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Capstone Project Presentation

April 2025

Restaurant Recommendation System Using Yelp Data

Agenda

- Introduction
- Prior Work
- Methodology
- Experiments and Results
- Web Application Demonstration
- Conclusions and Future Work

Problem Description

- Traditional recommenders mainly depend on numeric star ratings.
- Ratings do not capture customer emotions or detailed experiences.
- Example: A restaurant with 4.5 stars might still have poor recent service.
- Need a system that blends ratings with real customer emotions.

Objective

- Build a hybrid system combining Collaborative Filtering and Sentiment Analysis.
- Recommend restaurants considering both behavioral patterns and emotions.
- Improve trustworthiness, personalization, and user discovery experience.
- Deploy results through an easy-to-use interactive web app.

Importance of Emotional Sentiment

Star ratings oversimplify rich customer feedback.

Textual reviews capture service quality, ambiance, staff behavior.

Sentiment analysis reveals subtle positive/negative aspects missed by ratings.

Emotional-aware recommendations build higher user trust.

Prior Work – Collaborative Filtering

Ha (2022) explored user-based/item-based CF to improve Yelp recommendations.

Matrix Factorization like SVD better captures hidden user preferences.

Challenges: cold-start (new users/items) and data sparsity issues.

Prior Work – Hybrid Models and Sentiment

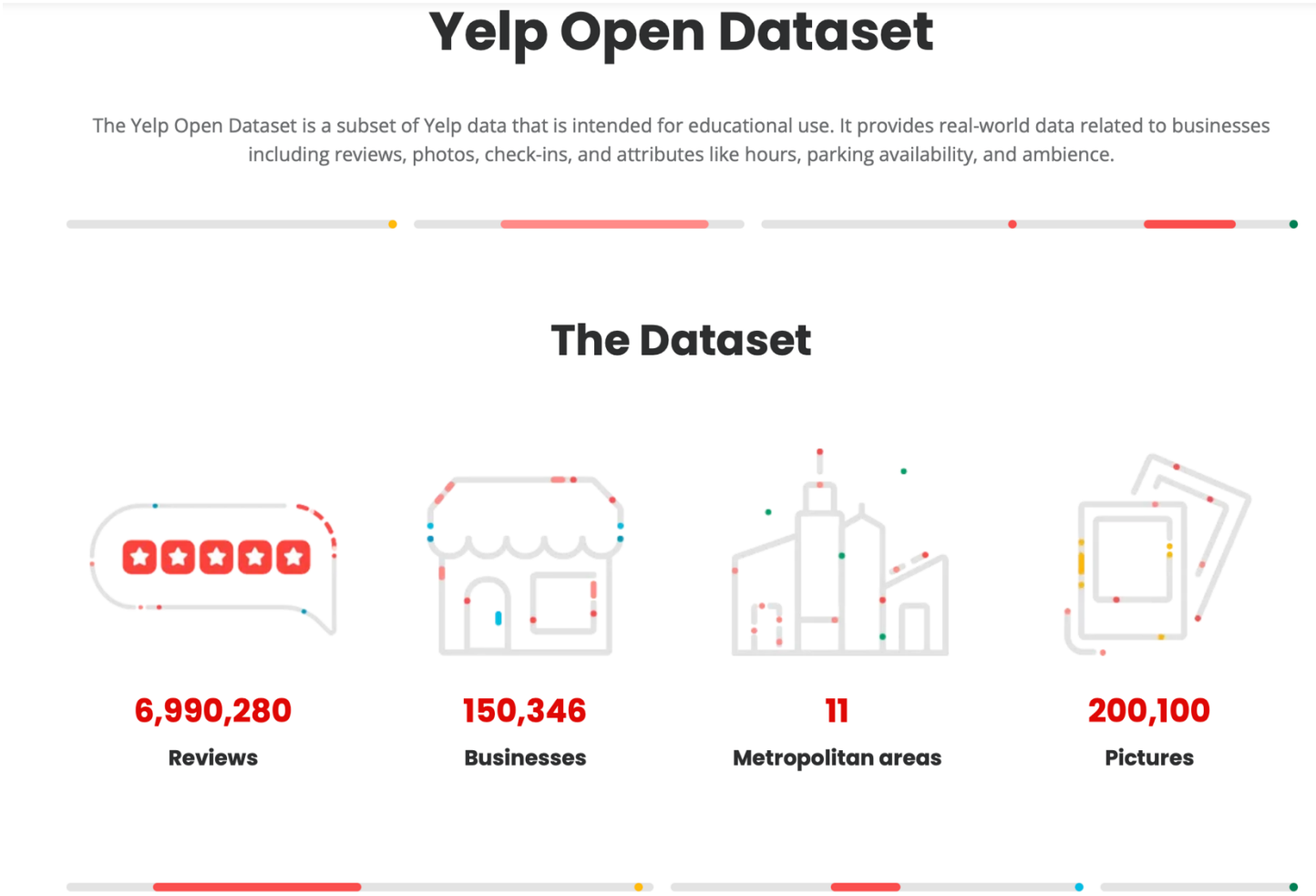
Sawant and Pai (2022) built hybrid systems using metadata + ratings.

