

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

Michael Cronk, IBM, 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

Disclaimer

IBM's statements regarding its plans, directions, and intent are subject to change or withdrawal without notice at IBM's sole discretion. Information regarding potential future products is intended to outline our general product direction and it should not be relied on in making a purchasing decision.

The information mentioned regarding potential future products is not a commitment, promise, or legal obligation to deliver any material, code or functionality. Information about potential future products may not be incorporated into any contract.

The development, release, and timing of any future features or functionality described for our products remains at our sole discretion I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve results like those stated here.

Information in these presentations (including information relating to products that have not yet been announced by IBM) has been reviewed for accuracy as of the date of initial publication and could include unintentional technical or typographical errors. IBM shall have no responsibility to update this information. **This document is distributed “as is” without any warranty, either express or implied. In no event, shall IBM be liable for any damage arising from the use of this information, including but not limited to, loss of data, business interruption, loss of profit or loss of opportunity.** IBM products and services are warranted per the terms and conditions of the agreements under which they are provided.

IBM products are manufactured from new parts or new and used parts.

In some cases, a product may not be new and may have been previously installed. Regardless, our warranty terms apply.”

Any statements regarding IBM's future direction, intent or product plans are subject to change or withdrawal without notice.

Performance data contained herein was generally obtained in controlled, isolated environments. Customer examples are presented as illustrations of how those customers have used IBM products and the results they may have achieved. Actual performance, cost, savings or other results in other operating environments may vary.

References in this document to IBM products, programs, or services does not imply that IBM intends to make such products, programs or services available in all countries in which IBM operates or does business.

Workshops, sessions and associated materials may have been prepared by independent session speakers, and do not necessarily reflect the views of IBM. All materials and discussions are provided for informational purposes only, and are neither intended to, nor shall

constitute legal or other guidance or advice to any individual participant or their specific situation.

It is the customer's responsibility to insure its own compliance with legal requirements and to obtain advice of competent legal counsel as to the identification and interpretation of any relevant laws and regulatory requirements that may affect the customer's business and any actions the customer may need to take to comply with such laws. IBM does not provide legal advice or represent or warrant that its services or products will ensure that the customer follows any law.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products about this publication and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products. IBM does not warrant the quality of any third-party products, or the ability of any such third-party products to interoperate with IBM's products. **IBM expressly disclaims all warranties, expressed or implied, including but not limited to, the implied warranties of merchantability and fitness for a purpose.**

The provision of the information contained herein is not intended to, and does not, grant any right or license under any IBM patents, copyrights, trademarks or other intellectual property right.

IBM, the IBM logo, ibm.com and [names of other referenced IBM products and services used in the presentation] are trademarks of International Business Machines Corporation, registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at "Copyright and trademark information" at: www.ibm.com/legal/copytrade.shtml.

© 2019 International Business Machines Corporation. No part of this document may be reproduced or transmitted in any form without written permission from IBM.

U.S. Government Users Restricted Rights — use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM.

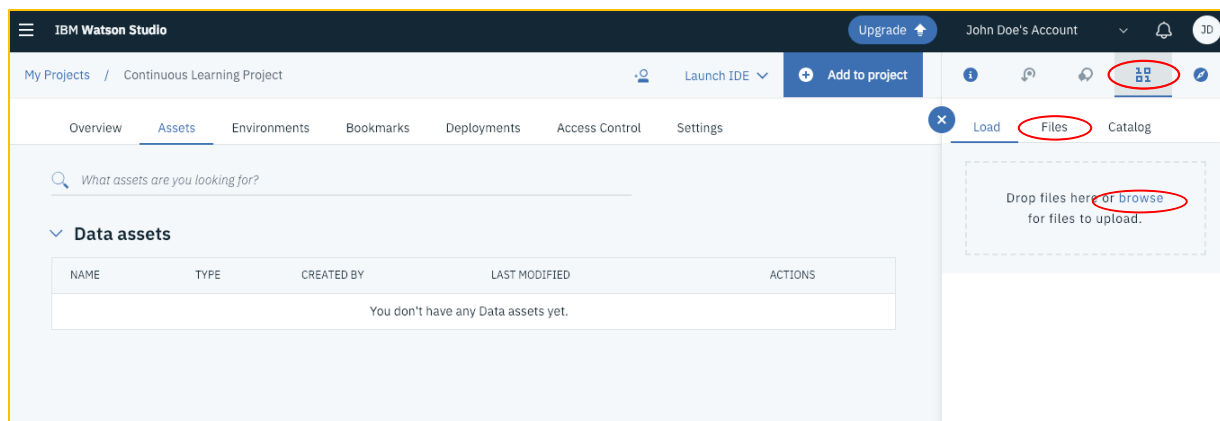
Introduction

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.

