

## **Lab Center – Hands-on Lab**

**Session #3259**

**Session Title: Introduction to Data Science using Watson Studio**

**Lab-2: Deploy a Continuous Machine Learning Model using Watson Studio**

Bernard Beekman, IBM, [beekmanb@us.ibm.com](mailto:beekmanb@us.ibm.com)

Michael Cronk, IBM, [michael.cronk@ibm.com](mailto:michael.cronk@ibm.com)

## Table of Contents

Disclaimer .....	3
Introduction .....	5
Step 1: Upload a New Data Asset.....	5
Step 2: Train, Compare, and Select a Machine Learning Model .....	7
Step 3 Set up Continuous Learning Model Capabilities .....	12
Step 4 Deploy a Machine Learning Model. ....	18
We Value Your Feedback!.....	25

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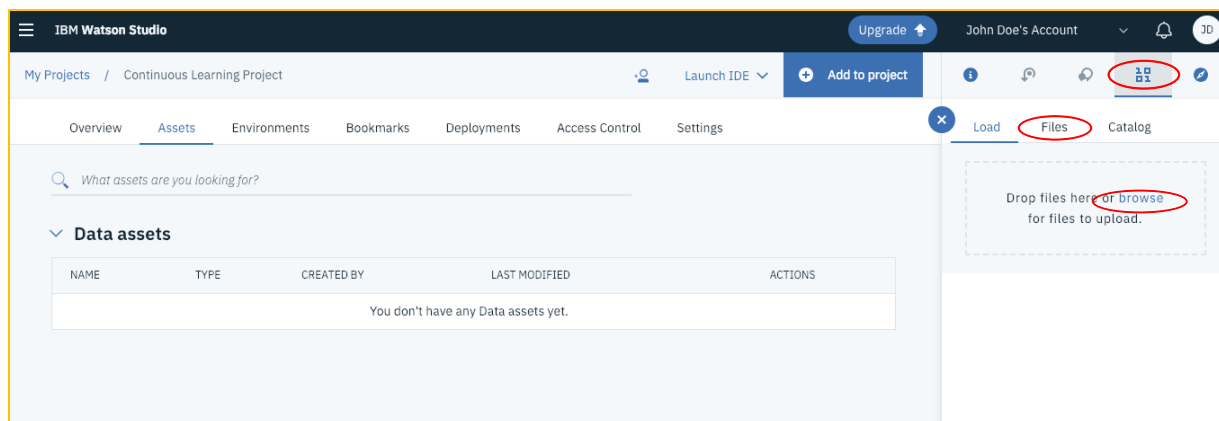
## Introduction

In this lab, you will be using building a machine learning model to predict the appropriate drugs to treat patients with heart disease. This model will be deployed and made available online allowing any medical professional to see a list of drugs considered the most appropriate for each of their patients. That said, the doctors will still have the final decision. You are starting with a small dataset and will continue to be provided with data on a daily basis. Continuous learning will be set up to monitor the model performance and ensure the highest performing model is always available for doctors to use.

### Step 1: Upload a New Data Asset.

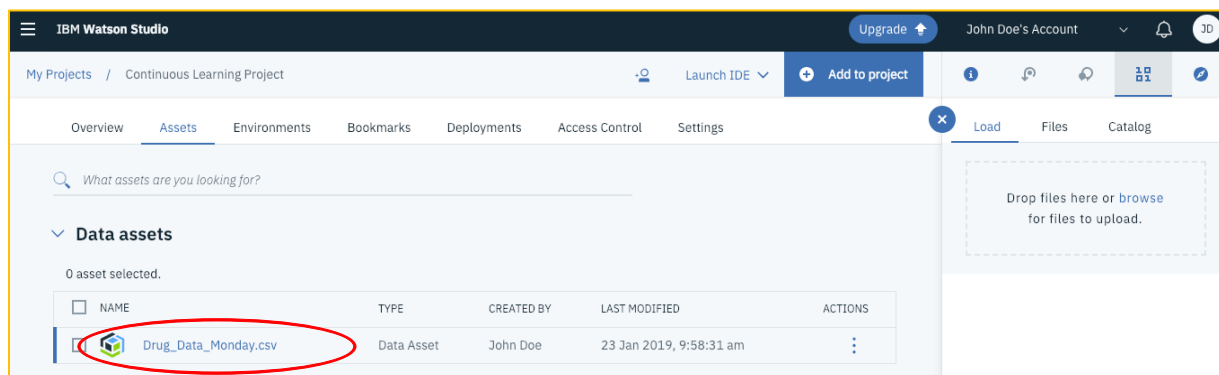
Before we build our models, we need to load data into our project.

1. Open [Continuous Learning Data](#)
2. Save the zip file to your desktop and unzip the contents.
3. Return to Watson Studio. In the top right of the screen, click the blue icon with 1's and 0's. This will open the data pallet.
4. Click on Load, browse, select the Drug\_Data\_Monday.csv file and click open.



The CSV file should now be listed under “Data assets.” It is now accessible by the Watson Studio modeling tools and applications.

5. Click on Drug\_Data\_Monday.csv under Data assets.



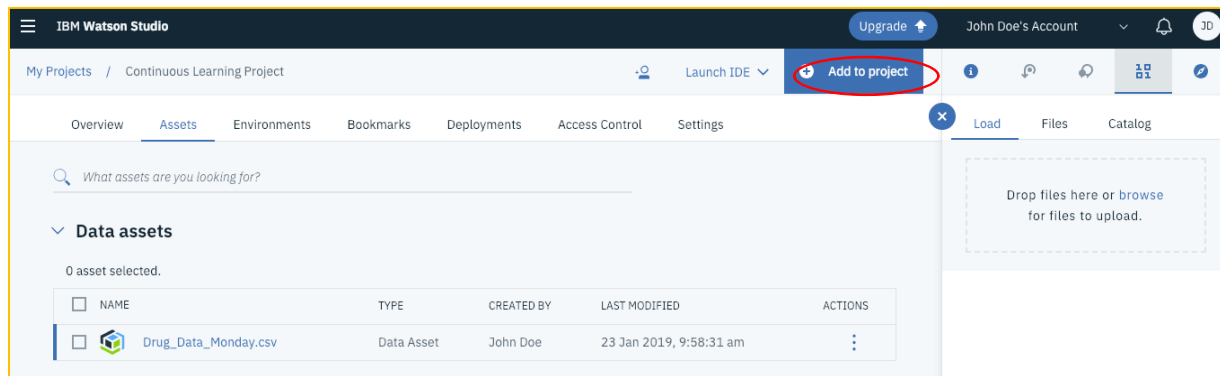
After clicking on Drug\_Data\_Monday.csv, you are brought to a data view. Once you are satisfied that this is the data you want, click on your project name to return to your project's assets.

