Predicting Emerging Food Trends

22 Feb, 2025 (Group 4)

I Han Chien - Jinger Chen - S Shujahat Ali – Neil Dilawari - Nikita Pawar

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Executive Summary

Objective: Use Yelp Data to Predict Culinary trends

Goal: Identifying emerging culinary trends using Yelp data review.

Approach:

- **Analyze review text and business attributes to identify trending food items, cuisines, or customer preferences.**
- **Using word frequency, Sentiment Analysis, Topic Modeling, Time Series Forecasting to detect shifts** in discussions over time.

Why it matters:

- **Helping restaurants, investors, and food delivery platforms** to identify new food trends and adapt their offerings accordingly.

Findings:

- **Rising interest in international Cuisines such as Tacos**, dumplings etc.
- **American, Japanese, Italian and Mexican Cuisines dominated the insights**
- **Pizza, Pasta and Waffles showed stable demand**, indicating steady consumer interest.

Business Problem Definition

Develop a culinary and dish trend predictor based on reviews from restaurants to help restaurants optimize their operations and marketing

Business Relevance

1 Million Restaurants

$ 1.09 Trillion Revenue
> GDP of Switzerland

13.2 Million People Employed
> Population of Belgium

Taste Buds - A startup to keep you ahead of the trend

- **Trends Predictions for Cuisines and Dishes**
- **Menu Optimization** viz a viz Trends and Dietary Considerations
- **Neighbourhood Healthiness** Tracker and Index
- **Restaurants Healthiness Index**
- Culinary **Tourism Guide**
- **Restaurant Investment and Operations** Optimization
- **Suppliers Inventory Planning** and Ordering Recommendation

Taste Buds - User Interface and Product Features

Over 1,000,000 Restaurants covered

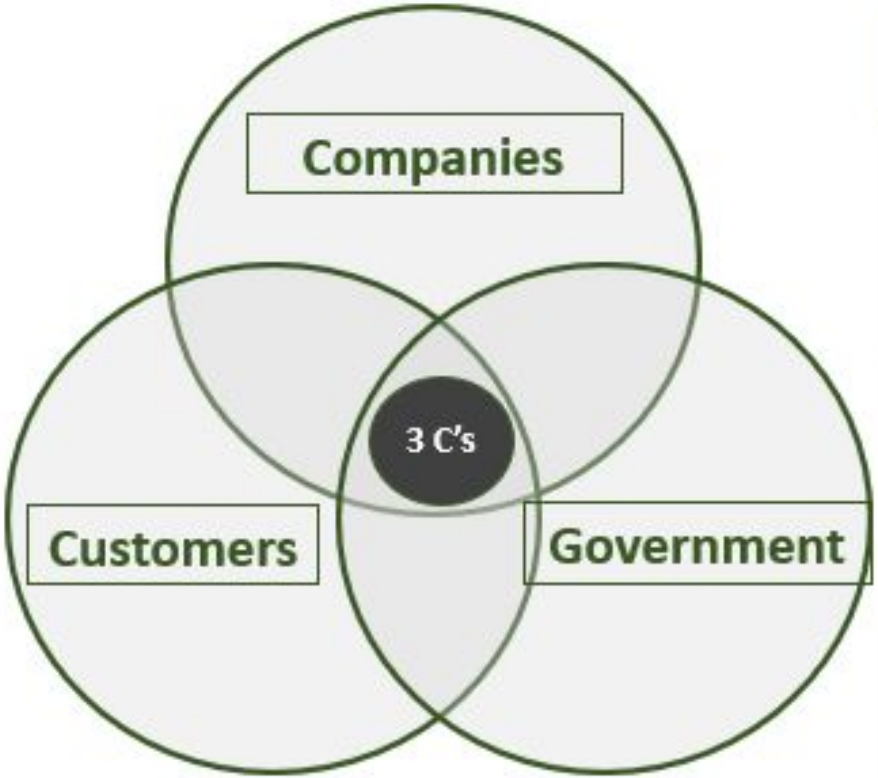
7 Product Lines and endless possibilities

7,000,000 + Reviews covered

Artificial Intelligence based Real Time Analysis

TASTE BUDS™
DECLUTTER AND REVIVED
PREDICTS CULINARY DISH TRENDS
USING RESTAURANT REVIEWS

Ohmae's 3C Model – Modified



3 C's	Sub Sector	Strategy/ Product Offering
Companies	Restaurants Food Chains Groceries Suppliers	• Trends and Dishes Predictions • Ingredients Forecast • Dish pairings and Concurrence • Rivals Identification
Customers	Individuals Tourist Guides Influencers	• Top Restaurants • Healthy Dining Options • Healthy Neighborhoods • Rising Trends
Government	Food Regulator Authorities Congress Public Services	• Healthiness of Foods • Supply Chain Stresses • Food Safety • Public Health Advisory

Why Philadelphia

Why Philadelphia

Diverse Food Scene & Cultural Fusion

Home to iconic dishes – Philly Cheesesteak, Roast Pork Sandwiches, Soft Pretzels
Ethnic Diversity – Rich influence from **immigrant communities**

Thriving Restaurant Industry & Trend Adoption

Over 6,000 restaurants – A **mix of Michelin-starred venues, family-owned spots, and fast-casual innovators**.
Philly often **adopts national food trends** early (e.g., plant-based dining, artisanal bread, and Korean BBQ).
Rising foodie culture – A **hub for experimentation** with pop-ups, food trucks, and **hyper-local sourcing**.

Rich Review Data for Analysis

Large volume of **Yelp reviews**, allowing deep **insights into customer sentiment & emerging trends**.

🌆 **Diverse culinary landscape +** 📈 **Trend adoption hub +** 🛒 **Rich data availability →** 🚀 **Ideal city for food trend prediction!**

Data Preprocessing – Process Followed

Merge and filter data to make reduce size and reduce the need to run code repeatedly by converting it to CSV

Data Pre-Processing

Merged Business and Reviews on Business_ID

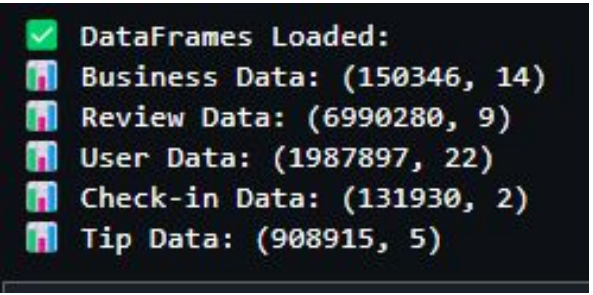
Filtered for PA

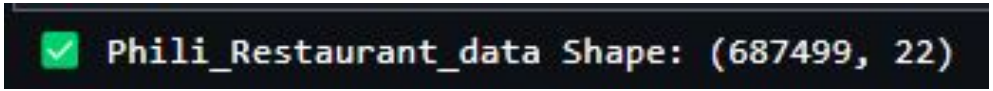
Filtered for Philadelphia

Filtered for Restaurants in categories

Download CSV (1.32 GB)

Data Preprocessing – Reducing and Filtering Data Size





Final Data (117869, 8)

12

Increased processing speed, relevant data and parallel development and analysis enablement

Data Preprocessing Current Data Structure

Keeping the relevant data for quick and robust analysis and parallel working

Columns

stars_x > 3
useful non zero
text reviews
Postal Code
review_count no restriction
is_open = 1
Months 1-12
year 2013 - 2016

Assumptions:

Star 4 or 5 because positive experience leads to trend

Useful non zero

Business is open

2013 to 2016 saw no economic, tech or health related disruption

Final Data Structure and Word Cloud

Data Loaded: 24947 rows, 10 columns

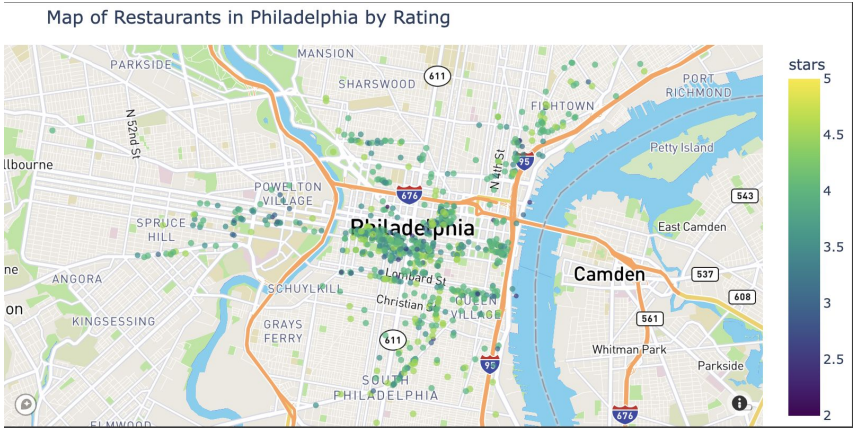
- Column Names & Data Types:

stars_x	int64
useful	int64
text	object
name	object
postal_code	int64
review_count	int64
categories	object
year	int64
month	int64
Day_Of_Week	object