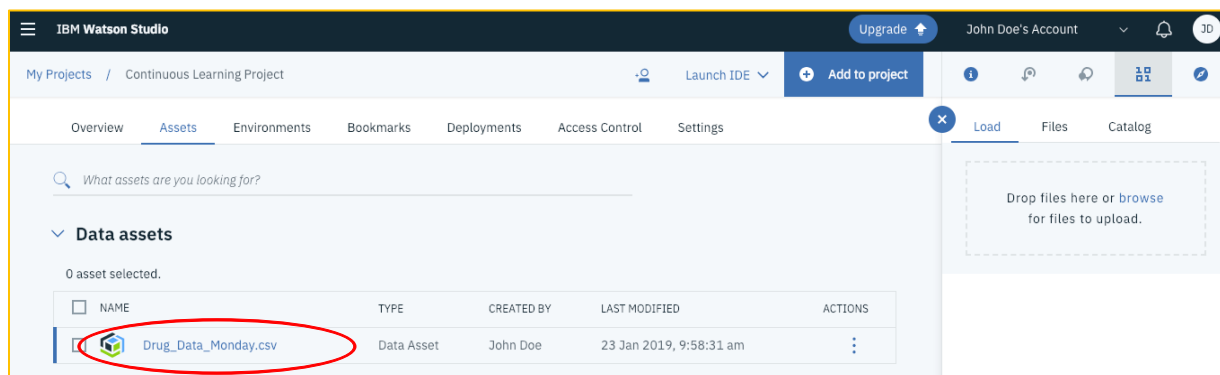
Before we build our models, we need to load data into our project.

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.



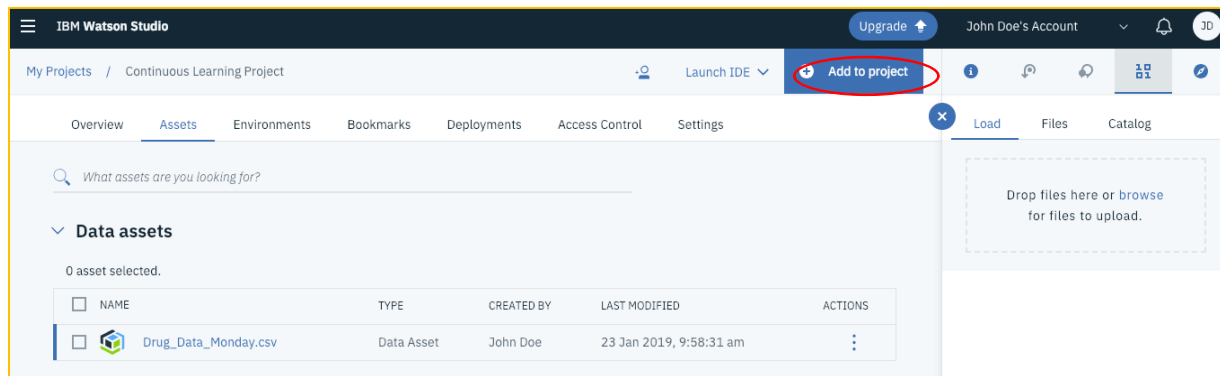
After clicking on Drug_Data_Monday.csv, you are brought to a data view. Once you are satisfied that this is the data you want, click on your project name to return to your project's assets.

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).

