Minitab

Mastering Model Optimization with Artificial Intelligence (AI)

WELCOME TO OUR WEBINAR

Mikhail Golovnya
Senior Advisory Data Scientist

David Peralta
Area Marketing Manager

WEB-AUDIO:
Please make sure you have your computer audio system activated and your speakers turned up.

QUESTIONS:
You can enter your questions at any time in the questions section.

Minitab

About Our Speakers:

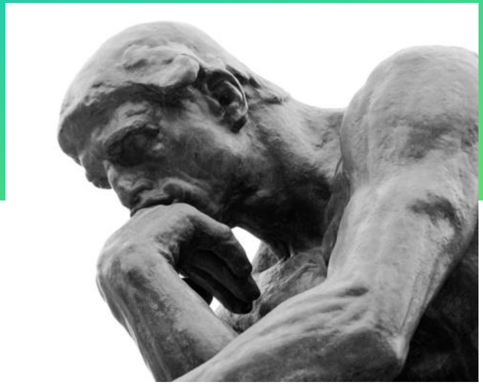
Mikhail Golovnya

Senior Advisory Data Scientist

Mikhail is a Senior Advisory Data Scientist at Minitab. He has been prototyping new machine learning algorithms and modeling automation for the past twenty years.

Mikhail has been a major contributor to Minitab’s on-going search for technological improvements among the most important algorithms in Machine Learning.

Things to Contemplate



Why?

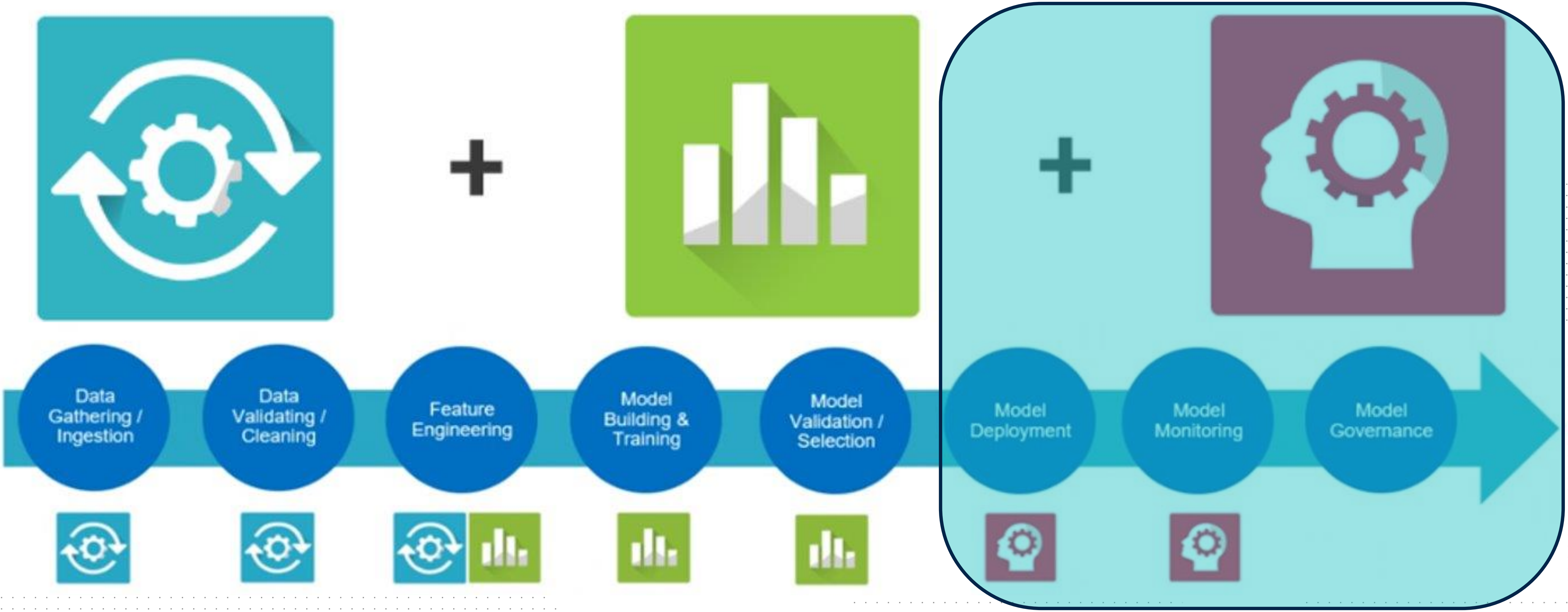
87% of machine learning models never make it into production

-Venture Beat

85% of machine learning projects fail to deliver on their intended promises

-Gartner

Predictive Analytics Workflow



Data Gathering / Ingestion

Data Validating / Cleaning

Feature Engineering

Model Building & Training

Model Validation / Selection

Model Deployment

Model Monitoring

Model Governance

Deployment Approaches

How can we operationalize a predictive analytics solution (PA model) to a problem?

Traditional answer: encode model equation

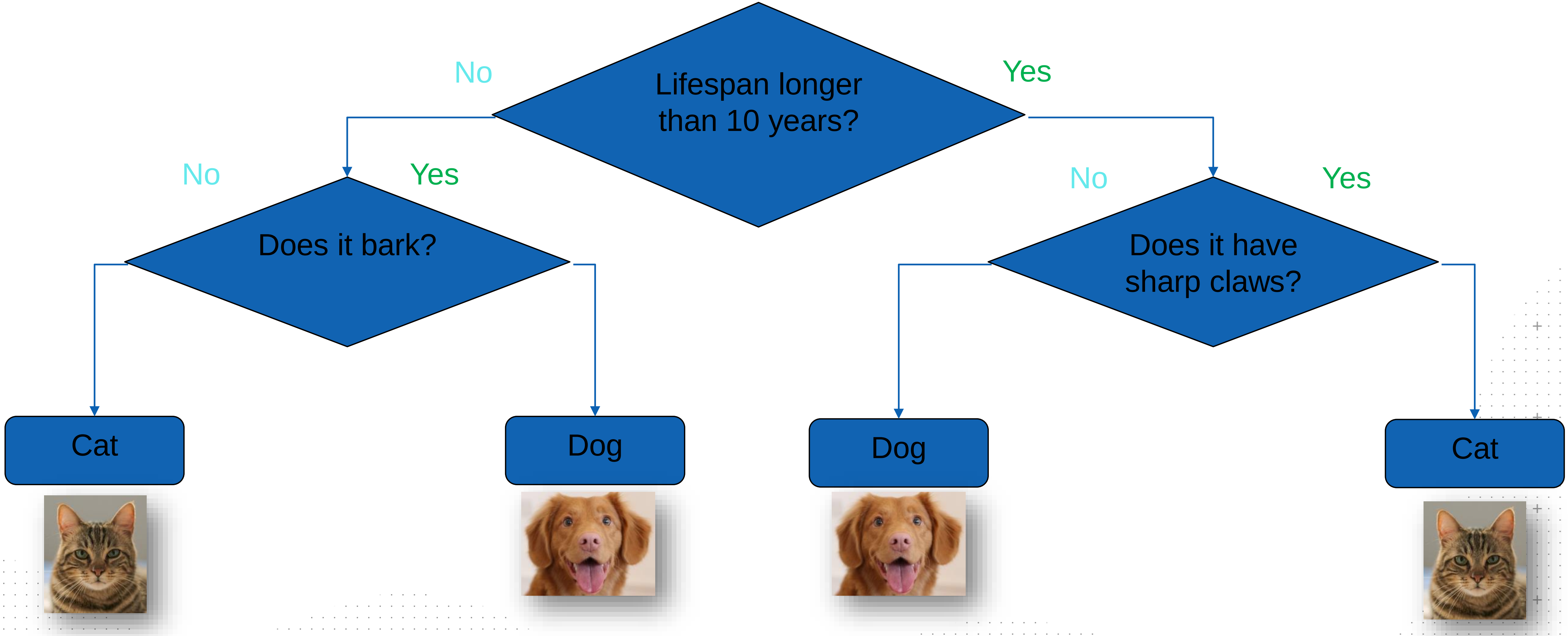
Modern Answer: deploy model universally in Model Ops

Survey 1

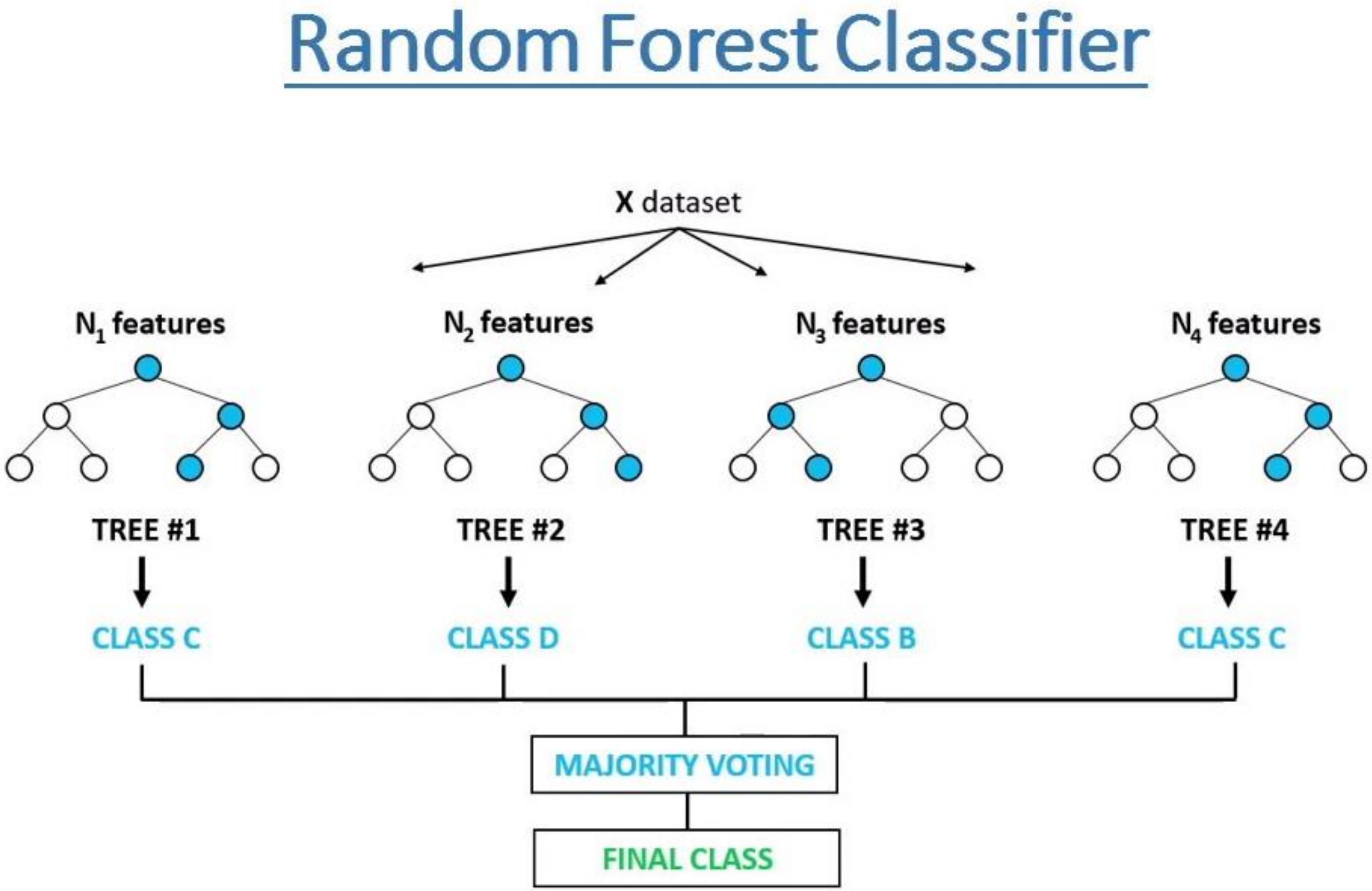
- How often do you need to operationalize your models?
  - Never
  - Sometimes
  - Always

