

UBER

Customer Obsession Ticket Assistant

Improving Uber Customer
Support with Natural Language
Processing and Deep Learning

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Huaixiu Zheng | Applied Machine Learning

Yi-Chia Wang | Applied Machine Learning



Main Takeaways

COTA v1: classical NLP + ML models

- Faster and more accurate customer care experience
- Million \$ of saving while retaining customer satisfaction

COTA v2: deep learning models

- Experiments with various deep learning architectures
- 20-30% performance boost compared to classical models

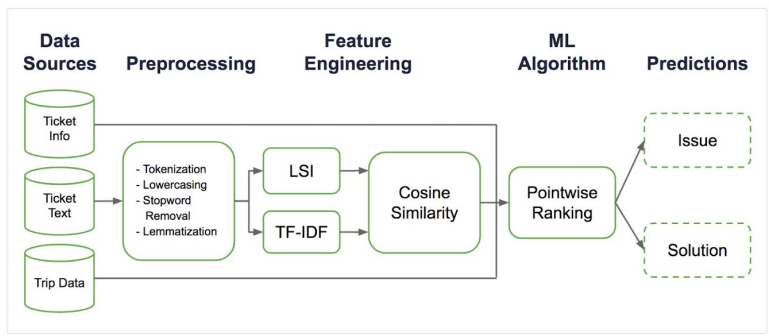
COTA Blog Post and followup, KDD paper

CATEGORIES

- [Architecture](#)
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- [Mobile](#)
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COTA: Improving Uber Customer Care with NLP & Machine Learning

By Huaixiu Zheng, Yi-Chia Wang, & Piero Molino
January 3, 2018



Agenda

Motivation and Solution

Complexity of Customer support @Uber

COTA v1: Traditional ML / NLP Models

Multi-class Classification vs Ranking

COTA v2: Deep Learning Models

Deep learning architectures

COTA v1 vs COTA v2

Agenda

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COTA v1 vs COTA v2

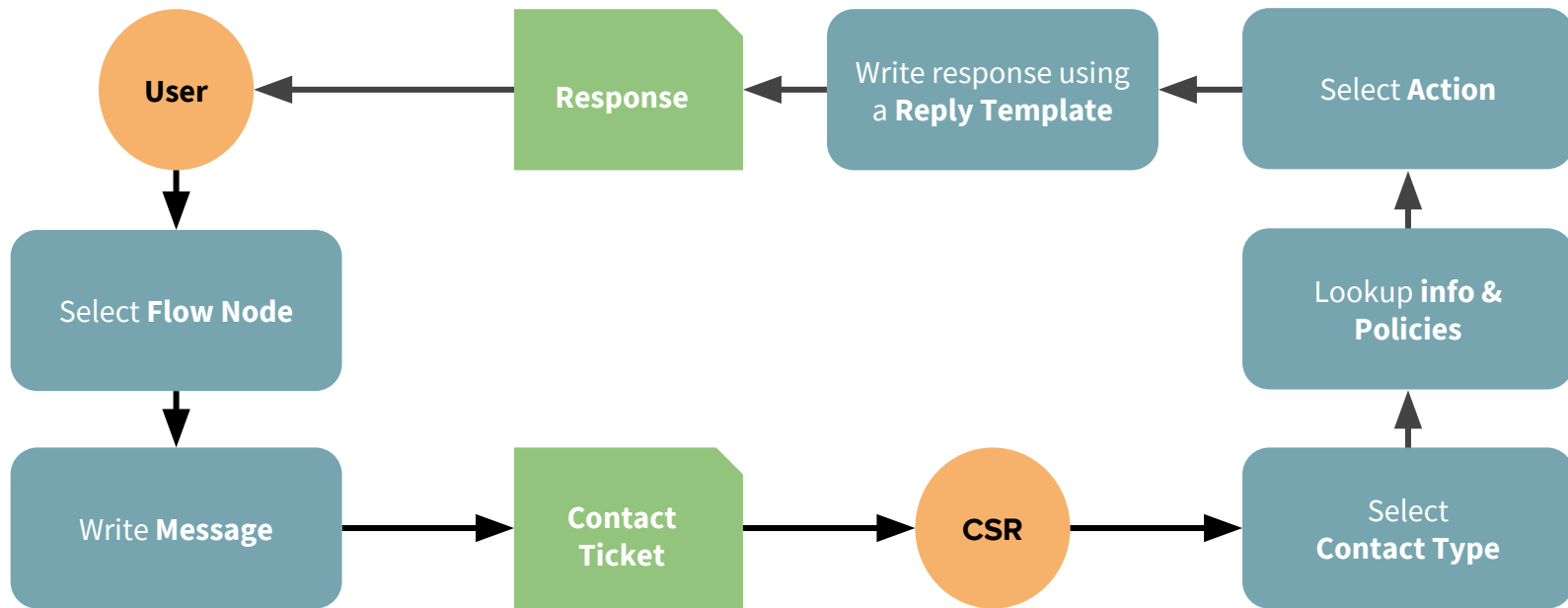
What is the challenge?

As Uber grows, so does our volume of support tickets

Millions of tickets from
riders / drivers / eaters
per week

**Thousands of different
types of issues** users
may encounter

Uber Support Platform



What is the challenge?

And it is not easy to solve a ticket

Contact us for rider support

SKIP

Driver > Account > Unable to sign in or go online > Account inactive > Background check not passed > Background check cancelled

2 hours ago

NK

UPDATED CONTACT STATUS TO OPEN

✓

Driver > Activations & Docs Concern

Please Assist

2 hours ago

JB

UPDATED CONTACT TYPE TO DRIVER > ACCOUNT > UNABLE TO SIGN IN OR GO ONLINE > ACCOUNT INACTIVE > BACKGROUND CHECK NOT PASSED > BACKGROUND CHECK CANCELLED

