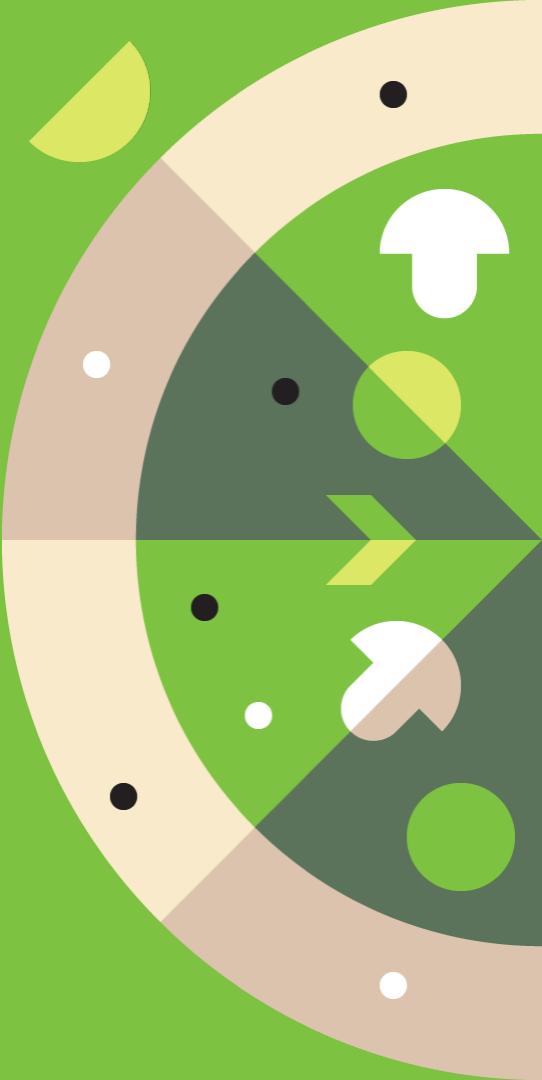




Artificial Intelligence in ^{UBER} eats

Zi Wang@Uber
QCon Shanghai 2018



极客时间 VIP 年卡

每天6元，365天畅看全部技术实战课程

- 20余类硬技能，培养多岗多能的混合型人才
- 全方位拆解业务实战案例，快速提升开发效率
- 碎片化时间学习，不占用大量工作、培训时间



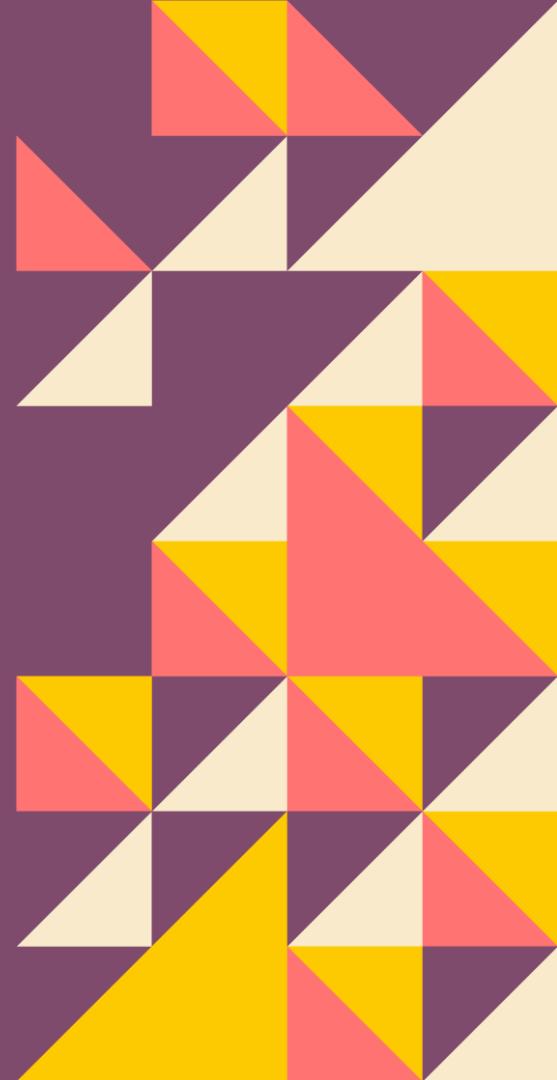
Agenda

1. Uber Eats Overview
 2. AI in Uber Eats
 3. How AI powers Dispatch System
 4. Other AIs:
 - Dynamic Pricing
 - Restaurants Ranking & Recommendation
 - Guided Exploration
-
1. Q&A





Uber Eats Overview



Uber Eats

- Quick Facts
- A Brief History
 - Instant Uber Eats
 - On-demand Uber Eats
- How does Uber Eats work?

London

LONDON

ENJOY



YOUR DAY RIGHT

www.mornflake.com



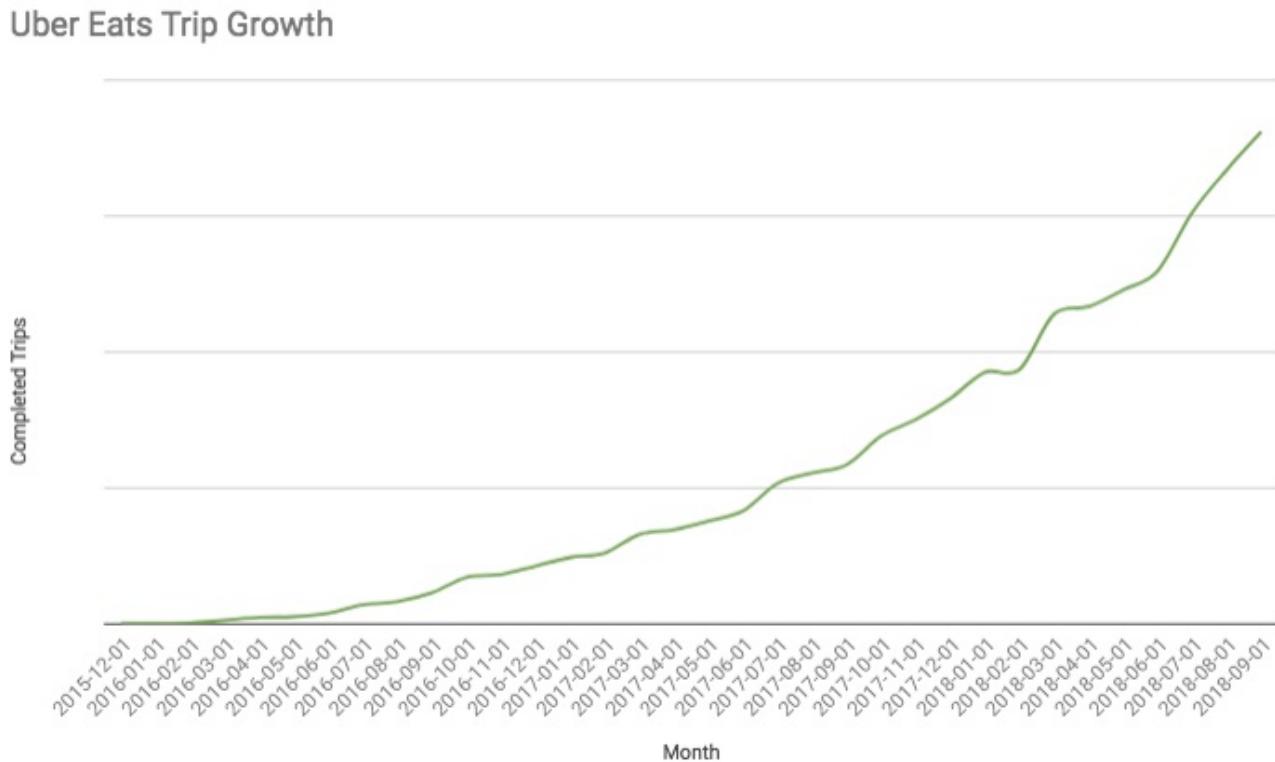
0:00.51



Our Scale

> 350
Cities

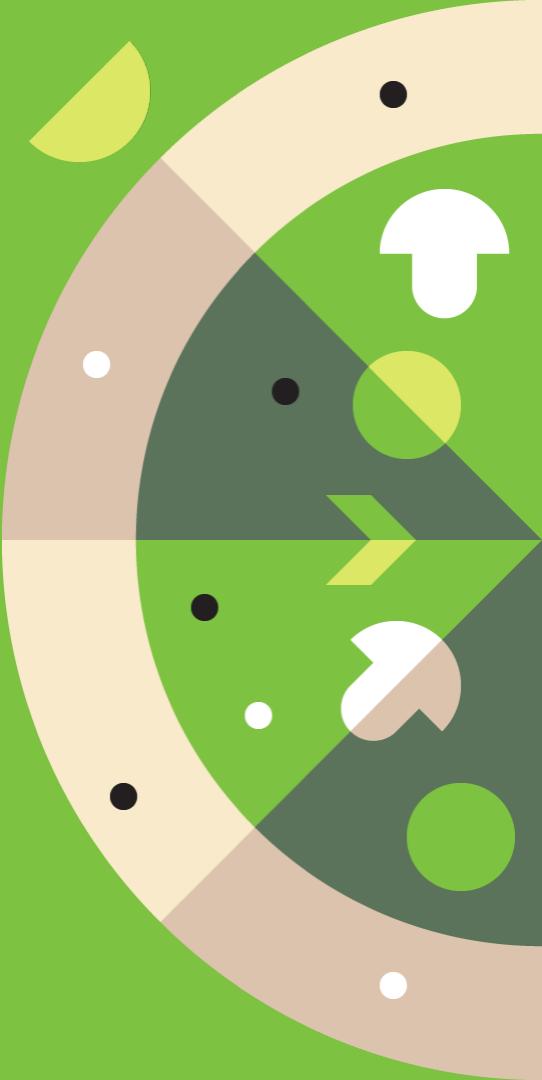
> 6B
Gross
Bookings





Our Mission

Make eating well **effortless, every day, for everyone.**



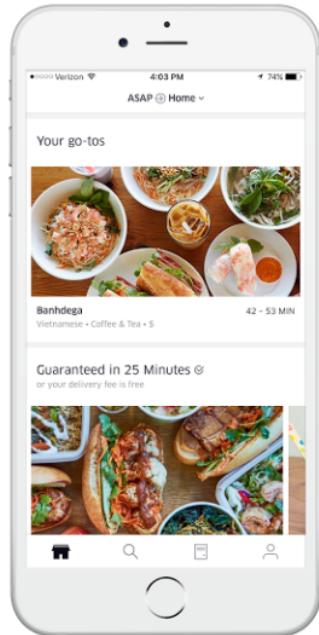
Then



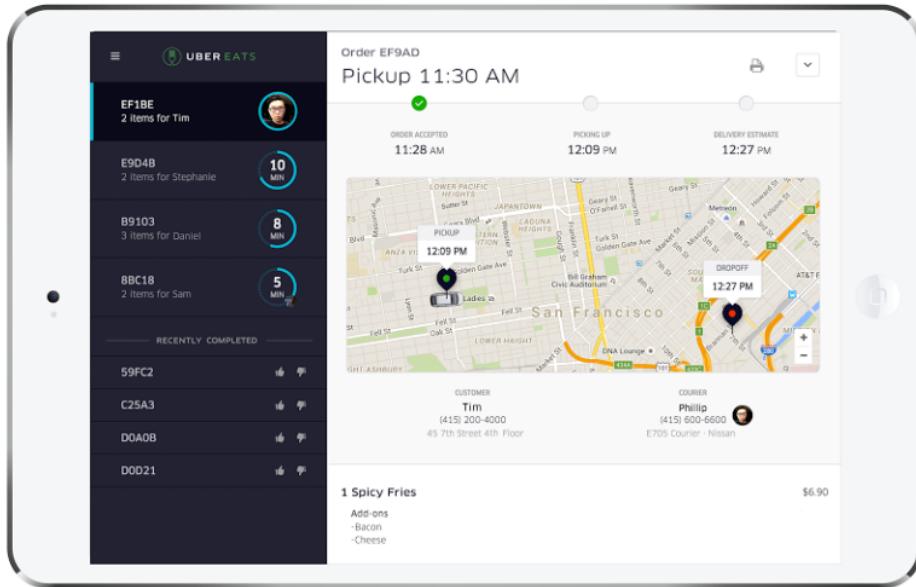
Now



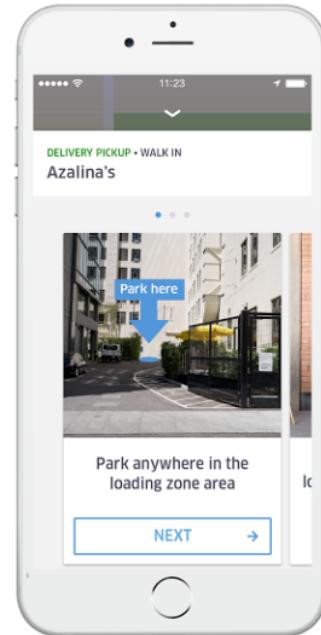
On-demand Uber Eats



UberEATS App



UberEATS restaurant app



Uber partner app:
delivery pickup

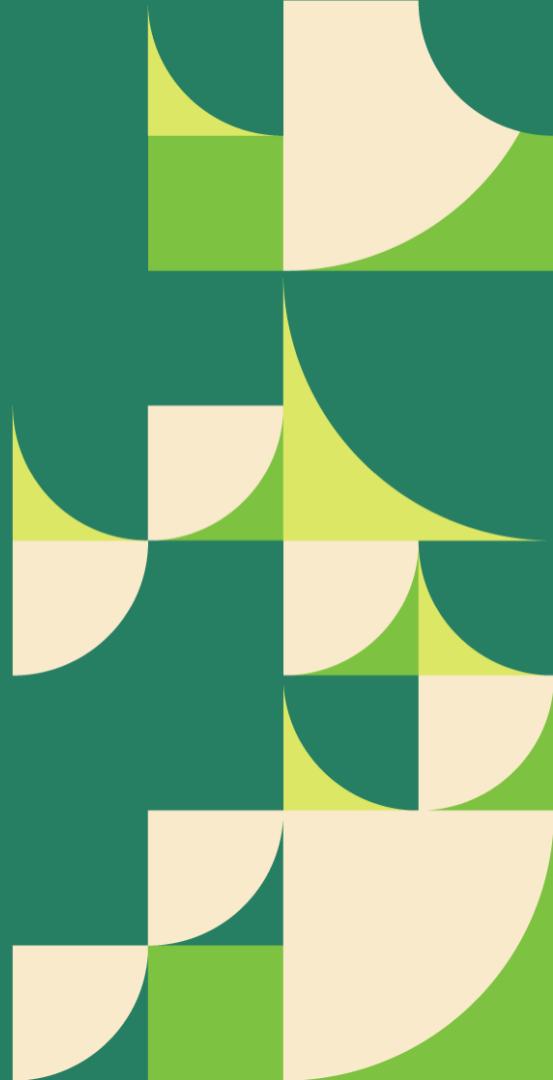
How does Uber Eats work?

