Microsoft

Exploring Apache Spark And Spark SQL In Microsoft Azure HDInsight

Introduction

This class introduces students to Apache Spark on Azure HDInsight. It helps student to understand the value proposition of Apache Spark over other Big Data technologies like Hadoop. They should understand the similarities between Hadoop & Spark, their differences and respective nuances. They should be able to decide when to use what and why for a given business use case in a typical enterprise environment.

Azure specific highlights of Apache Spark

Source: http://azure.microsoft.com/en-us/services/hdinsight/apache-spark/

#1 Ease of Deployment of Spark over the Azure Cloud

Users can create Spark clusters with HDInsight in minutes.

#2 Every cluster comes with Jupyter notebook for interactive data analysis

Every Spark for Azure HDInsight cluster has Jupyter notebook included. This allows users to do interactive and exploratory analysis in Scala, Python or SQL.

#3 Scale-up or Scale-down a running Spark cluster as per business needs

Users can take advantage of the elasticity of the cloud by using the Scale feature on every HDInsight Spark cluster using which they can scale-up or scale-down a running Apache Spark cluster.

Spark SQL is Spark's module for working with structured data

This class specifically focuses on Spark SQL module and highlights its value proposition in the Apache Spark Big Data processing framework.

Main highlights of Spark SQL

Source: http://spark.apache.org/sql/

#1 Integrated - Seamlessly mix SQL queries with Spark programs.Spark SQL lets users query structured data inside Spark programs, using either SQL or a familiar DataFrame API. Usable in Java, Scala, Python and R.

#2 Uniform Data Access - Connect to any data source the same way. DataFrames and SQL provide a common way to access a variety of data sources, including Hive, Avro, Parquet, ORC, JSON, and JDBC. Users can even join data across these sources.

#3 Hive Compatibility - Run unmodified Hive queries on existing data. Spark SQL reuses the Hive frontend and metastore, giving users full compatibility with existing Hive data, queries, and UDFs.

#4 Standard Connectivity - Connect through JDBC or ODBC.A server mode provides industry standard JDBC and

ODBC connectivity for business intelligence tools.

Takeaways

Provision an HDInsight Spark Cluster.

Access data from Azure storage container and create Dataframe.

Understand joins, functions and user defined functions.

Prerequisites

a) An Azure subscription. See Get Azure free trial.

b) Download and install Azure Storage Explorer.

c) Power BI account.

Cluster Credentials:

Generic information:

Resource Group: mtllab

*Storage Account : mtllab**<number 1 through 12>***

Location : East US

Spark Cluster:

*Cluster Name for Spark Cluster: mtllabspark**<1-12>***

Cluster URL (Ambari) for Hive Cluster: https://*mtllabspark**<1-12>***.azurehdinsight.net/

Username: admin

Password: HDItut@123

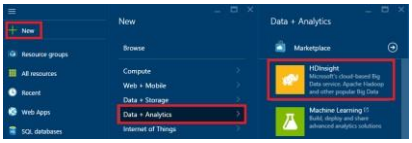
Class Section 1: Provision an HDInsight Spark cluster

Access Azure Preview Portal

1. Sign in to the Azure preview portal.

Create HDInsight Spark cluster

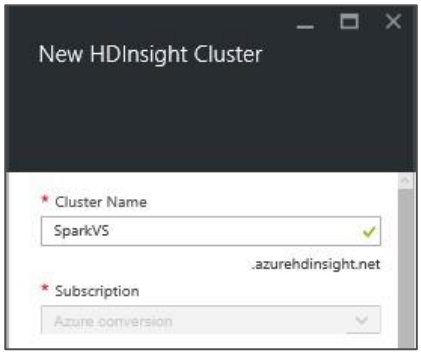
1. Click **NEW**, click **Data + Analytics**, and then click **HDInsight**.



Provide Cluster Details

1. In the New HDInsight Cluster blade, select the “Custom (size, settings, apps)” option to have more detailed control over the cluster creation.