Equation-Based Deployment

CART Has No Equation



Random Forest is a Black Box



Random Forest Classifier

X dataset

N_1 features

N_2 features

N_3 features

N_4 features

TREE #1 → CLASS C

TREE #2 → CLASS D

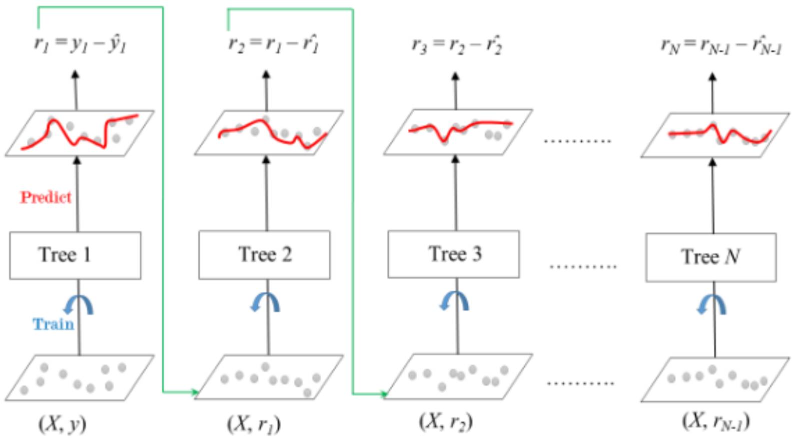
TREE #3 → CLASS B

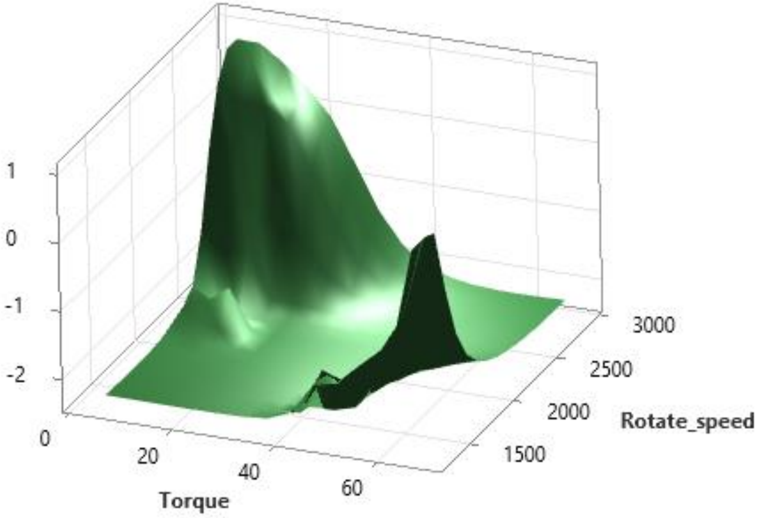
TREE #4 → CLASS C

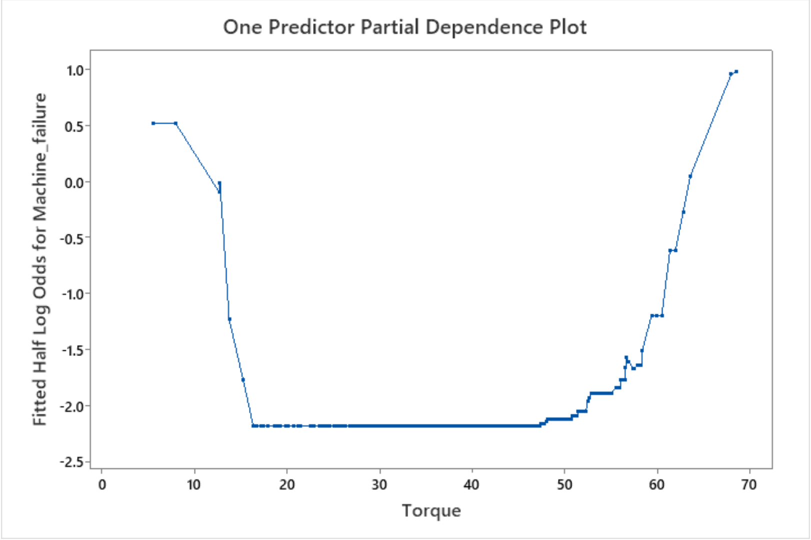
MAJORITY VOTING

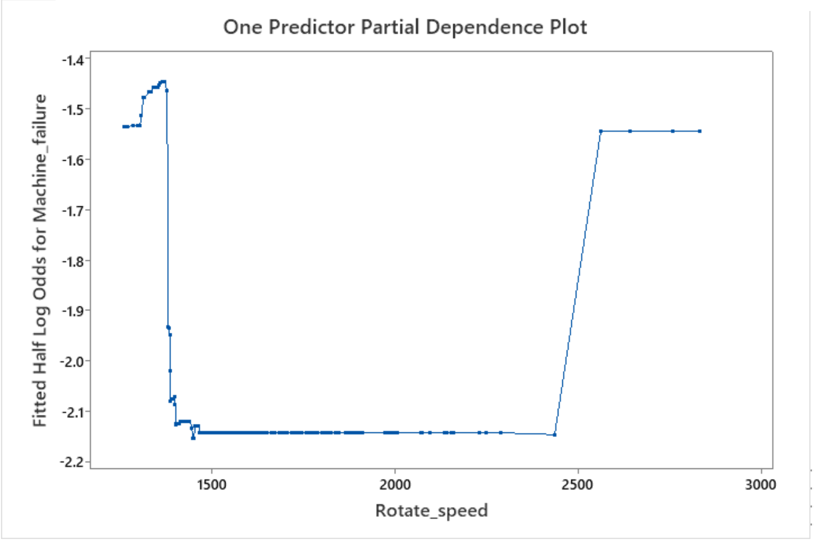
FINAL CLASS

TreeNet is an Enigma





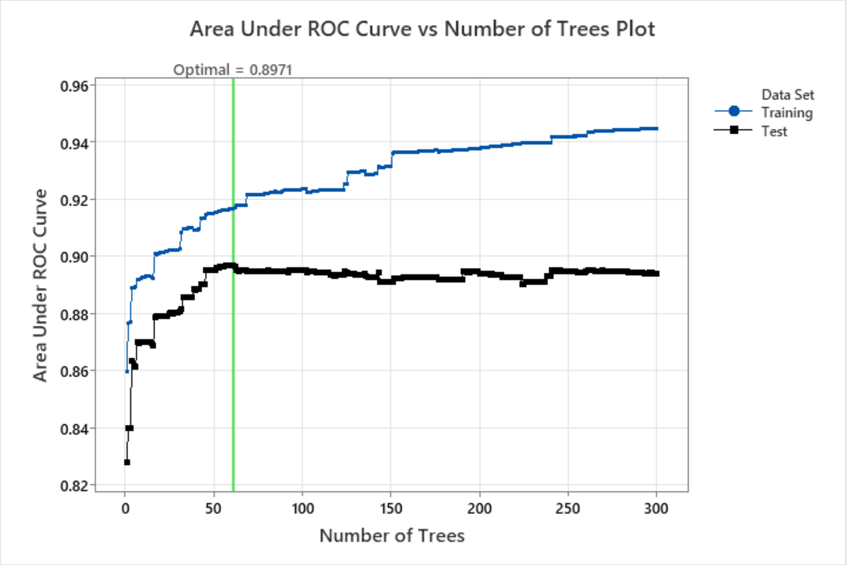




An Idea!

- Take the TreeNet plots and fit them with conventional parametric functions
  - Alternatively: construct splines using the cutoff points identified on the TreeNet plots
- Apply these functions to the original predictors as univariate transformations to obtain derived features
- Use the derived features to fit conventional linear or logistic regression
- Don’t worry about getting the scaling right, let the regression do it

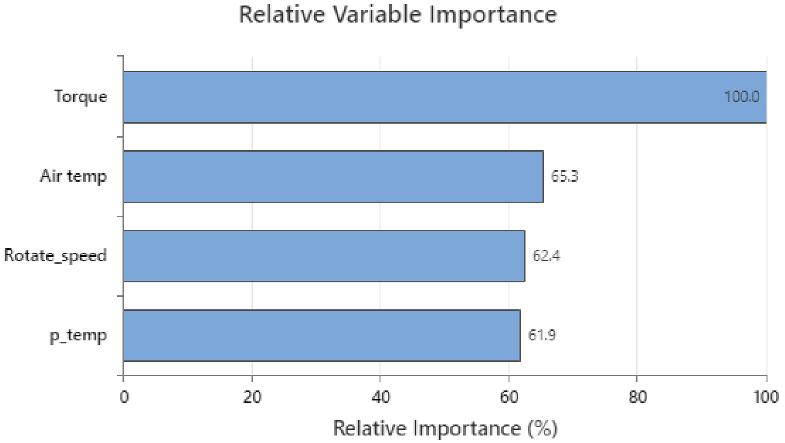
TreeNet Model (Classification)



Model Summary

Total predictors	4
Important predictors	4
Number of trees grown	300
Optimal number of trees	61

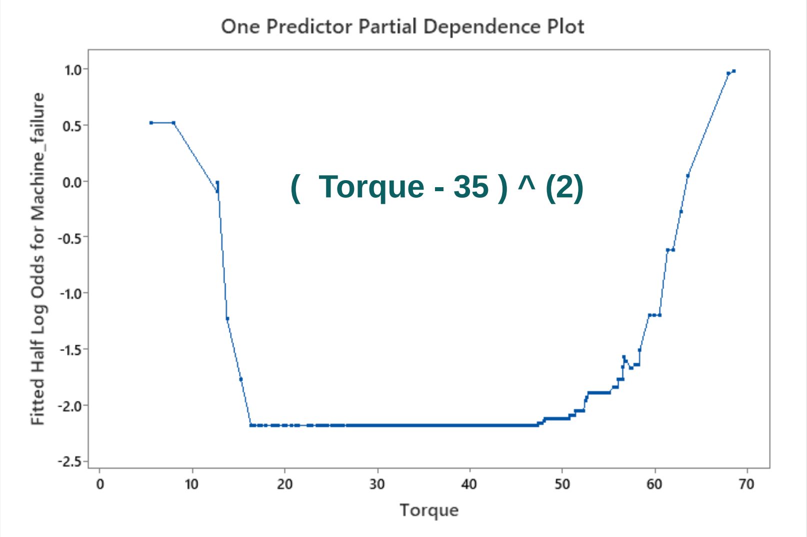
Statistics	Training	Test
Average -loglikelihood	0.0734	0.0798
Area under ROC curve	0.9168	0.8971
95% CI	(0.8924, 0.9412)	(0.8568, 0.9374)
Lift	8.0579	7.5258
Misclassification rate	0.0196	0.0222



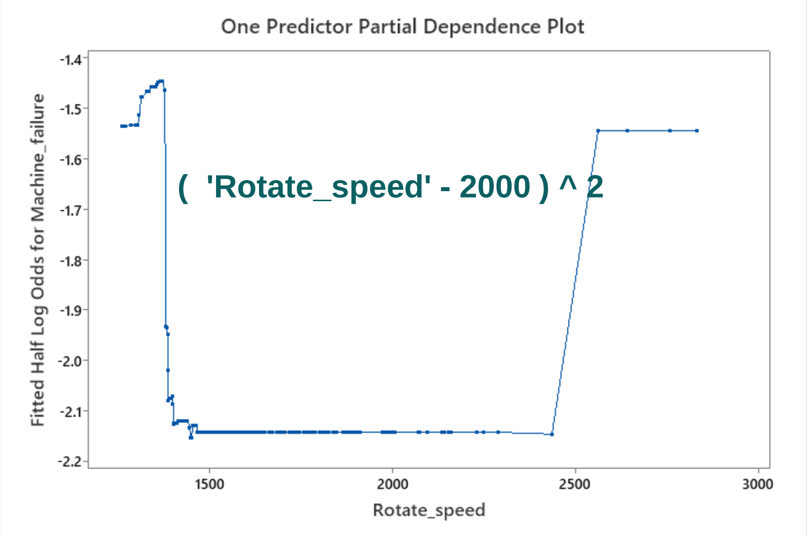
Compare Algorithms (ROC)

CART:	0.84
RandomForest:	0.89
TreeNet:	**0.90**

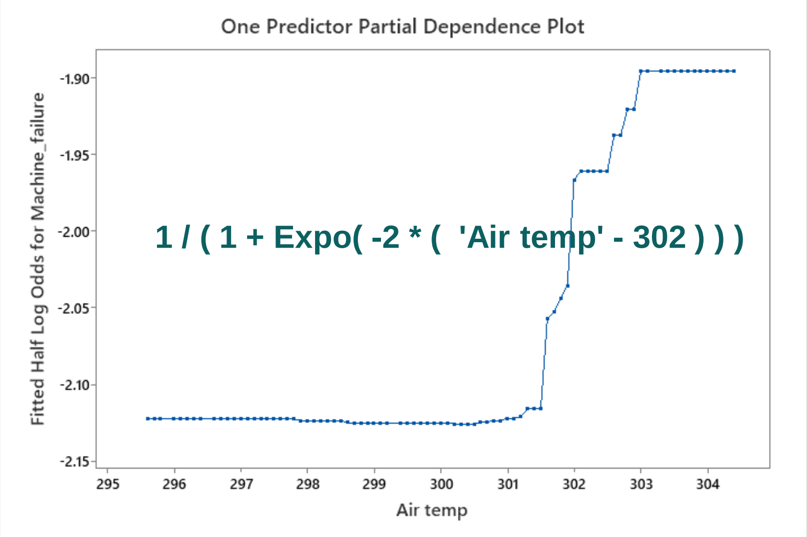
Guess the Equation!


