

## IBM Cloud and IBM Data Science Experience

*Using IBM Cloud and IBM Data Science Experience, to Create and deploy a scoring model to predict heart failure*

### *Lab Exercise*

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## Overview

The objective of this lab is to demonstrate how to use IBM Data Science Experience to build a predictive model within a Jupyter Notebook.

You will deploy this predictive model to the Watson Machine Learning Service in IBM Cloud. Based on the data provided by User, User will get prediction about his heart failure. This task will be accomplished without writing any programming code.

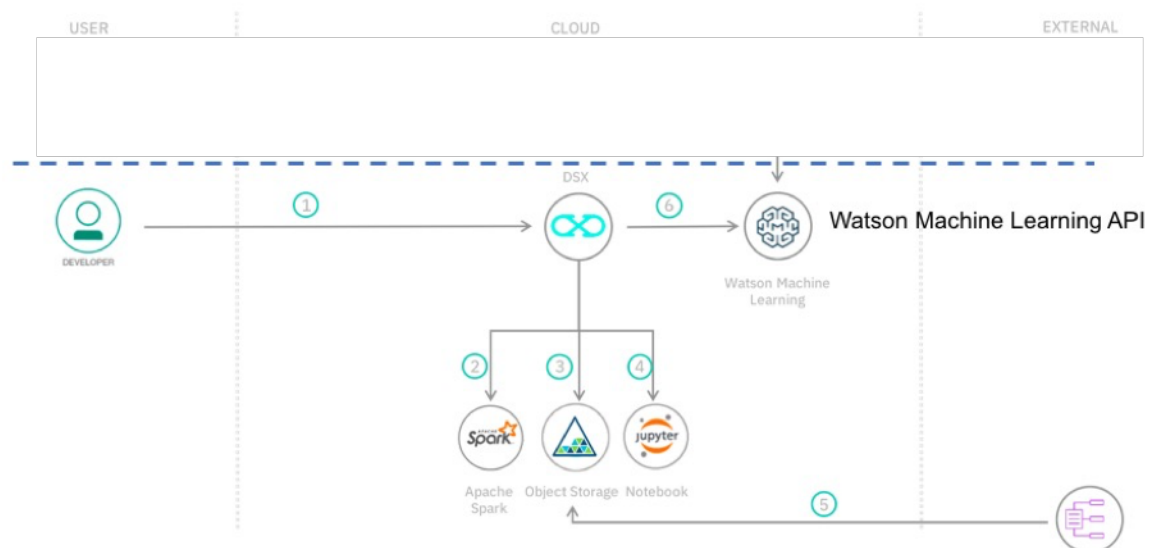
**Some of the tasks that you will perform in this lab include:**

- The developer creates an IBM Data Science Experience Workspace.
- IBM Data Science Experience depends on an Apache Spark service.
- IBM Data Science Experience uses Cloud Object storage to manage your data.
- This lab is built around a Jupyter Notebook, this is where the developer will import data, train, and evaluate their model.
- Import data on heart failure.
- Trained models are deployed into production using IBM's Watson Machine Learning Service.
- Accessing Watson ML Models and Deployments through API

## Introduction

This lab is designed to demonstrate how to use IBM Data Science Experience to build a predictive model within a Jupyter Notebook. The predictive model is then deployed to the Watson Machine Learning Service in IBM Cloud

### Flow



## Pre-requisites

- IBM Cloud supported web browser
- An IBM Cloud Account

## Duration

You should be able to complete this lab in approximately 60 minutes.

# Using IBM Cloud and IBM Data Science Experience, to Create and deploy a scoring model to predict heart failure

## Getting Started

To be able to do this lab an IBM Cloud account is necessary.

### Not registered

If you don't have one yet -- or you did not complete the initial set up of your IBM Cloud account. Please follow instructions as per note sent to you while Registration for this LAB.

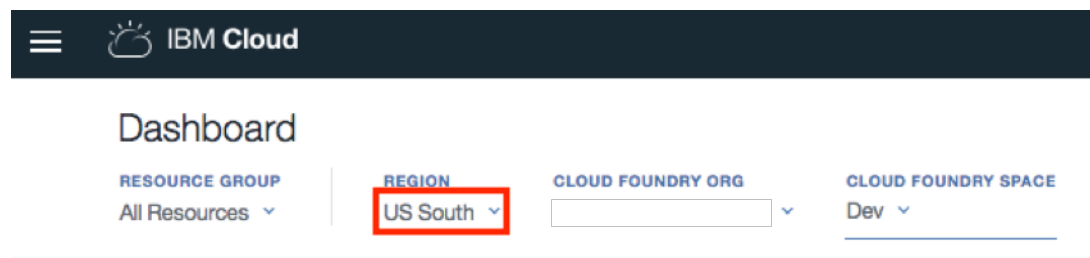
Your account must have enough resources available for at least 1 application (128MB) and 4 services.

### Already registered and completed set-up

When you are already registered, and completed the initial set-up of your IBM Cloud account, you directly jump to Create a space in **IBM Cloud US South region**.

### Create a space in IBM Cloud US South Region

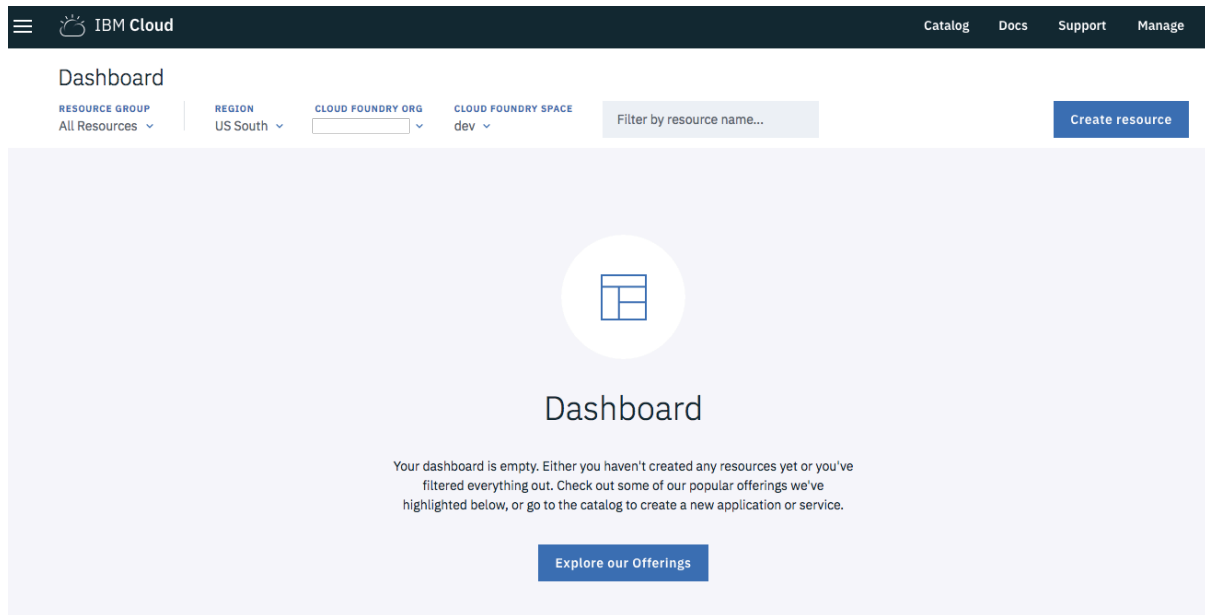
For the remainder of this lab we switch to the **US South Region** of IBM Cloud. For this, use Ctrl-click (or the equivalent for your system) to open the IBM Cloud dashboard. Click your account and choose **US South** as your active region.



