# Extract Transform Select

## INTRODUCTION TO SPARK SQL IN PYTHON

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# ETS

# Extract
# Transform
# Select

# Extract, Transform, and Select

- Extraction
- Transformation
- Selection

# Built-in functions

```
from pyspark.sql.functions import split, explode
```

# The length function

```
from pyspark.sql.functions import length
```

```
df.where(length('sentence') == 0)
```

# Creating a custom function

- User Defined Function
- UDF

# Importing the udf function

```
from pyspark.sql.functions import udf
```

# Creating a boolean UDF

```
print(df)
```

```
DataFrame[textdata: string]
```

```
from pyspark.sql.functions import udf
```

```
from pyspark.sql.types import BooleanType
```

# Creating a boolean UDF

```
short_udf = udf(lambda x:
                          True if not x or len(x) < 10 else False,
                          BooleanType())
```

```
df.select(short_udf('textdata')\
  .alias("is short"))\
  .show(3)
```

```
+--------+
|is short|
+--------+
|   false|
|    true|
|   false|
+--------+
```

# Important UDF return types

```
from pyspark.sql.types import StringType, IntegerType, FloatType, ArrayType
```

# Creating an array UDF

```
df3.select('word array', in_udf('word array').alias('without endword'))\
    .show(5, truncate=30)
```

```
+------------------------------+------------------------+
|                    word array|         without endword|
+------------------------------+------------------------+
|[then, how, many, are, there]||[then, how, many, are]|
|                   [how, many]||                 [how]|
|              [i, donot, know]||             [i, donot]|
|                   [quite, so]||                [quite]|
|    [you, have, not, observed]||      [you, have, not]|
+------------------------------+------------------------+
```

# Creating an array UDF

```
from pyspark.sql.types import StringType, ArrayType
```

```
# Removes last item in array
in_udf = udf(lambda x:
    x[0:len(x)-1] if x and len(x) > 1
    else [],
    ArrayType(StringType()))
```

# Sparse vector format

1. Indices
2. Values

Example:

- Array: `[1.0, 0.0, 0.0, 3.0]`
- Sparse vector: `(4, [0, 3], [1.0, 3.0])`

# Working with vector data

- `hasattr(x, "toArray")`
- `x.numNonzeros())`

# Let's practice!

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# Creating feature data for classification

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# Transforming a dense array

```
from pyspark.sql.functions import udf
from pyspark.sql.types import IntegerType
bad_udf = udf(lambda x:
              x.indices[0]
              if (x and hasattr(x, "toArray") and x.numNonzeros())
              else 0,
              IntegerType())
```

# Transforming a dense array

```
try:
    df.select(bad_udf('outvec').alias('label')).first()
except Exception as e:
    print(e.__class__)
    print(e.errmsg)
```

```
<class 'py4j.protocol.Py4JJavaError'>
An error occurred while calling o90.collectToPython.
```

# UDF return type must be properly cast

```
first_udf = udf(lambda x:
                int(x.indices[0])
                if (x and hasattr(x, "toArray") and x.numNonzeros())
                else 0,
                IntegerType())
```

# The UDF in action

```
+-------+--------------------+-----+--------------------+--------------------+
|endword|                 doc|count|            features|              outvec|
+-------+--------------------+-----+--------------------+--------------------+
|     it|[please, do, not,...| 1149|(12847,[15,47,502...|  (12847,[7],[1.0])|
| holmes|[start, of, the, ...|  107|(12847,[0,3,183,1...|(12847,[145],[1.0])|
|      i|[the, adventures,...|  103|(12847,[0,3,35,14...| (12847,[11],[1.0])|
+-------+--------------------+-----+--------------------+--------------------+
```

```
df.withColumn('label', k_udf('outvec')).drop('outvec').show(3)
```

```
+-------+--------------------+-----+--------------------+-----+
|endword|                 doc|count|            features|label|
+-------+--------------------+-----+--------------------+-----+
|     it|[please, do, not,...| 1149|(12847,[15,47,502...|    7|
| holmes|[start, of, the, ...|  107|(12847,[0,3,183,1...|  145|
|      i|[the, adventures,...|  103|(12847,[0,3,35,14...|   11|
+-------+--------------------+-----+--------------------+-----+
```

