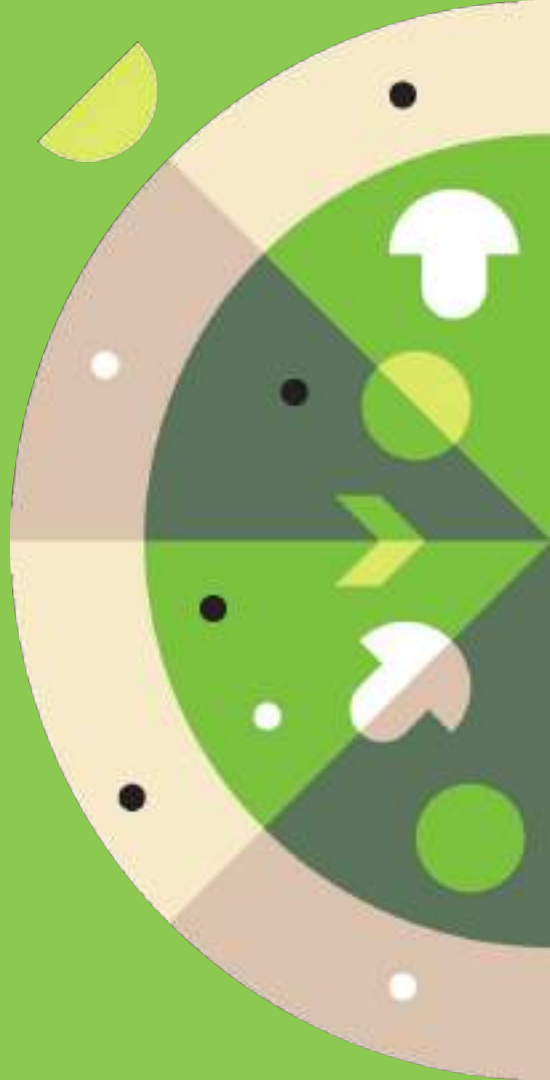




# How AI Powers <sup>UBER</sup>eats

[Yuanchi Ning](#) (Uber Eats)

December 2017



# QCon

全球软件开发大会

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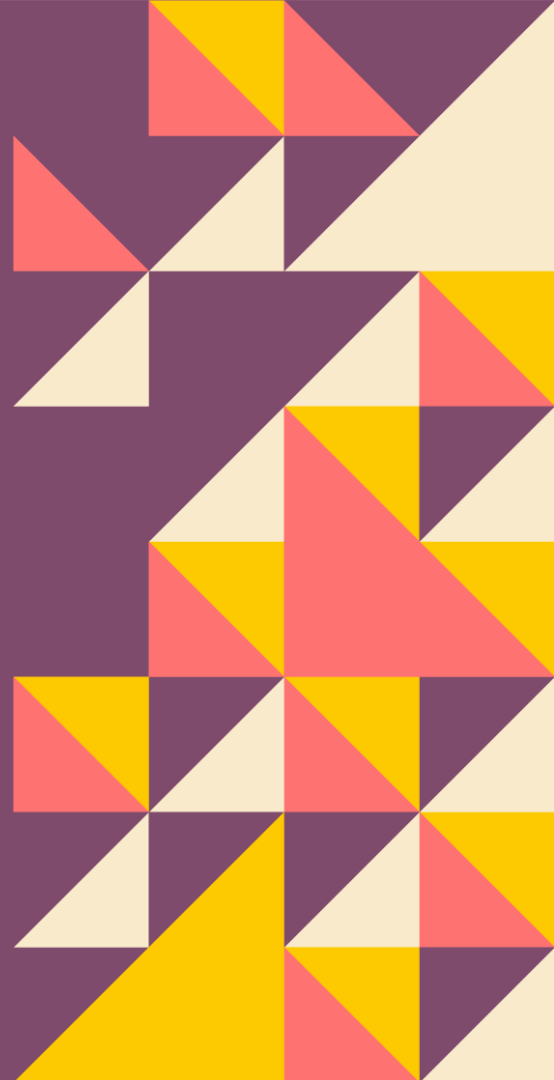
# Agenda

- Uber Eats Overview
- AI Platform
- AI Challenges
  - Challenges as a marketplace
  - Challenges of Uber Eats discovery
    - Restaurants ranking and recommendation
    - Guided Exploration





# Uber Eats Overview



Make eating well effortless at anytime,  
for anyone.