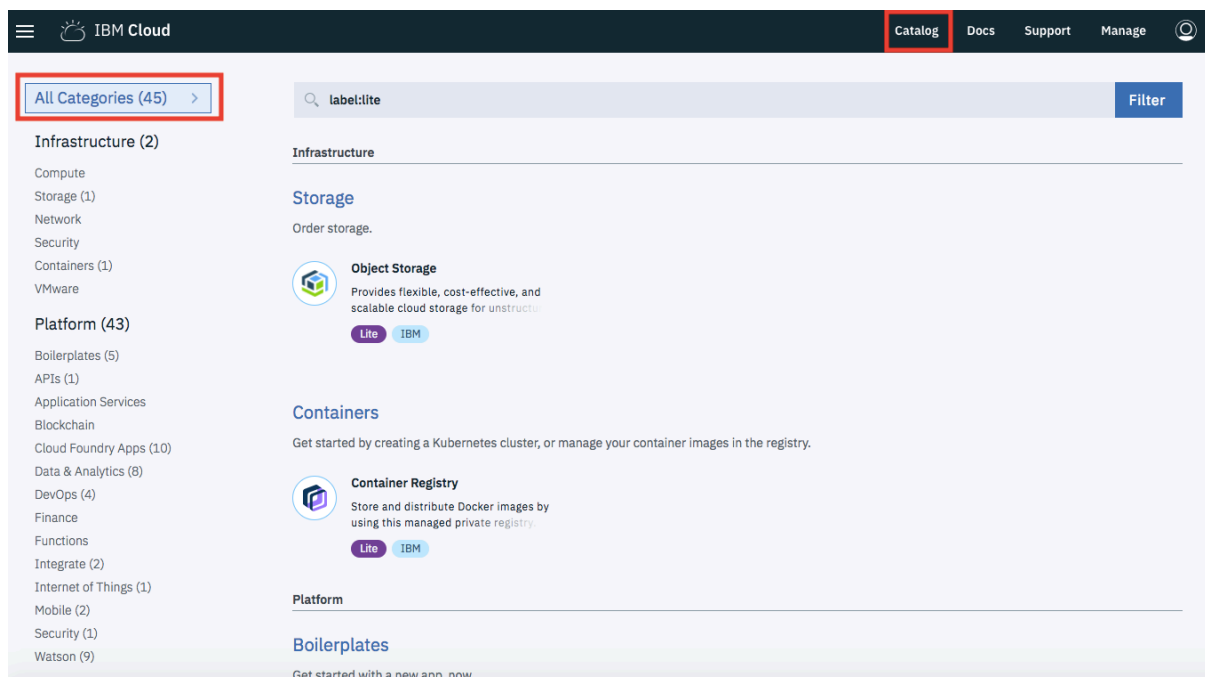
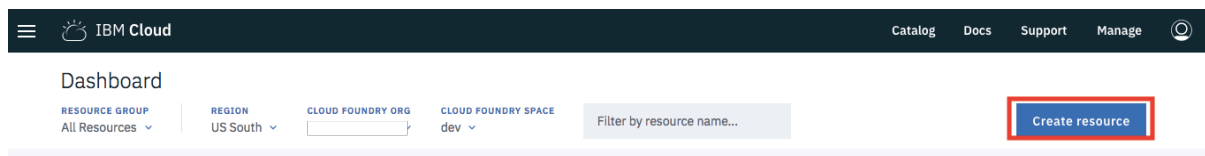
If you are all OK, you get the dashboard. Otherwise, you will be asked to create your first space in this region -- as depicted in the screenshot below. Typically, **Dev** would be a good name for your space.

## Step 1: Create IBM Data Science Experience Service

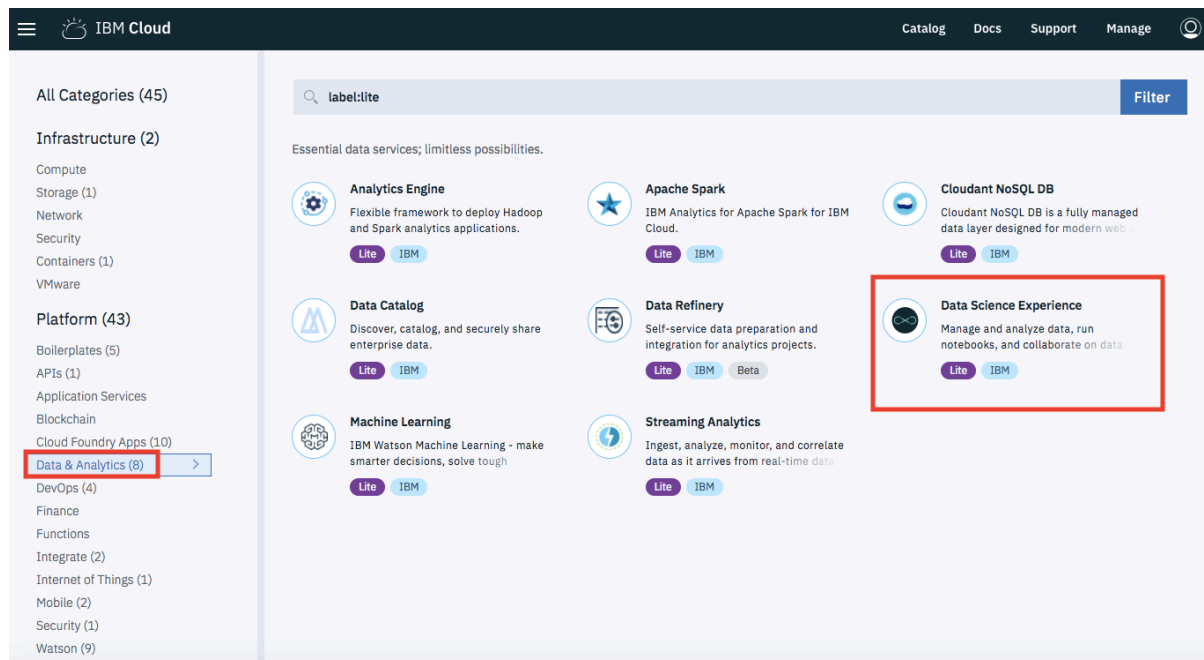
Once, you have logged in your IBM Cloud account, through <http://console.bluemix.net>, you will be landed on Dashboard.



As you are logging for the first time, you will not have any applications on your dashboard. Click on “**Create resource**” link. You will be taken to a “*Catalog*” page

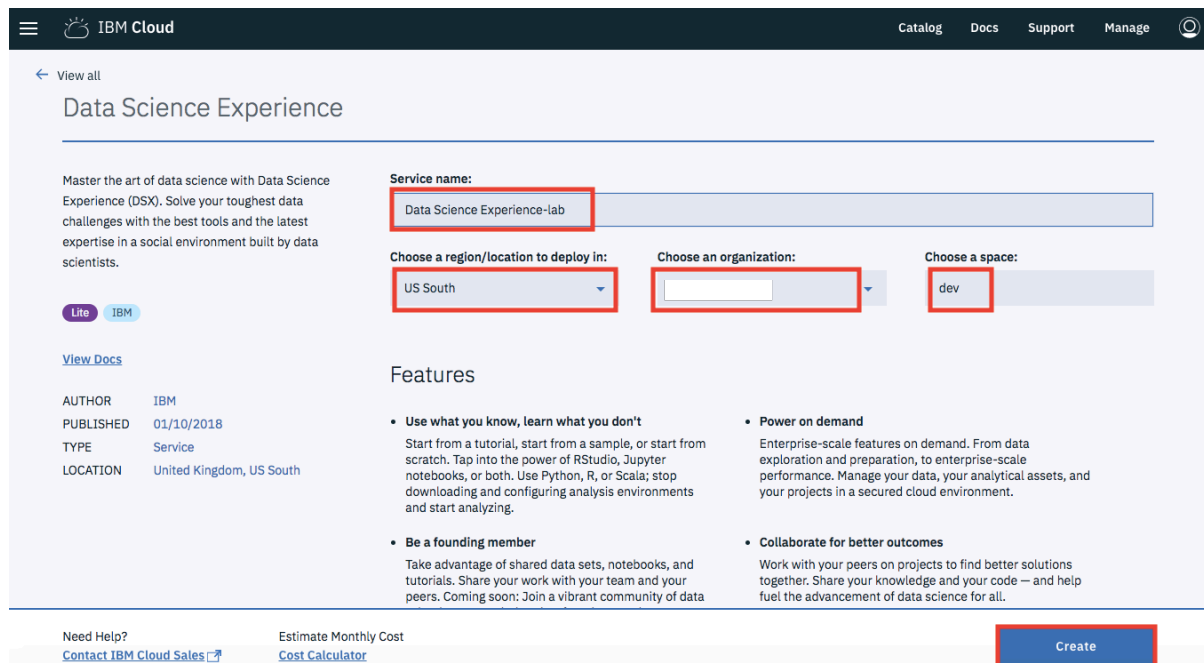


Select “Data & Analytics” Category from the left-hand side menu. Choose Data Science Experience



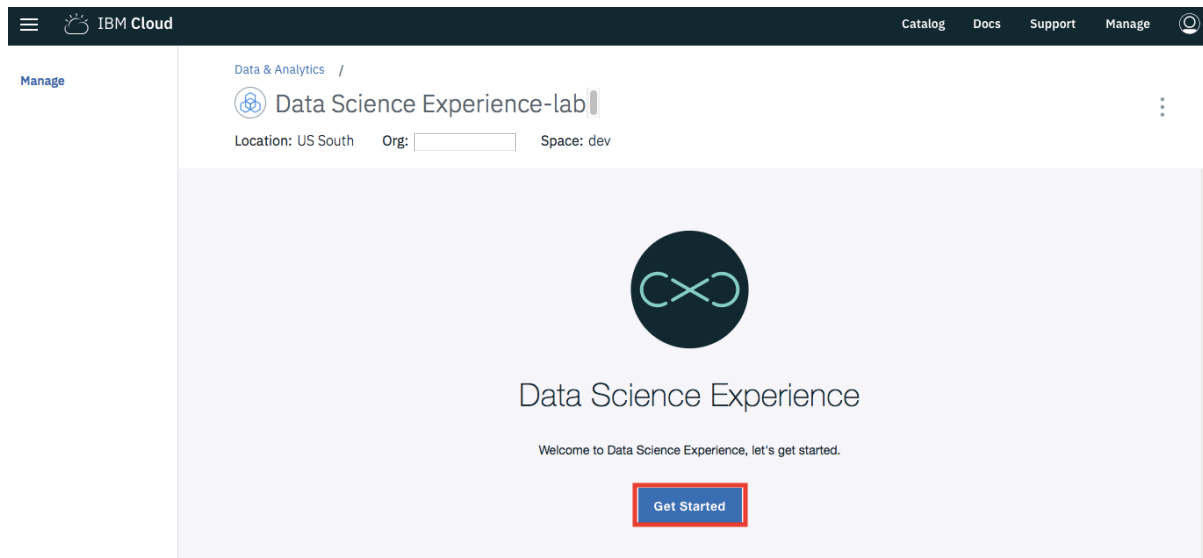
Once you click on Data Science Experience, you will be asked to give details on Service name and choose appropriate organization and space. After providing above details click on “Create” button.