   In the **Basic** tab, enter **Cluster Name.**

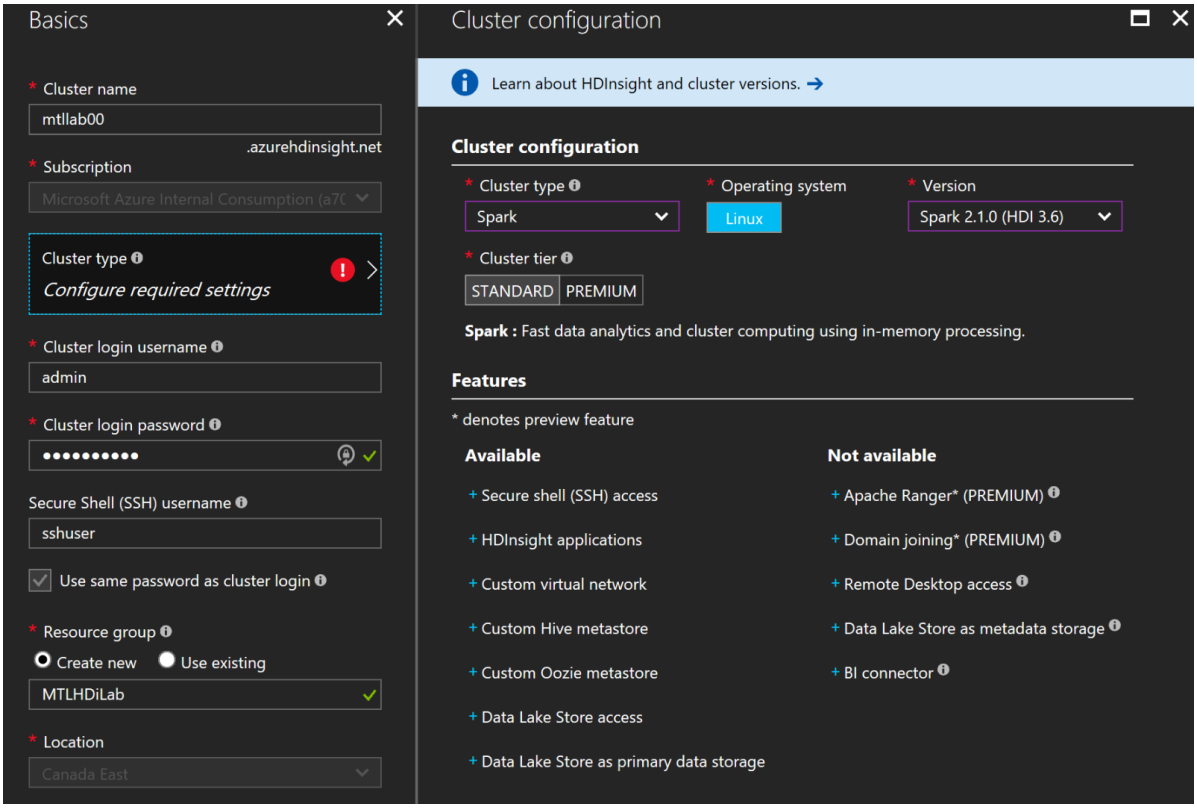


A green check mark appears beside the cluster name if it is available.

2. For **Subscription**, select **Azure Conversion.** If you have more than one subscription, click the Subscription entry to select the Azure subscription to use for the cluster.

Configure Cluster Type

1. Click on **Cluster type.** This will open the Cluster Type configuration blade.



2. Select **Spark** as **Cluster Type.**
3. **Operating System** will be **Linux** by default.
4. Select **Version** as **Spark 2.1.0 (HDI 3.6)**
5. For **Cluster Tier**, select **STANDARD**
6. Click **SELECT** to complete the configuration settings

Provide credentials to access cluster

1. Back in the Basic blade, specify the **Credentials.**
    a. Enter **Cluster Login Password**.
    b. Enter **SSH Username**.
    c. Select **PASSWORD** as **SSH Authentication Type**.
    d. Enter **SSH Password** and confirm it.

**SSH Username and Password is required to remote session of Spark Cluster*

Provide Resource Group

1. In the **Resource Group** section, you have options:

a) Click link Create New to provide new Resource Group.

Or

b) Use Existing by selecting appropriate Resource Group from list.

For the purpose of this lab, we will create a new resource group.

2. Enter the name **"mtllab"** for Resource Group

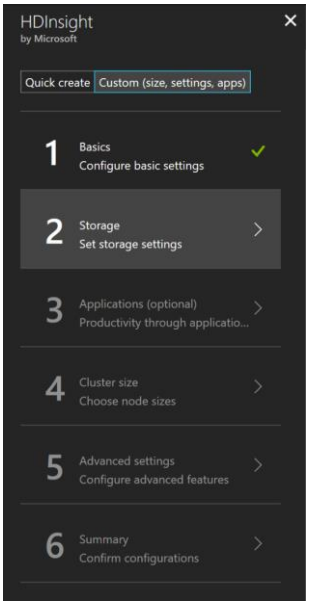
A green check appears beside the cluster name if this name is available.

If an error appears stating that the group already exist, change option to "Use existing and pick the **"mtllab"**

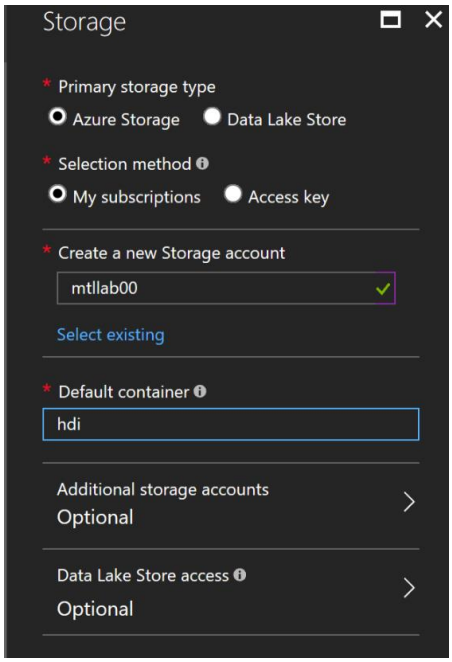
Provide Data Source

Data source will be used as primary location for most data access, such as job input and log output.

1. Click **Storage tab** present on New HDInsight Cluster blade



2. In the Storage blade**,** you will need to specify the **primary storage type** and the **Selection Method.** The **Primary storage type** has 2 options:



Option 1 – **Azure Storage** if you want to use blob storage from an Azure storage resource

Option 2 – **Data Lake Store** if you want to use the Azure Data Lake Store resourse.

Select **Azure Storage** for purpose of this Lab exercise

As for **Selection Method**, you have 2 options:

Option 1 - Set this to **Access Key** if you want to use existing storage account and you have **Storage Name** and **Access Key** of same, else

Option 2 - select **From all subscriptions** as Selection method.

Select **From all subscriptions** for purpose of this Lab exercise

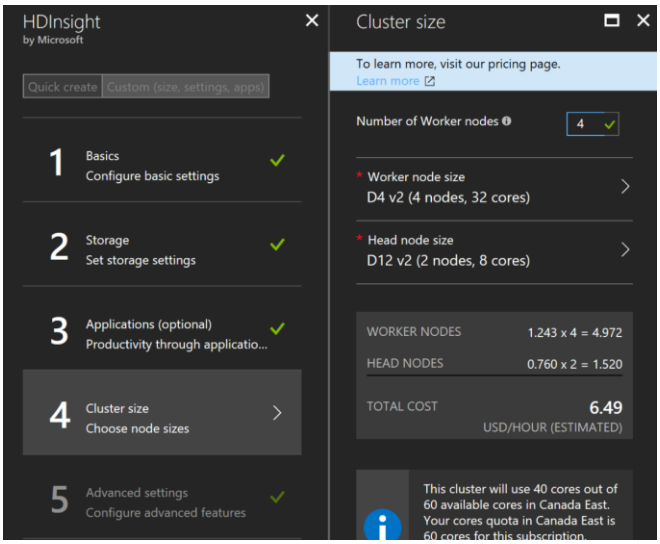
3. To create new storage account enter a name for new storage account in **Create New Storage Account** input box

   Or
   Click on link **Select Existing** to select from existing accounts.
   For purpose of this exercise, we will create a new storage account.