# CountVectorizer

- ETS : Extract Transform Select
- CountVectorizer is a Feature **Extractor**
- Its input is an array of strings
- Its output is a vector

# Fitting the CountVectorizer

```
from pyspark.ml.feature import CountVectorizer

cv = CountVectorizer(inputCol='words',
                     outputCol="features")
model = cv.fit(df)
result = model.transform(df)
print(result)
```

```
DataFrame[words: array<string>, features: vector]

# Dense string array on left, dense integer vector on right
+------------------------+---------------------------------------+
|words                   |features                               |
+------------------------+---------------------------------------+
|[Hello, world]          |(10,[7,9],[1.0,1.0])                   |
|[How, are, you?]        |(10,[1,3,4],[1.0,1.0,1.0])             |
|[I, am, fine, thank, you]|(10,[0,2,5,6,8],[1.0,1.0,1.0,1.0,1.0])|
+------------------------+---------------------------------------+
```

# Let's practice!

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# Text Classification

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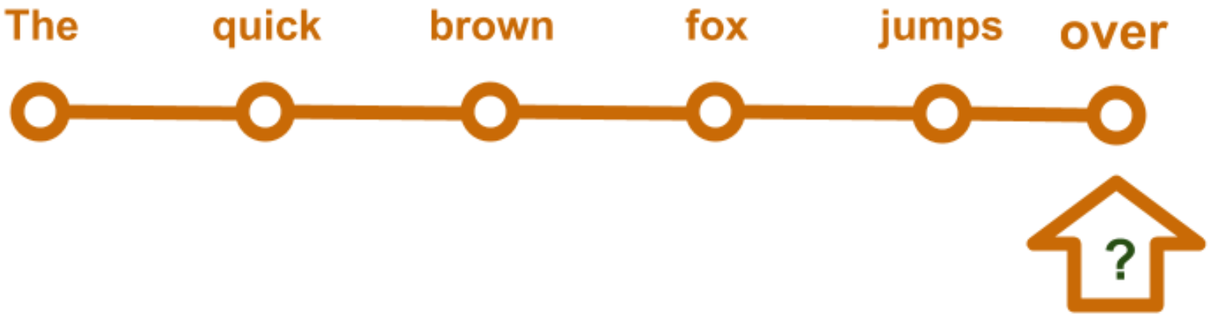
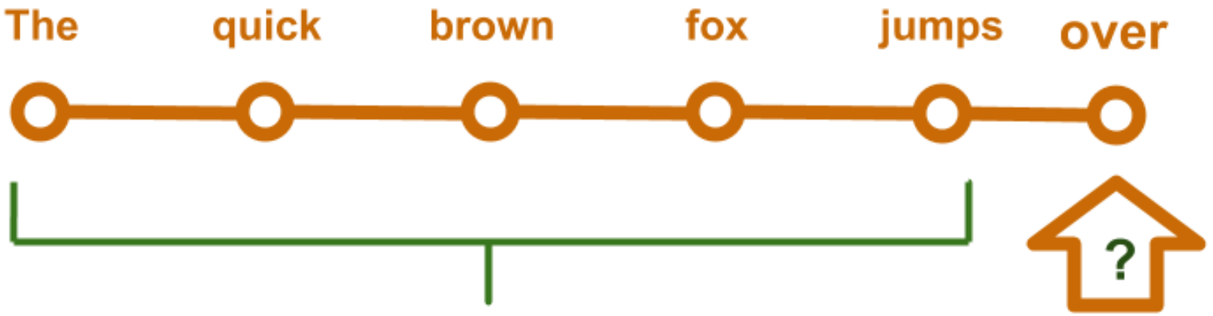
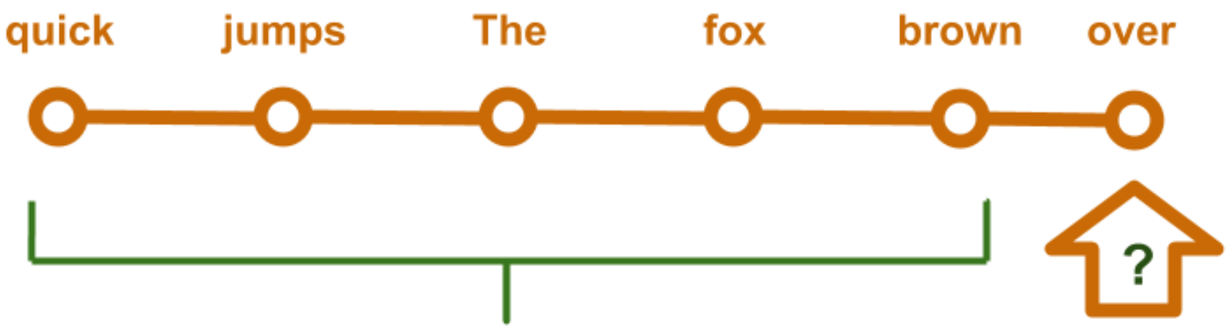
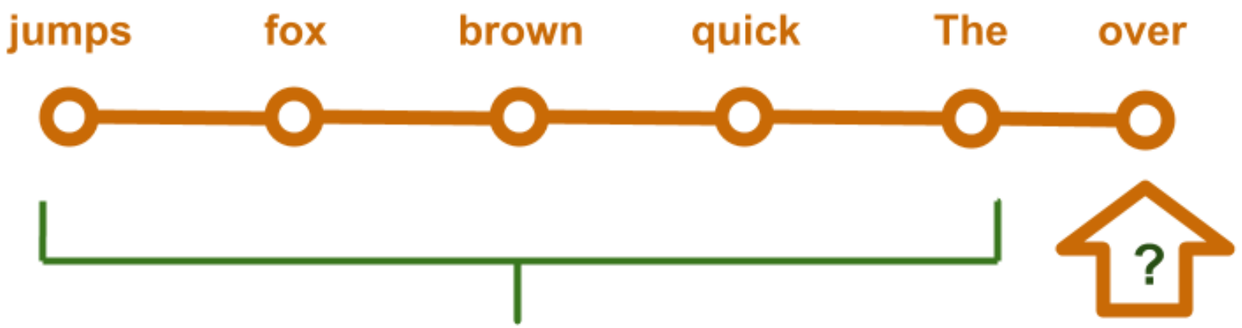
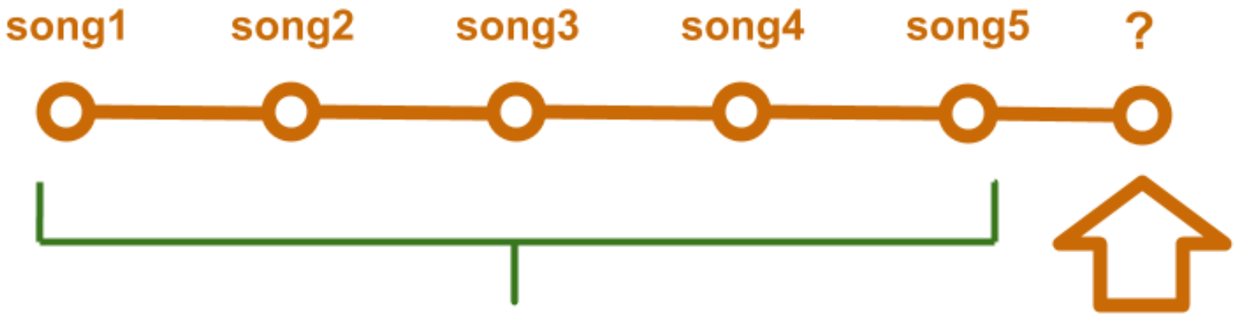
# Endword Prediction