Uber Eats mission



**Crave Cupcakes Kirby** 20-30 MIN

Dessert • Bakery • \$\$

Houston Press: Best Cupcakes



**Chaste Foods** 30-40 MIN

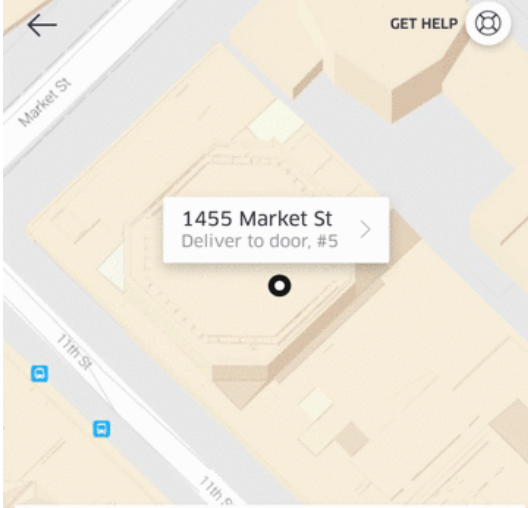
Sort Restaurants

### Under 30 Minutes



**Indie Fresh - Midtown West**  
Healthy • Vegan • Gluten Free • \$\$

Popular near you



Shanghai Dumpling King

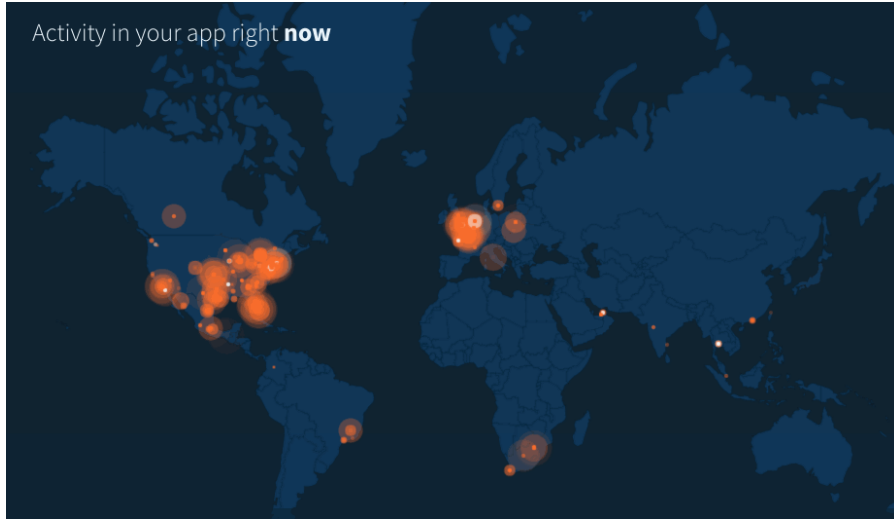
**11:10 AM** Est. delivery time

Food is being prepared 10:32 AM

Order Details



# Uber Eats Timeline

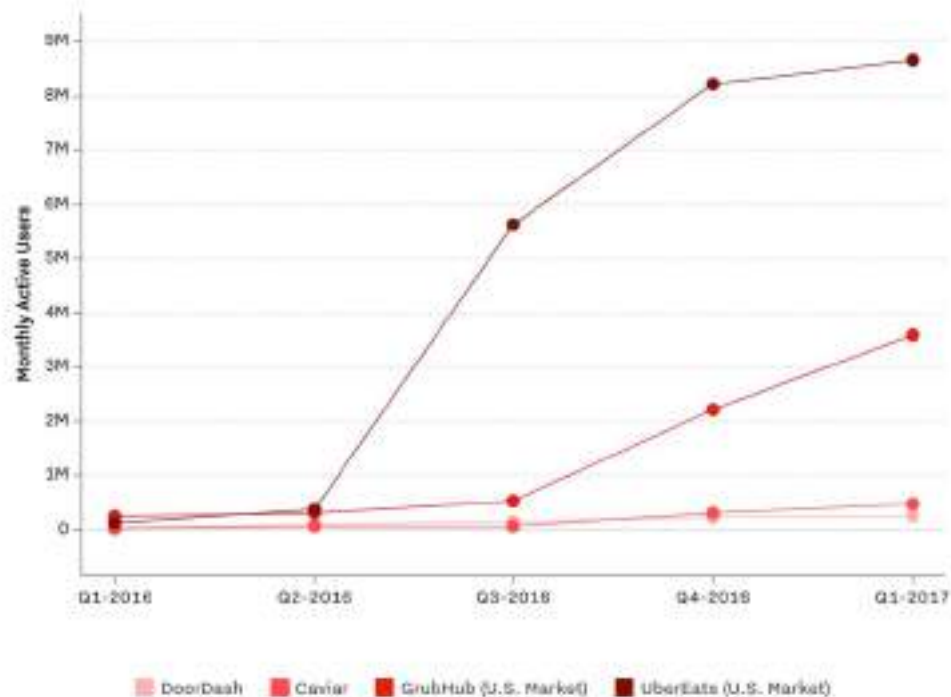


- March, 2009: Uber founded
- August, 2014: **UberFRESH** launched in LA
- April, 2015: **UberFRESH** rebranded to **Uber Eats**
- December, 2015: **Uber Eats** is spun off into a separate standalone app and launched in Toronto
- March, 2016: **Uber Eats** launched in LA, Chicago, Houston, and SF
- Today: **Uber Eats** launched in **200+** cities, **30+** countries, and **6** continents

## UberEats App Dominates in Most Active Users

📰 📱 📊

Despite being one of the youngest large food delivery apps, UberEats has capitalized on the Uber brand and has raked highest in the most monthly active users of the top American delivery apps.