One Predictor Partial Dependence Plot

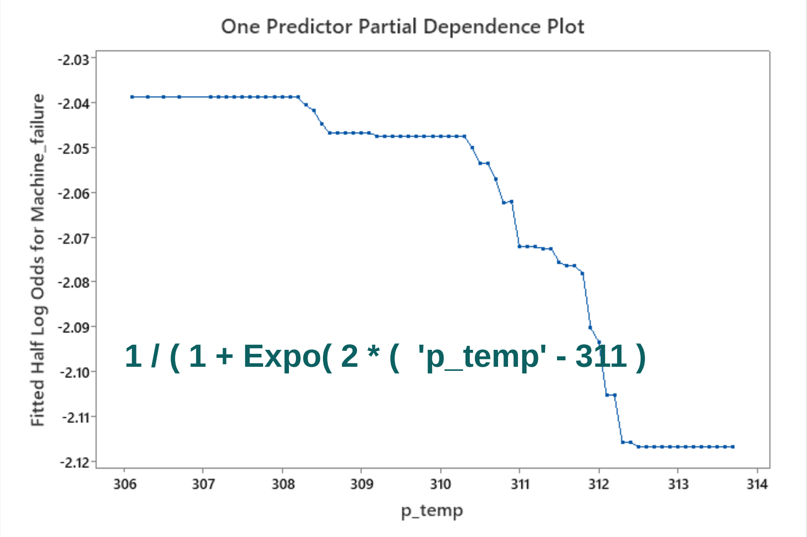
(Torque - 35) ^ (2)


One Predictor Partial Dependence Plot

('Rotate_speed' - 2000) ^ 2


One Predictor Partial Dependence Plot

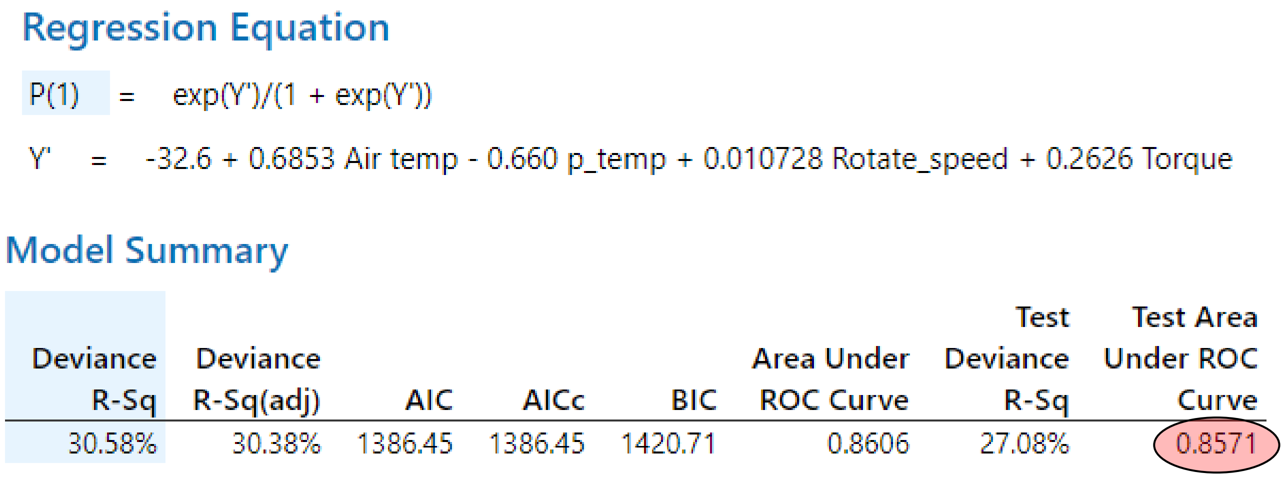
1 / (1 + Expo(-2 * ('Air temp' - 302)))


One Predictor Partial Dependence Plot

1 / (1 + Expo(2 * ('p_temp' - 311)

Build a Conventional Model

- Original Model



Regression Equation

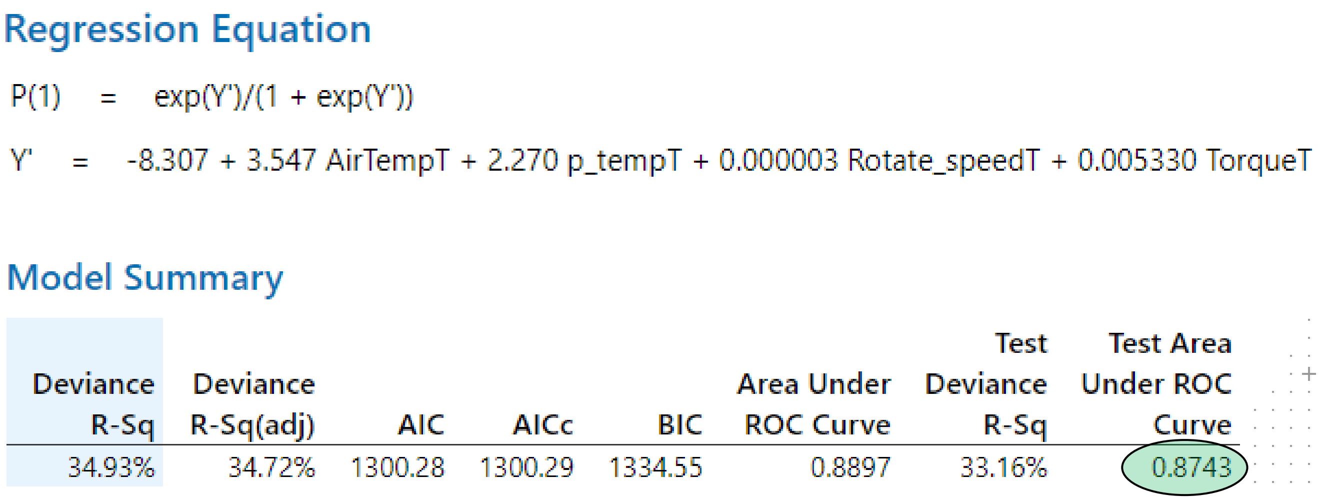
P(1) = exp(Y')/(1 + exp(Y'))

Y' = -32.6 + 0.6853 Air temp - 0.660 p_temp + 0.010728 Rotate_speed + 0.2626 Torque

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve	Test Deviance R-Sq	Test Area Under ROC Curve
30.58%	30.38%	1386.45	1386.45	1420.71	0.8606	27.08%	0.8571

- New Model



Regression Equation

P(1) = exp(Y')/(1 + exp(Y'))

Y' = -8.307 + 3.547 AirTempT + 2.270 p_tempT + 0.000003 Rotate_speedT + 0.005330 TorqueT

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve	Test Deviance R-Sq	Test Area Under ROC Curve
34.93%	34.72%	1300.28	1300.29	1334.55	0.8897	33.16%	0.8743

Summary of the Procedure

- We can use TreeNet to **automatically** discover the nature of non-linearities and then use this knowledge to improve conventional models
- **Residual loss** can be assessed by comparing the original TreeNet model performance with the improved conventional model performance
- Not capturing **interactions** is the usual culprit to explain the residual loss in accuracy
- Another way to get the formula is to use MARS

Survey 2

- Do you need to deploy/operationalize your models outside of MSS (universal deployment)?
  - Yes
  - No

Universal Deployment

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Minitab Model Ops™

Minitab Model Ops – a comprehensive platform to deploy, manage, and monitor predictive analytics models

Bridge the gap between model creation and model production with a simple, yet powerful Model Ops platform.

Build your models in Minitab Statistical Software and deploy them in **Minitab Model Ops**.

Key Steps to Model Deployment

- **Import** (upload) a model into Model Ops
- **Deploy** (turn on) a model in Model Ops
- **Activate** (access) a model in Model Ops
- **Score** records in real time

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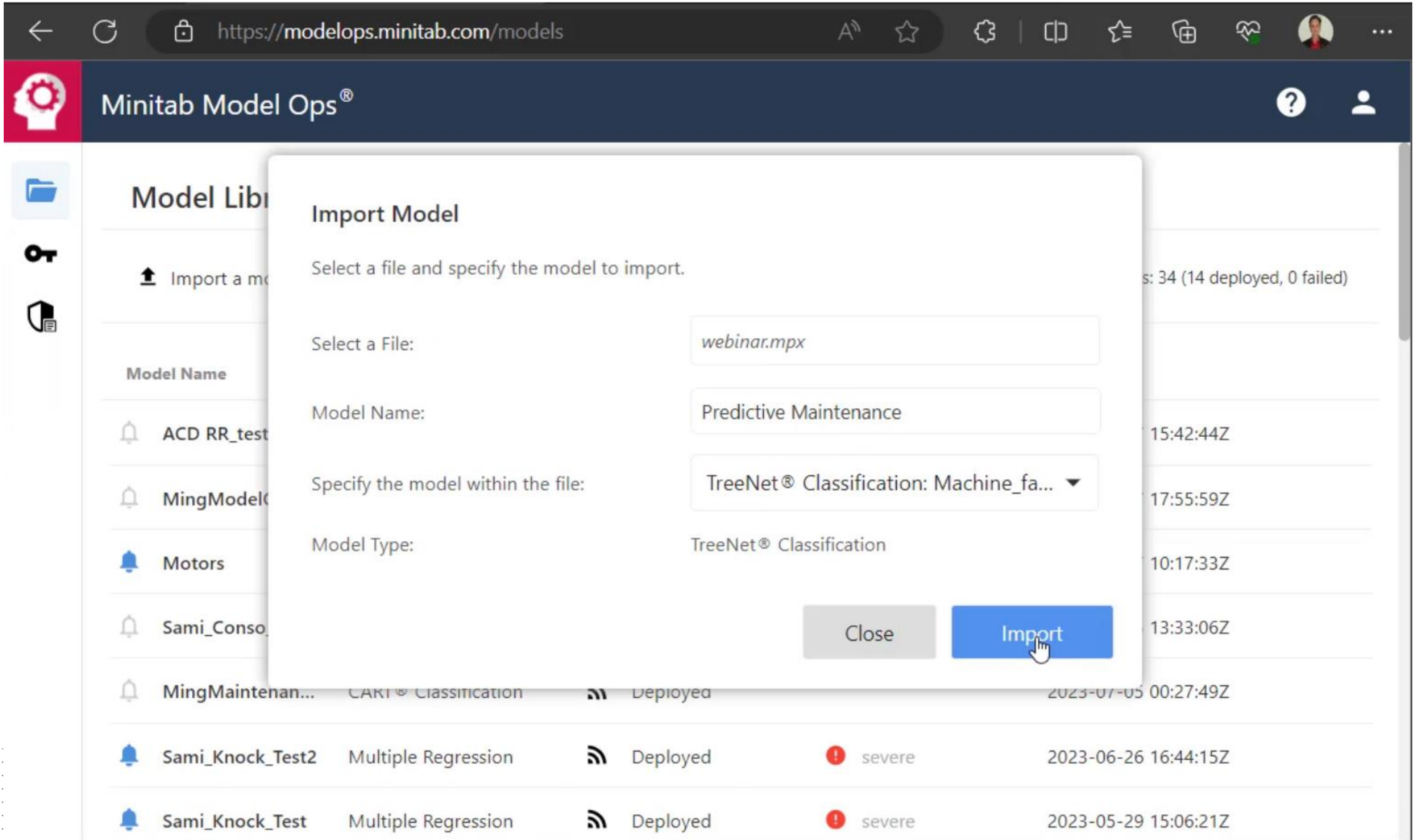
Step 1: Importing a Model into Model Ops


https://modelops.minitab.com/models
Minitab Model Ops®
Model Libı
Import a mo
s: 34 (14 deployed, 0 failed)
Model Name
Close
Import

Import Model

Select a file and specify the model to import.

Select a File: *webinar.mpx*

Model Name: Predictive Maintenance

Specify the model within the file: TreeNet® Classification: Machine_fa...

