



LLM-Powered Review Analysis: Optimising Data Engineering using Airflow

Naseem Shah

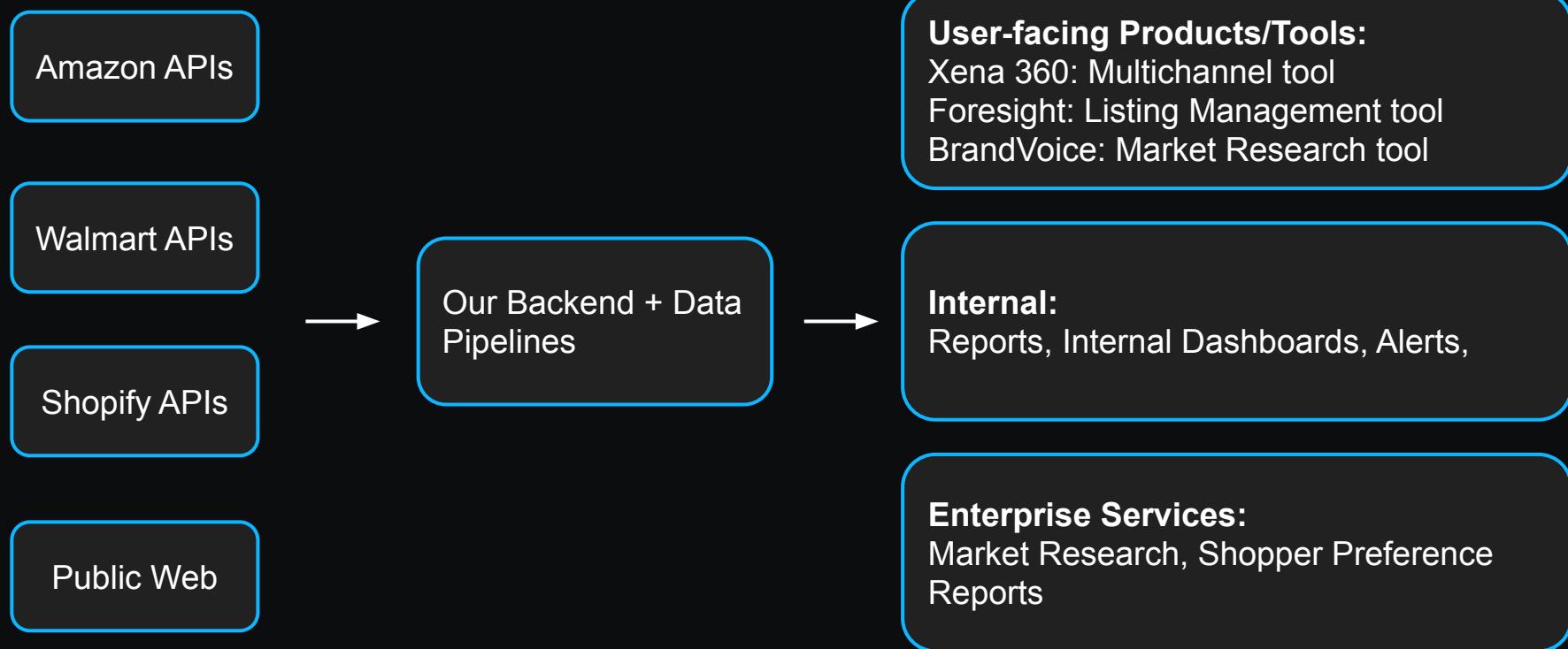
3.0

About me

Naseem Shah

- Head of Engineering at Xena Intelligence
- Loves to build products and engineer solutions
- Contributor to Airflow
- Fun Fact: I love airplanes; I'm a big-time aviation fan :)

Context



Review Analysis Requirement

It all started with one big question from a long-term enterprise customer

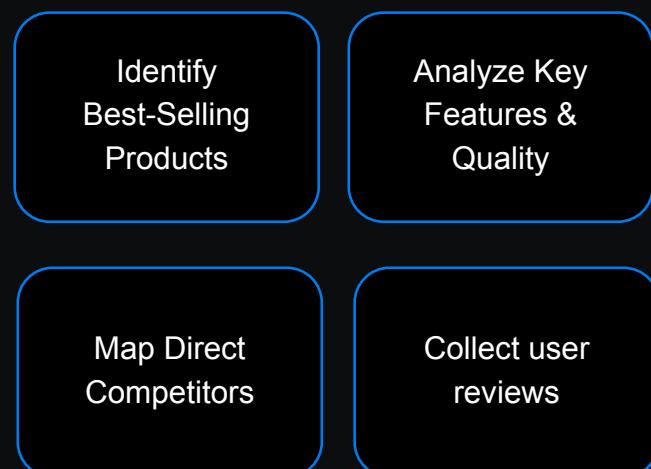
“Should we launch this new product in this market?”

“What do shoppers truly value across marketplaces?”

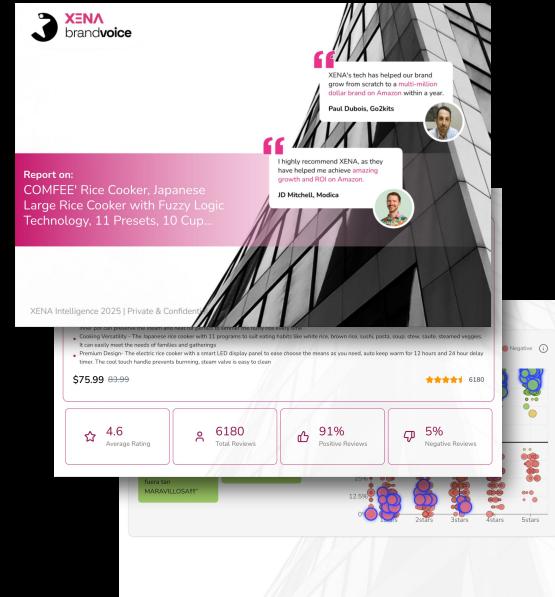
“What key risks and success factors must we plan for?”