*Note: Please ensure you are using US South as region for all services being created for this lab*

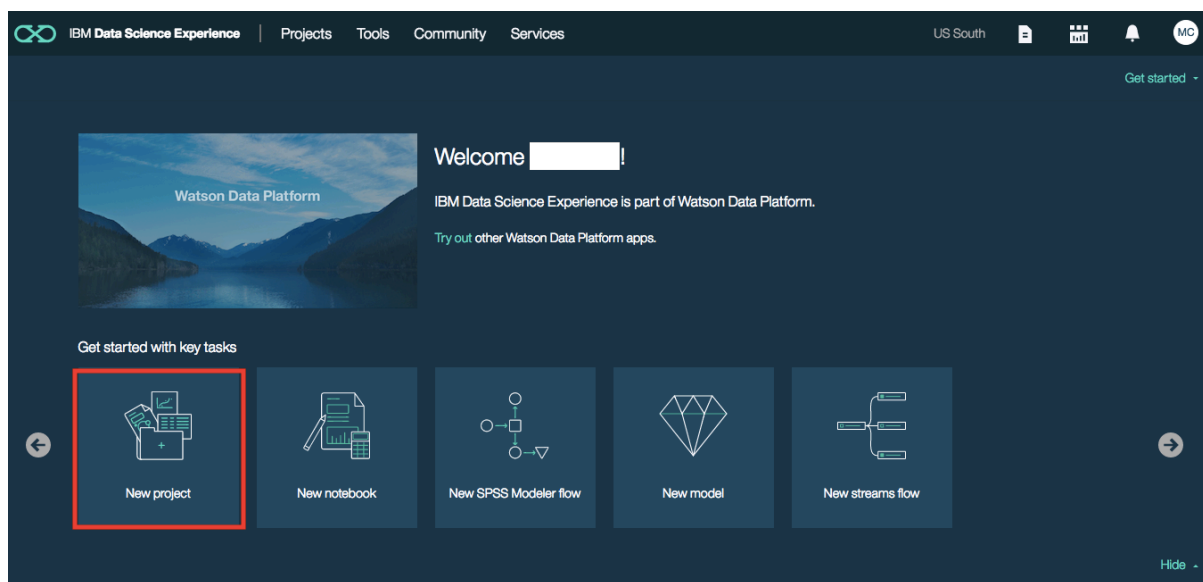


On successful creation of service, you will get to “Data Science Experience” Console launch page.





As soon as the 'Get Started' button is clickable, click it and you should be directed to the Data Science Experience dashboard as shown below.



Note that two IBM Cloud services will be created for you -- a Cloud Object Storage service and an Apache Spark service. (In case those are not created, Step 2 will cover creation of those services)

## Step 2: Create IBM Data Science Experience Service resources: Project, Services (Apache Spark and Cloud Object Storage)

In this part of the lab you will create a new project in IBM Data Science Experience and bind it to your instance of the Watson Machine Learning service.

1. From the dashboard, click on **"New project"** from the Get started with key tasks. Enter **"PredictHeartFailure"** as the project name and description Leave the other settings on their default value.

The screenshot shows the 'New project' form in IBM Data Science Experience. The 'Name' field is 'PredictHeartFailure' and the 'Description' is 'Predict heart failure with Watson Machine Learning'. The 'Define storage' section shows 'Select storage type' with 'IBM Cloud Object Storage' selected. The 'Define compute engine' section shows 'Select Spark service' with 'Add' button. The 'Choose project options' section has 'Restrict who can be a collaborator' checked. The 'Create' button is visible at the bottom right.

IBM Cloud services will be required

- a) Cloud Object Storage service and
- b) an Apache Spark service

Let's start creating these services

- a) Cloud Object Storage Service : Select Lite (Free) Plan for this Lab and Click on "Create"

The screenshot shows the 'Cloud Object Storage' page in IBM Data Science Experience. The 'New' tab is selected. The page shows the 'Cloud Object Storage' service description, features, and plans. The 'Lite and pay-as-you-go plans' section is highlighted.

**Pricing Plan:** Monthly Process shown above reflect the: **United States**

| Plan                                  | Features  | Pricing |
|---------------------------------------|---|---------|
| <input checked="" type="radio"/> Lite | 1 COS Service Instance<br>Storage up to 25 GB/mo.<br>Up to 20,000 GET requests/mo.<br>Up to 2,000 PUT requests/mo.<br>Up to Data Retrieval 10 GB/mo.<br>Up to 5GB Public Outbound<br>Applies to aggregate total across all storage bucket classes | Free    |
| <input type="radio"/> Standard        | There is no minimum fee, so you pay only for what you use.  | -       |

The Lite service plan for Cloud Object Storage includes Regional and Cross Regional resiliency, flexible data classes, and built in security.

Cancel **Create**

Click on “Create”

**Confirm Creation**

Plan  
☒ Lite

Resource group  
☒ Default

Service name

Cancel **Confirm**

On Confirmation “cloud-object-storage-lab” will be created.

## b) Apache Spark Service

**IBM Data Science Experience** | Projects Tools Community Services US South

### Apache Spark

Apache Spark is an open source cluster computing framework optimized for extremely fast and large scale data processing, which you can access via the newly integrated notebook interface IBM Analytics for Apache Spark. You can connect to your existing data sources or take advantage of the on-demand big data optimization of Object Storage. Spark plans are based on the maximum number of executors available to process your analytic jobs. Executors exist only as long as they're needed for processing, so you're charged only for processing done.

#### Features

- Incredibly Fast**  
Apache Spark delivers 100x the performance of Apache Hadoop for certain workloads because of its advanced in-memory computing engine.
- Easy to Use and Powerful**  
Apache Spark's Streaming and SQL programming models backed by MLlib and GraphX make it incredibly easy for developers and data scientists to build apps that exploit machine learning and graph analytics. Because the service is 100% compatible with Apache Spark, developers can build their apps and run them against the IBM managed service to benefit from operational, maintenance, and hardware excellence.
- Convenient Data Storage**  
Object Storage enables a convenient way to upload your data from a file for immediate use by your Spark instance. You can set up Object Storage directly from the Spark service interface.

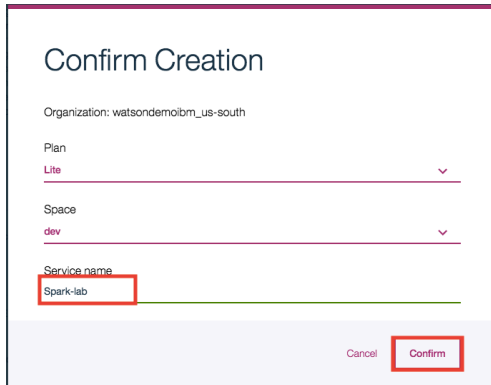
**Pricing Plan:** Monthly Process shown above reflect the: **United States**

| Plan                                  | Features          | Pricing |
|---------------------------------------|-------------------|---------|
| <input checked="" type="radio"/> Lite | 2 Spark Executors | Free    |

An entry level plan to run programs using up to 2 Spark executors

Terms

Cancel **Create**



**Confirm Creation**

Organization: watsondemoibm\_us-south

Plan  
Life

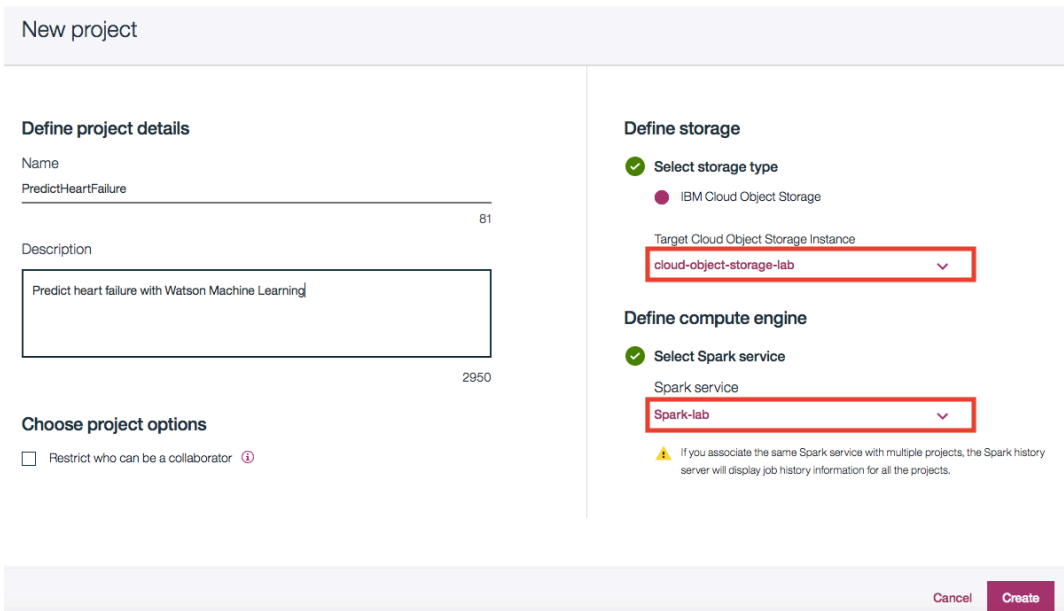
Space  
dev

Service name  
Spark-lab

Cancel Confirm

On Confirmation “spark-lab” will be created.