The screenshot displays the IBM Watson Studio interface. At the top, the navigation bar includes 'My Projects' and 'Continuous Learning Project' (highlighted with a red circle). Below the navigation bar, the 'Preview' tab is active, showing a data table with 7 columns: AGE, SEX, BP, CHOLESTEROL, NA, K, and DRUG. The table contains 181 rows of data. To the right of the table, a sidebar provides details for the 'Drug\_Data\_Monday.csv' data asset, including its description, tags, and metadata (Added: 02:58 PM UTC, 2019/01/23; Size: 7.467 KB).

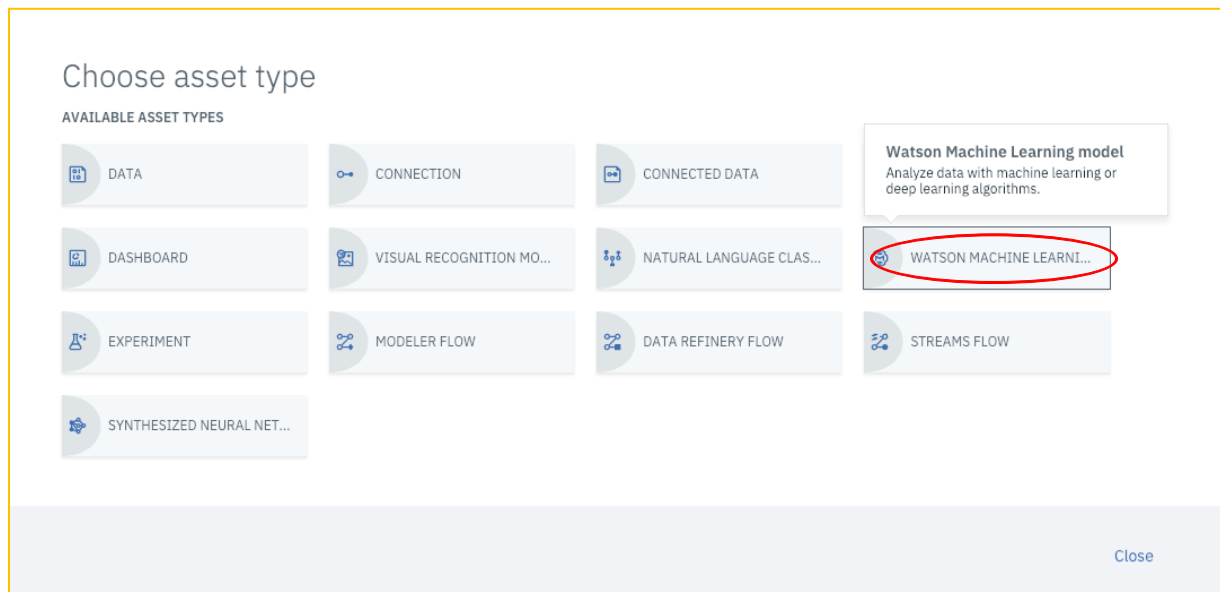
AGE <small>Type: String</small>	SEX <small>Type: String</small>	BP <small>Type: String</small>	CHOLESTEROL <small>Type: String</small>	NA <small>Type: String</small>	K <small>Type: String</small>	DRUG <small>Type: String</small>
43	M	HIGH	HIGH	0.656371	0.046979	drugA
32	M	HIGH	NORMAL	0.52975	0.056087	drugA
37	F	HIGH	HIGH	0.559171	0.042713	drugA
24	M	HIGH	NORMAL	0.613261	0.064726	drugA
29	M	HIGH	HIGH	0.625272	0.048637	drugA
36	F	HIGH	HIGH	0.734119	0.065556	drugA
19	F	HIGH	HIGH	0.516973	0.038832	drugA
38	F	HIGH	NORMAL	0.733842	0.064793	drugA
31	M	HIGH	NORMAL	0.695183	0.058559	drugA
45	F	HIGH	HIGH	0.547821	0.042619	drugA
50	M	HIGH	HIGH	0.518285	0.069193	drugA
32	F	HIGH	NORMAL	0.724375	0.070383	drugA
35	F	HIGH	HIGH	0.869854	0.06746	drugA

## Step 2: Train, Compare, and Select a Machine Learning Model

1. Click on Add to project.



2. Click on Watson Machine Learning model.



We are creating a model using a point-and-click UI called “Model builder” but can also create models through, APIs, notebooks, SPSS flows, Deep Learning flows, or the synthesized neural network tooling.

3. Enter a Name and a Description, select Default Spark Scala 2.11 under runtime, select Manual, and click Create.

IBM Watson Studio

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### New model

Name: Best Heart Drug Model

Description: Model description

Machine Learning Service: pm-20-ww

☒ Model builder ☐ From file ☐ From sample

Select runtime: Default Spark Scala 2.11

The selected runtime uses one driver with 1 vCPU and 4 GB RAM, and 2 executors each with 1 vCPU and 4 GB RAM. This runtime consumes 1.5 capacity units per hour.

⚠️ Your Spark runtime will be automatically stopped when you save your model, or after 3 hours of inactivity. To avoid consuming extra capacity unit hours delete your model builder instance or [stop your runtime](#) when you are finished with it.

[Learn more](#) about capacity unit hours and Watson Studio pricing plans.

**Automatic**  
Prepare my data and create a model automatically

**Manual**  
Let me prepare my data and select which models to train

Need something more flexible? Create a [notebook](#) or design a [Modeler flow](#)

Cancel **Create**

- You will be brought to a “Select data asset” page. Select `Drug_Data_Monday.csv` as our data asset and click Next.

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My Projects / Continuous Learning Project / Best Heart Drug Model

### Select data asset

The model builder currently supports CSV files and IBM Db2 Warehouse on Cloud data assets.

What asset are you looking for?