Solution: Market Research

We analyzed thousands of real shopper reviews to uncover what buyers care about most and turned those insights into a shopper preference report.



Shopper Preference Report



Review Analysis Workflow

Multiple Data Analysts,
Manually Copy Paste
Reviews

Analyzing them one by
one and grouping
insights

Building the final PDF

Downsides/challenges

Manual workflows quickly became unsustainable as projects and data grew.

Efficiency

Accuracy

Scale

Time-intensive

Error-prone

Doesn't Scale Across Products

Weeks of Manual Work

Heavy Human Involvement

Hard to Scale Across Marketplaces

From Manual to Automated

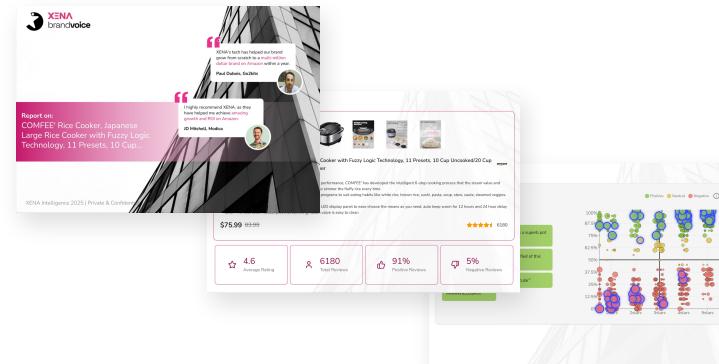
To overcome these challenges, we automated the entire workflow using Airflow + LLMs.



+

**OpenAI**

=

**Gemini****Automated Shopper
Preference Report**

Reviews Analysis: Challenges & Insights



To overcome these challenges, we automated the entire workflow using Airflow + LLMs.

Text Mining

Lack of Structure in
Reviews

Difficulty in understanding
context

Missing Key Sentiments

Lack of Structured Data
for Actionable Insights

Review Analysis Tasks

Summarisation

Aspect-Based Sentiment
Analysis

Use cases

Buyer Audience
Identification

Keywords Extraction

Improvement
Suggestions

Translation

Themes & Topic
Identification

Review Summarization



- Reading Lengthy reviews sucks!
- Easiest task in the review analysis
- Reviews have no standard structure
- Do we really need to read the full review to get the context?

PC
★★★★★ I love it
Reviewed in the United States on August 6, 2019
Color: Black/Silver | Verified Purchase

I need a watch has analog display (easy for me to read) and digital function (need the alarm and the countdown) also shows the day-date (the day has to be 3 digits e.g. Sunday is "sun" instead of "su"). I know I am very demanding, but it is just me, LOL.

Have bought this watch for a couple of days. Yes, it fits all my needs.

Pro:

- 1) Light weight, fair value materials, price is low and quality is fair. The glass is just a piece of plastic which is how I felt, but I put a packing clear tape on it and cut the edge off as my home made scratch protection.
- 2) There are 4 push buttons, except the center one for light, the other 3 seemed like are metal with rough surface which generate enough friction to hold and push it down.
- 3) It has Telememo, World Time, Snooze, two daily alarms, Count Down, hourly signal, and Stop watch functions.
- 4) 10 years battery which is better than solar battery (if solar battery never die), or it will be more expensive to replace a solar.
- 5) Casio always uses 4 screws to secure the back plate, much easier to replace the battery than other brands.
- 6) It has a smaller case (44 mm) with a larger LED display.

Neutral:

- 1) Telememo, I don't know who needs this, because smart phones can do much more. Also, I try not to buy a watch with Waveceptor, smart phone can always pick up the correct time right after the airplane touch down. However, Waveceptor can auto reset the watch, but the problem is if it can receive the signal? and for how long? I still prefer the old school way to manually adjust.

Con:

- 1) There is no pull out button to set up the analog, and this watch can only go forward. For example, if analog is 2 min faster, then I have to forward the hand for 11 hours and 58 min to correct it, that is a lot of pain, even you can hold both C & D to have the hand auto advance. Or, it only need to go backward for 2 min.
- 2) It can show two time zones time, but the digital day-date only matches with the digital time. One can not set the day-date to match with the analog.

Overall, I love this watch, and there is a metal version "AMW830D-2AV".
▲ Read less

16 people found this helpful

[Helpful](#) [Report](#)

Review Summarization

Simple prompt

```
You are an expert in analyzing  
e-commerce product reviews.  
Summarise the following product  
review
```

Output is also a string, which is what we need



The reviewer appreciates the watch for its lightweight design, affordability, useful functions, and long battery life. However, they note issues with the analog setup, glass quality, and synchronization between analog and digital displays.

Sentiment Analysis

Traditional Sentiment Analysis

Keyword-based:

“good” = positive,
“bad” = negative (no nuance).

Domain-specific models:

Needed retraining for every product/industry.

Shallow context:

can't capture sarcasm, irony, or aspect-level meaning.

Bag-of-Words:

ignores word order → “not good” still looks positive.

Sentiment Analysis

Why does context matter in sentiment analysis?

LLMs understand context = no more retraining.

Same word, different meaning:

“This phone is light and easy to carry” (positive).

“This phone feels light and cheap” (negative).

Without context, the model misclassifies.

Sentiment Analysis



Basic Sentiment Analysis using LLMs

Read the review and classify the sentiment as **Positive**,
Negative, or **Neutral**.

Review: 'The product quality is great but delivery was late.'

Sentiment: Neutral

Reason: The review contains both a **positive** remark about the product quality and a **negative** remark about the delivery delay. Since the positive and negative sentiments balance each other, the overall tone is **neutral/mixed**.

Sentiment Analysis

Downsides to this approach

Read the review and classify the sentiment as Positive, Negative, or Neutral.

Review:

I really like the phone's camera and the battery lasts all day, but the screen scratches way too easily and the charger stopped working in a week.

👉 Overall Sentiment: Negative

because the frustrations outweigh the positives when considering overall user experience).

Aspect-Based Sentiment Analysis

By treating a review as a single sentiment, we miss the rich layers of insight each line contains.

