

Lab Center – Hands-on Lab

Session #3259

Session Title: Introduction to Data Science using Watson Studio

Lab-3: Deploy a Continuous Machine Learning Model using Watson Studio

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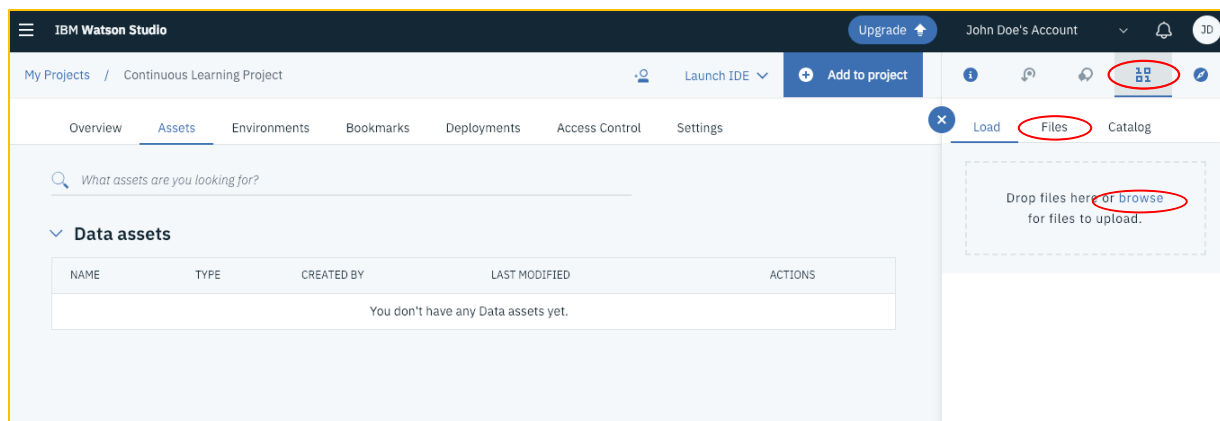
Introduction

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.

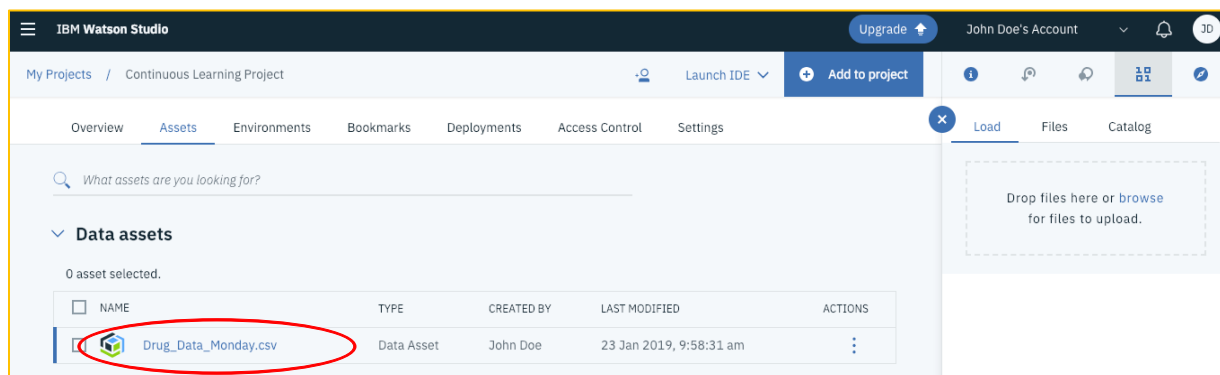
Before we build our models, we need to load data into our project.

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.



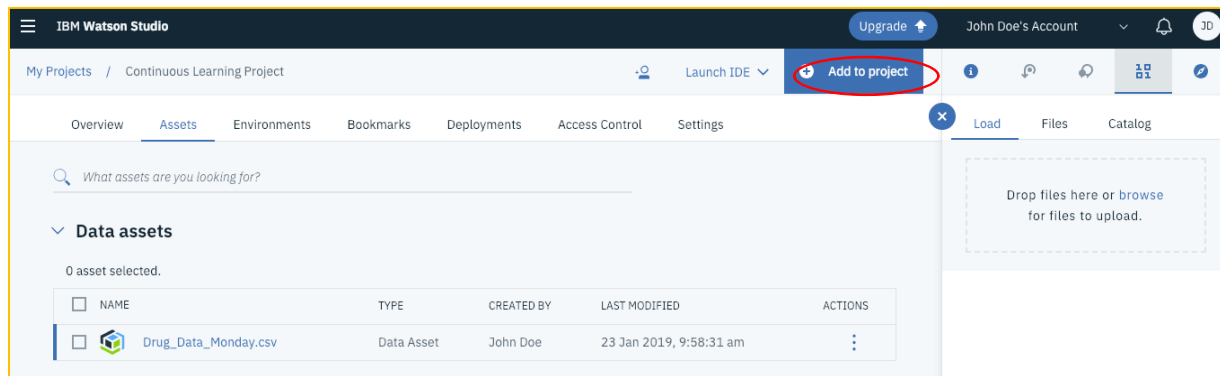
After clicking on Drug_Data_Monday.csv, you are brought to a data view. Once you are satisfied that this is the data you want, click on your project name to return to your project's assets.

