DATA+AI SUMMIT EUROPE
FORMERLY SPARK+AI SUMMIT

Context-aware Fast Food Recommendation with Ray on Apache Spark at Burger King

LUYANG WANG Burger King Corporation
KAI HUANG Intel Corporation

#DataTeams #DataAISummit

Agenda

LUYANG WANG

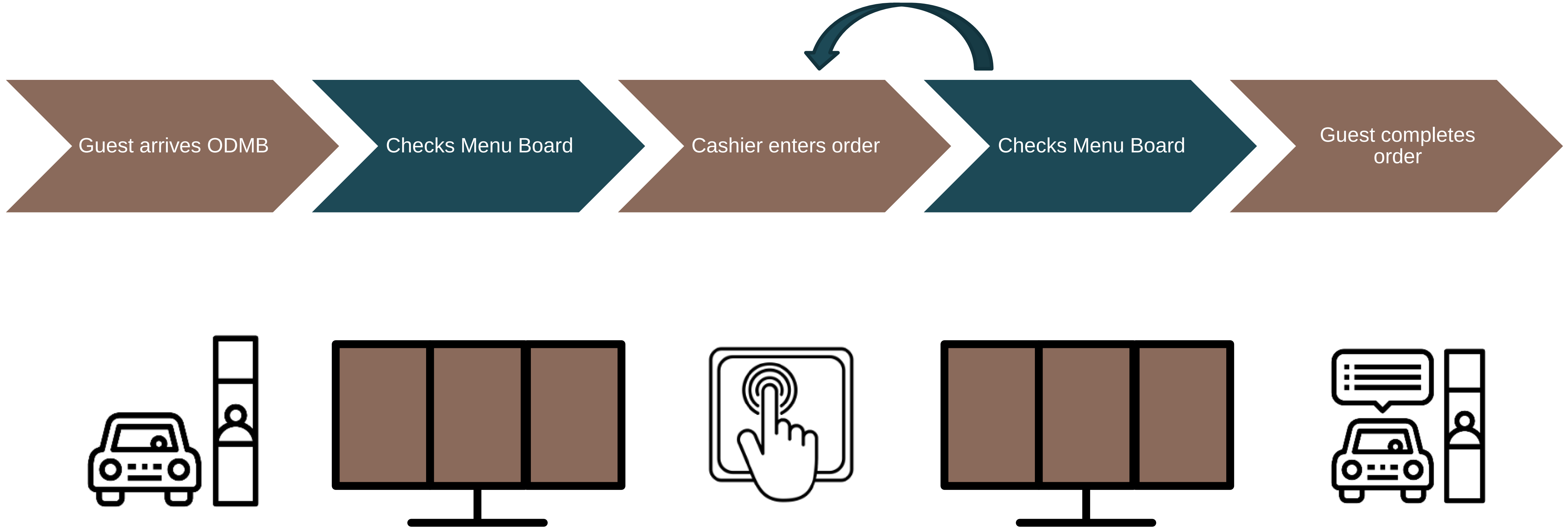
- Food recommendation use case
- TxT model in detail