Model Type: TreeNet® Classification

Model Name				
ACD RR_test				15:42:44Z
MingModel(				17:55:59Z
Motors				10:17:33Z
Sami_Conso				13:33:06Z
MingMaintenan...	CART® Classification	Deployed		2023-07-05 00:27:49Z
Sami_Knock_Test2	Multiple Regression	Deployed	severe	2023-06-26 16:44:15Z
Sami_Knock_Test	Multiple Regression	Deployed	severe	2023-05-29 15:06:21Z

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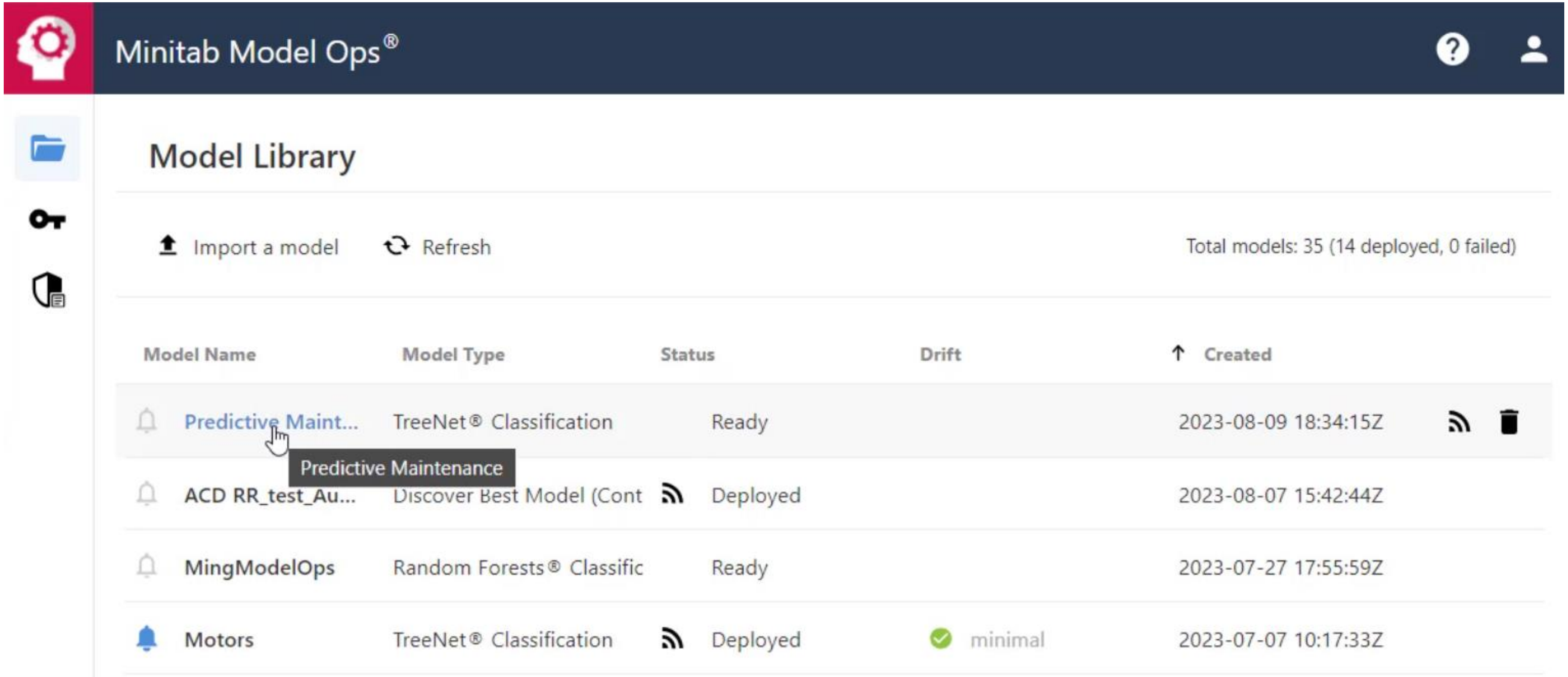
The Model is Available



Minitab Model Ops®

Model Library

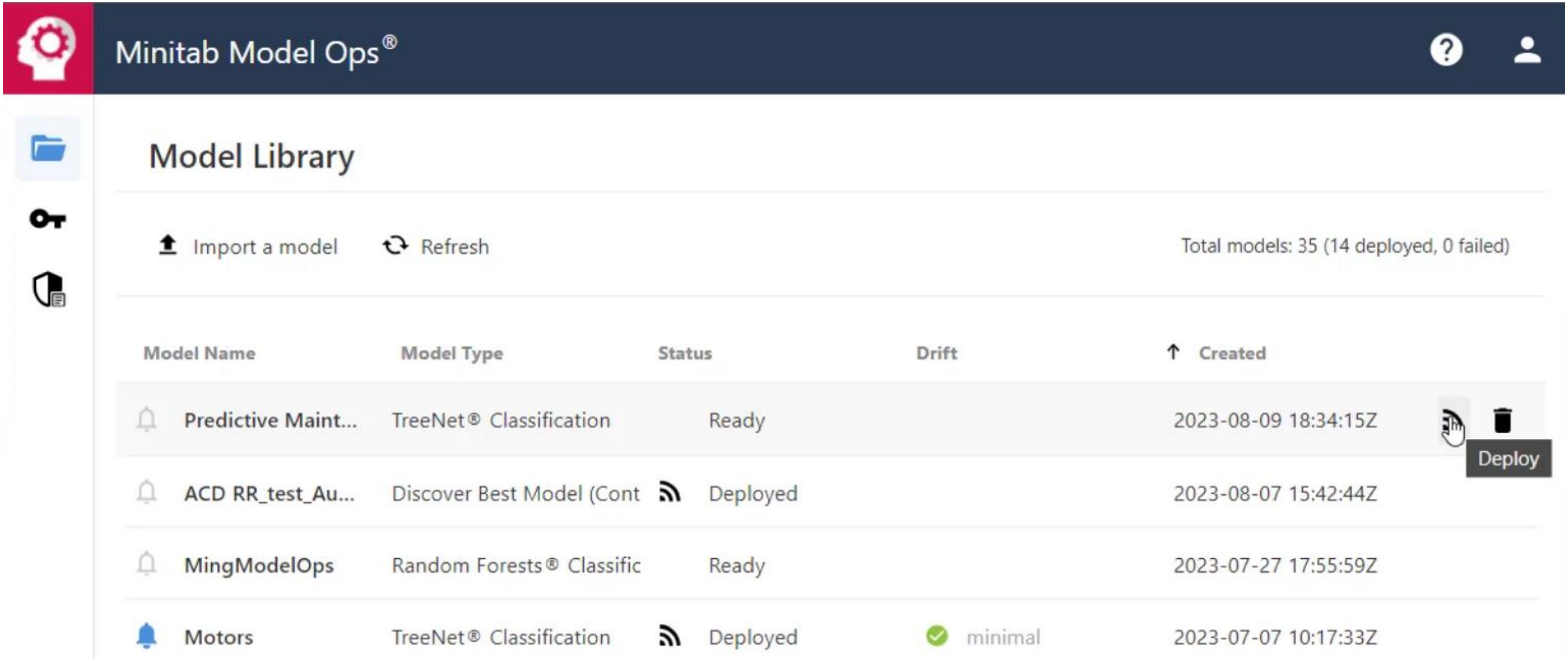
Import a model   Refresh   Total models: 35 (14 deployed, 0 failed)

Model Name	Model Type		Status	Drift		↑ Created
Predictive Maint...	TreeNet® Classification		Ready			2023-08-09 18:34:15Z
ACD RR_test_Au...	Discover Best Model (Cont		Deployed			2023-08-07 15:42:44Z
MingModelOps	Random Forests® Classific		Ready			2023-07-27 17:55:59Z
Motors	TreeNet® Classification		Deployed	✓	minimal	2023-07-07 10:17:33Z

Predictive Maintenance

- The model is now available for deployment

Step 2: Deploying a Model



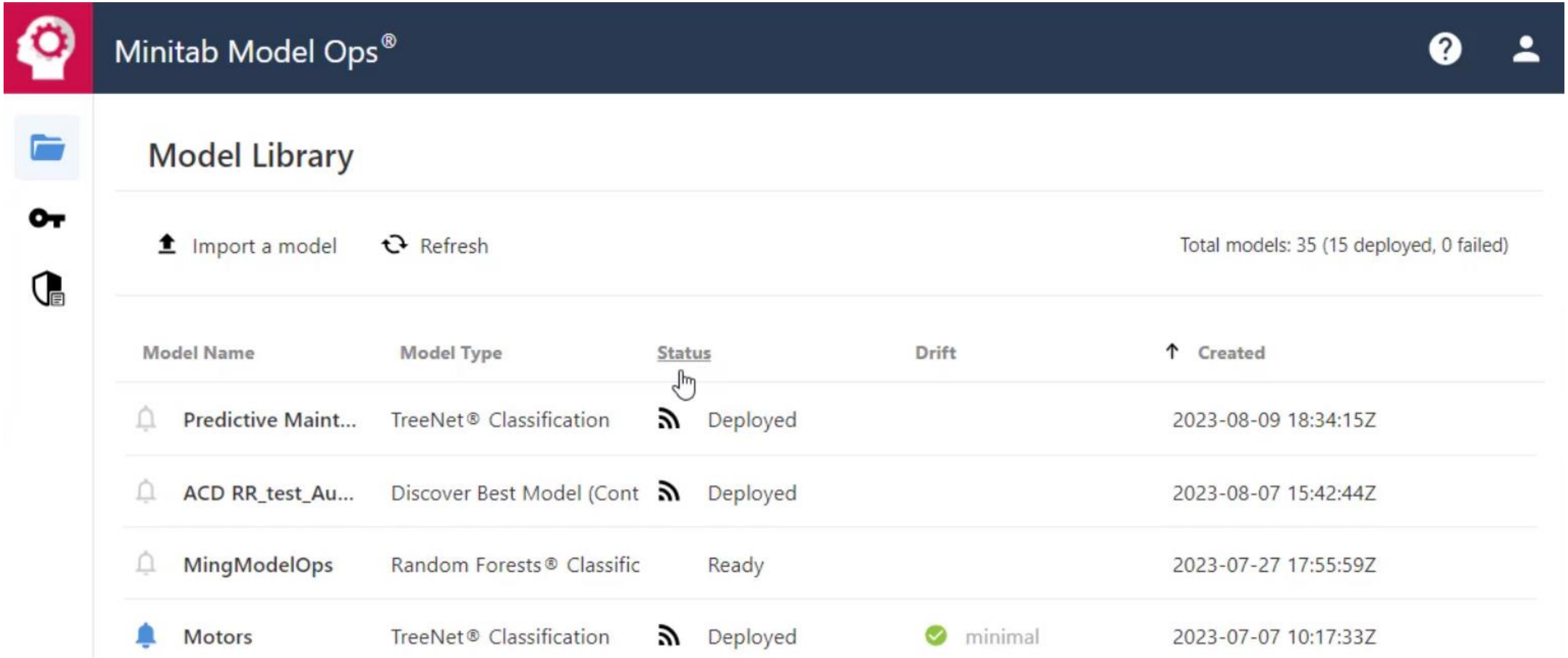
Minitab Model Ops®

Model Library

Total models: 35 (14 deployed, 0 failed)

Model Name	Model Type	Status	Drift	↑ Created
Predictive Maint...	TreeNet® Classification	Ready		2023-08-09 18:34:15Z
ACD RR_test_Au...	Discover Best Model (Cont	Deployed		2023-08-07 15:42:44Z
MingModelOps	Random Forests® Classific	Ready		2023-07-27 17:55:59Z
Motors	TreeNet® Classification	Deployed	✓ minimal	2023-07-07 10:17:33Z

The Model is Deployed



Minitab Model Ops®

Model Library

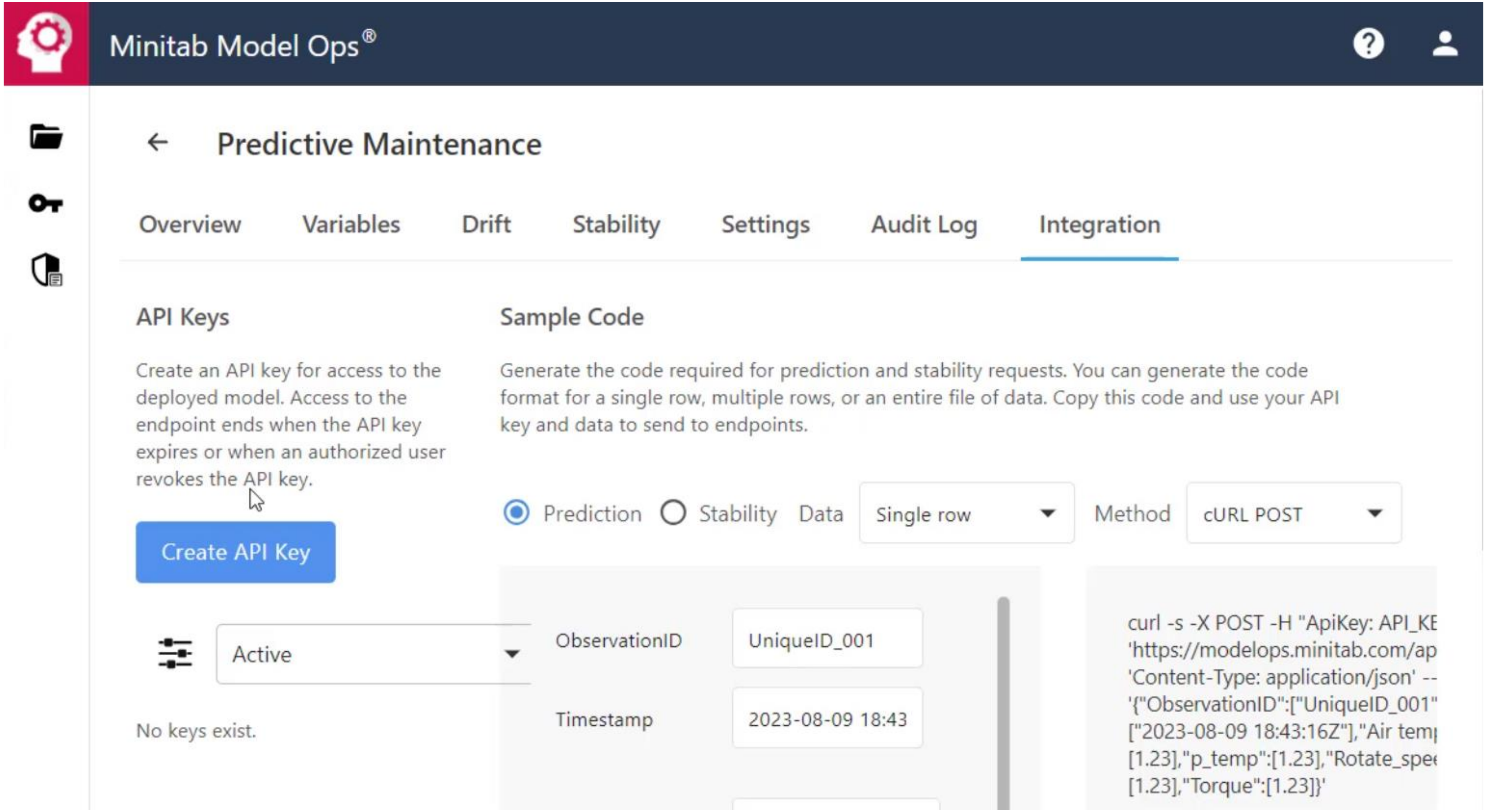
Import a model | Refresh

Total models: 35 (15 deployed, 0 failed)