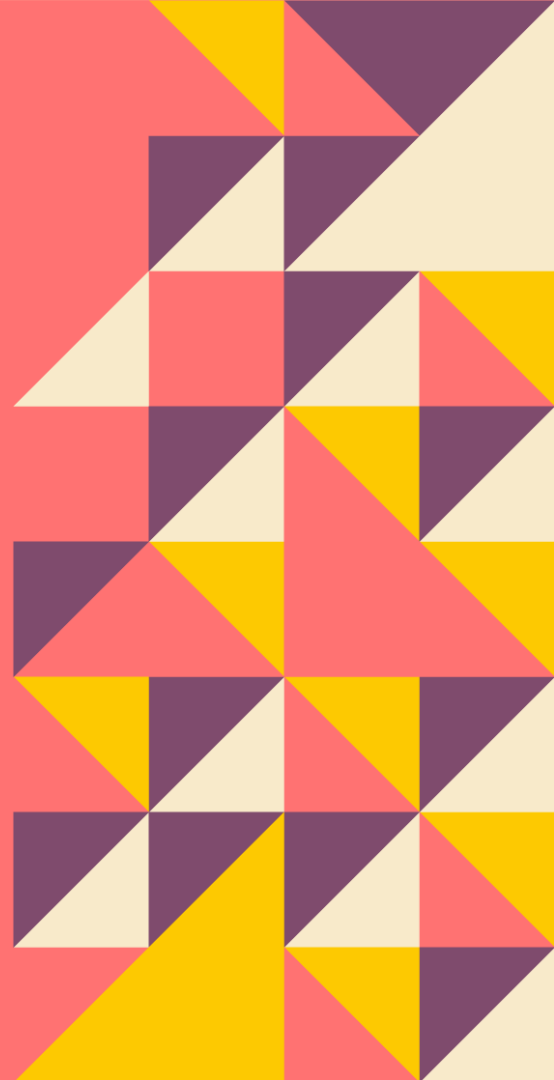


Source: App Annie

EATER



# AI Platform

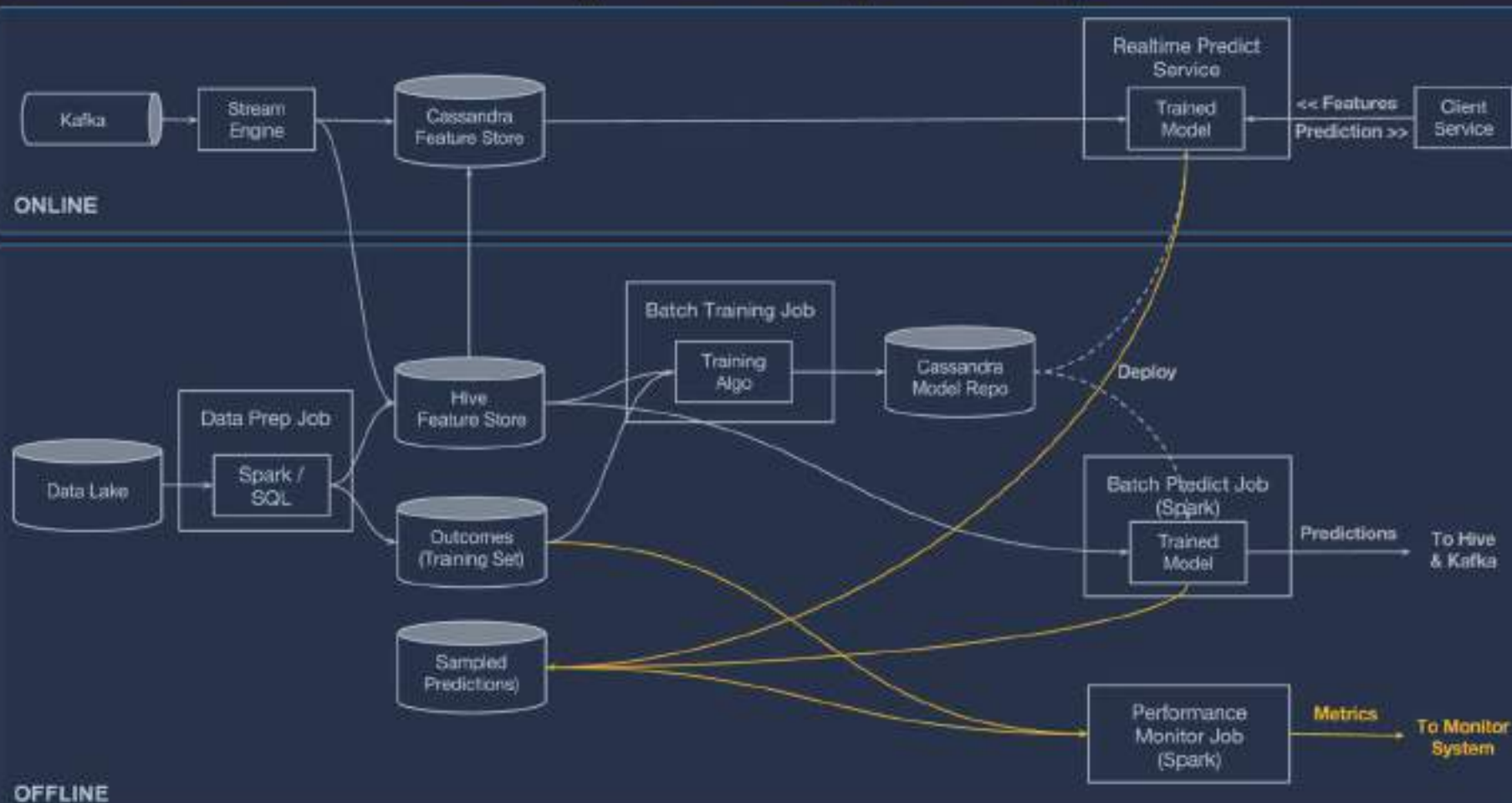


GET DATA

TRAIN MODELS

EVAL MODELS

DEPLOY, PREDICT &amp; MONITOR



# Feature Report

2017-06-02-12-35-47-065-UTC

DEPLOY
RETRAIN
⛔

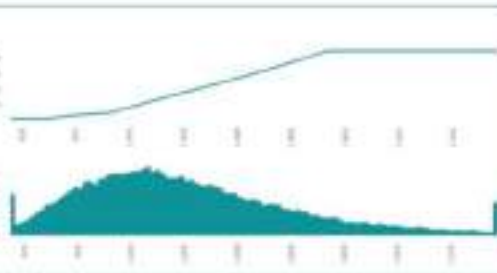
PERFORMANCE MODEL VIS **FEATURES**

## Features

Feature Histogram & Partial Dependence

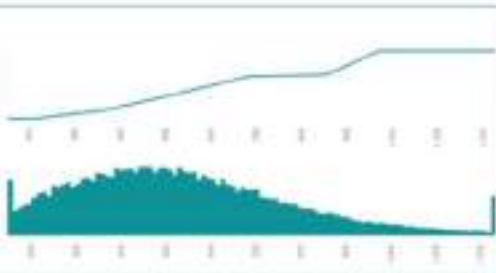
### feature\_31

importance: 0.2362  
 null: 85.28  
 nobs: 0  
 nobs: 0  
 mean: 2766  
 std: 2.39e+1  
 pct: 647.6  
 pct: 2360



### feature\_36

importance: 0.1774  
 null: 0.449  
 nobs: 0  
 nobs: 0  
 mean: 535.3  
 std: 340.4  
 pct: 547  
 pct: 1224



### feature\_12

importance: 0.1901  
 null: 159  
 nobs: 9.206e+4  
 nobs: 9.045e+4  
 mean: 2761  
 std: 4.302e+0  
 pct: -10  
 pct: 2434



### feature\_15

importance: 0.05766  
 null: 0  
 unique: 7  
 categories:



## Overview

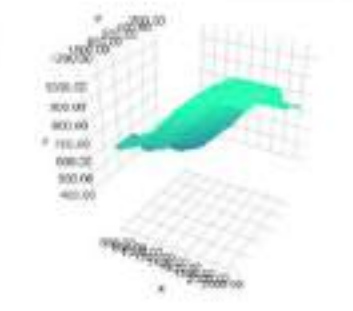
All features by importance



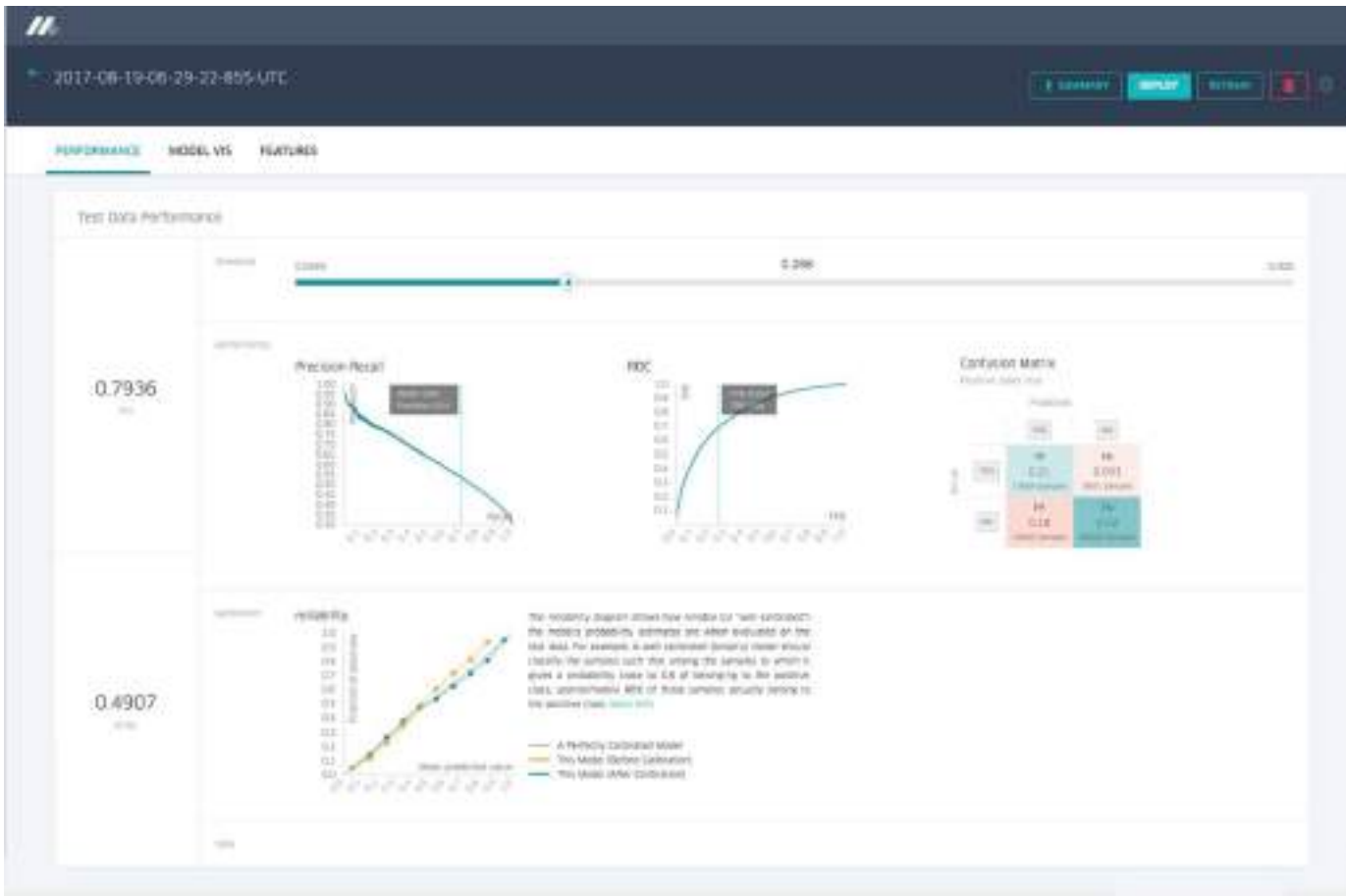
## Feature interaction

2-way partial dependence

X Axis: feature\_31  
 Y Axis: feature\_36



# Model Accuracy Report

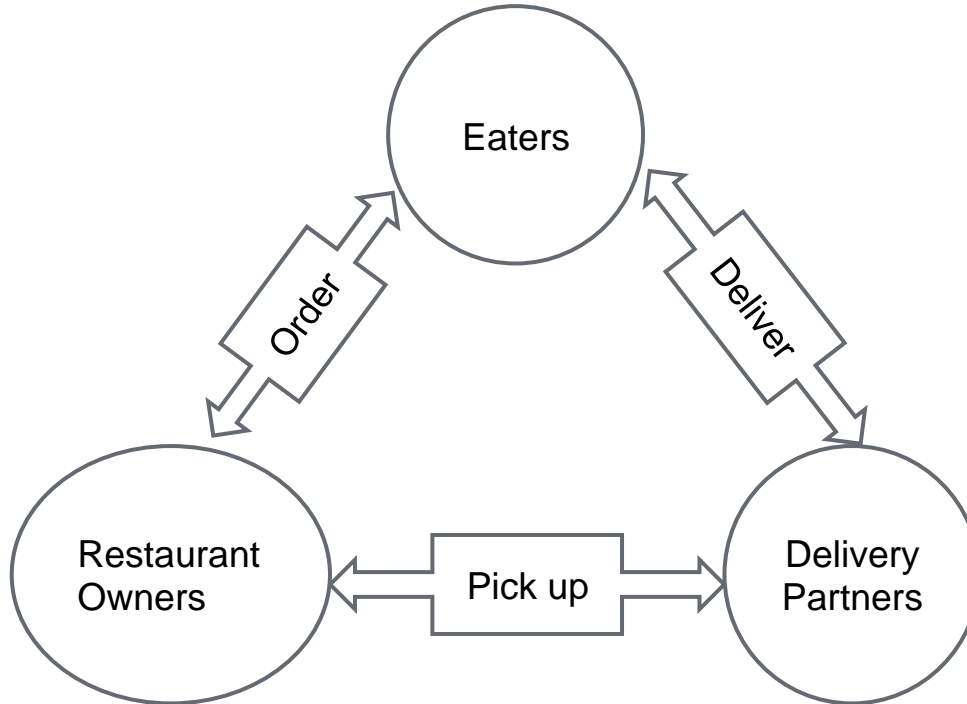


# AI Challenges with Uber Eats



# Uber Eats as a Marketplace

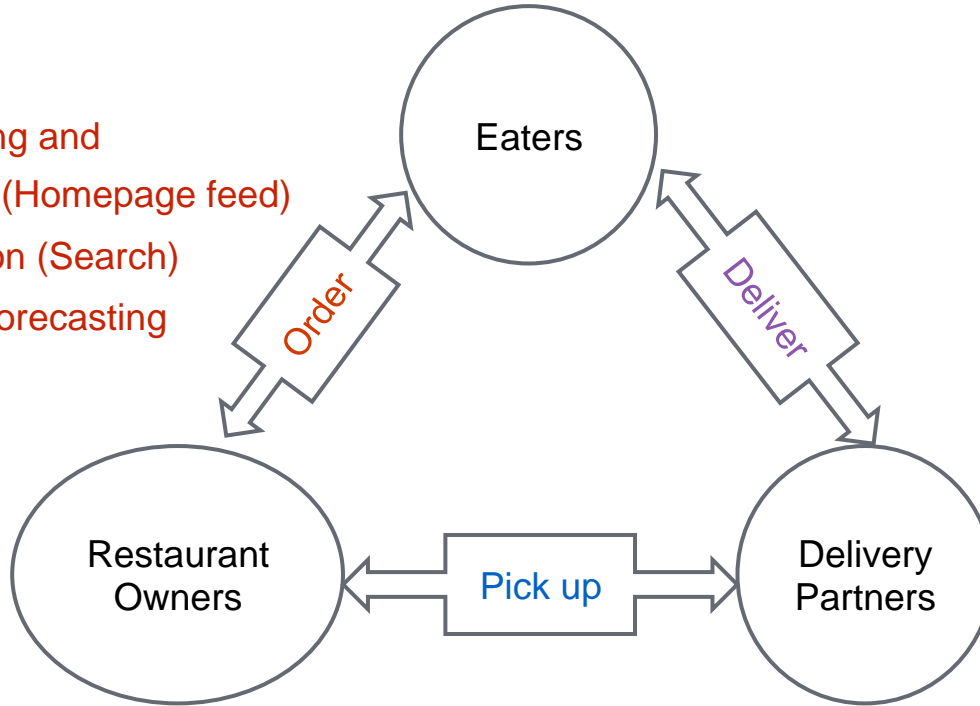
**Make eating well effortless at any time, for anyone**