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 'Drug_Data_Monday.csv' data asset is selected. The main content area shows a table with 7 columns: AGE, SEX, BP, CHOLESTEROL, NA, K, and DRUG. The table contains 181 rows of data. On the right side, a sidebar provides details about the data asset, including its description, tags, and metadata (Added: 02:58 PM UTC, 2019/01/23; Size: 7.467 KB).

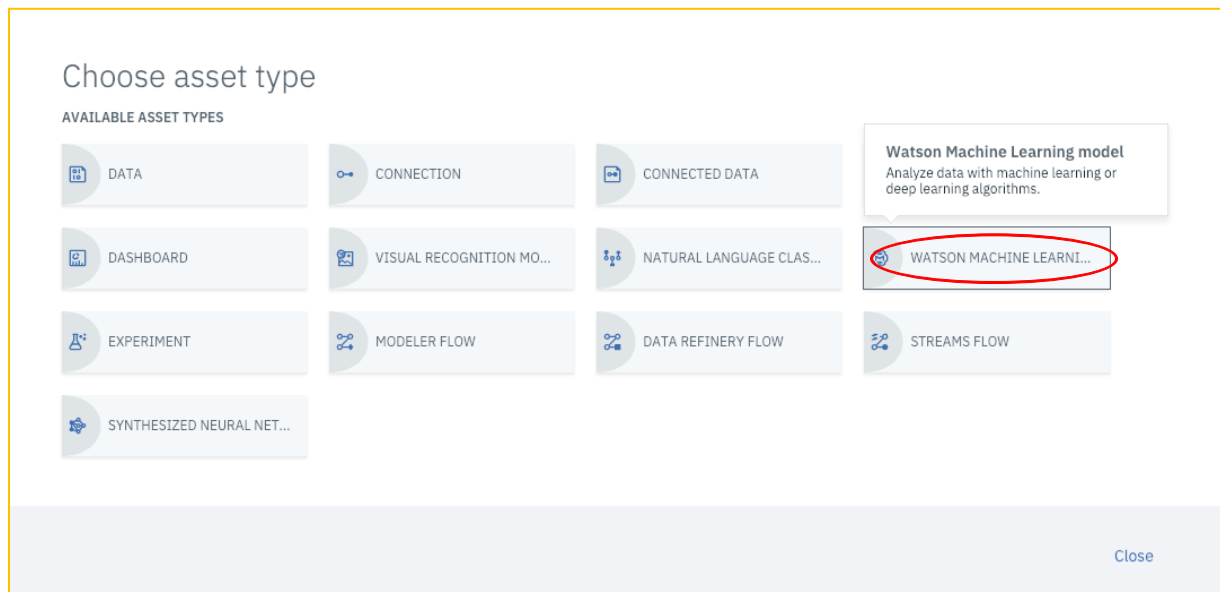
| AGE | SEX | BP | CHOLESTEROL | NA | K | DRUG |
|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Type: String | Type: String | Type: String | Type: String | Type: String | Type: String | Type: String |
| 43 | M | HIGH | HIGH | 0.656371 | 0.046979 | 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.

New model

Name
Continuous Learning

Description
Model description

Machine Learning Service
pm-20-ct

Model builder ☒ From file ☐ From sample

Select runtime
Only Spark environments supporting Scala kernels can be used for model builder creation.
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