4. Enter the name **"hdi"** for default container to be designated for cluster in **Choose Default Container** field**.**
5. If existing storage account is selected then no need to provide **Location** else select appropriate **Location**. By default, the HDInsight cluster is provisioned in the same data center as the storage account you specify
6. Click Select button at the bottom to save the data source configuration.

Set Pricing

1. Click **Cluster Size** tab to open the Cluster Size blade.



2. The Cluster Size blade provides options to the configure number of nodes in cluster, which will be the base pricing criteria. Enter number of worker node in **Number of Worker nodes** field, set it to **4** for this demo.

3. Leave all other values as default.

   Note that based on the number of worker notes and size, the estimated cost of the cluster is calculated and displayed in USD/HOUR.

4. Click **Select** button to save node pricing configuration.

Provision cluster

1. After completing all the configuration, in the New HDInsight Cluster blade, make sure to tick on the 'Pin to dashboard' option.

2. Click **Create** button to finalize cluster creation.

This creates the cluster and adds a tile for it to the **Dashboard** of your Azure portal.

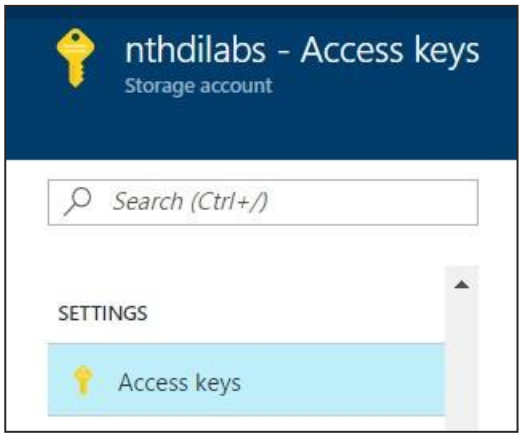
The icon will indicate that the cluster is provisioning, and will change to display the HDInsight icon once provisioning has completed.

Section 2: Load datasets files to storage account.

In this section, you'll copy the files required for the lab to your storage account. You'll copy the files between two storage account with the help of AzCopy utility. You can download the utility from here http://aka.ms/downloadazcopy

To copy the files, follow the below steps.

1. Copy your Azure Storage account access keys. This is required to copy data from the source Azure Storage account to your Azure Storage account. To get your storage account access key, navigate to your storage account on the Azure Management Portal and select **Access keys** under **Settings**.



2. Click on the copy icon to copy **Key1** from the **Access Keys** pane.

3. Press Window + R to open the run window. Type cmd and press enter to open a new command console window.

4. Change the directory to C:\Program Files (x86)\Microsoft SDKs\Azure\AzCopy.

5. Copy and paste the following command on the console window to transfer **all spark lab assets needed** from the source storage account to your storage account.

```
AzCopy /Source:https://mtlworkshop.blob.core.windows.net/hdi/Spark/
/Dest:https://mtllab<1-12>.blob.core.windows.net/hdi/Spark/
/SourceKey:s2eYqDZOhBOOv0glTcneXYC7t5jld58rP28BddfdP4Mv4/hI+pArEUAFjVgWOR
dyUC1Kxxro0o144vmm8QfKRw== /DestKey:<KEY1> /S
```

Section 3: Access data from Azure storage container and Create Data frame.

Access Azure Preview Portal (*Ignore this section if you're provided with a shared cluster)*

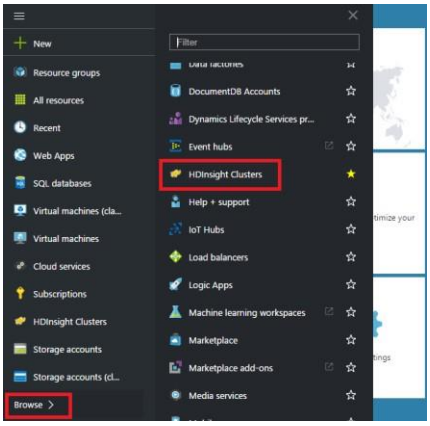
1. Sign in to the Azure preview portal.

If Spark Cluster pinned to Dashboard

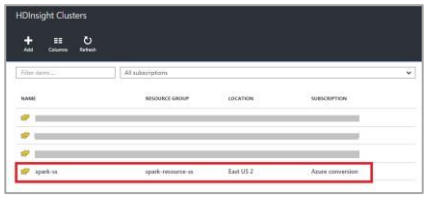
2. Click tile for your Spark Cluster.

If not pinned to Dashboard

2. Click **Browse,** select **HDInsight Clusters**.

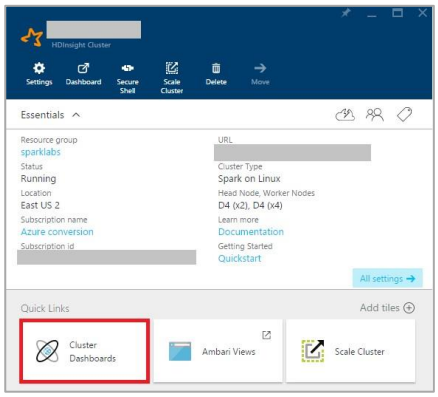


3. Select your Spark Cluster.

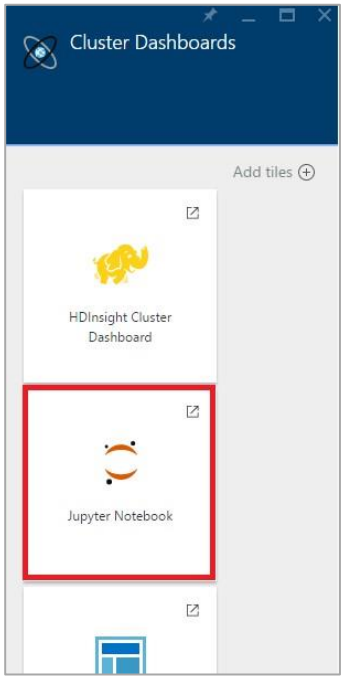


Launch Jupyter Notebook (*Ignore this section if you're provided with a shared cluster)*