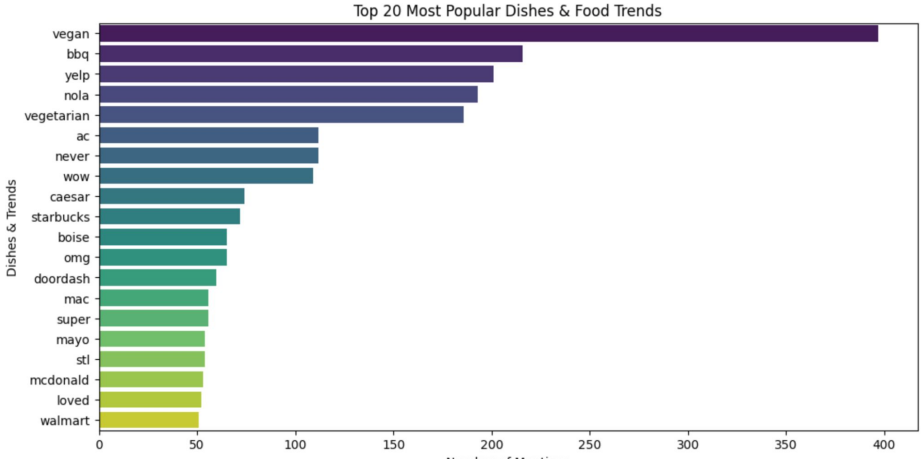
dtype: object

Geographic Breakdown & Most Popular Dishes

- Most of the restaurants in center Philadelphia were rated 3.5 - 4.5 stars showing high quality of restaurants



- We can see most popular dishes overall are **vegan, bbq, and caesar salads**…showing consumers enjoy healthy options with the occasional craving for some unhealthier options such as bbq

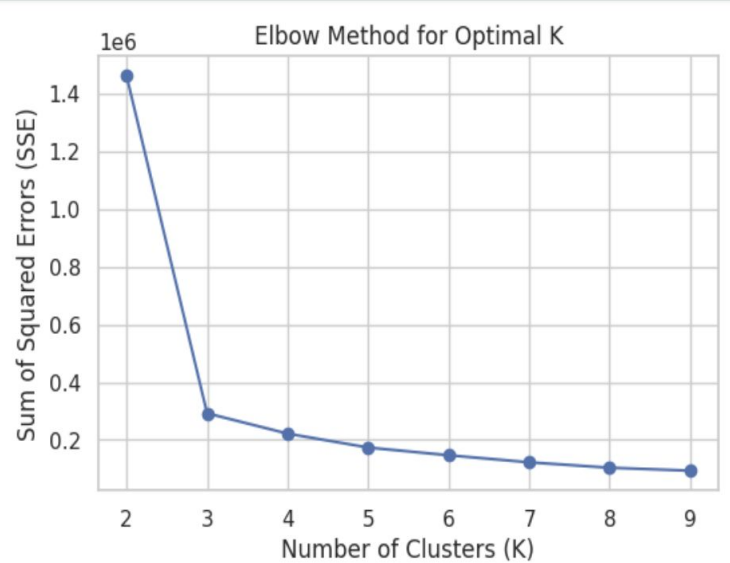


Machine Learning Methodologies Used

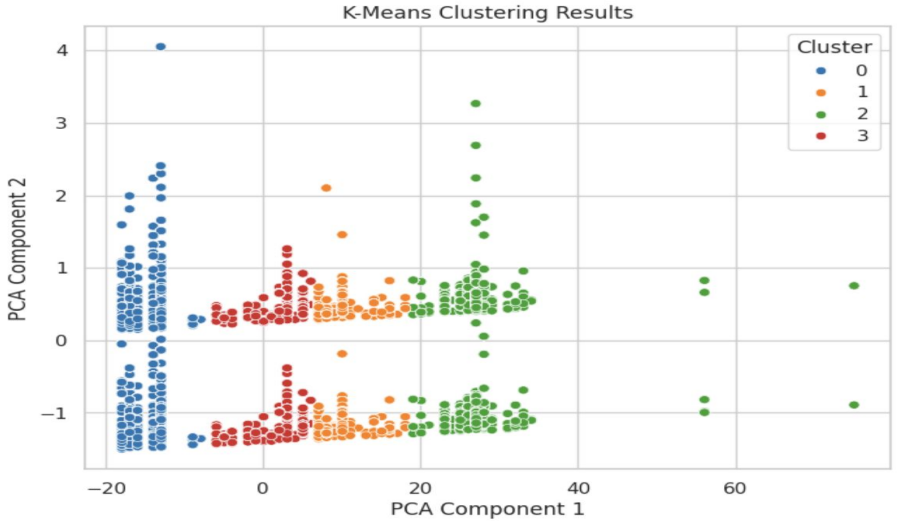
A host of text analysis and network analysis methods were used

1. Topic Modeling - LDA
2. Name Entity Recognition
3. Keyword Frequency Analysis
4. Network Analysis
5. Clustering (K-Means or DBSCAN)
6. Time Series Forecasting using LSTM

Yelp Restaurant Trend Analysis Using K-Means Clustering

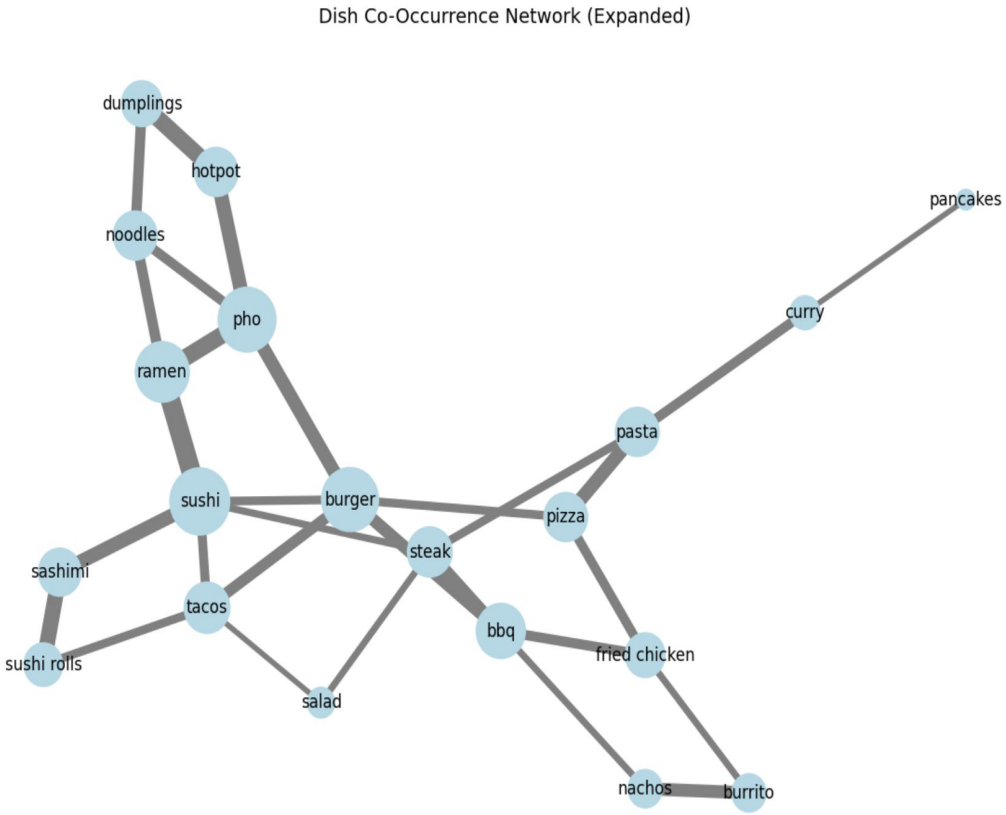


K-Means clustering to categorize Yelp data into four main groups.
When K=4, the decrease in SSE (Sum of Squared Errors) slows down, indicating that K=4 is the optimal choice for better analyzing restaurant trends.



- **Blue (Cluster 0):** Budget-friendly restaurants, affordable prices, moderate ratings
- **Orange (Cluster 1):** Mid-range restaurants, diverse cuisine, popular among customers
- **Green (Cluster 2):** High-end restaurants, high ratings, strong customer loyalty
- **Red (Cluster 3):** Specialty/niche restaurants, catering to specific needs

Dish Co-Occurrence Network Analysis - Menu Optimization



Asian cuisine dishes cluster strongly, signaling high cross-order potential.

Pasta and curry form distinct, less connected preference clusters.

BBQ and fried chicken co-occur, suggesting **Southern cuisine synergy**.

Sushi bridges diverse cuisines, indicating **strong fusion potential.**

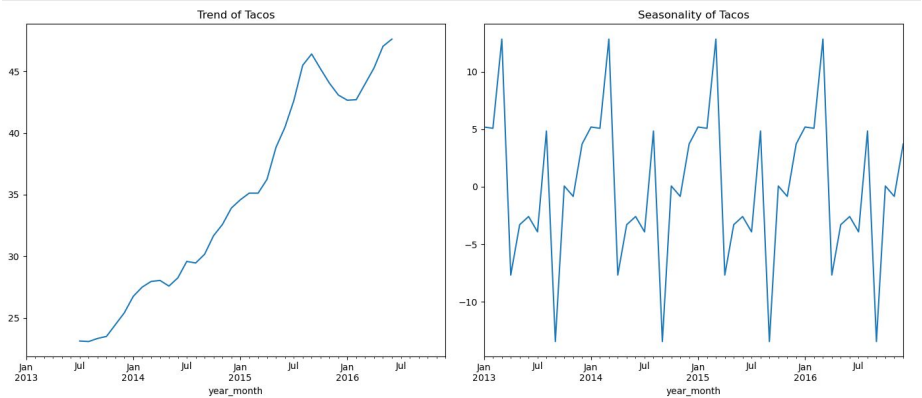
Dumplings, hotpot, and ramen show strong complementary ordering trends.