**Uber Eats Order and Dispatch Flow
(10,000 Foot Overview)**





AI in Uber Eats



AI in Uber Eats

- Goals & Challenges
- Michelangelo - AI Platform @ Uber

Goals & Challenges

Reliable

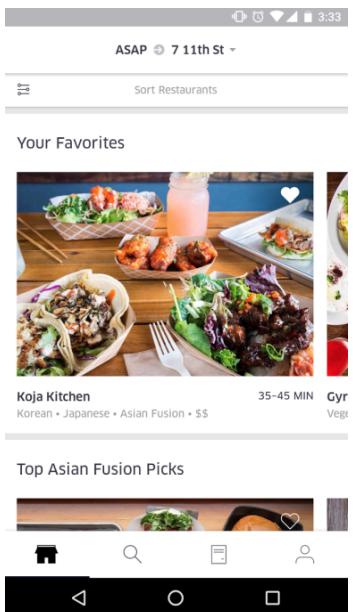
Affordable

Effortless

Predicting the Future

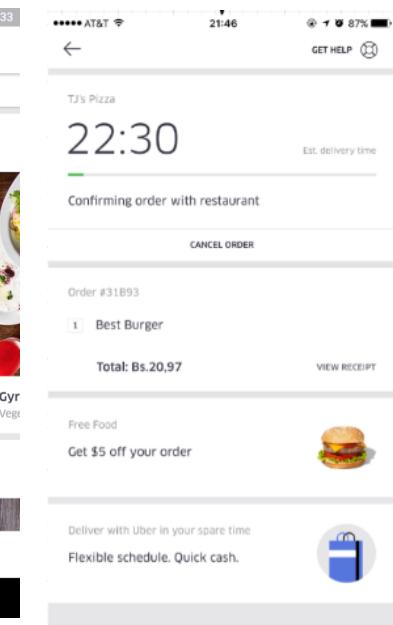
Network Efficiency

Food Discovery



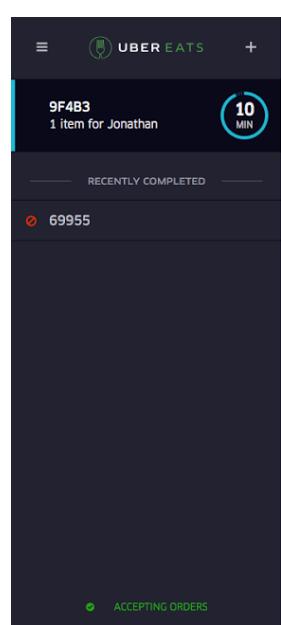
Restaurant/meal
search and ranking

eyeball



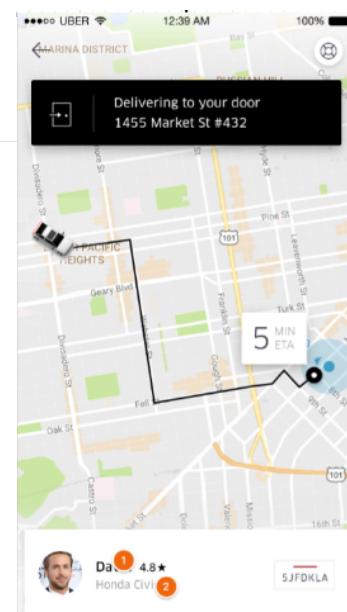
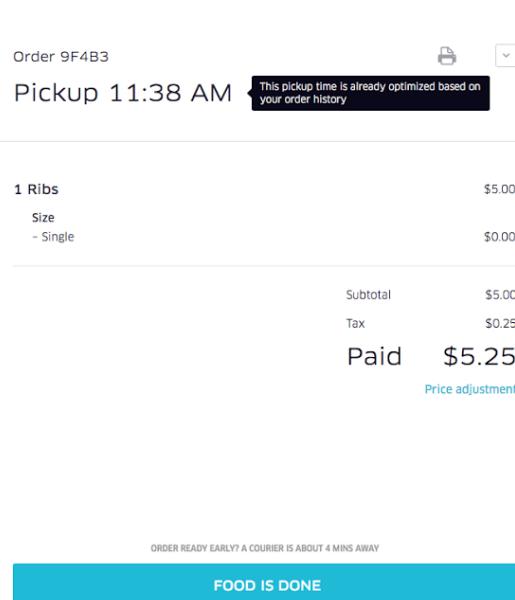
ETD prediction

order
created



Prep-time prediction

courier
arrival
food
ready



ETA prediction

courier
begin trip
courier
arrival
food
dropped-off



Michelangelo

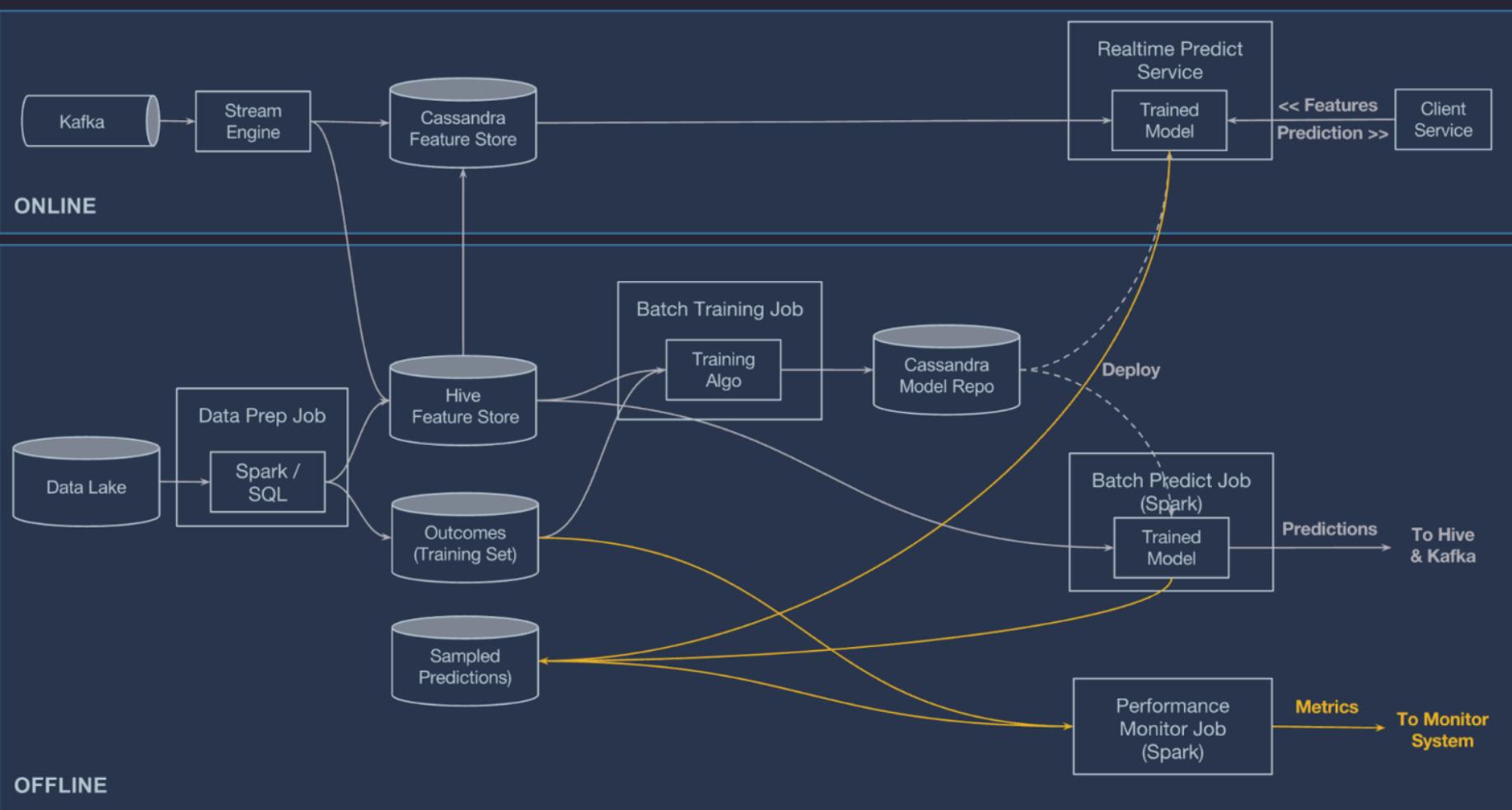
- AI Platform @ Uber

GET DATA

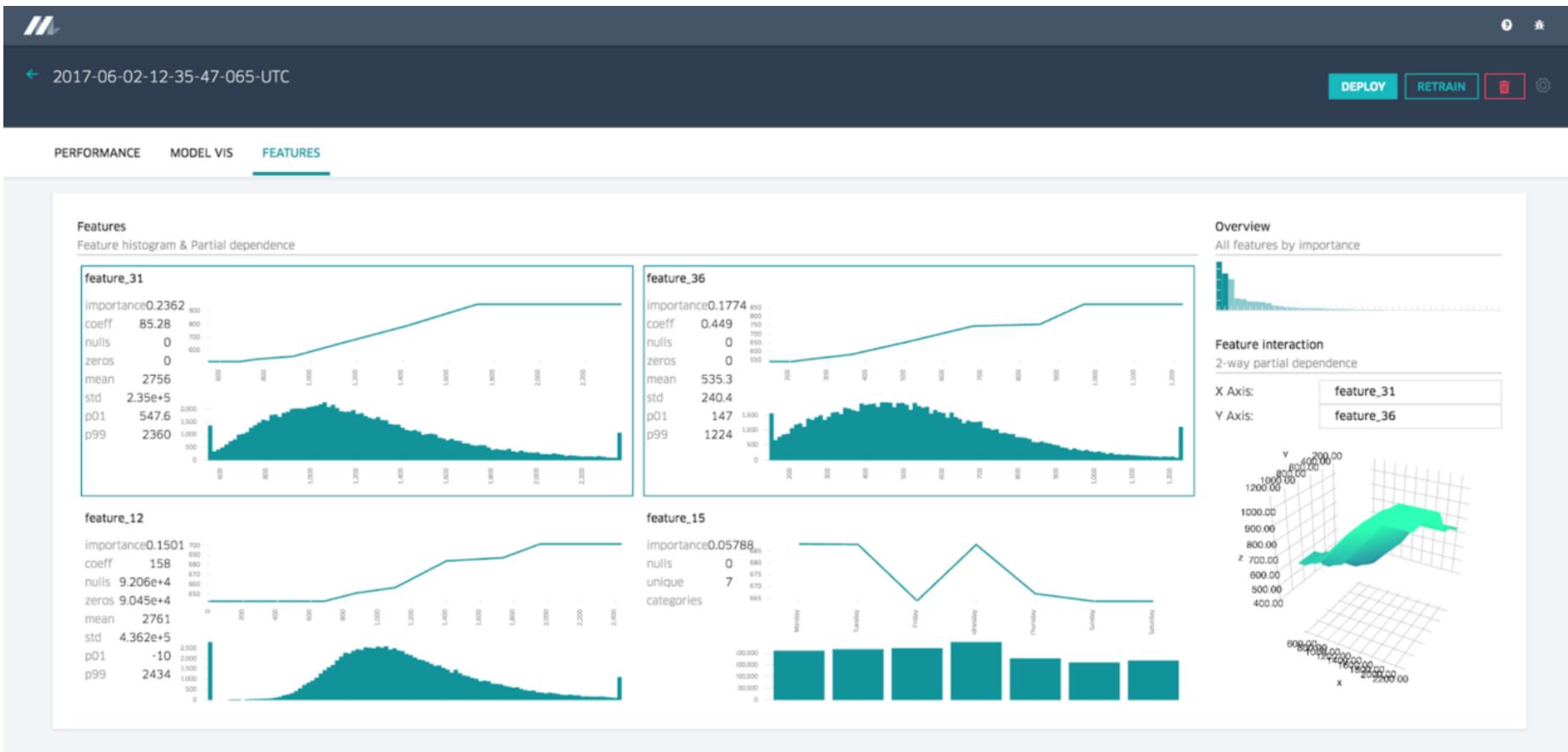
TRAIN MODELS

EVAL MODELS

DEPLOY, PREDICT & MONITOR



Feature Report



Model Accuracy Report

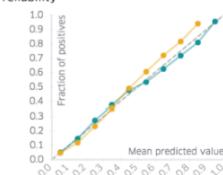
2017-08-19-06-29-22-855-UTC DEPLOY RETRAIN ⚙️

PERFORMANCE MODEL VIS FEATURES

Test Data Performance

	threshold	0.0584	0.288	0.925
AUC	0.7936			
Precision-Recall	Recall: 0.69 Precision: 0.54			
ROC	FPR: 0.253 TPR: 0.69			
Confusion Matrix	Positive label: true			
	Actual	Predicted		
YES	TP: 0.21 17604 Samples	FN: 0.093 7891 Samples		
NO	FP: 0.18 15005 Samples	TN: 0.52 44549 Samples		

