

# Multi-Agent Framework for Upsell Recommendations using GenAI

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# Agenda

1. Motivation of the project with an example
2. Multi Agents workflow with Langraph
3. Deep Dive into agents
4. Key challenges and considerations
5. Future Improvements and Roadmap
6. Debugging and Monitoring with Langsmith



# Upsell Recommendation for “Dasani Water”



## Dasani Water: \$1.00 per bottle :

Dasani Water is a popular bottled water brand produced by The Coca-Cola Company. It is known for its crisp, clean taste and is purified using a multi-step filtration process. Dasani adds a unique blend of minerals, including magnesium sulfate, potassium chloride, and salt, to enhance the taste. The water is sourced from local municipal supplies and undergoes reverse osmosis to remove impurities. Dasani is available in various sizes, including 16.9 oz, 20 oz, and 1-liter bottles, making it convenient for different hydration needs. The packaging is made from recyclable PET plastic, contributing to environmental sustainability. Overall, Dasani offers a reliable and refreshing hydration option at an affordable price.

LLM Generated Summary

## Evian Natural Spring Water: \$1.50 per bottle :



- 1.Sourced from the French Alps, providing a unique mineral composition and natural purity compared to Dasani's municipal sources.
- 2.Naturally filtered through glacial rocks, ensuring minimal human intervention, unlike Dasani's reverse osmosis process.
- 3.Known for its smooth, balanced taste, which some may find superior to Dasani's enhanced taste with added minerals.
- 4.Offers a luxurious hydration experience with a focus on natural purity and taste.

## Voss Artesian Water: \$2.50 per bottle



- 1.Sourced from an artesian well in Southern Norway, providing an exceptionally pure taste with low mineral content, unlike Dasani's added minerals.
- 2.Naturally filtered and free from sodium, making it a cleaner hydration option compared to Dasani.
- 3.Available in both still and sparkling varieties, offering more versatility than Dasani's still water.
- 4.Packaged in a sleek, cylindrical glass bottle, offering a stylish and functional design compared to Dasani's PET plastic bottles.

## Fiji Natural Artesian Water: \$2.00 per bottle



- 1. Sourced from an artesian aquifer in Fiji, providing a unique and exotic origin compared to Dasani's local municipal sources.
- 2. Naturally filtered through volcanic rock, enriching it with minerals like silica, which Dasani lacks.
- 3. Known for its soft, smooth taste and high silica content, offering a distinctive mouthfeel compared to Dasani.
- 4. Emphasizes natural artesian purity, which may be perceived as more premium than Dasani's multi-step filtration process