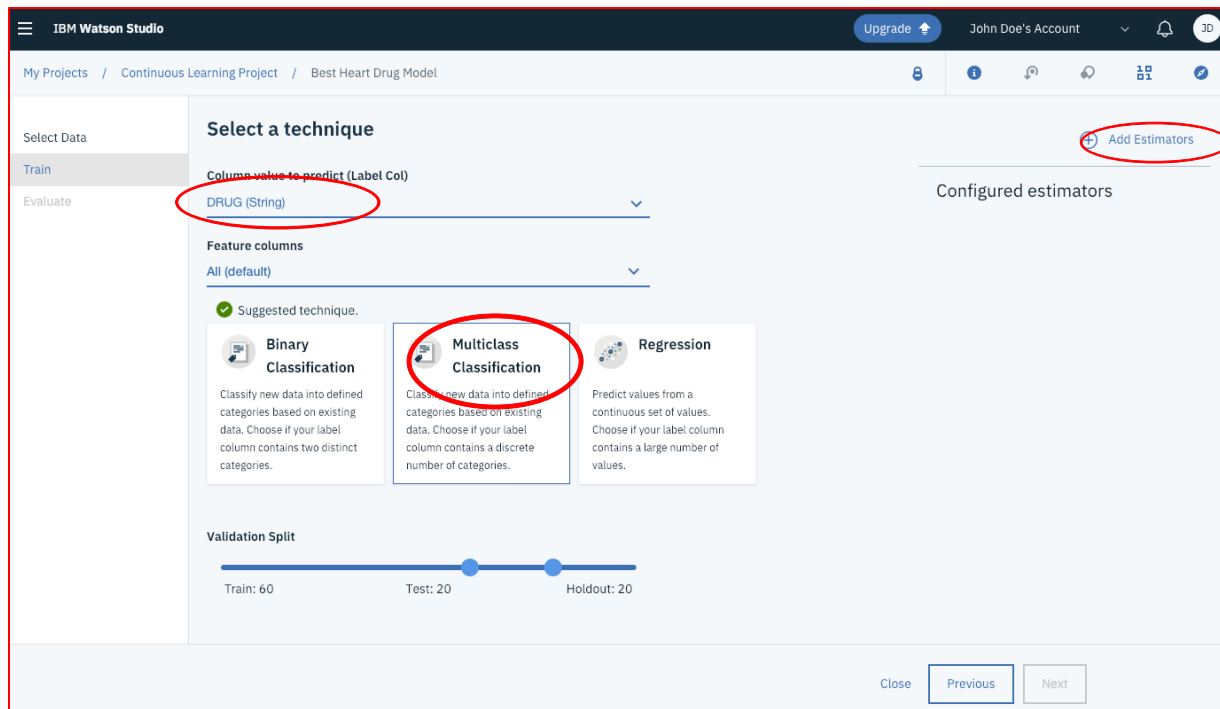
NAME	TYPE	SERVICE
<u>Drug_Data_Monday.csv</u>	Data Asset	Project

Close **Next**

We will now choose which techniques may work well given our data and given our goal to predict which drug is the best suited for a given patient.

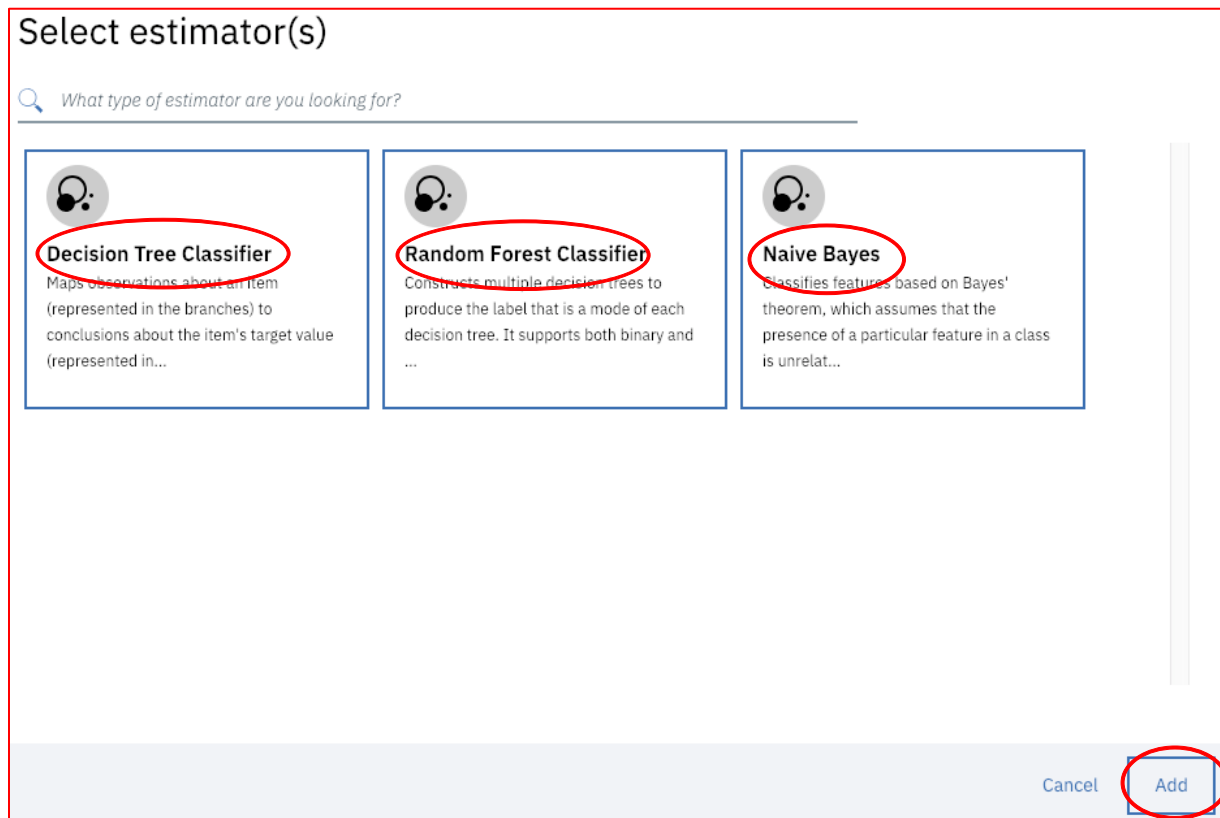
- On the “Select a technique” page, click on the Select Label Col dropdown and select DRUG (String).
- Select Multiclass Classification.
- Click Add Estimators in the upper right corner of the page.





Watson Studio only presents the estimators that would work with our selections on the previous page.

8. Select all three estimator options. Click Add.



9. Back on the “Select a technique” page, click Next.

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Select Data

Train

Evaluate

### Select a technique

You cannot change label column, feature columns, model type, or validation split after adding an estimator. You must first delete all estimators in order to make changes to these attributes.

Column value to predict (Label Col)  
DRUG (String)

Feature columns  
All (default)

✓ Suggested technique.

**Binary Classification**

Classify new data into defined categories based on existing data. Choose if your label column contains two distinct categories.

**Multiclass Classification**

Classify new data into defined categories based on existing data. Choose if your label column contains a discrete number of categories.