KAI HUANG

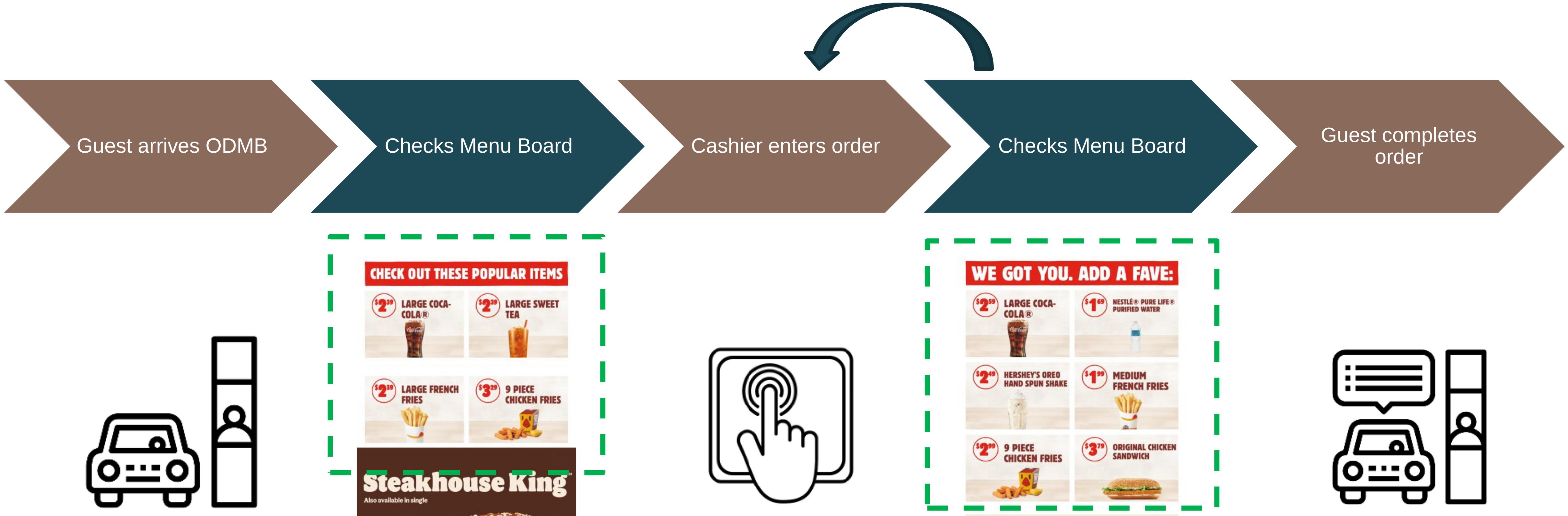
- AI on big data
- Distributed training pipeline with Ray on Apache Spark