1. Click on **Cluster Dashboards** tile present under **Quick Links** of Cluster Blade.



2. Locate the **Jupyter Notebook** tile on Cluster Dashboards tile array and click on it.



Launch Jupyter Notebook on shared cluster

Jupyter Tree URL: https://*mtllabspark**<1-12>***.azurehdinsight.net/jupyter/tree

Username: admin

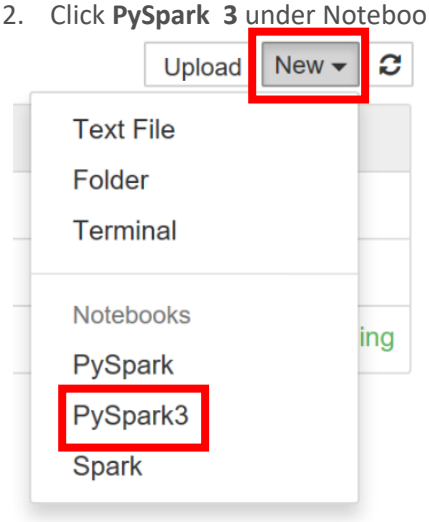
Password: HDItut@123

Create a new Jupyter Notebook

When prompted, enter the admin credentials for the Spark cluster.

Jupyter Notebook will open.

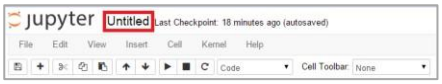
1. Click **New** dropdown button at top right side of Jupyter Notebook screen.
2. Click **PySpark 3** under Notebooks, from the dropdown.



Assign friendly name to notebook

A new notebook is then created and opened with the name **Untitled.pynb.**

1. Click the name of the notebook at the top to rename it.



2. Enter new name as **SparkSQL-Lab01** and press button **OK**.

Create Spark and SQL context

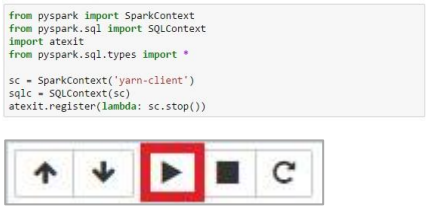
1. The statement "`from` *namespace* `import Class_Name`" imports classes from defined namespaces, required for execution of jobs
2. `SparkContext` ('yarn-client')
3. Above line initializes the spark context and launches Spark application on YARN in client mode.
4. `SQLContext(sparkContext)`
5. Above line of code initializes the sql context. Constructor `SQLContext` accepts `SparkContext object as a parameter.`

6. The **atexit** module defines functions to register and unregister cleanup functions. Functions thus registered are automatically executed upon normal interpreter termination.

Import the required modules and create the Spark and SQL contexts.

1. Paste the following snippet in an empty cell.
2. Press SHIFT + ENTER. Or Press Play button from tool bar to execute the code inside the cell.

```
from pyspark import SparkContext
from pyspark.sql import SQLContext
import atexit
from pyspark.sql.types import *

sqlc = SQLContext(sc)
atexit.register(lambda: sc.stop())
```



Create data frame from data stored in azure blob storage

1. Every time you run a job in Jupyter, your web browser window title will show a (Busy) status alongside the notebook title.
2. You will also see a solid circle next to the Python 2 text in the top-right corner.

3. After the job completes, this will change to a hollow circle

1. customerData = sc.textFile("File_Path") sc.textFile reads the text file line by line at the specified location.
2. customerData.map(lambda c:c.split(",")) splits each line in customerData variable, using “,” as delimiter and filter(lambda s:s[0]!="CustomerId") helps to filter out header line
3. StructField("Column_Name", DataType Boolean) defines column and it’s data type
4. StructType(List_of_StructFields) creates a schema for data frame using collection of StructField objects.

5. customerDataFinal.toDF(customerDataSchema) converts customerDataFinal rdd object to dataframe using customerDataSchema schema object

1. Paste the following snippet in below empty cell

2. Replace **<Container_Name>** in code with name of blob container containing dataset file to be accessed.

3. Replace **<Your_Storage_Account_Name>** in code with Azure storage account name 4. Press SHIFT + ENTER. Or Press Play button from tool bar to execute the code inside cell.

```
customerData = sc.textFile("wasb://hdi@mtllab<1-
12>.blob.core.windows.net/Spark/Lab01/CustomerData.csv")
customerDataFinal = customerData.map(lambda c:c.split(",")).filter(lambda
s:s[0]!="CustomerId")

customerDataFields = [StructField("Id", StringType(), True),
                      StructField("Name", StringType(), True),
                      StructField("City", StringType(), True),
                      StructField("State", StringType(), True),
                      StructField("Email", StringType(), True),
                      StructField("Phone", StringType(), True)]

customerDataSchema = StructType(customerDataFields)

customerData_DataFrame = customerDataFinal.toDF(customerDataSchema)
customerData_DataFrame.head(10)
```

5. Output of above code execution will be as shown below:

```
[Row(Id=u'JRK07IRCIJ', Name=u'Anne Fernandez', City=u'Charlotte', State=u'NC',
Email=u'annef@yahoo.com', Phone=u'212-776-4435'),
 Row(Id=u'ZJX5W46O91', Name=u'Adam Brown', City=u'Fremont', State=u'CA',
Email=u'adamb@googlemail.com', Phone=u'214-778-6654'),
 Row(Id=u'1AYIINRJT0', Name=u'Rob Wilson', City=u'Michigan City', State=u'MI',
Email=u'rob.wilson@gmail.com', Phone=u'206-877-8996'),
.
.
.]
```

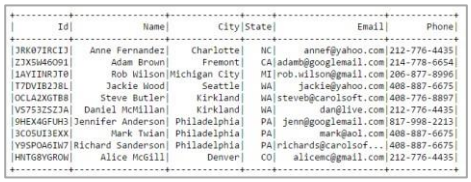
Output similar to this signifies successful creation of data frame for customer data.