**Regression**

Predict values from a continuous set of values. Choose if your label column contains a large number of values.

Validation Split

Train: 60 Test: 20 Holdout: 20

Configured estimators

- Decision Tree Classifier Not Yet Trained
- Random Forest Classifier Not Yet Trained
- Naive Bayes Not Yet Trained

Close Previous **Next**

The Select model page will allow us to compare the results of different estimator types.

10. For this tutorial, select RandomForestClassifier.

11. Click Save.

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My Projects / Continuous Learning Project / Best Heart Drug Model

Select Data

Train

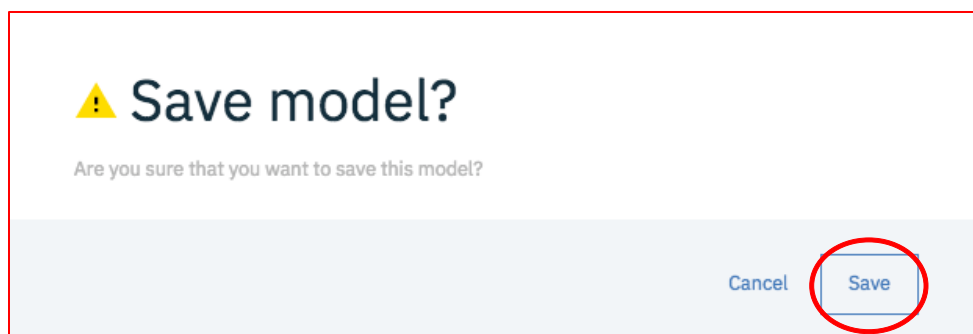
Evaluate

### Select model

ESTIMATOR TYPE	STATUS	PERFORMANCE	WEIGHTED TRUE POSITIVE RATE	WEIGHTED FALSE POSITIVE RATE	WEIGHTED PRECISION	WEIGHTED F MEASURE	WEIGHTED RECALL	LAST EVALUATION	ACTIONS
<input checked="" type="radio"/> RandomForestClassifier	Trained & Evaluated	Good	0.82051	0.1495	0.82906	0.81873	0.82051	23 Jan 2019, 10:34 AM	⋮
<input type="radio"/> DecisionTreeClassifier	Trained & Evaluated	Fair	0.79487	0.10483	0.85483	0.80861	0.79487	23 Jan 2019, 10:34 AM	⋮
<input type="radio"/> NaiveBayes	Trained & Evaluated	Poor	0.64103	0.36259	0.49752	0.55562	0.64103	23 Jan 2019, 10:34 AM	⋮

Close Previous **Save**

12. When the “Save model” window appears, click Save.



We have just saved the model in our Watson Machine Learning service and can now view information about the model specifications, details of construction, and input schema. The model can also be exposed as an API and used by data pipelines, applications, or other external systems.

13. Click on the console button with an “angle bracket” to view the schema in JSON format.

COLUMN	TYPE
AGE	"integer"
SEX	"string"

This schema can be copied and used elsewhere to help existing systems easily interact with our model and the Watson Machine Learning service.

```
Input Schema

{
  {
    "name": "AGE",
    "type": "integer",
    "nullable": true,
    "metadata": {
      "columnInfo": {
        "columnPrimaryKey": false,
        "columnTypeName": "integer",
        "columnSigned": true,
        "columnType": 4,
        "columnLength": -1,
        "columnNullable": true,
        "columnScale": 0
      }
    }
  }
},
```

14. Scroll up and click on the Evaluation tab.

**Best Heart Drug Model**

Overview **Evaluation** Deployments Lineage

**Summary**

Machine learning service	pm-20-ww
Model Type	wml-1.1
Runtime environment	spark-2.3
Training date	23 Jan 2019, 10:37 AM
Label column	DRUG
Latest version	fcd494cf-1676-4802-a6fe-68330d335be4
Model builder details	<a href="#">View</a>

**Input Schema**

COLUMN	TYPE
AGE	"integer"
SEX	"string"

## Step 3 Set up Continuous Learning Model Capabilities

Model performance is critical for solving data science problems. This page provides information and functionality to aid in continuous training, tuning, and redeployment. We will now set up parameters to automatically retrain our model.

1. Click on Configure Performance Monitoring.

The screenshot shows the IBM Watson Studio interface. The top navigation bar includes 'IBM Watson Studio', 'Projects', 'Services', 'Community', 'Docs', 'Support', 'Manage', an 'Upgrade' button, and a user profile 'John Doe's Account'. The breadcrumb trail is 'My Projects / Continuous Learning Project / Best Heart Drug Model'. The main content area is titled 'Best Heart Drug Model' and has tabs for 'Overview', 'Evaluation', 'Deployments', and 'Lineage'. The 'Evaluation' tab is active, showing the 'Last Evaluation Result' table.

Last Evaluation Result	
Version	fcd494cf-1676-4802-a6fe-68330d335be4
Phase	setup
Accuracy	0.821
WeightedPrecision	0.829
WeightedRecall	0.821
WeightedFMeasure	0.819
WeightedFalsePositiveRate	0.15
WeightedTruePositiveRate	0.821

Below the table is the 'Performance Monitoring' section, which contains a text block explaining the need for a database connection and a button labeled 'Configure Performance Monitoring' circled in red.

2. Under Spark Service or Environment, select the Default Spark Scala 2.11 option.
3. Under Metric details, select Accuracy. This relies on a database table of new data. We will use DB2 Warehouse on Cloud, a data store optimized for analytic data sets.
4. Click on Create a new connection

## Configure performance monitoring

**Spark Service or Environment**  
Only Spark environments supporting Scala kernels can be used for continuous learning.

Default Spark Scala 2.11

**Prediction type**  
multiclass

Metric details (type / optional threshold)  
accuracy

**Feedback data connection** (PostgreSQL or IBM Db2 Warehouse on Cloud) [Create new connection](#)

Select feedback data reference

Record count required for re-evaluation  
1000

**Auto retrain**  
when model performance is below threshold

**Auto deploy**  
when model performance is better than previous version

5. On the “New connection” page, click Db2 Warehouse.

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### New connection

IBM services

BigInsights HDFS	Cloud Object Storage	Cloud Object Storage (infrastructure)	Cloudant
Compose for MySQL	Compose for PostgreSQL	Db2	Db2 Big SQL
Db2 for i	Db2 for z/OS	Db2 Hosted	Db2 on Cloud
<b>Db2 Warehouse</b>	Informix	Object Storage OpenStack Swift	Object Storage OpenStack Swift (infrastructure)
PureData for Analytics	Watson Analytics		

6. Click on [Access DB2 Credentials](#)

Ask your instructor for your assigned database.