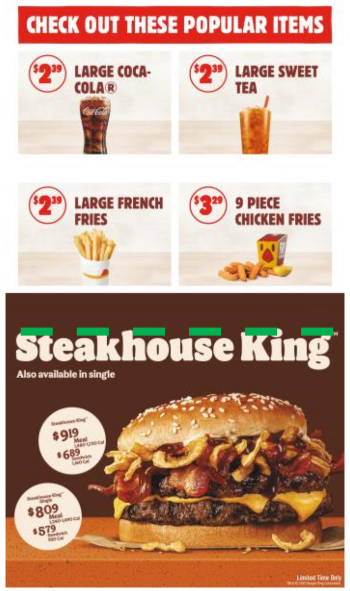
Food Recommendation Use Case

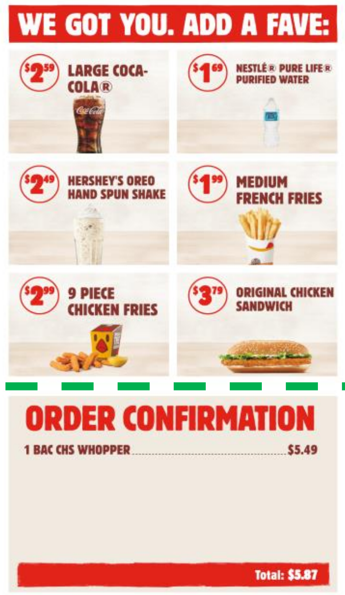
Food Recommendation Use Case



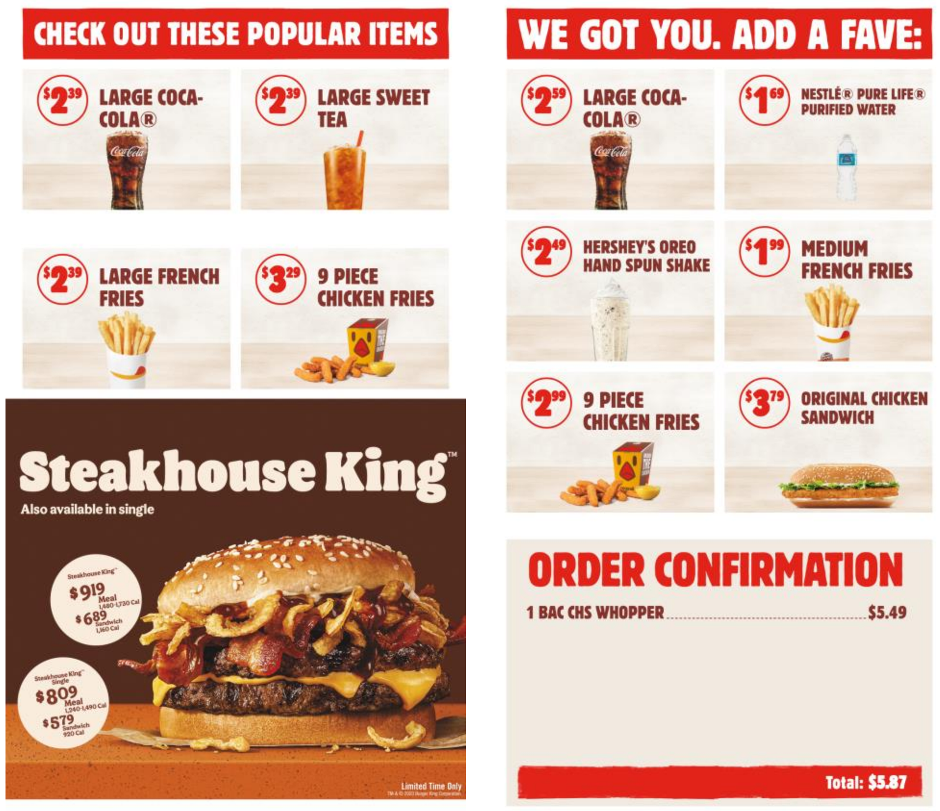
Food Recommendation Use Case






WE GOT YOU. ADD A FAVE:
$2.59 LARGE COCA-COLA®
$1.69 NESTLÉ® PURE LIFE® PURIFIED WATER
$2.49 HERSHEY'S OREO HAND SPUN SHAKE
$1.99 MEDIUM FRENCH FRIES
$2.99 9 PIECE CHICKEN FRIES
$3.79 ORIGINAL CHICKEN SANDWICH
ORDER CONFIRMATION
1 BAC CHS WHOPPER $5.49
Total: $5.87

Use Case Challenges



CHECK OUT THESE POPULAR ITEMS

- $2.39 LARGE COCA-COLA®
- $2.39 LARGE SWEET TEA
- $2.39 LARGE FRENCH FRIES
- $3.29 9 PIECE CHICKEN FRIES

Steakhouse King™
Also available in single

Steakhouse King™ $9.19 Meal 1,480-1,730 Cal; $6.89 Sandwich 1,160 Cal
Steakhouse King™ Single $8.09 Meal 1,240-1,490 Cal; $5.79 Sandwich 920 Cal

Limited Time Only

WE GOT YOU. ADD A FAVE:

- $2.59 LARGE COCA-COLA®
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ORDER CONFIRMATION

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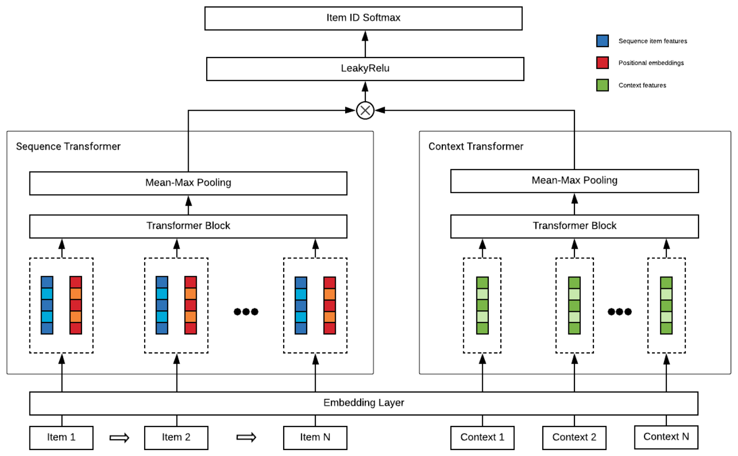
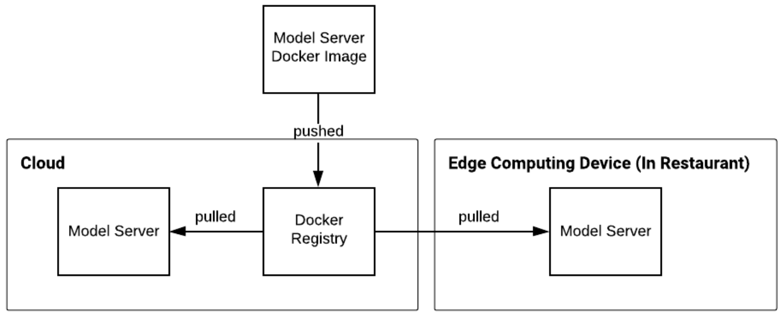
Challenges

- Lack of user identifiers
- Same session food compatibilities
- Other variables in our use case: locations, weathers, time, etc.
- Deployment challenges