Sentiment from reviews improves personalization further.

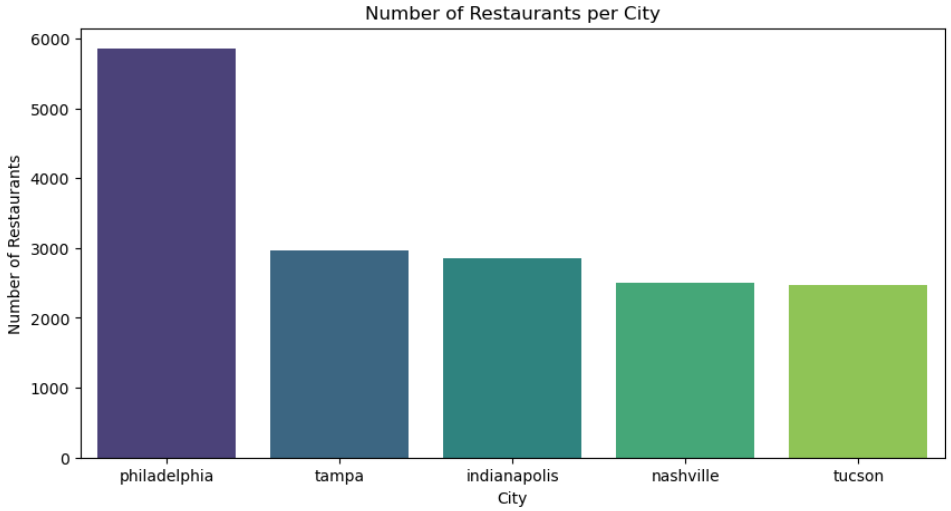
Xu and Lee (2021) showed integrating attributes like service/ambiance improves user experience.