	Model Name	Model Type	Status	Drift	↑ Created
	Predictive Maint...	TreeNet® Classification	Deployed		2023-08-09 18:34:15Z
	ACD RR_test_Au...	Discover Best Model (Cont	Deployed		2023-08-07 15:42:44Z
	MingModelOps	Random Forests® Classific	Ready		2023-07-27 17:55:59Z
	Motors	TreeNet® Classification	Deployed	✓ minimal	2023-07-07 10:17:33Z

- The model is now deployed

Step 3: Activating a Model



Predictive Maintenance

API Keys

Create an API key for access to the deployed model. Access to the endpoint ends when the API key expires or when an authorized user revokes the API key.

Active

No keys exist.

Sample Code

Generate the code required for prediction and stability requests. You can generate the code format for a single row, multiple rows, or an entire file of data. Copy this code and use your API key and data to send to endpoints.

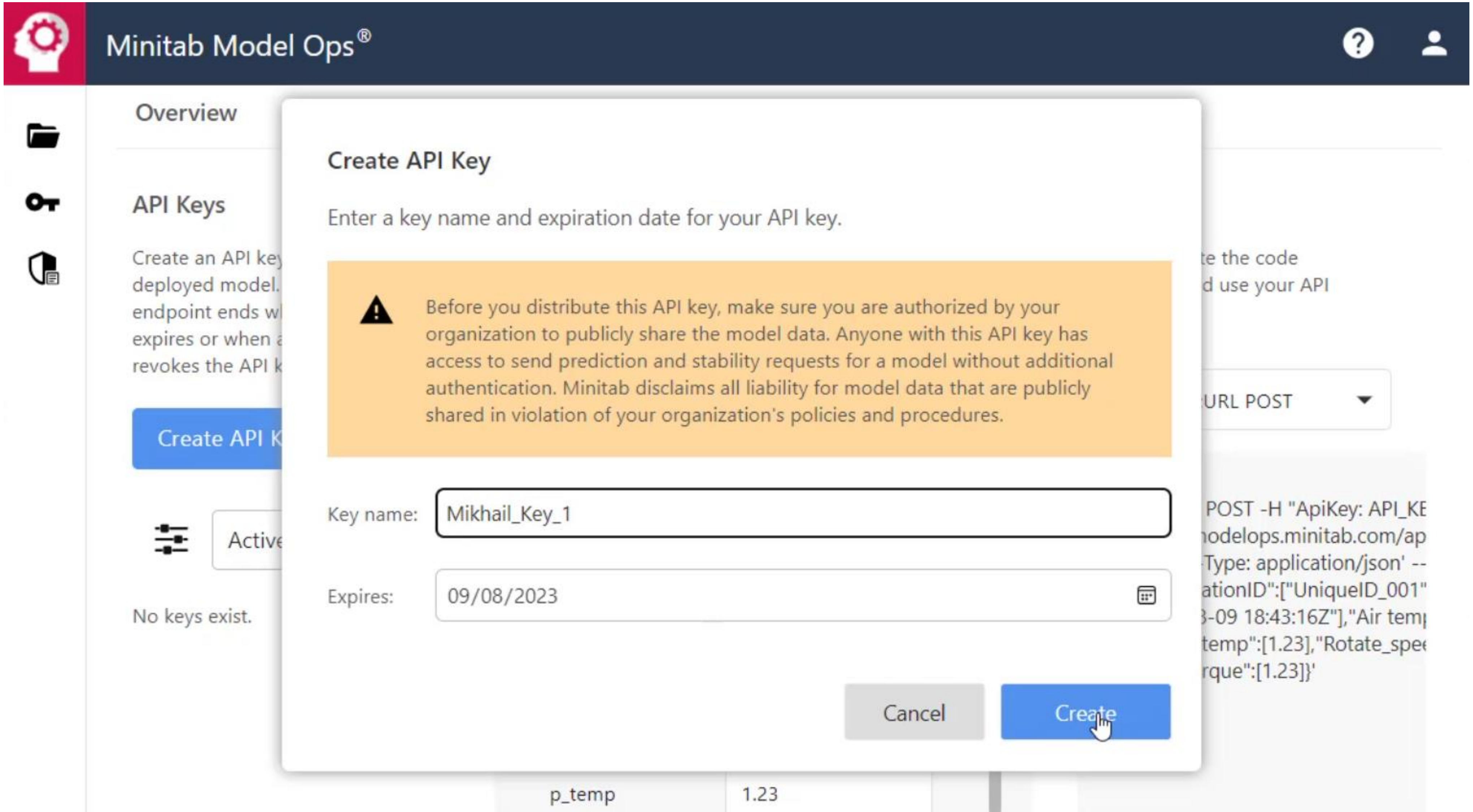
● Prediction ○ Stability Data: Single row Method: cURL POST

ObservationID: UniqueID_001

Timestamp: 2023-08-09 18:43

```
curl -s -X POST -H "ApiKey: API_KE
'https://modelops.minitab.com/ap
'Content-Type: application/json' --
'{"ObservationID":["UniqueID_001"
["2023-08-09 18:43:16Z"],"Air temp
[1.23],"p_temp":[1.23],"Rotate_spee
[1.23],"Torque":[1.23]}'
```

Creating API Key



Create API Key

Enter a key name and expiration date for your API key.

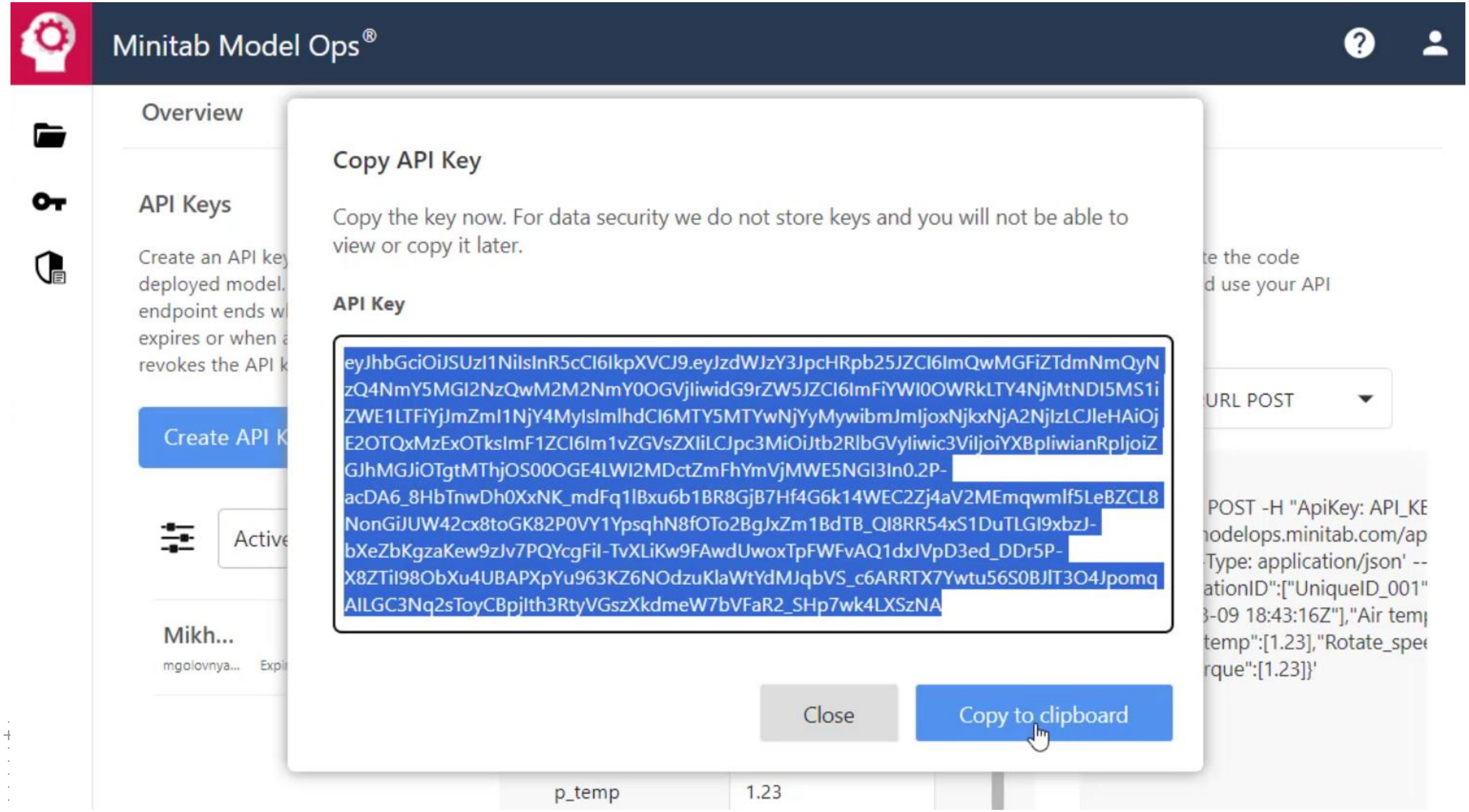
⚠ Before you distribute this API key, make sure you are authorized by your organization to publicly share the model data. Anyone with this API key has access to send prediction and stability requests for a model without additional authentication. Minitab disclaims all liability for model data that are publicly shared in violation of your organization's policies and procedures.

