intel AI

使用深度学习、RAY和ANALYTICS ZOO进行自动化时间序列分析

Intel *Analytics Zoo* Team

ANALYTICS ZOO

Mar 13, 2020

Agenda

- **Background**
  - Introduction of *Analytics Zoo*
  - Background about *Time Series Analysis*
  - Background about *AutoML* and *Ray*
- **Time Series Analysis using AutoML and Ray on Analytics Zoo**
- **Use Case Sharing**

Background

What is Analytics Zoo

BigDL

Distributed, High-Performance

Deep Learning Framework

for Apache Spark

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

ANALYTICS ZOO

Unified Analytics + AI Platform

Distributed TensorFlow, Keras, PyTorch and BigDL on Apache Spark

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

Accelerating Data Analytics + AI Solutions At Scale

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Unified Big Data Analytics and AI Platform

Seamless Scaling from Laptop to Production

- Easily prototype the integrated data analytics & AI solution
- "Zero" code change from laptop to distributed cluster
- Directly access production data (Hadoop/Hive/HBase) without data copy
- Seamlessly deployed on production big data clusters

Analytics Zoo

Unified Big Data Analytics and AI Platform

Models & Algorithms	Recommendation	Time Series	Computer Vision	NLP
ML Workflow	AutoML for Time Series		Automatic Cluster Serving	
Integrated Analytics & AI Pipelines	Distributed TensorFlow & PyTorch on Spark		RayOnSpark	
	Spark Dataframes & ML Pipelines for DL		Model Serving	

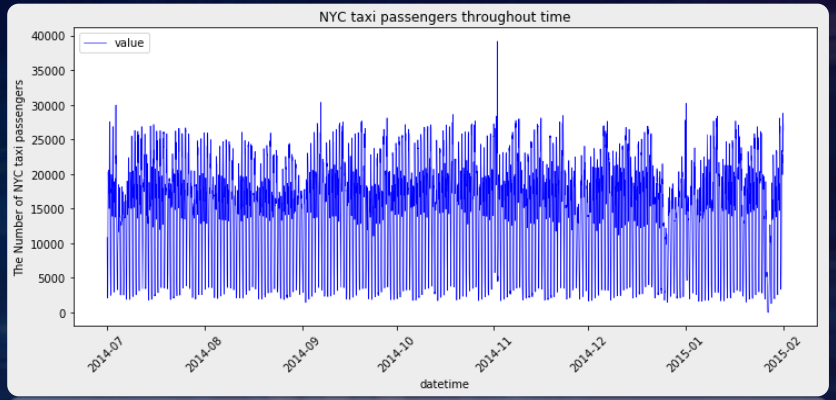
Library & Framework	Distributions (Cloudera/Databricks/....)	Distributed Analytics (Spark/Flink/Ray/...)	DL Frameworks (TF/PyTorch/...)	Python Libraries (Numpy/Pandas/...)

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

Time Series Analysis

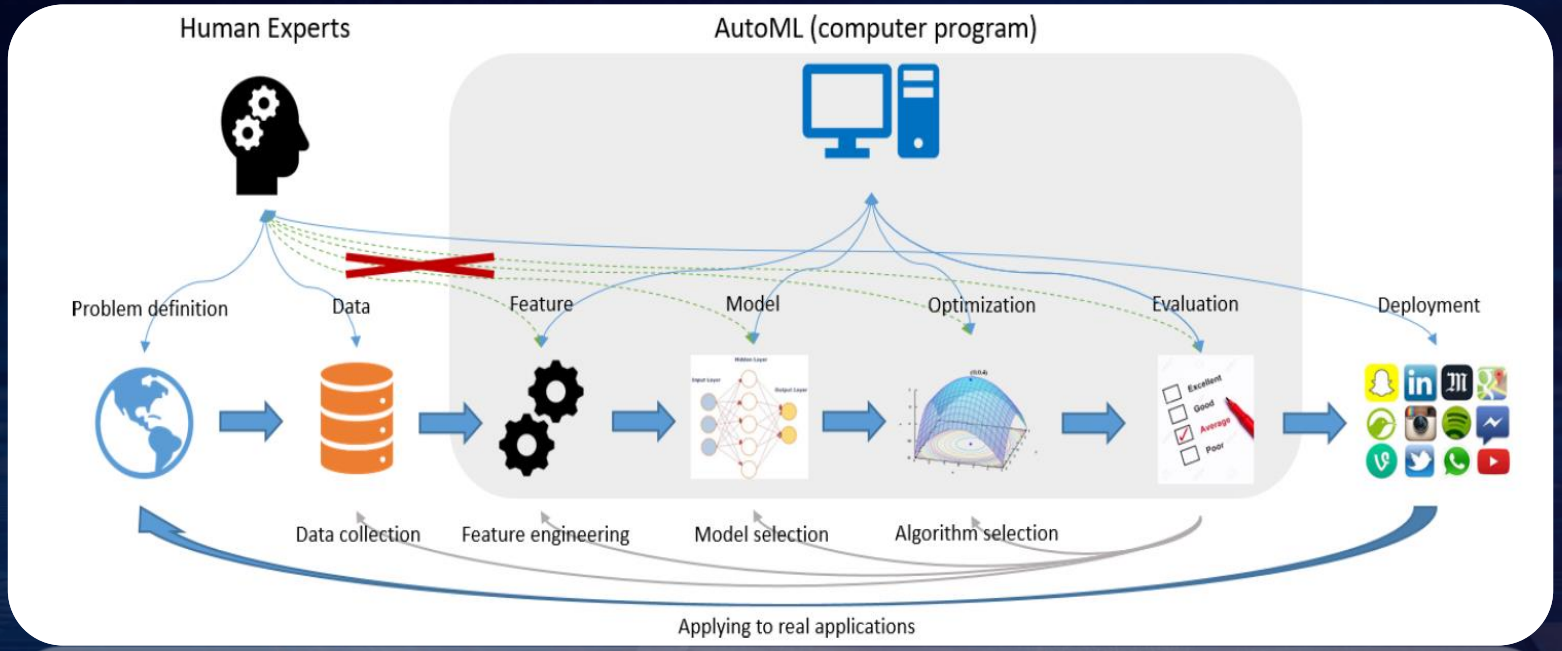
- **Time Series data**
  - A series of data that is observed sequentially in time.
  - Numerical & unstructured
  - Stock prices, sales volume, CPU/IO monitoring data, etc.