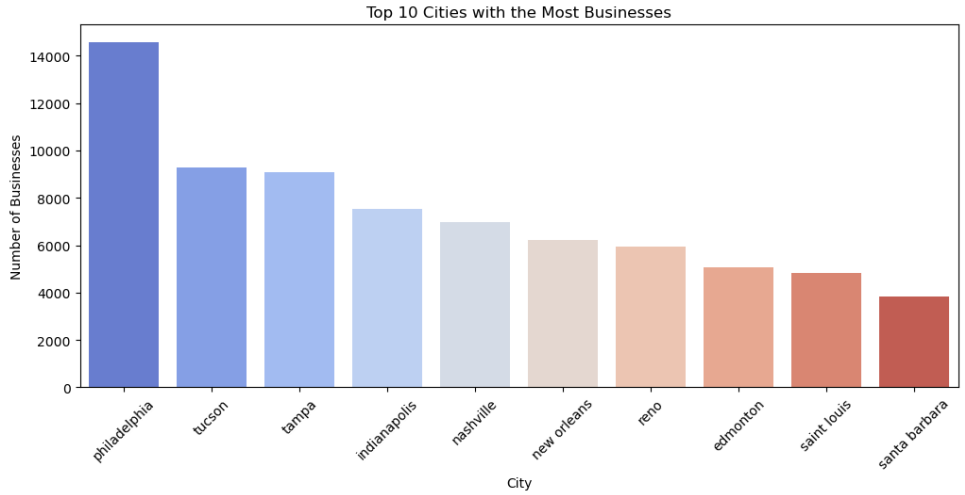
Dataset Overview

- Yelp Academic Dataset used: Reviews + Business metadata.
- Focus on five cities: Philadelphia, Indianapolis, Tampa, Tucson, Nashville.
- Final dataset: ~2.5 million reviews filtered down to restaurant-focused subset.
- Rich metadata: cuisines, stars, location, open/closed status.



Data Preprocessing

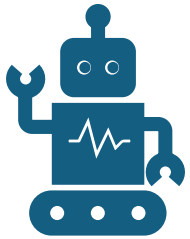




- Filter non-restaurant businesses and short/incomplete reviews.
- Add review length, review year, city metadata.
- Merge datasets on Business ID for unified analysis

Sentiment Analysis Techniques

VADER: Rule-based quick scoring.



TF-IDF + Logistic Regression: Classical ML on text features.

BERT: Deep contextual embeddings and fine-tuning for emotional detection.

Sentiment Model – VADER

Lightweight, no training needed.

Good for fast estimations.

Struggles with sarcasm, context-heavy reviews.

Sentiment Model – TF-IDF + Logistic Regression

Transform text to vector space using TF-IDF.

Logistic Regression classifier predicts polarity.

Good accuracy (~81.7%), interpretable results.

Sentiment Model – BERT

Deep Bidirectional Encoder Representations from Transformers.

Fine-tuned on Yelp reviews for custom sentiment classification.

Achieved highest accuracy (91.5%), robust to context variations.

Collaborative Filtering Overview

COLLABORATIVE FILTERING VIA SVD CAPTURES USER-RESTAURANT INTERACTIONS.

FACTORIZES RATING MATRIX INTO LATENT SPACES.

HANDLES MISSING DATA BETTER THAN NEIGHBORHOOD METHODS.