Adjusting the prompt gives us this:

Analyze the following review and identify all the key aspects mentioned. For each aspect, classify the sentiment as Positive, Negative, or Neutral, and explain briefly why.

Review: '[insert review text here]

Aspect Based Sentiment Analysis



Aspect-Wise Analysis

Aspect	Sentiment	Explanation
Camera quality	Positive	The user says "I really like the phone's camera," showing clear satisfaction with this feature.
Battery life	Positive	"The battery lasts all day" indicates a good experience with battery performance.
Screen durability	Negative	"The screen scratches way too easily" highlights a clear complaint about build quality/durability.
Charger reliability	Negative	"The charger stopped working in a week" points to a failure of the accessory, leading to a negative experience.

The challenge: Structure

We get the response from the LLM – but it's just a string of text.

As mentioned earlier, text mining is hard.

Why do we need structure?

We need the output in a format we can easily parse, store, and work with.

That's where JSON comes in.

Why JSON?

Structured & flexible

Web-native

Supports nesting

Dashboard-ready

Modelling the JSON



Considerations:

UI/UX

Handling multiple languages

Context aware

SQL Query Friendly

Support Nested Structures

Extendable

Adjusted Prompt

Prompt



You are an expert **in** analyzing e-commerce product reviews, focusing on sentiment analysis. **Analyze** and **return** the following information **in** JSON format:

positive_sentiments: Extract the positive sentiments from the review and organize them as an array of objects. **Each** object should contain an aspect, a comment and a sentimentScore (**0-100**).

```
"positive_sentiments": [  
  {  
    "aspect": "Add the positive sentiment aspect here",  
    "comment": "Add the direct mention here",  
    "sentimentScore": "sentiment score out of 100"  
  }  
]
```

Output



```
{  
  "positive_sentiments": [  
    {  
      "aspect": "Comfort",  
      "comment": "Super comfortable shoes",  
      "sentimentScore": 95  
    },  
    {  
      "aspect": "Support",  
      "comment": "excellent support",  
      "sentimentScore": 92  
    },{...},{...}  
  ]  
}
```

Handling Foreign Languages

Original Prompt

You are an expert **in** analyzing e-commerce product reviews, focusing on sentiment analysis. **Analyze** and **return** the following information **in** JSON format:

positive_sentiments: Extract the positive sentiments from the review and organize them as an array of objects. **Each** object should contain an aspect, a comment and a sentimentScore (**0-100**).

```
"positive_sentiments": [  
  {  
    "aspect": "Add the positive sentiment aspect here",  
    "comment": "Add the direct mention here",  
    "sentimentScore": "sentiment score out of 100"  
  }  
]
```

Output

```
{  
  "positive_sentiments": [  
    {  
      "aspect": "Product quality",  
      "comment": "Buena calidad!!",  
      "sentimentScore": 90  
    },  
    {  
      "aspect": "Design/Functionality",  
      "comment": "Para ajustar la hora  
analógica, se hace desde los botones, lo  
que da mayor seguridad al uso en el agua.",  
      "sentimentScore": 85  
    }  
  ]  
}
```

Handling Foreign Languages

Adding a comment translation key



You are an expert **in** analyzing e-commerce product reviews, focusing on sentiment analysis. **Analyze** and **return** the following information **in** JSON format:

positive_sentiments: Extract the positive sentiments from the review and organize them as an array of objects. Each object should contain an aspect, a comment, a **commentTranslated** (**if** the review is **in** a non-English language, include the corresponding direct mention from the **translatedReview** key; otherwise, set **this** to **null**) and a **sentimentScore** (**0-100**).

```
"positive_sentiments": [  
  {  
    "aspect": "Add the positive sentiment aspect here",  
    "comment": "Add the direct mention from the review here",  
    "commentTranslated": "If the review is in a non-English  
language, add the corresponding direct mention from the  
translatedReview key here; otherwise, this becomes null",  
    "sentimentScore": "sentiment score out of 100"  
  }  
]
```

Output



```
{  
  "positive_sentiments": [  
    {  
      "aspect": "Product quality",  
      "comment": "Buenísimo el reloj. Buena  
calidad!!",  
      "commentTranslated": "The watch is great.  
Good quality!!",  
      "sentimentScore": 90  
    },  
    {  
      "aspect": "Product functionality",  
      "comment": "Para ajustar la hora  
análogica, se hace desde los botones, lo que da  
mayor seguridad al uso en el agua.",  
      "commentTranslated": "To adjust the analog  
time, it is done from the buttons, which  
provides greater safety for use in water.",  
      "sentimentScore": 85  
    }  
  ]  
}
```

Themes & Topics

Themes and **topics** help organize insights in a structured, actionable way.

Themes

- High-level category aspect
- Think of it as the “big idea” behind what reviewers are talking about.
- Examples:
Product Quality, Packaging,
Delivery Experience, Ease of Use,

Topics

- A topic is a specific sub-aspect within a theme.
- It captures exact details or points mentioned in the review.
- Examples:
Durability, Comfort, Material, and Color Accuracy.

Modeling Themes & Topics

Themes and **topics** help organize insights in a structured, actionable way.



You are an expert **in** analyzing e-commerce product reviews, focusing on sentiment analysis, keyword optimization, and actionable insights. **For** each product review, analyze and **return** the following information **in** JSON format:

themes: Organize the review insights into themes, where each theme contains a list of topics and associated mentions. **Each** theme represents a general category, and each topic within the theme represents a specific aspect of the review **with** direct mentions from the review body.

```
"themes": [{  
    "theme": "Add the theme here",  
    "topics": [{  
        "topic": "Add the topic here",  
        "mentions": [  
            "Add mention from the review here"  
        ],  
        "translatedMentions": [  
            "Add mention from the translatedReview here"  
        ]  
    }]  
}]
```



```
"theme": "Product Quality",  
"topics": [  
    {  
        "topic": "Comfort",  
        "mentions": ["The shoes feel  
soft and light on my feet"],  
        "translatedMentions": [null]  
    }  
]
```

Other Analysis tasks

Buyer Audience



```
"buyer_audience": [  
    "runners",  
    "athletes",  
    "people with pronation issues"  
]
```

Use cases



```
"usecases": [  
    "running",  
    "long-distance running",  
    "athletic training"  
],
```

Keywords Extraction



```
"keywords": [  
    "pronated stride shoes",  
    "GTS running shoes",  
    "cushioning running shoes",  
    "best running shoes",  
    "running shoes for pronation"  
]
```

Improvements



```
"improvements": [  
    "Improve toe box fit",  
    "Enhance arch support",  
],
```

The result?