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

IBM Watson Studio

Upgrade John Doe's Account

My Projects / Continuous Learning Project / Best Heart Drug Model

Select Data

Train

Evaluate

Select data asset

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

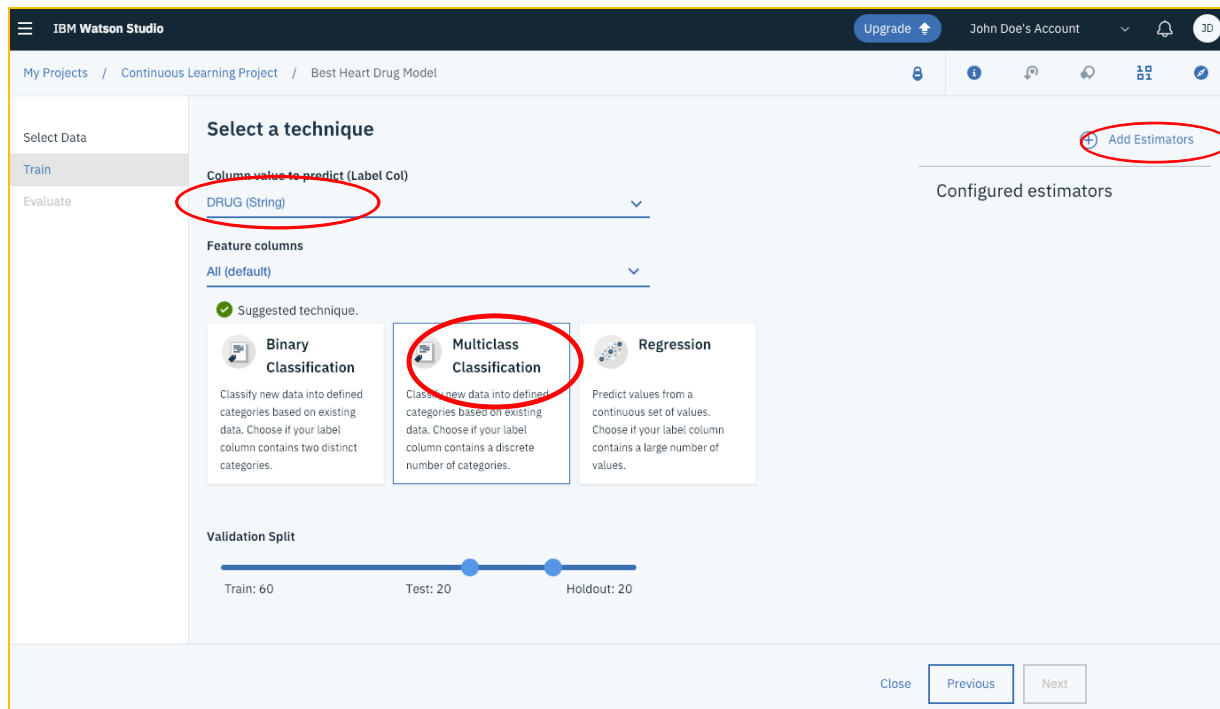
What asset are you looking for?

| NAME | TYPE | SERVICE |
|----------------------|------------|---------|
| Drug_Data_Monday.csv | Data Asset | Project |

Close Next

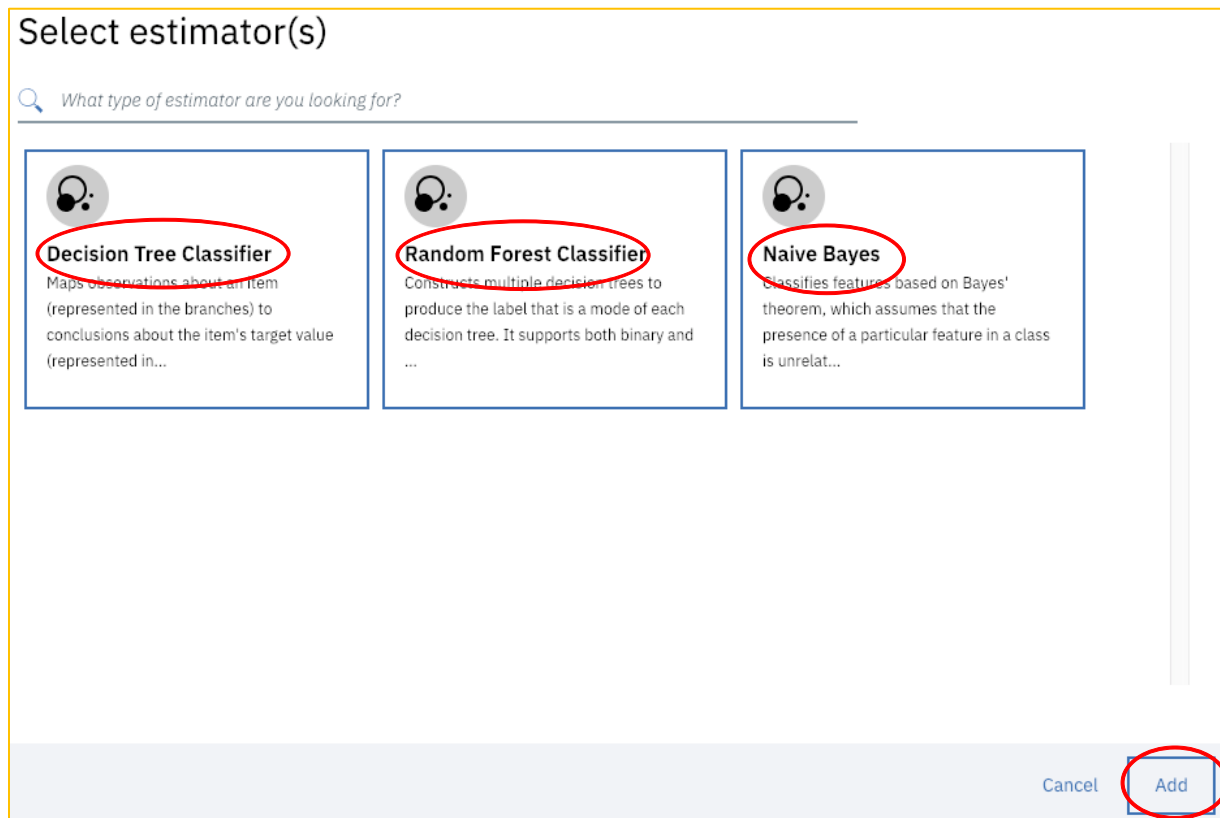
We will now choose which techniques may work well given our data and given our goal to predict which drug is the best suited for a given patient.