✓

21 minutes ago

JB

UPDATED CONTACT STATUS TO OPEN

✓

21 minutes ago

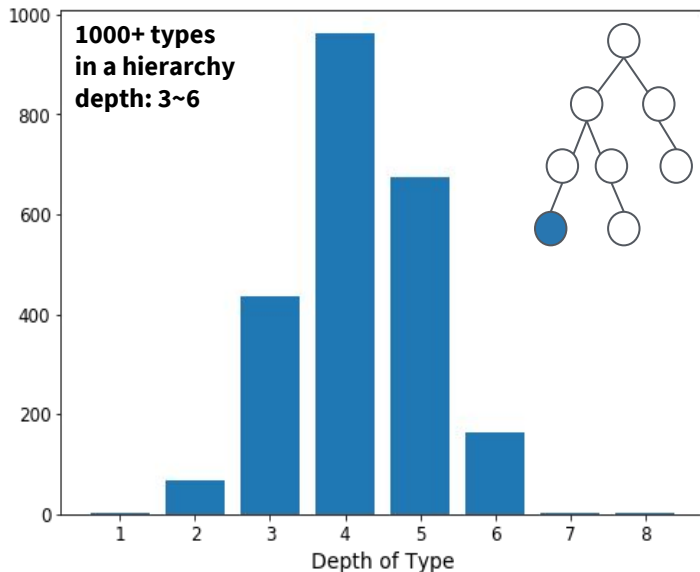
I WANT TO ADD DRIVER NOTE CHANGE DRIVER STATUS OR SOMETHING ELSE

10+ actions (adjust fare, add appeasement, ...)

All Saved Replies

- Explain - re-consent needed
- Explain - reactivation requires new background check
- Reactivate - inactive

1000+ reply templates



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COTA v1: Suggested Resolution

Machine learning models recommending the 3 most relevant solutions

Contact us for rider support ⓘ

SKIP | ▾

Driver > Account > Unable to sign in or go online > Account inactive > Background check not passed > Background check cancelled

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21 minutes ago

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21 minutes ago

I WANT TO | ADD DRIVER NOTE | CHANGE DRIVER STATUS | OR | SOMETHING ELSE ▾

SUGGESTED CONTACT TYPES

Driver > Account > Unable to sign in or go online > Account inactive
Driver > Account > Profile > Unsubscribe > SMS or Text
Driver > Account > Vehicles > Edit vehicle class

Reorder actions in relevance

Suggested Replies

Explain - license verification

Explain - invalid SSN

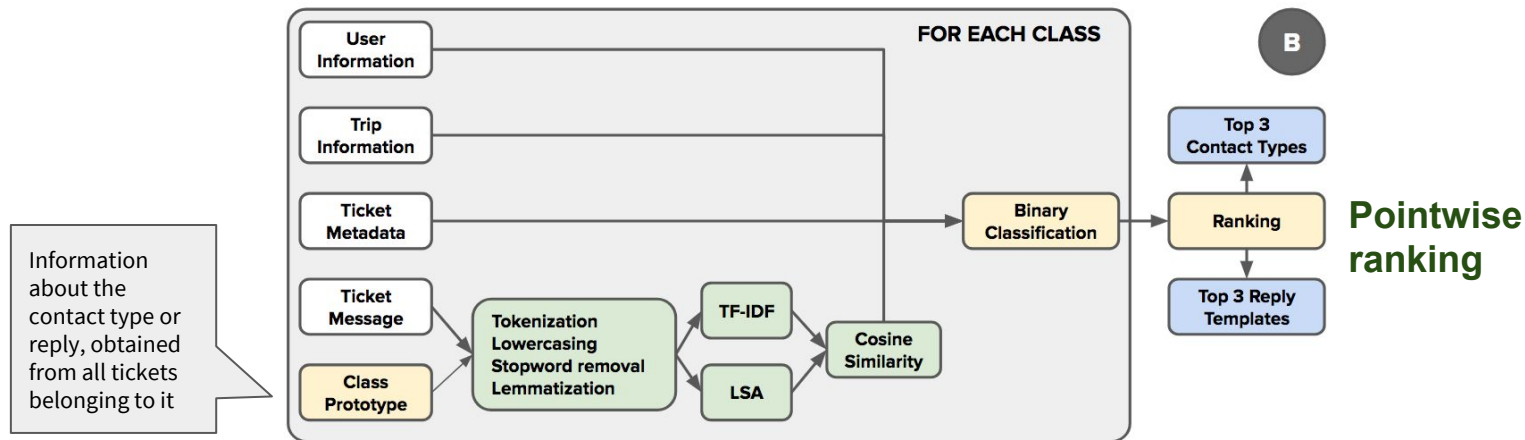
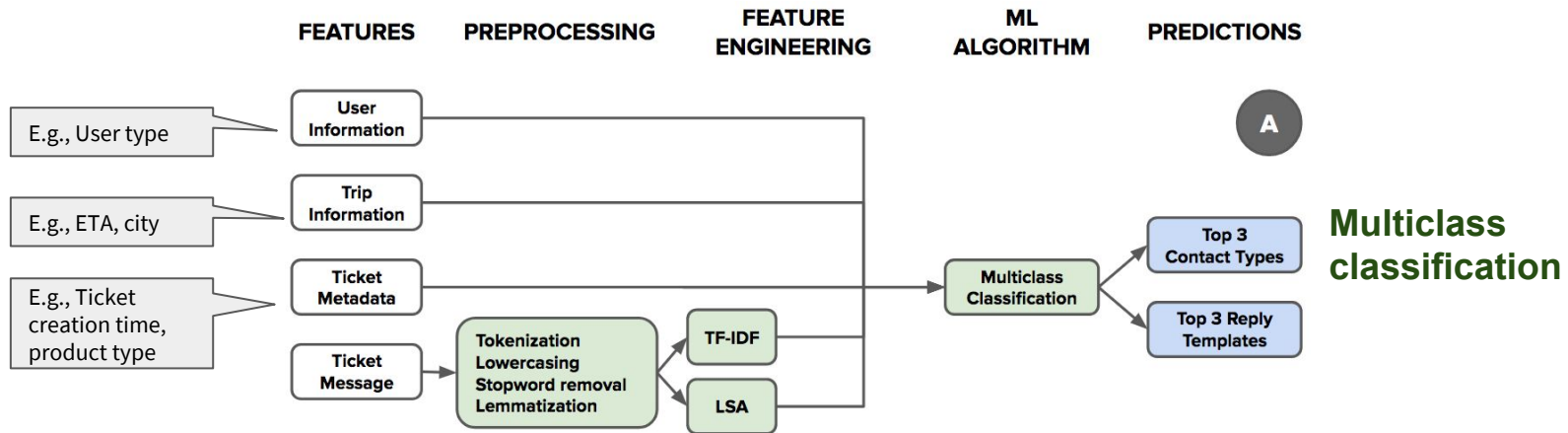
Confirm - Jira submitted