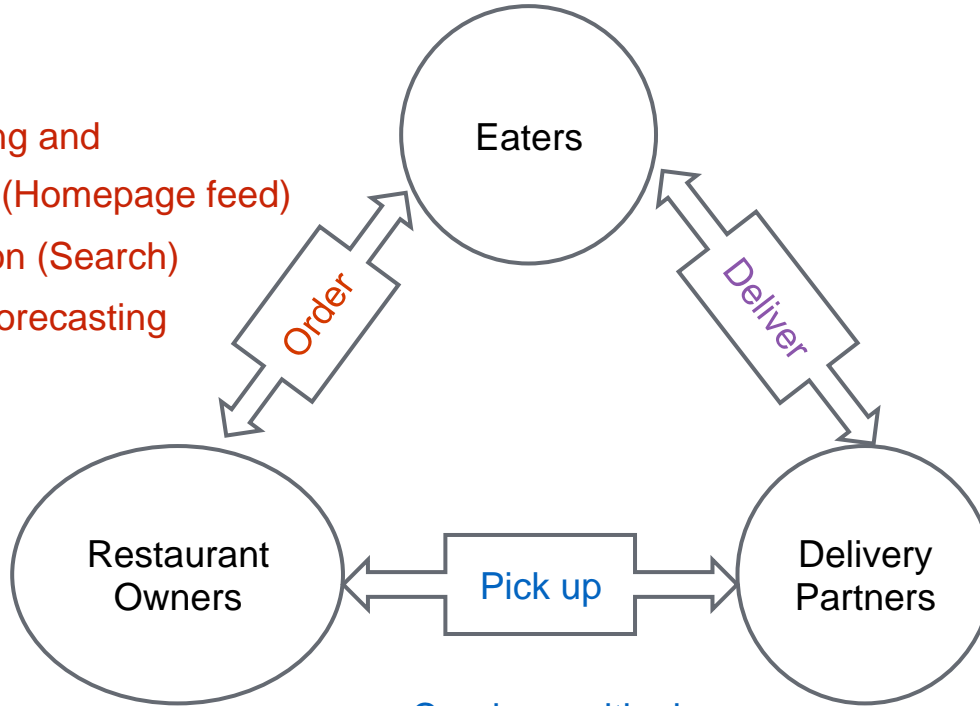
# AI & Uber Eats

- Restaurant ranking and recommendation (Homepage feed)
- Guided exploration (Search)
- Demand-supply forecasting
- ...



# AI & Uber Eats

- Restaurant ranking and recommendation (Homepage feed)
- Guided exploration (Search)
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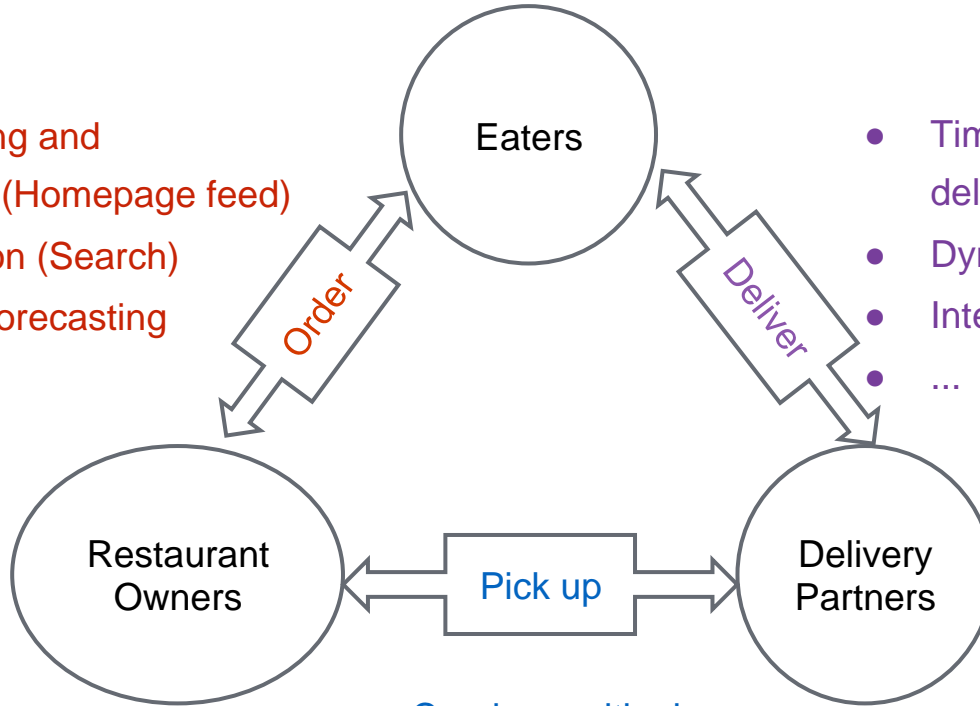


- Courier positioning
- Dispatch
- Batching

# AI & Uber Eats

- Restaurant ranking and recommendation (Homepage feed)
- Guided exploration (Search)
- Demand-supply forecasting
- ...

- Time prediction (estimated time of delivery)
- Dynamic pricing
- Intelligent spending
- ...