- 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.

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.

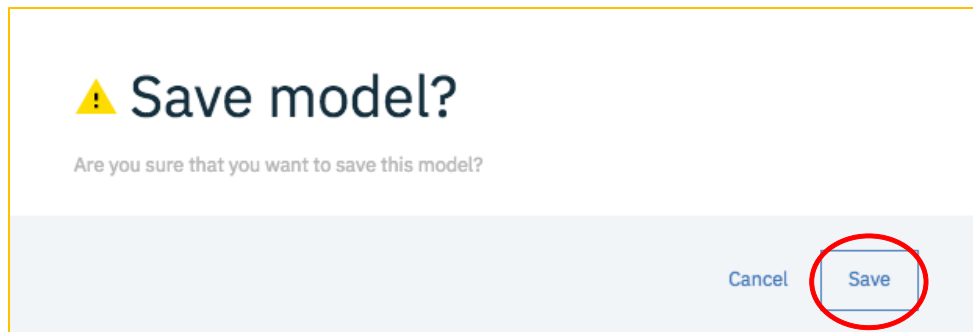
11. Click Save.

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.

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 | View |

Input Schema

| 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.

The screenshot shows the IBM Watson Studio interface. At the top, there's a navigation bar with 'IBM Watson Studio' and various menu items. Below it, the breadcrumb trail reads 'My Projects / Continuous Learning Project / Best Heart Drug Model'. The main content area is titled 'Best Heart Drug Model' and has four tabs: 'Overview', 'Evaluation' (which is circled in red), 'Deployments', and 'Lineage'. Under the 'Evaluation' tab, there's a 'Summary' section with a table of model details. Below that is an 'Input Schema' section with a table showing columns and their types.

| 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 | View |

| 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 heading is 'Best Heart Drug Model' with a subheading 'Evaluation' selected from a tab menu (Overview, Evaluation, Deployments, Lineage). Below this is a section titled 'Last Evaluation Result' containing a table with the following data:

| | |
|---------------------------|--------------------------------------|
| 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 a 'Performance Monitoring' section with a text box explaining the need for a database connection. At the bottom of this section, a button labeled 'Configure Performance Monitoring' is circled in red.

2. Under Spark Service or Environment, select the Spark service that was created in the prerequisites, not the Default Spark Scala 2.11 option.
3. Under Metric details, select Accuracy and put .8. 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.

Spark

Prediction type
multiclass

Metric details (type / optional threshold)
accuracy .8

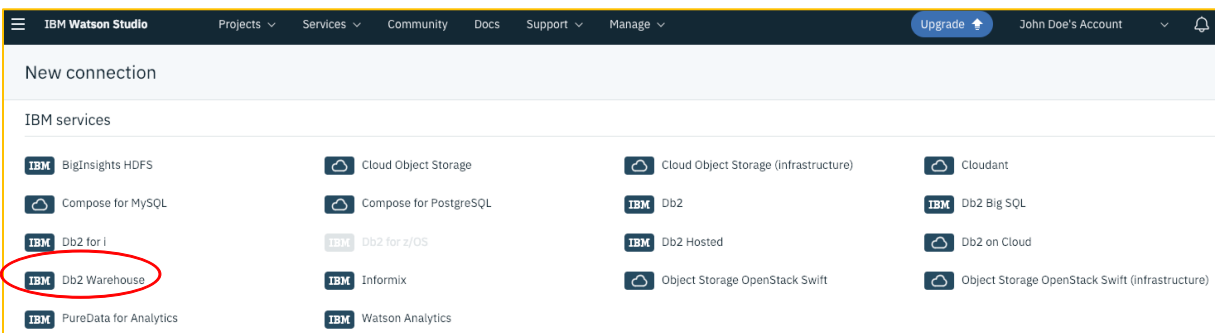
Feedback data connection (PostgreSQL or IBM Db2 Warehouse on Cloud - [Create new connection](#))
Select feedback data reference

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.