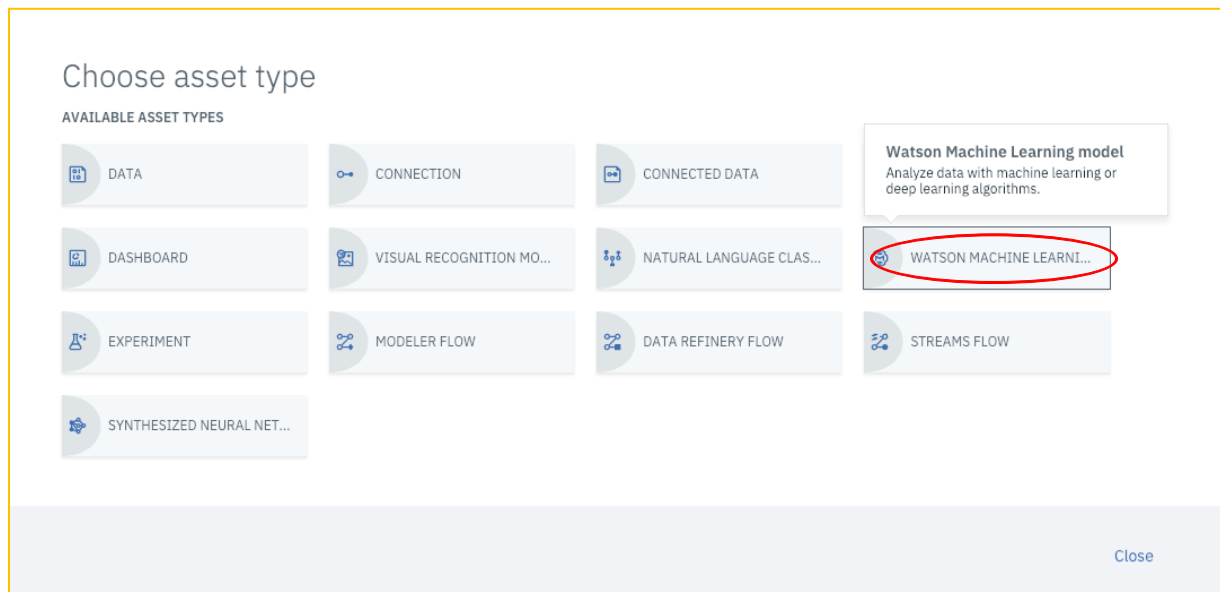
AGE	SEX	BP	CHOLESTEROL	NA	K	DRUG
Type: String	Type: String	Type: String	Type: String	Type: String	Type: String	Type: String
43	M	HIGH	HIGH	0.656371	0.046979	drugA
32	M	HIGH	NORMAL	0.52975	0.056087	drugA
37	F	HIGH	HIGH	0.559171	0.042713	drugA
24	M	HIGH	NORMAL	0.613261	0.064726	drugA
29	M	HIGH	HIGH	0.625272	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

Define model details

Name: Continuous Learning

Description:
Model description

Machine Learning Service: pm-20-us

Select model type

☒ Model builder ☐ From file ☐ From sample

Select runtime

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

Spark

Automatic
Prepare my data and create a model automatically

Manual
I will 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.

IBM Watson Studio

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.

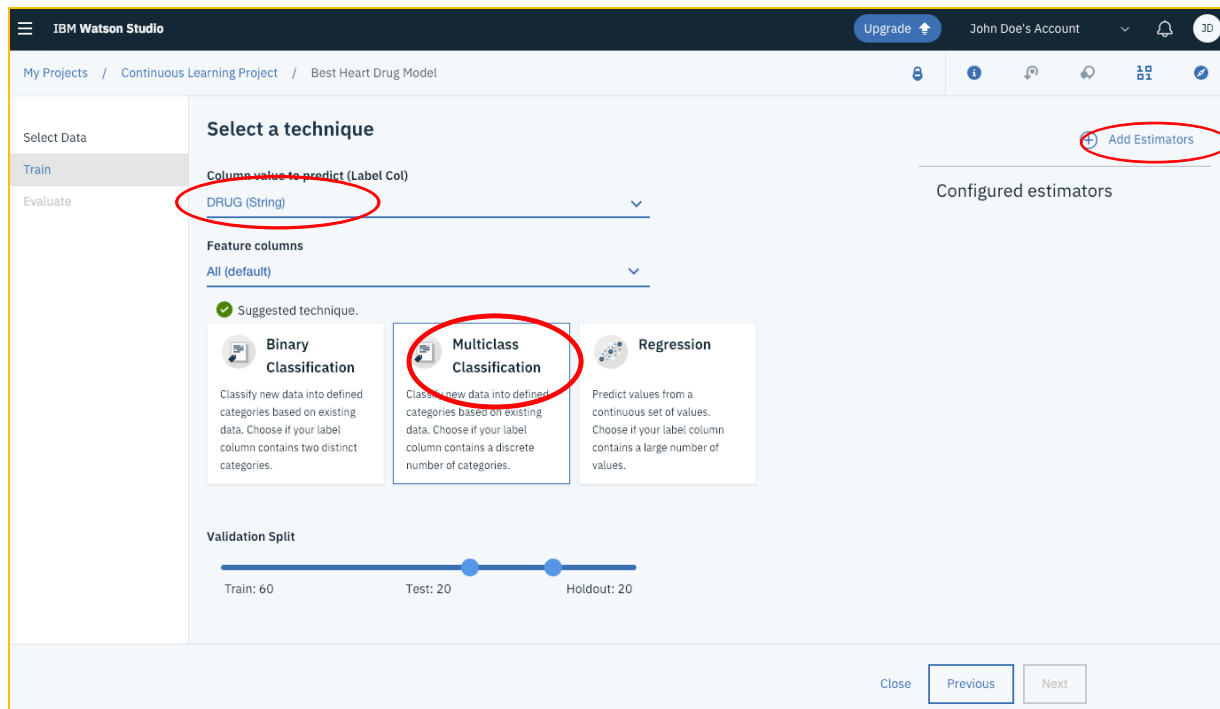
What asset are you looking for?