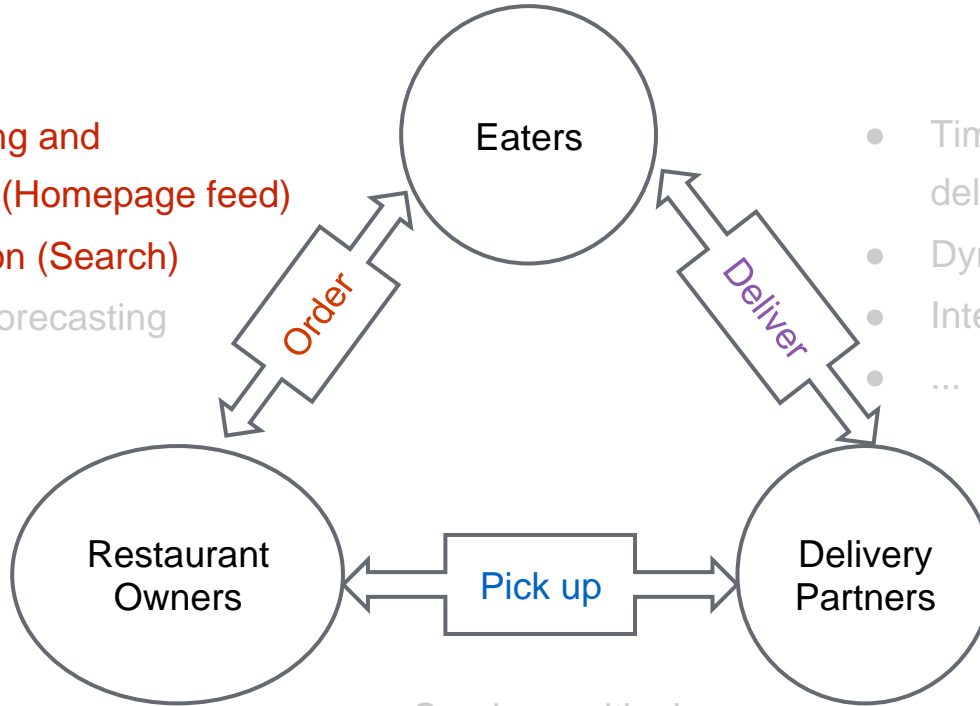


- Courier positioning
- Dispatch
- Batching

# Today's Discussion: Eats Discovery

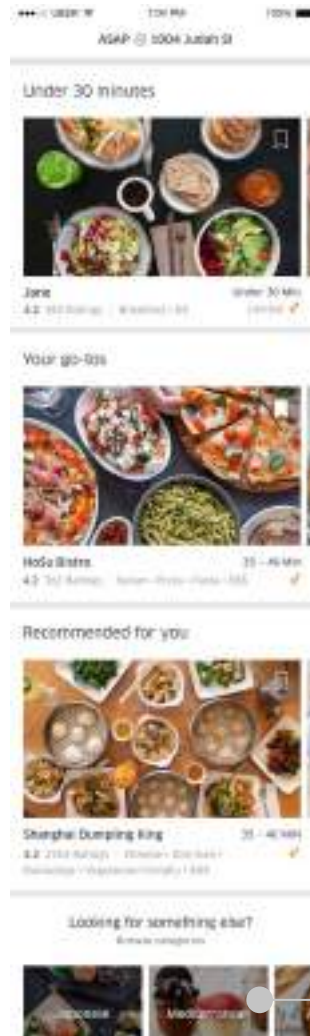
- Restaurant ranking and recommendation (Homepage feed)
- Guided exploration (Search)
- Demand-supply forecasting
- ...

- Time prediction (estimated time of delivery)
- Dynamic pricing
- Intelligent spending
- ...



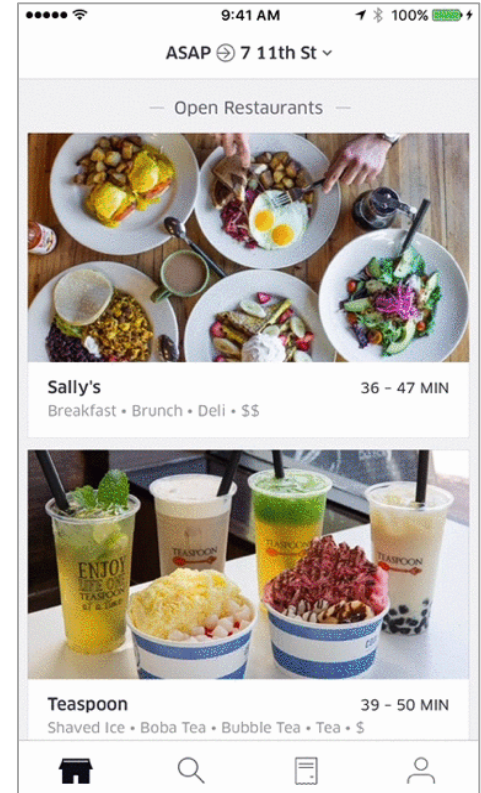
- Courier positioning
- Dispatch
- Batching

# Restaurant Ranking And Recommendation



# A Few Unique Challenges

- Ranking to serve the marketplace
- Relevance vs. diversity
- Building a fair marketplace
- ...



# Ranking to Serve the Marketplace

- Conventional ML Model
  - Single objective
    - Keep users 😊
    - or
    - Keep restaurant owners 😊
  - GBDT, RankSVM

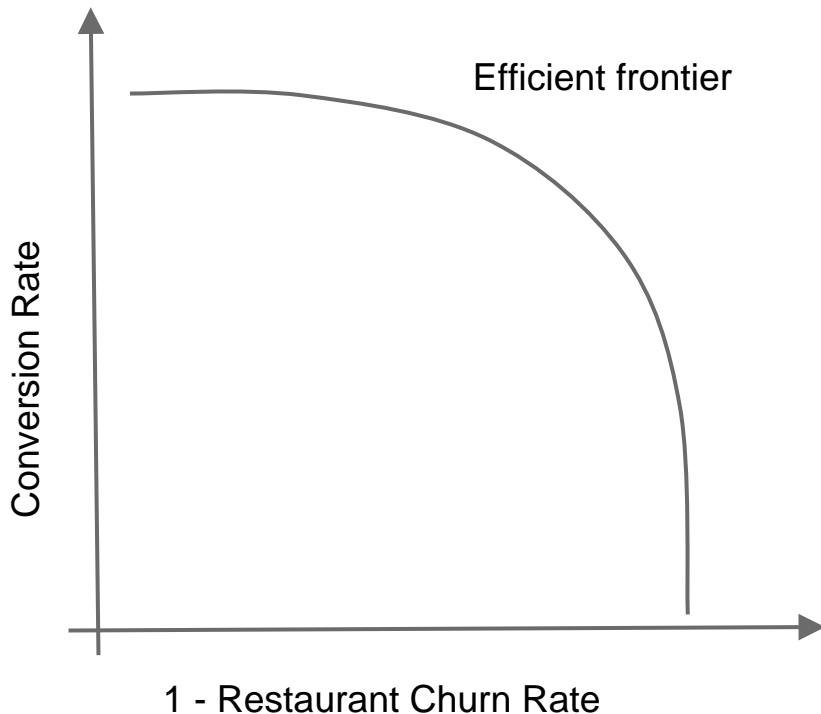
# Ranking to Serve the Marketplace

- Conventional ML Model

- Single objective
  - Keep users 😊 **or** 😊
  - Keep restaurant owners 😊
- GBDT, RankSVM