Unstructured Text

 Ali Bazon
★★★☆☆ Good looks and battery but very travel-unfriendly, no timezone, dual clock a letdown
 Reviewed in the United States on February 20, 2020
 Color: Tan | [Verified Purchase](#)
 I've had my share of both Casio regular and G-shock watches and pretty familiar with relatively consistent programming and functions of their other designs. This one turned out to be an outlier. It was supposed to be an upgrade from my last Casio, AQ-S810W, but in many ways it was a downgrade.
 I like how it looks, at least in tan/black color scheme. It supposedly has a 10-year battery, which I prefer over the Solar charging. With solar, when the watch wasn't exposed to enough light, it'd go into a "hibernation" mode and effectively shut off the display to preserve and extend battery life, which happened on more than one occasion and usually at night. So a 10-year battery is a plus.
 The LCD display on this model shows both date and day of the week in the same view (on AQ-S810W you had to change the view, which was really annoying)
 HDC700 also has a dual clock, but it's implemented very poorly- to the point where it's practically useless. It seemed like a good idea to have the analog hands show the time in the current/home location and for the LCD to show the time in another time zone, however there's only one calendar and it's tied to the LCD
[▼ Read more](#)
 10 people found this helpful
[Helpful](#) | [Report](#)



Structured Data

- Summarisation
- Buyer Audience Identification
- Translation
- Aspect-Based Sentiment Analysis
- Keywords Extraction
- Themes & Topic Identification
- Use cases
- Improvement Suggestions

```

{  

  "positive_sentiments": [  

    {  

      "aspect": "Product quality",  

      "comment": "Buenísimo el reloj. Buena  

      calidad!!!",  

      "commentTranslated": "The watch is great.  

      Good quality!!",  

      "sentimentScore": 90
    },  

    {  

      "aspect": "Product functionality",  

      "comment": "Para ajustar la hora  

      analógica, se hace desde los botones, lo que da  

      mayor seguridad al uso en el agua.",  

      "commentTranslated": "To adjust the analog  

      time, it is done from the buttons, which  

      provides greater safety for use in water.",  

      "sentimentScore": 85
    }
  ]
}

```

Putting it all together



Public Web

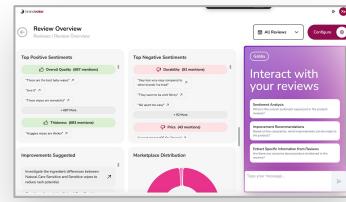


Apache
Airflow



PostgreSQL

SQL queries



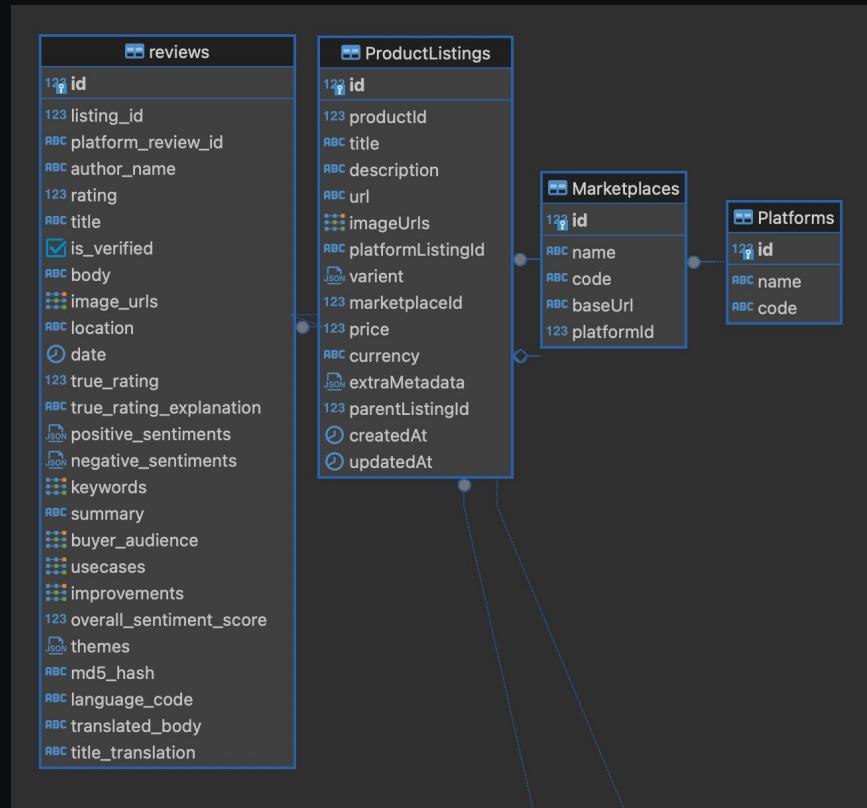
Interactive
Dashboard



PDF
Automated Shopper
Preference Report

Entity Relationship Modeling

```
model reviews {
    id           Int          @id @default(a
    language_code String?
    author_name  String?
    rating       Int?
    title        String?
    is_verified  Boolean?
    body         String?
    translated_body String?
    title_translation String?
    date         DateTime
    positive_sentiments Json?      @db.JsonB
    negative_sentiments Json?      @db.JsonB
    keywords      String[]
    summary       String?
    buyer_audience String[]
    usecases      String[]
    improvements  String[]
    themes        Json?      @db.JsonB
    md5_hash      String
    listing_id    Int
    product_listing ProductListings @relation(fiel
    @@unique([listing_id, md5_hash])
}
```