NAME	TYPE	SERVICE
<input checked="" type="radio"/> Drug_Data_Monday.csv	Data Asset	Project

Close Next

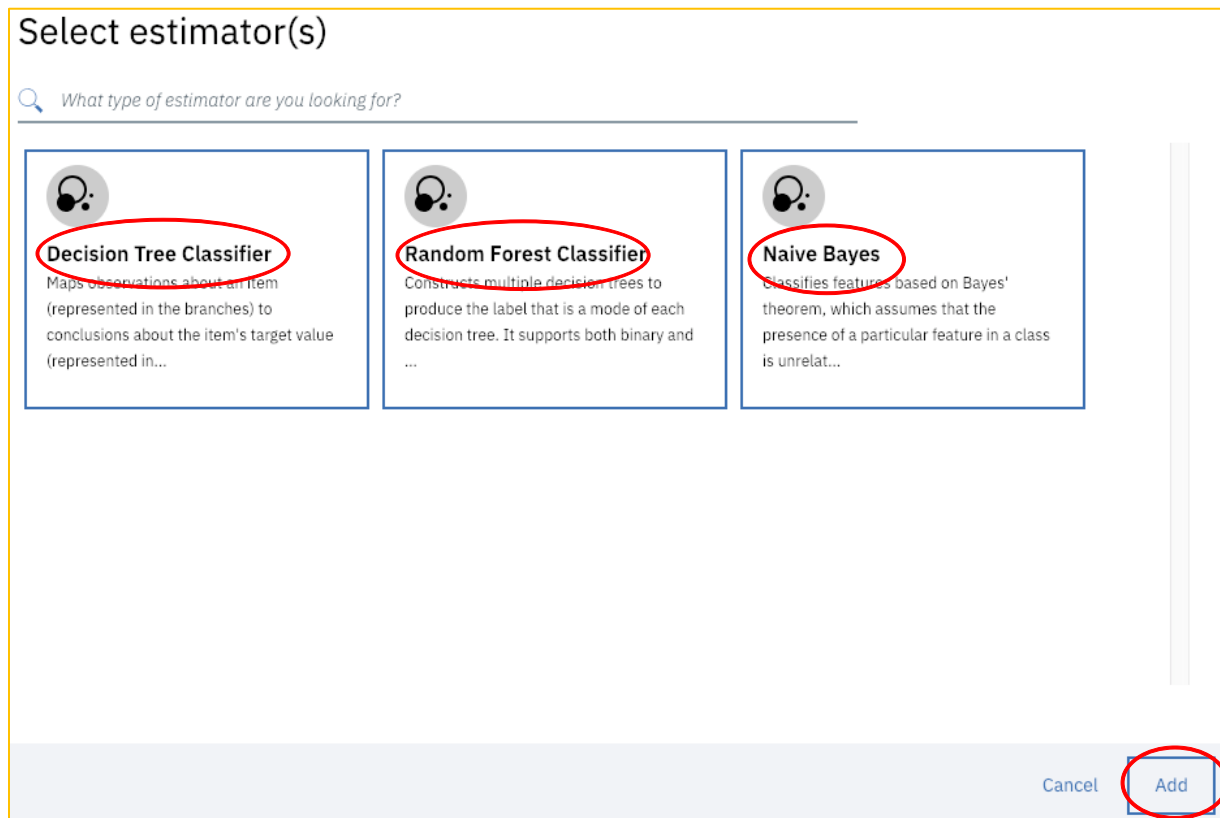
We will now choose which techniques may work well given our data and given our goal to predict which drug is the best suited for a given patient.

- 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.

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

My Projects / Continuous Learning Project / Best Heart Drug Model

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.