7. Enter a Name for your connection (e.g. DB2 Warehouse Connection).

8. Using the credentials cut and paste the fields under Username, Hostname, Password, and Database.

9. Click Create.

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### New connection (DB2 Warehouse Connection - Db2 Warehouse)

Connection overview

**Name**

DB2 Warehouse Connection

**Description**

IBM Db2 warehouse database on Cloud

Connection details

**Username \***

dash100103

**Hostname or IP Address \***

dashdb-entry-yp-dal09-10.services.dal.bluem

**Secure Gateway**

☐ Use a secure gateway

**Password \***

\*\*\*\*\*

**Database \***

BLUDB

2965

Cancel Create

- Return to the “Configure performance monitoring page” and click Select feedback data reference.

## Configure performance monitoring

**Spark Service or Environment**

Only Spark environments supporting Scala kernels can be used for continuous learning.

Default Spark Scala 2.11

**Prediction type**

multiclass

**Metric details (type / optional threshold)**

accuracy

**Feedback data connection** (PostgreSQL or IBM Db2 Warehouse on Cloud - [Create new connection](#))

Select feedback data reference

**Record count required for re-evaluation**

1000

**Auto retrain**

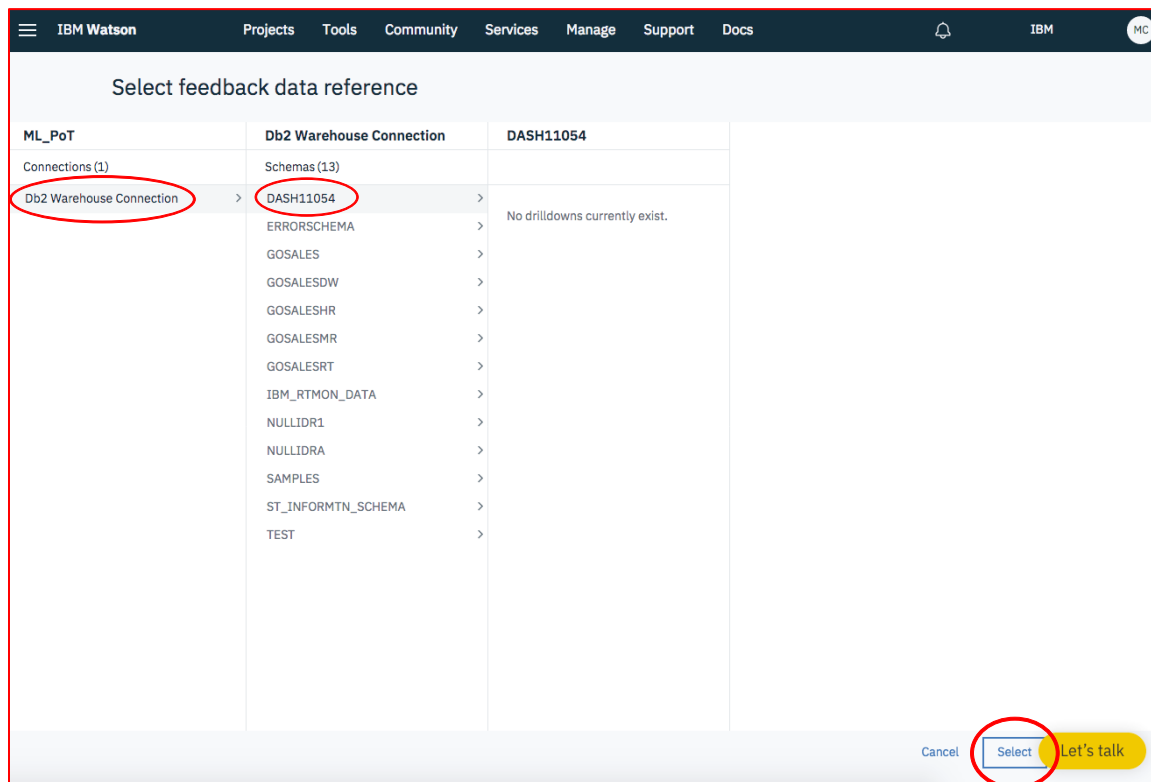
when model performance is below threshold

**Auto deploy**

when model performance is better than previous version

- Click on your DB2 Warehouse-xx name.
- Select the schema that matches DASH####.

13. Click select.



14. After returning to the “Configure performance monitoring” page, enter a unique table name (attendees are sharing the DB2 Warehouse service so make your name unique by appending your initials to the table name).


15. Enter 150 as the Record count.


16. Under Auto retrain select always.


17. Under Auto deploy, Never.

18. Click Save.



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Configure performance monitoring

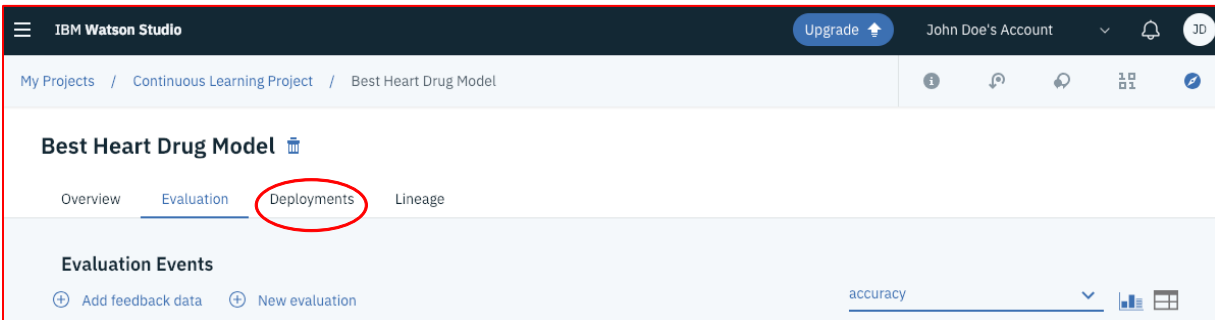
**Spark Service or Environment**  
Only Spark environments supporting Scala kernels can be used for continuous learning.  
Default Spark Scala 2.11 **Prediction type**  
multiclass Metric details (type / optional threshold)  
accuracy  **Feedback data connection** (PostgreSQL or IBM Db2 Warehouse on Cloud - [Create new connection](#) )  
dashdb: BLUDB [Change feedback data reference](#)  
NewTable\_JBD  
Record count required for re-evaluation  
150  
**Auto retrain**  
always   
**Auto deploy**  
never Cancel 

We have just set our model to retrain whenever new data is submitted. We set our model to never automatically redeploy as we would like to review each model before making it available to the medical staff who rely on it.