- **Example of time series analysis**
  - Product demand prediction
  - Network quality analysis
  - Predictive maintenance for high-value equipment



Total volume of taxi passengers in NYC from 2014/07-2015/02 (source : https://github.com/intel-analytics/analytics-zoo/blob/master/apps/anomaly-detection/anomaly-detection-nyc-taxi.ipynb)

AutoML Overview



Taking the Human out of Learning Applications : A Survey on Automated Machine Learning. Yao, Q., Wang, et. al

Ray and Ray On Spark

- **Ray**
  - A distributed framework for emerging AI applications
- **RayOnSpark**
  - Directly run Ray programs on big data cluster
  - Seamlessly integrate ray into spark data processing pipeline

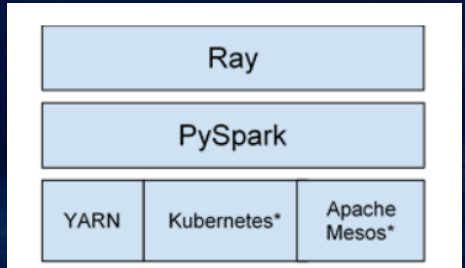


Figure1: Deploy Ray* on Apache Spark*

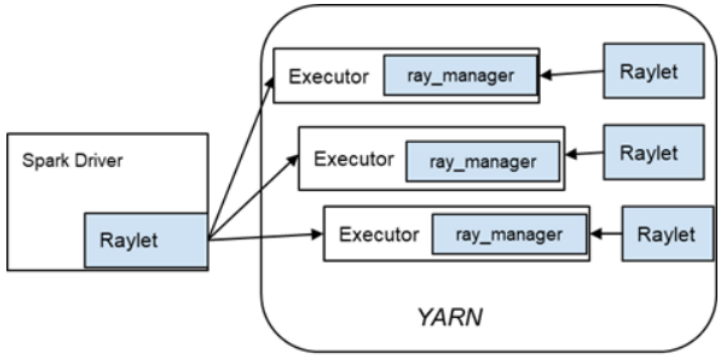


Figure 2: Launch Ray* process on Apache Spark*

https://ray.readthedocs.io/en/latest/
https://analytics-zoo.github.io/master/#ProgrammingGuide/rayonspark/