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

My Projects / Continuous Learning Project / Best Heart Drug Model

Select Data

Train

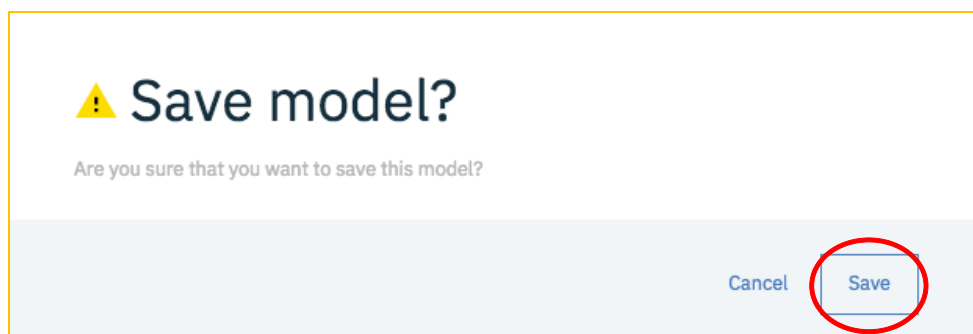
Evaluate

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.

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 four tabs: 'Overview', 'Evaluation' (which is circled in red), 'Deployments', and 'Lineage'. Under the 'Evaluation' tab, there is a 'Summary' section with a table of model details and an 'Input Schema' section with a table of column 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 for 'John Doe's Account'. The breadcrumb trail indicates the path: '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' (selected), 'Deployments', and 'Lineage'. Under the 'Evaluation' tab, there is a section 'Last Evaluation Result' containing a table of metrics. Below this is a 'Performance Monitoring' section with a text block explaining the need for a database connection and a button labeled 'Configure Performance Monitoring' which is circled in red.

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

Performance Monitoring

Configure performance monitoring to evaluate and retrain the model periodically to ensure the model performance is acceptable. You will need an existing PostgreSQL or IBM Db2 Warehouse on Cloud connection associated with your project to be used as your feedback data connection.

[Configure Performance Monitoring](#)

2. Under Spark Service or Environment, select the Spark service that was created in the prerequisites, not the Eefault 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.

Spark ▼

Prediction type
multiclass ▼

Metric details (type / optional threshold)
accuracy ▼ **.8** +

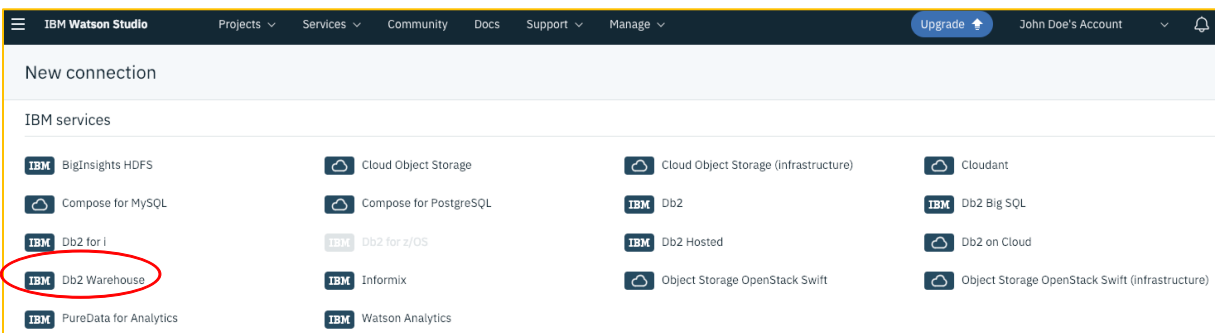
Feedback data connection (PostgreSQL or IBM Db2 Warehouse on Cloud - [Create new connection](#))
Select feedback data reference

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](#)

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.

13. Click select.

IBM Watson

ProjectsToolsCommunityServicesManageSupportDocs

IBM

MC

Select feedback data reference

ML_PoT

Connections (1)

Db2 Warehouse Connection

Db2 Warehouse Connection

>

DASH11054

Schemas (13)

DASH11054

ERRORSCHEMA

GOSALES

GOSALESDW

GOSALESHR

GSALESMR

GSALESRT

IBM_RTMON_DATA

NULLIDR1

NULLIDRA

SAMPLES

ST_INFORMTN_SCHEMA

TEST

No drilldowns currently exist.