Advantages of JsonB in Postgres

Flexibility

Faster Queries

Querying Specific Parts of JSON

Partial Updates

Evolving Schema

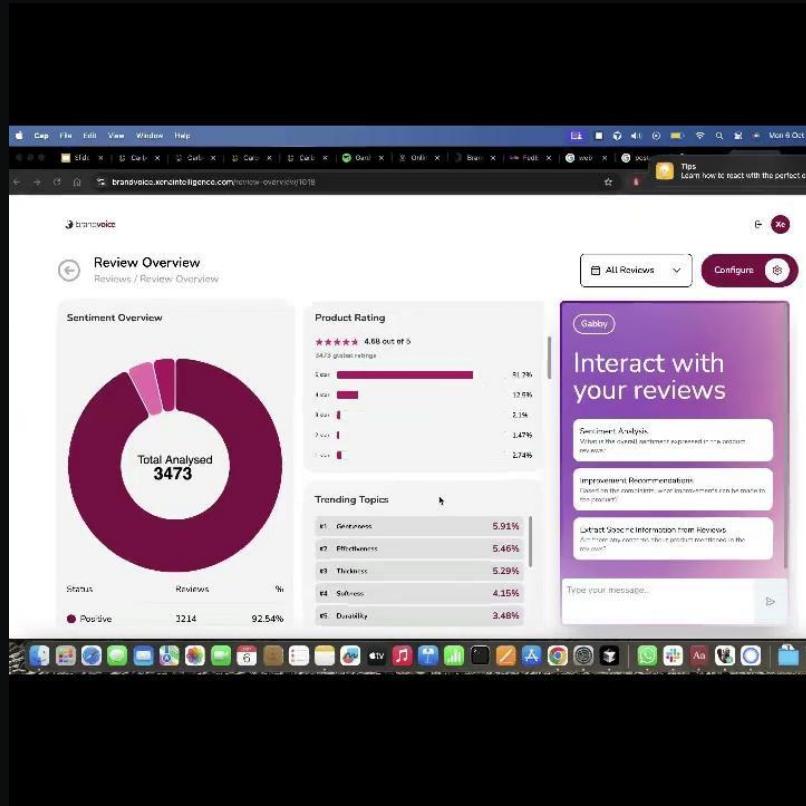
Example Query

Groups all the positive sentiment

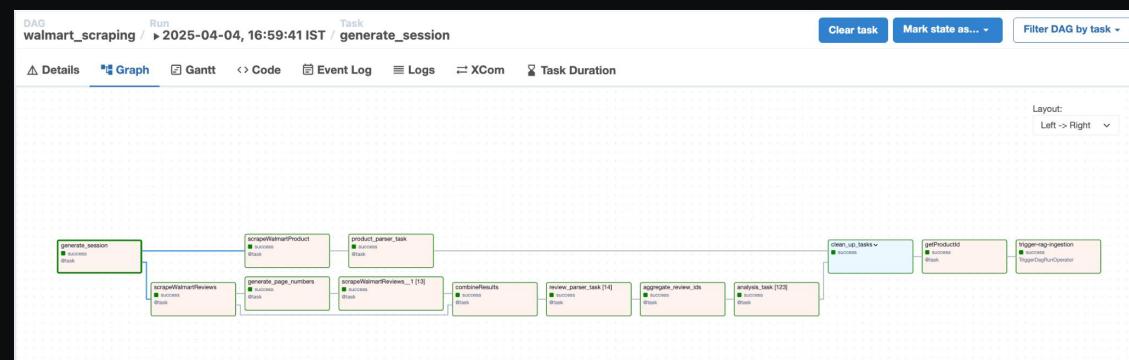
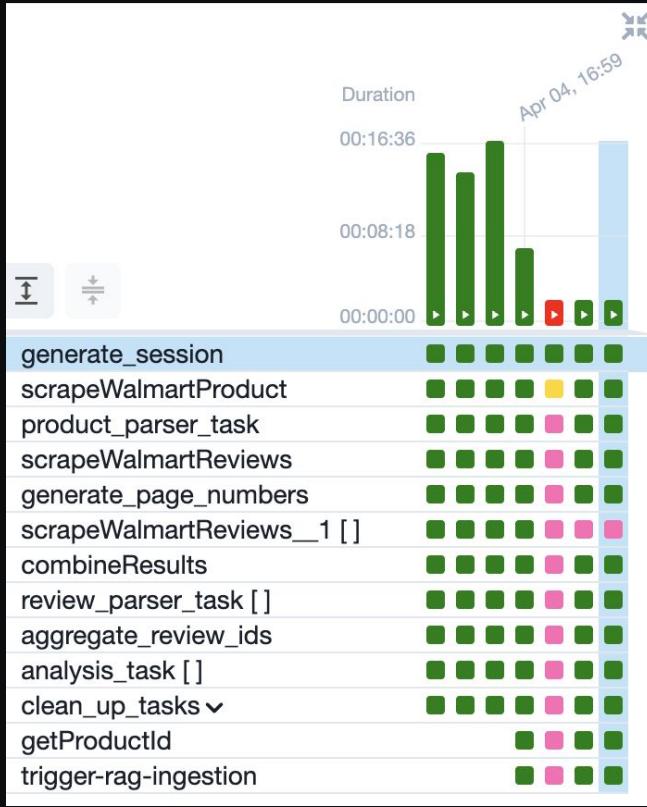
```

SELECT
    aspect_data ->> 'aspect' AS aspect,
    COUNT(*)::int AS count,
    jsonb_agg(
        jsonb_build_object(
            'mention', aspect_data ->> 'comment',
            'review', jsonb_build_object(
                'id', r.id,
                'rating', r.rating,
                'title', r.title,
                'body', r.body,
                -- ... other review fields ...
                'themes', r.themes,
                'md5_hash', r.md5_hash
            )
        )
    ) AS comments
FROM reviews r
CROSS JOIN LATERAL
    jsonb_array_elements(r.positive_sentiments) AS
    aspect_data
GROUP BY aspect
ORDER BY count DESC
LIMIT 100;

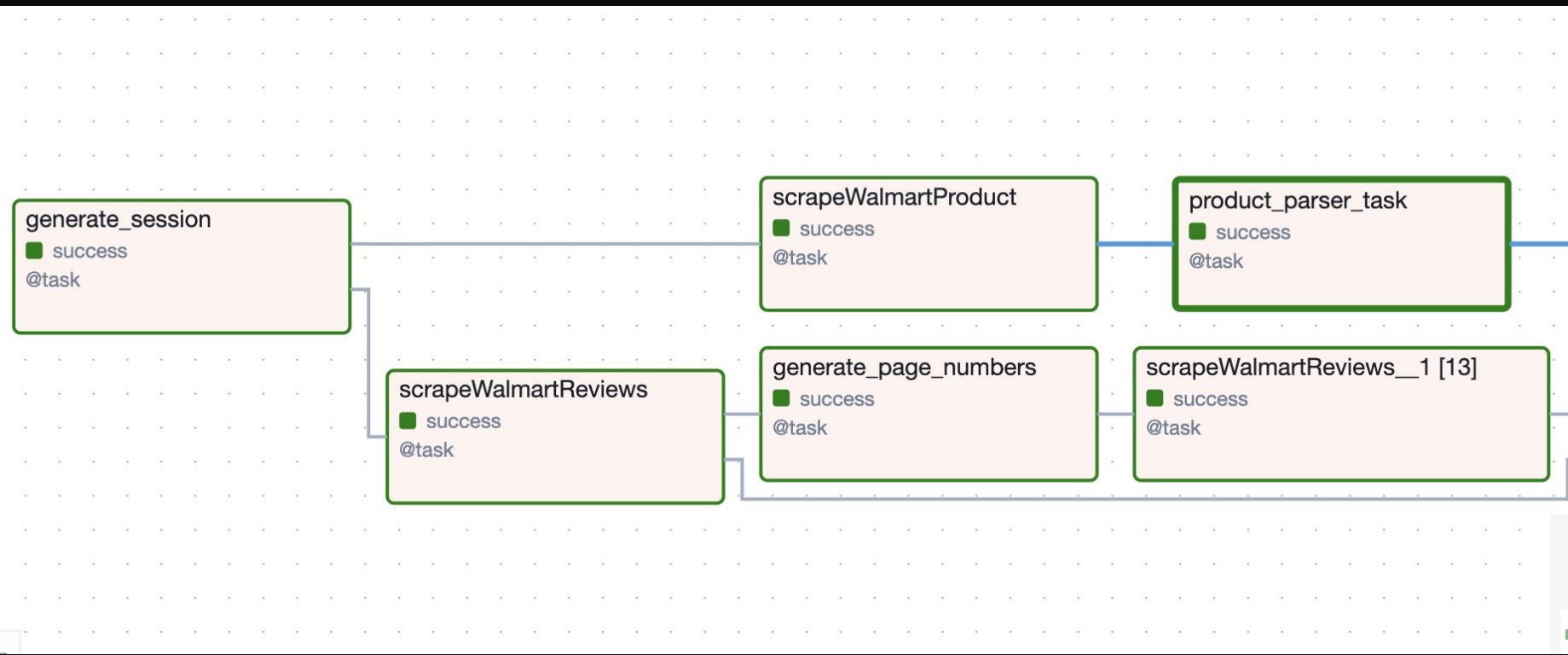
```