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

You should have an index card that provides your assigned database. If not, 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.

IBM Watson Studio Projects Services Community Docs Support Manage Upgrade John Doe's Account

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

Cancel Create

10. 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

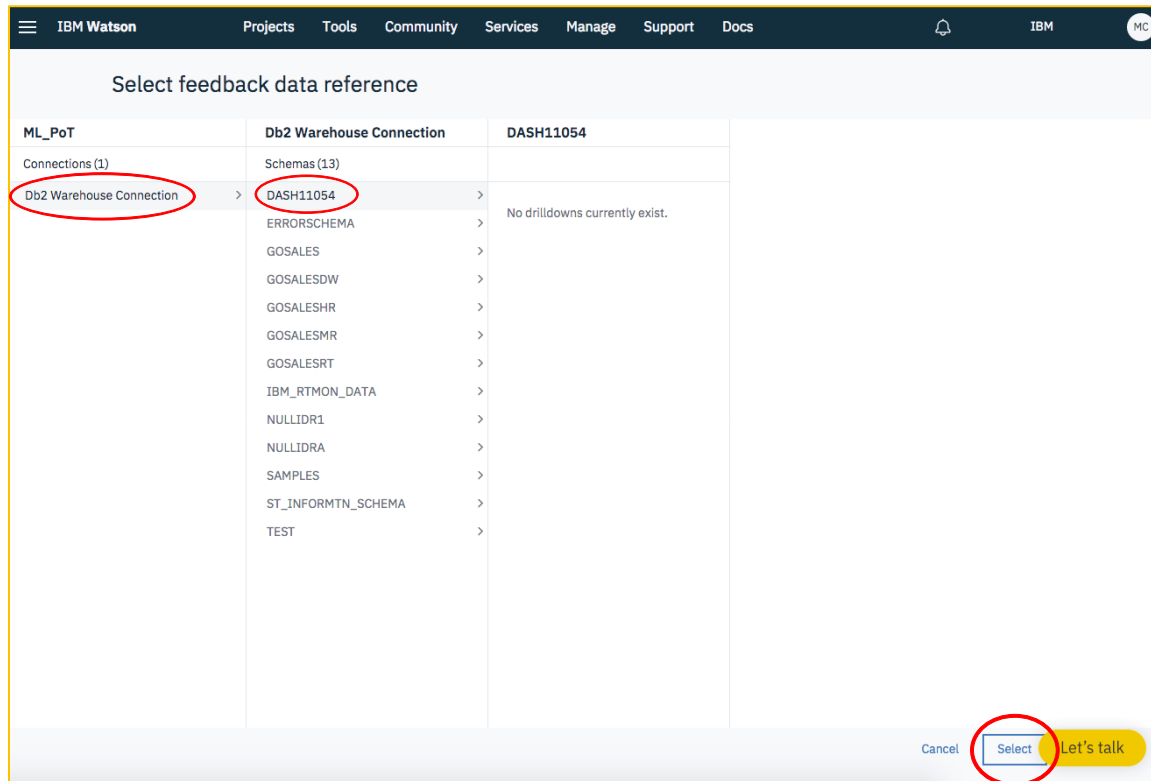
when model performance is below threshold

Auto deploy

when model performance is better than previous version

11. Click on your DB2 Warehouse-xx name.

12. 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.

IBM Watson Studio

Upgrade

John Doe's Account

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

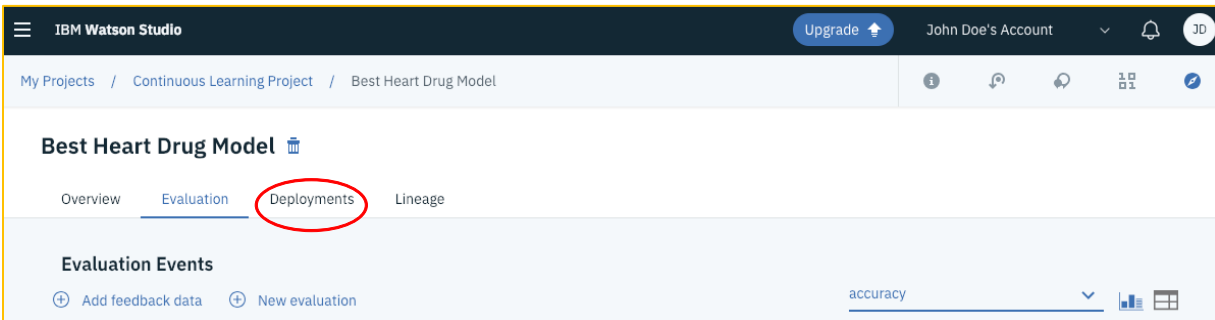
Save

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.