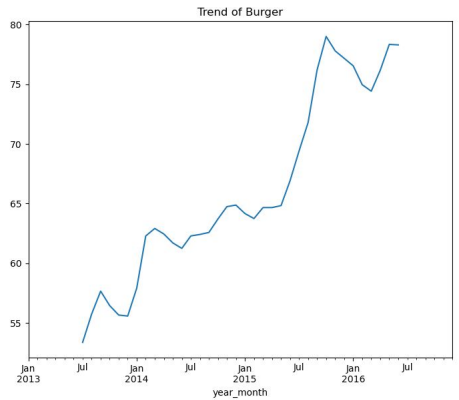
Pizza and steak act as central **Western dish connectors.**

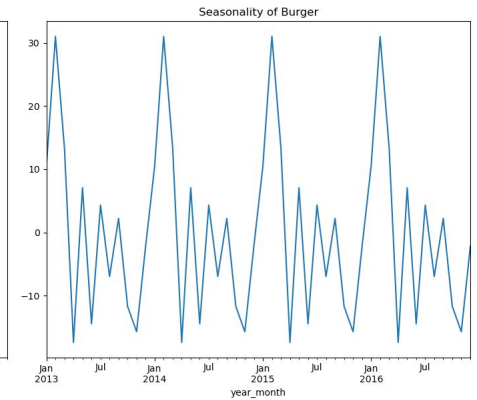
Keyword Frequency Analysis - Trends Prediction

Seasonal Changes: When Do Foods Trend the Most?

Some foods exhibit **clear seasonal fluctuations** in their popularity.

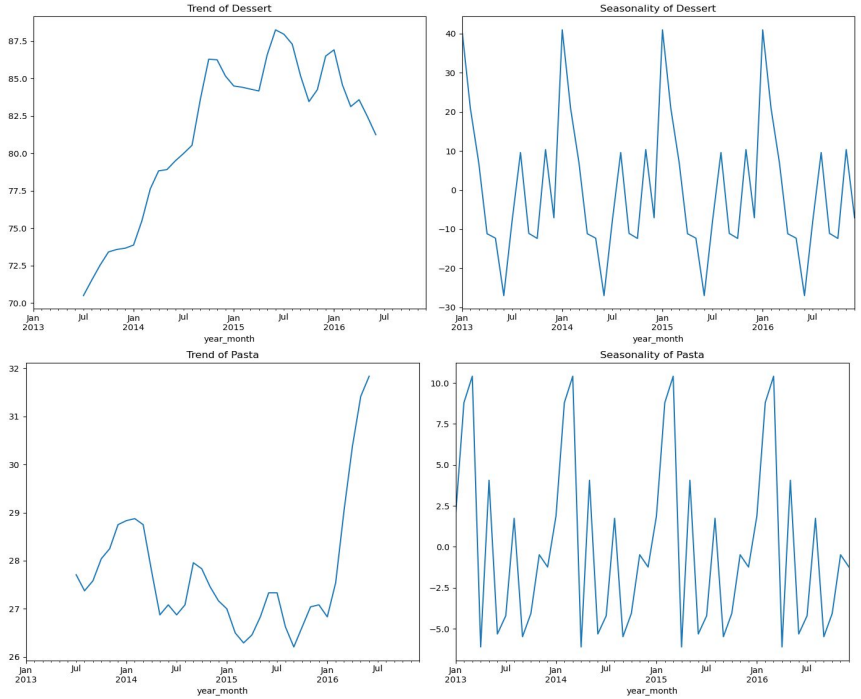


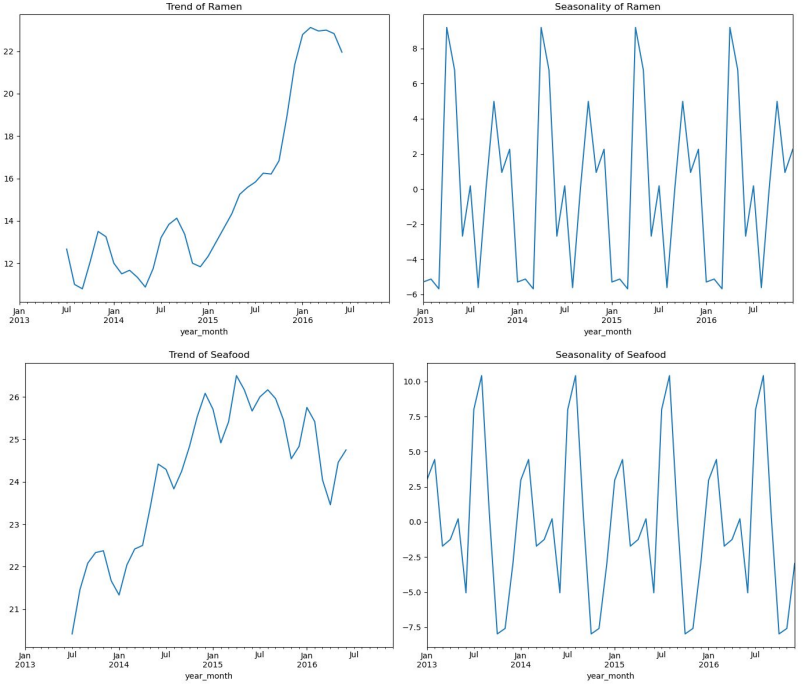




- **Tacos tend to peak in certain months**, likely **during the summer or around events like Cinco de Mayo.**
- **Burgers experience higher mentions during the U.S. BBQ season (May to July),** indicating a strong connection to outdoor activities and summer dining.

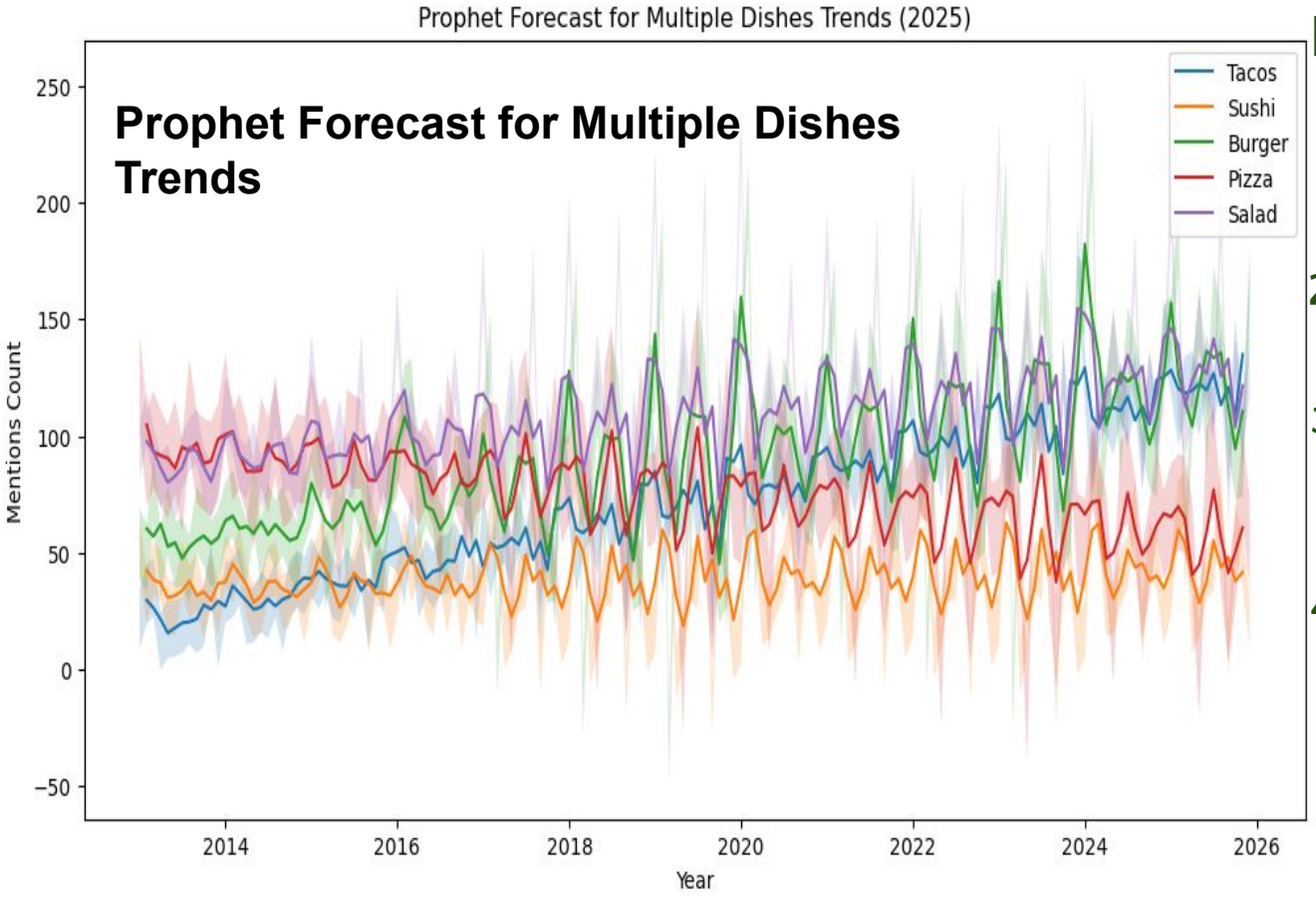
Keyword Frequency Analysis - Trends Prediction





- **Desserts and Pasta see increased discussions during winter months,** possibly due to consumer preferences for **comforting, high-calorie foods in colder weather.**
- **Ramen and Seafood also show distinct seasonal trends,** suggesting that consumer eating habits shift based on the time of year.