Time Series Analysis using AutoML and Ray on Analytics Zoo

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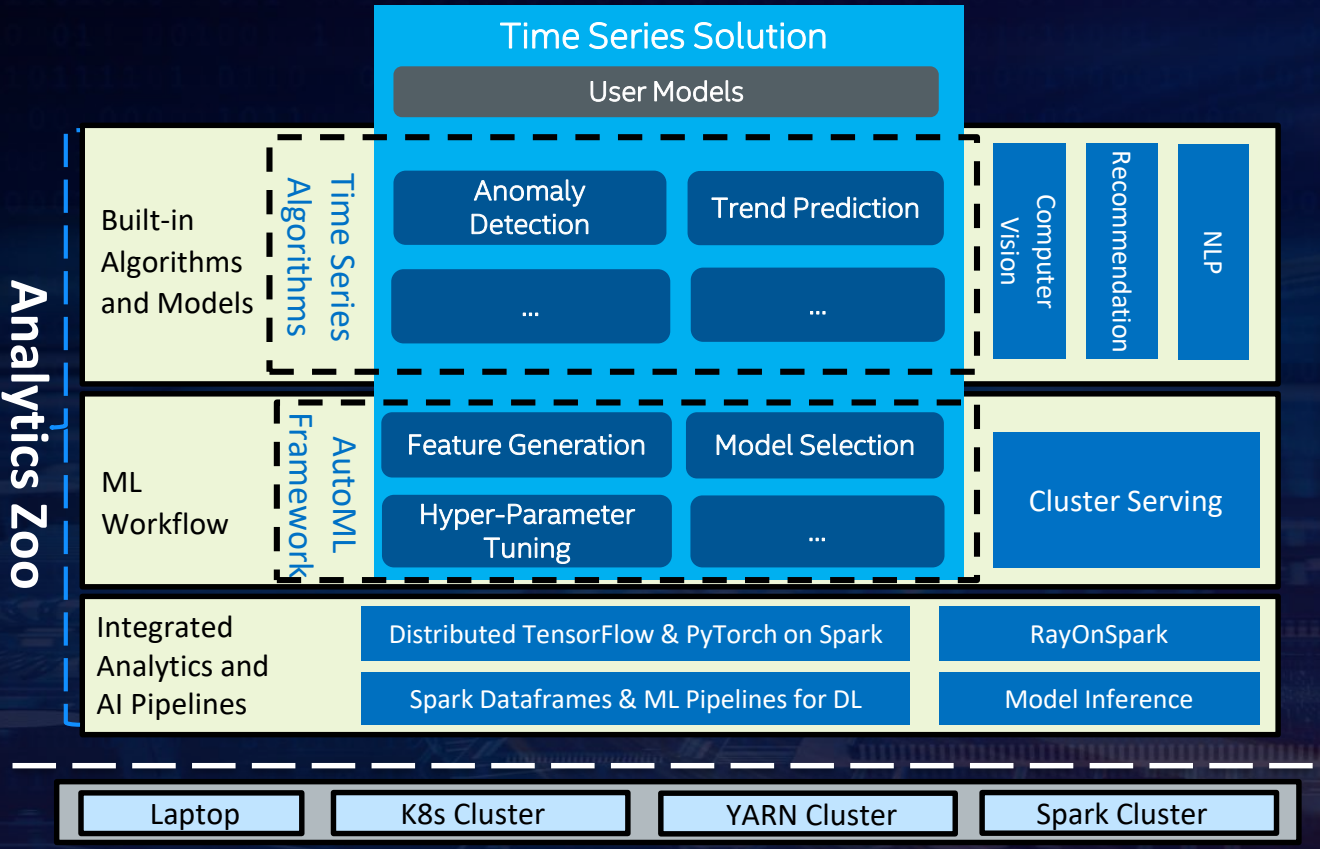
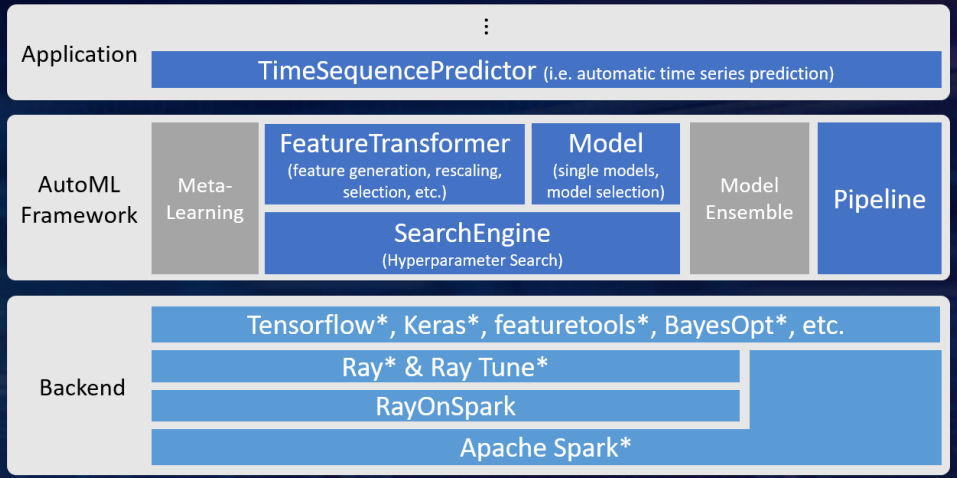
Time Series Solution In Analytics Zoo



- **Time series Applications**
  - Time series forecasting
  - Anomaly detection
  - Time Series Clustering
  - etc
- **AutoML**
- **Seamless scaling**
- **Full-stack Intel SW+HW Optimization w/ Analytics Zoo**