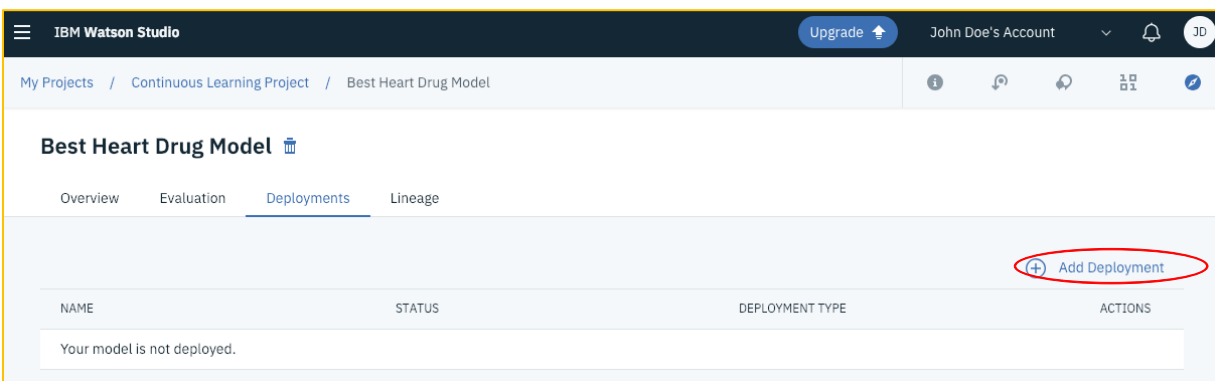
Step 4 Deploy a Machine Learning Model.

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.

IBM Watson Studio

Upgrade John Doe's Account

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).

IBM Watson Studio

Upgrade John Doe's Account

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 'Deployment' table with the following details:

| | |
|--------------------------|--------------------------------------|
| 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 main heading is 'Heart Drug Deployment'. Below it are three tabs: 'Overview', 'Implementation', and 'Test'. The 'Test' tab displays the 'Implementation' section, which includes a 'View API Specification' link and a table with the following details:

| | |
|--------------------------------|---|
| Scoring End-point | https://us-south.ml.cloud.ibm.com/v3/wml_instances/dc34a279-7c0a-41db-a34d-854f1b9ce99f/deployments/d06458c9-ac57-4356-83ca-365f27e2a989/online |
| 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. |