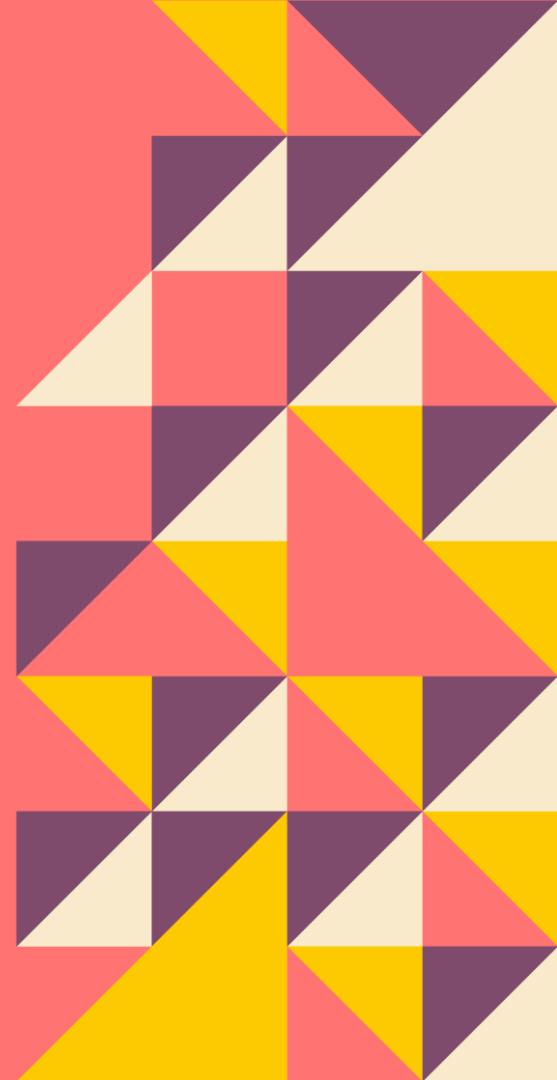
calibration

	reliability
error	0.4907
	
	<p>The reliability diagram shows how reliable (or "well-calibrated") the model's probability estimates are when evaluated on the test data. For example, A well calibrated (binary) model should classify the samples such that among the samples to which it gives a probability close to 0.8 of belonging to the positive class, approximately 80% of those samples actually belong to the positive class. More Info</p>
	<p>— A Perfectly Calibrated Model — This Model (Before Calibration) — This Model (After Calibration)</p>

data



How AI powers Dispatch System



How AI powers Dispatch System

- Overview
- A Brief History
 - Dispatch System w/o AI
 - Dispatch System w/ AI
- Time Predictions
 - Meal Prep-time
 - ETD
 - ETA



Make Demand-Supply Matching Decisions

Challenges

- Solve an NP-Hard problem with a large problem space within seconds
- Improve efficiency without compromising delivery quality
- Eater & Restaurant & Courier

Eater & Restaurant & Courier



Eater

- Fast drop-off
- Low delivery fee
- 24/7



Restaurant

- Short wait time
- Low Unfulfillment

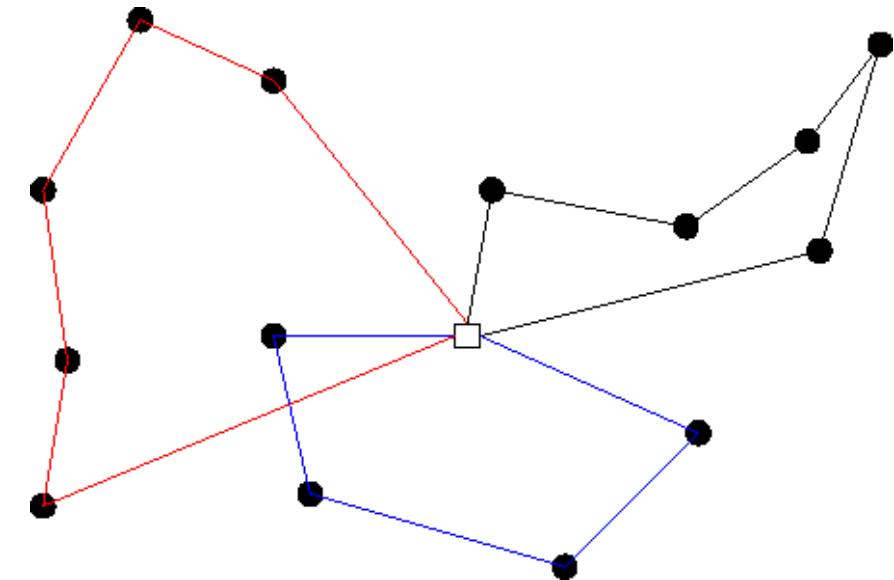


Courier

- Short wait time
- Smart route planning
- Quick hand-off

Matching Algorithm:

An Augmented Vehicle Routing Problem (VRP)



$Input(Plans(Supplies, Jobs, Constraints)) \Rightarrow \max \sum_{p \in plans} DOF(p) \Rightarrow optimal\ plans$

DOF : dispatch objective function

$Supply$: A courier eligible for job assignments

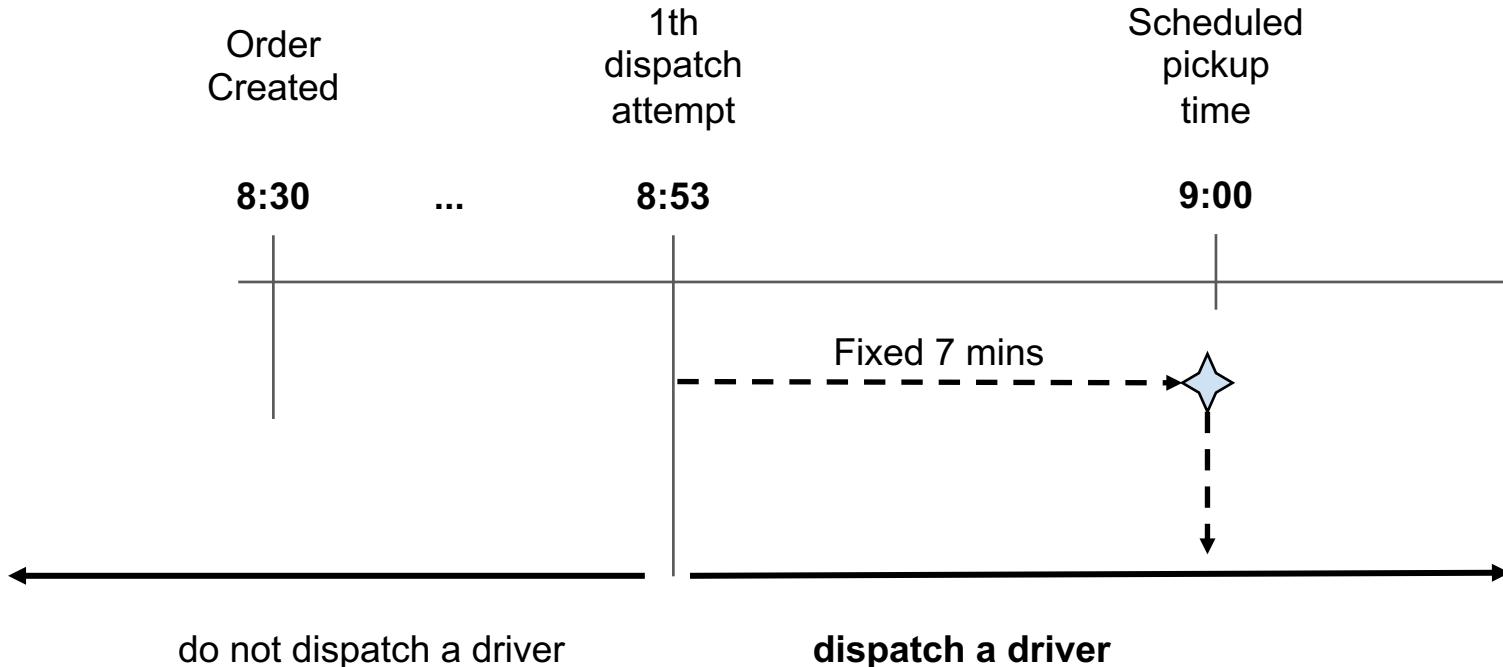
Job : A ordered list of waypoints (pickup, dropoff)

$Plan$: a combination of a supply and job(s)



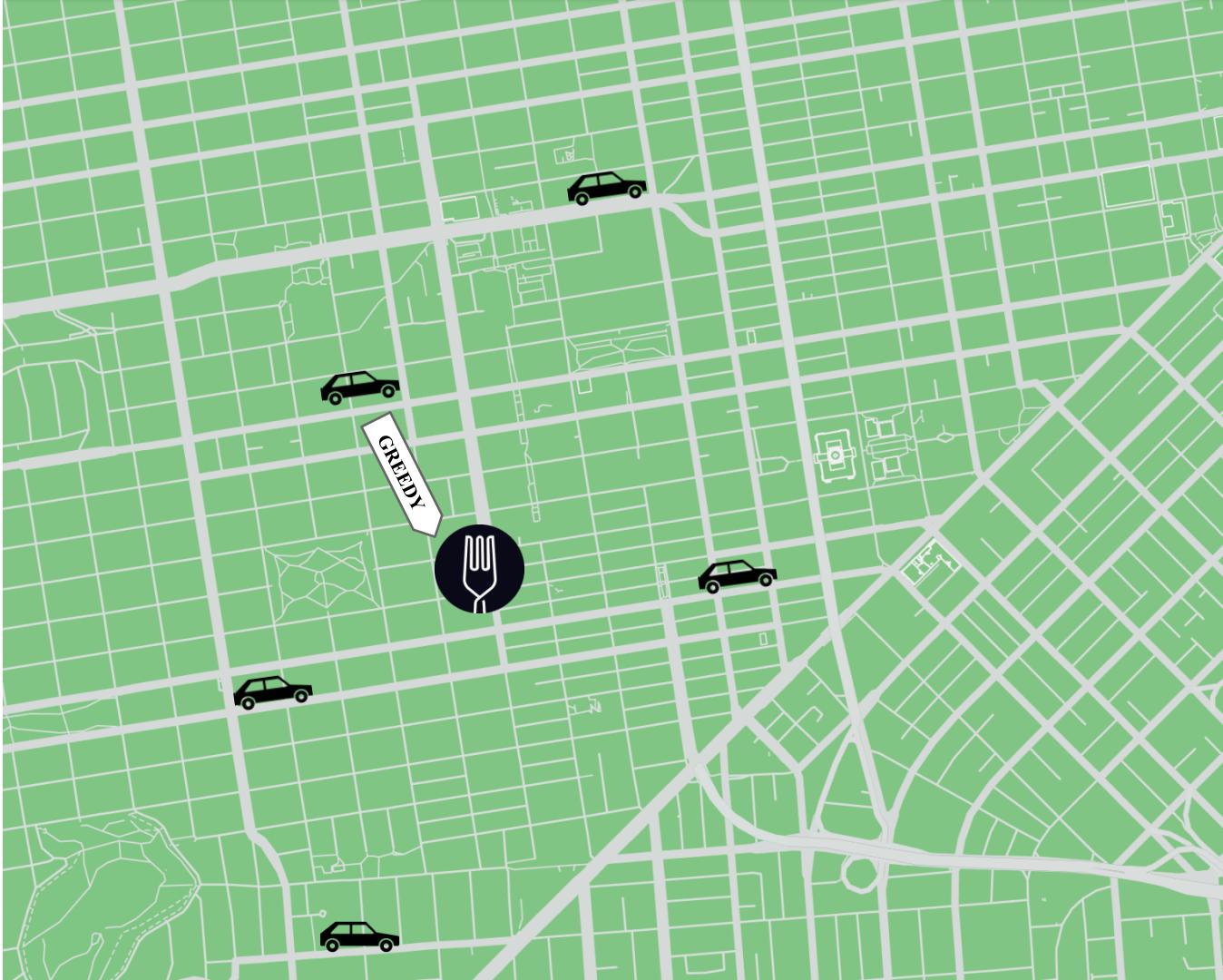
Dispatch system w/o AI

When to dispatch?

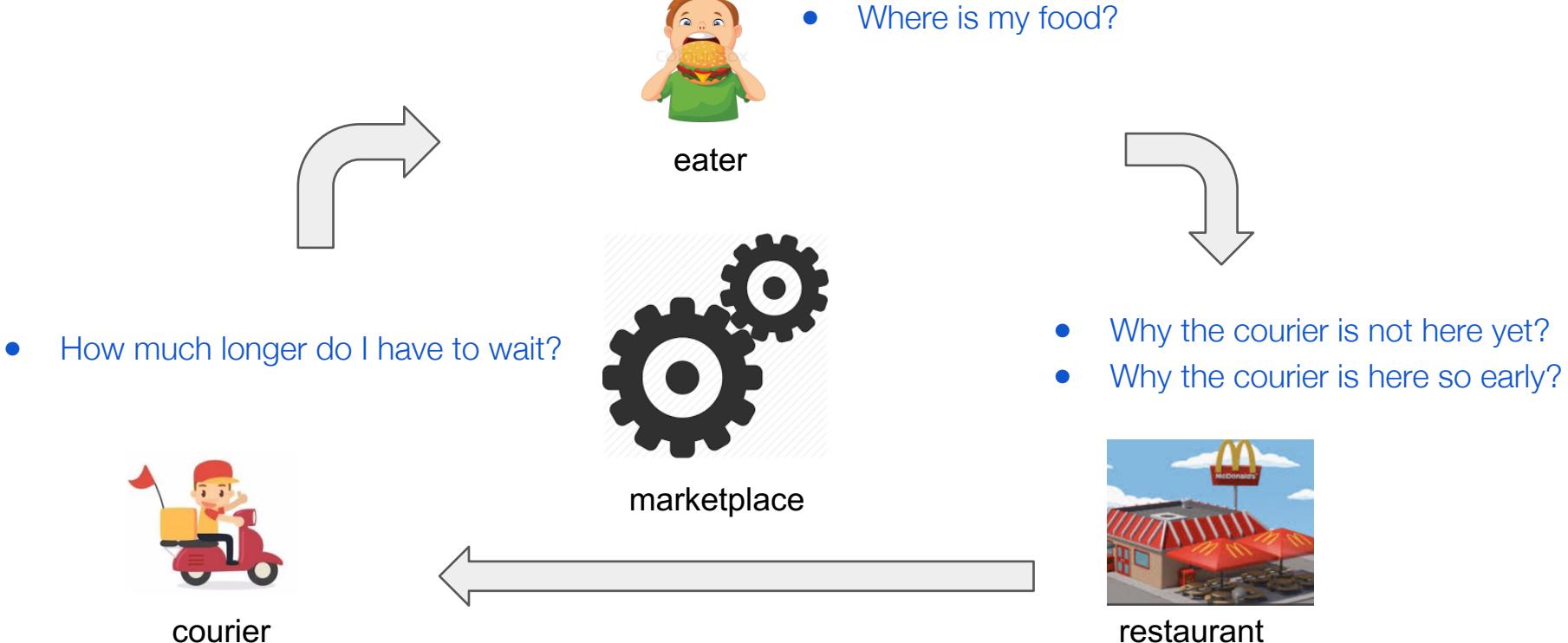


How to dispatch? (Greedy)

- Jobs dispatched independently without considering other jobs.