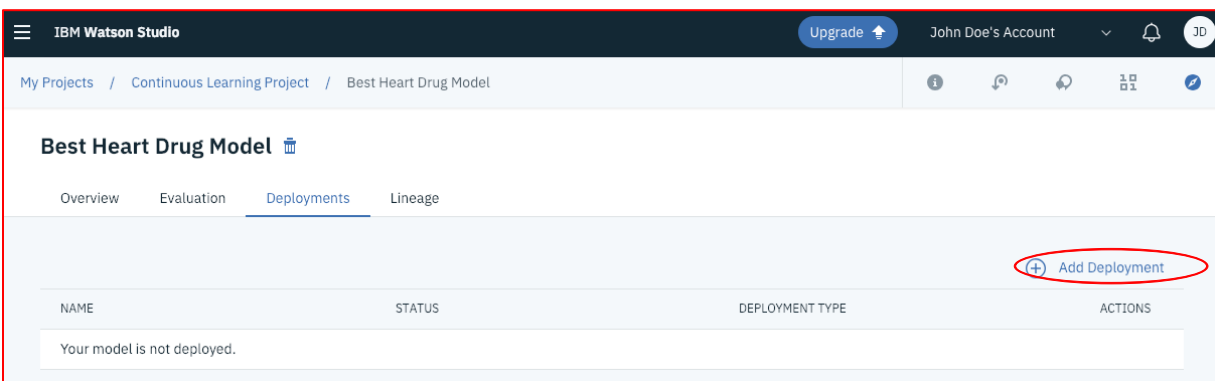
## Step 4 Deploy a Machine Learning Model.

Now we will focus on deployment.

1. Click the Deployment tab.



2. Click Add Deployment.



3. Enter a Name (e.g. Heart Drug Deployment).
4. Enter a Description.
5. Click Save.

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### Create Deployment

Define deployment details

Name  
Heart Drug Deployment

Description  
Best Heart Drug Deployment

Deployment type  
☒ Web service

Cancel Save

The model is now accessible by external systems.

6. Click on your deployment (e.g. Heart Drug Deployment).

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My Projects / Continuous Learning Project / Best Heart Drug Model

### Best Heart Drug Model

Overview Evaluation **Deployments** Lineage

+ Add Deployment

NAME	STATUS	DEPLOYMENT TYPE	ACTIONS
Heart Drug Deployment	DEPLOY_SUCCESS	Web Service	

You are automatically brought to the Overview tab lists information related to the model deployment including services used and version number.

7. Click the Implementation tab.

The screenshot shows the IBM Watson Studio interface. The top navigation bar includes the IBM Watson Studio logo, an 'Upgrade' button, and the user's account 'John Doe's Account'. The breadcrumb trail is 'My Projects / Continuous Learning Project / Best Heart Drug Model / Heart Drug Deployment'. The main heading is 'Heart Drug Deployment'. Below it are three tabs: 'Overview', 'Implementation' (which is circled in red), and 'Test'. The 'Implementation' tab displays a table with deployment details.

Deployment	
Name	Heart Drug Deployment
Type	Web Service
Deployment ID	d06458c9-ac57-4356-83ca-365f27e2a989
Status	DEPLOY_SUCCESS
Asset type	model
Asset name	Best Heart Drug Model
Machine learning service	pm-20-ww
Created	23 Jan 2019 11:44am
Last modified	23 Jan 2019 11:45am

The implementation tab provides developers information to help minimize the time it takes to develop models and place them in a production environment.

8. Click on the Test tab.

The screenshot shows the same IBM Watson Studio interface, but the 'Test' tab is now selected and circled in red. The 'Implementation' tab is still visible in the background. The 'Test' tab displays the 'Implementation' section with a 'View API Specification' link. Below this is a table with API details. Further down is the 'Code Snippets' section with tabs for 'cURL', 'Java', 'JavaScript', 'Python', and 'Scala'. The 'cURL' tab is selected, showing a code block with instructions and a curl command.

Implementation	
Scoring End-point	<a href="https://us-south.ml.cloud.ibm.com/v3/wml_instances/dc34a279-7c0a-41db-a34d-854f1b9ce99f/deployments/d06458c9-ac57-4356-83ca-365f27e2a989/online">https://us-south.ml.cloud.ibm.com/v3/wml_instances/dc34a279-7c0a-41db-a34d-854f1b9ce99f/deployments/d06458c9-ac57-4356-83ca-365f27e2a989/online</a>
Authorization: Bearer <token>	See code snippets below for information on how to retrieve the WML Authorization Token to be passed with scoring requests.
Content-type: application/json	Required if the request body is sent in JSON format.

**Code Snippets**

[cURL](#) [Java](#) [JavaScript](#) [Python](#) [Scala](#)

```
# retrieve your $WML_SERVICE_CREDENTIALS_USERNAME, $WML_SERVICE_CREDENTIALS_PASSWORD, and $WML_SERVICE_CREDENTIALS_URL from the
# Service credentials associated with your IBM Cloud Watson Machine Learning Service instance.

curl --basic --user $WML_SERVICE_CREDENTIALS_USERNAME:$WML_SERVICE_CREDENTIALS_PASSWORD $WML_SERVICE_CREDENTIALS_URL/v3/identity/t

# the above CURL request will return an auth token that you will use as $WML_AUTH_TOKEN in the scoring request below
# TODO: manually define and pass values to be scored below
curl -X POST --header 'Content-Type: application/json' --header 'Accept: application/json' --header "Authorization: Bearer $WML_A
```

The Test tab allows manual testing of the deployed model and viewing of results.