Use Case Challenges



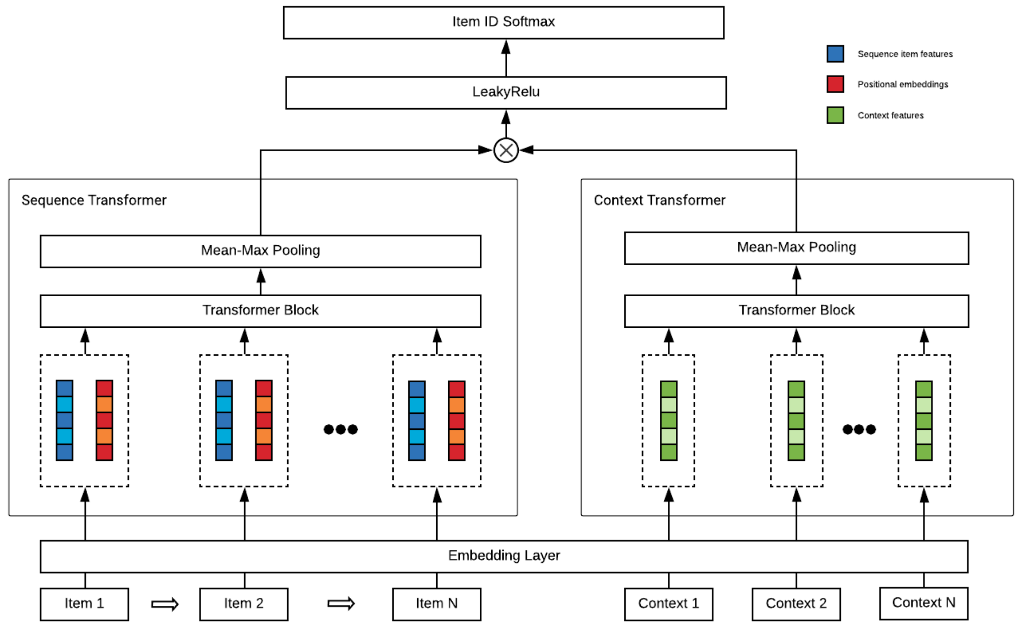

Model Server Docker Image
pushed
Cloud
Model Server
pulled
Docker Registry
Edge Computing Device (In Restaurant)
pulled
Model Server

Solutions

- Session based recommendation model
- Able to take complex context features into consideration
- Able to be deployed anywhere, both edge / cloud

Transformer Cross Transformer (T*x*T)