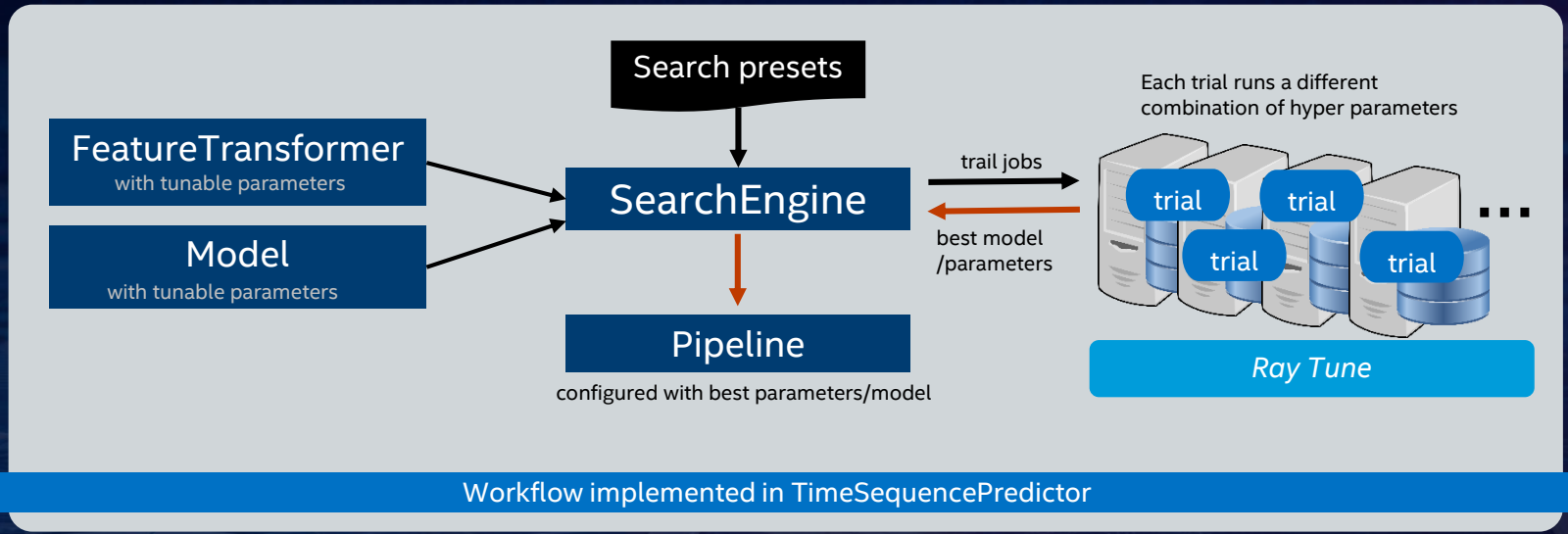
AutoML + Time Series Analysis Framework In *Analytics Zoo*

- **AutoML Framework**
  - FeatureTransformer
  - Model
  - SearchEngine
  - Pipeline
- **Time Series Prediction w/ AutoML**
  - TimeSequencePredictor
  - TimeSequencePipeline



https://medium.com/riselab/scalable-automl-for-time-series-prediction-using-ray-and-analytics-zoo-b79a6fd08139

Typical Workflow of Training w/ AutoML



General API Usage

- Training a **Predictor**
  - **fit** (w/ automl)
  - recipe
  - distributed

```
from zoo.automl.regression.time_sequence_predictor import TimeSequencePredictor
tsp = TimeSequencePredictor( dt_col="datetime",
                             target_col="value",
                             extra_features_col=None,
                             future_seq_len=1)
pipeline = tsp.fit(train_df,
                   metric="mean_squared_error",
                   recipe=RandomRecipe(num_samples=100),
                   distributed=True)
```

- Using a **Pipeline**
  - save/load
  - evaluate/predict
  - fit (incremental)

```
pipeline.save("/tmp/saved_pipeline/my.ppl") #save

from zoo.automl.pipeline.time_sequence import load_ts_pipeline
pipeline = load_ts_pipeline("/tmp/saved_pipeline/my.ppl") #load
rs = pipeline.evaluate(test_df, metric=["r_square"]) # evaluation
result_df = pipeline.predict(test_df) # inference
pipeline.fit(newtrain_df, epoch_num=5) # incremental training
```

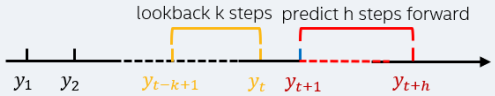
Application: Time Series Forecasting

Time series forecasting
Anomaly Detection
Time series clustering
Characterization
Time series Transformation
Representation Learning
Pattern Discovery

Time Series Application

Definition

- Given all history observations $y_1, \dots, y_t$, Predict values of next **h** steps, $y_{t+1}, \dots, y_{t+h}$
- Usually only lookback **k** steps, $y_{t-k+1}, \dots, y_t$

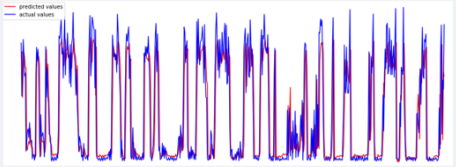


Use Case

- Sales volume/demand prediction.
- As a pre-step for Anomaly Detection
- Commonly used in AIOps: Resource planning, Anomaly Detection, etc.