All Saved Replies

Explain - re-consent needed

Surface top-3 most-relevant reply templates

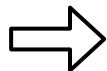
COTA v1 Model Pipeline



From Classification to Ranking

Multi-class Classification

Tickets Features	Label (CT1, CT2)
t1 features	CT1
t2 features	CT2

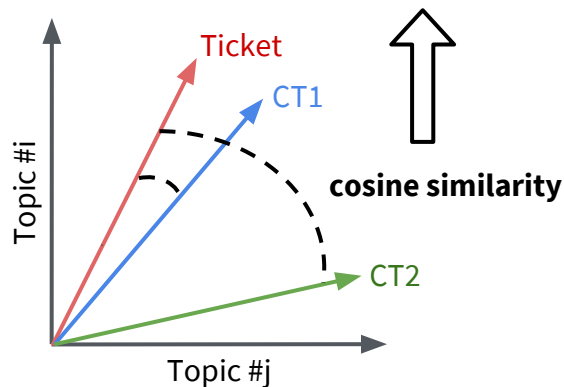


Pointwise Ranking

Tickets Features	Type Features	Sim (t, CT)	Label (0, 1)
t1 features	CT1 features	0.8	1
t1 features	CT2 features	0.1	0
t2 features	CT1 features	0.2	0
t2 features	CT2 features	0.7	1

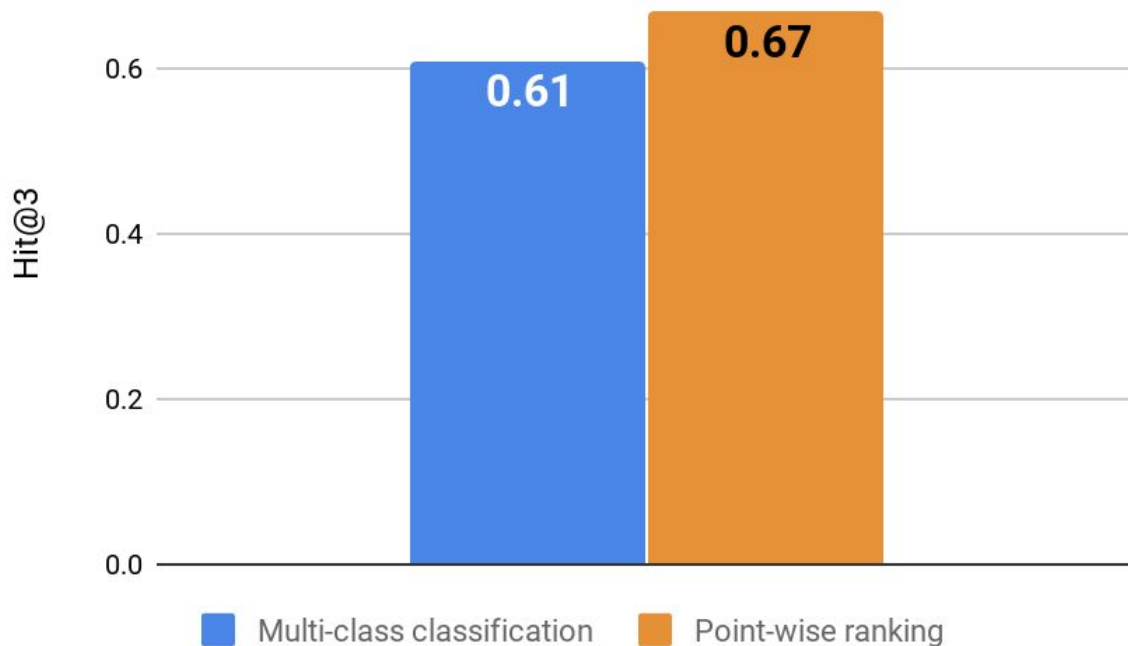
Ranking allows us to include **features of candidate types** and **similarity features** between a ticket and a candidate type

Model: **Random Forest** with hyperparameters optimized through **grid search**



Performance Comparison

6% absolute (10% relative) improvement



Hits@3: any of the top 3 suggestions is selected by CSRs

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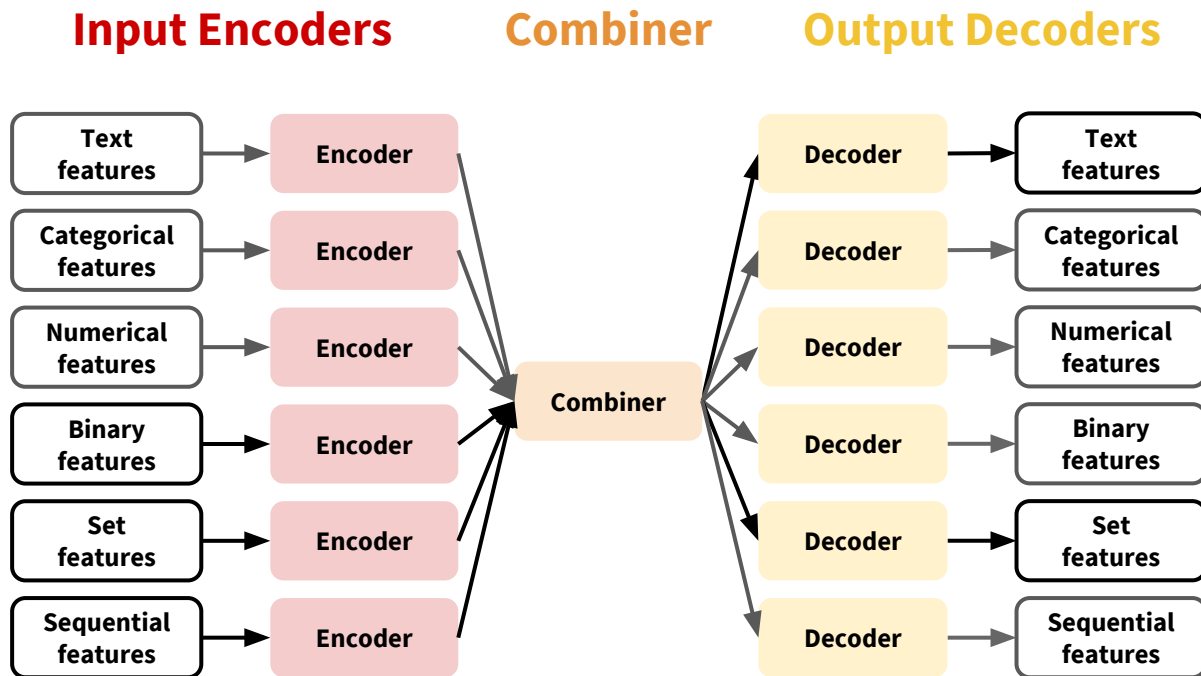
Multi-class Classification vs Ranking