TxT Model Overview

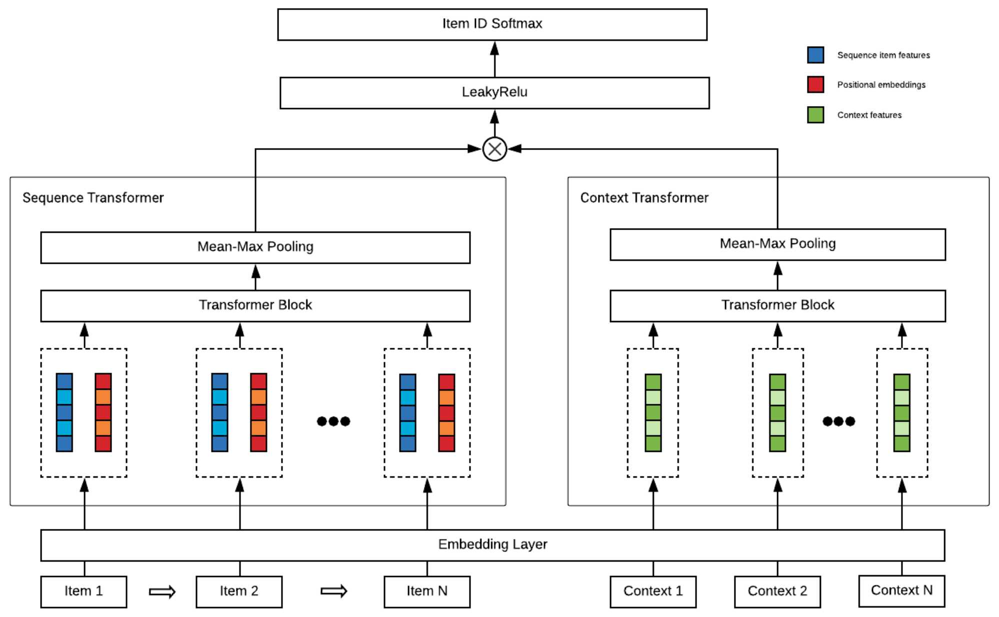


Model Components

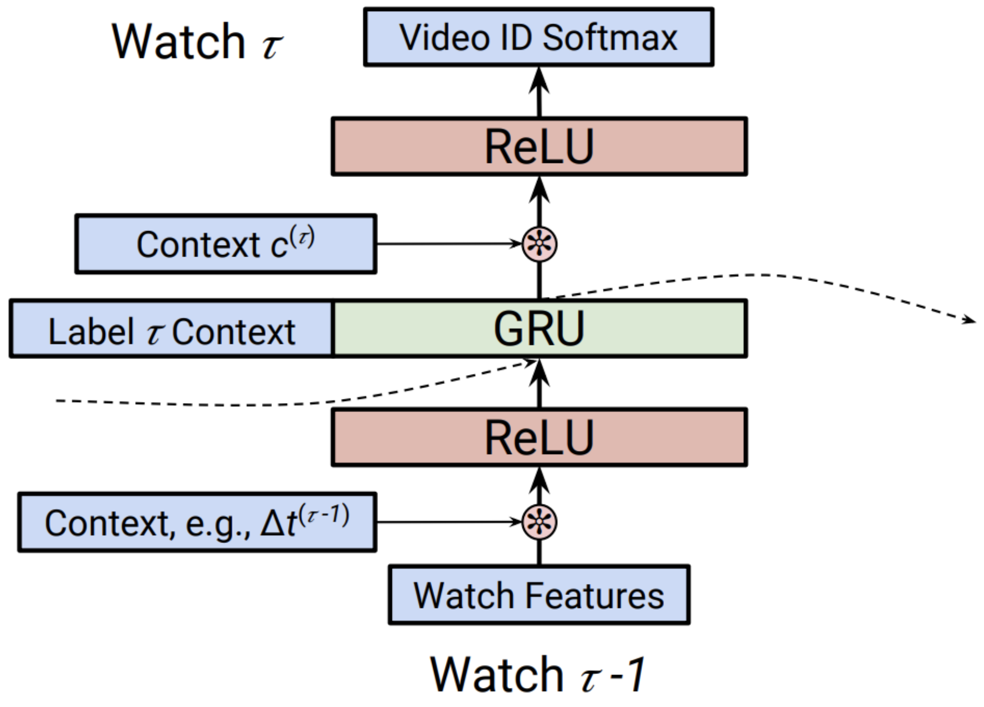
- Sequence Transformer
  - Taking item order sequence as input
- Context Transformer
  - Taking multiple context features as input
- Latent Cross Joint Training
  - Element-wise product for both transformer outputs