## Perrier Sparkling Mineral Water: \$1.75 per bottle

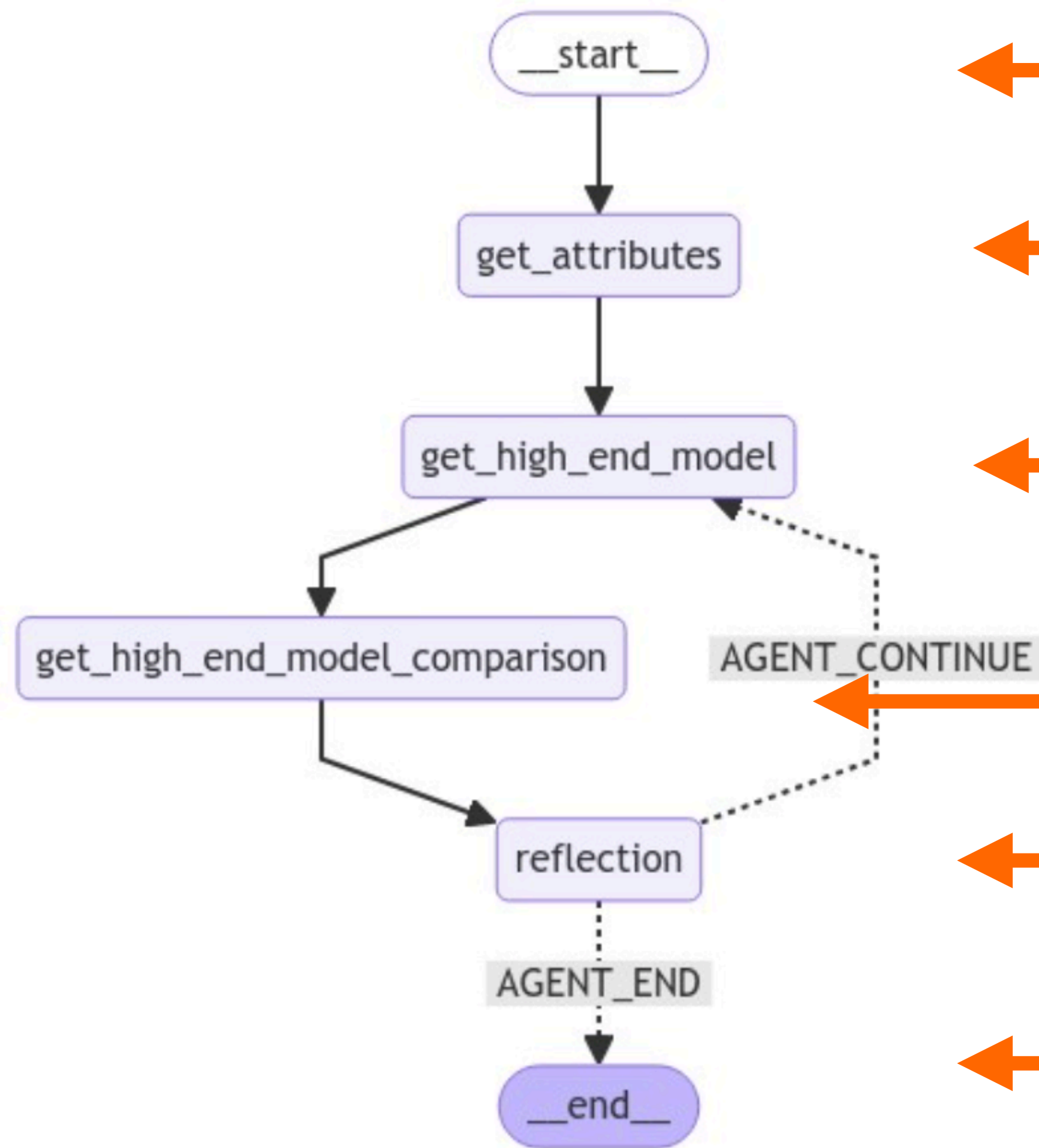


- 1. Sourced from the Vergèze spring in France, providing natural carbonation and a unique mineral blend compared to Dasani's still water.
- 2. Known for its refreshing, effervescent taste, offering a different hydration experience than Dasani's crisp, clean taste.
- 3. Bottled at the source, preserving its natural carbonation and mineral content, unlike Dasani's reverse osmosis process.
- 4. Available in both glass and PET plastic bottles, offering more packaging options compared to Dasani.

LLM Generated Comparison Data



# Agents Workflow for Upsell Recommendation using Lang-graph



Input: anchor product example: DASANI Water

Agent 1 : Identify category and decide attributes to compare other products with

Agent 2: Identify the high end models and summarize on the attributes

Agent 3: Compare each High End model with the direct anchor

Agent 4: Iterate on the comparison to make sure it is relevant and answering "Why is it worth paying extra?"

Output: Comparison with High End Products



# Agent 1: Get Attributes

## Task of the Get Attribute Agent1

1. Identify the category of the product (e.g., "BMW 328i belongs to Luxury Sedan Cars", "Dasani Water belongs to Drinking Water").
2. Develop a list of up to 10 key attributes, that a user would consider when comparing the product to more expensive or higher-end models/items.

### LLM Generated Attribute List

## Agent 1 Handover

1. Handover the attribute list to the "Agent 2: Get High End Models"
2. This will be sequential step

user\_query: Dasani Water  
attribute\_results:

- Brand Reputation
- Purity Level
- Mineral Content
- Packaging Quality
- Bottle Design
- Environmental Impact
- Price per Liter
- Availability
- Taste
- Source of Water



# Agent 2: Get High End Models

## Tasks of the Agent 2

### ● Get High End Models

1. Identify the price of user given product.
2. Identify at-most 4 high end products from the one user suggested. It can be from the same brand or other brands. The key is they should be comparable. The price of high end models should be higher than the exact price of all items.
3. Summarize the finding for each product in detail, including the original user given product.
4. Make sure the summary covers all the aspects of this attribute list
5. Summary should be between 300 words

### ● Address Concerns from Agent 4

1. Act on the advise of agent 4 if there is an issue with the product description or its not clear “Why paying extra is worth it?” or if price is lower.
2. Based on the issue tries to fix the issue until the Agent 4 is satisfied.

### LLM Generated Summary for the Original Anchor and four high end models/items

**original\_product:** "Dasani Water: \$1.50 per liter: Dasani is a well-known brand under Coca-Cola, offering purified water with added minerals for taste. The purity level is high, but it is not natural spring water. The mineral content is balanced to enhance flavor. Packaging quality is standard, with a focus on recyclability. The bottle design is functional but not luxurious. Dasani has a moderate environmental impact due to its use of plastic bottles, though they are recyclable. Price per liter is affordable. Availability is widespread, making it easy to find. The taste is clean and crisp, but not as distinctive as some premium brands. The source of water is municipal, which is then purified."