9. Enter:

AGE: 62

SEX: M

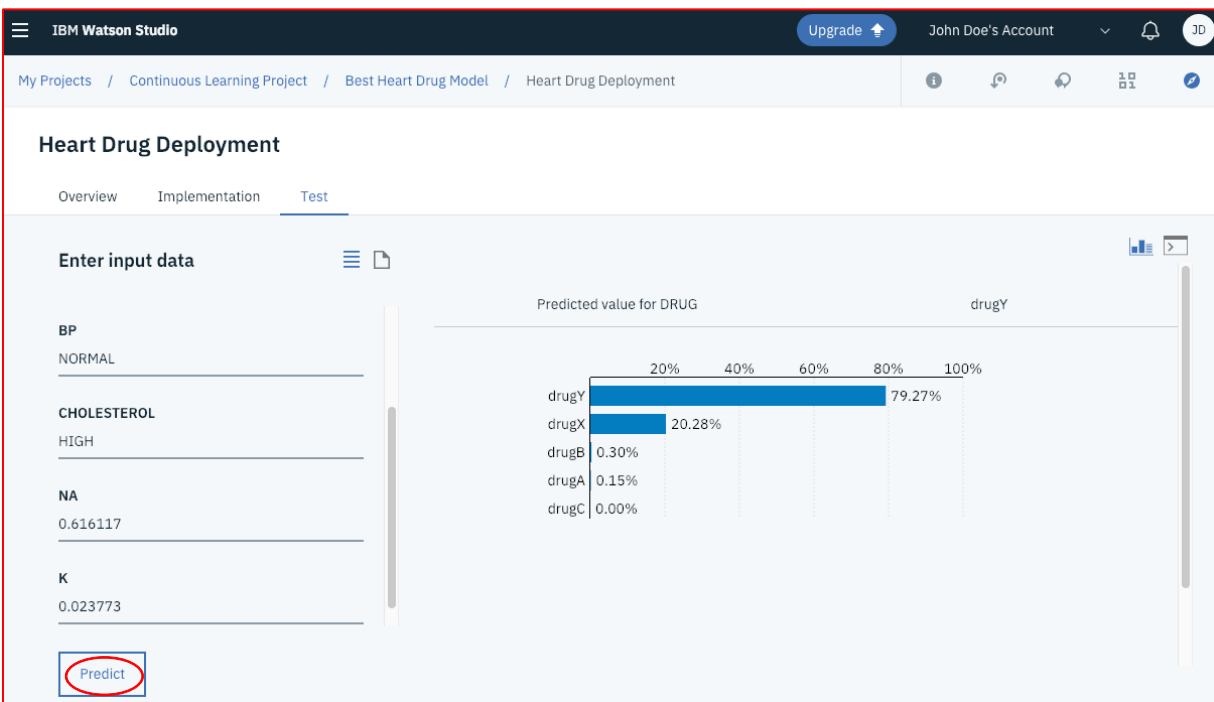
BP: NORMAL

CHOLESTEROL: HIGH

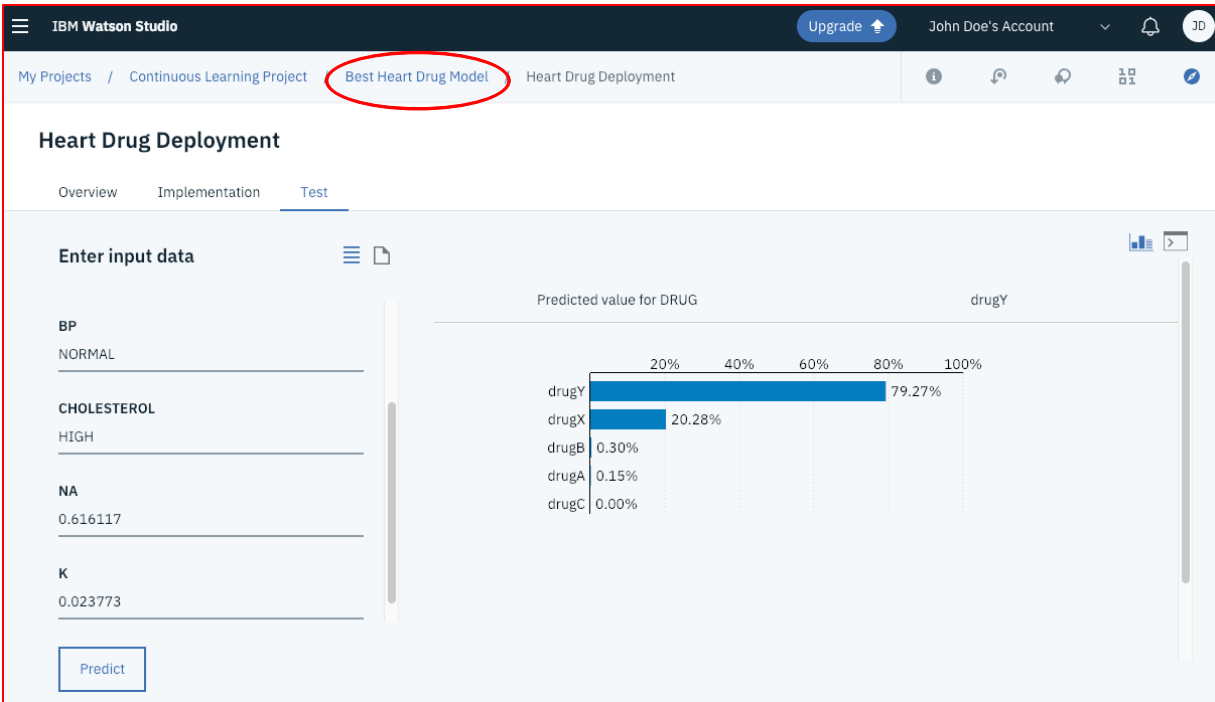
NA: 0.616117

K: 0.023773

10. Click Predict.



11. Feel free to change the input data and run new predictions. When ready, click on your model name (e.g. Best Heart Drug Model)



12. Click on the Evaluation tab.

Best Heart Drug Model

Overview **Evaluation** Deployments Lineage

Summary

Property	Value
Machine learning service	pm-20-ww
Model Type	wml-1.1
Runtime environment	spark-2.3
Training date	23 Jan 2019, 10:37 AM
Label column	DRUG
Latest version	fcd494cf-1676-4802-a6fe-68330d335be4
Model builder details	<a href="#">View</a>

