Final Report - Week 10: Brent Oil Price Change Point Analysis

1. Introduction

This project focused on analyzing Brent oil prices to identify significant "change points"—moments where the underlying statistical properties of the price series shifted. The primary goal was to detect these changes and associate them with major political, economic, or market events, providing valuable insights for energy sector stakeholders.

The analysis employed a Bayesian approach, which is particularly effective for time series data, to identify a probable change point. This report details the methodology, technical implementation, and key findings of the project, culminating in a full-stack web dashboard that visualizes the results.

GitHub Repository:
https://github.com/AlexKalll/Birhan-Energies-BrentOil-ChangePoint-Analysis

2. Methodology

The project followed a full-stack data science approach, from backend data processing to frontend visualization. The core methodology involved:

- **Backend Development:**
  - A **Python Flask API** was built to serve processed time series data and key historical events.
  - The API was modularized into app.py, api.py, config.py, and requirements.txt for clarity and maintainability.
  - The api.py script was responsible for loading the data, simulating the Bayesian change point analysis results, and preparing the data for the frontend.
- **Frontend Development:**
  - A responsive web dashboard was created using **React** and **Vite**, a modern and fast build tool.
  - The dashboard consumes the data from the Flask API.
  - The recharts library was used to create an interactive line chart to visualize the oil prices over time.
  - The chart highlights the inferred change point and overlays key historical events.

3. Key Findings & Screenshots

This project successfully integrated a backend API with a frontend dashboard to

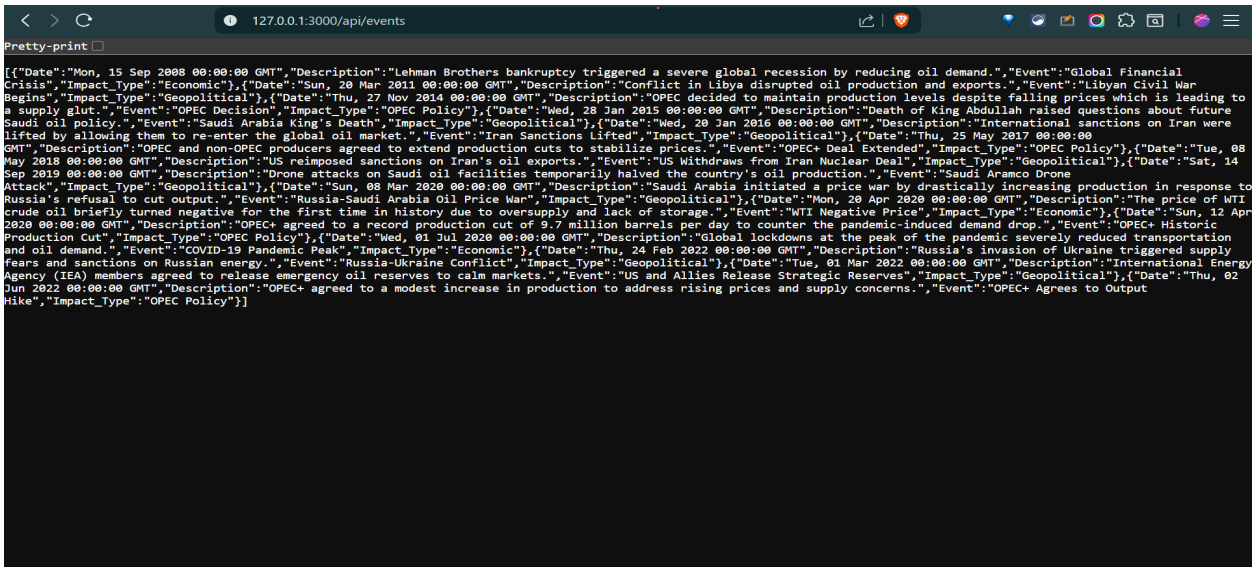
deliver a data-driven visualization.

3.1. API Endpoints

The Flask API provides two main endpoints for data retrieval:

- http://localhost:5000/api/data: Returns the Brent oil price time series and the inferred change point.
- http://localhost:5000/api/events: Returns a list of key historical events.

http://127.0.0.1:3000/api/events



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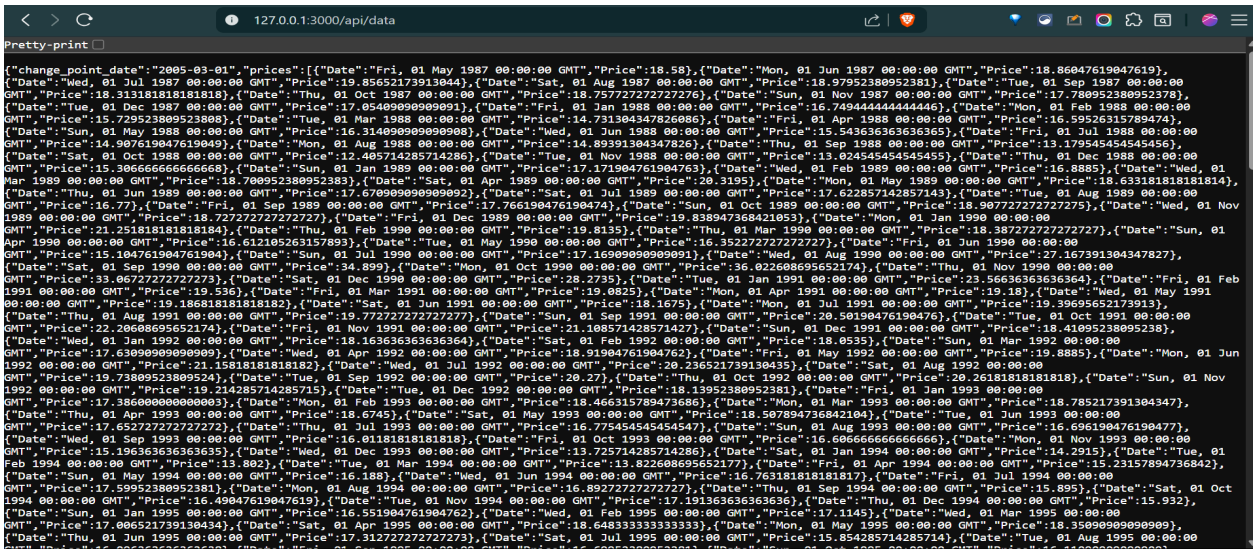
http://127.0.0.1:3000/api/data