COTA v2: Deep Learning Models

Deep learning architectures

COTA v1 vs COTA v2

COTA v2: Deep Learning Architecture

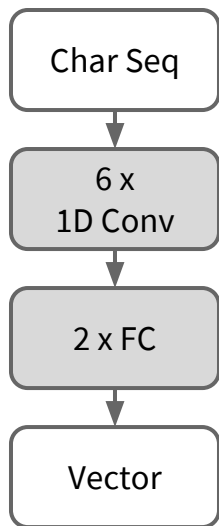


Generic architecture, reusable in many different applications.

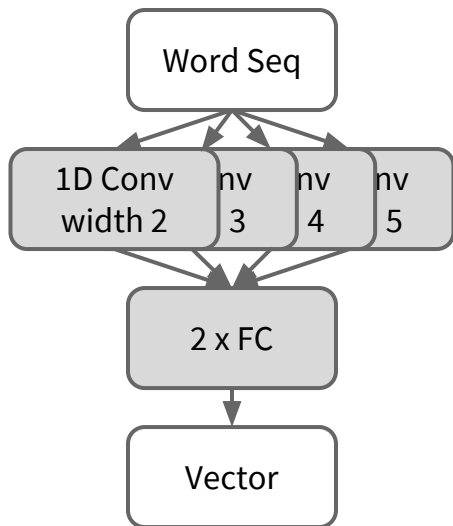
We are considering open-sourcing it!

COTA v2: Text Encoding Models

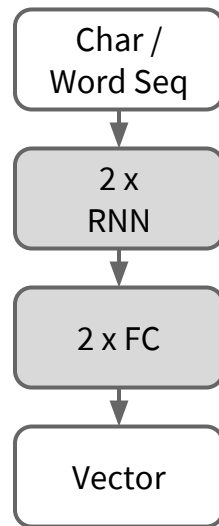
Char CNN



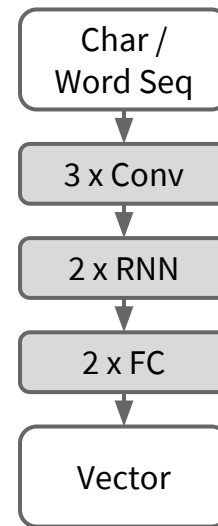
Word CNN



Char / Word RNN

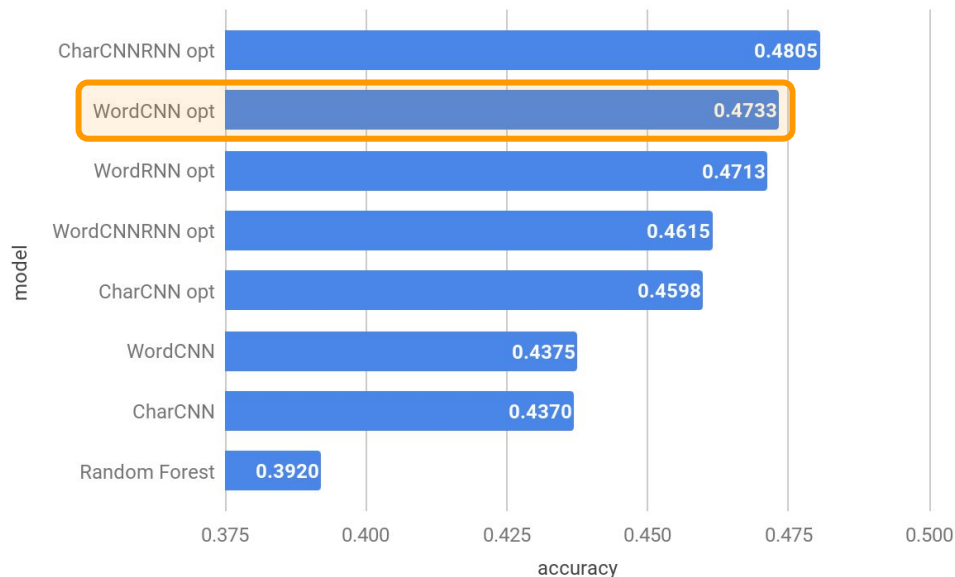


Char / Word CNN RNN



Which text encoder?

Hyperparameter search for contact type classification



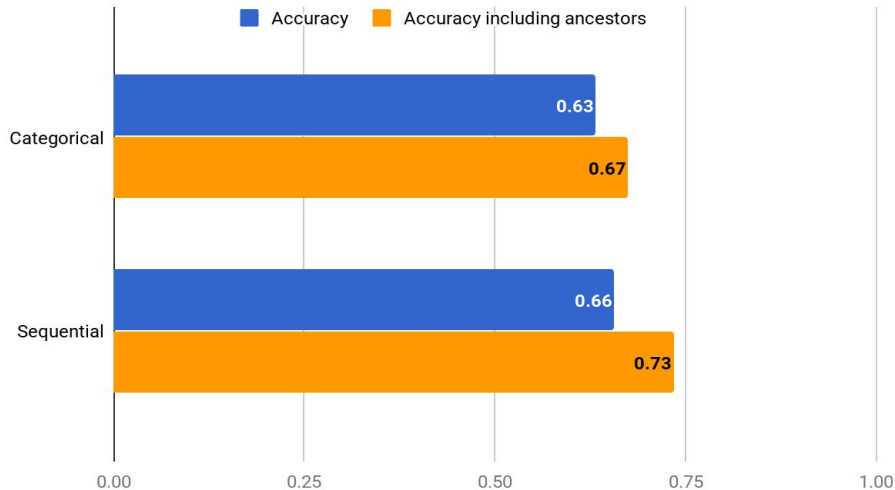
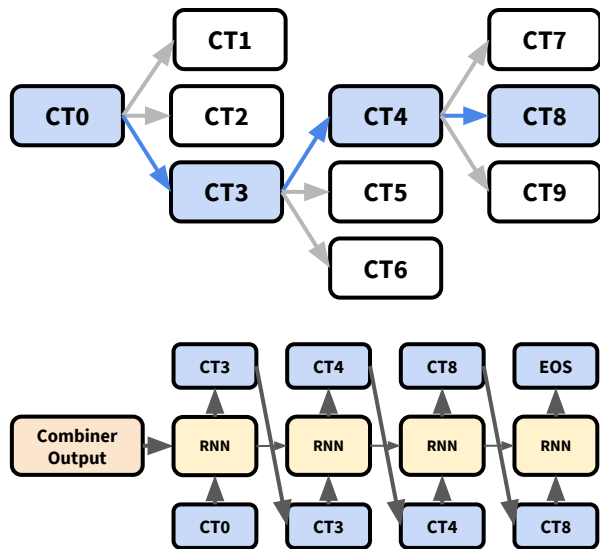
Model	Validation accuracy	Training time per epoch in minutes
CharCNNRNN opt	0.4805	35
WordCNN opt	0.4733	4
WordRNN opt	0.4713	17
WordCNNRNN opt	0.4615	12
CharCNN opt	0.4598	5