**product1:** "Evian Natural Spring Water: \$2.00 per liter: Evian is a prestigious brand known for its natural spring water sourced from the French Alps. The purity level is exceptional, with no additives. The mineral content is naturally occurring, providing a unique taste. Packaging quality is high, with a focus on premium materials. The bottle design is elegant and recognizable. Evian has a moderate environmental impact, with efforts towards sustainability. Price per liter is higher, reflecting its premium status. Availability is good, though not as ubiquitous as Dasani. The taste is smooth and refreshing, with a distinct mineral profile. The source is a protected spring, ensuring natural purity."

### Similarly summary for three other high-end models

## Agent 2 to handover the summaries to Agent 3

1. Handover the high end product names, their price and summaries for each of them including the anchor product to the Agent3: Get High End Model Comparison
2. This step will be in the loop till:
  - The Agent 4 is satisfied as to “Why is it worth paying extra?” Question has been satisfactorily answered and all the high end products price are above the anchor product.
  - Or the max iterations has been reached



# Agent 3: Compare High End Models with Original Product

## Task of the Agent3: Compare high end models

- 1.Understand and assess the original product's features and qualities.
- 2.Compare each higher-end model to the original product.
- 3.Determine why the higher-end models justify the higher price.
- 4.List clear, key points that highlight the benefits of paying more for the higher-end model.
  - Each point should directly compare with the original product to demonstrate added value.

## Agent 3 handover the comparison to Agent 4 for review

This step will be in the loop till:

- The Agent 4 is satisfied as to “Why is it worth paying extra?” Question has been satisfactorily answered and all the high end products price are above the anchor product.
- Or the max iterations has been reached

### Evian Natural Spring Water: \$1.50 per bottle

- 1.Sourced from the French Alps, providing a unique mineral composition and natural purity compared to Dasani's municipal sources.
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- 3.Available in both still and sparkling varieties, offering more versatility than Dasani's still water.
- 4.Packaged in a sleek, cylindrical glass bottle, offering a stylish

Similarly comparisons for two other products



# Agent 4: AI Checking Upsell Recs Before output is presented to the user

## Task of the Agent 4 Reflection Agent

1. Ensure the higher-end items have a price greater than the original product.
2. Verify that the reasoning behind recommending the higher-end products makes sense.
3. If the reasoning is convincing, respond with "Satisfied." If it's not convincing, mention the product name in your review.
4. Suggest changing the product if its price is lower than the original product.

**LLM Generated Feedback for each of the product comparison listed by Agent 3**

product1: Satisfied  
product2: Satisfied  
product3: Satisfied  
product4: Satisfied

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## Agent 4 Reflection: Conditional Edge

1. If Agent 4 is "Satisfied" or max tries are finished loop ends.
2. If there are suggestions the Agent 4 sends it back to Agent 2 to make corrections



# Structured JSON Outputs: Important aspect of scalable LLM workflow

## Naive Approach: Using prompts to generate JSON

1. Inconsistent formatting: Outputs may vary, leading to parsing issues.
2. Lack of validation: No built-in checks to ensure data adheres to required structure.
3. Limited scalability: Difficult to manage across more complex or large-scale tasks.

## Advanced Approach: Leveraging Python Classes for structured outputs

1. Ensures consistent JSON formatting: Outputs are automatically structured according to predefined rules.
2. Validation with formatting instructions: Data is validated against expected schemas, reducing the chance of errors.
3. Scalability: Easy to extend to more complex tasks or multiple use cases.
4. Improved error handling: Invalid outputs are caught early, ensuring higher reliability and fewer downstream errors.

## Guardrails for Output Validation

1. Automatic re-triggering of LLM: If the output fails validation (e.g., unstructured, incorrect fields), the system automatically calls the LLM again with refined prompts.
2. Fallback logic: Implement fallback strategies to handle recurring failures, ensuring graceful degradation instead of complete failure.