Cancel

Select

Let's talk

15. Enter 150 as the Record count.

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

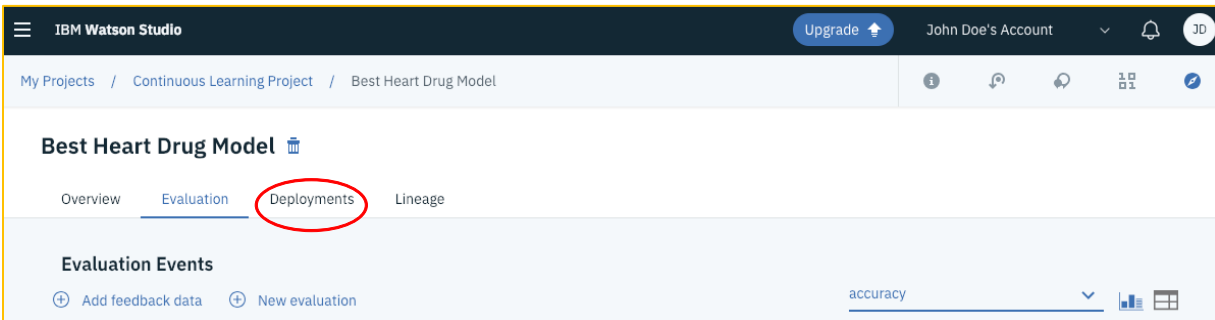
Save

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.

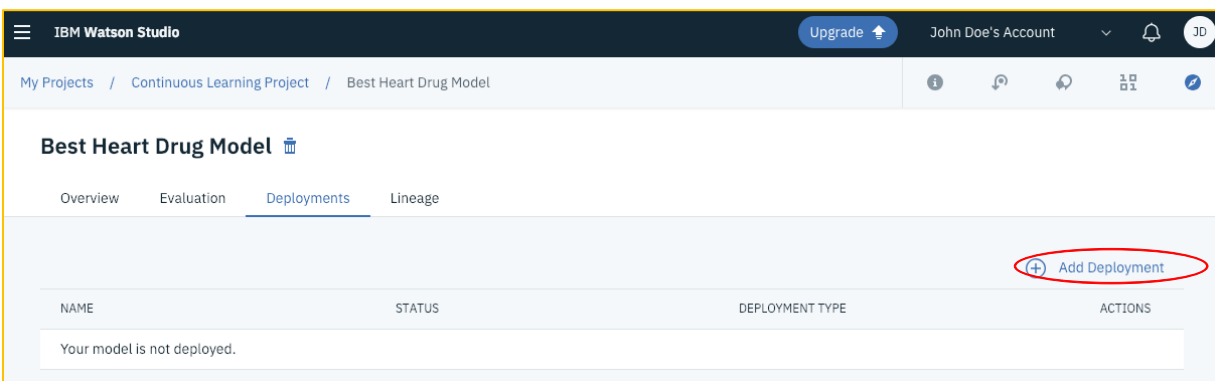
Step 4 Deploy a Machine Learning Model.