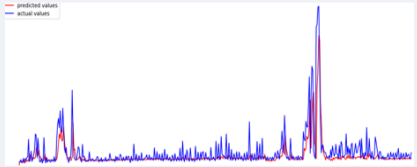
Patterns to Forecast

Varying Length of Periods



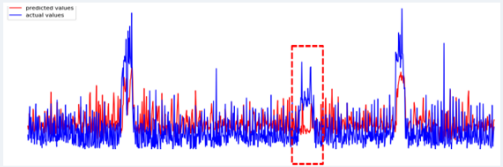
Traditional method does not forecast well when the length of the periods changes over time, while our solution works much better.

Varying Peak Value



Traditional method does not forecast well when peak values changes over time., while our solution works much better.

Various Forms of Waves



Our time series forecasting can tolerate various (normal) forms of waves, while still recognize abnormal forms.

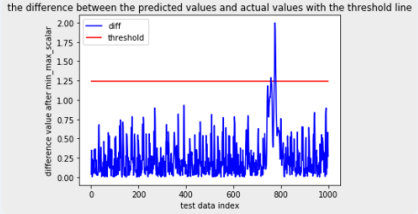
Application: Anomaly Detection

Time Series Application

- Time series forecasting
- **Anomaly Detection**
- Time series clustering
- Characterization
- Time series Transformation
- Representation Learning
- Pattern Discovery

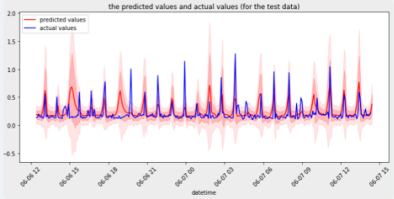
Anomaly Detection after Time Series Forecasting

Threshold w/ X Percentile



Use x Percentile of the diff between predicted and actual values (99 percentile as we use in our anomaly example)

Threshold w/ Uncertainty



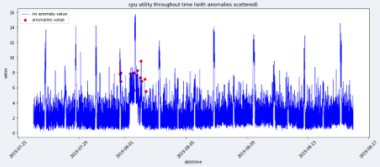
Based on Monte Carlo Dropout (refer to "Deep and Confident Prediction for Time Series at Uber" paper)

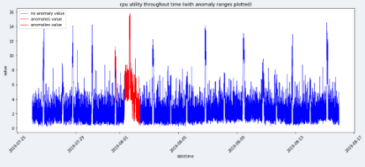
Use Case

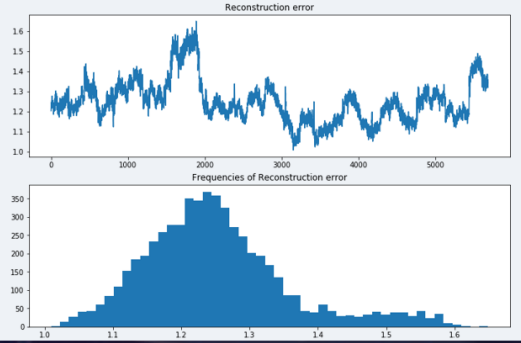
- Alerts generation
- Resource utilization anomaly detection
- ...

Anomaly Detection w/o Time Series Forecasting

Anomaly detection can also be done without forecasting, using an autoencoder and analyze the reconstruction error.