The DAG



The DAG

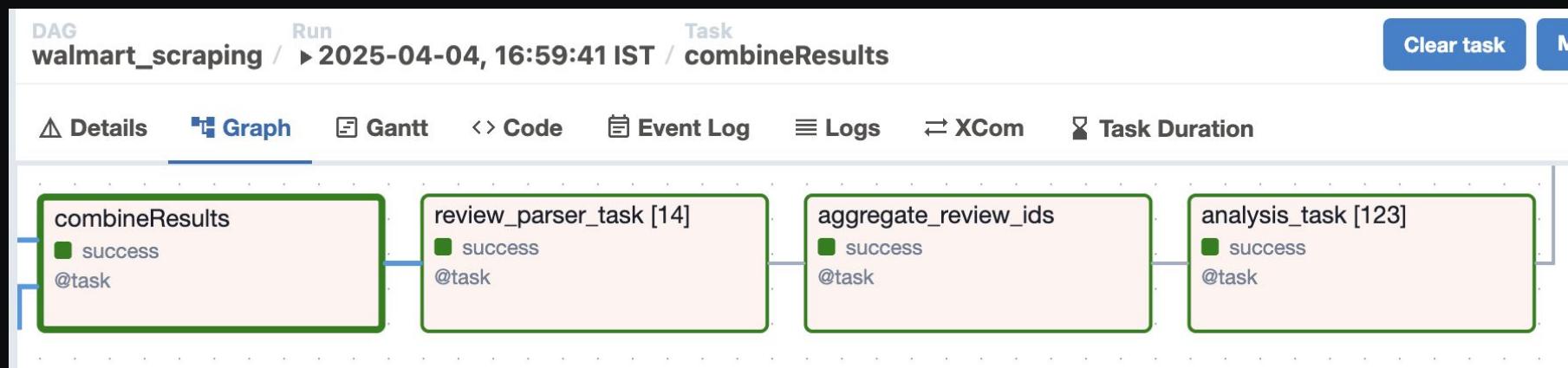


The DAG

XComs are powerful, but use them wisely

DAG Run Task	
walmart_scraping / ► 2025-04-04, 16:59:41 IST / scrapeWalmartProduct	
Details Graph Gantt Code Event Log Logs XCom Task Duration	
Key	Value
gcsUrl	gs://brandvoice/scraping-sessions/1186/html_product.html
return_value	<pre>▼ { 2 items "gcsUrl" : "gs://brandvoice/scraping-sessions/1186/html_product.html" "session_id" : 1186 }</pre>
session_id	1186