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

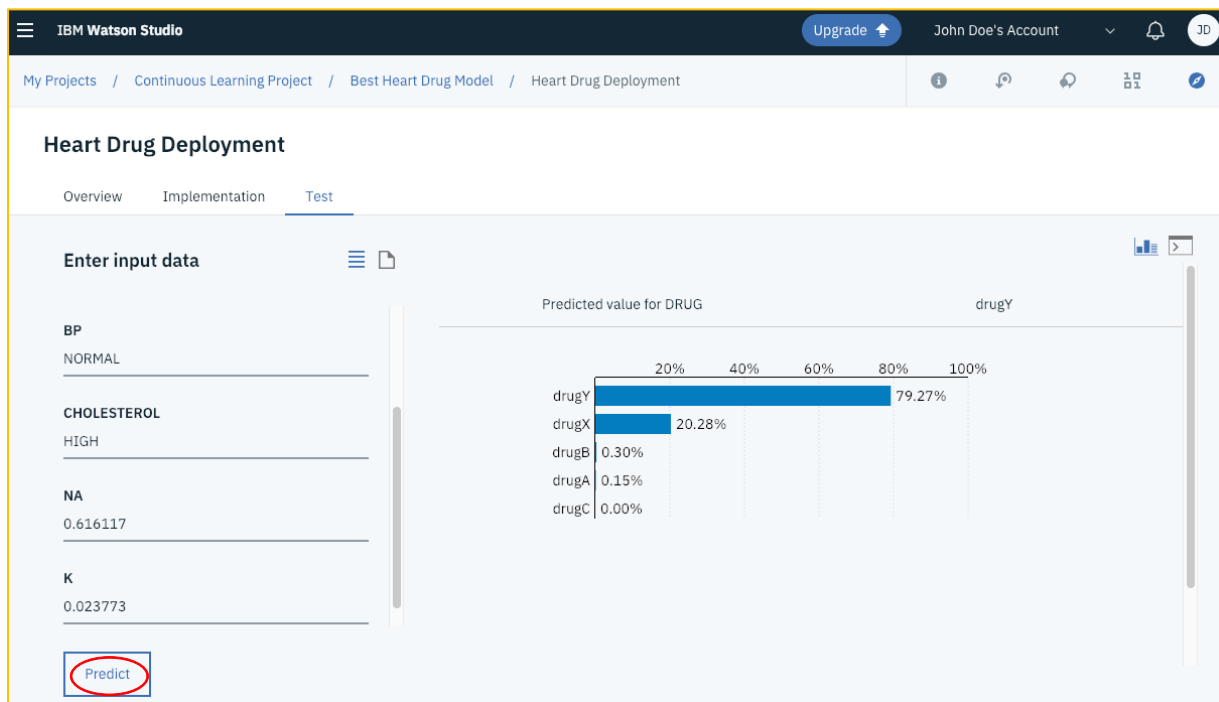
BP: NORMAL

CHOLESTEROL: HIGH

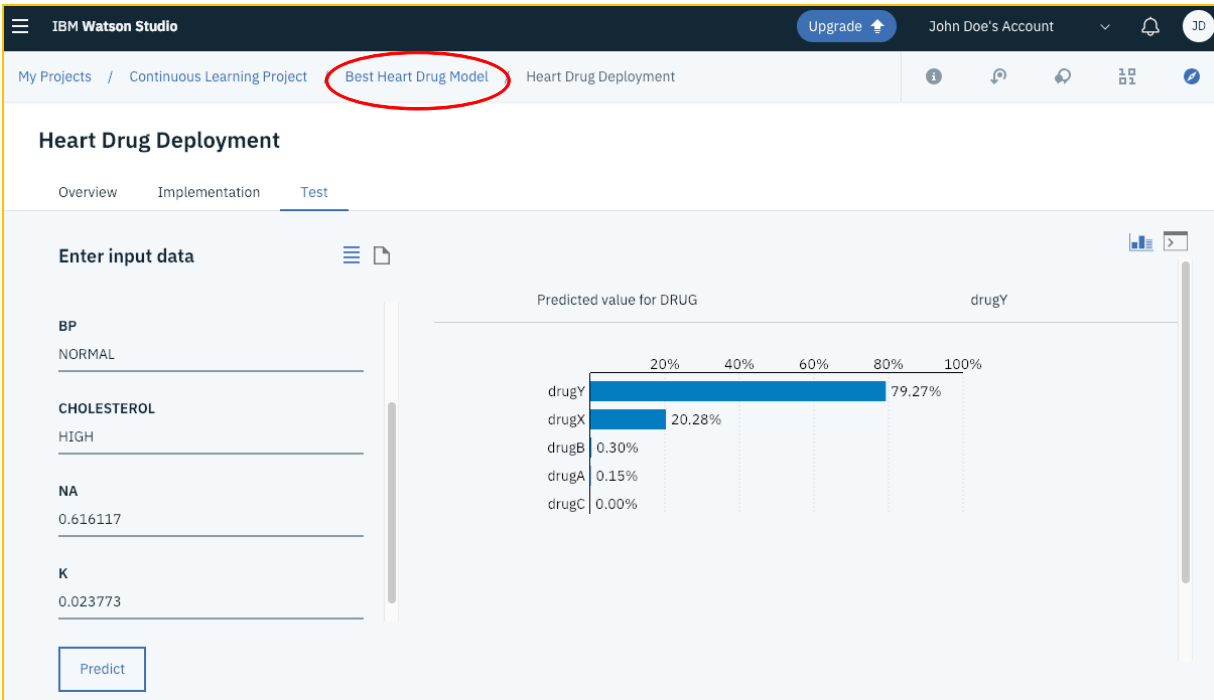
NA: 0.616117

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

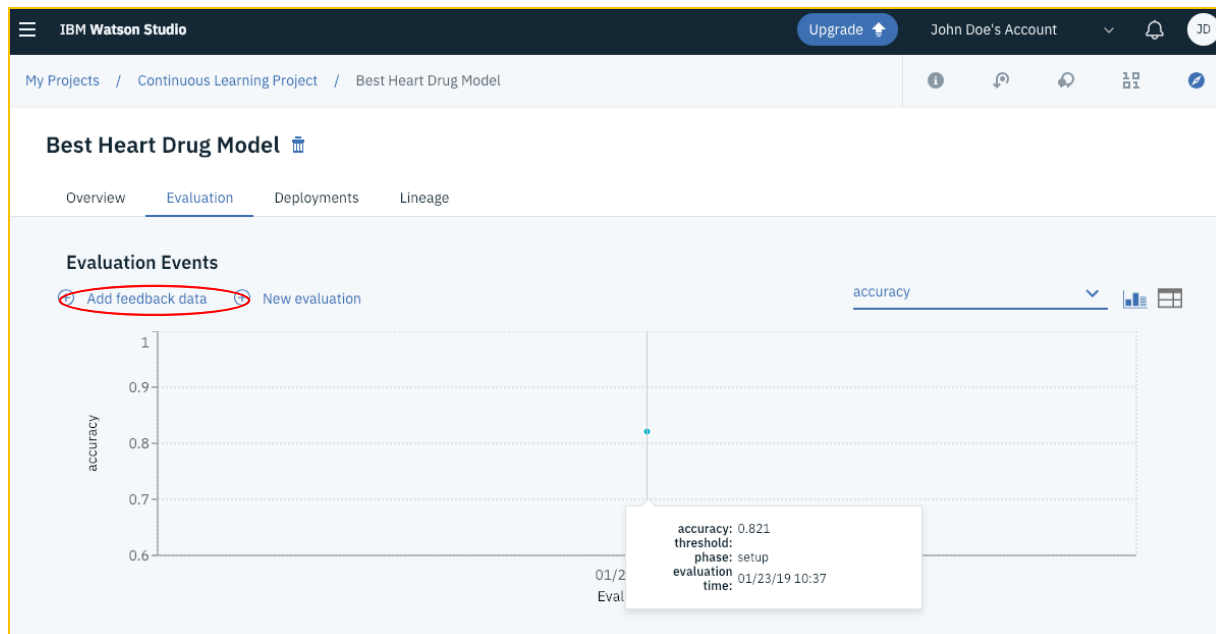
Input Schema

COLUMN	TYPE