- Solution: Multi-Objective Optimization

- Multiple objectives
  - Keep users 😊 **and** 😊
  - Keep restaurant owners 😊
- Linear / Quadratic Programming (LP/QP)





# MOO: Multi-Objective Optimization

$$\max(f_1(x), f_2(x), \dots, f_k(x))$$

$$\text{s.t. } x \in X$$

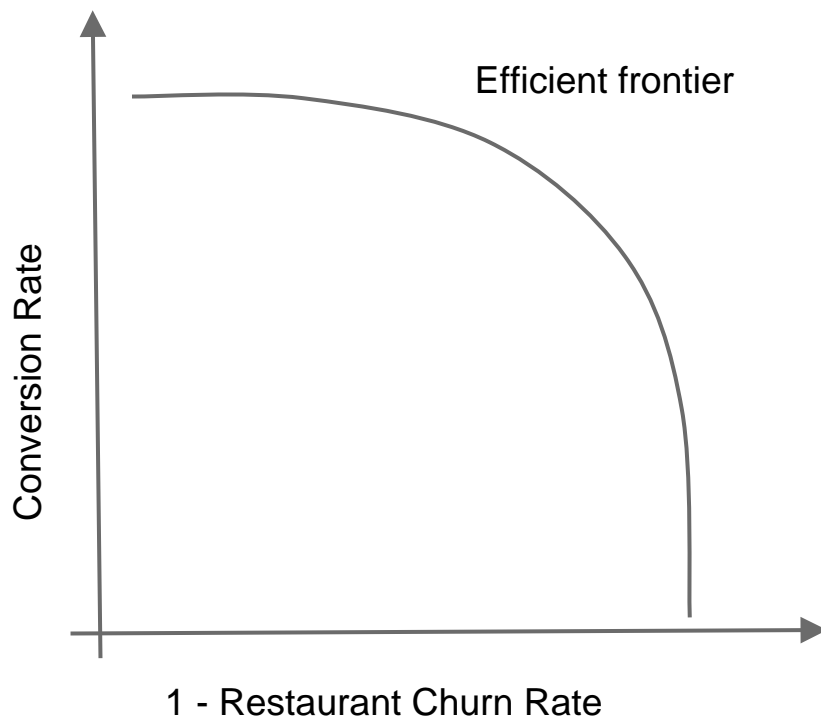
$f_k(x)$  is the ML/AI model for the kth objective

For example:

$f_1(x)$  is the conversion rate ML/AI model

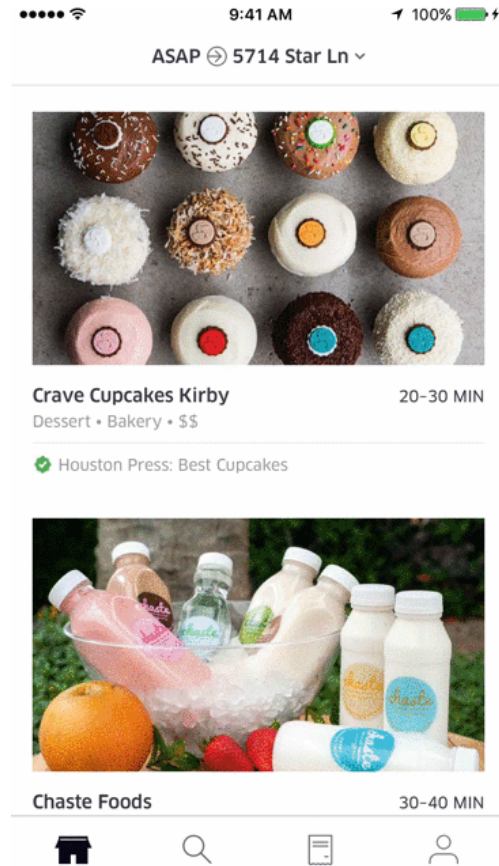
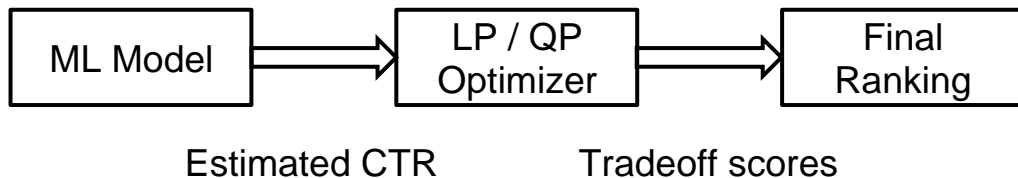
$f_2(x)$  is the 1 - restaurant churn rate ML/AI model

Challenge is to formulate the above problem as convex optimization problem (LP / QP)



# MOO Example: Relevance vs. Diversity

- Pointwise ranking is **greedy**
- Listwise ranking is **costly**
- **Holistic** ranking
  - Estimate CTR of each restaurant with an ML Model
  - Optimize the ranking of all restaurants holistically given estimated CTR



# Building a Fair Marketplace



VS.



New / Low-Volume Restaurants

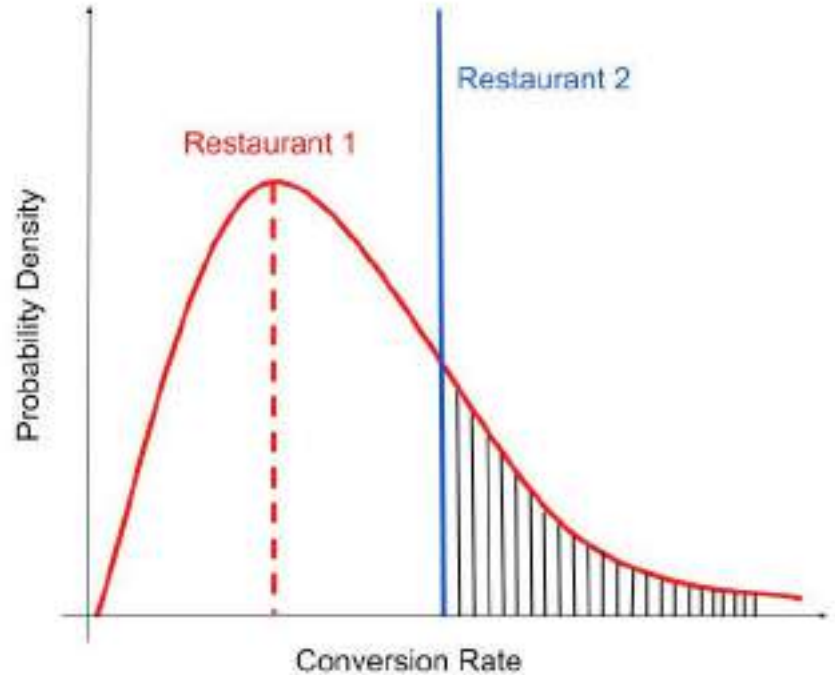
Img source: <https://www.fotolia.com/p/326910>