SVD Model Performance

Model	RMSE
SVD (optimized)	0.982

Hybrid Recommendation Model

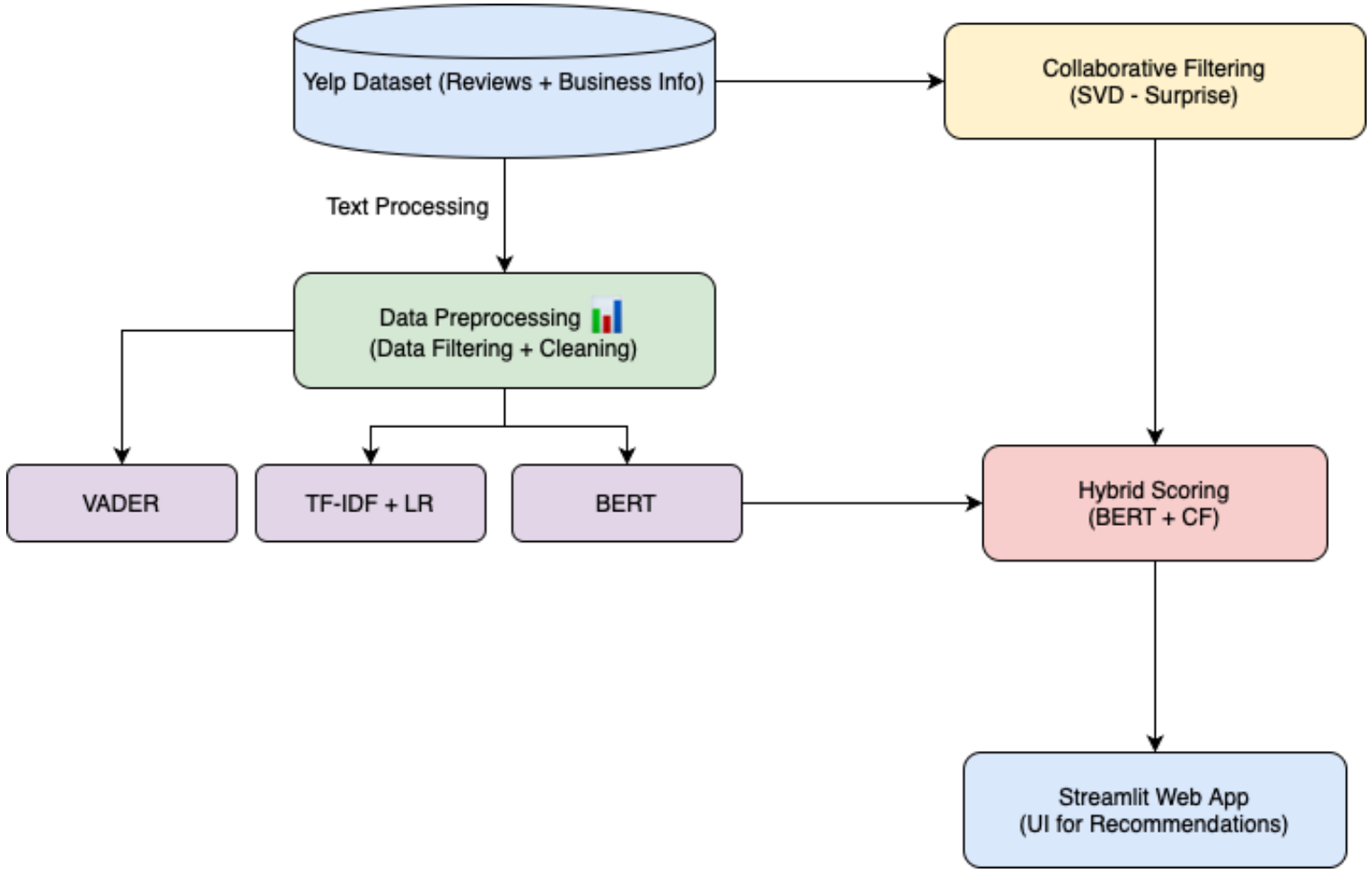
Final hybrid score combines CF prediction and Sentiment strength.

Formula:

Hybrid Score = 0.6 × CF Score + 0.4 × Sentiment Score

More stable and emotionally aligned recommendations.

Hybrid Recommendation Architecture



Top-10 Restaurants (Tucson)

Rank	Restaurant Name	Categories	Business Stars	Review Count	Avg BERT Score	CF Score	Hybrid Score
1	Tumerico	Mexican, Gluten-Free, Vegetarian	5.0	724	4.83	4.82	0.975
2	The Blacktop Grill	Hot Dogs, Food Stands, Nightlife	5.0	100	4.50	4.72	0.929
3	Tacos Apson	Mexican	4.5	248	5.00	4.43	0.909
4	The Quesadillas	Tacos, Mexican	4.5	517	4.22	4.68	0.900
5	The Little One	Mexican, Breakfast & Brunch	4.5	365	4.50	4.57	0.900
6	Aqui Con El Nene	Fast Food, Mexican, Food Stands	4.5	335	4.60	4.50	0.894
7	Taqueria Juanito's	Mexican	4.5	390	4.80	4.41	0.891
8	Sunny Daze Cafe	Diners, Tex-Mex, Cafes	4.5	421	5.00	4.29	0.883
9	Anita Street Market	Food, Grocery, Mexican	4.5	189	5.00	4.29	0.883
10	Salsa Verde Restaurant	Mexican	4.5	342	4.29	4.49	0.869

Observations

Hybrid model highlights hidden gems with strong sentiment.

Balances popularity + emotional satisfaction.

