Microsoft

Vowpal Wabbit on Spark

December 2019
Azure Global – Customer Engineering AI

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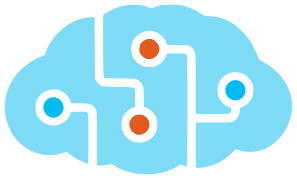
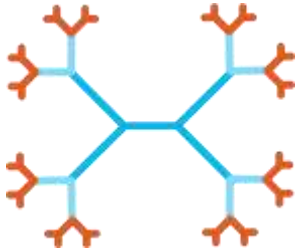
Microsoft Machine Learning for Apache Spark

Vowpal Wabbit



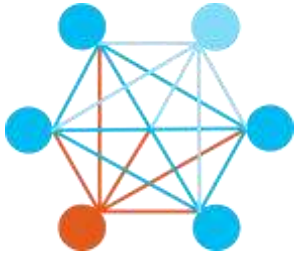
Cognitive Service



LightGBM

Spark Serving

HTTP on Spark



CNTK

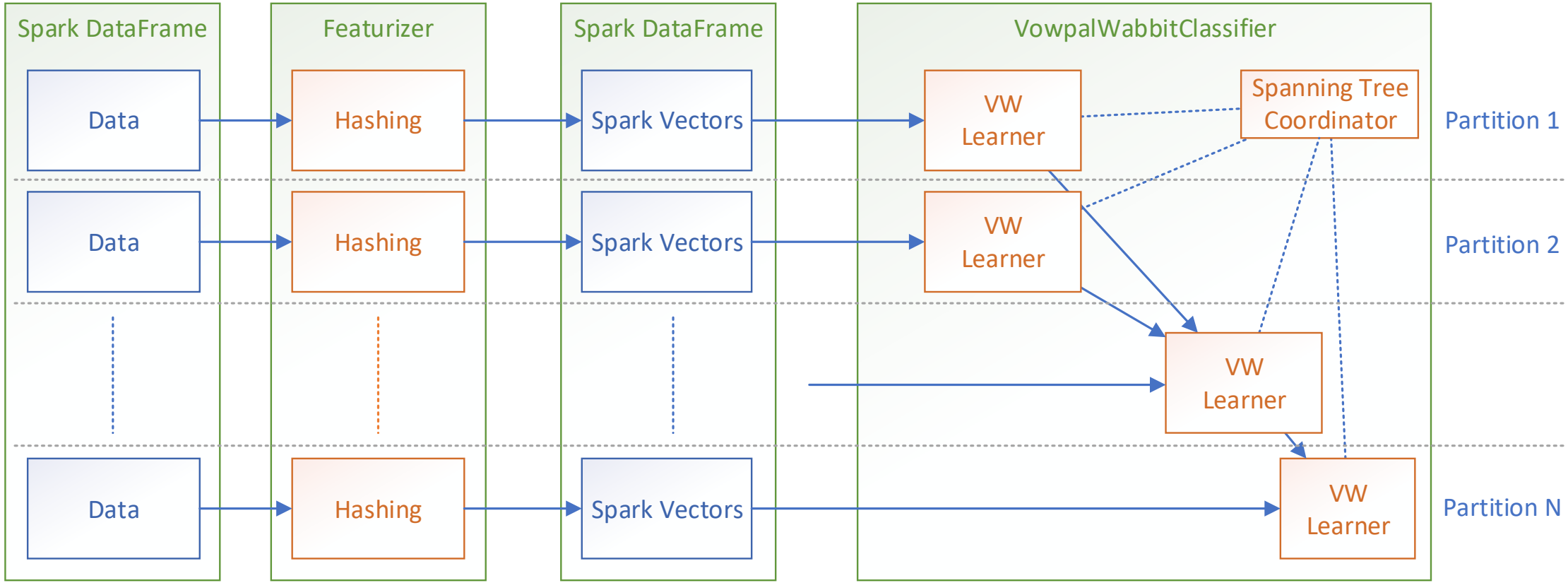
Lime

Binding Autogeneration

Vowpal Wabbit on Spark | Goals

Easy to use	→	Seamless integration w/ Spark ML
Blazing fast	→	Linear out-of-core learning
Distributed	→	Data parallel w/o manual cluster configuration
Scalable	→	10TB experiments

Vowpal Wabbit on Spark | Architecture



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VOWPAL WABBIT

APACHE Spark

Vowpal Wabbit on PySpark | Featurize

```
from mmlspark.vw import VowpalWabbitFeaturizer

featurizer = VowpalWabbitFeaturizer(
    inputCols=['sepal length', 'sepal width', 'petal length'],
    outputCol='features')

df_train = featurizer.transform(df_input)
```

