HTML
files
|   |-- fetcher.py            # Fetches job postings from target websites
|   |-- main.py               # Entire scraping workflow
|   |-- progress_tracker.py   # Logs and tracks scraping progress
|   |-- scraper.py            # Core scraper logic (extracts job data)
|
|-- venv/                     # Virtual environment
|
|-- .env                  # Stores API keys and sensitive credentials
|-- .gitignore            # Specifies which files should be ignored by Git
|-- requirements.txt      # Lists required dependencies
|-- README.md             # Documentation about the project
|-- README.pdf            # Documentation about the project
```

Scraping Workflow

Processes job postings efficiently from extraction to storage.

- **Link Extraction (`fetcher.py`)** - Scrapes job URLs, handling pagination dynamically. Uses a **queue-based system** to prevent duplicates and track progress efficiently. Multi-threading speeds up processing, while error handling retries failed requests.
- **Data Extraction (`scraper.py`)** - Extracts **Title, Location, Workload, Salary, Contract Type, Date**. Uses a **separate method for job titles** due to HTML structure differences. Salary extraction applies regex to detect numerical ranges and **convert monthly salaries to yearly when needed**. Handles missing values and adapts to site changes.
- **Storage (`data_saver.py`)** - Saves jobs in **CSV, JSON, SQLite**. Implements **batch writing** to reduce disk operations and improve performance. Prevents duplicates and ensures **data integrity** through validation checks.
- **HTML Download (`downloader.py`)** - Saves full job descriptions in `/data/html/` and archives them in `job_html_files.zip`. Uses **multi-threading for parallel downloads** and retries failed pages. Ensures job pages are **indexed correctly** for retrieval.
- **Config (`config.py`)** - Centralized settings for **paths, limits, API Key, anti-detection, and threading**. Configures **multi-threading (`SCRAPER_THREADS`, `FETCHER_THREADS`)** for optimal performance. User-Agent rotation prevents detection, and API keys are securely loaded from `.env`.
- **Logging (`progress_tracker.py`)** - Logs job progress in `scraper.log`, tracking **processed, skipped, and failed jobs**. Prints real-time updates while keeping logs clean. Uses `count_lock` to ensure correct job tracking in multi-threading.
- **Workflow (`main.py`)** - Orchestrates **fetching, scraping, storing, downloading, tracking**. Uses **a queue system to ensure each job is processed once**. Implements **error handling, retries, and multi-threading**, balancing speed and stability.

A preliminary programming workflow was designed to develop the first edition of job_crawling.



Challenges & Solutions

- **Pagination & Link Extraction** - `jobs.ch` limits job listings per page, requiring multiple requests. The scraper **detects additional pages dynamically** and fetches them **recursively**, ensuring all jobs are collected without needing hardcoded page limits.
- **Duplicate Job Storage** - Some job postings **appear multiple times** across different searches, and multithreading caused duplicate processing. A **unique ID system (job ID + title)** filters jobs before storage, ensuring each job is stored only once.
- **Efficient HTML Downloads** - Storing **100+ raw HTML files** increased storage needs. The scraper **compresses pages into** `job_html_files.zip`, reducing file size and improving retrieval speed. Multi-threading allows **parallel downloads**, and failed requests are **retried up to three times**.
- **Safe Multithreading (`count_lock`)** - Unsynchronized threads caused **race conditions**, leading to incorrect job counts. Using `threading.Lock()`, job processing is now **atomic**, ensuring only **one thread updates shared counters at a time**, preventing missed or double counts.
- **Job Queues for Processing** - Without a structured queue, **some jobs were processed multiple times, while others were skipped**. A **FIFO queue system** ensures jobs are processed **in order**, allowing multiple worker threads to handle jobs **without conflicts** while preventing duplicate execution.
- **Progress Tracking & Logging** - Real-time updates cluttered the terminal, and debugging failed jobs was difficult. Now, **logs track processed, skipped, and failed jobs**, while real-time terminal updates provide user-friendly feedback. Log files include timestamps for **debugging failed requests** without disrupting execution.
- **Scraping Job Titles Differently** - Job titles have a unique **HTML structure**, causing issues when using the same extraction method for all data. A **separate scraping method** ensures correct extraction by processing **titles first**, followed by the remaining job details, improving accuracy and robustness.

How to Run the Scraper

1. **Clone the repository:** `git clone https://gitlab.ti.bfh.ch/franc1/job-crawling.git`
2. **Install dependencies:** `pip install -r requirements.txt`
3. **Adjust settings** in `config.py` (HTML limit, job count). -> 2000 scrapes 100 downloads take 12min.
4. **Run the scraper:** `python src/job_scraper.py`
5. **Analyze data in Jupyter Notebook:** `jupyter notebook job_analysis.ipynb`

Final Notes

This project was developed for **Data Engineering Project & Training 2 - Slot 1**, applying best practices in **web scraping, data transformation, and analysis**. It integrates concepts from **Machine Learning Foundations, Data Engineering Fundamentals, and Python courses**.

The scraper is optimized with **multithreading, job queues, and progress tracking**, ensuring efficient data handling while preventing duplicates and optimizing downloads.

References

Documentation & Libraries

- Python Official Docs
- ScrapingBee API Docs
- Python `threading` (Multithreading Guide)
- Python `Queue` (Thread-Safe Job Management)
- Python `threading.Lock()`

AI Assistance

Some code components were AI-assisted due to time constraints, including:

- **Multithreading & Job Queues** (`threading.Lock()`, `Queue` management)
- **Exception Handling & Debugging** (network failures, retries)
- **File Compression & Storage** (`zip_html_files()`)
- **Data Storage & Processing** (`save_to_sqlite()`, `save_to_json()`, `save_to_csv()`)

All AI-generated code was **significantly modified** to fit the project's structure without disrupting prior work.

For questions or contributions, submit issues or merge requests on **GitLab**.

Author: *[Cyril Franzini, franc1@bfh.ch]*
GitLab Repository: *[https://gitlab.ti.bfh.ch/franc1/job-crawling.git]*