The DAG



The DAG

Mapped tasks make multi-output workflows seamless

Key	Value
return_value	<pre> ▼ [14 items 0 : "gs://brandvoice/scraping-sessions/1186/html_page_1.html" 1 : "gs://brandvoice/scraping-sessions/1186/html_page_2.html" 2 : "gs://brandvoice/scraping-sessions/1186/html_page_3.html" 3 : "gs://brandvoice/scraping-sessions/1186/html_page_4.html" 4 : "gs://brandvoice/scraping-sessions/1186/html_page_5.html" 5 : "gs://brandvoice/scraping-sessions/1186/html_page_6.html" 6 : "gs://brandvoice/scraping-sessions/1186/html_page_7.html" 7 : "gs://brandvoice/scraping-sessions/1186/html_page_8.html" 8 : "gs://brandvoice/scraping-sessions/1186/html_page_9.html" 9 : "gs://brandvoice/scraping-sessions/1186/html_page_10.html" 10 : "gs://brandvoice/scraping-sessions/1186/html_page_11.html" 11 : "gs://brandvoice/scraping-sessions/1186/html_page_12.html" 12 : "gs://brandvoice/scraping-sessions/1186/html_page_13.html" 13 : "gs://brandvoice/scraping-sessions/1186/html_page_14.html"] </pre>

DAG: walmart_scraping / Run: 2025-04-04, 16:59:41 IST / Task: review_parser_task []			
MAP INDEX	STATE	DURATION	START DATE
0	■ success	00:00:01	2025-04-04, 17:03:11 IST
1	■ success	00:00:02	2025-04-04, 17:03:10 IST
2	■ success	00:00:02	2025-04-04, 17:03:10 IST
3	■ success	00:00:02	2025-04-04, 17:03:10 IST
4	■ success	00:00:01	2025-04-04, 17:03:11 IST
5	■ success	00:00:02	2025-04-04, 17:03:07 IST
6	■ success	00:00:01	2025-04-04, 17:03:11 IST
7	■ success	00:00:02	2025-04-04, 17:03:10 IST
8	■ success	00:00:02	2025-04-04, 17:03:10 IST
9	■ success	00:00:02	2025-04-04, 17:03:10 IST

The DAG



Each parser task processes reviews, saves them to the database, and returns their IDs.

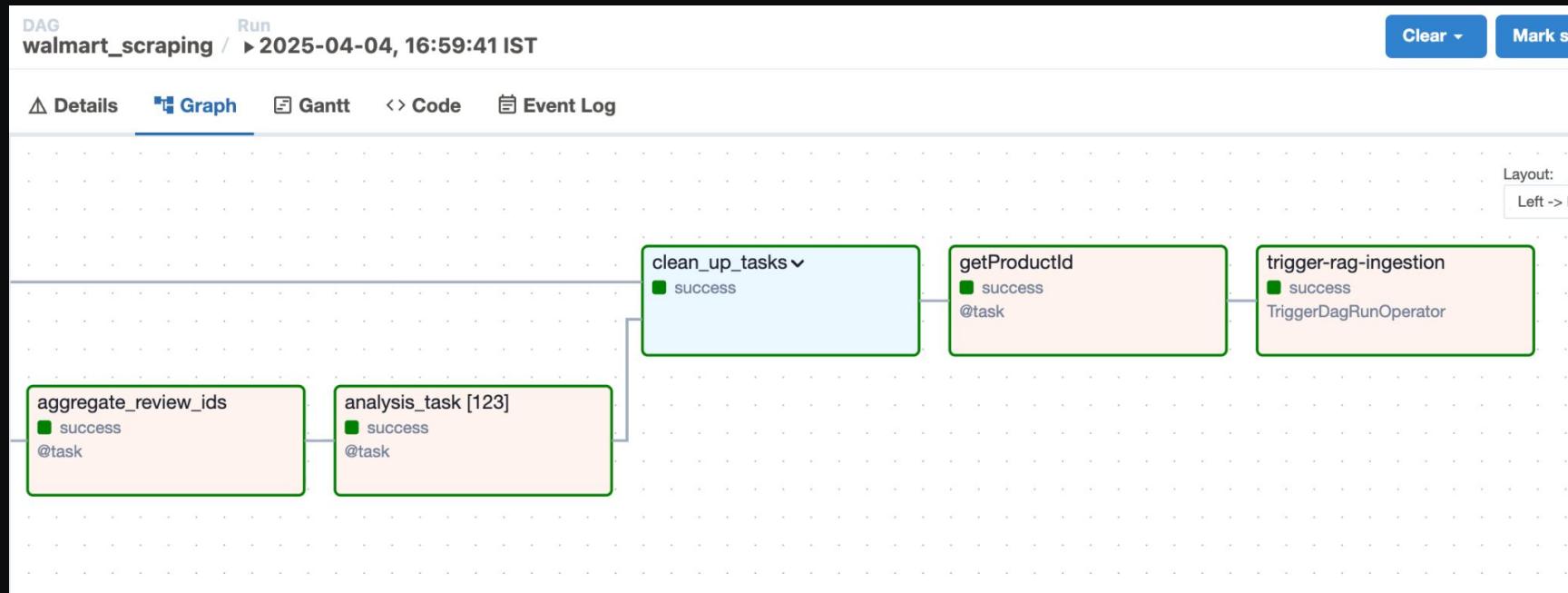
DAG [Run](#) [Task Map](#) [Index](#)
walmart_scraping / ▶ 2025-04-04, 16:59:41 IST / review_parser_task [] / 5 Clear