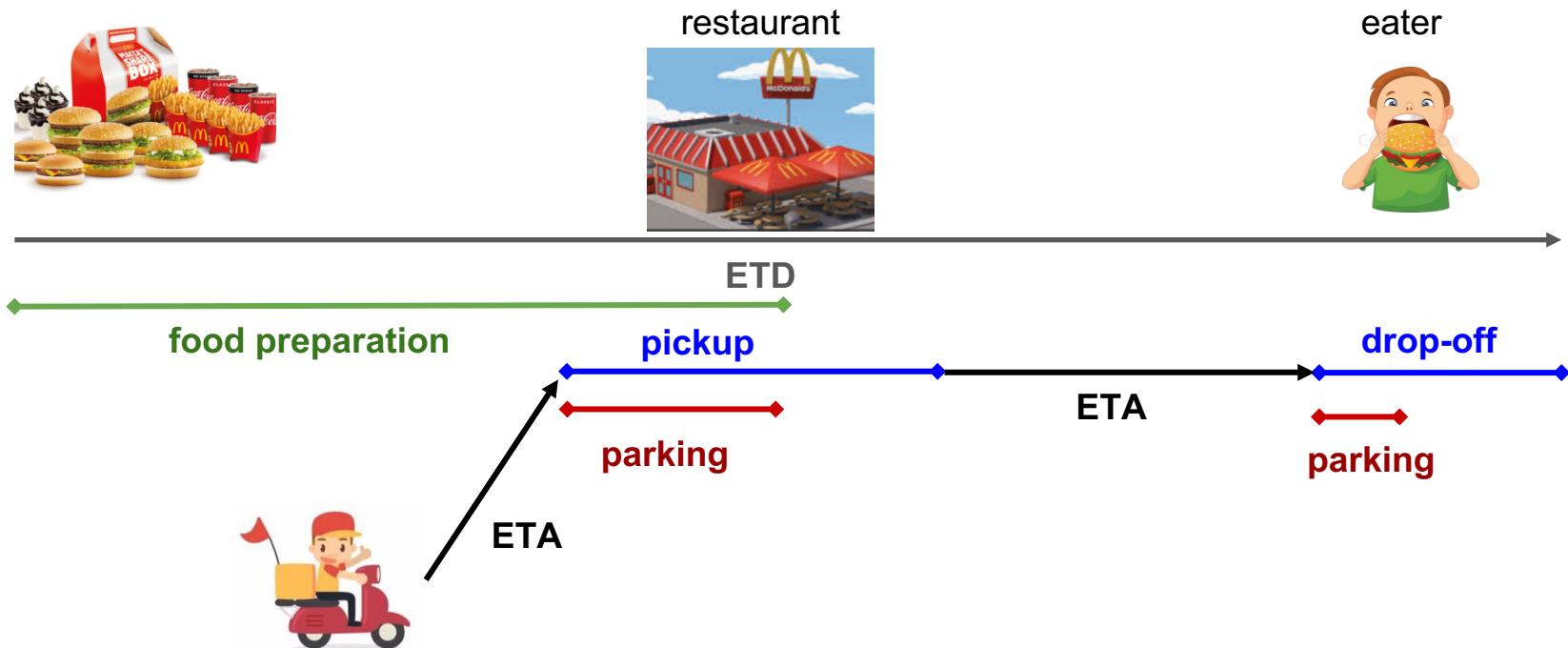
Before...



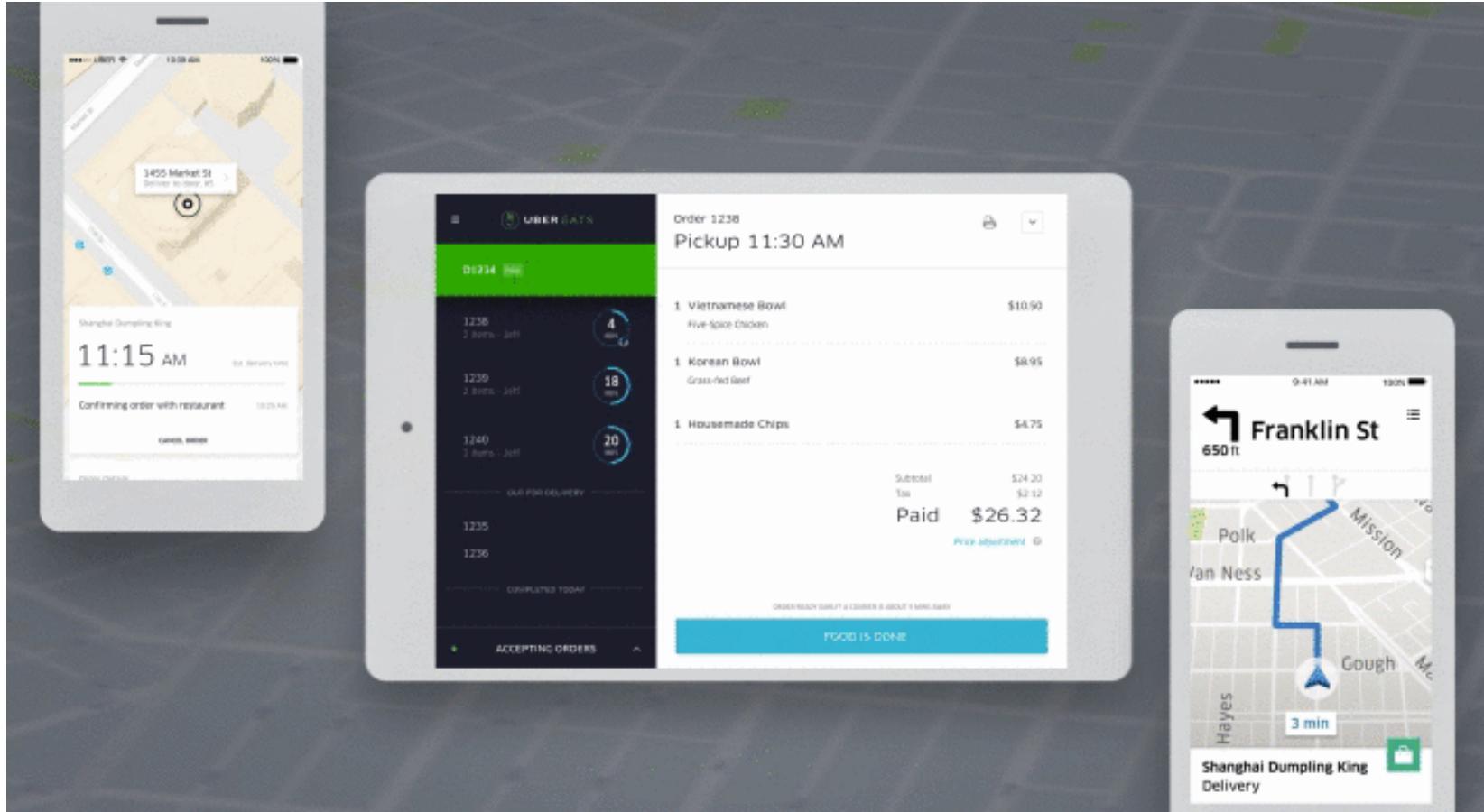


Dispatch system w/ AI

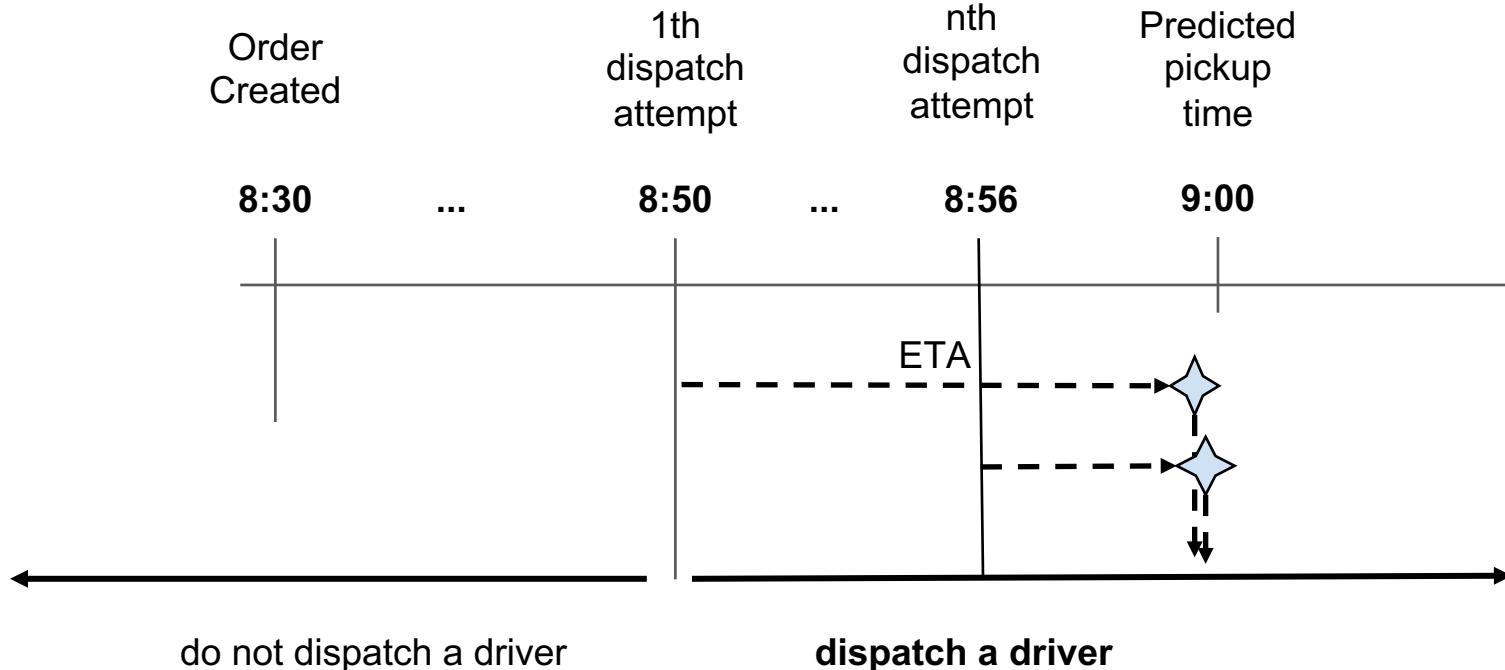
Key Component - Time Predictions



Key Component - Time Predictions (Cont'd)

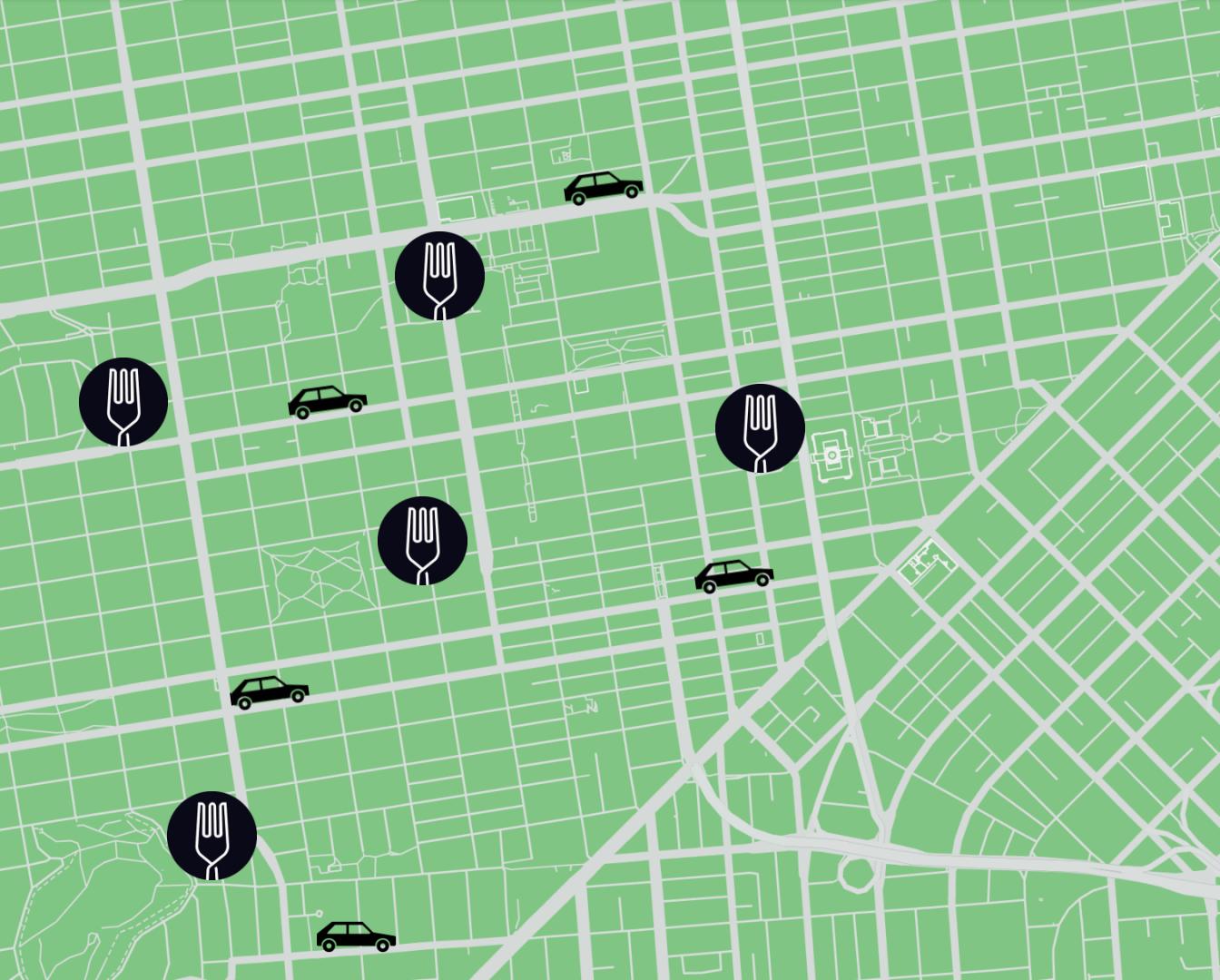


When to dispatch?