WordCNN is the **best compromise** between **performance** and **speed**

20%+ over Random Forest used in COTA v1 and **~10x** faster than CharCNNRNN

Sequence Model for Type Selection

Predict the sequence of nodes instead of leaf node



Example: **Driver > Trips > Pickup and drop-off issues > Cancellation Fee > Driver Cancelled**

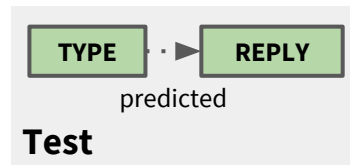
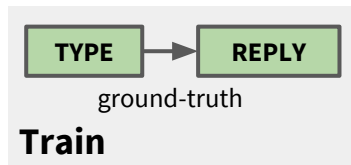
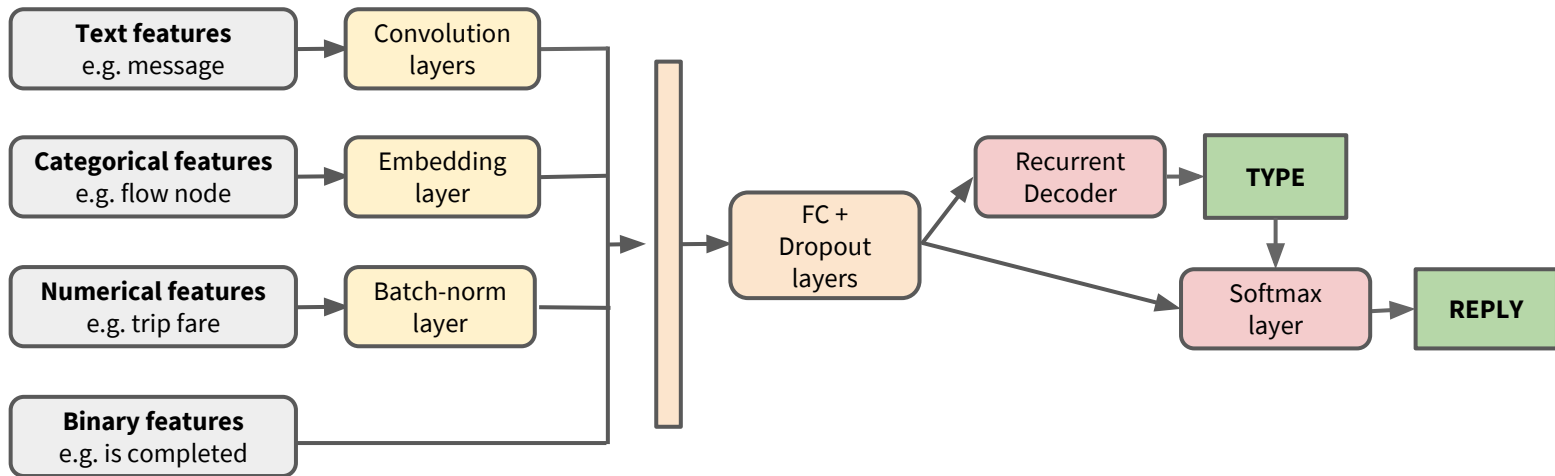
Use a Recurrent Decoder to predict **sequences of nodes** in the contact type tree

Pick the last class before <eos> as prediction

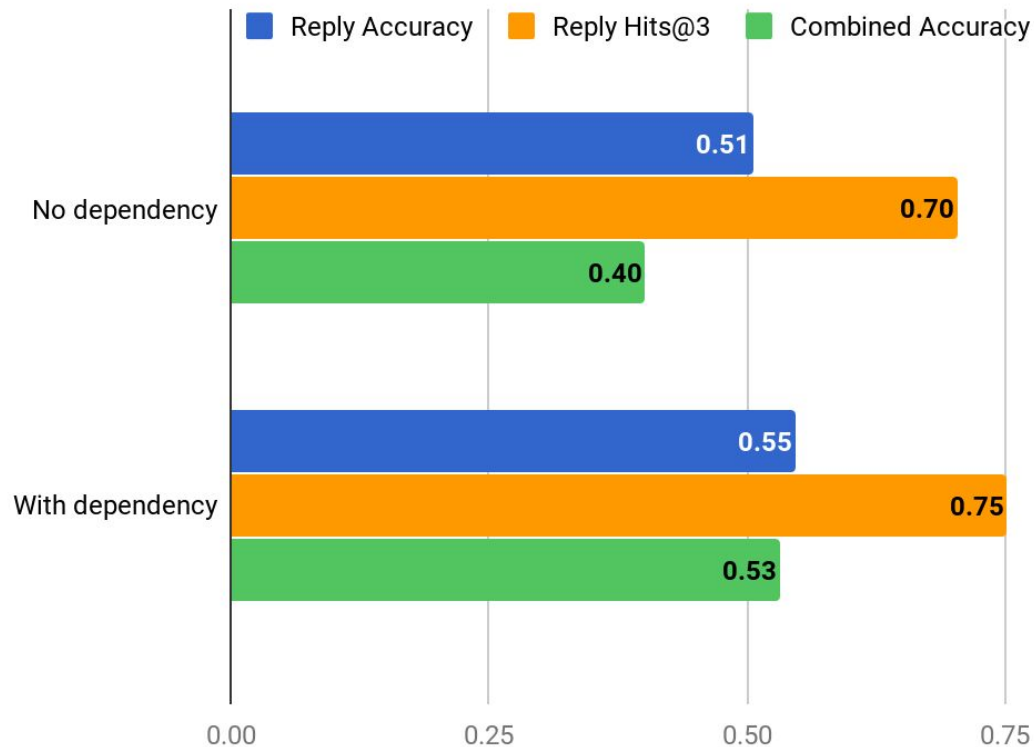
Model makes **more reasonable mistakes**