Use case sharing

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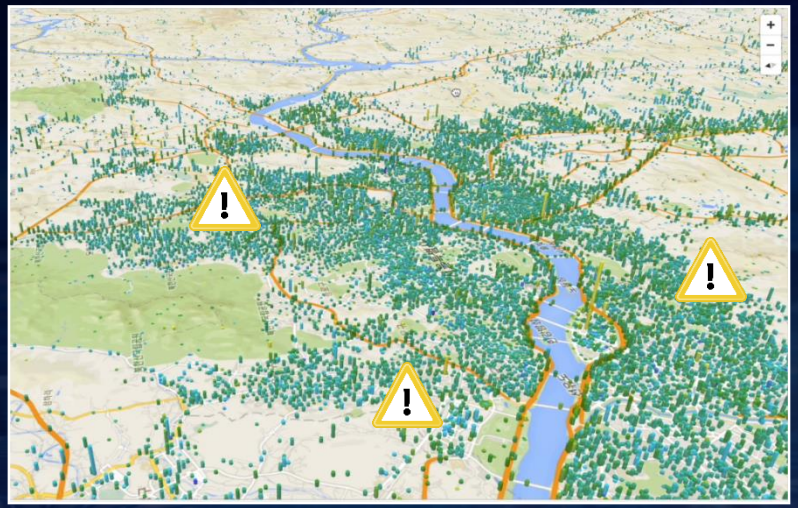
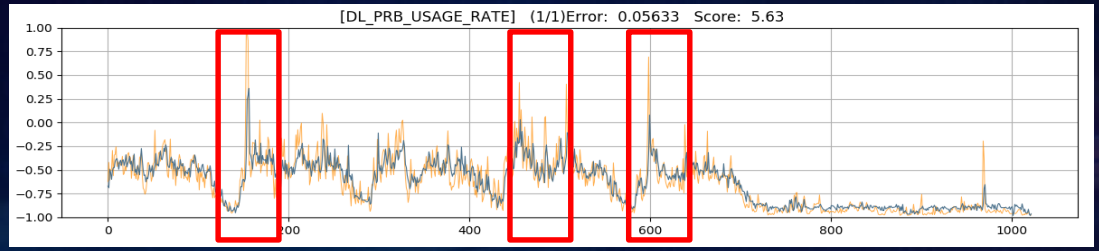
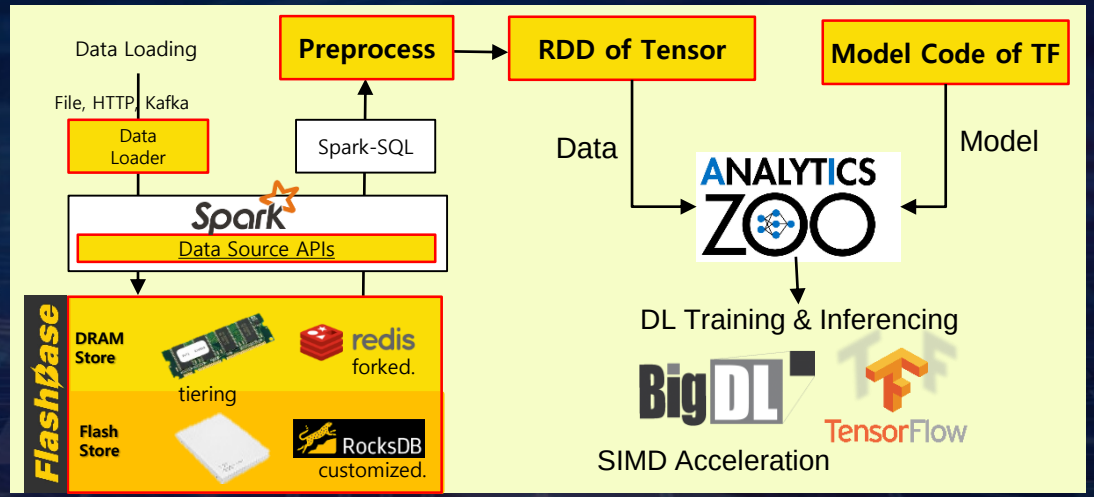
Time Series Based Network Quality Prediction in SK Telecom