Go back to “View All Projects” and Select “PredictHeartFailure” Project, menu screen and Click on “Create” button



**New project**

**Define project details**

Name  
PredictHeartFailure

Description  
Predict heart failure with Watson Machine Learning

**Choose project options**

☐ Restrict who can be a collaborator

**Define storage**

Select storage type  
IBM Cloud Object Storage

Target Cloud Object Storage Instance  
cloud-object-storage-lab

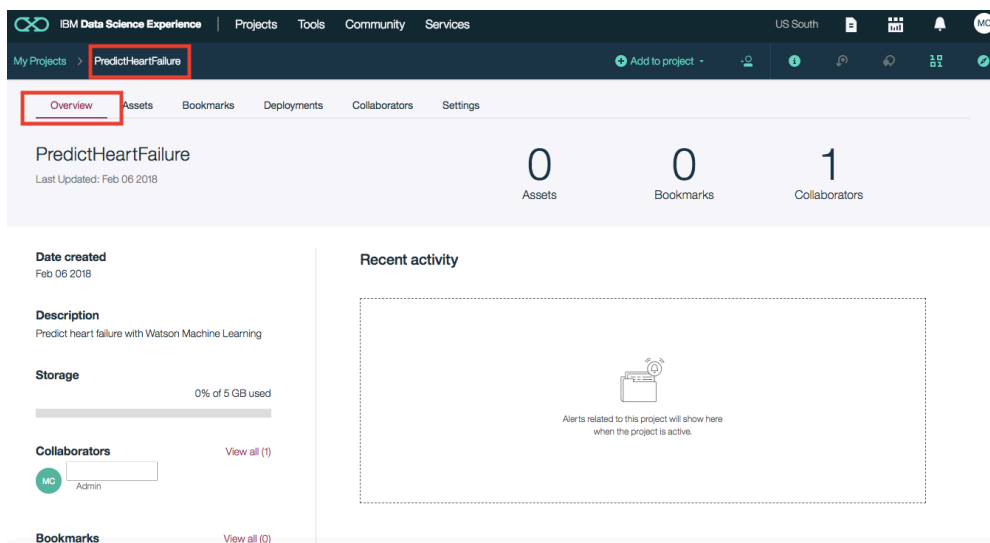
**Define compute engine**

Select Spark service  
Spark-lab

If you associate the same Spark service with multiple projects, the Spark history server will display job history information for all the projects.

Cancel Create

On successful creation of project, you will be on “Overview” page of created Project.



IBM Data Science Experience | Projects Tools Community Services

US South

My Projects > PredictHeartFailure

Overview Assets Bookmarks Deployments Collaborators Settings

**PredictHeartFailure**  
Last Updated: Feb 06 2018

0 Assets 0 Bookmarks 1 Collaborators

**Date created**  
Feb 06 2018

**Description**  
Predict heart failure with Watson Machine Learning

**Storage**  
0% of 5 GB used

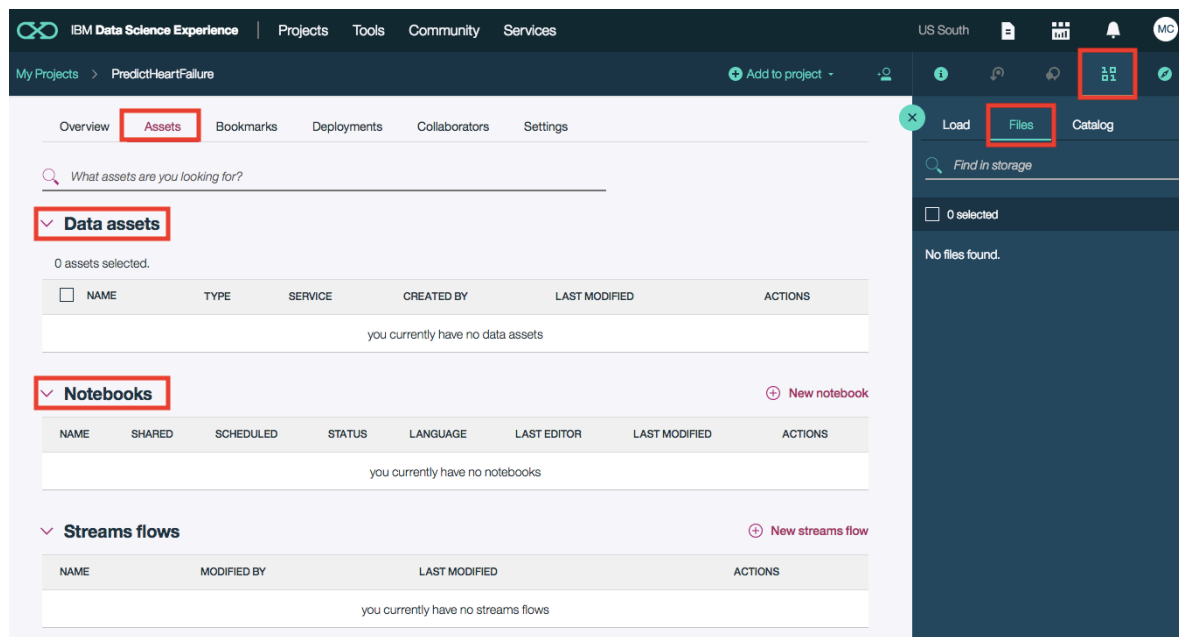
**Collaborators**  
View all (1)  
Admin

**Bookmarks**  
View all (0)

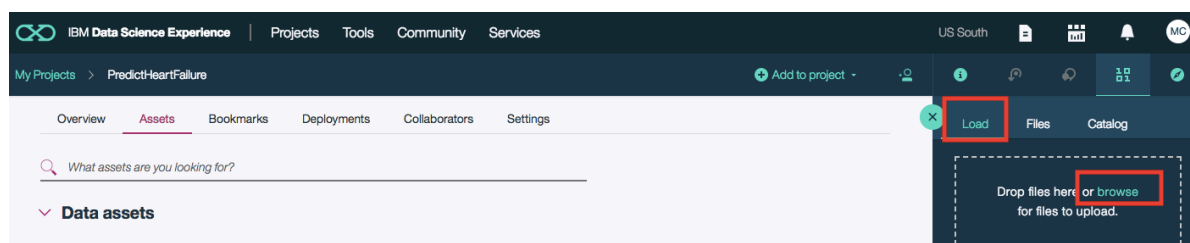
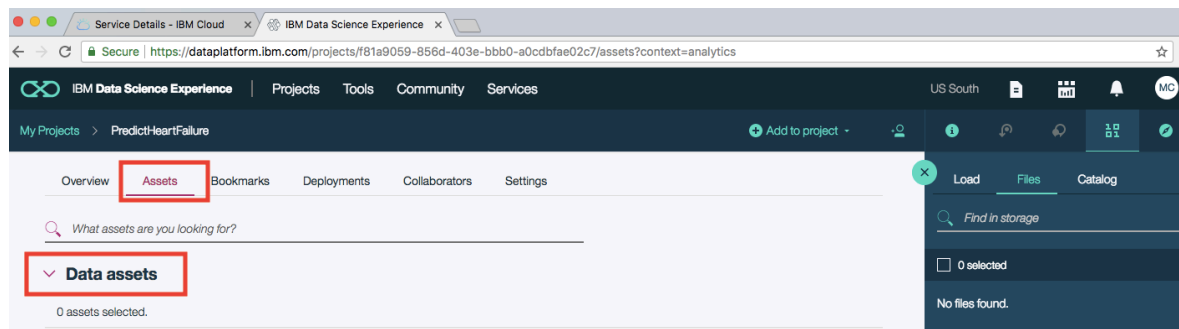
**Recent activity**

Alerts related to this project will show here when the project is active.

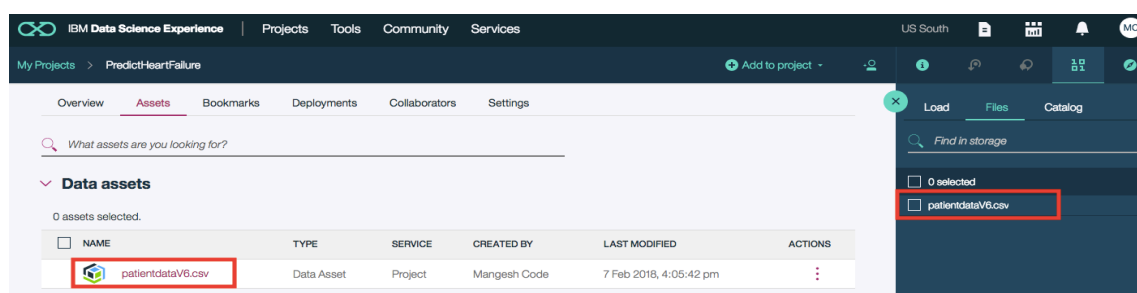
Click on “Assets” menu, all assets related to your project will be displayed here, like data assets, notebooks, etc.