Vowpal Wabbit on Spark | Feature Engineering

Type	Sample Data	Vowpal Wabbit Format	Feature Inde[x|ices]	Feature Value(s)
Numeric	3.2	|col1 col1:3.2	hash(col1)	3.2
Boolean	True	|col1 col1:1	hash(col1)	1
String	NewYork	|col1 NewYork:1	hash(New York)	1
Array of String	[“Hello”,”world”]	|col1 Hello:1 World:1	hash(Hello), hash(World)	1, 1
Map of String to String	{“Income”:”High”, “Age”:”Middle”}	|col1 IncomeHigh:1 AgeMiddle:1	hash(IncomeHigh) hash(AgeMiddle)	1, 1
Map of String to Numeric	{“Speed”:12.3, “Velocity”:3}	|col1 Speed:12.3 Velocity:3	hash(Speed) hash(Velocity)	12.3, 3

- 1st namespace character = feature group used for interactions, n-grams, …
- Numeric: Double, Float, Integer, Long, Short, Byte

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Vowpal Wabbit on PySpark | Train & Predict

```
from mmlspark.vw import VowpalWabbitClassifier

estimator = VowpalWabbitClassifier(
      args="--holdout_off --loss_function logistic --progress 1000000",
      learningRate=1.0,
      powerT=0.0,
      l1=1e-8)

model = estimator.fit(df_train)

predictions = model.transform(df_test)
```

Vowpal Wabbit on Spark | Hyper-parameter sweeps

Spark ML integration

Frequent parameters

- learningRate, powerT, l1, l2, interactions

Parallel cross-validation

```
val vw = new VowpalWabbitClassifier()
    .setArgs("--link=logistic")

val paramGrid = new ParamGridBuilder()
   .addGrid(vw.learningRate, Array(0.5, 0.05, 0.001))
   .addGrid(vw.numPasses, Array(1, 3, 5))
   .build()

val cv = new CrossValidator()
  .setEstimator(vw)
  .setEvaluator(new BinaryClassificationEvaluator)
  .setEstimatorParamMaps(paramGrid)
  .setNumFolds(3)
  .setParallelism(2)

val model = cv.fit(dataset)
model.transform(dataset)

val auc = model.avgMetrics(0)
```

Vowpal Wabbit on Spark | Bandit Support

Coming soon…

Multi-line examples

- Actions
- Multi-class

Label support

- action:cost:probability

Nested structures

Thanks!

VOWPAL WABBIT

Vowpal Wabbit on Spark | Features

Distributed AllReduce training

- Data partitions → compute jobs
- Limited by number of available executors

Multi-pass using VW cache file on disk

Performance metrics exposed as data frame

- average loss, total number of features,…

Native Model Export

Vowpal Wabbit on Spark | Features

Machine learning tasks

- Binary classification
- Regression

Data input

- Sparse and dense features using Spark Vector
- Example weights
- Namespace support by using multiple columns