Key name: Mikhail_Key_1

Expires: 09/08/2023

Cancel | Create

Saving API Key



```
POST -H "ApiKey: API_KE
nodelops.minitab.com/ap
Type: application/json' --
ationID":["UniqueID_001"
3-09 18:43:16Z"],"Air temp
temp":[1.23],"Rotate_spee
rque":[1.23]}'
```

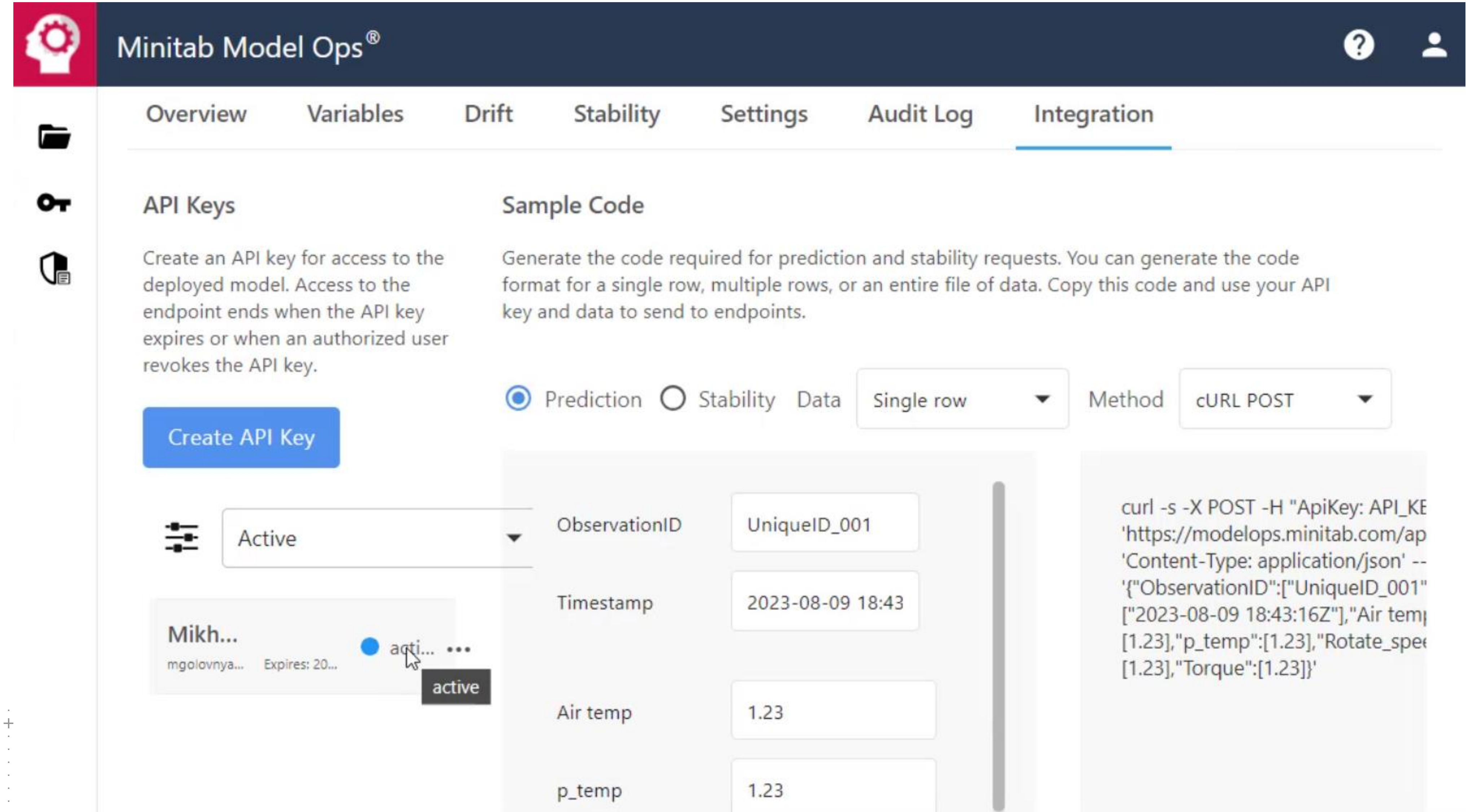
Copy API Key

Copy the key now. For data security we do not store keys and you will not be able to view or copy it later.

API Key

```
eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWJzY3JpcHRpb25JZCI6ImQwMGFiZTdmNmQyN
zQ4NmY5MGI2NzQwM2M2NmY0OGVjIiwidG9rZW5JZCI6ImFiYWI0OWRkLTY4NjMtNDI5MS1i
ZWE1LTFiYjJmZmI1NjY4MyIsImlhdCI6MTY5MTYwNjYyMywibmJmIjoxNjkxNjA2NjIzLCJleHAiOj
E2OTQxMzExOTksImF1ZCI6Im1vZGVsZXIiLCJpc3MiOiJtb2RlbGVyIiwic3ViIjoiYXBpIiwianRpIjoiZ
GJhMGJiOTgtMThjOS00OGE4LWI2MDctZmFhYmVjMWE5NGI3In0.2P-
acDA6_8HbTnwDh0XxNK_mdFq1lBxu6b1BR8GjB7Hf4G6k14WEC2Zj4aV2MEmqwmlf5LeBZCL8
NonGiJUW42cx8toGK82P0VY1YpsqhN8fOTo2BgJxZm1BdTB_QI8RR54xS1DuTLGI9xbzJ-
bXeZbKgzaKew9zJv7PQYcgFiI-TvXLiKw9FAwdUwoxTpFWFvAQ1dxJVpD3ed_DDr5P-
X8ZTiI98ObXu4UBAPXpYu963KZ6NOdzuKlaWtYdMJqbVS_c6ARRTX7Ywtu56S0BJlT3O4Jpomq
AILGC3Nq2sToyCBpjIth3RtyVGszXkdmeW7bVFaR2_SHp7wk4LXSzNA
```

The Model is Active!



API Keys

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Sample Code

Generate the code required for prediction and stability requests. You can generate the code format for a single row, multiple rows, or an entire file of data. Copy this code and use your API key and data to send to endpoints.

◉ Prediction ○ Stability Data: Single row Method: cURL POST

ObservationID: UniqueID_001

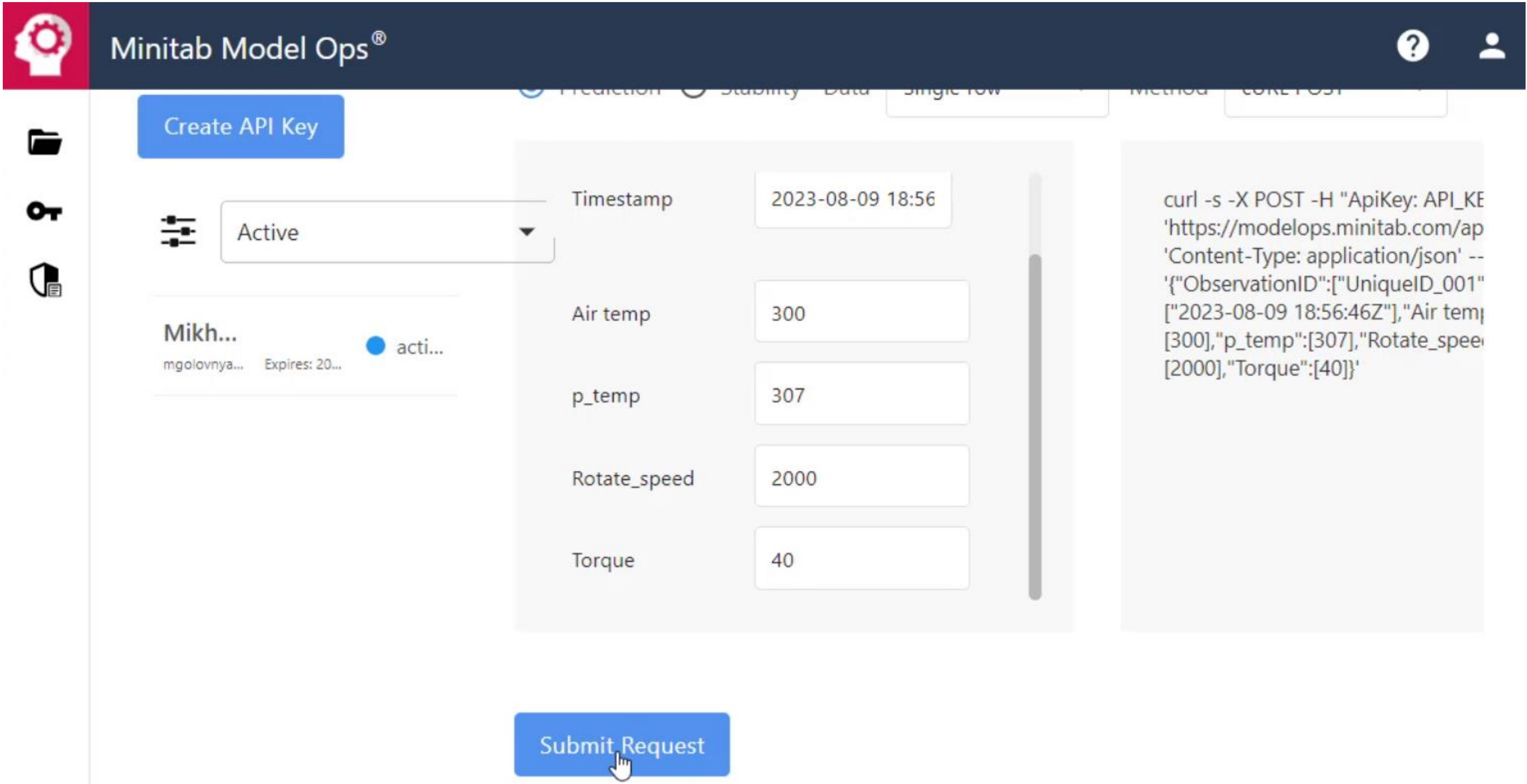
Timestamp: 2023-08-09 18:43

Air temp: 1.23

p_temp: 1.23

```
curl -s -X POST -H "ApiKey: API_KE
'https://modelops.minitab.com/ap
'Content-Type: application/json' --
'{"ObservationID":["UniqueID_001"
["2023-08-09 18:43:16Z"],"Air temp
[1.23],"p_temp":[1.23],"Rotate_spee
[1.23],"Torque":[1.23]}'
```

Scoring a Record Manually



● Prediction ○ Stability Data Single row Method CURL POST

Timestamp 2023-08-09 18:56

Air temp 300

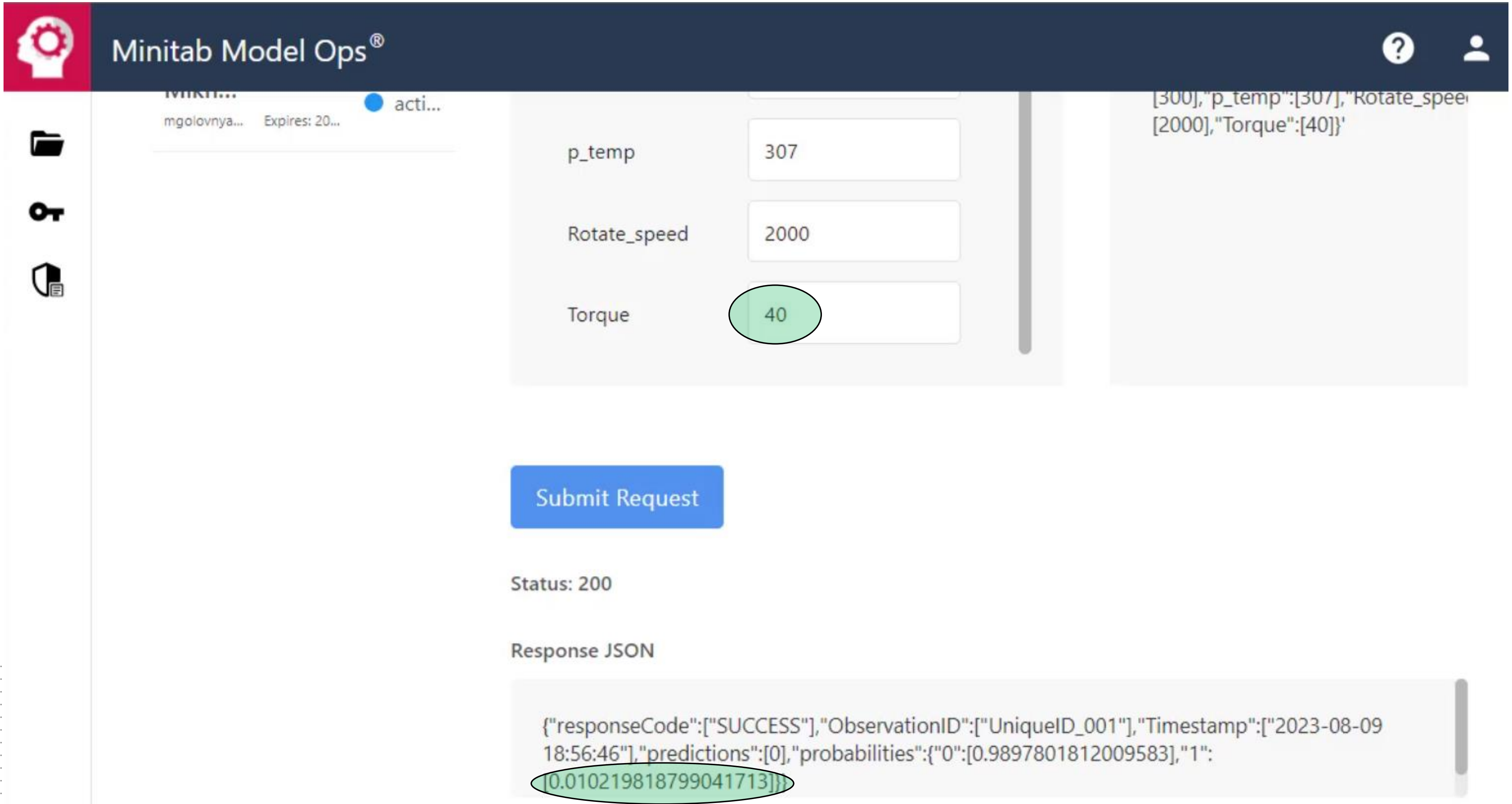
p_temp 307

Rotate_speed 2000

Torque 40

```
curl -s -X POST -H "ApiKey: API_KE
'https://modelops.minitab.com/ap
'Content-Type: application/json' --
'{"ObservationID":["UniqueID_001"
["2023-08-09 18:56:46Z"],"Air temp
[300],"p_temp":[307],"Rotate_spee
[2000],"Torque":[40]}'
```