Final Architecture

Multi-task sequential learning



Effect of Adding Dependencies Between Tasks



Adding the dependency from Type to Reply **improves accuracy**

It also improves a lot the **coherence** between the two models, **increasing combined accuracy** consistently

Combined accuracy computed requiring both Type and Reply model to be **correct at the same time**

Outline

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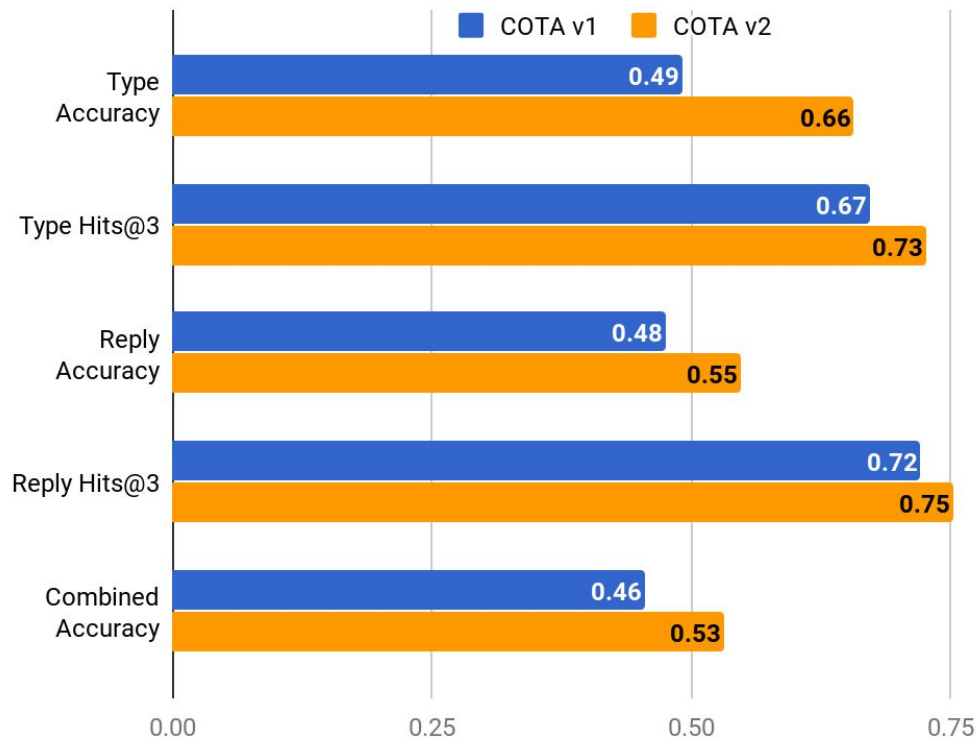
Multi-class Classification vs Ranking

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COTA v1 vs COTA v2

COTA v1 vs. COTA v2 offline comparison



COTA v2 is **consistently more effective** than COTA v1 on **all metrics** for **both models**

The combined accuracy in particular shows an absolute **+9%** (relative **+~20%**)

COTA v1 vs. COTA v2 A/B Test

I had an issue with my pickup ⓘ SKIP | ▾

Rider > Trips > Pickup and drop-off issues > Cancellation Fee

Control

Please set a contact type that best represents the user's issue: SET

Rider > Trips > Pickup and drop-off issues > Cancellation Fee

Search Contact Type

Cleaning fee >	Fare review >	Brought to wrong destination	Cancellat
Cross Support - General >	Feedback about driver >	Cancellation Fee >	Couldn't
Cross Support - Safety >	Feedback about vehicle >	Had to walk to pickup or destination	Driver a
Duplicate contact >	Invoice >	No cars available >	Driver ca
Info >	Lost items general info >	Pickup difficulty without cancellation fee >	Driver d
Lost Items >	Pickup and drop-off issues >	Trip automatically cancelled	Driver to
IRT: Accidents >	Promotions >	uberPOOL no show fee >	Driver w
IRT: Incidents >	Receipt >	Scheduled rides	Phone ba
Service Denial >	uberPOOL on trip issues >	None of the above works	Refused
Tech issues >	DOST		Road iss
Trips >	External Sources >		Set Wron