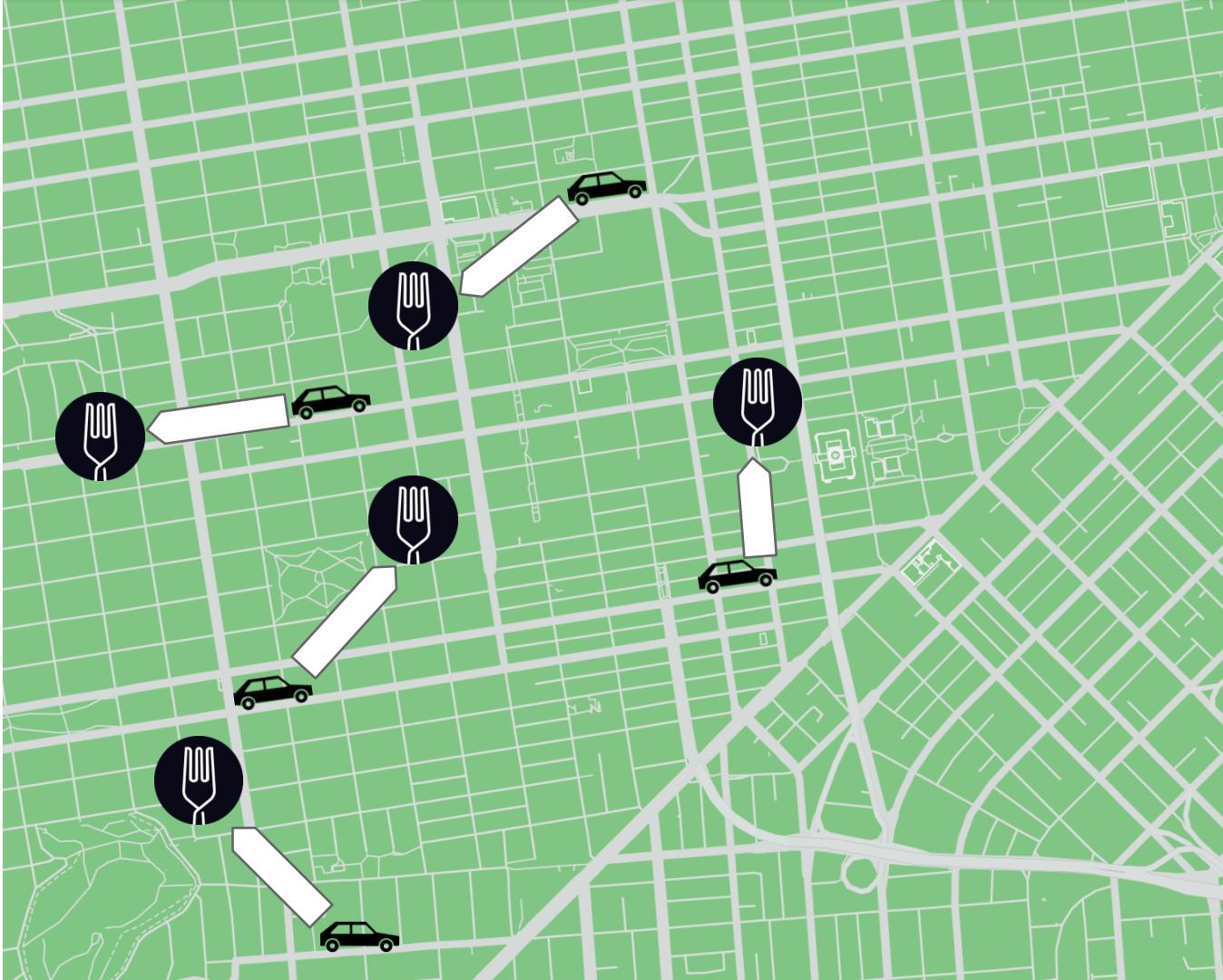


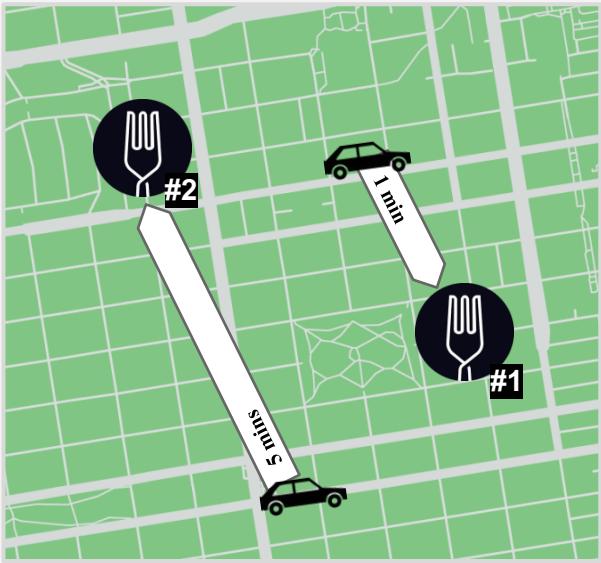
How to dispatch? (Global)

- All jobs and supplies are considered at the same time.



- Then we solve the entire set of jobs and supplies as a single global optimization problem.



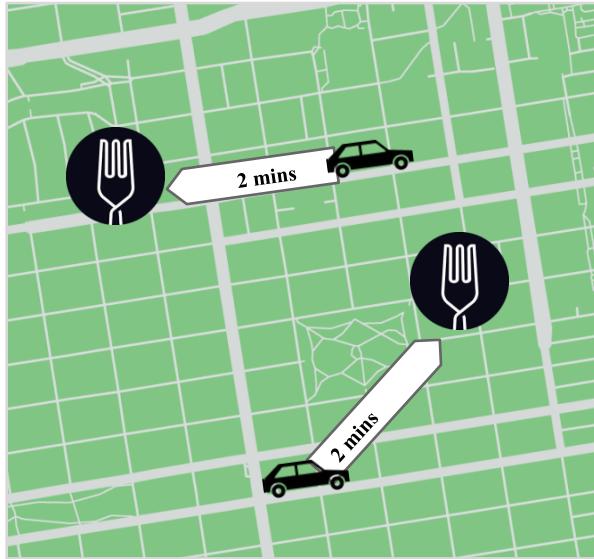


Greedy

1 MIN +

5 MIN

6 MIN



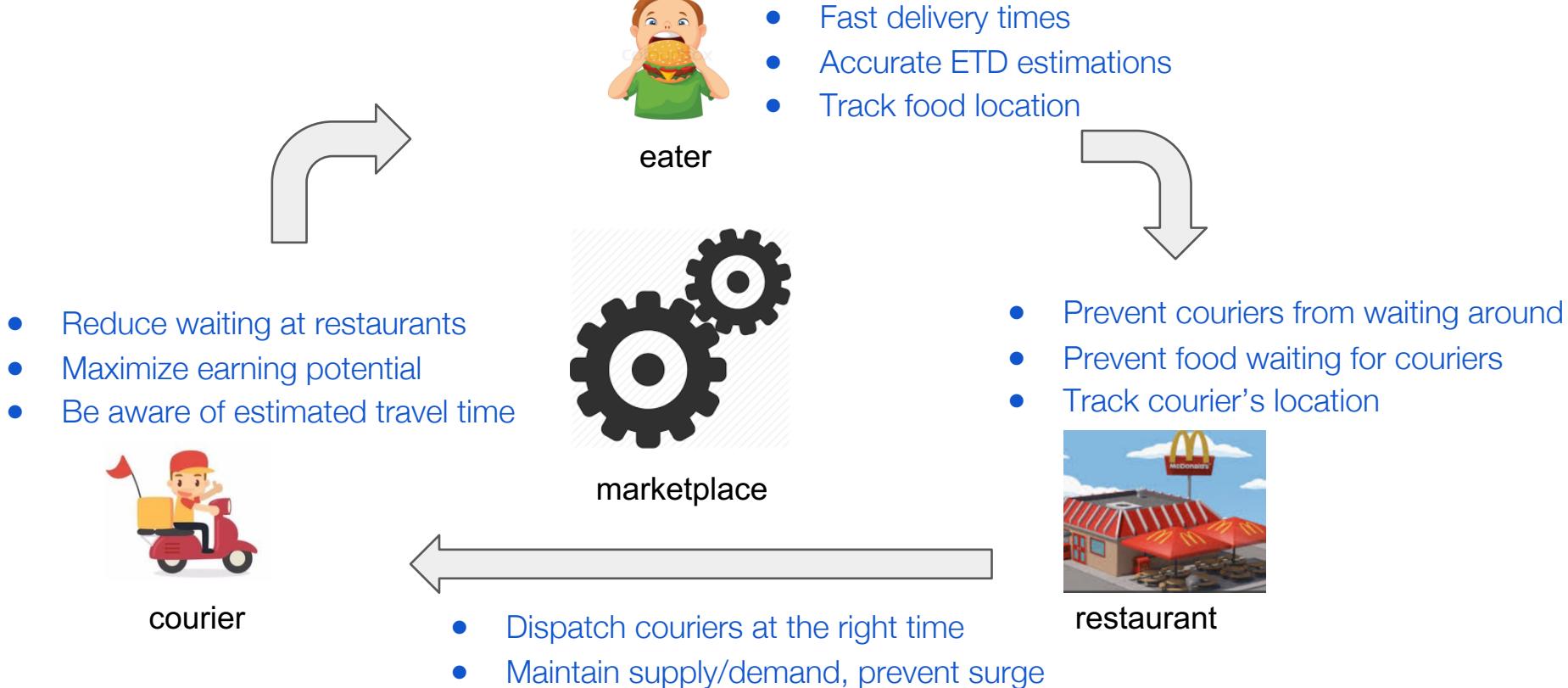
Global

2 MIN +

2 MIN

4 MIN

After...





Time Predictions

- Meal Prep-time

Why predicting meal prep-time is difficult?

- 1) True restaurant prep-time is unknown!
 - Example: We need to infer true prep-time in a retrospective manner based *on restaurants and couriers' signals*.
- 2) Prediction with limited signals
 - Example: The business in the actual restaurant is unknown

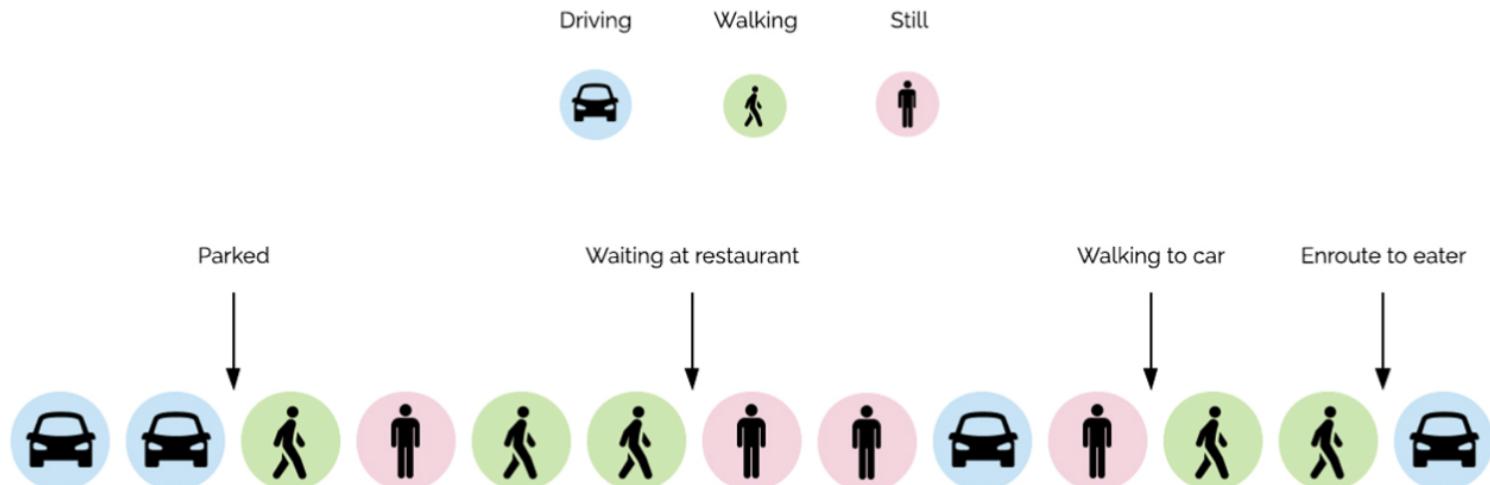
How did we solve it by AI?