Scoring a Record Manually



[300],"p_temp":[307],"Rotate_spee
[2000],"Torque":[40]}'

p_temp: 307

Rotate_speed: 2000

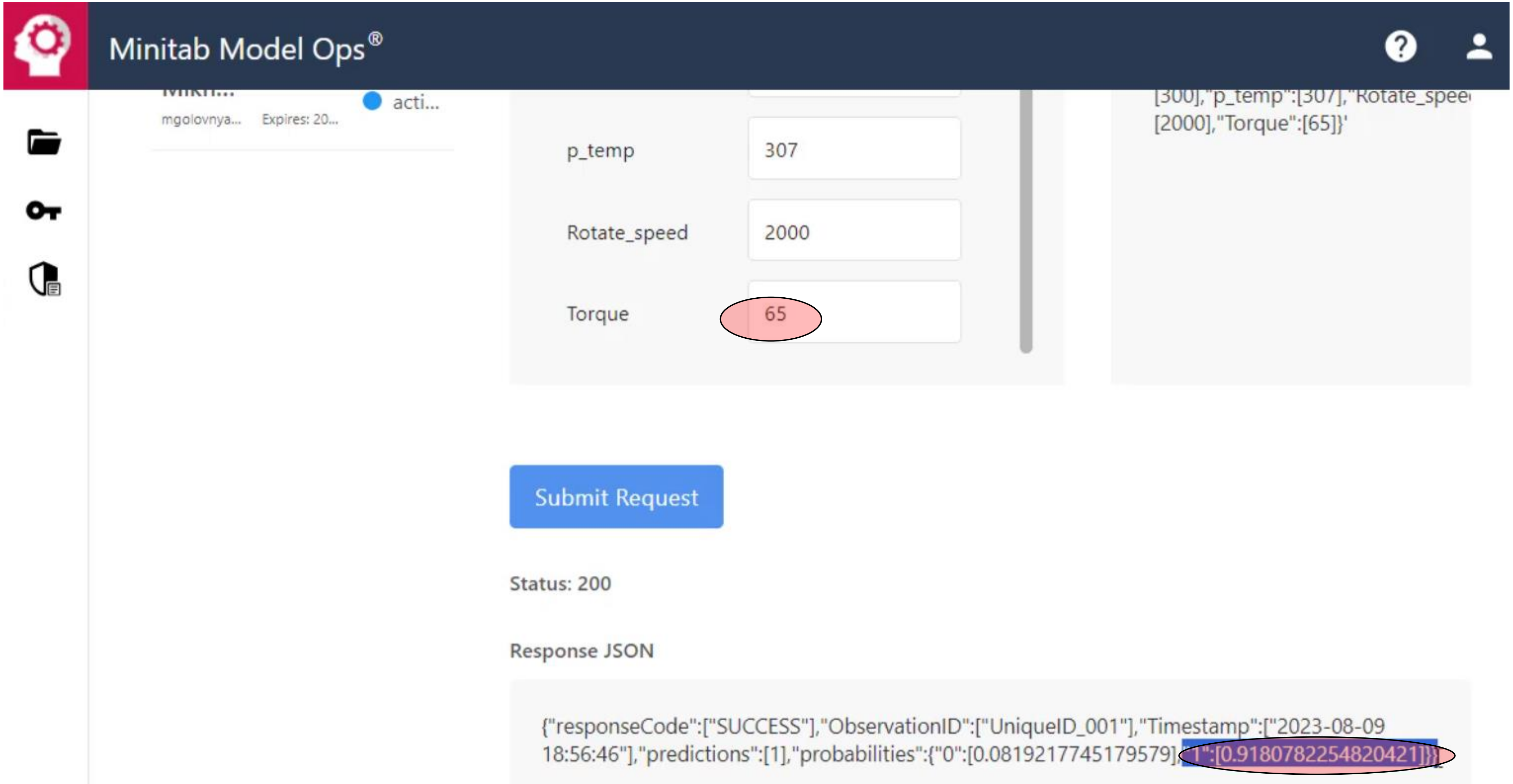
Torque: 40

Status: 200

Response JSON

{"responseCode":["SUCCESS"],"ObservationID":["UniqueID_001"],"Timestamp":["2023-08-09 18:56:46"],"predictions":[0],"probabilities":{"0":[0.9897801812009583],"1":[0.01021981879904171 3]}}

Scoring a Different Record



[300],"p_temp":[307],"Rotate_spee
[2000],"Torque":[65]}'

p_temp 307

Rotate_speed 2000

Torque 65

Status: 200

Response JSON

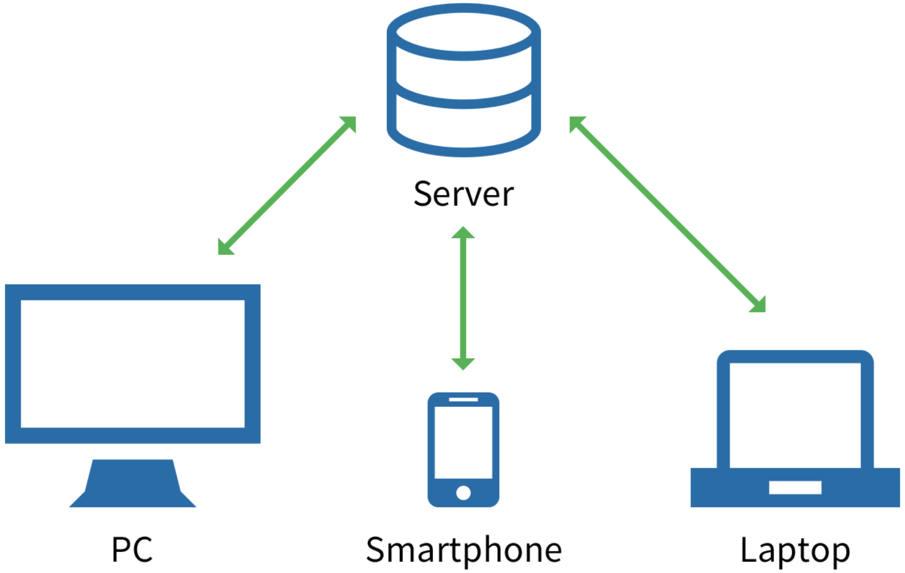
```
{"responseCode":["SUCCESS"],"ObservationID":["UniqueID_001"],"Timestamp":["2023-08-09
18:56:46"],"predictions":[1],"probabilities":{"0":[0.0819217745179579],"1":[0.918078225482042]}}
```

Survey 3

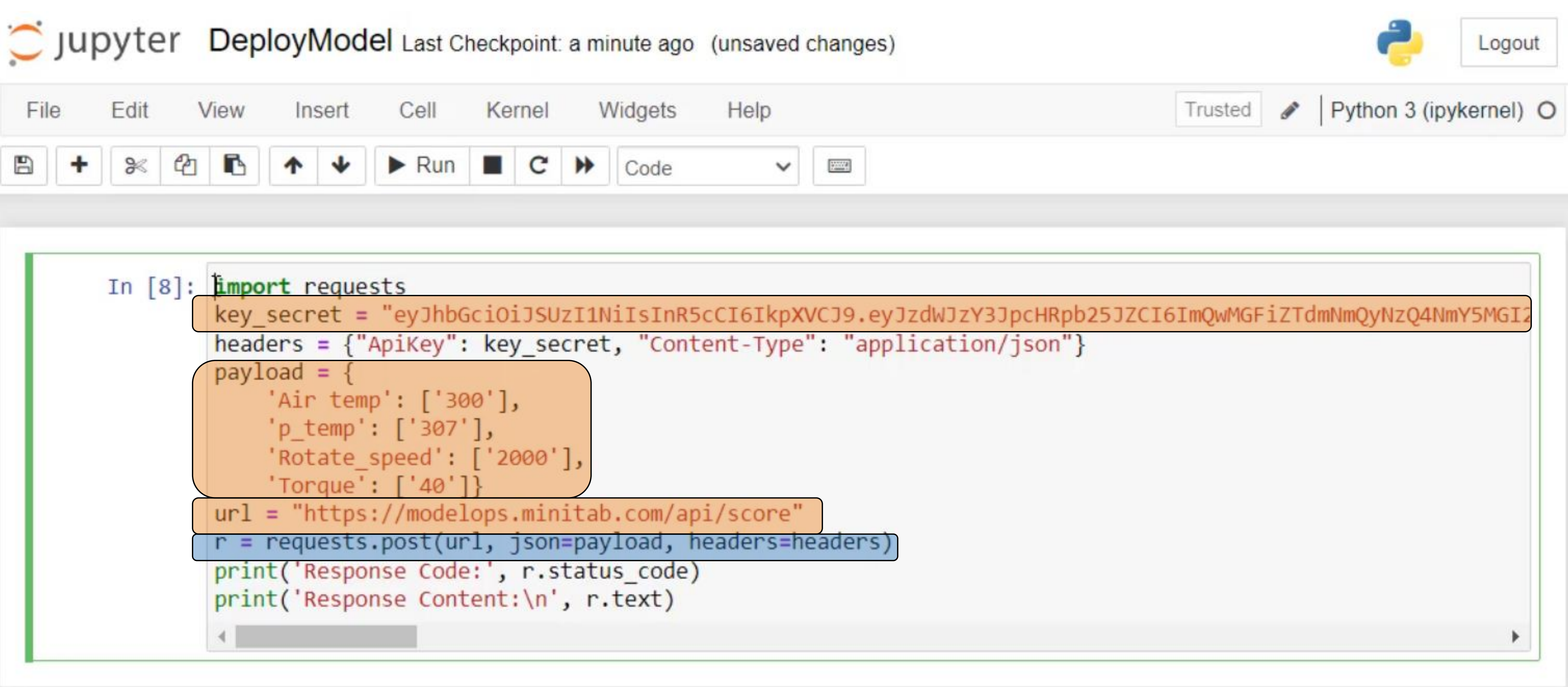
- You need to score your data from
  - Python
  - R
  - Minitab Connect
  - Other

Universal Scoring Summary

- Reference **a model repo**
  - https://modelops.minitab.com/api/score
- Reference **a deployed model**
  - Unique API Key
- Post **a data record**
- Receive **the predicted response**

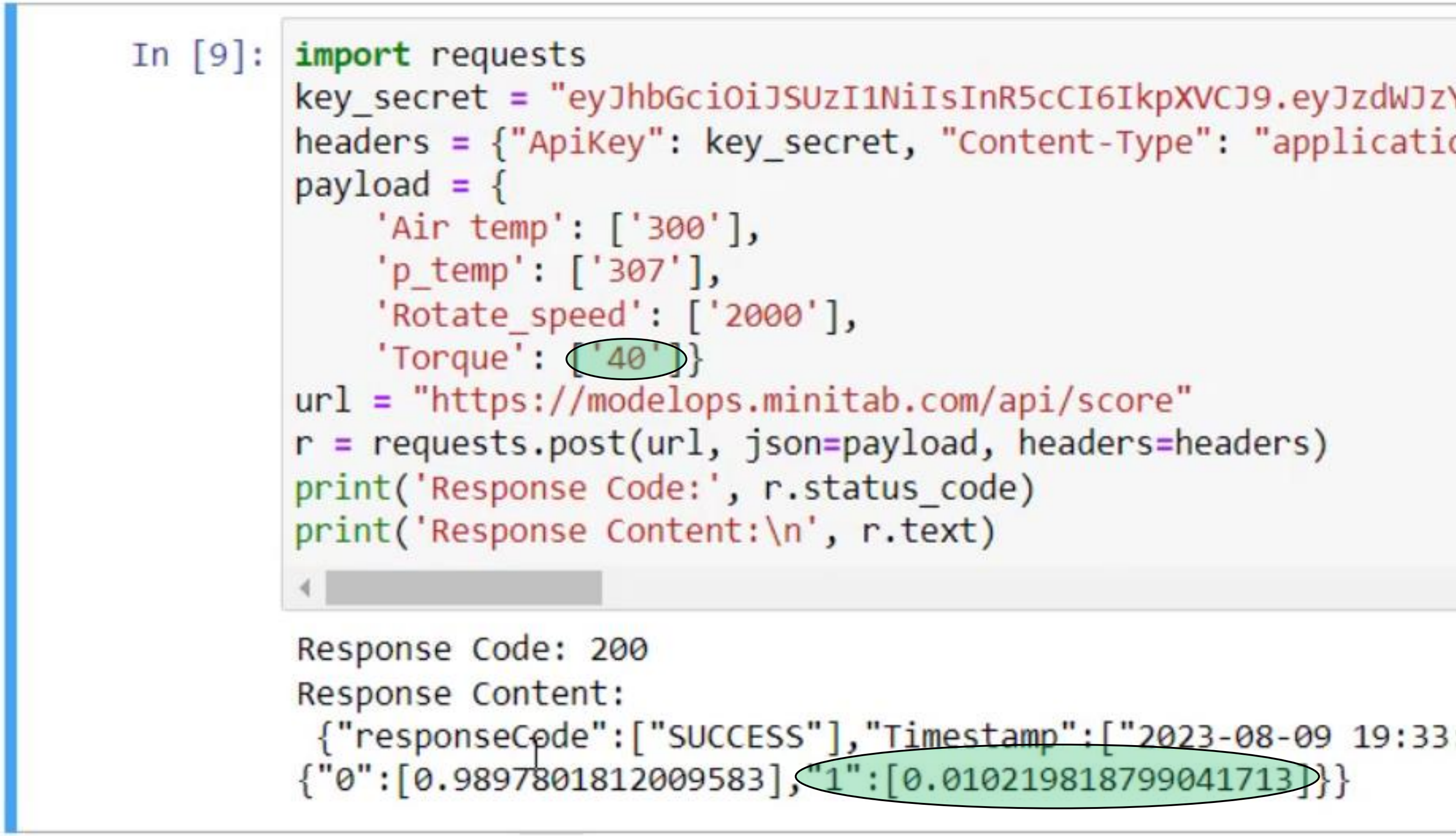


Scoring a Record from Python



```python
import requests
key_secret = "eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWJzY3JpcHRpb25JZCI6ImQwMGFiZTdmNmQyNzQ4NmY5MGI2
headers = {"ApiKey": key_secret, "Content-Type": "application/json"}
payload = {
    'Air temp': ['300'],
    'p_temp': ['307'],
    'Rotate_speed': ['2000'],
    'Torque': ['40']}
url = "https://modelops.minitab.com/api/score"
r = requests.post(url, json=payload, headers=headers)
print('Response Code:', r.status_code)
print('Response Content:\n', r.text)
```