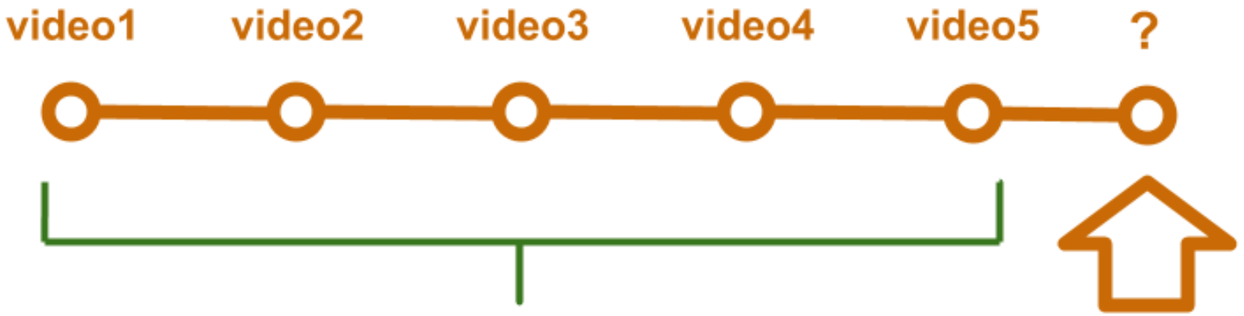

The
quick
brown
fox
jumps
over
?


The
quick
brown
fox
jumps
over
?


quick
jumps
The
fox
brown
over
?


jumps
fox
brown
quick
The
over
?


song1
song2
song3
song4
song5
?


video1
video2
video3
video4
video5
?

# Selecting the data

```
df_true = df.where("endword in ('she', 'he', 'hers', 'his', 'her', 'him')")\
            .withColumn('label', lit(1))
```

```
df_false = df.where("endword not in ('she', 'he', 'hers', 'his', 'her', 'him')")\
            .withColumn('label', lit(0))
```

# Combining the positive and negative data

```
df_examples = df_true.union(df_false)
```

# Splitting the data into training and evaluation sets

```
df_train, df_eval = df_examples.randomSplit((0.60, 0.40), 42)
```

# Training

```
from pyspark.ml.classification import LogisticRegression
logistic = LogisticRegression(maxIter=50, regParam=0.6, elasticNetParam=0.3)
model = logistic.fit(df_train)
print("Training iterations: ", model.summary.totalIterations)
```

# Let's practice!

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# Predicting and evaluating

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# Applying a model to evaluation data

```
predicted = df_trained.transform(df_test)
```

- prediction column: double
- probability column: vector of length two

```
x = predicted.first
print("Right!" if x.label == int(x.prediction) else "Wrong")
```

# Evaluating classification accuracy

```
model_stats = model.evaluate(df_eval)
```

```
type(model_stats)
```

```
pyspark.ml.classification.BinaryLogisticRegressionSummary)
```

```
print("\nPerformance: %.2f" % model_stats.areaUnderROC)
```

# Example of classifying text

- Positive labels:
  - ['her', 'him', 'he', 'she', 'them', 'us', 'they', 'himself', 'herself', 'we']
- Number of examples: **5746**
- Number of examples: **2873 positive**, **2873 negative**
- Number of training examples: **4607**
- Number of test examples: **1139**
- training iterations: **21**
- Test AUC: **0.87**

# Predicting the endword

- Positive label: **'it'**
- Number of examples: **438**
- Number of examples: **219 positive**, **219 negative**
- Number of training examples: **340**
- Number of test examples: **98**
- Test AUC: **0.85**

# Let's practice!

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# Recap

## INTRODUCTION TO SPARK SQL IN PYTHON

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# Recap

- Window function SQL
- **E**xtract
- **T**ransform
- **S**elect
- Train
- Predict
- Evaluate

# Congratulations!

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