- Feature engineering
- Model Training
- Data analysis & Experimentation

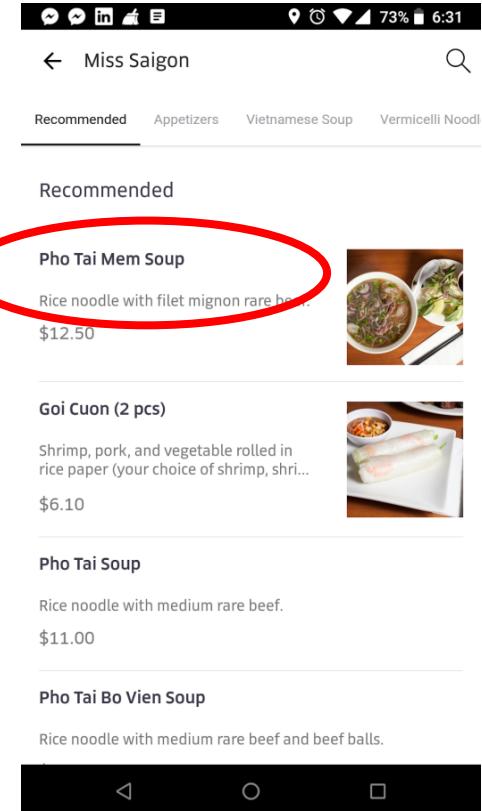
Feature Engineering

- Real-time features
 - Time of day, day of week, order size, location, ...
- Batch (offline) features
 - Avg prep-time for 1 week, ...
- Near real-time features
 - Avg prep-time for last 10 mins, ...

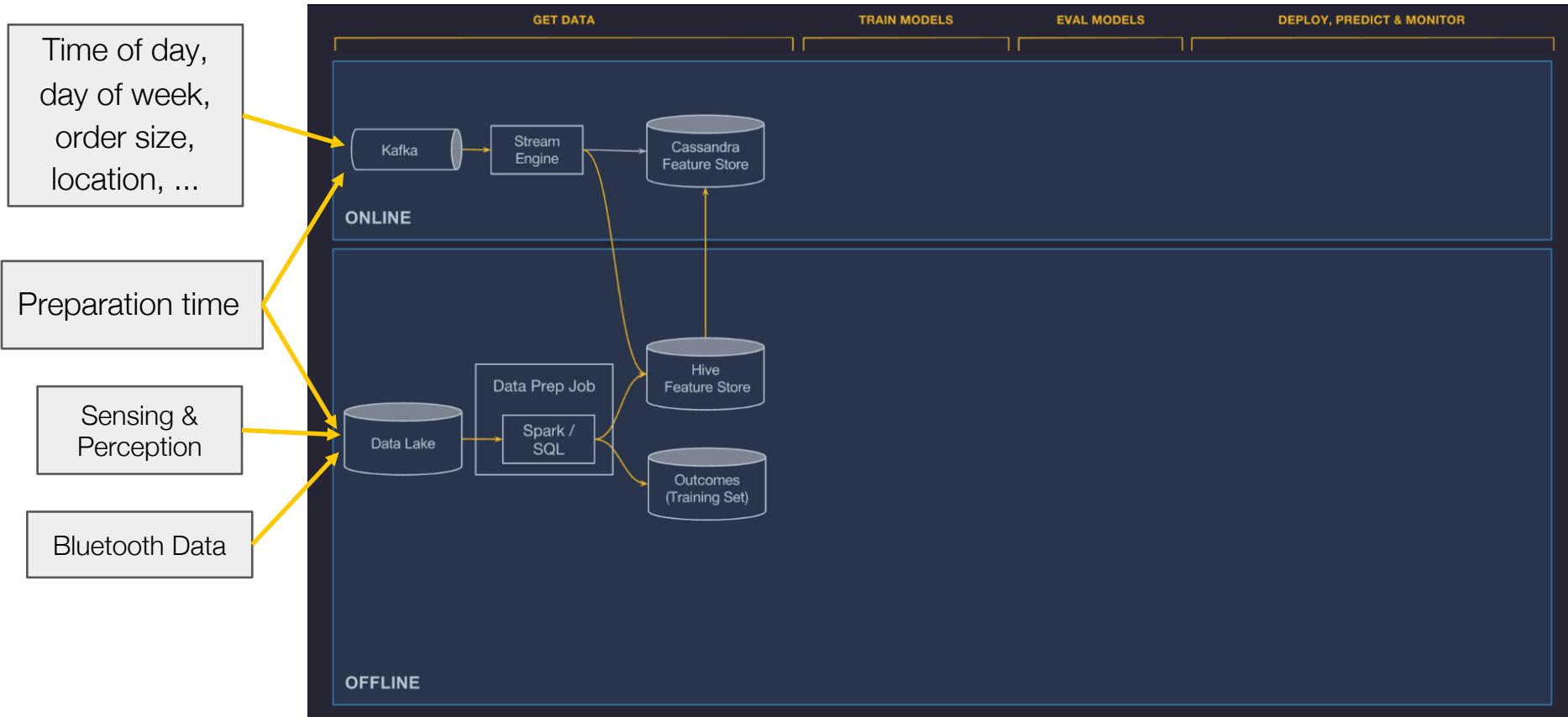
Feature Engineering (Cont'd) - Sensor signals



Feature Engineering (Cont'd) - Representation learning

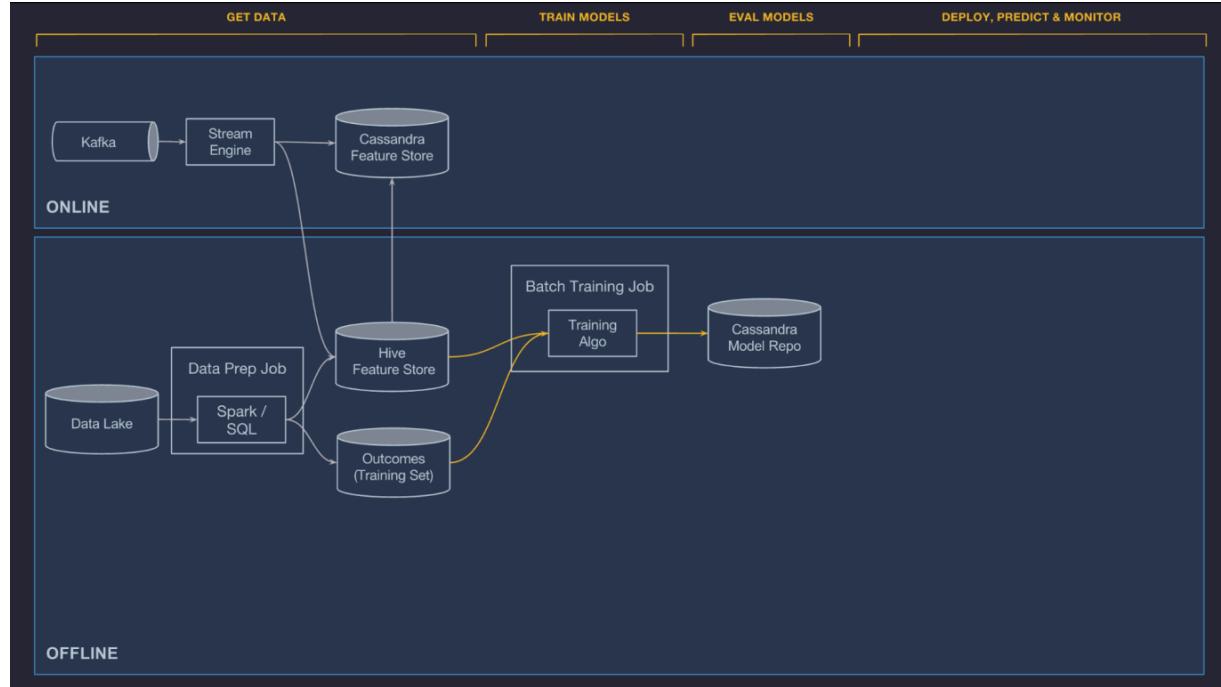


Feature Engineering (Cont'd) - Data pipeline



Data preparation pipelines push data into the Feature Store tables and training data repositories.

Model Training

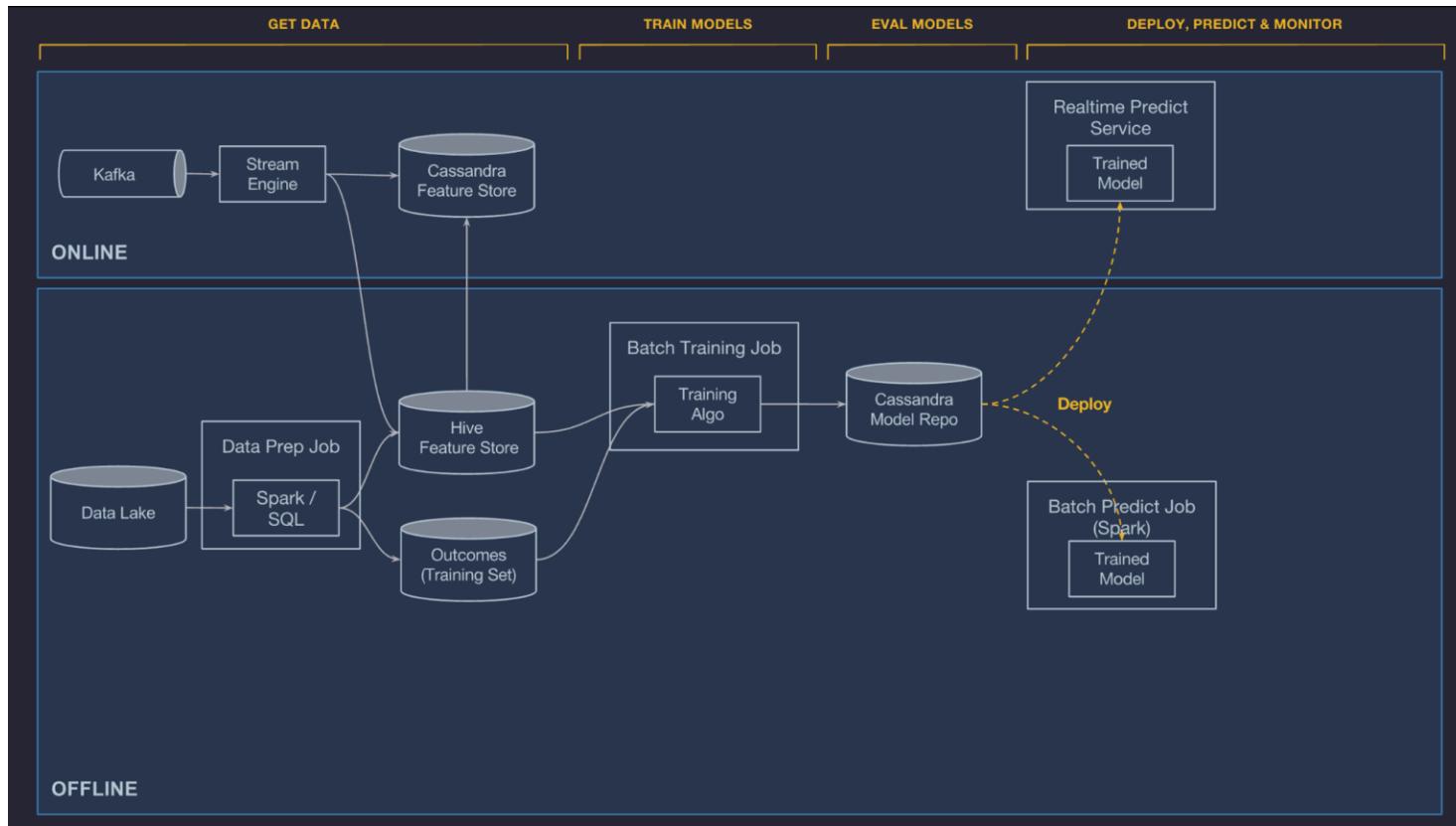


Models

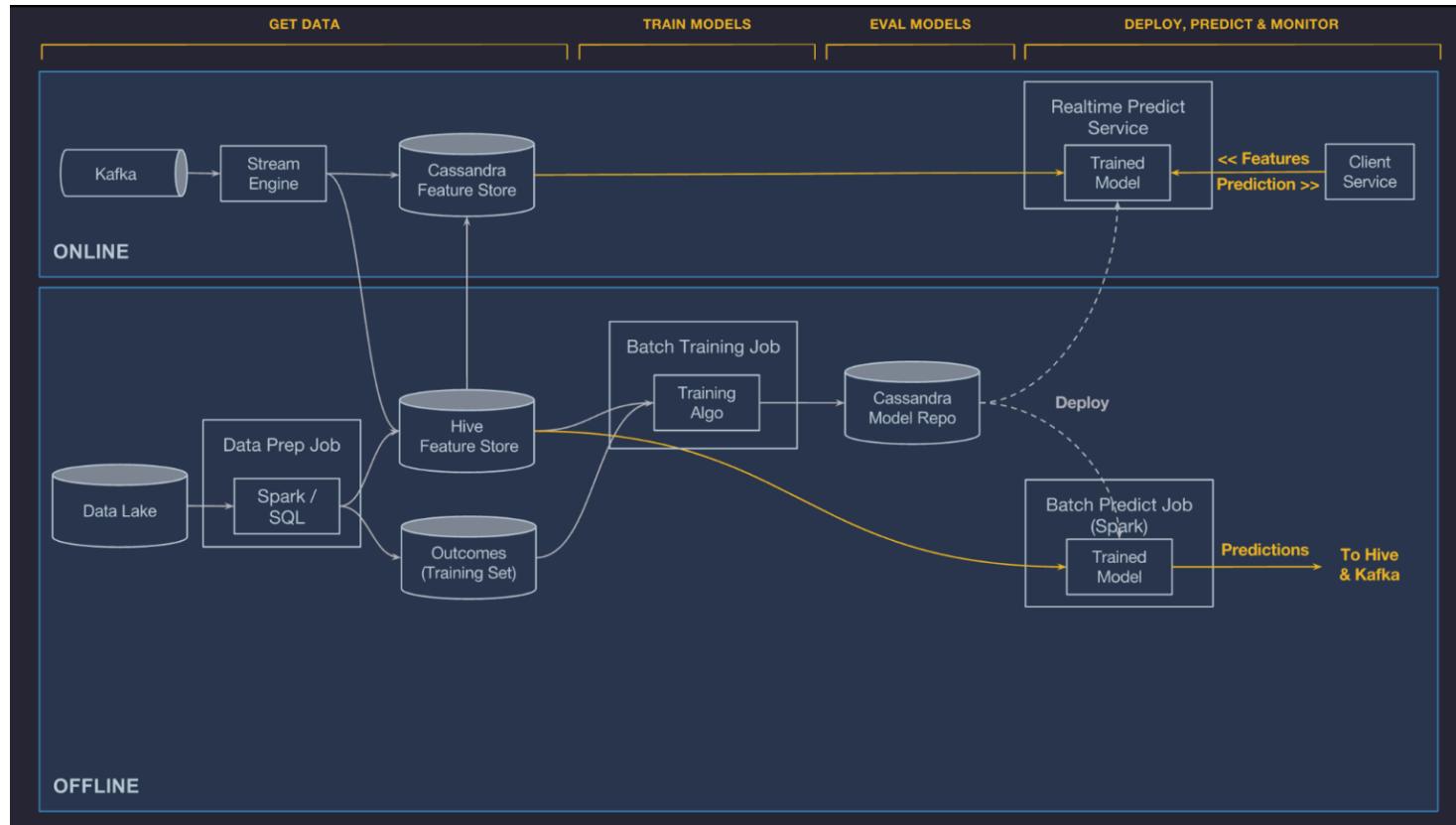
- Gradient Boosted Decision Trees
- Model retrained every few weeks (with each new experiment)
- Near-realtime data refreshed every few minutes
- Historical data refreshed every day

Model training jobs use Feature Store and training data repository data sets to train models and then push them to the model repository.