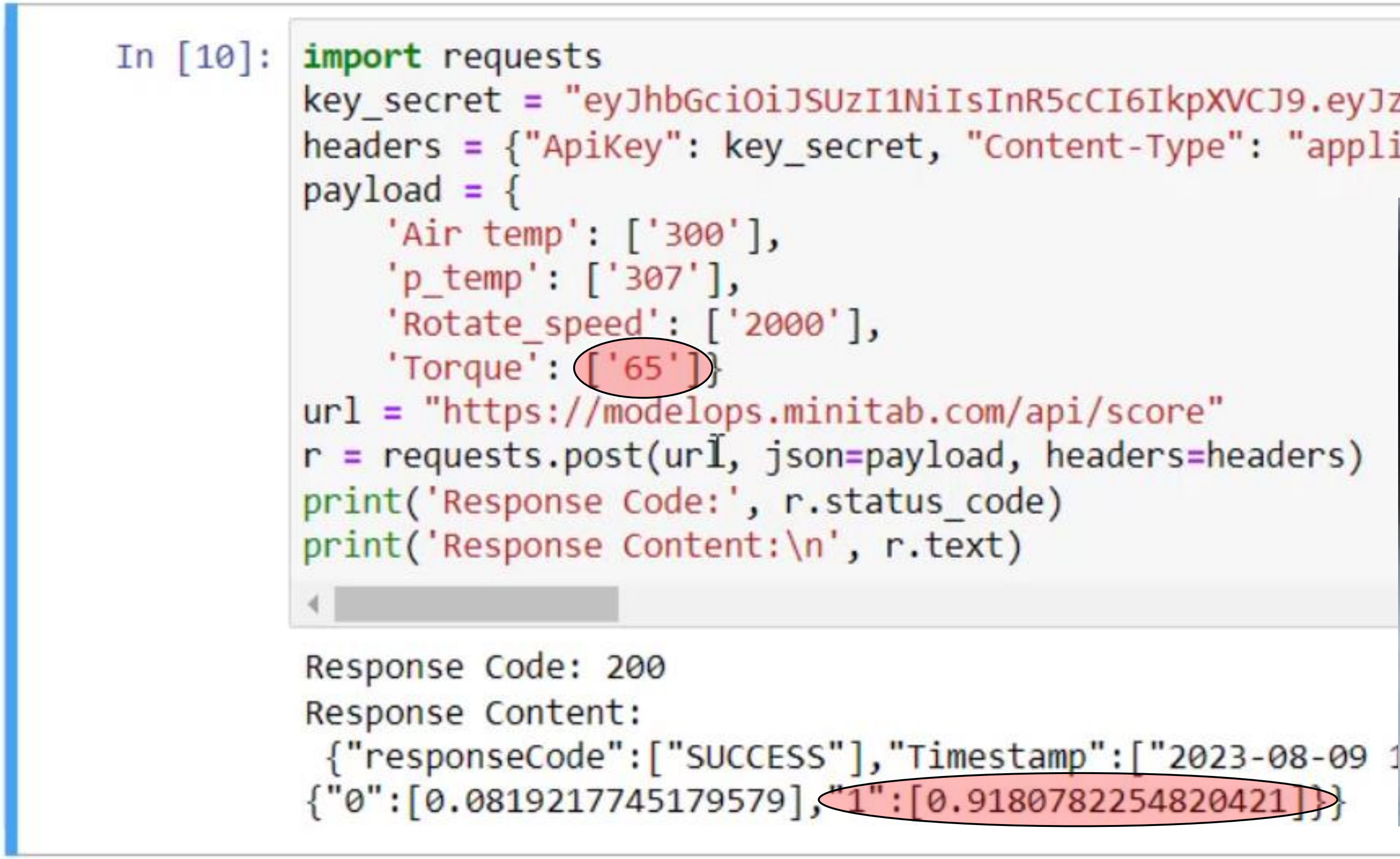
Scoring a Record from Python



```
In [9]: import requests
        key_secret = "eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWJzY3JpcHRpb25JZCI6ImQwMGFiZTdmNmQyNzQ4NmY5MGI2
        headers = {"ApiKey": key_secret, "Content-Type": "application/json"}
        payload = {
            'Air temp': ['300'],
            'p_temp': ['307'],
            'Rotate_speed': ['2000'],
            'Torque': ['40']}
        url = "https://modelops.minitab.com/api/score"
        r = requests.post(url, json=payload, headers=headers)
        print('Response Code:', r.status_code)
        print('Response Content:\n', r.text)
```

```
Response Code: 200
Response Content:
 {"responseCode":["SUCCESS"],"Timestamp":["2023-08-09 19:33
{"0":[0.9897801812009583],"1":[0.010219818799041713]}}
```

Scoring a Different Record from Python



```
In [10]: import requests
         key_secret = "eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWJzY3JpcHRpb25JZCI6ImQwMGFiZTdmNmQyNzQ4NmY5MGI2
         headers = {"ApiKey": key_secret, "Content-Type": "application/json"}
         payload = {
             'Air temp': ['300'],
             'p_temp': ['307'],
             'Rotate_speed': ['2000'],
             'Torque': ['65']}
         url = "https://modelops.minitab.com/api/score"
         r = requests.post(url, json=payload, headers=headers)
         print('Response Code:', r.status_code)
         print('Response Content:\n', r.text)
```

```
Response Code: 200
Response Content:
 {"responseCode":["SUCCESS"],"Timestamp":["2023-08-09 1
{"0":[0.0819217745179579],"1":[0.9180782254820421]}}
```

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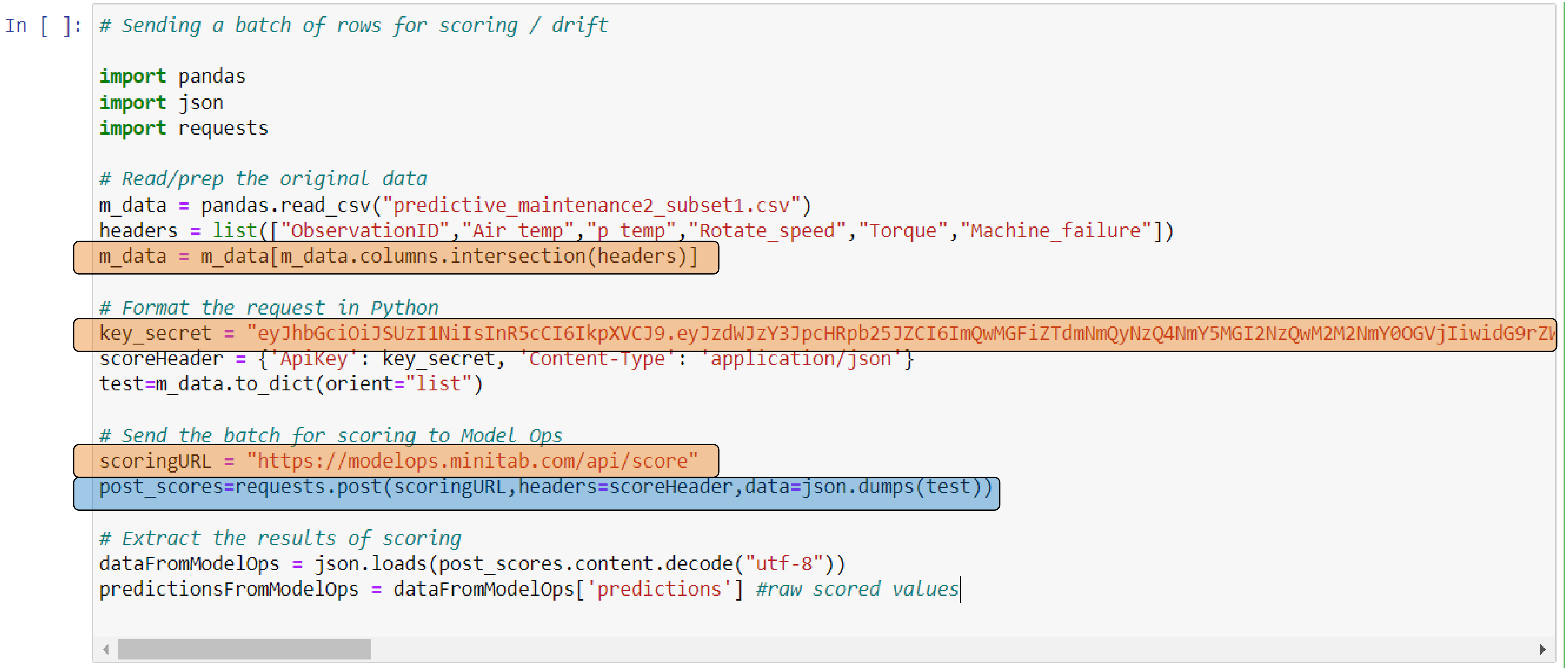
Scoring a Dataset from Python



```
In [ ]: # Sending a batch of rows for scoring / drift

        import pandas
        import json
        import requests

        # Read/prep the original data
        m_data = pandas.read_csv("predictive_maintenance2_subset1.csv")
        headers = list(["ObservationID","Air temp","p temp","Rotate_speed","Torque","Machine_failure"])
        m_data = m_data[m_data.columns.intersection(headers)]

        # Format the request in Python
        key_secret = "eyJhbGciOiJSUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWJzY3JpcHRpb25JZCI6ImQwMGFiZTdmNmQyNzQ4NmY5MGI2NzQwM2M2NmY0OGVjIiwidG9rZ
        scoreHeader = {'ApiKey': key_secret, 'Content-Type': 'application/json'}
        test=m_data.to_dict(orient="list")

        # Send the batch for scoring to Model Ops
        scoringURL = "https://modelops.minitab.com/api/score"
        post_scores=requests.post(scoringURL,headers=scoreHeader,data=json.dumps(test))

        # Extract the results of scoring
        dataFromModelOps = json.loads(post_scores.content.decode("utf-8"))
        predictionsFromModelOps = dataFromModelOps['predictions'] #raw scored values
```

Conclusion

- TreeNet can be used to suggest classical **formula-based deployments** of ML models
- MSS Model Ops offers powerful **enterprise-level solution** for model deployment and monitoring
- Once deployed in Model Ops, the model can be accessed for scoring in a variety of ways
  - Web access
  - Python access
  - MSS Connect access
- But what about model monitoring?

Q&A

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Upcoming In-Person Events

Dates and Location in the US

- Rosemont, IL – June 18th
- Columbus, OH – August 15th
- Dallas, TX – September 10th
- Anaheim, CA – October 10th

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Gracias
Hvala
Ahsante
Cảm ơn
நன்றி
谢谢
תודה

ευχαριστώ
Obrigado
Teşekkürler
شكريه
Köszönöm
Tack
多謝晒

Danke
Kiitos
متشکرم
Terima Kasih
ありがとうございます
Mulţumesc
дякую

Grazie
شكراً
Salamat Po
Dank u Wel
ขอบคุณครับ
спасибо
Ďakujem

благодаря
Tak
감사합니다
Děkuji
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