I had an issue with my pickup ⓘ SKIP | ▾

Rider > Trips > Pickup and drop-off issues > Cancellation Fee

Treatment

Please set a contact type that best represents the user's issue: SET

Rider > Trips > Pickup and drop-off issues > Cancellation Fee

Search Contact Type

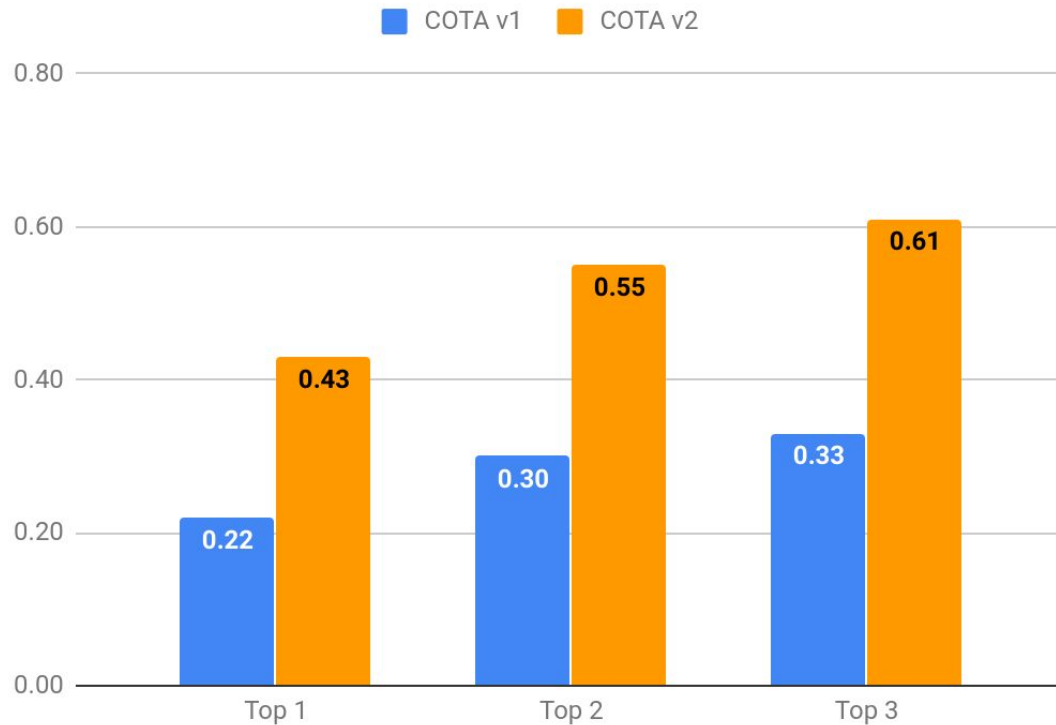
Rider > Trips > Pickup and drop-off issues > Cancellation Fee > **Driver cancelled**

Rider > Trips > Pickup and drop-off issues > Cancellation Fee > **Cancellation policy**

Rider > Trips > Pickup and drop-off issues > Cancellation Fee > **Couldn't find or get to driver**

DOST	Brought to wrong destination	Cancellation policy
External Sources >	Cancellation Fee >	Couldn't find or get to driver
Fare review >	Had to walk to pickup or destination	Driver arrived too early
Feedback about driver >	No cars available >	Driver cancelled
Feedback about vehicle >	Pickup difficulty without cancellation fee >	Driver didn't answer phone
Invoice >	Scheduled rides	Driver took too long
Lost items general info	Trip automatically cancelled	Driver went to a totally different place >

COTA v1 vs. COTA v2 A/B Test

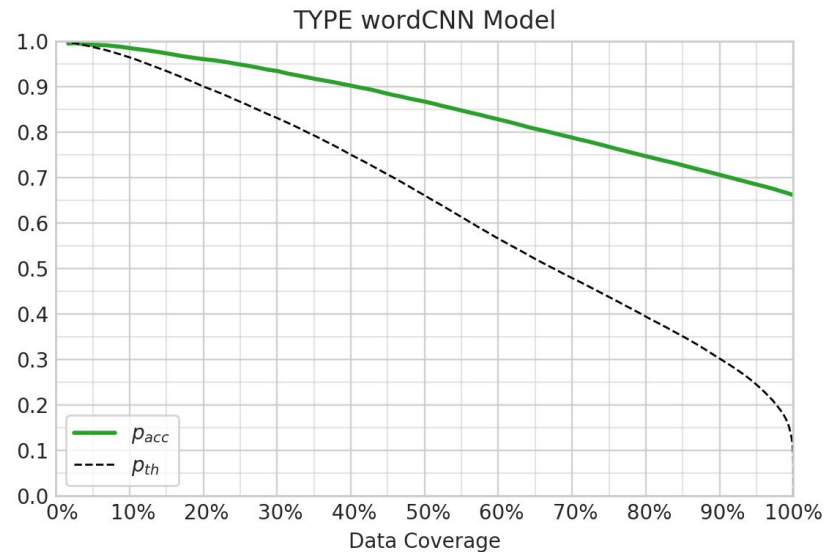
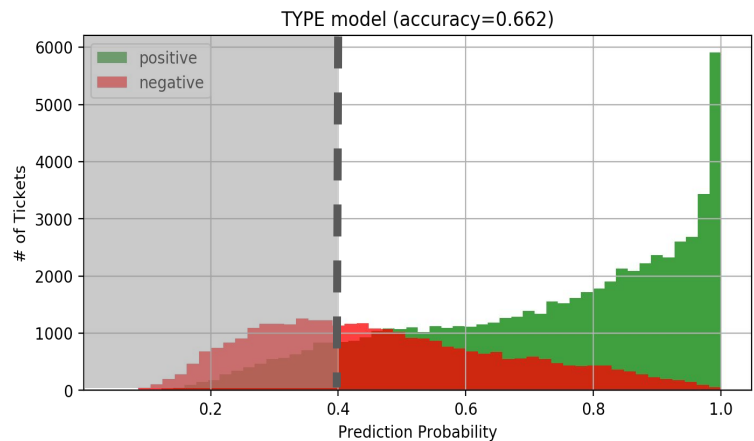