DataFrame operations

Execute following operations on DataFrame created earlier in this lab and observe the output. Use Empty cells in the notebook to execute these operations.

1. customerData_DataFrame.show()

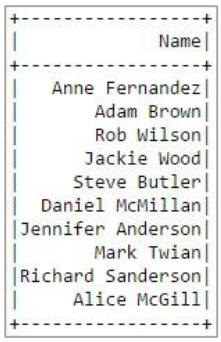
Output:



Id	Name	City	State	Email	Phone
JRK07IRCI	Anne Fernandez	Charlotte	NC	annef@yahoo.com	212-776-4435
ZJXSW46O91	Adam Brown	Fremont	CA	adamb@googlemail.com	214-778-6654
1AYIINRJT0	Rob Wilson	Michigan City	MI	rob.wilson@gmail.com	206-877-8996
T7DVIB2J8L	Jackie Wood	Seattle	WA	jackie@yahoo.com	408-887-6675
OCLA2XGTB8	Steve Butler	Kirkland	WA	steveb@carolsoft.com	408-776-8897
V5753ZSZJA	Daniel McMillan	Kirkland	WA	dan@live.com	212-776-4435
9HEX4GFUH3	Jennifer Anderson	Philadelphia	PA	jenn@googlemail.com	817-998-2213
3CO5UI3EXX	Mark Twian	Philadelphia	PA	mark@aol.com	408-887-6675
Y9SPOA6IW7	Richard Sanderson	Philadelphia	PA	richards@carolsof...	408-887-6675
HNTG8YGROW	Alice McGill	Denver	CO	alicemc@gmail.com	212-776-4435

2. customerData_DataFrame.select("Name").show()

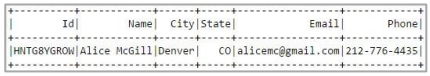
Output:



Name
Anne Fernandez
Adam Brown
Rob Wilson
Jackie Wood
Steve Butler
Daniel McMillan
Jennifer Anderson
Mark Twian
Richard Sanderson
Alice McGill

3. customerData_DataFrame.filter(customerData_DataFrame.Name == 'Alice McGill').show()

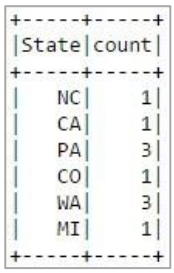
Output:



Id	Name	City	State	Email	Phone
HNTG8YGROW	Alice McGill	Denver	CO	alicemc@gmail.com	212-776-4435

4. customerData_DataFrame.groupBy("State").count().show()

Output:



State	count
NC	1
CA	1
PA	3
CO	1
WA	3
MI	1

Running SQL Queries

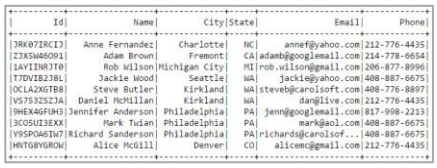
1. To register the DataFrame as SQL table copy below code in empty cell and execute it

```
customerData_DataFrame.registerTempTable("CustomerTable")
```

2. Execute below SQL queries in empty cells and observe the output

```
%%sql
Select * from CustomerTable
```

Output:



Id	Name	City	State	Email	Phone
JRK07IRCI3	Anne Fernandez	Charlotte	NC	annef@yahoo.com	212-776-4435
Z3XSW46O91	Adam Brown	Fremont	CA	adamb@googlemail.com	214-778-6654
1AYIIWRJT0	Rob Wilson	Michigan City	MI	rob.wilson@gmail.com	206-877-8996
T7DVIB2J8L	Jackie Wood	Seattle	WA	jackie@yahoo.com	408-887-6675
OCLA2XGTB8	Steve Butler	Kirkland	WA	steveb@carolsoft.com	408-776-8897
VS753ZSZJA	Daniel McMillan	Kirkland	WA	dan@live.com	212-776-4435
9HEX4GFUH3	Jennifer Anderson	Philadelphia	PA	jenn@googlemail.com	817-998-2213
3CO5UI3EXX	Mark Twian	Philadelphia	PA	mark@aol.com	408-887-6675
Y9SPOA6IW7	Richard Sanderson	Philadelphia	PA	richards@carolsof...	408-887-6675
MNTGBYGROW	Alice McGill	Denver	CO	alicemc@gmail.com	212-776-4435

```
%%sql
Select Name from CustomerTable order by Name
```

Output:

Name
Adam Brown
Alice McGill
Anne Fernandez
Daniel McMillan
Jackie Wood
Jennifer Anderson
Mark Twian
Richard Sanderson
Rob Wilson
Steve Butler

```
%%sql
Select Name from CustomerTable where State='WA'
```

Output:

Name
Jackie Wood
Steve Butler
Daniel McMillan

```
%%sql
Select State,count(Name) as CNT from CustomerTable group by State
```

Output:

State	CNT
NC	1
CA	1
PA	3
CO	1
WA	3
MI	1

Section 4: Understand joins, functions and user defined functions

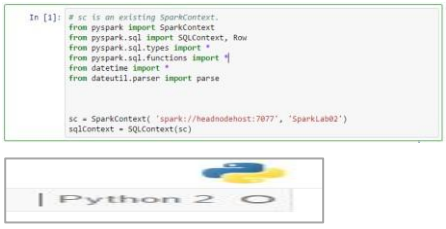
Create New Jupyter Notebook

Create Spark and SQL context

Import the required modules and create the Spark and SQL contexts.