On your laptop, browse to the location where you downloaded the file **patientdataV6.csv** in the section [Download patient data](#) of this lab. Select the file and click on Open (or the equivalent action for your operating system).



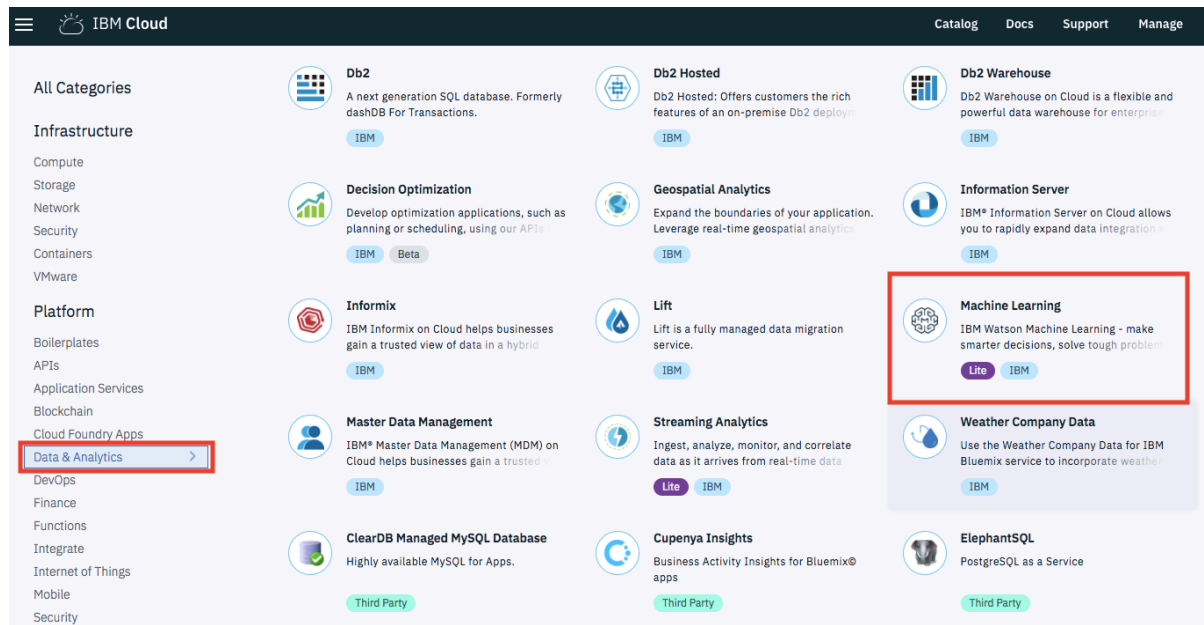
6. Once successfully uploaded, the file should appear in the **Data Assets** section.



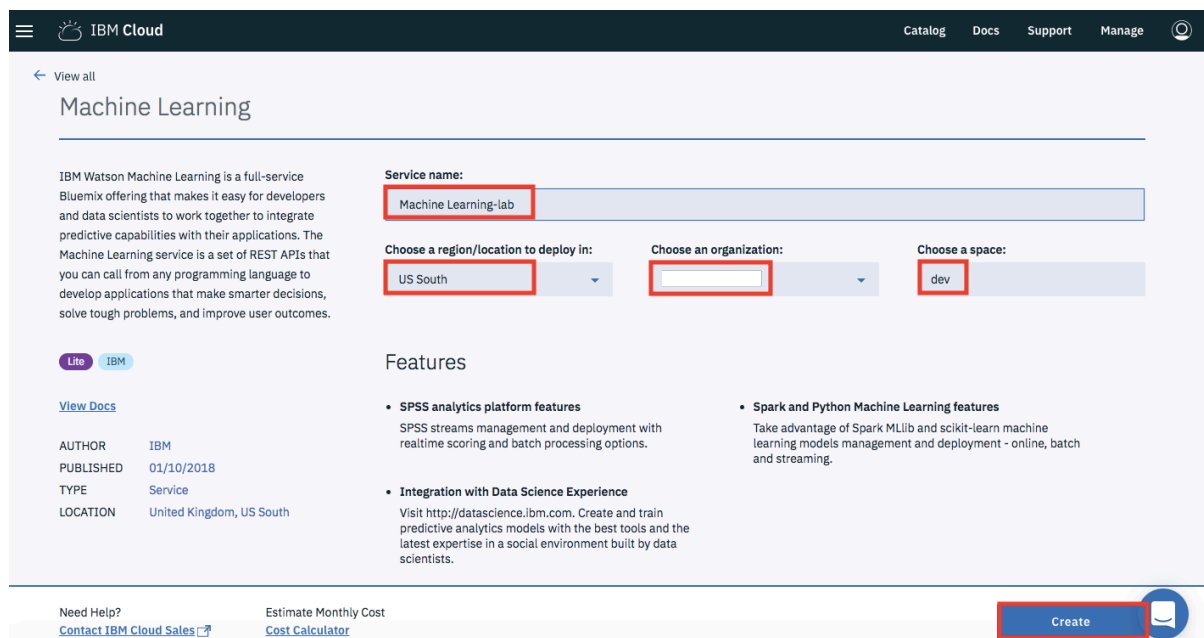
## Step 3: Create an instance of the Watson Machine Learning Service

In this part of the lab, you'll create an instance of the Watson Machine Learning service. In your browser go to the IBM Cloud Dashboard and click **Catalog**.

1. In the navigation menu at the left, select **Data & Analytics** (under **Platform**) and then select **Machine Learning**.



3. In the **Choose a region/location** drop-down, select the **US South** where deployed earlier Data Science Service.



4. Verify this service is being created in the same space as the app in Step 2.

Verify :

- On Successful creation of Step 1, Step 2 and Step3, your IBM Cloud Dashboard should have following services created.

The screenshot shows the IBM Cloud Dashboard interface. At the top, there's a navigation bar with 'Catalog', 'Docs', 'Support', and 'Manage'. Below this, the 'Dashboard' section is visible, showing filters for 'RESOURCE GROUP' (All Resources), 'REGION' (US South), 'CLOUD FOUNDRY ORG' (mancodefebdx), and 'CLOUD FOUNDRY SPACE' (dev). A 'Create resource' button is on the right.

The 'Cloud Foundry Services' section shows 3/2000 Used. It contains a table with the following data:

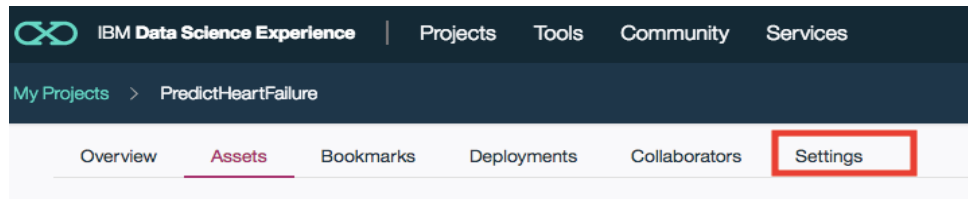
| Name                        | Service Offering        | Plan |
|-----------------------------|-------------------------|------|
| Data Science Experience-lab | Data Science Experience | Lite |
| Machine Learning-lab        | Machine Learning        | Lite |
| Spark-lab                   | Apache Spark            | Lite |

The 'Services' section shows 1 service. It contains a table with the following data:

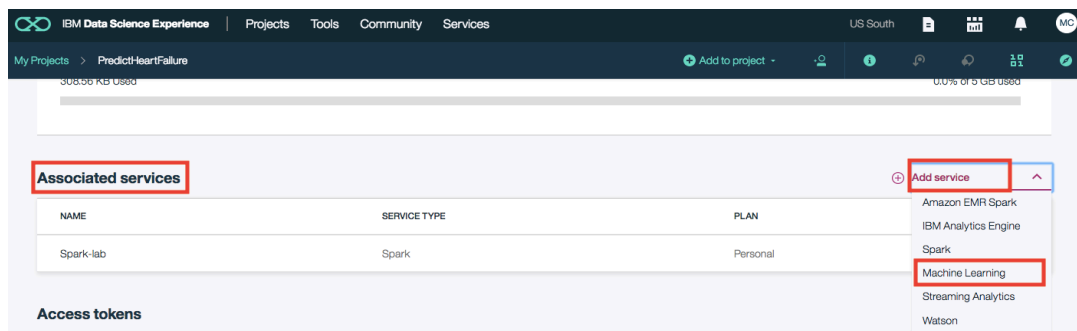
| Name                     | Resource Group | Service Offering     | Plan | Details     |
|--------------------------|----------------|----------------------|------|-------------|
| cloud-object-storage-lab | Default        | Cloud Object Storage | Lite | Provisioned |