COTA v2 is **20-30% more accurate** than COTA v1 in online A/B tests

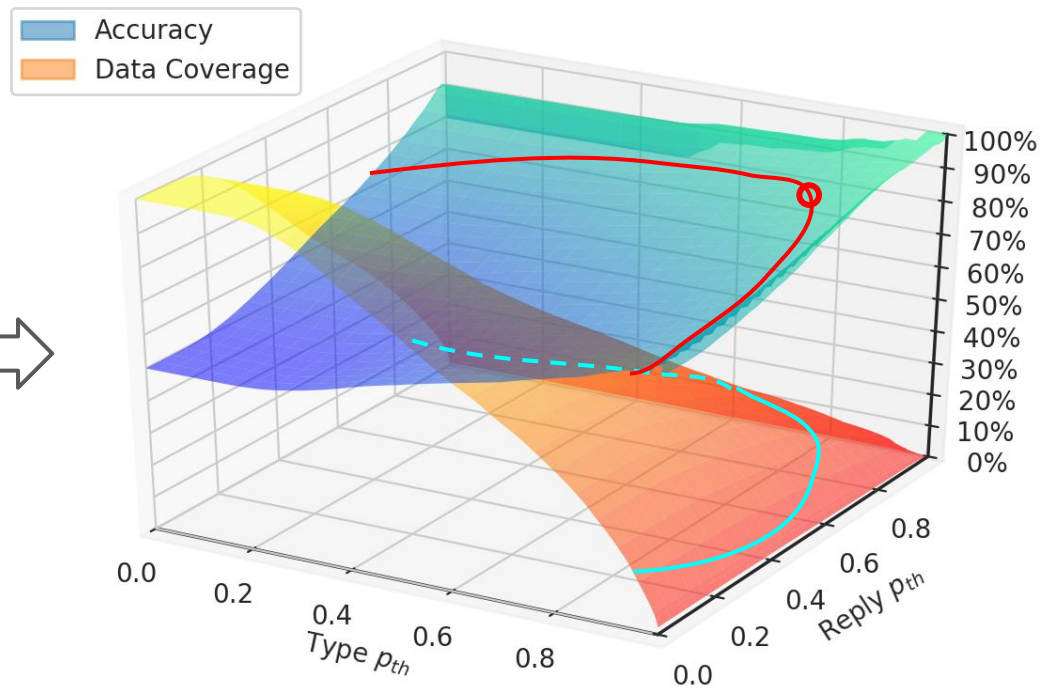
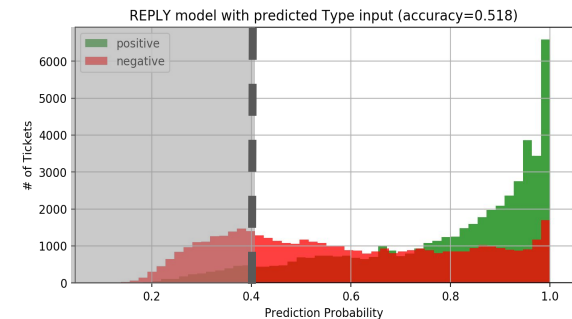
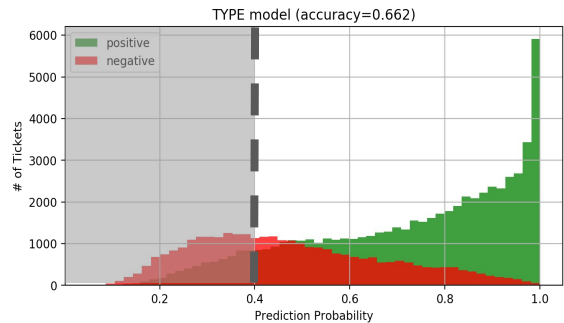
COTA v1 **reduces handling time** of ~8%, while COTA v2 provides an additional ~7% **reduction**, more than ~15% **overall reduction**

Statistically significant **customer satisfaction improvement**

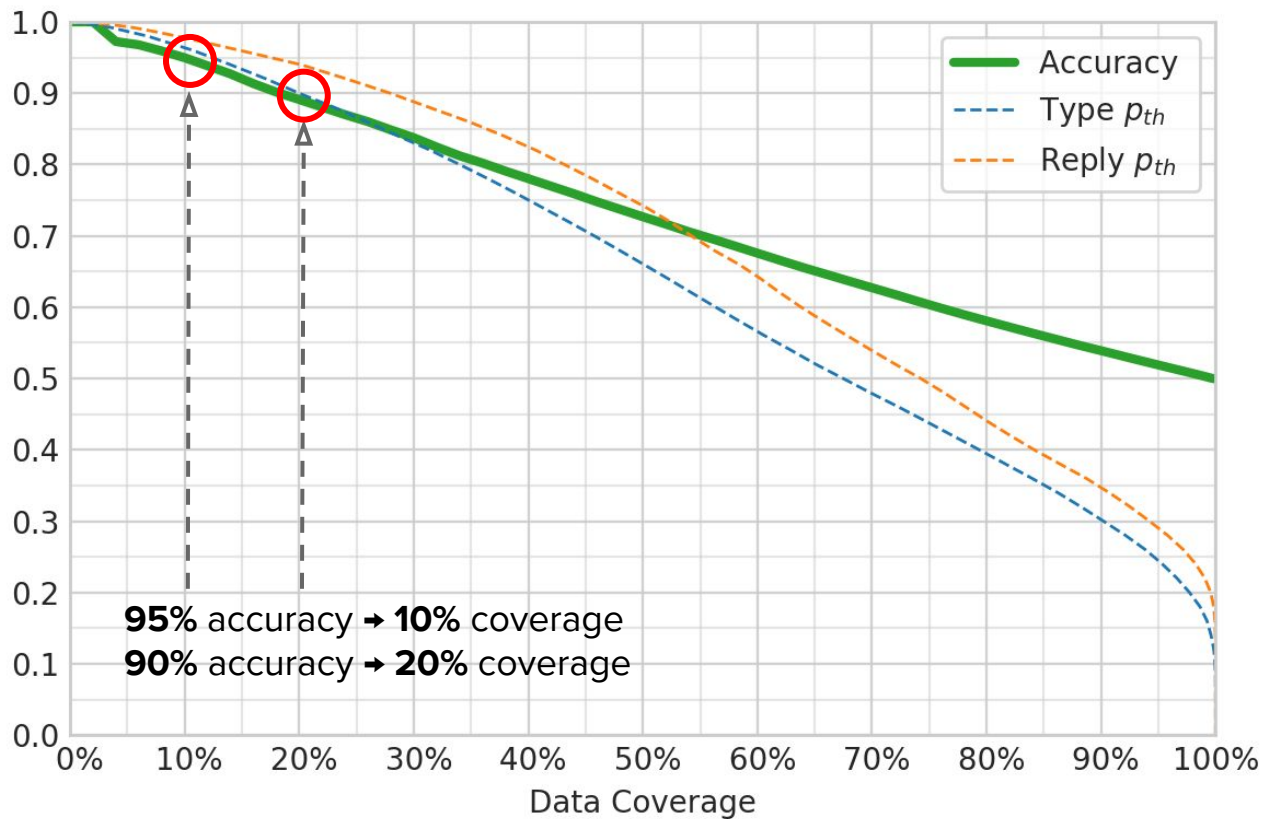
Threshold on Type Model Confidence



Threshold on Both Models' Confidence



Coverage vs. Maximum Accuracy



Conclusions

Using NLP & ML COTA makes customer care experience **faster** and **more accurate** while **saving Uber millions of \$**

Moving from traditional to deep learning models, we observe a substantial **performance boost** (up to **30%**)

Using intelligent suggestions we were able to **reduce ticket handling time without impacting customer satisfaction**

COTA Team

Cross-functional collaboration

AI Labs

Applied Machine Learning

Customer Obsession

Michelangelo

Sensing and Perception



UBER

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