VOWPAL WABBIT

Microsoft Research sponsored

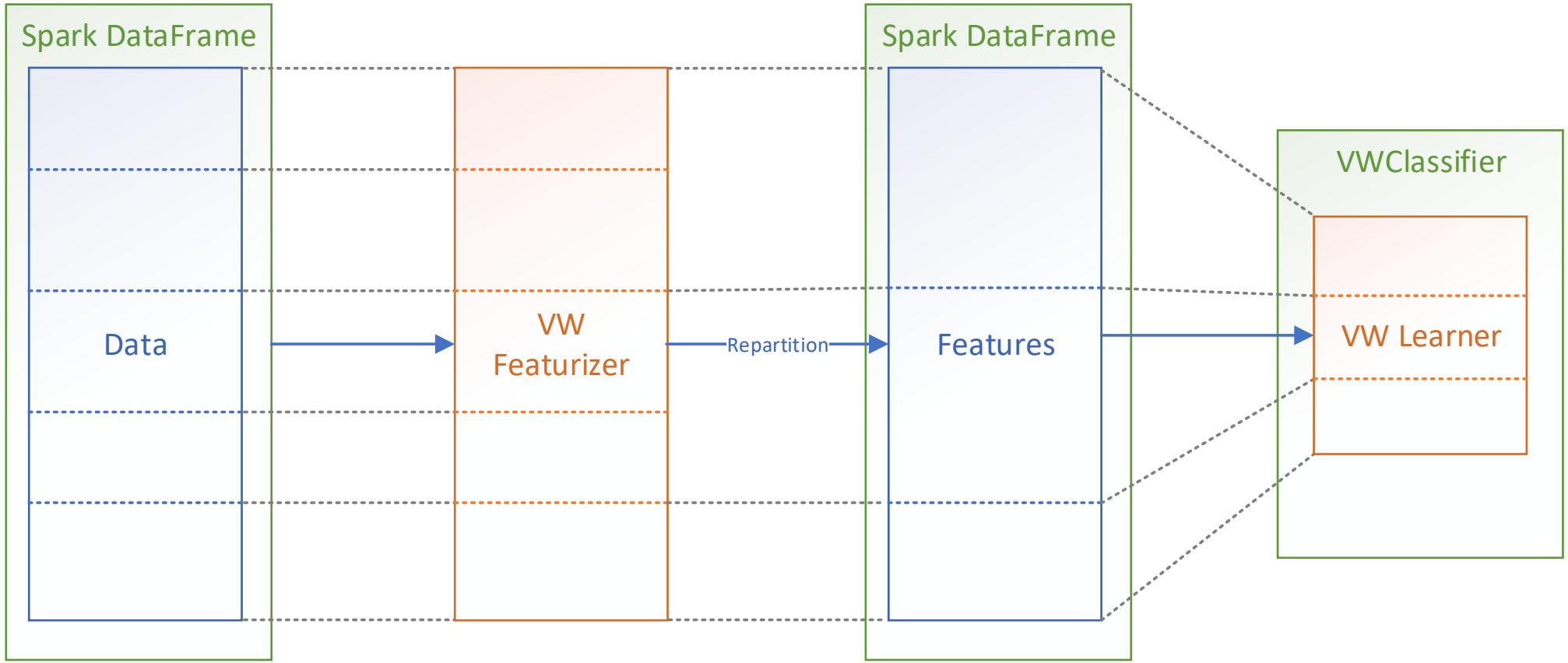
Suite of algorithms

- Supervised
- Unsupervised
- Reinforcement learning
  - Azure Cognitive Service Personalizer

Strengths

- Speed
- Memory efficiency
- Sparse features

Vowpal Wabbit on Spark | Optimizations



Repartitioning featurized data can reduce parallel training jobs

Vowpal Wabbit on Spark | Feature Engineering

```
new VowpalWabbitFeaturizer()
  .setInputCols(Array("title", "body"))
  .setOutputCol("features")
  .transform(df)
```

Option	Description
SumCollisions	Summed if true, otherwise the first is kept.
Seed	Seed used for hashing.
StringSplitInputCols	String column values split on whitespace.
PreserveOrderNumBits	Bits used to preserve order. If >0 inserts position at the highest order bits.
PrefixStringsWithColumnName	Prefixes string features with column name (default: true).

Vowpal Wabbit on Spark | N-Grams

Vowpal Wabbit supports n-gram generation at learning time

- Reduces memory footprint significantly

Obstacle

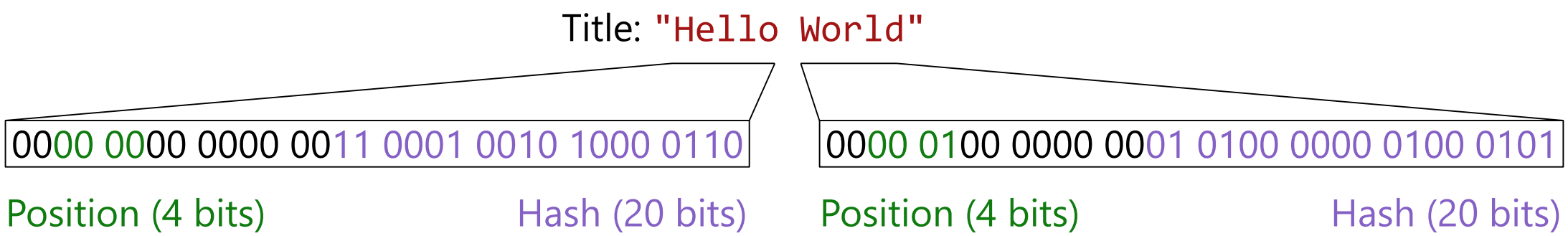
- Features must be presented in order of occurrence (e.g. text) for n-gramming
- Spark Sparse Vectors require **feature indices** to be sorted
- After hashing input text order is lost (indices = hash of word)

Solution

- Create composite feature indices (position + hash)
- Strip position for learning

Vowpal Wabbit on Spark | N-Grams

```
new VowpalWabbitFeaturizer()
   .setStringSplitInputCols(Array("title", "body"))
   .setPreserveOrderNumBits(4)
   .setNumBits(20)
   .setPrefixStringsWithColumnName(false)
   .transform(df)
```



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