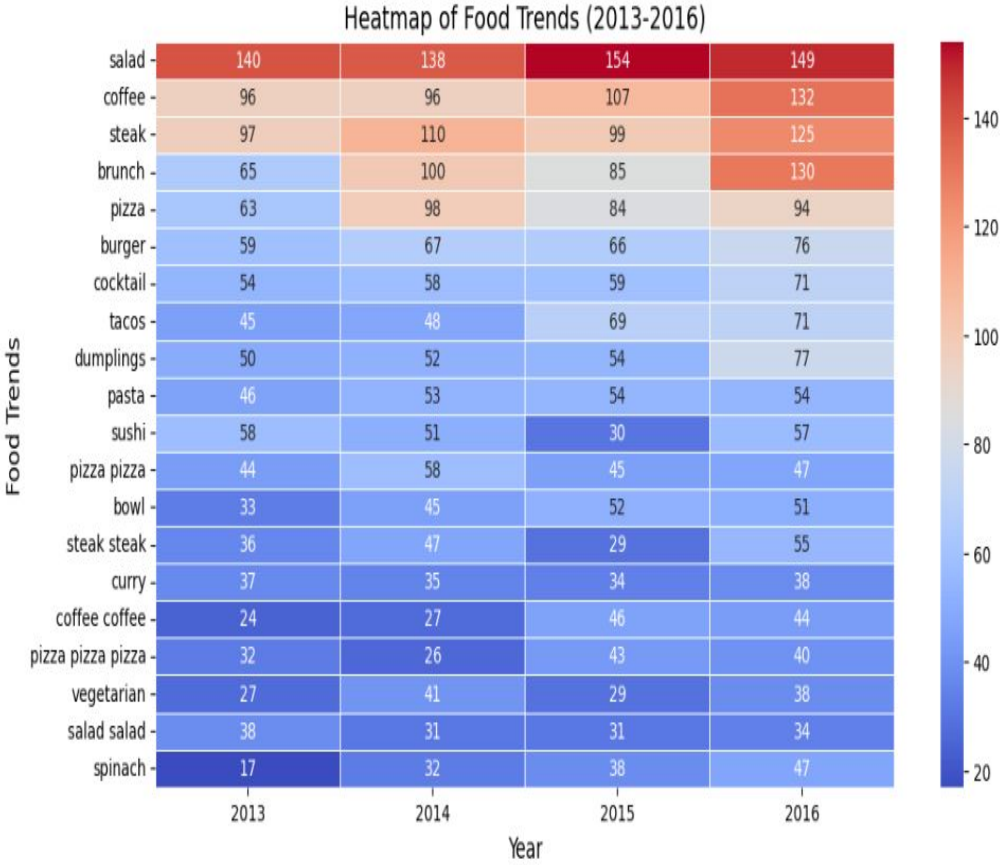
Keyword Frequency Analysis - Predicting Future Demand



Key Insights

1. **Strong Growth in Burgers, Tacos, and Salads**
2. Stable but **Slower Growth for Pizza** and Sushi
3. **Peak demand periods align** across dishes, supporting **combo meal strategies.**
4. **Salad demand is volatile, indicating health-conscious seasonal shifts.**

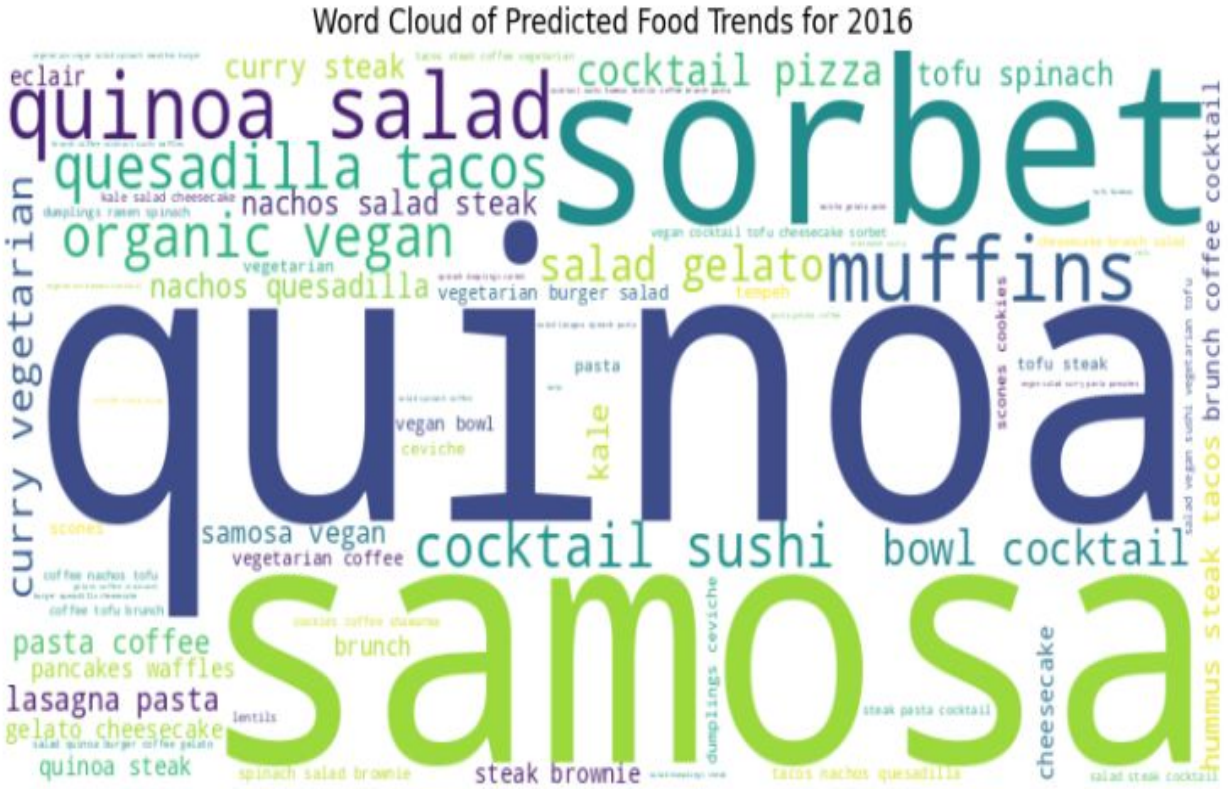
Time Series Forecasting for Food Trends Using LSTM Model



Key Food Trend Insights (2013- 2016):

- Most Popular Food Trends :
  Salad , Coffee, Steak
- New Emerging Trends:
  Dumpling and tacos - suggested growing interest in international cuisine.
  Burger and cocktail trends - reflecting changes in dining and beverage preferences.
- Declining Food mentions :
  Sushi saw decline from year 2023- 2015 but slightly rebounded in 2016.
  Curry and vegetarian mentions fluctuated, with no obvious upward trend, showing sustained but narrow appeal.
- Stable Trends : **Pizza, Pasta and waffles**
- Business Implications : Growing demand for healthy and global cuisines.

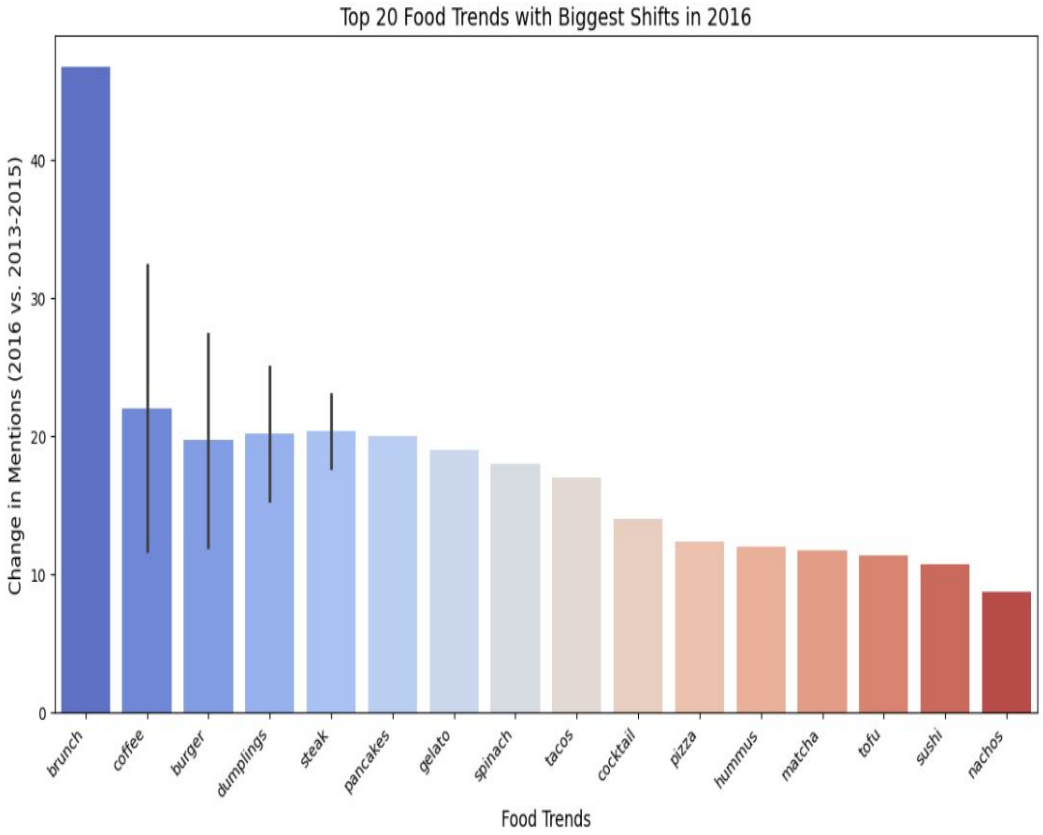
Time Series Forecasting for Food Trend Using LSTM Model



Predicted Food Trends for 2016 – Key Insights:

- 2016 food trends show a push towards **healthier options**, although **ethnic flavours and desserts continue to thrive.**
- **Restaurants, food companies, and marketers** should connect their offers with these trends to remain **competitive in the ever-changing food business.**
- The combination of **wellness and indulgence represents an unique potential** for market innovation.