AGE	"integer"
SEX	"string"

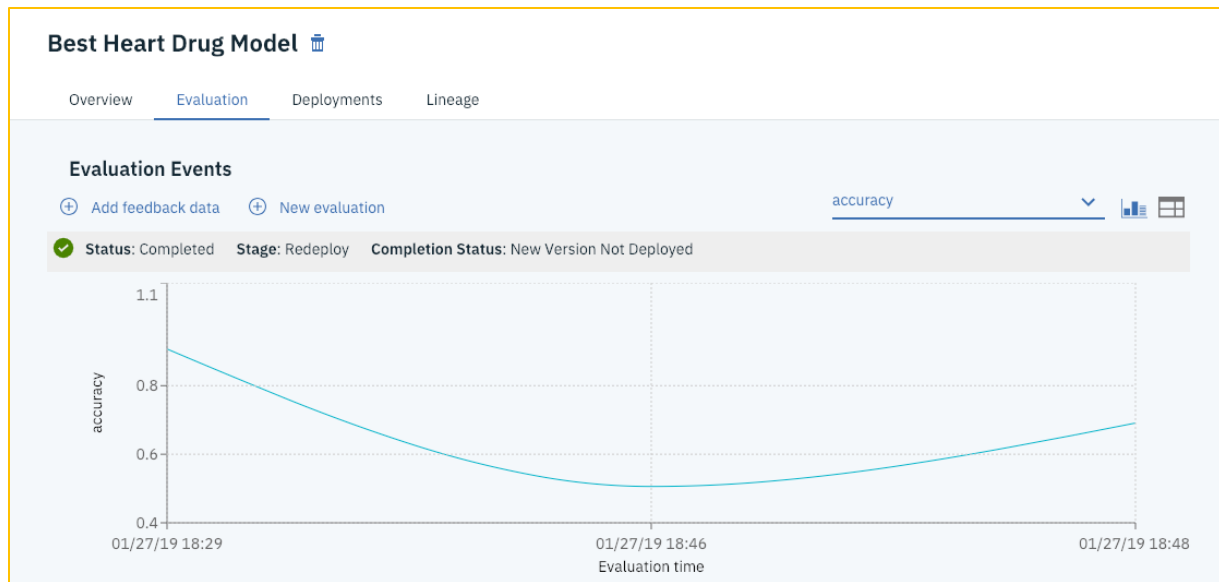
13. If you scroll to the bottom you will be able to see which model version is deployed. Currently we only have one model.

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!

- 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.