## Step 4: Bind Data Science Experience Service to your Watson Machine Learning service instance

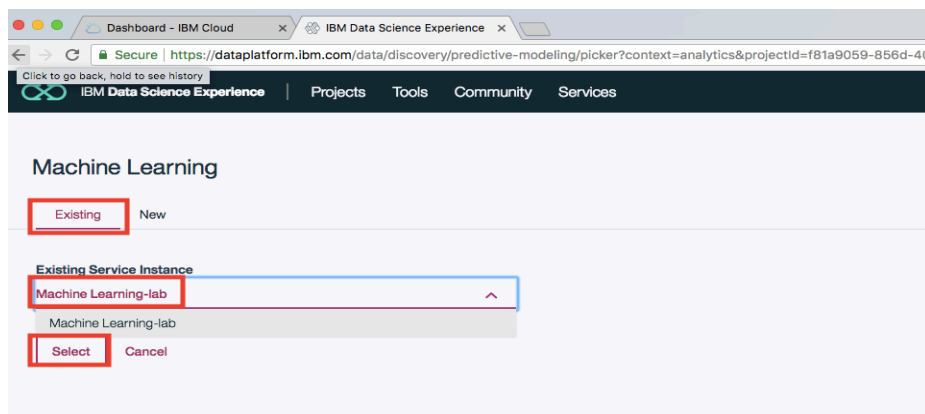
Go Back to IBM Data Science Exercise Home page. Go to “PredictHeartFailure” Project. Click on **Settings** for the project.



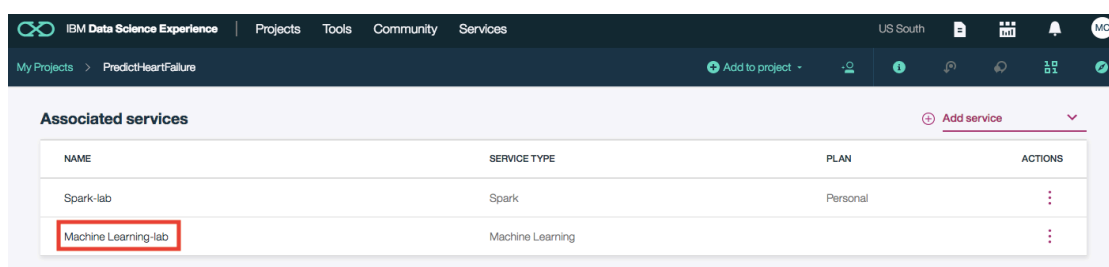
9. Click on add associated service and select **Machine Learning**



10. Choose your existing Machine Learning instance and click on **Select**.



11. Click on your browser's Back button and verify that the Watson Machine Learning service is now listed as one of your **Associated Services**.



12. Leave the browser tab open for later.



## Step 5: Save the credentials for your Watson Machine Learning Service

In this part of the lab you'll save the credentials for your Watson Machine Learning instance so you can use it later in your code.

1. In a different browser tab go to <http://console.bluemix.net> and log in to the Dashboard
2. Click on your Watson Machine Learning instance under **Services**.

Services (4) 4/10 Used

| NAME                | SERVICE OFFERING    | PLAN              | ACTIONS |
|---------------------|---------------------|-------------------|---------|
| Continuous Delivery | Continuous Delivery | Free (Deprecated) | ⋮       |
| DSX-ObjectStorage   | Object Storage      | Lite              | ⋮       |
| DSX-Spark           | Apache Spark        | Lite              | ⋮       |
| Machine Learning-yu | Machine Learning    | Free              | ⋮       |

3. Click on **Service credentials** and then on **View credentials** to see the credentials.

Service credentials

| KEY NAME      | DATE CREATED           | ACTIONS          |
|---------------|------------------------|------------------|
| Credentials-1 | Feb 7, 2018 - 04:26:37 | View credentials |

```

{
  "url": "https://ibm-watson-ml.mybluemix.net",
  "access_key": "oBkEVqarK0JD7b8oA8AkXd0HEYS1D3imvzWXFH0S3QKD208hHZk294op0vnFvUI0HxGxQ3pIogjgE0jN0TGDtCL0h32gVzPkWmBmHXNpi+FQYUqQmv73SQJrb1WXWeZv",
  "username": "a291b62f-b641-4e52-8124-69cd5a7beb92",
  "password": "448066c3-7464-4a32-9fd9-04c88f181267",
  "instance_id": "1590ffff-119e-486f-b644-f6ef42b134c3"
}

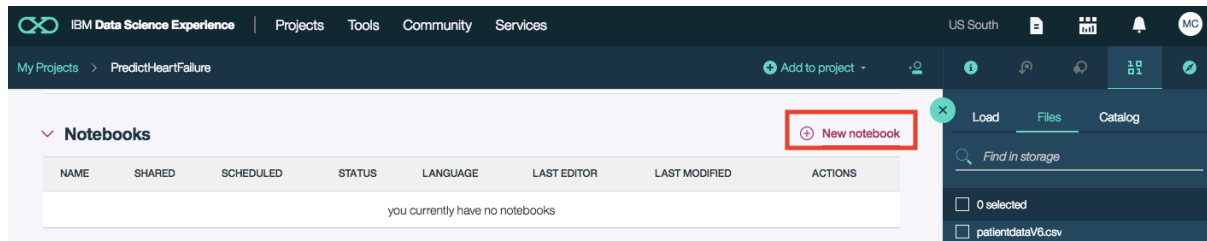
```

4. Save the username and password to a text file on your machine. You'll need this information later in your Jupyter notebook.

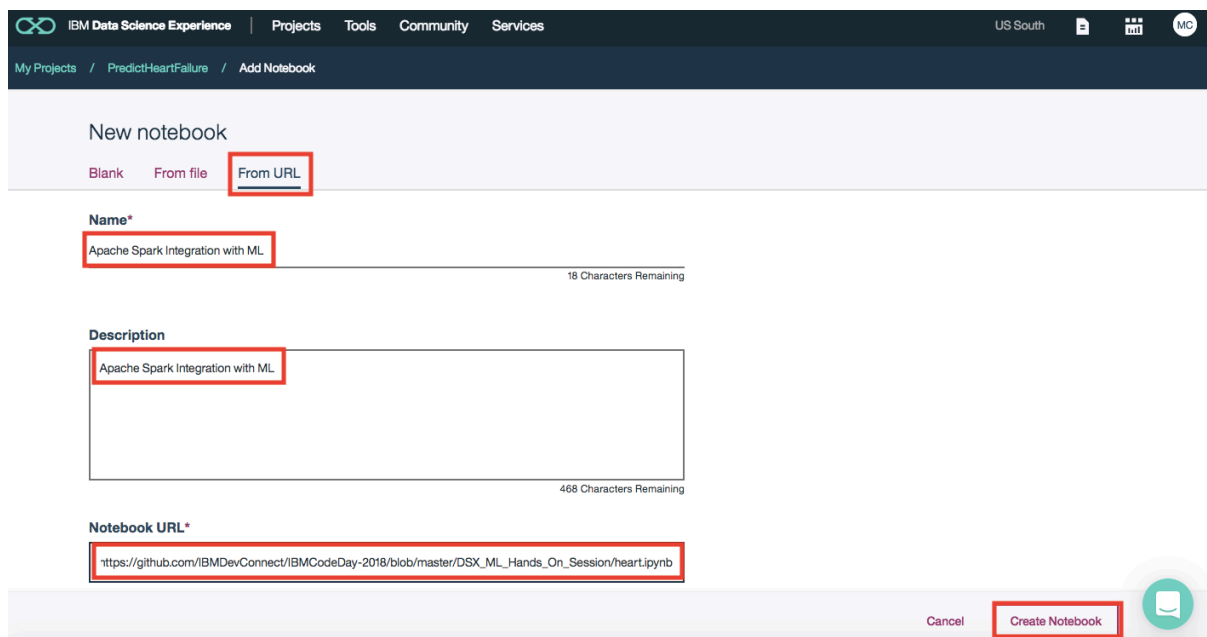
## Step 6: Create a notebook in IBM Data Science Experience

In this part of the lab you'll create a Jupyter notebook and import the code to create a predictive model.

1. Open created Project, first click **Projects -> View All Projects**, and then select your newly created project "PredictHeartFailure" from Step 4. Next, in the Data Science Experience browser tab click on **Overview** and then click **add notebooks**.