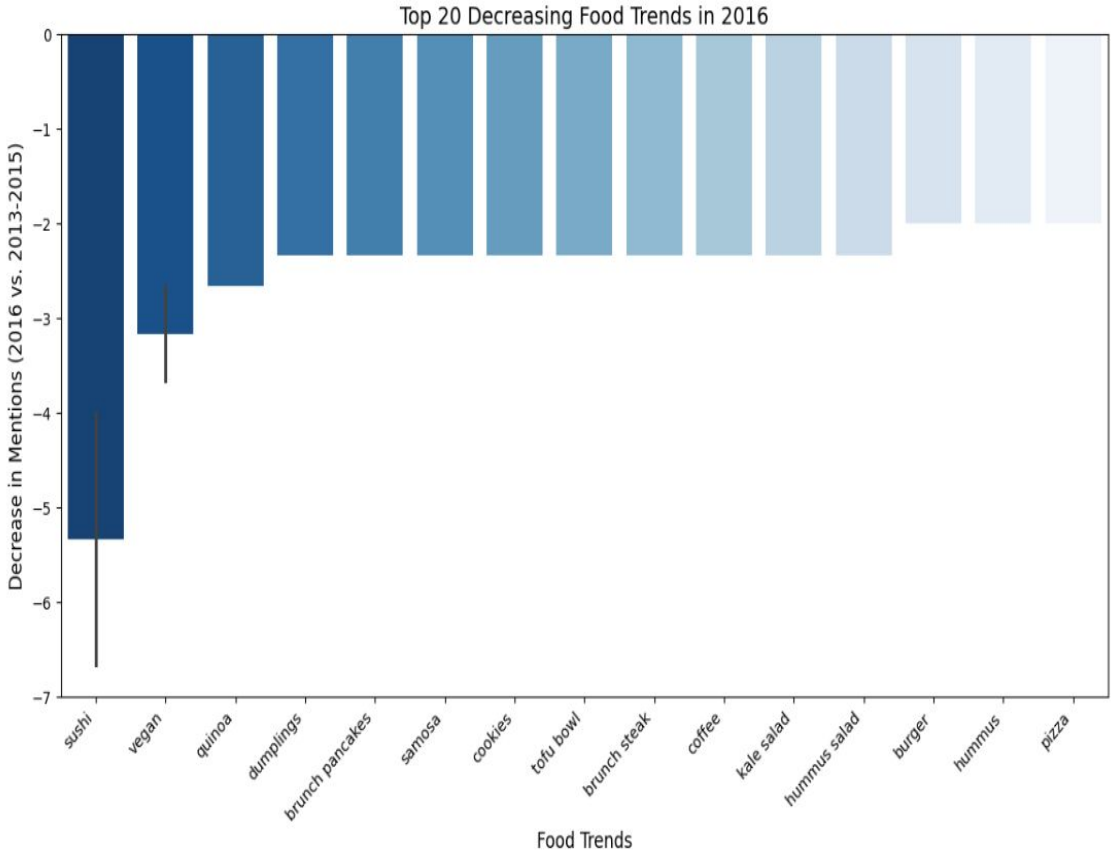
Top 20 Food Trends with Biggest Shifts in 2016



Actionable Insights:

- **Businesses should focus on brunch, coffee, and international cuisine** as these trends have shown strong growth.
- **Burgers** continue to thrive, likely due to gourmet and plant-based burger innovations. **Dumplings** gained traction, showing an increasing diversity in food preferences.
- **Health-conscious foods (tofu, matcha, spinach, hummus) continue to rise**, presenting opportunities in **vegan, organic, and functional food categories**.
- **Specialty drinks (cocktails, coffee) are gaining traction**, indicating demand for **premium and craft beverage experiences**.
- **Sushi and nachos saw a smaller increase** compared to emerging food trends.

Top 20 Decreasing Food Trends in 2016



Potential causes for the declining Food Trends:

- **Shifting Consumer Preferences:** People might be exploring **newer food trends**, causing previous favorites to lose traction.
- **Saturation of Health Trends:** The hype around **vegan, quinoa, and kale-based meals** may have plateaued.
- **Emergence of New Trends:** Other trends like **protein-based, keto-friendly, and plant-based fast foods** might be taking over.
- **Cultural and Lifestyle Changes:** Consumers may prefer **convenience-focused foods** over traditional dishes requiring longer preparation.
- **Dumplings and Coffee** shows **Contradictory trends** , suggesting that consumer preferences shift in specific context.

Named Entity Recognition (NER)

- Based on the Named Entity Recognition Analysis, what we found is:
  - Most popular dishes include: pizza, fries, steak, burger, noodles, and sushi
  - The most popular cuisines include: American, Japanese, Italian, and Mexican

- Certain items like fries and burger will remain at the top of the list due to their national popularity, especially prevalence in fast food restaurants

- The prevalence of broth, sushi, and noodles show an increasing trend of Asian dishes

Top Food Dishes

	Food Item
8	pizza
2	fries
7	steak
3	burger
6	noodles
14	sushi
1	pasta
12	broth
9	bbq
11	curry

Cuisine Trends:

	Cuisine	Count
3	American	8650
2	Japanese	5737
0	Italian	5390
1	Mexican	1377

Time Series Analysis of predicting popular dishes

Insights:

- Based on this table, lists food and beverage items with their MAE, to measure prediction accuracy
- The model was best at predicting beverage items as some of the top performing predictions were smoothie, latte, espresso, and matcha
- The single best performer in this model was smoothies

Top Performing Predictions:

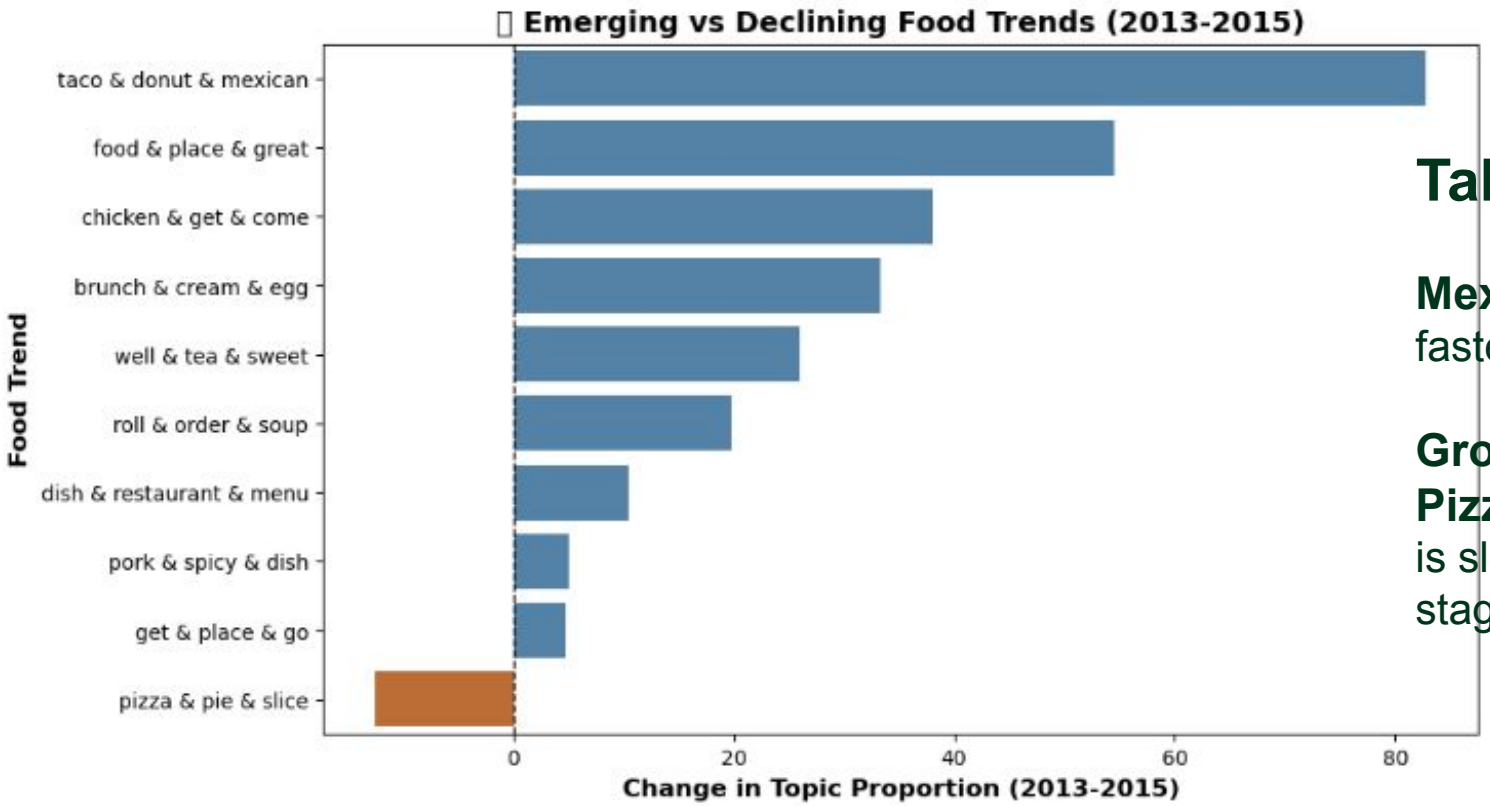
	Food Item	MAE
26	smoothie	2.703769
14	latte	3.360423
11	falafel	3.804190
10	espresso	3.990232
22	ramen	4.372028
31	waffles	4.477824
32	matcha	5.333015