Below the table is the 'Code Snippets' section, which includes tabs for 'cURL', 'Java', 'JavaScript', 'Python', and 'Scala'. The 'cURL' tab is selected, showing the following code snippets:

```
# 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

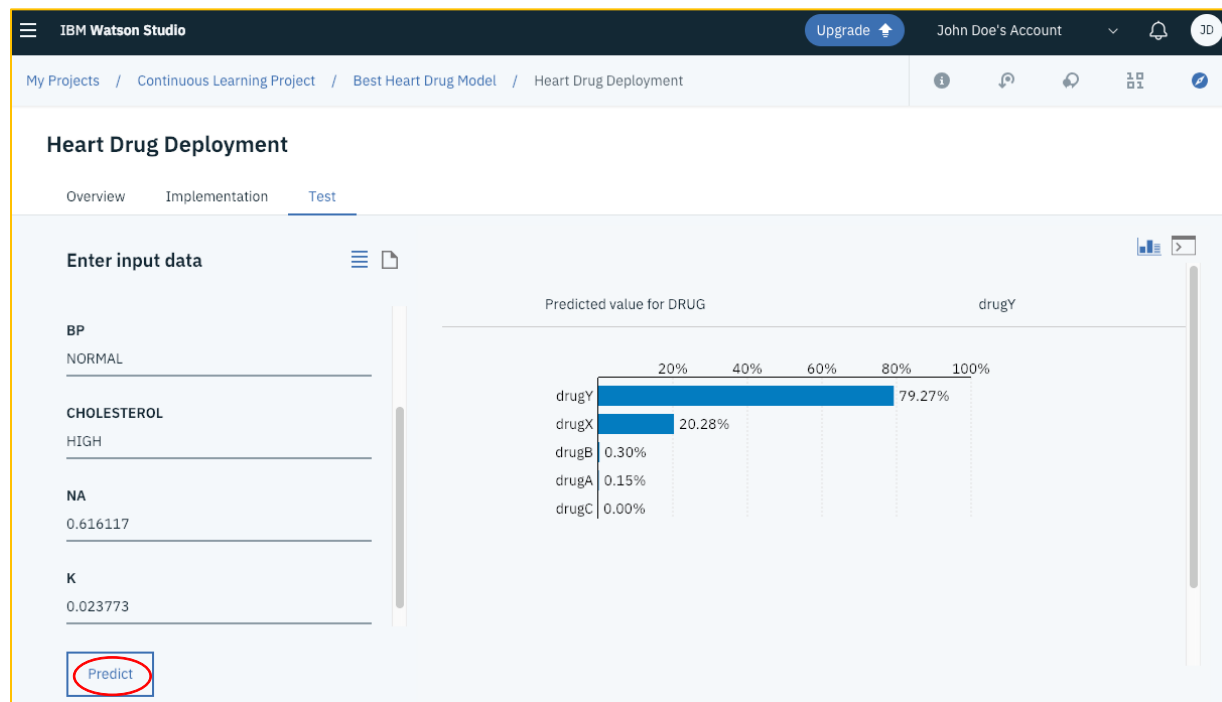
BP: NORMAL

CHOLESTEROL: HIGH

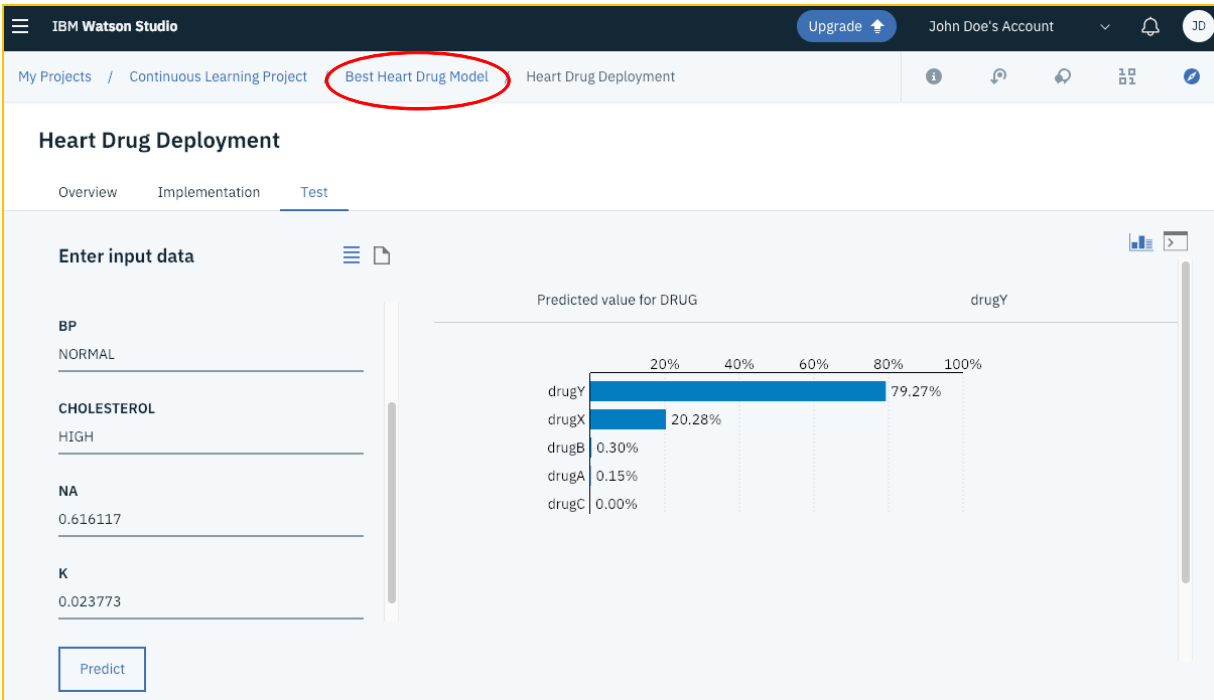
NA: 0.616117

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 | View |