1. Paste the following snippet in an empty cell
2. Press SHIFT + ENTER. Or Press Play button from tool bar to execute the code inside cell.

```
from pyspark import SparkContext
from pyspark.sql import SQLContext
import atexit
from pyspark.sql.types import *
from pyspark.sql.functions import *

sqlc = SQLContext(sc)
atexit.register(lambda: sc.stop())
```



Create Data Frame for Datasets

Create Data Frame for customer data set

1. Paste the following snippet in an empty cell.
2. **<azure_storage_account>** placeholder with name of storage account used to store datasets and replace **<blob_container>** with name of container containing datasets.
3. Press **SHIFT + ENTER**. Or Press **Play** button from tool bar to execute the code inside cell.

```
customerData = sc.textFile("wasb://hdi@mtllab<1-
12>.blob.core.windows.net/Spark/Lab01/CustomerData.csv")
customerDataFinal = customerData.map(lambda c:c.split(",")).filter(lambda
s:s[0]!="CustomerId")
customerDataFields = [StructField("Id", StringType(), True),
                      StructField("Name", StringType(), True),
                      StructField("City", StringType(), True),
                      StructField("State", StringType(), True),
                      StructField("Email", StringType(), True),
                      StructField("Phone", StringType(), True)]

customerDataSchema = StructType(customerDataFields)

customerDF = customerDataFinal.toDF(customerDataSchema)

customerDF.head(10)
```

4. Output like below figure denotes successful data frame creation

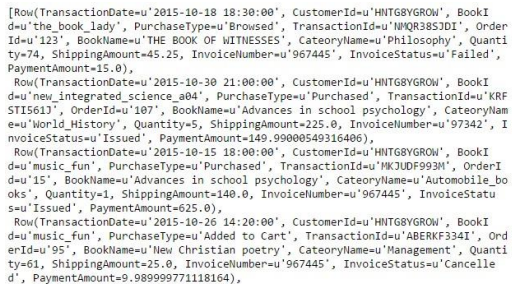
Create Data Frame for transaction data set

1. Paste the following snippet in an empty cell.
2. **<azure_storage_account>** placeholder with name of storage account used to store datasets and replace **<blob_container>** with name of container containing datasets.
3. Press **SHIFT + ENTER**. Or Press **Play** button from tool bar to execute the code inside cell.

```
transactionData = sc.textFile("wasb://hdi@mtllab<1-
12>.blob.core.windows.net/Spark/Lab01/TransactionData.csv")
transactionDataRaw = transactionData.map(lambda c:c.split(",")).filter(lambda
s:s[0]!="TransactionDate")

transactionHeaders = transactionData.first()
transactionFields = [StructField("TransactionDate",StringType(),True),
                     StructField("CustomerId",StringType(),True),
                     StructField("BookId",StringType(),True),
                     StructField("PurchaseType",StringType(),True),
                     StructField("TransactionId",StringType(),True),
                     StructField("OrderId",StringType(),True),
```

```
                    StructField("BookName",StringType(),True),
                    StructField("CateoryName",StringType(),True),
                    StructField("Quantity",IntegerType(),True),
                    StructField("ShippingAmount",FloatType(),True),
                    StructField("InvoiceNumber",StringType(),True),
                    StructField("InvoiceStatus",StringType(),True),
                    StructField("PaymentAmount",FloatType(),True)]

transactionSchema = StructType(transactionFields)
transactionDataFinal = transactionDataRaw.map(lambda p:
(p[0],p[1],p[2],p[3],p[4],p[5],p[6],p[7],int(p[8]),float(p[9]),p[10],p[11],float(p[12]))
)
transactionsDF = transactionDataFinal.toDF(transactionSchema)

transactionsDF.head(10)
```

4. Output similar to below figure denotes successful data frame creation



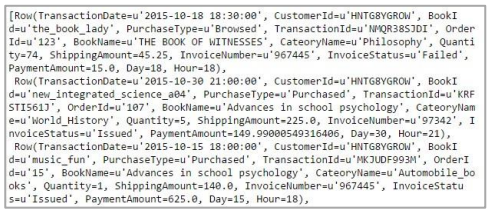
```
[Row(TransactionDate=u'2015-10-18 18:30:00', CustomerId=u'HNTG8YGROW', BookI
d=u'the_book_lady', PurchaseType=u'Browsed', TransactionId=u'NMQR38SJDI', Order
Id=u'123', BookName=u'THE BOOK OF WITNESSES', CateoryName=u'Philosophy', Quanti
ty=74, ShippingAmount=45.25, InvoiceNumber=u'967445', InvoiceStatus=u'Failed',
PaymentAmount=15.0),
 Row(TransactionDate=u'2015-10-30 21:00:00', CustomerId=u'HNTG8YGROW', BookI
d=u'new_integrated_science_a04', PurchaseType=u'Purchased', TransactionId=u'KRF
STI561J', OrderId=u'107', BookName=u'Advances in school psychology', CateoryNam
e=u'World_History', Quantity=5, ShippingAmount=225.0, InvoiceNumber=u'97342', I
nvoiceStatus=u'Issued', PaymentAmount=149.99000549316406),
 Row(TransactionDate=u'2015-10-15 18:00:00', CustomerId=u'HNTG8YGROW', BookI
d=u'music_fun', PurchaseType=u'Purchased', TransactionId=u'MKJUDF993M', OrderI
d=u'15', BookName=u'Advances in school psychology', CateoryName=u'Automobile_bo
oks', Quantity=1, ShippingAmount=140.0, InvoiceNumber=u'967445', InvoiceStatu
s=u'Issued', PaymentAmount=625.0),
 Row(TransactionDate=u'2015-10-26 14:20:00', CustomerId=u'HNTG8YGROW', BookI
d=u'music_fun', PurchaseType=u'Added to Cart', TransactionId=u'ABERKF334I', Ord
erId=u'95', BookName=u'New Christian poetry', CateoryName=u'Management', Quanti
ty=61, ShippingAmount=25.0, InvoiceNumber=u'967445', InvoiceStatus=u'Cancelle
d', PaymentAmount=9.989999771118164),
```