# Cost Considerations, Quality and Latency: Choice of LLMs

Plays a huge role on the quality, latency and cost

Current Model : **GPT-4o**

Avg. Cost Per Query: **\$0.0432**

Avg Latency Per Query: **29.4 seconds**

Avg Tokens Per Query: **5100 tokens**

Cost for 1M Anchors: **\$43000 dollars**

Time for 1M Anchors: **8166 hours**

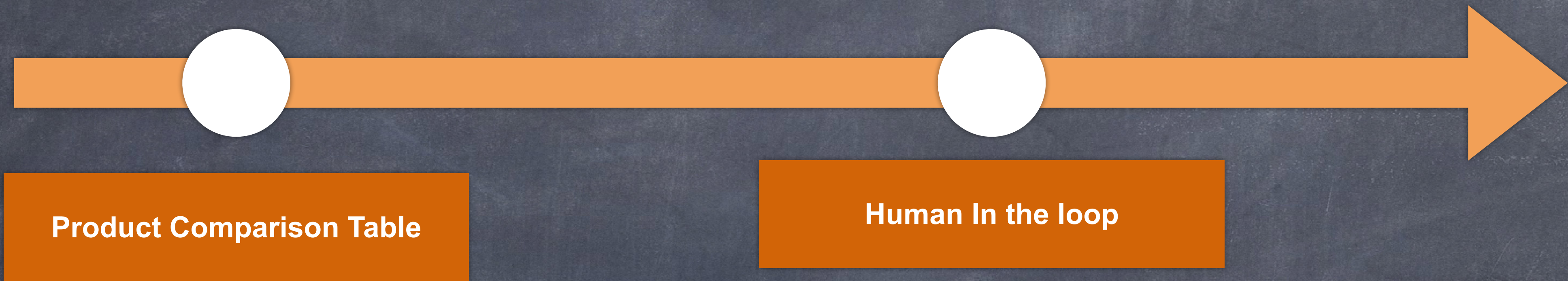


# Future Improvements to Improve Latency

1. LLM Caching, store attributes for category so as to not re-generate every-time and also constant across products.
2. Create Product Summarization once and cache it and use the same across all anchors
- 3.Reduce the number of iterations
- 4.Use Faster Model such as Gemini-Flash and fine-tune it
- 5.Target only relevant categories which has high affinity for upselling



# Roadmap to make it more unique experience for customers



Product Comparison Table


Feature	Dasani Water	Evian Natural Spring Water	Fiji Natural Artesian Water	Voss Artesian Water	Smartwater
Price	\$1.50	\$1.75	\$1.80	\$1.85	\$1.95
Source	Purified municipal water	French Alps	Yaqara Valley, Viti Levu	Southern Norway	Purified municipal water
Bottle Size	500ml	500ml	500ml	500ml	600ml
pH Level	5.6 (slightly acidic)	7.2 (neutral)	7.7 (naturally alkaline)	7.0 (neutral)	6.5 (slightly acidic)
Mineral Content	Balanced with added minerals	Naturally occurring electrolytes	Natural electrolytes and silica	Low mineral content	Added electrolytes
Brand Reputation	Strong (Coca-Cola association)	High-end	Premium	Luxury	High (Coca-Cola association)
Packaging Material	Recyclable plastic	Recyclable plastic	Recyclable plastic (square-shaped)	Recyclable glass	Recyclable plastic
Sustainability Efforts	Yes	Yes	Yes	Yes	Yes
Flavor Options	No	No	No	Yes (flavored sparkling options)	Yes






Give ability to the customer to directly interact and ask specific questions about any of the product



# Langsmith: Debugging and Monitoring

## DEMO





Personal > Projects > agent\_report

agent\_report

RunsThreadsMonitorSetup

1 filter

Last 7 days

Root Runs

LLM Calls

All Runs

ID

Data Retention14d

Add Rule

Edit

Name	Input	Output	Start Time	Latency	Dataset	Annotation Queue	Tokens	Cost	First Token (r
LangGraph	InSinkErator Badger 5...	{"user_query":"In...	8/15/2024, 9:28:32 ...	🕒 24.42s	<input type="checkbox"/> 📄	<input type="checkbox"/> ✎	5,473	\$0.045045	N/A
LangGraph	HDX Superior Pleated...	{"user_query":"H...	8/15/2024, 9:24:51 ...	🕒 27.11s	<input type="checkbox"/> 📄	<input type="checkbox"/> ✎	5,174	\$0.04539	N/A
LangGraph	GE Profile 4.8 cu. ft. S...	{"user_query":"G...	8/15/2024, 9:19:19 ...	🕒 25.26s	<input type="checkbox"/> 📄	<input type="checkbox"/> ✎	5,311	\$0.044305	N/A
LangGraph	Pampers Baby Diaper	{"user_query":"P...	8/15/2024, 9:15:13 ...	🕒 24.33s	<input type="checkbox"/> 📄	<input type="checkbox"/> ✎	5,021	\$0.041445	N/A

Stats

Last 7 days

RUN COUNT

145

TOTAL TOKENS

374,759 / \$5.43 ⓘ

MEDIAN TOKENS

1,908

ERROR RATE

28%

% STREAMING

0%

LATENCY

P50: 18.56s

P99: 139.45s