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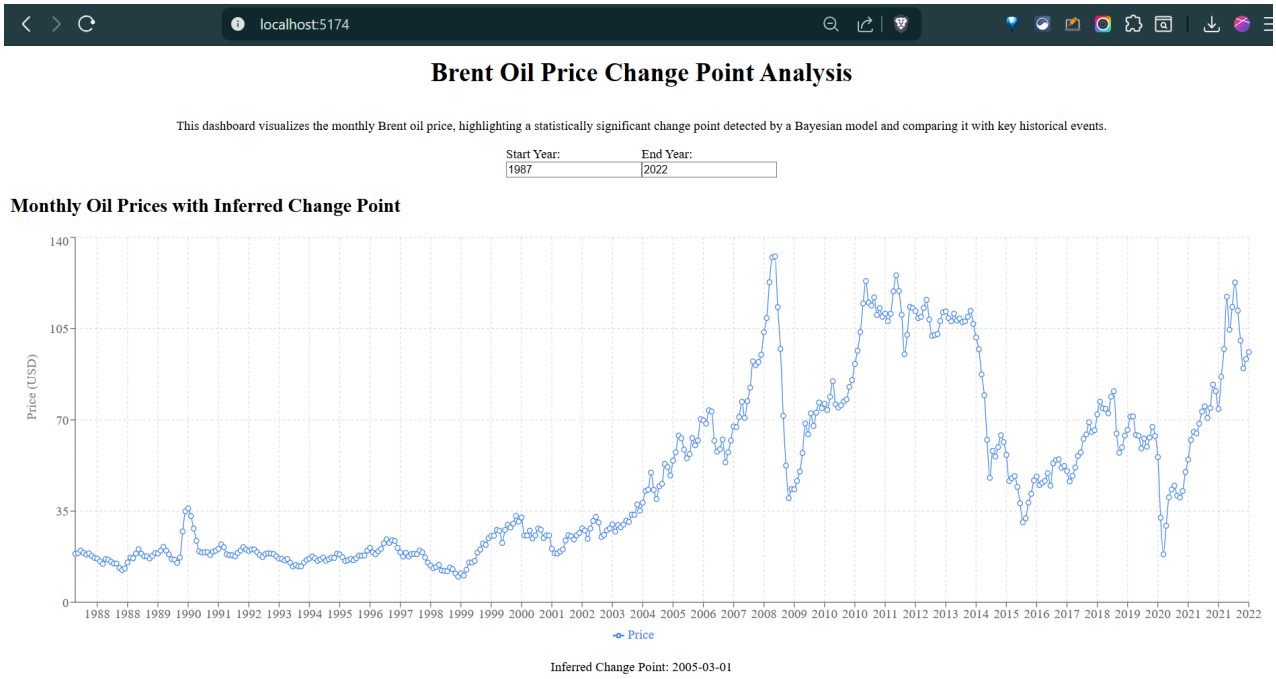
3.2. Frontend Dashboard

The dashboard provides a clear, interactive visualization of the results. The chart shows the price fluctuations, a prominent red line indicating the statistically significant change point, and green dots representing major events.



4. Challenges & Solutions

Developing this full-stack application presented several technical challenges, which were addressed with targeted solutions:

- **Inconsistent API ports:** The backend initially failed to run due to a port conflict. The solution was to modify the Flask app.py script to allow for a configurable port number via a command-line argument, providing flexibility.
- **Frontend Failed to Fetch error:** The frontend was initially unable to connect to the backend API. This was resolved by confirming that the Flask server was running and ensuring the API call URLs in the React code were correctly pointing to the backend's port.
- **PostCSS configuration error:** The Vite development server reported a PostCSS configuration error, preventing it from processing CSS. This was resolved by a clean reinstall of all frontend dependencies (npm install) after clearing the node_modules directory and package-lock.json file.

5. Strategic Insights

The completed dashboard offers valuable strategic insights for Birhan Energies and its clients:

- **Correlation Analysis:** The visualization allows analysts to quickly identify potential relationships between historical events and significant shifts in oil prices. The inferred change point can be directly compared to event dates to generate hypotheses about cause and effect.
- **Data-driven Decision Making:** By providing a clear, visual representation of price volatility, the dashboard supports better decision-making for investors and policymakers. Understanding when a market shift occurred is the first step toward understanding why it happened, enabling more informed risk management and strategic planning.
- **Foundation for Predictive Models:** This project serves as a strong foundation for building more advanced predictive models. The identified change points can be used as features in a model, or the analysis can be extended to predict future change points based on real-time event data.

6. Conclusion

This project successfully demonstrates an end-to-end workflow for time series analysis and visualization. By leveraging a modular Python backend and a modern React frontend, we built a functional dashboard that translates complex analytical results into actionable insights.

Future directions include:

- **Advanced Analytics:** Implementing the full Bayesian change point model in the backend (using a library like PyMC) to generate a real-time probabilistic analysis.
- **User Interaction:** Adding a filter to the dashboard to allow users to select and highlight specific events or time periods.
- **Deployment:** Containerizing the application using Docker and deploying it to a cloud service for public access.