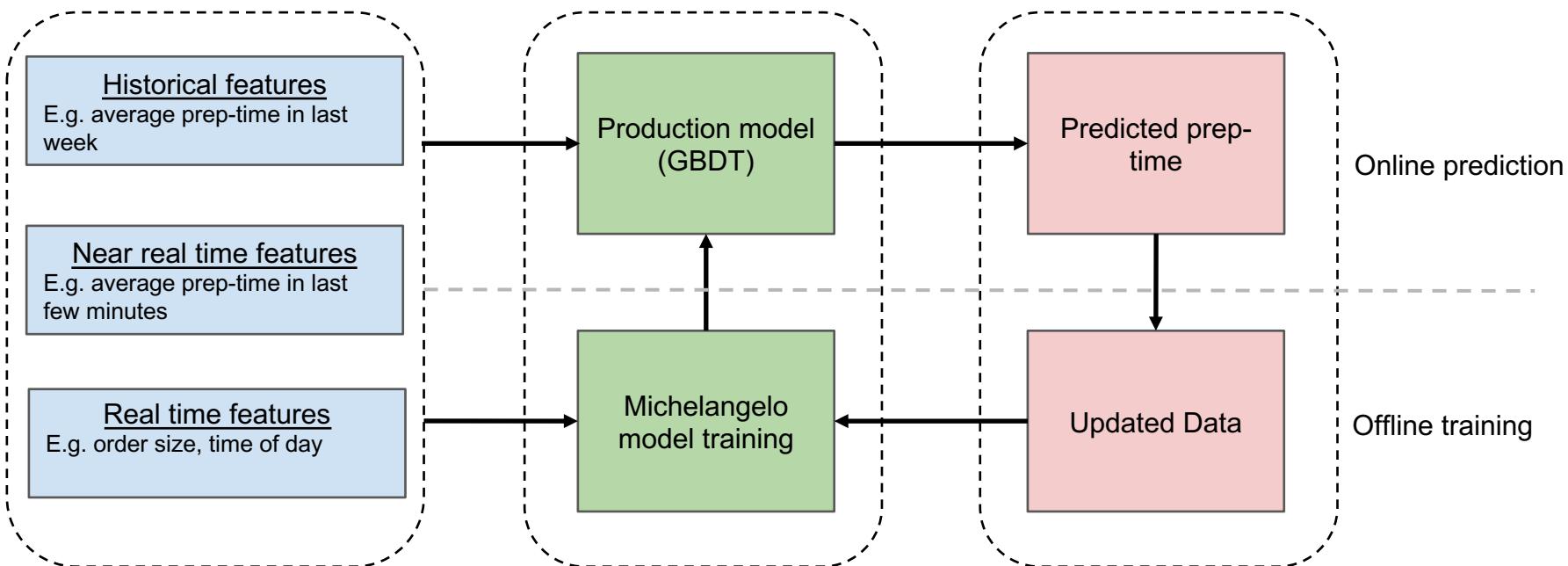
Model Training (Cont'd) - Model deployment



Model Training (Cont'd) - Make predictions



Model Training (Cont'd) - ML model with feedback loop



Improvements - from the latest model iteration

Potential increase of:

Tens of millions of  in gross bookings

Future Improvements

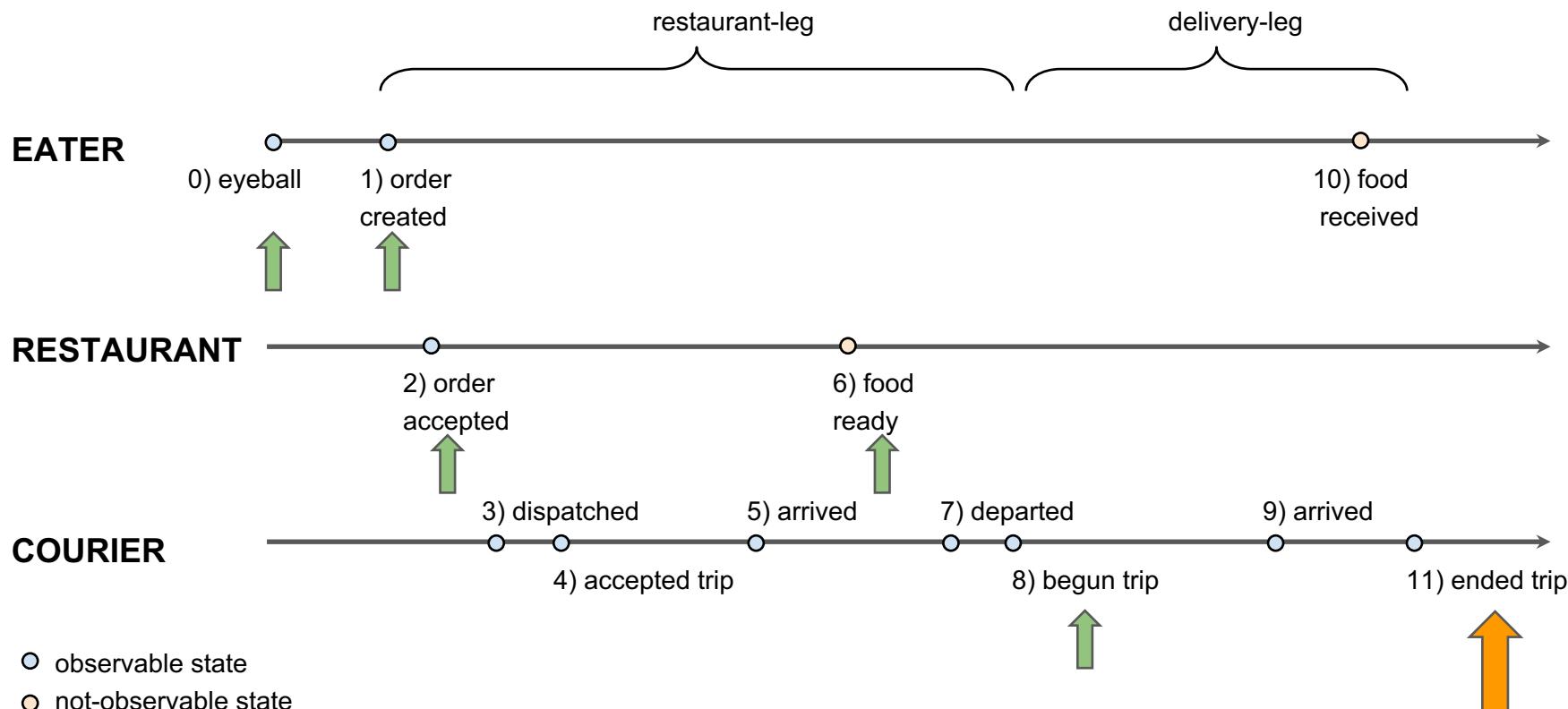
- Ground truth exploration
 - Experiment on encouraging restaurant signals
 - ...
- Improving ML model
 - Feature engineering
 - Exploration of places, weather, and event data
 - Model partitioning
 - ...
 - Leverage ensemble learning (stacking) in prep-time prediction
 - Collaboration with AI Labs on more deep learning models



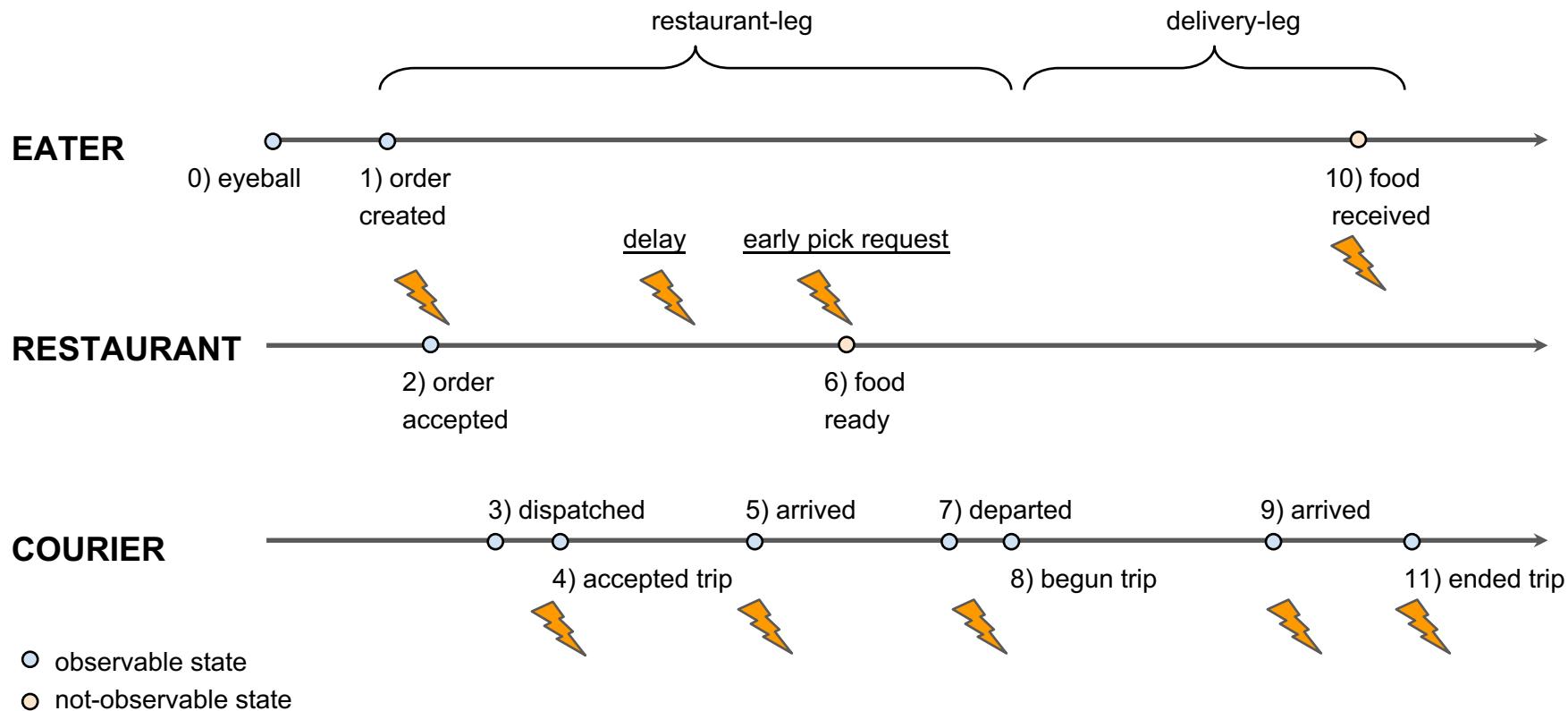
Time Predictions

- ETD

Eater-facing ETD



Why is predicting ETD difficult?



How did we solve it by AI?

- Restaurant features
 - Location, avg prep-time, avg delivery time, avg demand during lunch ...
- Contextual features
 - Time of day, day of week,
- Order features
 - # of items, total cost, ...
- Near real-time features
 - Info about the past N orders
- Model: Gradient boosted decision trees

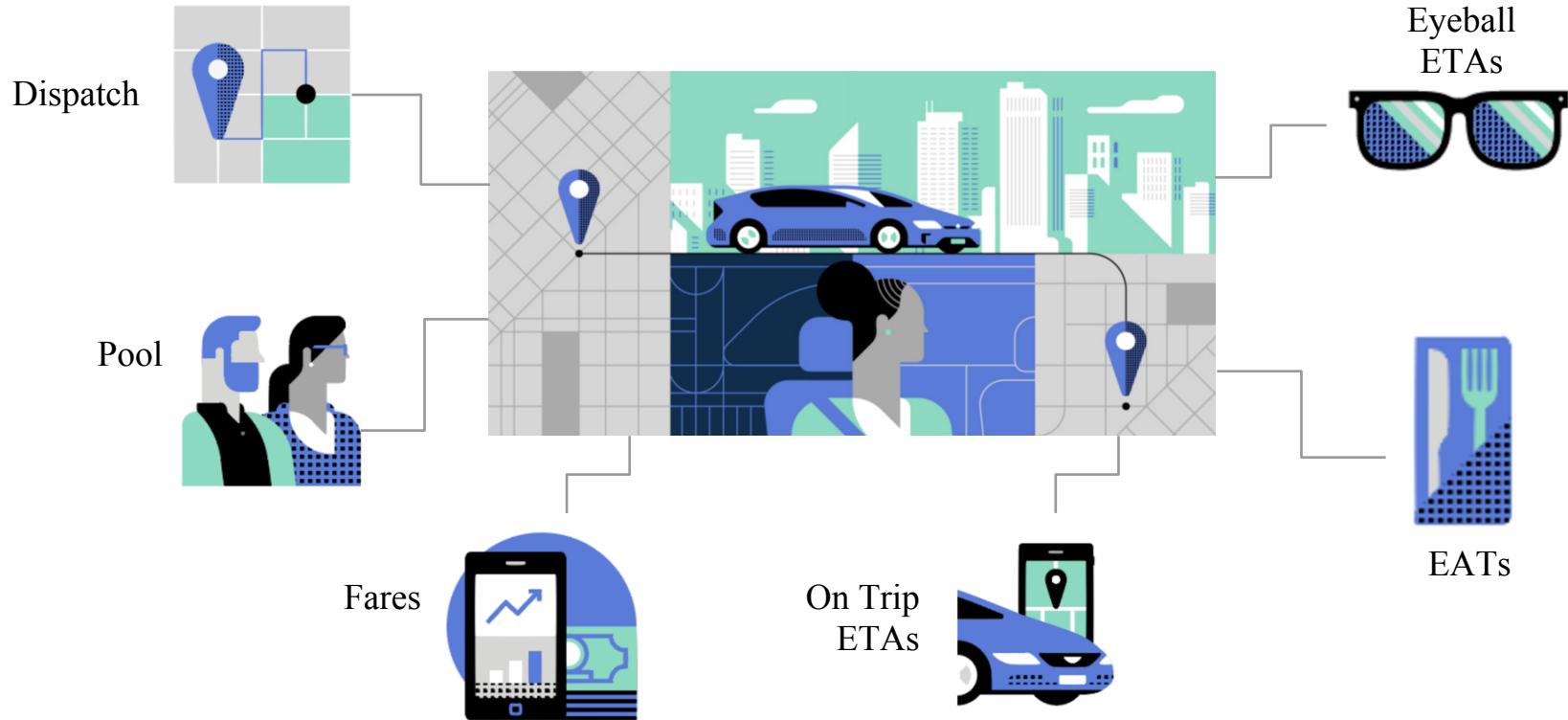
=> Major reductions in mean and p95 ETD errors