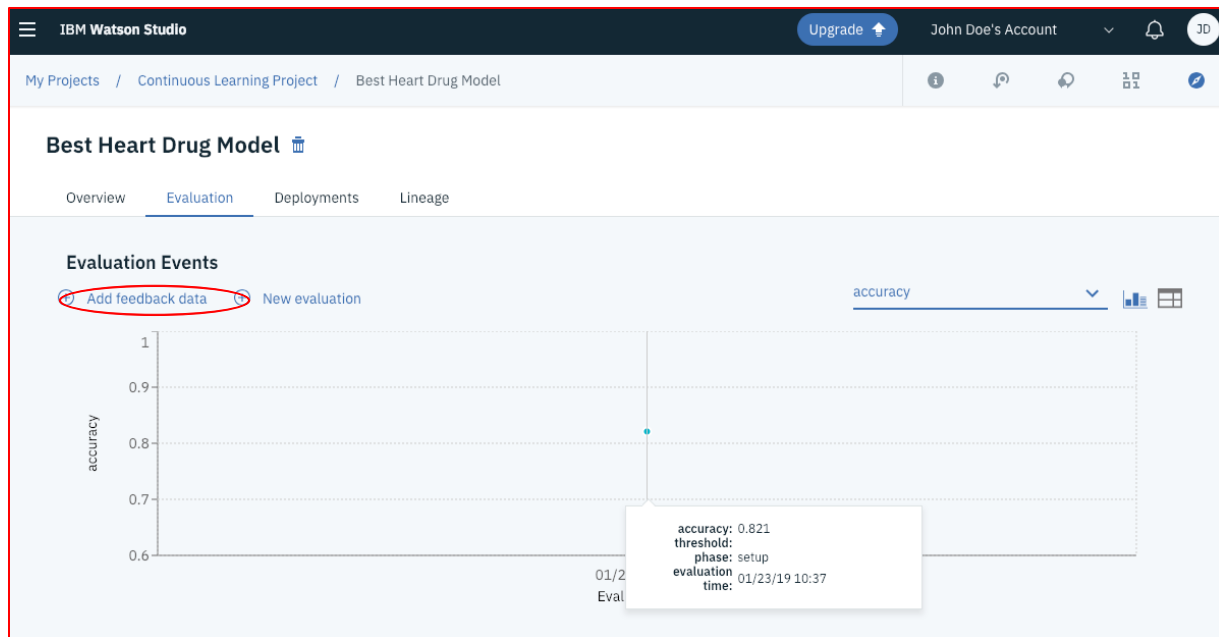
Input Schema

COLUMN	TYPE
AGE	"integer"
SEX	"string"

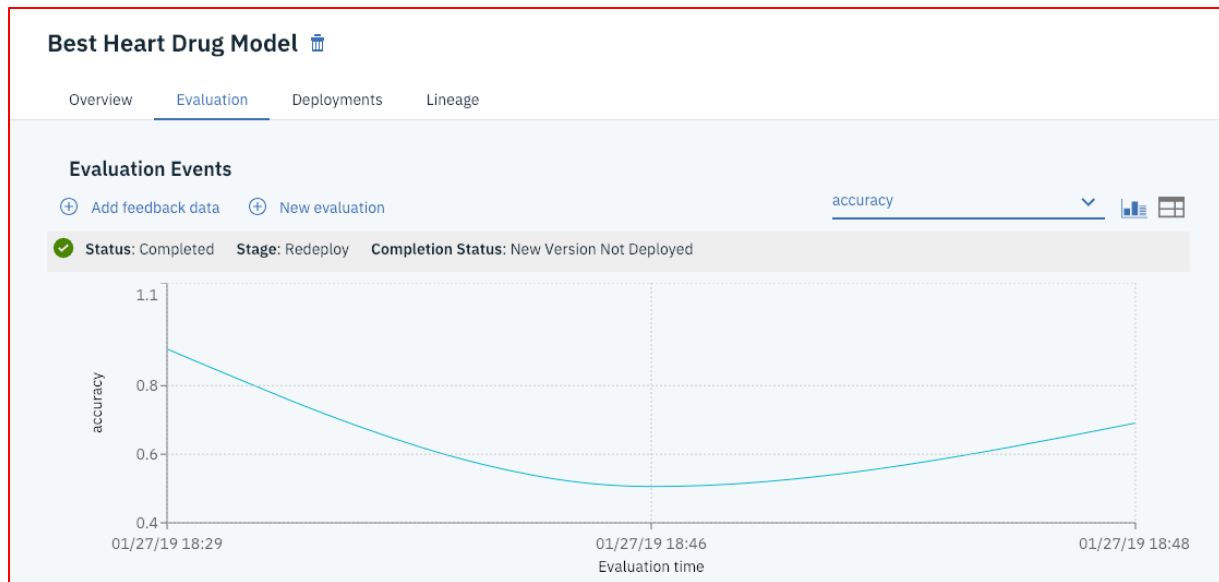
13. If you scroll to the bottom you will be able to see which model version is deployed. Currently we only have one model.

Suppose a day has passed and we have received more data to improve our model.

14. Scroll up and click on Add feedback data and select Drug\_Data\_Tuesday.csv.



15. When the “New evaluation” window appears, click New Evaluation. Re-evaluating the model may take a few minutes. This is a great time to grab coffee.
  16. Notice that additional data caused our original model’s performance to drop but retraining the model on the new unified dataset caused model performance to increase. Although we run these steps graphically, we can configure these steps to run easily through APIs.
- The continuous learning feature can be configured to automatically retrain or redeploy models under certain conditions (e.g. redeploy if accuracy falls below 0.9 or redeploy if the new model is better than the previous model). We currently have set our model to only allow manual redeployment. Our choice is now to either deploy this current model or re-run the model building process to build an entirely new model and choose the best algorithm to fit this new dataset.



If you scroll down you will be able to see all model versions listed. We have two versions, but only our original model is deployed.

**Versions**

TIME	VERSION	DEPLOYED	ACCURACY	ACTIONS
27 Jan 2019 06:47pm	4d465219-abf5-48ad-ba10-3807ef038259		0.691	⋮
27 Jan 2019 06:29pm	5b806cef-f591-4f89-8dfc-768463d5374f	✓	0.907	⋮

17. For the purpose of this lab, select the three dots under the Actions column and click Use this version to deploy the new model.

**Versions**

TIME	VERSION	DEPLOYED	ACCURACY	ACTIONS
27 Jan 2019 06:47pm	4d465219-abf5-48ad-ba10-3807ef038259		0.691	⋮
27 Jan 2019 06:29pm	5b806cef-f591-4f89-8dfc-768463d5374f	✓	0.907	Use this version

18. The new model version should now have a green checkmark under the Deployed column.

**Versions**

TIME	VERSION	DEPLOYED	ACCURACY	ACTIONS
27 Jan 2019 06:47pm	4d465219-abf5-48ad-ba10-3807ef038259	✓	0.691	⋮
27 Jan 2019 06:29pm	5b806cef-f591-4f89-8dfc-768463d5374f		0.907	⋮

19. (Optional) scroll up and upload the final csv file, Drug\_Data\_Wednesday.csv, as feedback data.



During this lab we have very quickly compared various machine learning models and chosen the best one tuned to our dataset and objectives. We then created a continuous machine learning model that automatically monitors and retrains allowing Watson Machine Learning to keep applications, data pipelines, or external systems relying on the machine learning model as up to date as possible.

## **We Value Your Feedback!**

- Don't forget to submit your Think 2019 session and speaker feedback! Your feedback is very important to us – we use it to continually improve the conference.
- Access the Think 2019 agenda tool to quickly submit your surveys from your smartphone, laptop or conference kiosk.