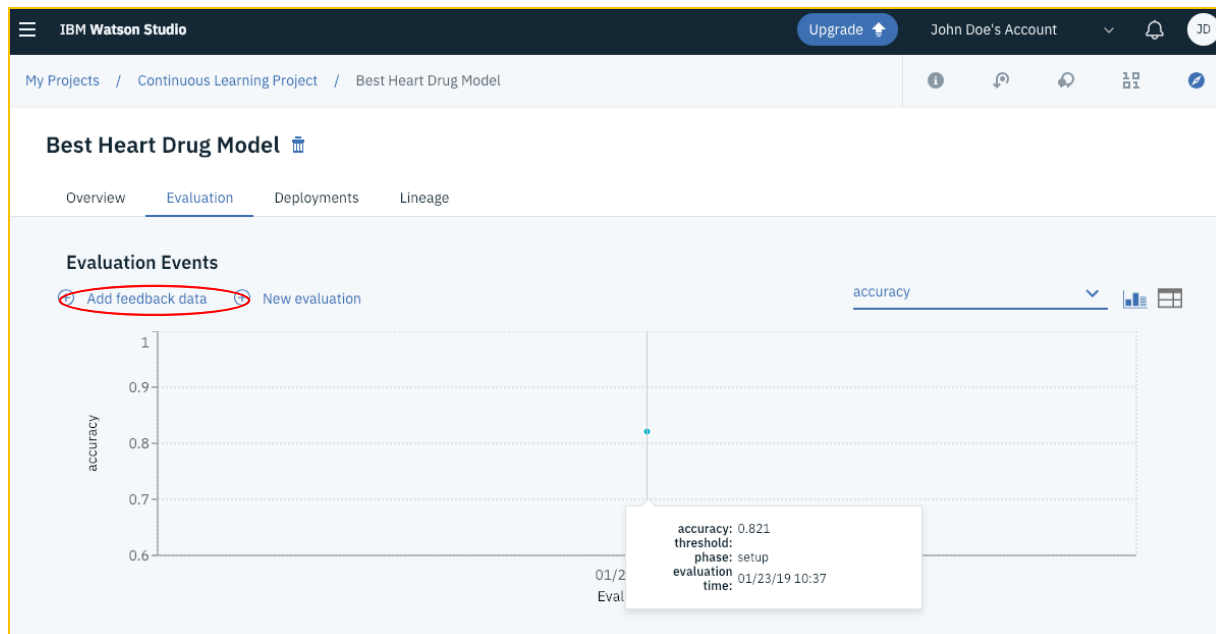
Input Schema

| COLUMN | TYPE |
|--------|-----------|
| AGE | "integer" |
| SEX | "string" |

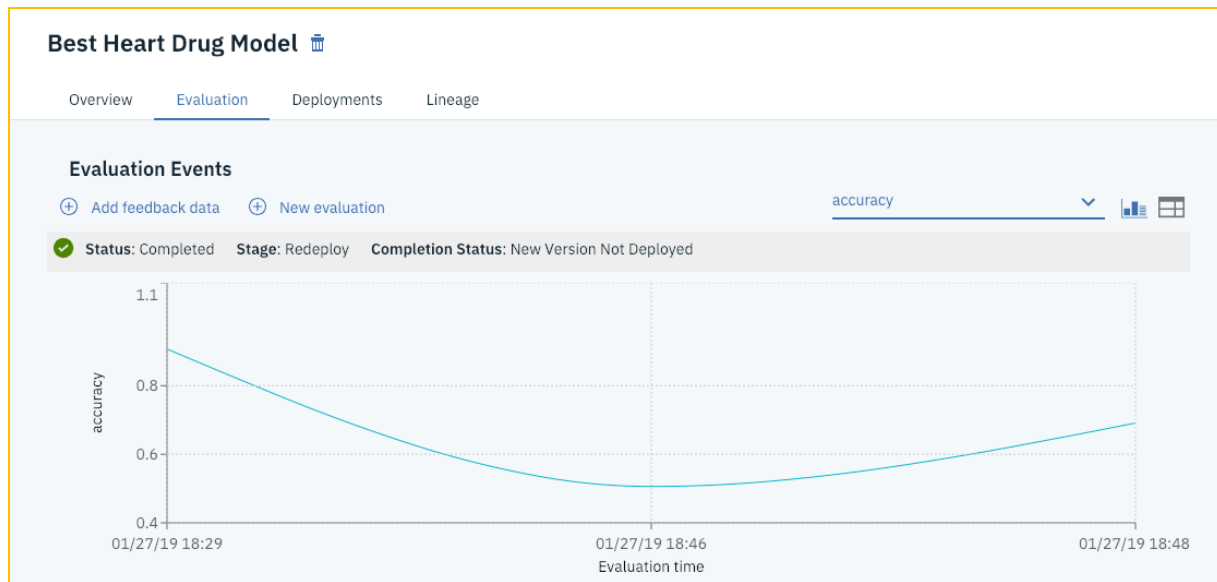
13. If you scroll to the bottom you will be able to see which model version is deployed. Currently we only have one model.

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!

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