2. Click on **From URL** and name the notebook *Apache Spark integration with Watson ML*.
3. Under **Notebook URL** provide the following URL : [heart.ipynb](https://github.com/IBMDevConnect/IBMDCodeDay-2018/tree/master/DSX_ML_Hands_On_Session/heart.ipynb)  
[https://github.com/IBMDevConnect/IBMDCodeDay-2018/tree/master/DSX\_ML\_Hands\_On\_Session/heart.ipynb]



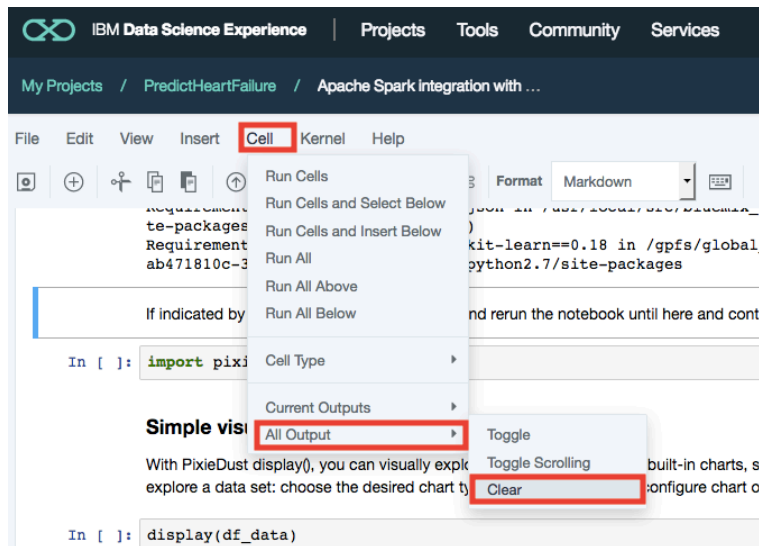
4. Click **Create Notebook** to create the new notebook.
5. Leave your browser tab open for the next part.

## Step 7: Run the notebook in IBM Data Science Experience

In this part of the lab you will run the Jupyter Notebook code creating a predictive model, and save it in the Watson Machine Learning Service.

### Note:

*Clear the output in case ran before*

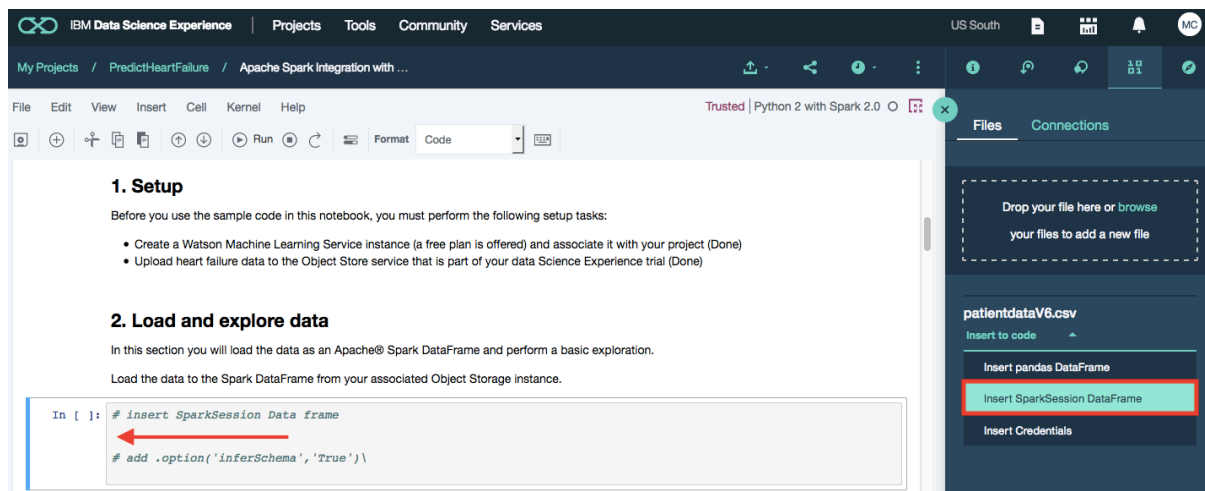


Following steps will be followed in Notebook, which was imported from URL.

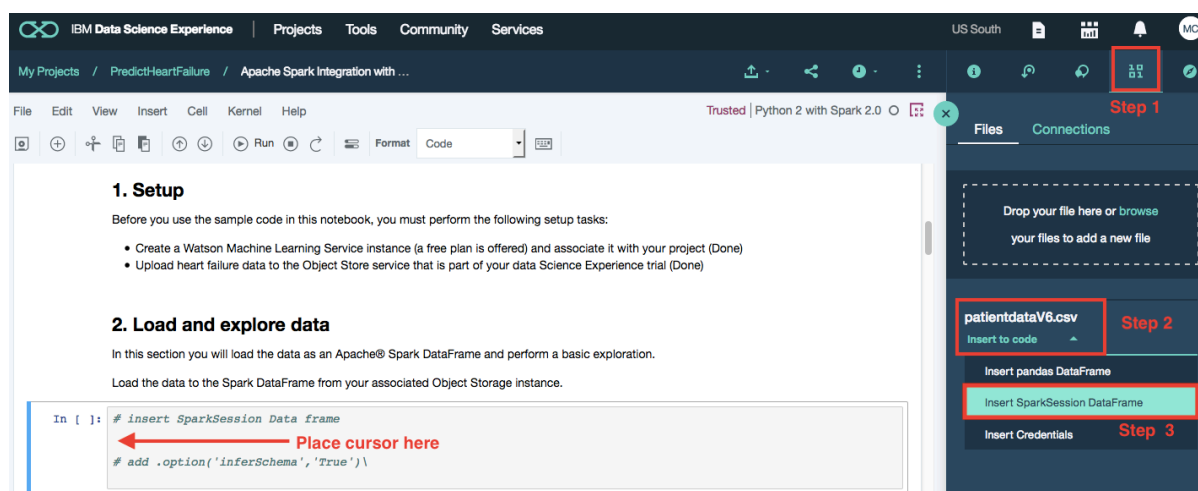
### 1. Setup (Completed) :

- Create a Watson Machine Learning Service instance (a free plan is offered) and associate it with your project (Done)
- Upload heart failure data to the Object Store service that is part of your data Science Experience trial (Done)

### 2. Place your cursor in this block in the notebook. Import existing data set.



Click on the **Find and Add data** icon -- see *step 1* in diagram below -- and then select **Insert to code** under the file **patientdataV6.csv**. This is *step 2* in diagram below. Finally select **Insert SparkSession DataFrame Credentials** -- which is *step 3* in diagram below.



After auto insertion of credentials, do following changes

- change `df_data_1` to `df_data`
- add one more option as `.option('inferSchema','True')`

```
import ibmos2spark

# @hidden_cell
credentials = {
    'endpoint': 'https://s3-api.us-geo.objectstorage.service.networklayer.com',
    'api_key': 'H0wXyItZZPqEiaXqaA9M50RNj-vD8wjJokVxErEKy7Ww',
    'service_id': 'iam-ServiceId-bc1d9355-b9d1-48be-968a-c1894ac37d7c',
    'iam_service_endpoint': 'https://iam.ng.bluemix.net/oidc/token'}

configuration_name = 'os_69e6f853ef384782888308cb979fb0b9_configs'
cos = ibmos2spark.CloudObjectStorage(sc, credentials, configuration_name, 'bluemix_cos')

from pyspark.sql import SparkSession
spark = SparkSession.builder.getOrCreate()
df_data = spark.read\
    .format('org.apache.spark.sql.execution.datasources.csv.CSVFileFormat')\
    .option('header', 'true')\
    .option('inferSchema', 'True')\
    .load(cos.url('patientdataV6.csv', 'predictheartfailure3e016fa9337a416ab99ded3a85a42b6d'))
df_data.take(5)
```

- Load and explore data : In this section you will load the data as an Apache® Spark DataFrame and perform a basic exploration like, check schema , check number of records , check data.

Explore the loaded data by using the following Apache® Spark DataFrame methods:

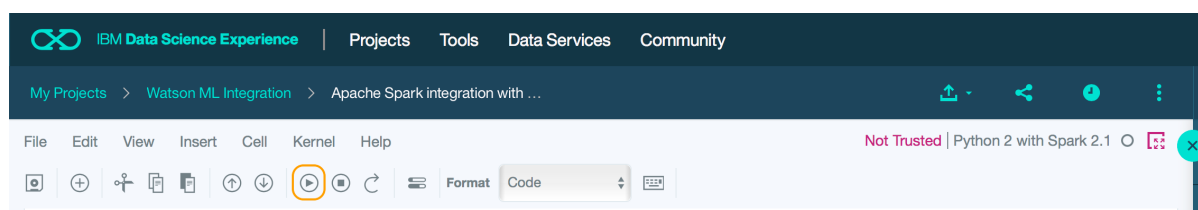
- print schema

Note: As you can see, the data contains ten fields. The HEARTFAILURE field is the one we would like to predict (label).

- print top ten records
- count all records : As you can see, the data set contains 10800 records.

Load the data to the Spark DataFrame from your associated Object Storage instance.

- Click on the **Run** icon to run the code in the cell.



Move your cursor to each code cell and run the code in it. Read the comments for each cell to understand what the code is doing. **Important** when the code in a cell is still running, the label to the left changes to **In [\*]**. Do **not** continue to the next cell until the code is finished running.

5. You can also see some visualizations on the existing data set with Pixie.

For that Interactive Visualizations w/PixieDust

- a) PixieDust Install packages
- b) Simple visualization using bar charts

With PixieDust `display()`, you can visually explore the loaded data using built-in charts, such as, bar charts, line charts, scatter plots, or maps. To explore a data set: choose the desired chart type from the drop down, configure chart options, configure display options.