Model Comparison

TxT

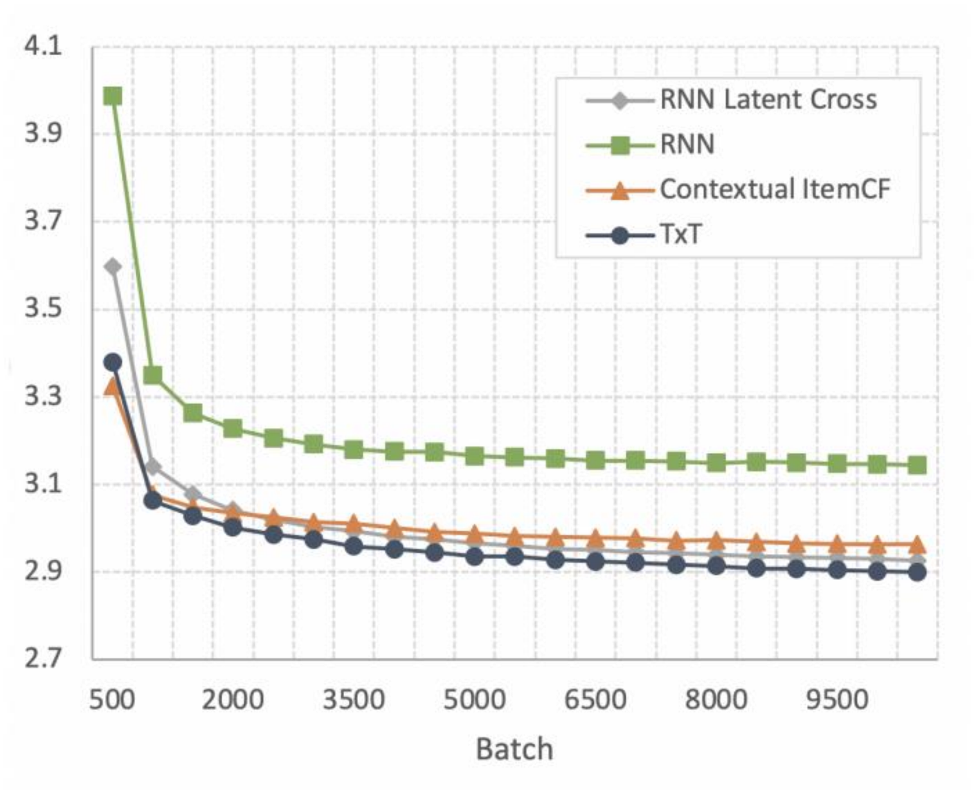


RNN Latent Cross



Offline Evaluation

Offline Training Loss

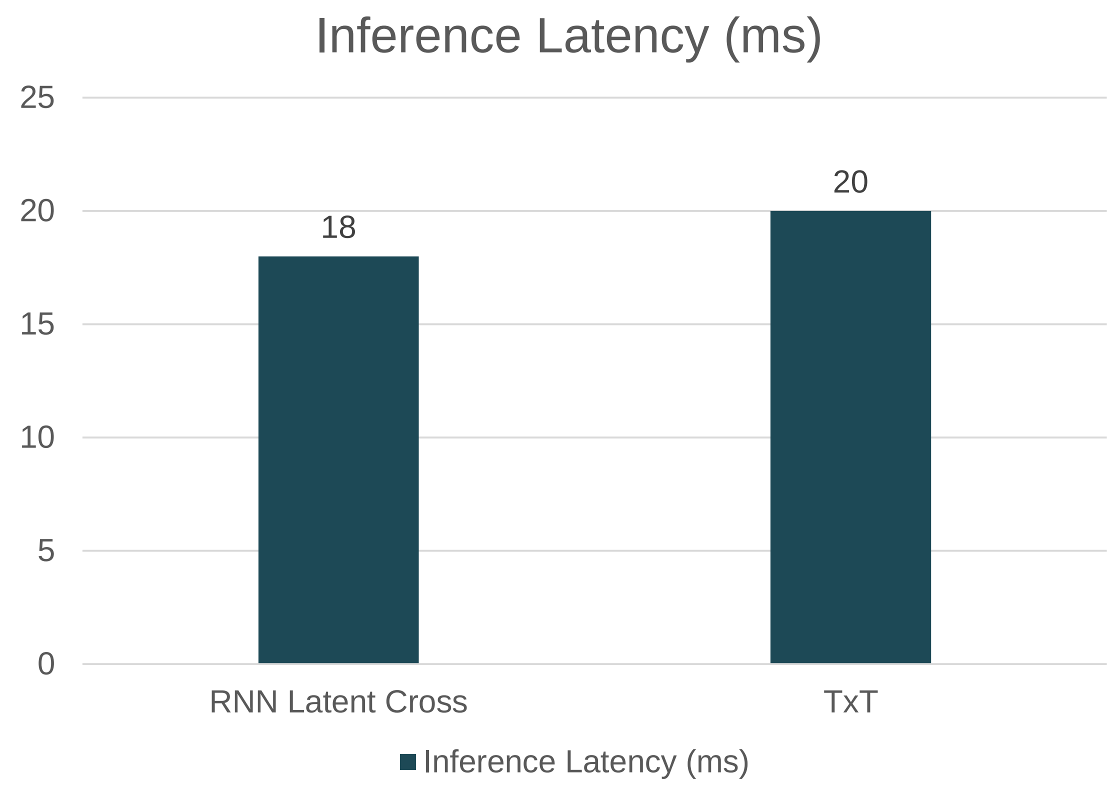


Offline Training Result

Model	Top1 Accuracy	Top3 Accuracy
RNN	29.98%	46.24%
Contextual ItemCF	32.18%	48.37%
RNN Latent Cross	33.10%	49.98%
TxT	34.52%	52.37%