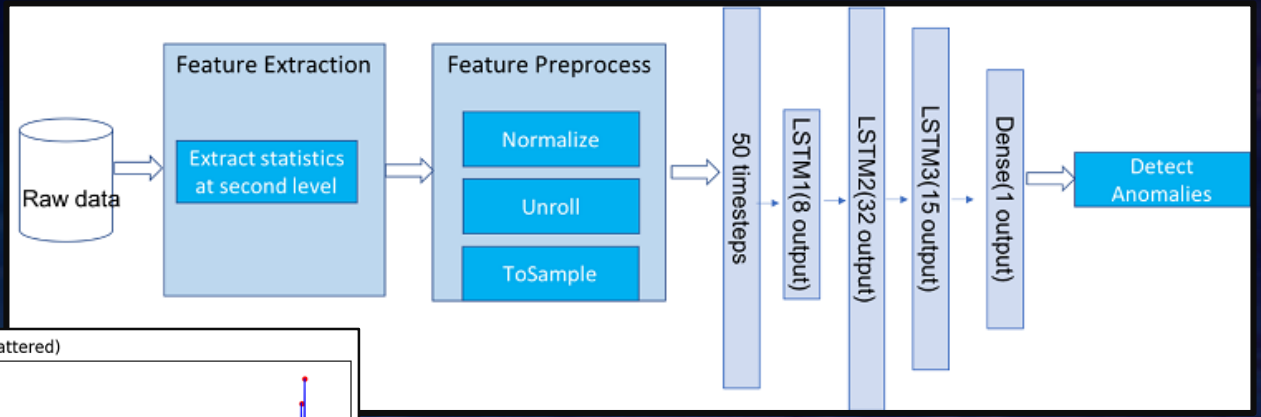


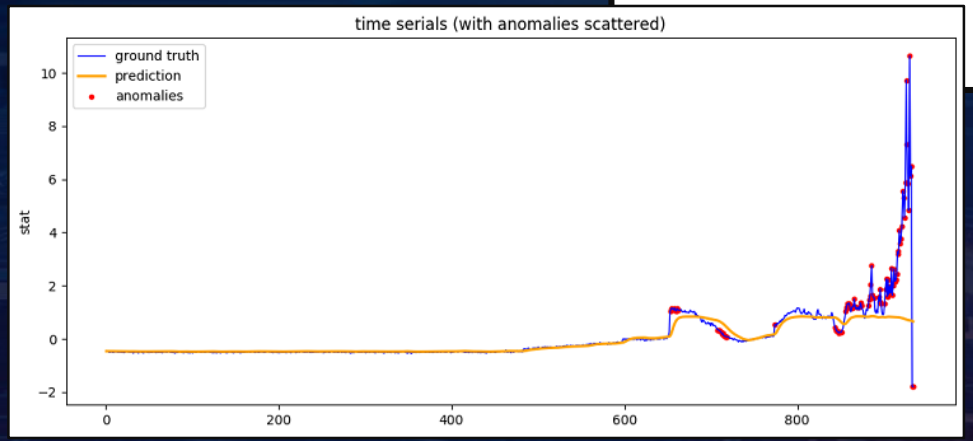




https://databricks.com/session_eu19/apache-spark-ai-use-case-in-telco-network-quality-analysis-and-prediction-with-geospatial-visualization

Unsupervised Time Series Anomaly Detection for Baosight

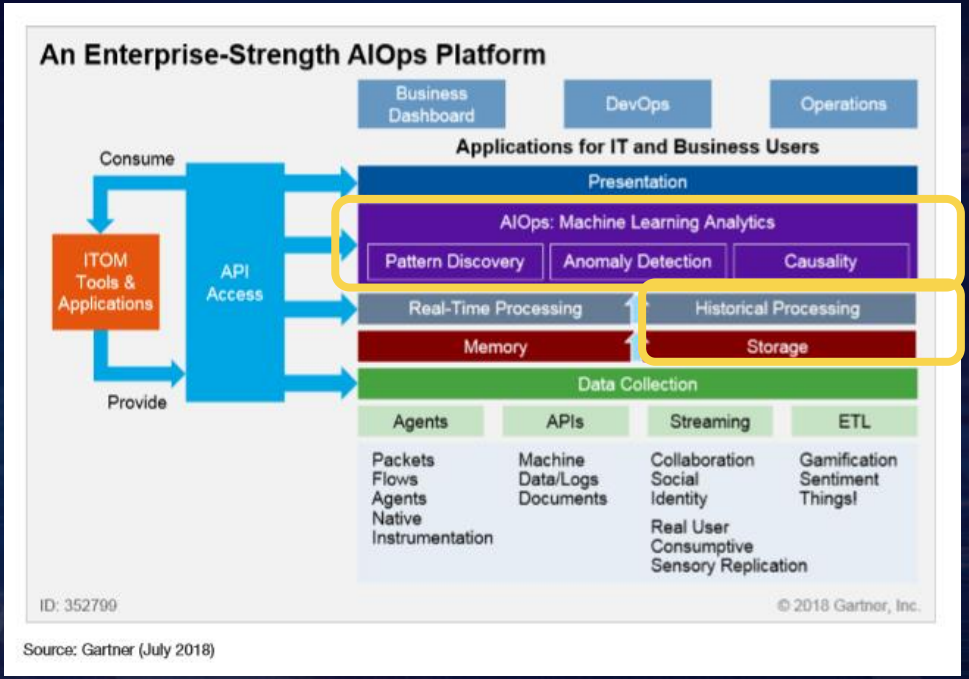




https://software.intel.com/en-us/articles/lstm-based-time-series-anomaly-detection-using-analytics-zoo-for-apache-spark-and-bigdl

Yunda: Anomaly Detection for AIOps

- AIOps
- Monitoring log/metrics analysis for data center operations
- AIOps helps cost saving and MTTR (mean-time-to-repair)



Source: Gartner (July 2018)