Create Data Frame for session data set

1. Paste the following snippet in an empty cell.
2. Replace **<azure_storage_account>** placeholder with name of storage account used to store datasets and replace **<blob_container>** with name of container containing datasets.
3. Press **SHIFT + ENTER**. Or Press **Play** button from tool bar to execute the code inside cell.

```
sessionData = sc.textFile("wasb://hdi@mtllab<1-
12>.blob.core.windows.net/Spark/Lab01/SessionData.csv")
sessionDataRaw = sessionData.map(lambda c:c.split(","))

sessionFields = [StructField("CustomerId",StringType(),True),
                 StructField("SessionId",StringType(),True),
                 StructField("VisitTime",StringType(),True),
                 StructField("Url",StringType(),True),
                 StructField("TimeSpent",IntegerType(),True)]

sessionSchema = StructType(sessionFields)
sessionDataFinal = sessionDataRaw.map(lambda p: (p[0],p[1],p[2],p[3],int(p[4])))
sessionsDF = sessionDataFinal.toDF(sessionSchema)

sessionsDF.head(10)
```

Output like below figure denotes successful data frame creation



Modify transaction data frame to add calculated columns

1. Transaction Date is in **"yyyy:mm:dd hh:mm:ss"** string format. For data analysis, we will split above string to get Day and Hour and put them in separate columns "**Day**" and "**Hour**" in integer format respectively.

2. To achieve this, we have to create user defined functions using the format as follows:

```
def py_function_name(argument_list)
#code
return return_parameter
udf_name = udf(py_function_name, data_type)
```

3. Before using **udf** function, **udf** class should be imported to notebook

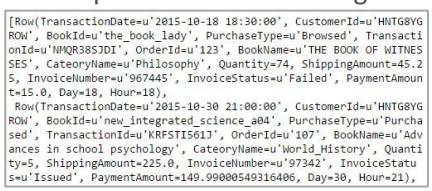
```
E.g.: from pyspark.sql.functions import udf
```

4. Paste the following snippet in an empty cell.

5. Press **SHIFT + ENTER**. Or Press Play button from tool bar to execute the code inside cell.

```
from pyspark.sql.functions import udf
# function to extract hour from string date time
def functionGetHour(Date):
    split1 = Date.split(" ")[1]
    Hour = split1.split(":")[0]
    return int(Hour)

getHour = udf(functionGetHour, IntegerType())

# function to extract day from string date time
def functionGetDay(Date):
    split1 = Date.split("-")[2]
    Day = split1.split(" ")[0]
    return int(Day)

getDay = udf(functionGetDay, IntegerType())
transactionsDF01 = transactionsDF.select("*",
getDay(transactionsDF.TransactionDate).alias('Day'),
getHour(transactionsDF.TransactionDate).alias('Hour'))

transactionsDF01.head(10)
```

6. Output similar to below figure denotes successful data frame creation

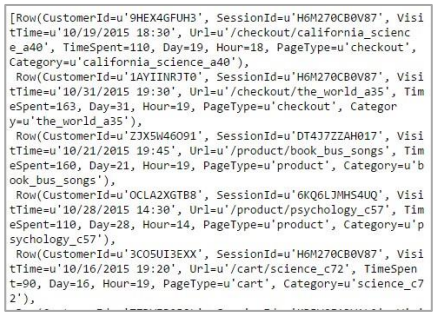


Modify session data frame to add calculated columns

1. Similar to transaction data frame, we will create two columns in session data frame, for Day and Hour by splitting date time string in VisitTime column.
2. We will also write two separate functions to extract page type and category of book from Url of data and place it in **PageType** and **Category** column respectively.
3. Paste the following snippet in an empty cell.
4. Press **SHIFT + ENTER**. Or Press Play button from tool bar to execute the code inside cell.

```
# function to extract Day from date time string
def functionGetDayS(Date):
    Day = Date.split("/")[1]
    return int(Day)

getDayS = udf(functionGetDayS, IntegerType())

# function to extract page type from url
def functionGetPageType(URL):
    PageType = URL.split("/")[1]
    return PageType

getPageType = udf(functionGetPageType, StringType())

# function to extract category from url
def functionGetCategory(URL):
    Category = URL.split("/")[2]
    return Category

getCategory = udf(functionGetCategory, StringType())
sessionsDF01 = sessionsDF.select("*", getDayS(sessionsDF.VisitTime).alias('Day'),
getHour(sessionsDF.VisitTime).alias('Hour'),getPageType(sessionsDF.Url).alias('PageType'),
getCategory(sessionsDF.Url).alias('Category') )

sessionsDF01.head(10)
```

5. Output similar to below figure denotes successful data frame creation



```
[Row(CustomerId=u'9HEX4GFUH3', SessionId=u'H6M270CB0V87', Visi
tTime=u'10/19/2015 18:30', Url=u'/checkout/california_scienc
e_a40', TimeSpent=110, Day=19, Hour=18, PageType=u'checkout',
Category=u'california_science_a40'),
 Row(CustomerId=u'1AYIINRJT0', SessionId=u'H6M270CB0V87', Visi
tTime=u'10/31/2015 19:30', Url=u'/checkout/the_world_a35', Tim
eSpent=163, Day=31, Hour=19, PageType=u'checkout', Categor
y=u'the_world_a35'),
 Row(CustomerId=u'ZJX5W46O91', SessionId=u'DT4J7ZZAH017', Visi
tTime=u'10/21/2015 19:45', Url=u'/product/book_bus_songs', Tim
eSpent=160, Day=21, Hour=19, PageType=u'product', Category=u'b
ook_bus_songs'),
 Row(CustomerId=u'OCLA2XGTB8', SessionId=u'6KQ6LJMHS4UQ', Visi
tTime=u'10/28/2015 14:30', Url=u'/product/psychology_c57', Tim
eSpent=110, Day=28, Hour=14, PageType=u'product', Category=u'p
sychology_c57'),
 Row(CustomerId=u'3CO5UI3EXX', SessionId=u'H6M270CB0V87', Visi
tTime=u'10/16/2015 19:20', Url=u'/cart/science_c72', TimeSpen
t=90, Day=16, Hour=19, PageType=u'cart', Category=u'science_c7
2'),
```

Join transaction and session data frames with customer data frame

1. Paste the following snippet in an empty cell to join transaction and session data frame with customer data frame.

2. Press **SHIFT + ENTER**. Or Press **Play** button from tool bar to execute the code inside cell.

```
#perform joins on session and customer data frame
customerSessionDF = sessionsDF01.join(customerDF,sessionsDF01.CustomerId ==
customerDF.Id)

#perform joins on transaction and customer data frame
customerTransactionDF = transactionsDF01.join(customerDF,transactionsDF01.CustomerId ==
customerDF.Id)
```

Perform operations on data frames to analyze the data

Call functions on data frames to analyze the data

- **groupBy(*cols)** : Groups the DataFrame using specified columns, inorder to run aggregation on them.
- **count():** Returns the number of rows in DataFrame.
- **collect():** Returns all records as list of row.
- **orderBy(*cols):** Returns a new DataFrame sorted by the specified columns.
- **desc():** Returns a sort expression based on the descending order of the given column name.
- **avg(*args):** Computes average values for each numeric column for each group.
- **sum(*args):** Computes sum for each numeric column for each group.