Well-Established Restaurants

Img source: <https://thehalalguys.com/>, <https://archives.sfweekly.com/sanfrancisco/shanghai-dumpling-king/Location?oid=2192071>

# Explore-Exploit with Multi-Armed Bandit

- Bayesian modeling for posterior variance
  - New /low-volume restaurant - high variance
  - Well-established restaurant - low variance
  
- Multi-armed bandit
  - ML model to estimate the mode of conversion rate
  - Bandit algorithm for explore-exploit



# Guided Exploration (Search)



Item listicle

Search results

# Challenges

- Understand user query and our food
  - Restaurant
  - Dish types
  - Cuisine types
- No results / low results
  - Not on the platform
  - Out of delivery radius / time
- Ranking
  - Personalized - but not so much



# AI/ML Solutions

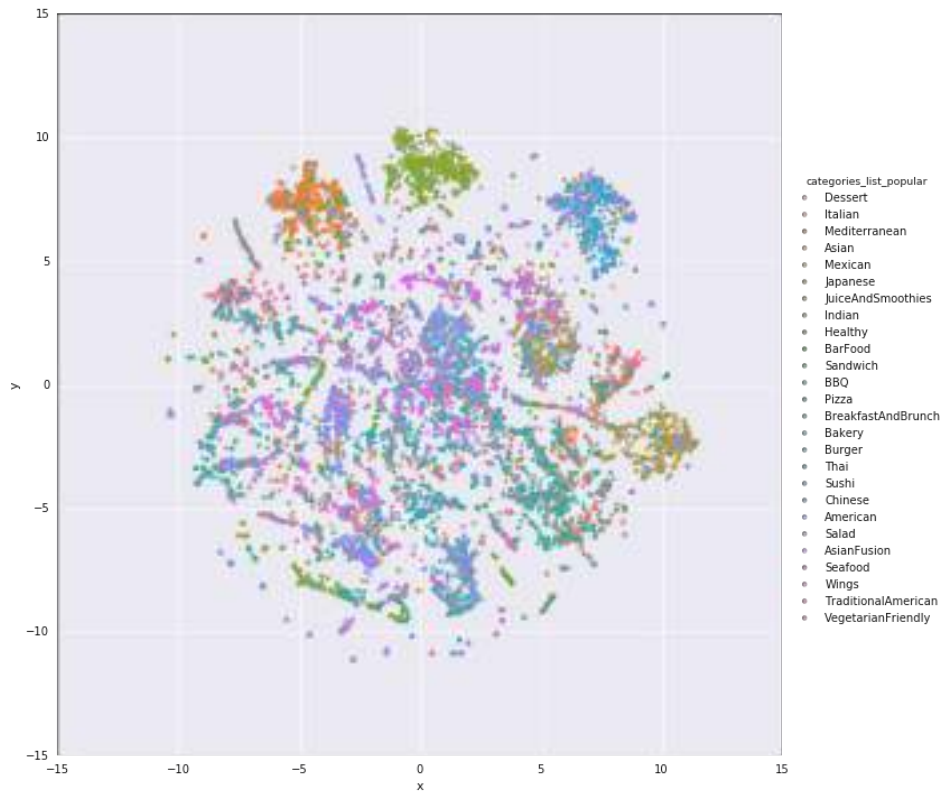
- Understand user query and our food - Representation Learning
  - Restaurant
  - Dish types
  - Cuisine types
- No results / low results - Food Knowledge Graph
  - Not on the platform
  - Out of delivery radius / time
- Ranking - ML/AI models
  - Personalized - but not so much





# Representation Learning

- Food graph-based
- Latent space-based
  - Word2Vec, GloVe
  - End-to-end deep neural network



# Ranking

- Personalized model?
- Closed/missing restaurants
- In-menu search and ranking



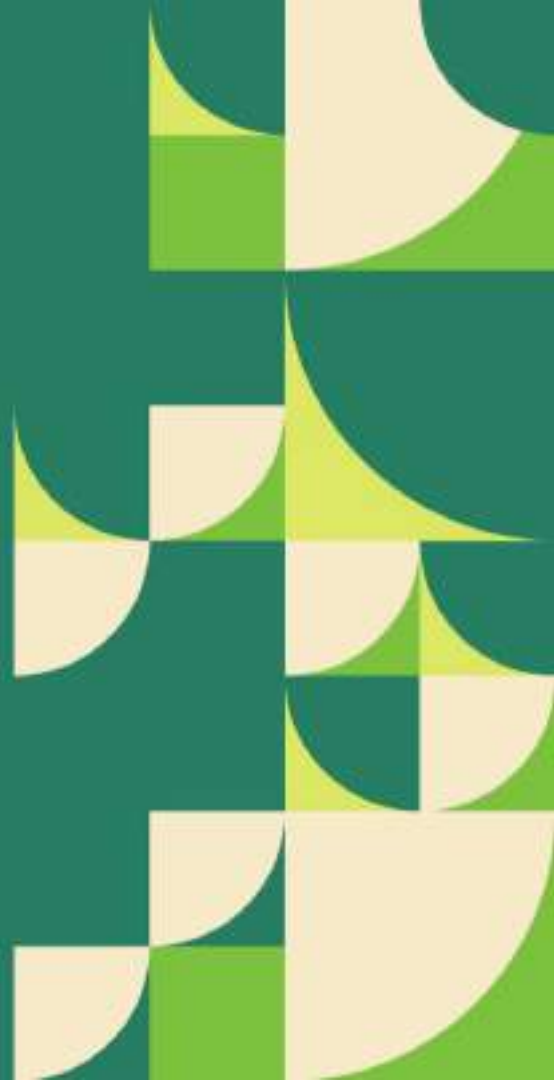
# Takeaways

- Uber Eats is a marketplace for **eaters**, **restaurant owners** and **delivery partners**.
- AI is the underlying **engine** that runs this marketplace.



**Thank you and bon appétit**

**Q & A**



The image shows the interior of a car, focusing on the dashboard and air vents. The dashboard is black with silver accents around the air vents. The steering wheel is visible on the left side. The background is a blurred view of a street with trees and buildings.

# UBER

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