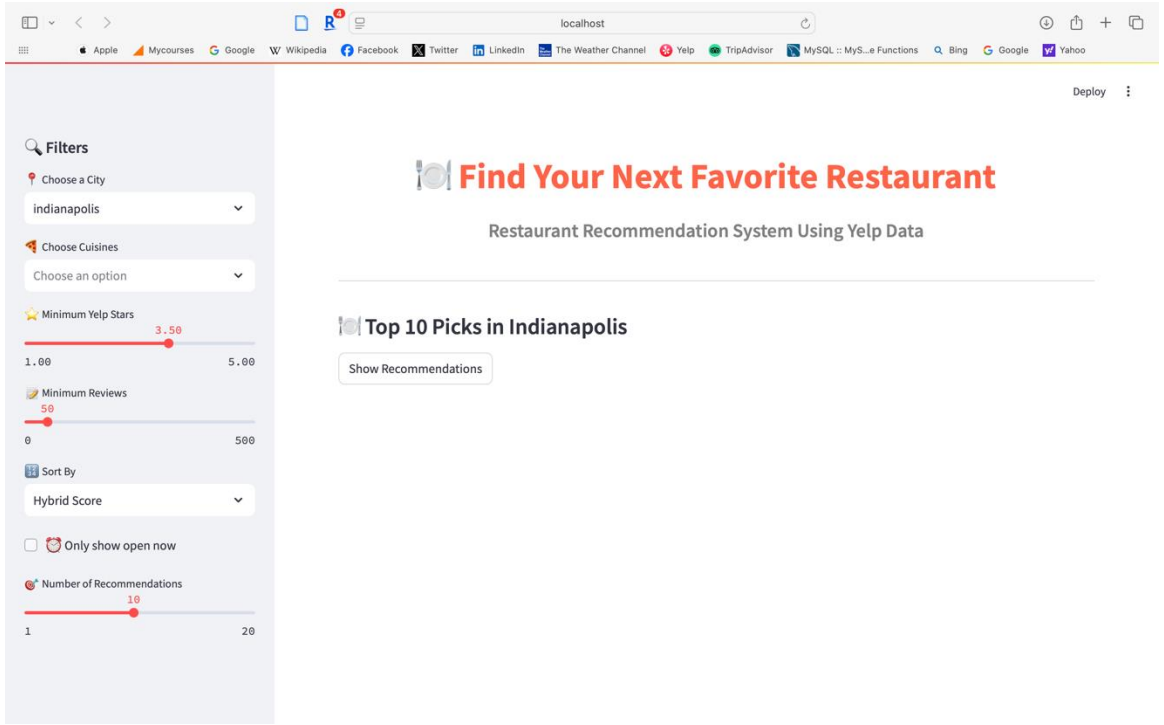
Surface trustworthy recommendations beyond just ratings.