Details Graph Gantt Code Event Log Logs XCom Task Duration

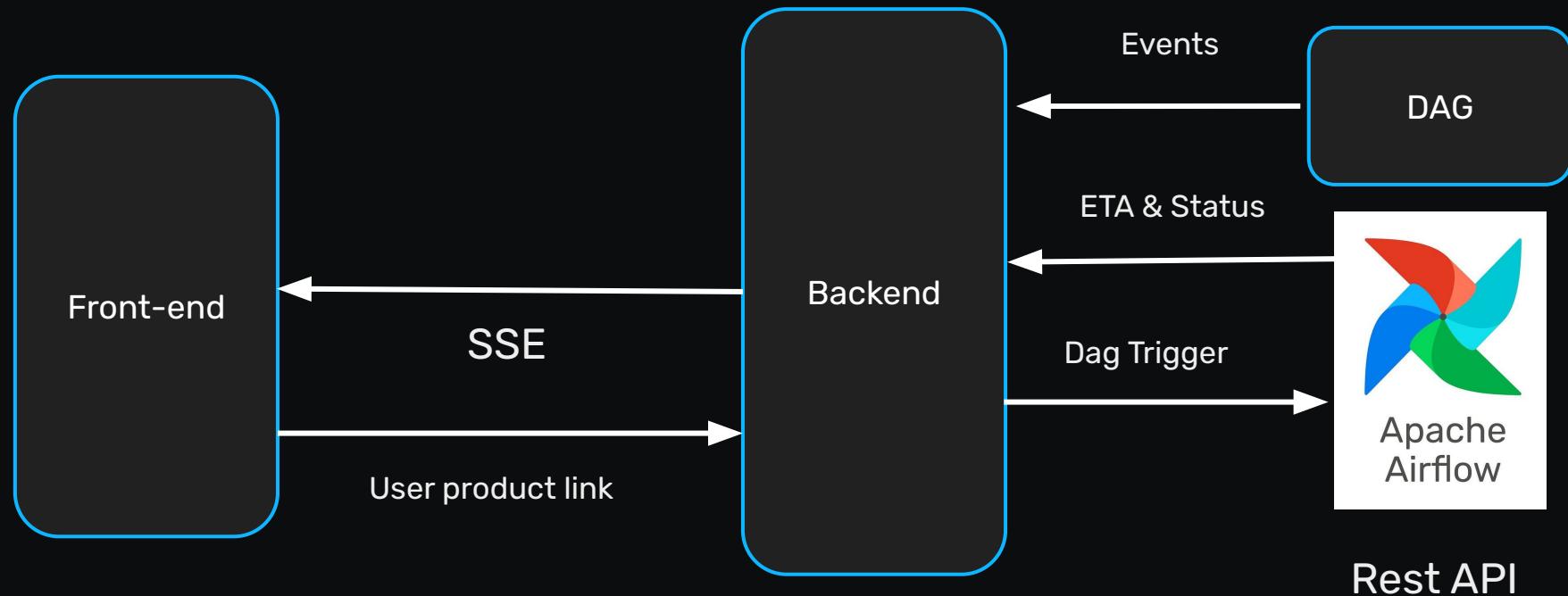
Key	Value
processed_file	gs://brandvoice/scraping-sessions/1186/html_page_6.html
return_value	<pre> { 2 items "processed_file" : "gs://brandvoice/scraping-sessions/1186/html_page_6.html" "saved_review_ids" : [10 items 0 : 24297 1 : 24298 2 : 24299 3 : 24300 4 : 24301 5 : 24302 6 : 24303 7 : 24304 8 : 24305 9 : 24306] }</pre>

The DAG

The output from all parser tasks is aggregated and passed into an analysis step, mapped task pulls reviews by their IDs and sends them to an LLM for analysis.



Getting progress, ETAs, etc.



Getting progress, ETAs, etc.



```
~~~~~  
default_args = {  
    'owner': 'airflow',  
    'start_date': datetime(2025, 3, 1),  
    'retries': 5,  
    'retry_delay': timedelta(seconds=20),  
    "on_success_callback": send_eta_and_progress_to_webhook  
}  
#L to chat, #K to generate  
# Define a separate function for extracting reviews  
  
@dag(default_args=default_args, schedule_interval=None, catchup=False)  
def walmart_brandvoice_lite(**context):  
    dag_conf = extract_dag_conf()
```

```
def send_eta_and_progress_to_webhook(context):  
    elapsed, remaining, eta, progress = compute_dag_eta_and_progress()  
  
    product_id = context["dag_run"].conf.get("product_id")  
  
    payload = {  
        "event_type": "overview",  
        "elapsed": str(elapsed),  
        "eta": eta,  
        "progress": progress,  
    }  
  
    base_url = Variable.get("BV_LITE_API_BASE_URL")  
    url = f"{base_url}/events/stream/product_{product_id}"  
    try:  
        # Ensure all datetime objects in the payload are converted to ISO  
        # strings before serializing.  
        serialized_payload = {k: (v.isoformat() if isinstance(v, datetime) else v) for k, v in payload.items()}  
        requests.post(url, json=serialized_payload, timeout=5)  
    except Exception as e:  
        context["task_instance"].log.error(f"Failed to send ETA: {e}")
```

Getting progress, ETAs, etc.

```
def analysis_task(productData, parsedReview, **kwargs):  
  
    print(f"Analysis for review_id {review_id or '(No id)'}:  
  
    analysis = get_analysis_from_llm(  
        product_title=product_title,  
        review_title=review_title,  
        review_body=review_body  
    )  
  
    send_event_to_webhook(  _____ → Sending SSE Events  
        payload={  
            "event_type": "analysis_data",  
            "data": analysis["micro_insight"]  
        },  
        product_id=product_id  
    )
```

Integrating it all in UI/UX



The screenshot shows a web browser window on a Mac OS X desktop. The title bar indicates it's a Chrome browser with many tabs open. The main content is a modal window titled "Review Collection in Progress" from "XENA Brandvoice".

Platform:

- Home
- Products
- Amazon US
- Walmart US
- Nooh
- Amazon CA
- Amazon IN
- Amazon AE
- Target

Obtaining Public Reviews ETA: 8m 19s

BOSS Men's Quartz Watch – Grey Dial with Stainless Steel Strap – Sleek and Modern Everyday Timepiece

4.7 Average Rating

15 Total Ratings

90% Positive Reviews

10% Negative Reviews

\$0.00
0 bought in past month

Obtaining Public Reviews

The bottom of the screen shows the Mac OS X dock with various application icons.

The Impact: Stats

2.3+ Million reviews

2500+ reports generated

From
2-3 weeks/report
to 10 mins



I'm Excited for

New features of Airflow 3

Migration to Airflow 3

Human-in-the-Loop workflows



Questions?