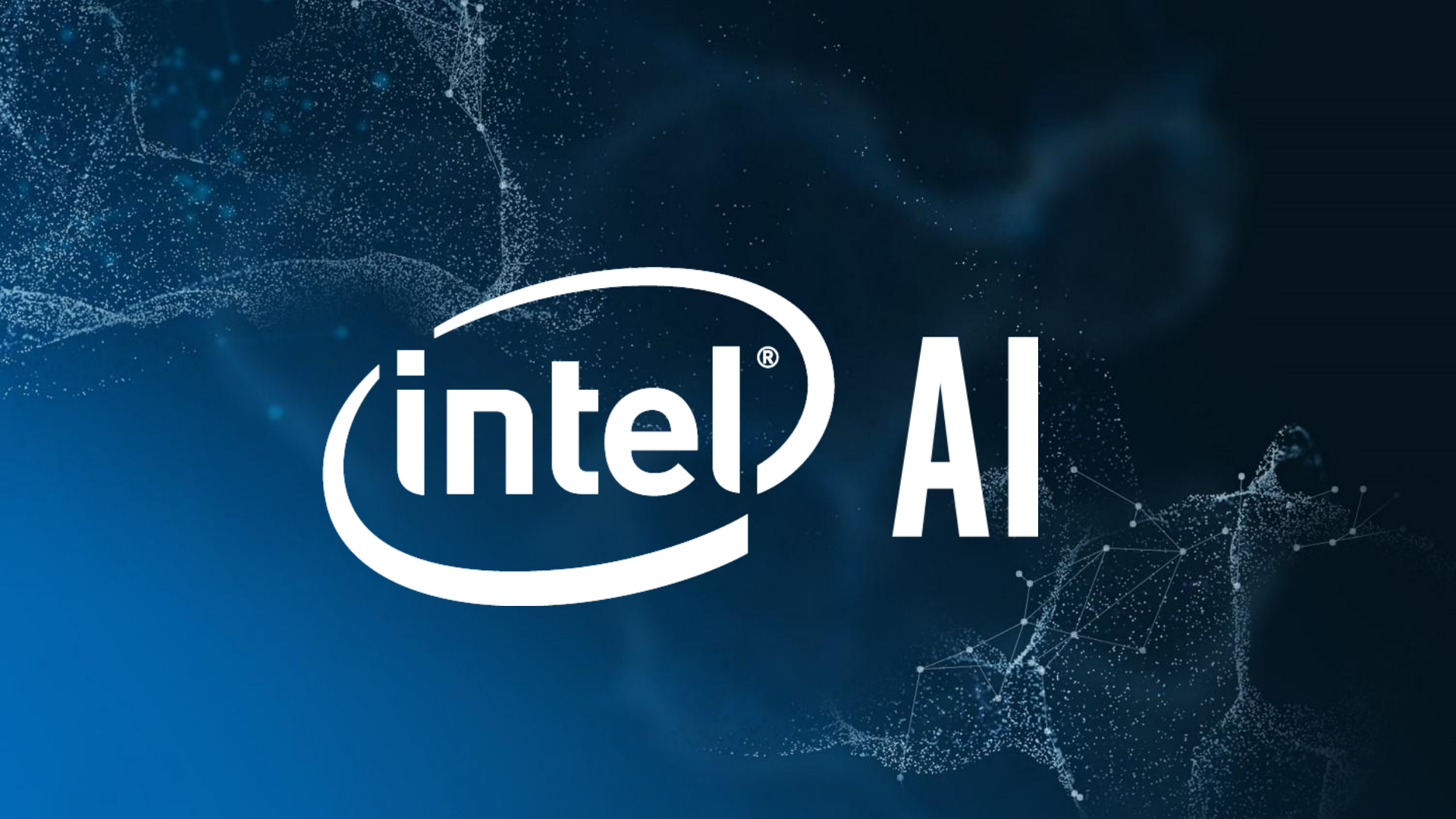
https://www.intel.cn/content/www/cn/zh/analytics/artificial-intelligence/yunda-brings-quality-change-to-the-express-delivery-industry.html

More Information about AutoML + Time Series in Analytics Zoo

- **Scalable AutoML for Time Series Analysis**
  - Source code as a branch of analytics-zoo repo @ https://github.com/intel-analytics/analytics-zoo/tree/automl
  - README @ https://github.com/intel-analytics/analytics-zoo/blob/automl/pyzoo/zoo/automl/README.md
  - Blog https://medium.com/riselab/scalable-automl-for-time-series-prediction-using-ray-and-analytics-zoo-b79a6fd08139
- **Anomaly Detection Reference Examples**
  - Time Series Forecast w/ AutoML https://github.com/intel-analytics/analytics-zoo/blob/automl/apps/automl
  - Anomaly Detection based on Forecast https://github.com/intel-analytics/analytics-zoo/tree/master/apps/anomaly-detection
  - Anomaly Detection based on AutoEncoder https://github.com/intel-analytics/analytics-zoo/tree/master/apps/anomaly-detection-hd
- **Real-world Customer Applications**
  - Baosight's anomaly detection for intelligent equipment management. Details refer to http://software.intel.com/en-us/articles/lstm-based-time-series-anomaly-detection-using-analytics-zoo-for-apache-spark-and-bigdl
  - Yunda anomaly detection for AIOps https://www.intel.cn/content/www/cn/zh/analytics/artificial-intelligence/yunda-brings-quality-change-to-the-express-delivery-industry.html

More Information on Analytics Zoo

- Project website
  - https://github.com/intel-analytics/analytics-zoo
  - https://github.com/intel-analytics/bigdl
- Tutorials
  - CVPR 2018: https://jason-dai.github.io/cvpr2018/
  - AAAI 2019: https://jason-dai.github.io/aaai2019/
- "BigDL: A Distributed Deep Learning Framework for Big Data"
  - *In proceedings of ACM Symposium on Cloud Computing 2019 (SOCC'19)*
- Use cases
  - *Azure, CERN, MasterCard, Office Depot, Tencent, Midea, etc.*
  - https://analytics-zoo.github.io/master/#powered-by/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