6. Create an Apache® Spark machine learning model

In this section, you will learn how to prepare data, create and train an Apache® Spark machine learning model.

4.1: Prepare data : In this subsection, you will split your data into: train and test data sets.

You will split the data set into training set and test set because once we trained the model we would want to test it with some data. This is done as a random split.

You will see output as:

Number of training records: 8637

Number of testing records : 2163

4.2: Create pipeline and train a model

In this section, you will create an Apache® Spark machine learning pipeline and then train the model. In the first step you need to import the Apache® Spark machine learning packages that will be needed in the subsequent steps.

A sequence of data processing is called a *data pipeline*. Each step in the pipeline processes the data and passes the result to the next step in the pipeline, this allows you to transform and fit your model with the raw input data

you can train your Random Forest model by using the previously defined **pipeline** and **training data**. You can check your **model accuracy** now. To evaluate the model, use **test data**.

Accuracy = 0.867314

Test Error = 0.132686

You can tune your model now to achieve better accuracy. For simplicity of this example tuning section is omitted.

Continue running each cell until you reach to a step where it says, **Stop here !!!!** in a notebook.

## 7. Persist model

In this section, you will learn how to store your pipeline and model in Watson Machine Learning repository by using Python client libraries.

## 8. Authenticate to Watson Machine Learning service on IBM Cloud.

When you get to the cell that says **Stop here !!!!** insert the username and password that you saved from your Watson Machine Learning instance into the code before running it.

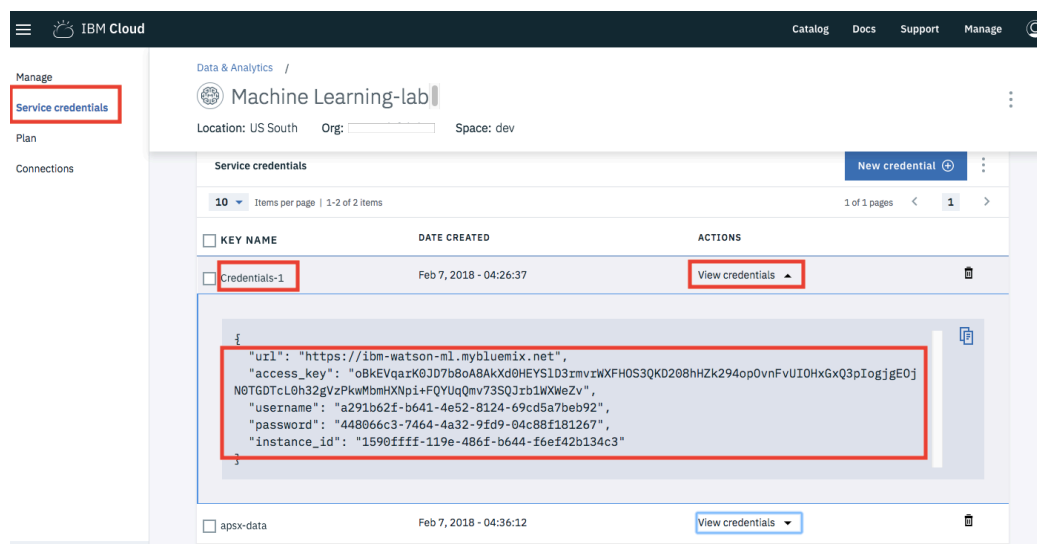
Authenticate to Watson Machine Learning service on IBM Cloud.

**STOP here !!!!:**

Put authentication information (username and password) from your instance of Watson Machine Learning service here.

```
In [ ]: wml_url = 'https://ibm-watson-ml.mybluemix.net'
        username = 'a291b62f-b641-4e52-8124-69cd5a7beb92'
        password = '448066c3-7464-4a32-9fd9-04c88f181267'
        instance_id = '1590ffff-119e-486f-b644-f6ef42b134c3'
```

Note this credentials from Watson Machine Learning Service created earlier in Step 3



At end of this step

Heart Failure Prediction Model

Congratulations. You've successfully created a predictive model and saved it in the Watson Machine Learning service.

## Step 8: Accessing Watson ML Models and Deployments through API

### Get Details about currently published model id

Get the deployment details as this stage

```
In [34]: print('{} model(s) are available in your Watson ML Service'.format(published_models['count']))
for model in published_models['resources']:
    print('\t- name: {}'.format(model['entity']['name']))
    print('\t model_id: {}'.format(model['metadata']['guid']))
    print('\t deployments: {}'.format(model['entity']['deployments']['count']))

1 model(s) are available in your Watson ML Service
- name: Heart Failure Prediction Model
  model_id: c5e100fb-3892-4056-8c90-f1d7849f96b3
  deployments: 0
```

Create a new deployment of the Model

### Create a new deployment of the Model

Change the model\_id to above model\_id and Run this Step

```
Create a new deployment of the Model

In [ ]: model_id = 'c5e100fb-3892-4056-8c90-f1d7849f96b3'

deployment_url = wml_url + "/v3/wml_instances/" + instance_id + "/published_models/" + model_id + "/deployments"

payload = {"name": "Heart Failure Prediction Model", "description": "First deployment of Heart Failure Prediction Model", "type": "online"}
headers = {'authorization': 'Bearer ' + watson_ml_token, 'content-type': 'application/json'}

response = requests.request("POST", deployment_url, data=payload, headers=headers)

print(response.text)
```

### Monitor the status of Deployment

```
In [34]: deployment = json.loads(response.text)

print('Model {} deployed.'.format(model_id))
print('\tname: {}'.format(deployment['entity']['name']))
print('\tdeployment_id: {}'.format(deployment['metadata']['guid']))
print('\tstatus: {}'.format(deployment['entity']['status']))
print('\tscore url: {}'.format(deployment['entity']['scoring_url']))

Model c5e100fb-3892-4056-8c90-f1d7849f96b3 deployed.
- name: Heart Failure Prediction Model
  deployment_id: b53bc50b-2db5-4640-abc9-b92c78dc0d99
  status: INITIALIZING
  scoring url: https://ibm-watson-ml.mybluemix.net/v3/wml_instances/1590ffff-119e-486f-b644-f6ef42b134c3/published_models/c5e100fb-3892-4056-8c90-f1d7849f96b3/deployments/b53bc50b-2db5-4640-abc9-b92c78dc0d99/online
```

Monitor the status of deployment

Note scoring\_url from this step

```
In [38]: deployment_details = json.loads(response.text)

for resources in deployment_details['resources']:
    print('name: {}'.format(resources['entity']['name']))
    print('status: {}'.format(resources['entity']['status']))
    print('scoring url: {}'.format(resources['entity']['scoring_url']))

name: Heart Failure Prediction Model
status: ACTIVE
scoring url: https://ibm-watson-ml.mybluemix.net/v3/wml_instances/1590ffff-119e-486f-b644-f6ef42b134c3/published_models/c5e100fb-3892-4056-8c90-f1d7849f96b3/deployments/0fe68bcf-aaf3-4890-bbb2-d6b5abfc1ae7/online
```

## Invoke prediction model deployment

### 6.3 Invoke prediction model deployment

Define a method to call scoring url. Replace the `scoring_url` in the method below with the `scoring_url` returned from above.

```
In [39]: def get_prediction_ml(ahb, ppd, chol, bmi, age, sex, fh, smoker, exercise_minutes):
scoring_url = "https://ibm-watson-ml.mybluemix.net/v3/wml_instances/1590ffff-119e-486f-b644-f6ef42b134c3/pml"
scoring_payload = { "fields":["AVGHEARTBEATSPERMIN","PALPITATIONSPERDAY","CHOLESTEROL","BMI","AGE","SEX","FH"]
header = { "authorization": "Bearer " + watson_ml_token, "content-type": "application/json" }
scoring_response = requests.post(scoring_url, json=scoring_payload, headers=header)
print(scoring_response.text)
return (json.loads(scoring_response.text).get("values"))[0][12])
```

And Finally, Call `get_prediction_ml` method exercising our prediction model

```
print('Is a 44 year old female that smokes with a low BMI at risk of Heart Failure?:
{}'.format(get_prediction_ml(100,85,242,24,44,"F","Y","Y",125)))
```

#### RESULT:

Is a 44 year old female that smokes with a low BMI at risk of Heart Failure?: 1.0

If the value is 1.0: Means There are chances of Heart Failure and If the value is 0.0 Then No Heart Failure predicted.

Test this for another set of data:

```
print('Is a 42 year old male that smokes with a low BMI at risk of Heart Failure?:
{}'.format(get_prediction_ml(100,85,178,22,42,"M","N","N",45)))
```

Is a 42 year old male that smokes with a low BMI at risk of Heart Failure?: 0.0

#### RESULT:

No Heart Failure predicted as value is 0.0

Congratulations, you successfully created a predictive model in Apache Spark and deployed and tested it using the Watson Machine Learning Service in IBM Cloud 😊!



## Additional links

- More data science journeys on IBM Code: <https://developer.ibm.com/code/journey/category/data-science/>
- IBM Data Science Experience: <https://www.ibm.com/analytics/us/en/watson-data-platform/data-science-experience/>
- Watson Data Platform: <https://www.ibm.com/analytics/us/en/watson-data-platform/>