Time Predictions

- ETA

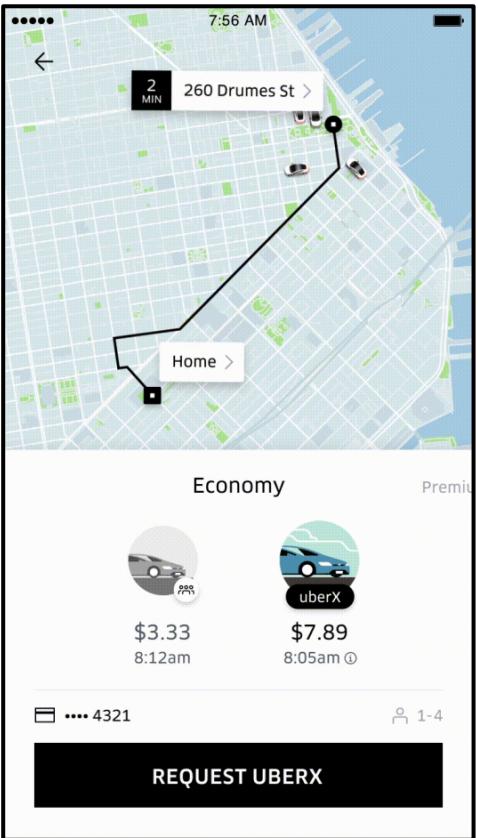
Why are ETAs important? - Every SECOND Matters!



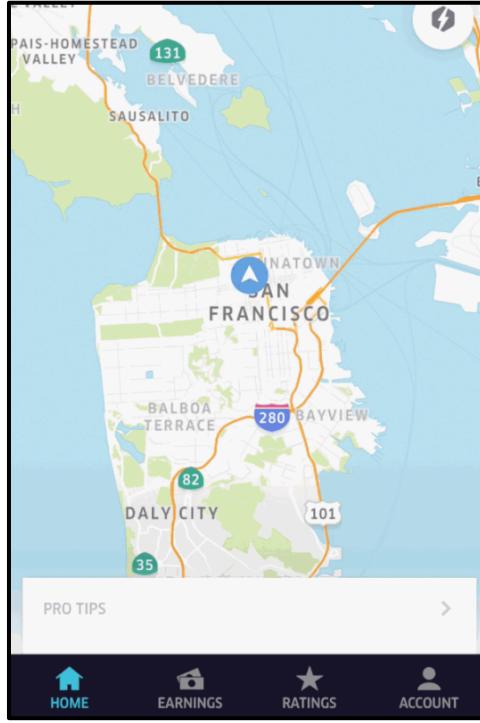
Rider



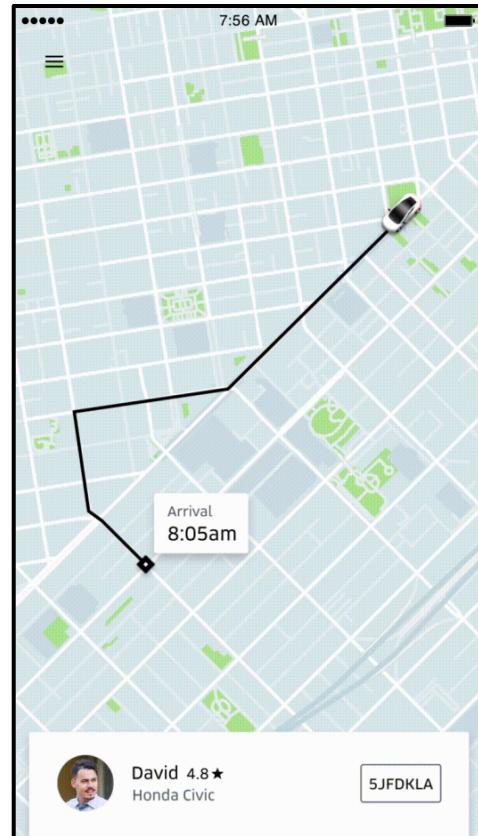
Rider - Request Ride



Driver



Rider - On Trip



Why predicting ETA is difficult?

- 1) Underlying map data is inaccurate
 - Example: Creating/maintaining map data up-to-date requires a lot of resources.
- 2) Real-time events
 - Example: road closures, events etc.
- 3) Human factors
 - Example: detour, wait time, gas etc

How did we solve it by AI?

- Features
 - Time source,
 - Distance source,
 - Current speed,
 - Hour of day,
 - Day of week,
 - Location
 - Number of turns...
- Model: Gradient boosted decision trees

=> Major reductions in mean and median ETA errors



Other Als

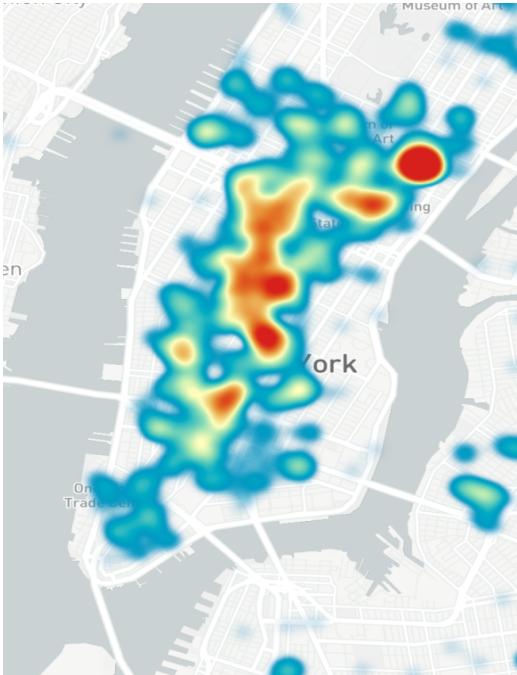


Other AIs

- Dynamic Pricing
- Restaurants Ranking & Recommendation
- Guided Exploration



Dynamic Pricing



Supply (couriers)



Demand (orders)



Perilla - Haight
Vietnamese • \$\$
🕒 UNDER 30 MIN ★ 4.7 (200+)
※ UberEATS is busy in this area. There's an extra \$9.98 fee.

Dinner Q

Recommended

Pork and Vermicelli
Cool vermicelli with a mix of red leaf lettuce, sprouts, mint, and cucumber. Topped with peanuts, and green...
\$11.95

Shrimp Rolls
Soft rice paper rolls filled with poached shrimp, lettuce, mint leave...
\$8.50

Restaurant Ranking & Recommendation

7:04 PM 100%  UBER 

ASAP ⏲ 1004 Judah St

Under 30 minutes



Jane 
4.2 382 Ratings | Breakfast • \$\$ 

Your go-tos



HoSu Bistro 
35 - 46 Min
4.2 382 Ratings | Italian • Pizza • Pasta • \$\$\$ 

Recommended for you



Shanghai Dumpling King 
35 - 46 MIN
4.2 2382 Ratings | Chinese • Dim Sum •
Dumplings • Vegetarian-friendly • \$\$\$ 

Looking for something else?
[Browse categories](#)



Japonese 
Mediterranean 
An 

Looking for something else?
[Browse categories](#)



Japonese



Mediterranean



An

More restaurants



One More Sushi 
25 - 35 Min
4.6 113 Ratings | Japonais • €€



Picto 
25 - 35 Min
4.6 113 Ratings | Français • €€



Eat N' Drink 
25 - 35 Min
4.6 113 Ratings | Américain • €€

[BROWSE OR SEARCH](#)

[SEE ALL RESTAURANTS \(1,402\)](#)

You might like

Kobe Beef Pho \$14.00
Co Nam
30–40 min \$5 Fee

Fresh Roll With Prawns
Green Papaya
30–40 min \$5

Item listicle

16 Restaurants

Co Nam 30–40 MIN
Asian • Vietnamese • \$\$
\$5

Banh Mi Town 35–45 MIN
Vietnamese • \$\$
\$5

Search results

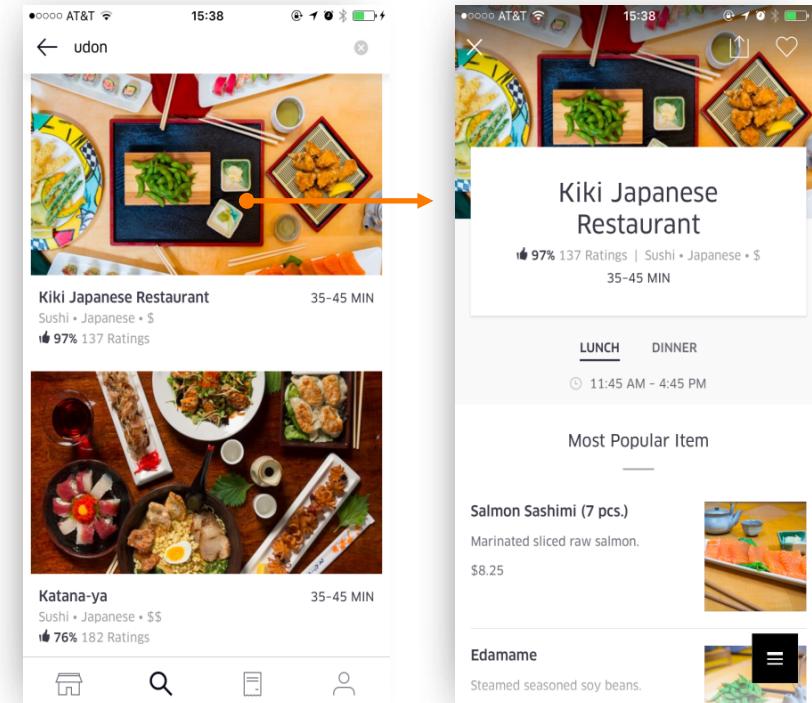
People also search for

 ramen spring rolls noodle sou

Guided Exploration (Search)

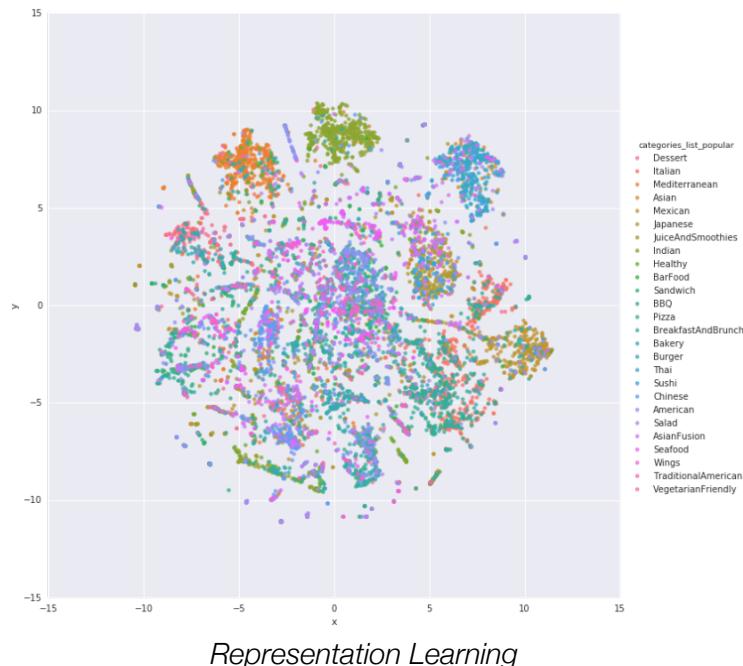
Challenges

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



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



Food Knowledge Graph

- Chipotle
 - Is it a restaurant?
 - Fast food?
 - Sells burritos?
 - Similar restaurants?
- Poke
 - Is it a cuisine?
 - Similar cuisines?



Credits

Teams @ Uber

Special thanks to:

- **Engineers**
- **Data Scientists**
- **Product managers**
- **Product Ops**
- **Data Analysts**

50+ 年末充电[⚡] 开发&运维技术干货大盘点

容器

Kubernetes

DevOps

全链路压测

Serverless

自动化运维

Service Mesh

Elasticsearch

微服务

使用折扣码 「QCon」 优惠报名 咨询电话：13269078023



扫码锁定席位

AI商业化下的技术演进实战干货分享

京东：智能金融

景驰科技：自动驾驶

阿里巴巴：NLP

清华大学人工智能研究院：机器学习

今日头条：机器学习

Twitte：搜索推荐

AWS：计算机视觉

Netflix：机器学习



扫码了解详情



THANK YOU

Q & A