Online Performance

Inference Performance

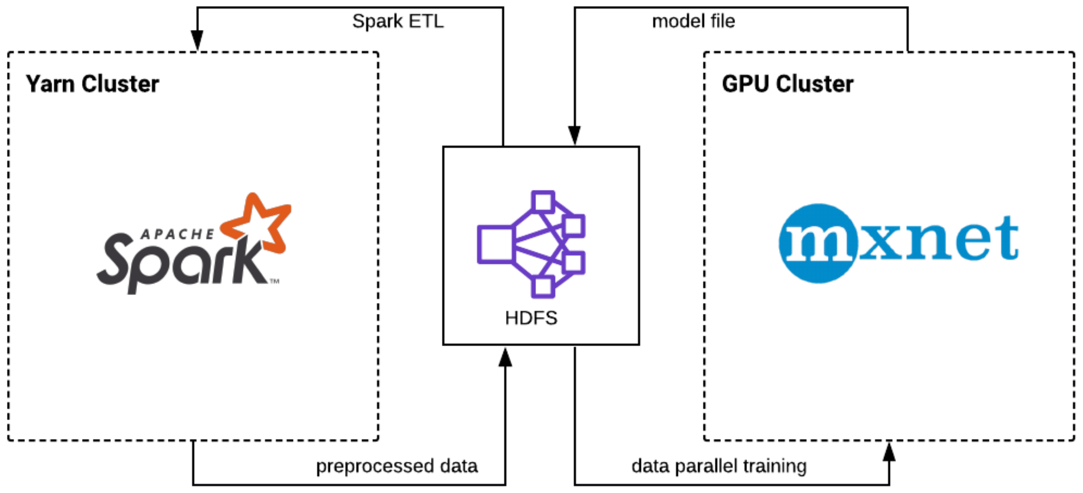


A/B Testing Result

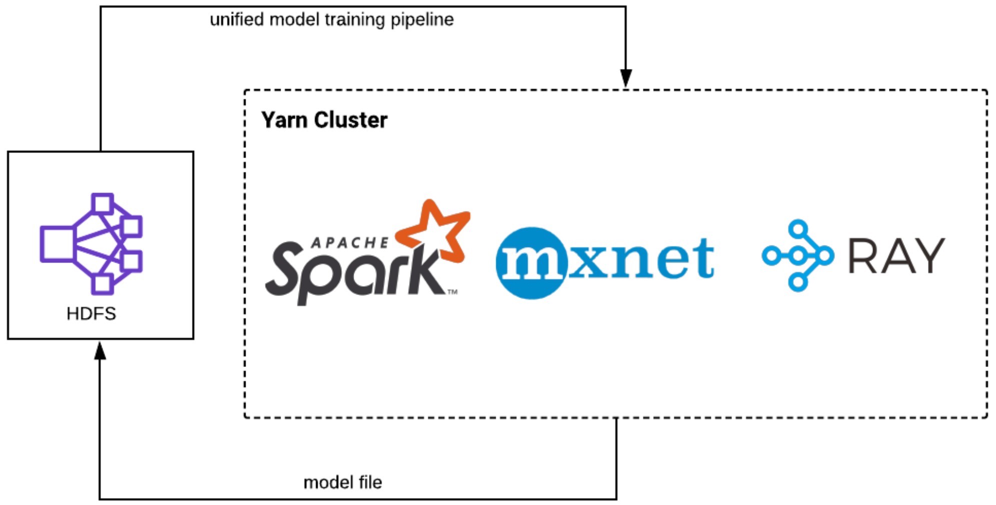
Model	Conversation Rate Gain	Add-on Sales Gain
RNN Latent Cross (control)	-	-
TxT	+7.5%	+4.7%

Model Training Architecture

Previous



Current



AI on Big Data

AI on Big Data

Accelerating Data Analytics + AI Solutions At Scale

- BigDL: Distributed Deep Learning Framework for Apache Spark
  https://github.com/intel-analytics/BigDL
- Analytics Zoo: Distributed TensorFlow, Keras and PyTorch on Apache Spark/Flink & Ray https://github.com/intel-analytics/analytics-zoo
- We develop *Project Orca* in Analytics Zoo based on Spark and Ray to allow users to easily scale out single node Python notebook across large clusters, by providing:
  - Data-parallel preprocessing for Python AI (supporting common Python libraries such as Pandas, Numpy, PIL, TensorFlow Dataset, PyTorch DataLoader, etc.)
  - Sklearn-style APIs for transparently distributed training and inference (supporting TensorFlow, PyTorch, Keras, MXNet, Horovod, etc.)

  https://github.com/intel-analytics/analytics-zoo/tree/master/pyzoo/zoo/orca

Ray

Ray is a fast and simple framework for building and running distributed applications.

- Ray Core provides easy Python interface for parallelism by using remote functions and actors.

