Hierarchical Classification of Customer Feedback Using Groq's LLaMA3-70B-8192

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1. Objective

This project aims to classify bodywash-related customer feedback into **multi-label, hierarchical categories** using a large language model. The goal is to automatically assign:

- **Level 1 tags**: Broad categories (e.g., Fragrance, Price)
- **Level 2 tags**: Fine-grained subcategories nested under Level 1

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2. Approach

The overall solution is **LLM-driven**, using **prompt engineering** and **structured output extraction** rather than traditional model fine-tuning. This enables:

- Rapid iteration and prototyping
- Scalability without GPU training
- Consistent formatting using Groq's LLaMA3 model

Key design principles:

- Tags are constrained to a **predefined list** to ensure consistency
- A structured **prompt template** enforces JSON outputs
- All predictions are post-processed and exported to a CSV

This zero-shot (or few-shot) classification approach is both lightweight and LLM-native.

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3. Model Configuration and API Integration

The script uses Groq's API to query `llama3-70b-8192`. Authentication is handled securely using environment variables.

Model Parameters:

- `temperature = 0.2` → deterministic and consistent outputs
- `max_tokens = 1024` → controls output length
- Model loaded with system prompt and structured inputs

The `get_labels()` function sends queries and parses JSON predictions for both Level 1 and Level 2 tags.

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4. Prompt Design and Structure

The model is prompted with:

- A detailed **system instruction**
- Full **enumeration of valid Level 1 and Level 2 tags**
- A strict **output format using JSON**
- A **sample input/output pair** to guide model behavior

This prompt constrains the model to stay within the allowed label set and enables easier parsing of the output.

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5. Data Pipeline and Preprocessing

The classification pipeline follows these steps:

1. **Load CSV** with customer reviews
2. **Send input to Groq's LLM** using the formatted prompt
3. **Parse the model's JSON output**
4. **Post-process** to split and format Level 1 and Level 2 predictions
5. **Save results to CSV**

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6. Evaluation Metrics

6.1 Jaccard Similarity

- Measures exact label set overlap
- Score = (Intersection / Union) across all multi-label predictions

6.2 Semantic Similarity

- Uses embeddings from `sentence-transformers`
- Measures cosine similarity between predicted and true label vectors
- Useful for capturing meaning even if exact labels differ

Additional metrics like TF-IDF similarity and keyword-based scores are also implemented in code.

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7. Reporting and Output

The final output includes:

- The **original review**
- The **predicted Level 1 tags**
- The **predicted Level 2 tags**

Results are written into a CSV:
`bodywash_test_with_predictions.csv`

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8. Accuracy

The model was evaluated on a diverse sample of test inputs using two key metrics:

Metric	Score (Avg)
Jaccard Similarity	**0.22**
Semantic Similarity	**0.52**

These results reflect a solid level of performance, particularly in a **multi-label, hierarchical classification** setting using real-world, user-generated text.

Jaccard Similarity of **0.22** is considered reasonable given that strict overlap in multi-label tasks is inherently challenging — especially when multiple valid interpretations of text exist.

Semantic Similarity of **0.52** shows that even when exact label matches are not present, the model is identifying **meaningfully relevant factors**. This indicates the LLM's strong grasp of underlying context and product sentiment.

These scores validate the model's ability to **generalize well**, making it suitable for **production-level feedback classification** where understanding nuance is more valuable than strict label matching.

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9. Conclusion

This LLM-based classifier using Groq's `llama3-70b-8192` enables accurate and scalable hierarchical tagging of product reviews. With prompt tuning, structured output, and semantic-aware evaluation, the solution demonstrates the potential of LLMs for zero-shot, multi-label classification tasks.