Topic Modeling with 12 Topics

Topic	Words
Topic 0: get & place & go	get, place, go, time, like, one, make, take, eat, say
Topic 1: dish & restaurant & menu	dish, restaurant, menu, meal, order, one, like, make, dessert, would
Topic 2: chicken & get & come	chicken, get, come, order, place, really, food, try, like, sauce
Topic 3: sandwich & cheese & burger	sandwich, cheese, burger, fry, cheesesteak, steak, order, meat, philly, onion
Topic 4: taco & donut & mexican	taco, donut, mexican, chip, burrito, salsa, margarita, guacamole, flavor, fresh
Topic 5: pizza & pie & slice	pizza, pie, slice, cheese, sauce, crust, fresh, tomato, italian, order
Topic 6: pork & spicy & dish	pork, spicy, dish, sauce, chicken, hot, dan, beef, korean, spice
Topic 7: great & food & bar	great, food, bar, place, beer, drink, come, go, get, night
Topic 8: roll & order & soup	roll, order, soup, noodle, food, sushi, place, rice, thai, dumple
Topic 9: food & place & great	food, place, great, philly, restaurant, service, go, love, amazing, always
Topic 10: brunch & cream & egg	brunch, cream, egg, chocolate, sweet, toast, ice, breakfast, delicious, cheese
Topic 11: well & tea & sweet	well, tea, sweet, light, offer, make, serve, like, coffee, flavor

Topic Modeling to get Topics

Absolute Proportion Change in Topics from 2013-2015

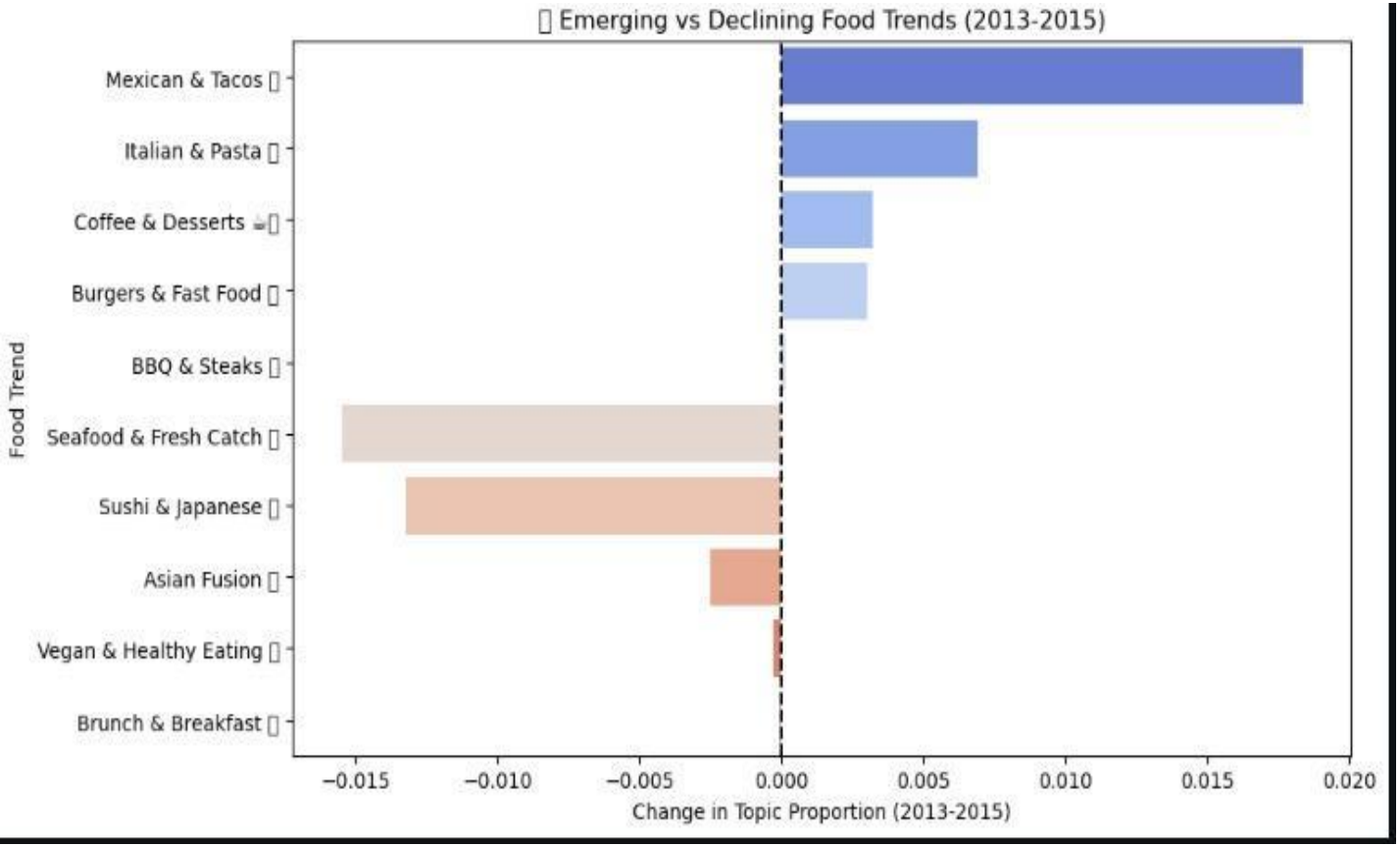


Takeaways:

Mexican Food is fastest growing

Growth in Sushi, Pizza and fast food is slowing or stagnating

Relative Proportion Change in Topics from 2013-2015



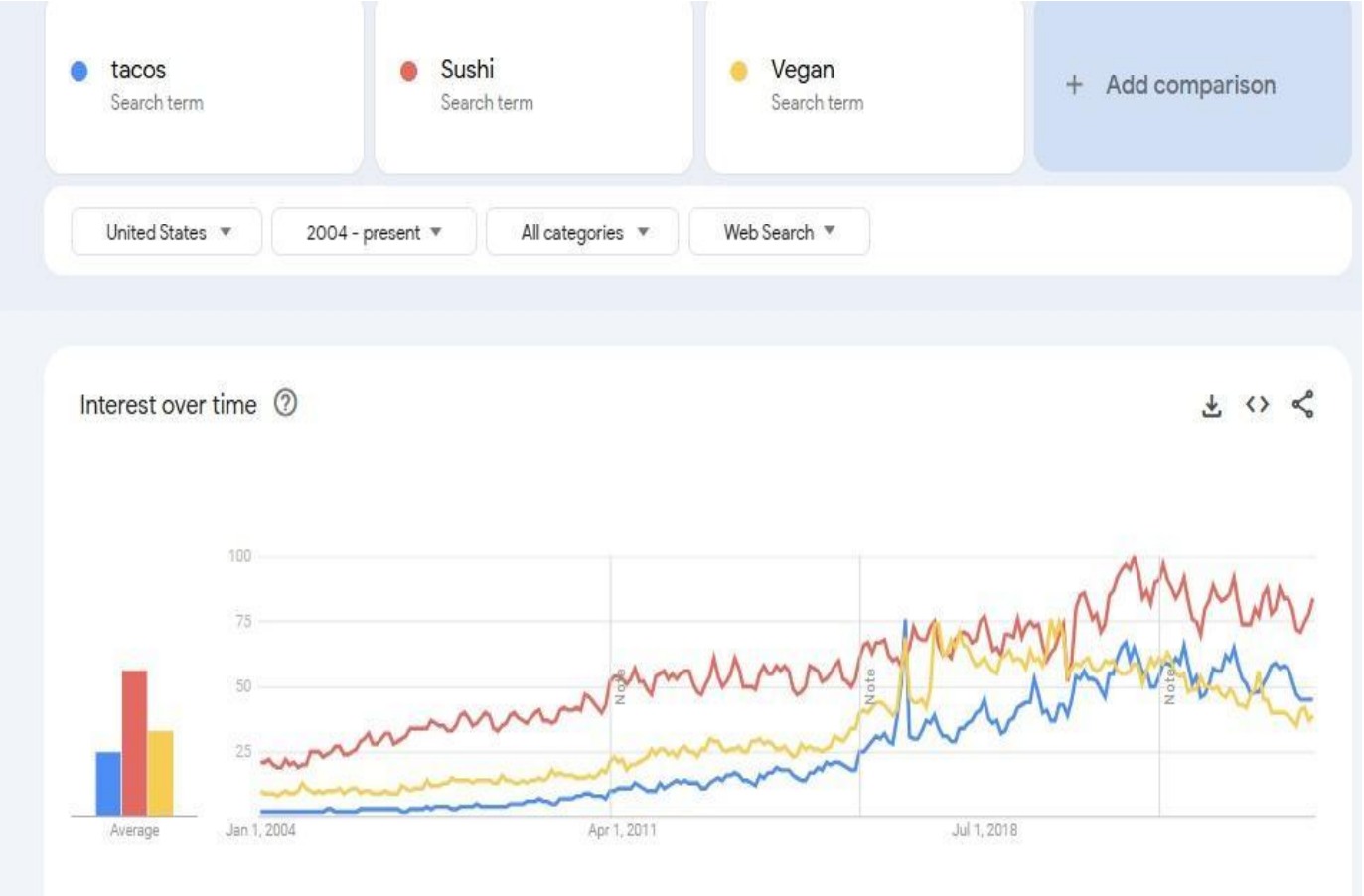
Takeaways:

Mexican Food is fastest growing

Growth in Sushi, Pizza and fast food is slowing or stagnating

Validates finding from Absolute change data

Cross Validation with Google Trends



Takeaways:

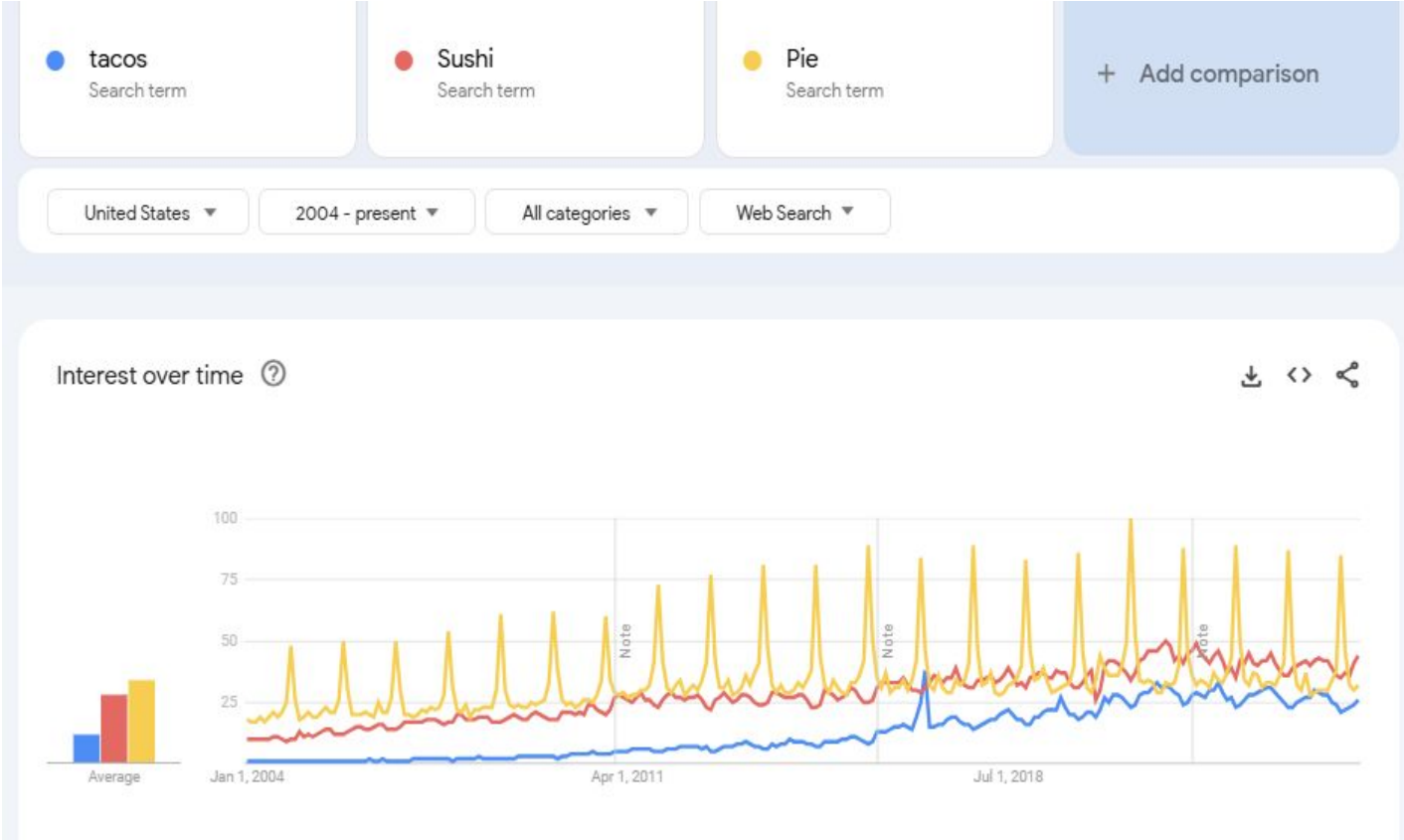
Confirms finding that Tacos did grow fast

Tacos have **overtaken Sushi and rolls**

Validates finding from Absolute and Relative change data

Tacos have **closed gap on vegan** too

Cross Validation with Google Trends - Taco/Pie



Takeaways:

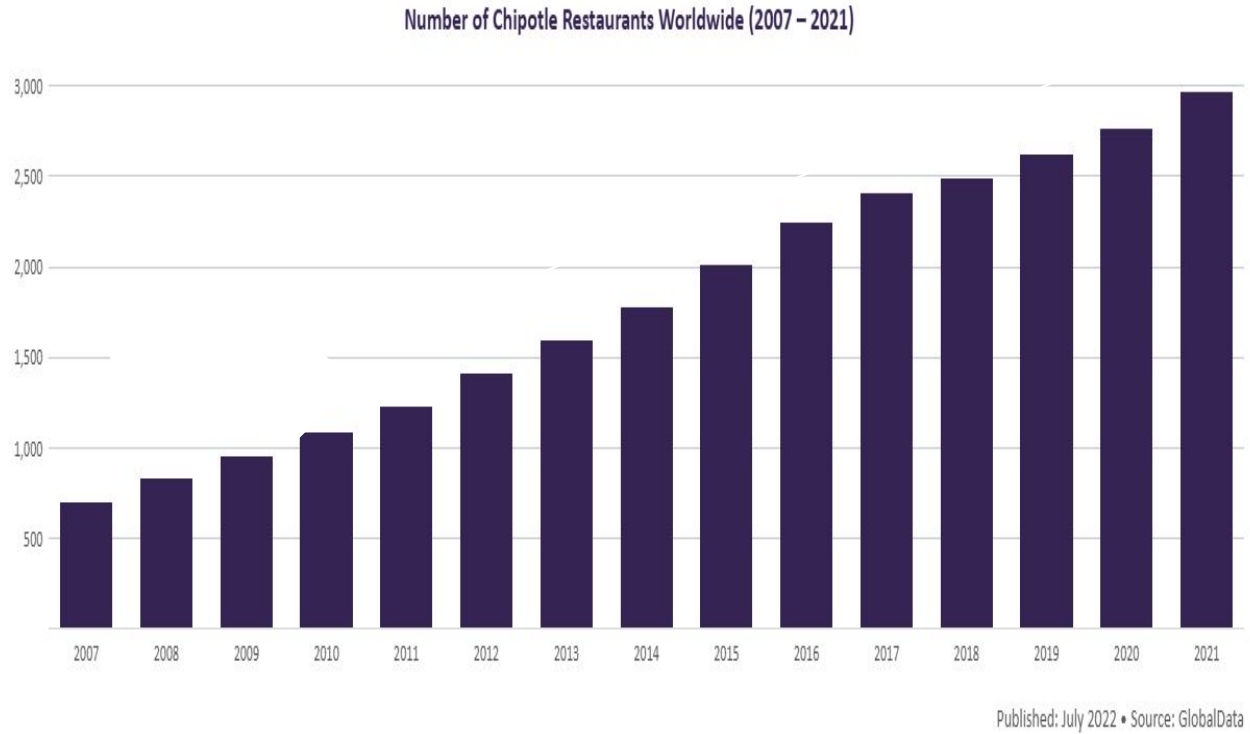
Confirms finding that Tacos did grow fast

Tacos have **overtaken Sushi and rolls and Pie**

Validates finding from Absolute and Relative change data

Tacos have **closed gap on Pie** too

Cross Validation through Comparison with Chipotle



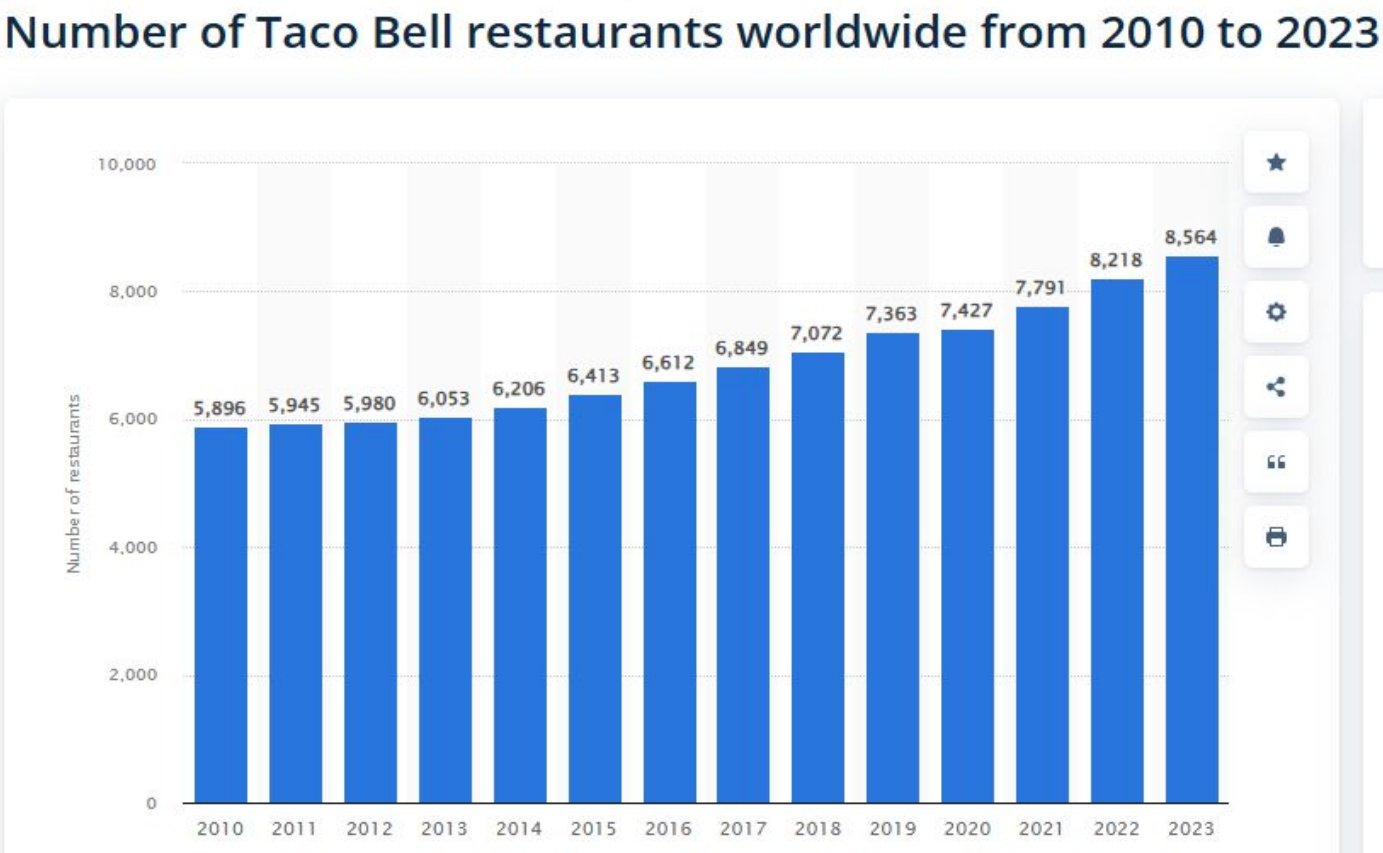
Takeaways:

7000 Branches and growing

2023 15% Revenue growth compared to 7% for industry

Validates finding from Absolute and Relative change data that Mexican Food is on the rise

Cross Validation through Comparison with Chipotle



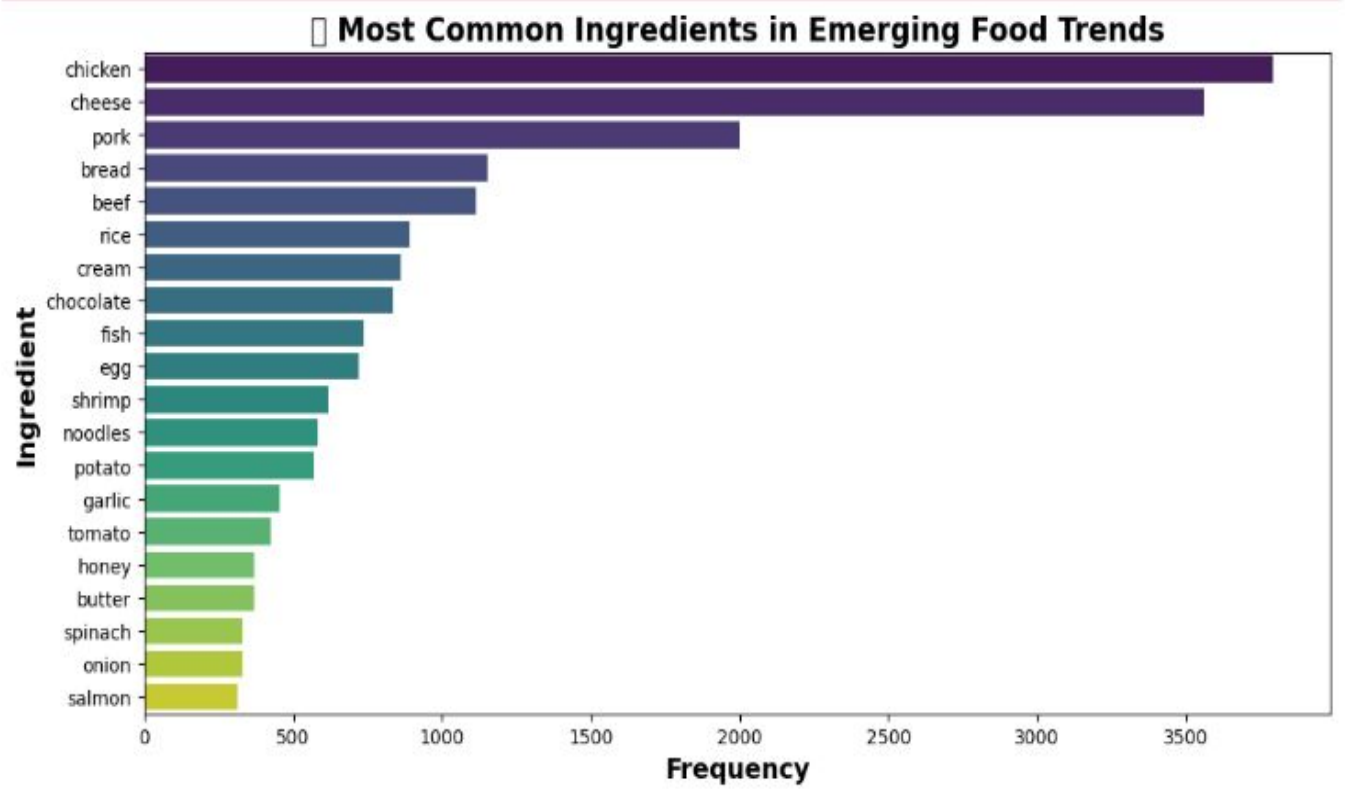
Takeaways:

8,564 Branches and growing

2023 5% same store Revenue growth for higher than competitors

Validates finding from Absolute and Relative change data that Mexican Food is on the rise

Ingredient Demand - Supplier planning and inventory



Takeaways:

Chicken and cheese dominate – Most frequently used emerging ingredients.

Protein-rich trend – Pork, beef, fish, and shrimp are popular.

Diverse ingredients – Sweet, savory, and healthy foods are trending.

Staples remain strong – Rice, noodles, and potatoes still relevant.

Neighbourhood Healthiness Index

	Healthy Keywords	Unhealthy Keywords
1	salad	burger
2	quinoa	fries
3	smoothie	fried
4	grilled	cake
5	avocado	pizza
6	veggie	donut
7	organic	bacon
8	kale	bbq
9	poke	cheese

Top 10 Healthiest Postal Codes

	Postal Code	Healthy Score
1	19139	0.99999
2	19149	0.477273
3	19112	0.444444
4	19153	0.392857
5	19103	0.384918
6	19106	0.377897
7	19102	0.362661
8	19121	0.3
9	19148	0.299065
10	19107	0.289523

Top 10 Unhealthiest Postal Codes

	Postal Code	Unhealthy Score
1	19135	0.999999
2	19126	0.999999
3	19151	0.999998
4	19124	0.999998
5	19144	0.999997
6	19154	0.99999
7	19132	0.99999
8	19129	0.959183
9	19111	0.954545
10	19122	0.953642

Restaurants Healthiness Index

	Healthy Keywords	Unhealthy Keywords
1	salad	burger
2	quinoa	fries
3	smoothie	fried
4	grilled	cake
5	avocado	pizza
6	veggie	donut
7	organic	bacon
8	kale	bbq
9	poke	cheese

Top 10 Healthiest Restaurants

	Restaurant Name	Healthy Score
1	sweetgreen	1.0
2	Khmer Kitchen	1.0
3	Dizengoff	0.999999
4	Tria Cafe Rittenhouse	0.999999
5	Mood Cafe	0.999999
6	Stock	0.999999
7	Effie's Restaurant	0.999999
8	Fat Salmon	0.999999
9	Vientiane Café	0.999999
10	Zama	0.999999

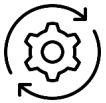
Top 10 Unhealthiest Restaurants

	Restaurant Name	Unhealthy Score
1	Pizzeria Beddia	1.0
2	Beiler's Bakery	1.0
3	Rosa's Fresh Pizza	1.0
4	Federal Donuts	1.0
5	Shake Shack	1.0
6	SPOT Gourmet Burgers	1.0
7	P'unk Burger	1.0
8	Nine Ting	1.0
9	Deke's Bar-B-Que	1.0
10	Vince's Pizzeria	1.0

Summary - Comparison of Models and Results

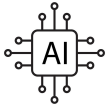
Model Used	Strengths	Weaknesses	What did it predict	Why did it predict that
K-Means Clustering & Dish Co-Occurrence Network Analysis	Identifies restaurant trends and menu item associations to optimize sales	Requires predefined K value, sensitive to outliers, and can't directly predict sales	Categorized restaurants into four types (budget) and identified frequent pairings	Elbow method determined K=4, and clustering was based on PCA features.
Keyword Frequency Analysis	Simple, interpretable, effective for identifying emerging trends.	Lacks context, sentiment, and synonym handling.	Rise of plant-based food, mexican cuisine.	Based on word count shifts in reviews
Time Series Forecasting using LSTM Model	LSTM effectively predicts time-dependent correlations in food trends, forecasting shifts based on past data.	Requires a large amount of training data. Sensitive to data preprocessing and model tuning and Can be computationally expensive.	Accurately forecasted rising interest in healthy foods, international cuisine, and specialty drinks, while identifying declining trends.	Helps restaurants, marketers, and suppliers adjust inventory, menu offerings, and marketing strategies based on anticipated trends.
Named Entity Recognition Time Series	Identified popular dishes along with cuisines to prioritize strategic marketing initiatives.	Limited generalization to new entities, and Overlapping Entities (Philly, Cheesesteak, Philly Cheesesteak)	Performed really well in predicting upcoming beverage popularity	Helps smoothie cafes, coffee shops, etc in predicting future demand, along with what to focus their spending on.
Topic Modeling LDA	Unsupervised, interpretable, scalable, and effective for trend analysis.	Manual topic labeling, sensitive to parameter tuning, and fixed	Rise of Mexican Cuisine, Brunches, tacos.	Based on recurring patterns in customer reviews, identifying

Limitations



Small Dataset

Technical Issues

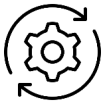


Pandemic Effects

Cross Platform Collaboration and Data Sharing

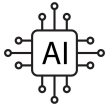
High Seasonality

Future Perspectives



Expansion across geography for other States

Developing a Similar Model for other industries say Fashion



AI based Menu Generator

Sustainability and Ethical Eating Trends

Federated Learning and in house consultancy for Customers Preference