Ray is packaged with several high-level libraries to accelerate machine learning workloads.

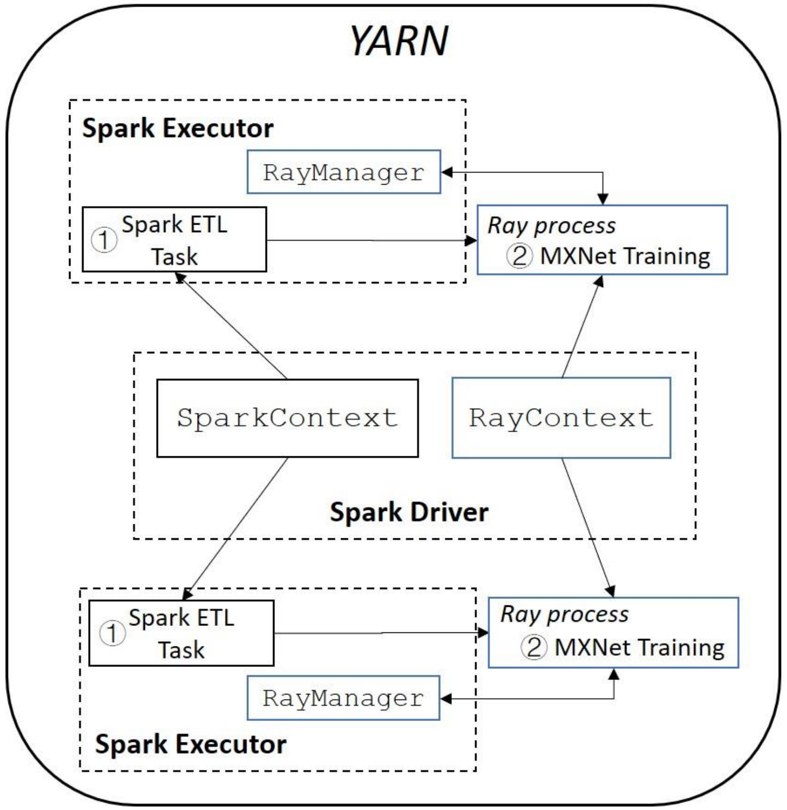
- Tune: Scalable Experiment Execution and Hyperparameter Tuning
- RLlib: Scalable Reinforcement Learning
- RaySGD: Distributed Training Wrappers
- https://github.com/ray-project/ray/

Distributed Training Pipeline on Big Data

RayOnSpark

Seamlessly integrate Ray applications into Spark data processing pipelines.

- Runtime cluster environment preparation.
- Create a *SparkContext* on the drive node and use Spark to perform data cleaning, ETL, and preprocessing tasks.
- *RayContext* on Spark driver launches Ray across the cluster.
- Similar to RaySGD, we implement a lightweight shim layer around native MXNet modules for easy deployment on YARN cluster.
- Each MXNet worker takes the local data partition of Spark RDD or DataFrame from the plasma object store used by Ray.



End-to-end Distributed Training Pipeline

Project Orca provides a user-friendly interface for the pipeline.

- Minimum code changes and learning efforts are needed to scale the training from single node to big data clusters.
- The entire pipeline runs on a single cluster. No extra data transfer needed.

```
from zoo.orca import init_orca_context
from zoo.orca.learn.mxnet import Estimator

# init_orca_context unifies SparkContext and RayContext
sc = init_orca_context(cluster_mode="yarn", num_nodes, cores, memory)
# Use sc to load data and do data preprocessing.

mxnet_estimator = Estimator(train_config, model=txt, loss=SoftmaxCrossEntropyLoss(),
                            metrics=[mx.metric.Accuracy(), mx.metric.TopKAccuracy(3)])

mxnet_estimator.fit(data=train_rdd, validation_data=val_rdd, epochs=…, batch_size=…)
```

Conclusion

- Context-Aware Fast Food Recommendation at Burger King with RayOnSpark

https://arxiv.org/abs/2010.06197

https://medium.com/riselab/context-aware-fast-food-recommendation-at-burger-king-with-rayonspark-2e7a6009dd2d

- For more details of RayOnSpark: https://databricks.com/session_na20/running-emerging-ai-applications-on-big-data-platforms-with-ray-on-apache-spark

- More information for Analytics Zoo at:

https://github.com/intel-analytics/analytics-zoo

https://analytics-zoo.github.io/

ANALYTICS ZOO

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