1. Paste the following queries one by one in the empty cells and execute them to observe their output.
2. Press **SHIFT + ENTER**. Or Press **Play** button from tool bar to execute the code inside cell.
3. Get number of sessions created by customers

```
Query:
customerSessionDF.groupBy("Name").count().collect()
```

Output:

```
[Row(Name=u'Jennifer Anderson', count=27984),
 Row(Name=u'Rob Wilson', count=28036),
 Row(Name=u'Alice McGill', count=27897),
 Row(Name=u'Mark Twian', count=27913),
 Row(Name=u'Steve Butler', count=28052),
 Row(Name=u'Anne Fernandez', count=28152),
 Row(Name=u'Jackie Wood', count=27987),
 Row(Name=u'Daniel McMillan', count=27901),
 Row(Name=u'Richard Sanderson', count=27866),
 Row(Name=u'Adam Brown', count=28212)]
```

4. Get names of first three customers who created maximum sessions.

```
Query:
customerSessionDF.groupBy("Name").count().orderBy("count",ascending=False).head(3)
```

Output:

```
[Row(Name=u'Adam Brown', count=28212),
 Row(Name=u'Anne Fernandez', count=28152),
 Row(Name=u'Steve Butler', count=28052)]
```

5. Get average time spent by customer on each session.

```
Query:  customerSessionDF.groupBy().avg("TimeSpent").collect()
```

Output:

```
[Row(AVG(TimeSpent)=145.43445714285716)]
```

6. Get the name of customer who spent maximum time and total time spent.

Query:

```
customerSessionDF.groupBy("Name").sum("TimeSpent").orderBy("sum(TimeSpent)",ascending=False).head(1)
```

Output:

```
[Row(Name=u'Adam Brown', SUM(TimeSpent)=4103352)]
```

7. Get day wise session frequency.

Query:

```
customerSessionDF.groupBy("Day").count().collect()
```

Output:

```
[Row(Day=31, count=23474),
 Row(Day=12, count=23426),
 Row(Day=15, count=23363),
 Row(Day=16, count=23484),
 Row(Day=19, count=23454),
 Row(Day=20, count=23426),
 Row(Day=21, count=46306),
 Row(Day=23, count=23363),
 Row(Day=25, count=23253),
 Row(Day=28, count=23054),
 Row(Day=30, count=23397)]
```

Output denotes session frequency is same for all days **except 21st due to offers provided on bookstore site**.

8. Get three most browsed urls.

Query:

```
customerSessionDF.groupBy("Url").count().orderBy("count", ascending=False).head(3)
```

Output:

```
[Row(Url=u'/product/psychology_c57', count=28213),
 Row(Url=u'/product/spotlight_books', count=28139),
 Row(Url=u'/cart/driving_jarvis_ham', count=28078)]
```

Perform analysis on purchased book data

Where(condition): Filters rows based on provided condition.

1. Transaction data contains column PurchaseType, it has three values Browsed, Purchased and Added to Cart.
2. To perform operations on purchased books, filter transaction data to create new DataFrame having only purchased data.
3. Paste the following code snippet in empty cell to create DataFrame for purchased data 4. Press **SHIFT + ENTER**. Or

   Press Play button from tool bar to execute the code inside cell.

```
purchasedDF = customerTransactionDF.where(transactionsDF01.PurchaseType =='Purchased')
```

withColumn(colName, colExpr): Returns a new data frame by adding column.

1. Perform following operations one by one in empty cells and observe the output
2. Find out five most purchased book categories

```
Query:
purchasedDF.groupBy("CateoryName").sum("Quantity").orderBy("sum(Quantity)",ascending=False).show(5)
```

Output:

CateoryName	SUM(Quantity)
Drive_books	211029
Adventure	112470
World_History	112263
Art	112105
Non_Fiction	111731

3. Find out most purchased books **Query**:

```
purchasedDF.groupBy("BookName").sum("Quantity").orderBy("sum(Quantity)",
ascending=False).show(5)
```

Output:

BookName	SUM(Quantity)
The voyages of Ca...	232414
Advances in schoo...	231410
Science in Dispute	231408
History of politi...	231255
THE BOOK OF WITNE...	230872

4. Add a new calculated column to purchasedDF DataFrame having name "AmountPaid" and containing value

```
AmountPaid = (Quantity * PaymentAmount) + ShippingAmount
```

And find out top five customers who paid most.

Query:

```
purchasedDF01 = purchasedDF.withColumn("AmountPaid",(purchasedDF.Quantity *
purchasedDF.PaymentAmount) + purchasedDF.ShippingAmount)
purchasedDF01.groupBy("Name").sum("AmountPaid").orderBy("sum(AmountPaid)",ascending
=False).select("Name").show(5)
```

Output:

Name
Anne Fernandez
Steve Butler
Jennifer Anderson
Alice McGill
Rob Wilson

Get the amount collected on 18th day

Query:

```
purchasedDF01.where(purchasedDF01.Day == 18).groupBy().sum("AmountPaid").collect()
```

Output:

```
[Row(SUM(AmountPaid)=49105849.035095215)]
```

Disclaimer: Once you have completed the lab, to reduce costs associated with your Azure subscription, you may want to delete your clusters.

Note, delete the Azure resource group **MTLLAB**