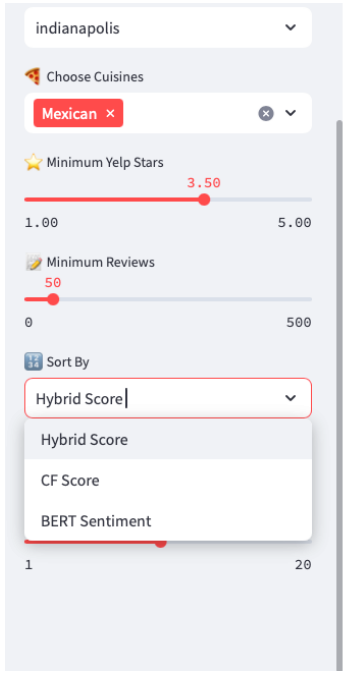
Streamlit App Overview

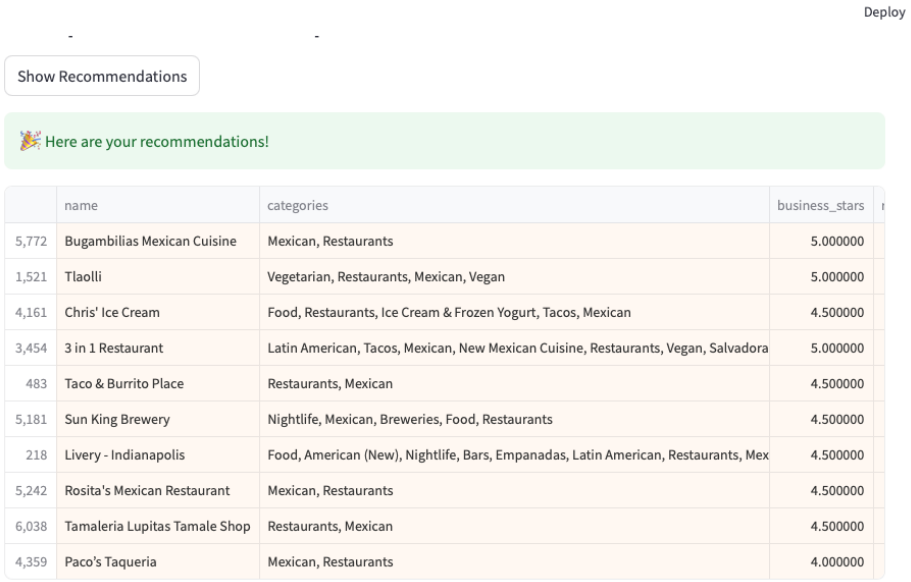
Sidebar filters: City, Cuisine, Minimum Stars, Open Now.

Dynamic Top-N restaurant recommendations.

Easy-to-use offline web deployment.







	name	categories	business_stars
5,772	Bugambilias Mexican Cuisine	Mexican, Restaurants	5.000000
1,521	Tlaolli	Vegetarian, Restaurants, Mexican, Vegan	5.000000
4,161	Chris' Ice Cream	Food, Restaurants, Ice Cream & Frozen Yogurt, Tacos, Mexican	4.500000
3,454	3 in 1 Restaurant	Latin American, Tacos, Mexican, New Mexican Cuisine, Restaurants, Vegan, Salvadora	5.000000
483	Taco & Burrito Place	Restaurants, Mexican	4.500000
5,181	Sun King Brewery	Nightlife, Mexican, Breweries, Food, Restaurants	4.500000
218	Livery - Indianapolis	Food, American (New), Nightlife, Bars, Empanadas, Latin American, Restaurants, Mex	4.500000
5,242	Rosita's Mexican Restaurant	Mexican, Restaurants	4.500000
6,038	Tamaleria Lupitas Tamale Shop	Restaurants, Mexican	4.500000
4,359	Paco's Taqueria	Mexican, Restaurants	4.000000

- App Sidebar (Filters)
- Recommendation Table (Main Area)

Streamlit App Screenshot

Experiment Summary Table

Task	Model/Approach	Metric	Result	Notes
Sentiment Analysis	VADER	Accuracy	71.2%	Rule-based baseline
Sentiment Analysis	TF-IDF + Logistic Regression	Accuracy	81.7%	Classical machine learning
Sentiment Analysis	BERT (Fine-tuned)	Accuracy	91.5%	Best performing sentiment model
Collaborative Filtering	SVD	RMSE	0.982	Matrix factorization approach
Recommendation System	Yelp Stars Only	User satisfaction (qualitative)	Medium	Misses emotional context
Recommendation System	CF Only (SVD)	User satisfaction (qualitative)	High	Focuses on ratings history only
Recommendation System	Hybrid (CF + BERT Sentiment)	User satisfaction (qualitative)	Very High	Best personalized recommendations

Conclusions

- Combining rating history + emotions improves recommendations.
- Hybrid system outperforms standalone models.
- Deploying app demonstrates practical usability.

Future Work – System Enhancements

EXPAND DATASET TO NATIONWIDE/GLOBAL CITIES.

INTEGRATE REAL-TIME REVIEW UPDATES.

ADD IMAGES/MENU ANALYSIS INTO RECOMMENDATIONS.

Future Work – User Personalization

- Add user-specific profiles/preferences.
- Aspect-based sentiment for food, service, ambiance.
- Mobile app version for wider accessibility.

Thank You!