Using the BigQuery ML Hyperparameter Tuning to Improve Model Performance

1 hour 30 minutes Free

Overview

This lab introduces data analysts to BigQuery ML. BigQuery ML enables users to create and execute machine learning models in BigQuery using SQL queries. This lab introduces a method of hyperparameter tuning that specifies the `num_trials` training option.

In this lab, you use the `tlc_yellow_trips_2018` sample table to create a model that predicts the tip for a taxi ride. You will see a ~40% performance (r2_score) improvement with hyperparameter tuning.

Objectives

In this lab, you use BigQuery ML to:

- Create a linear regression model using the `CREATE MODEL` statement with the `num_trials` set to 20.
- Check the overview of all 20 trials using the `ML.TRIAL_INFO` function.
- Evaluate the ML model using the `ML.EVALUATE` function.
- Make predictions using the ML model and `ML.PREDICT` function.

Setup and requirements

For each lab, you get a new Google Cloud project and set of resources for a fixed time at no cost.

1. Sign in to Qwiklabs using an **incognito window**.
2. Note the lab's access time (for example, `1:15:00`), and make sure you can finish within that time.
   There is no pause feature. You can restart if needed, but you have to start at the beginning.
3. When ready, click **Start lab**.
4. Note your lab credentials (**Username** and **Password**). You will use them to sign in to the Google Cloud Console.
5. Click **Open Google Console**.
6. Click **Use another account** and copy/paste credentials for **this** lab into the prompts.
   If you use other credentials, you'll receive errors or **incur charges**.
7. Accept the terms and skip the recovery resource page.

Note: Do not click **End Lab** unless you have finished the lab or want to restart it. This clears your work and removes the project.

Enable the BigQuery API

1. In the Google Cloud Console, on the **Navigation menu** (☰), click **APIs & services > Library**.
2. Search for **BigQuery API**, and then click **Enable** if it isn't already enabled.

Task 1. Create your training dataset

The first task is to create a BigQuery dataset to store your training data and ML model. To create your dataset:

1. On the BigQuery page, in the **Explorer** panel, click **View actions** (⋮) next to your project ID, and select **Create dataset**.
2. For **Dataset ID**, type **bqml_tutorial**, and for **Data location**, select **United States (US)**.
   Currently, the public datasets are stored in the US multiregional location. For simplicity, place your dataset in the same location.
3. Leave the remaining settings as their defaults, and click **Create dataset**.

Task 2. Create your training input table

In this task, you materialize the training input table with 100k rows.

1. View the schema of the source table tlc_yellow_trips_2018 (Open this link in a new tab).
2. Click **Compose New Query**, and paste the following query in the Query Editor text area to create the training input data table:

```
CREATE TABLE `bqml_tutorial.taxi_tip_input` AS SELECT * EXCEPT(tip_amount), tip_amount AS label FROM `bigquery-public-data.new_york_taxi_trips.tlc_yellow_trips_2018` WHERE tip_amount IS NOT NULL LIMIT 100000
```

3. Click **Run**.

Task 3. Create your model

- Next, create a linear regression model with hyperparameter tuning using the `tlc_yellow_trips_2018` sample table in BigQuery.

The following standard SQL query is used to create the model with hyperparameter tuning:

```
CREATE MODEL `bqml_tutorial.hp_taxi_tip_model` OPTIONS (model_type='linear_reg', num_trials=20, max_parallel_trials=2) AS SELECT * FROM `bqml_tutorial.taxi_tip_input`
```

Query details

The LINEAR_REG model has two tunable hyperparameters: `l1_reg` and `l2_reg`. The previous query uses the default search space. You can also specify the search space explicitly:

OPTIONS (... l1_reg=hparam_range(0, 20), l2_reg=hparam_candidates([0, 0.1, 1, 10]))

In addition, these other hyperparameter tuning training options also use their default values:

- hparam_tuning_algorithm: `"VIZIER_DEFAULT"`
- hparam_tuning_objectives: `["r2_score"]`

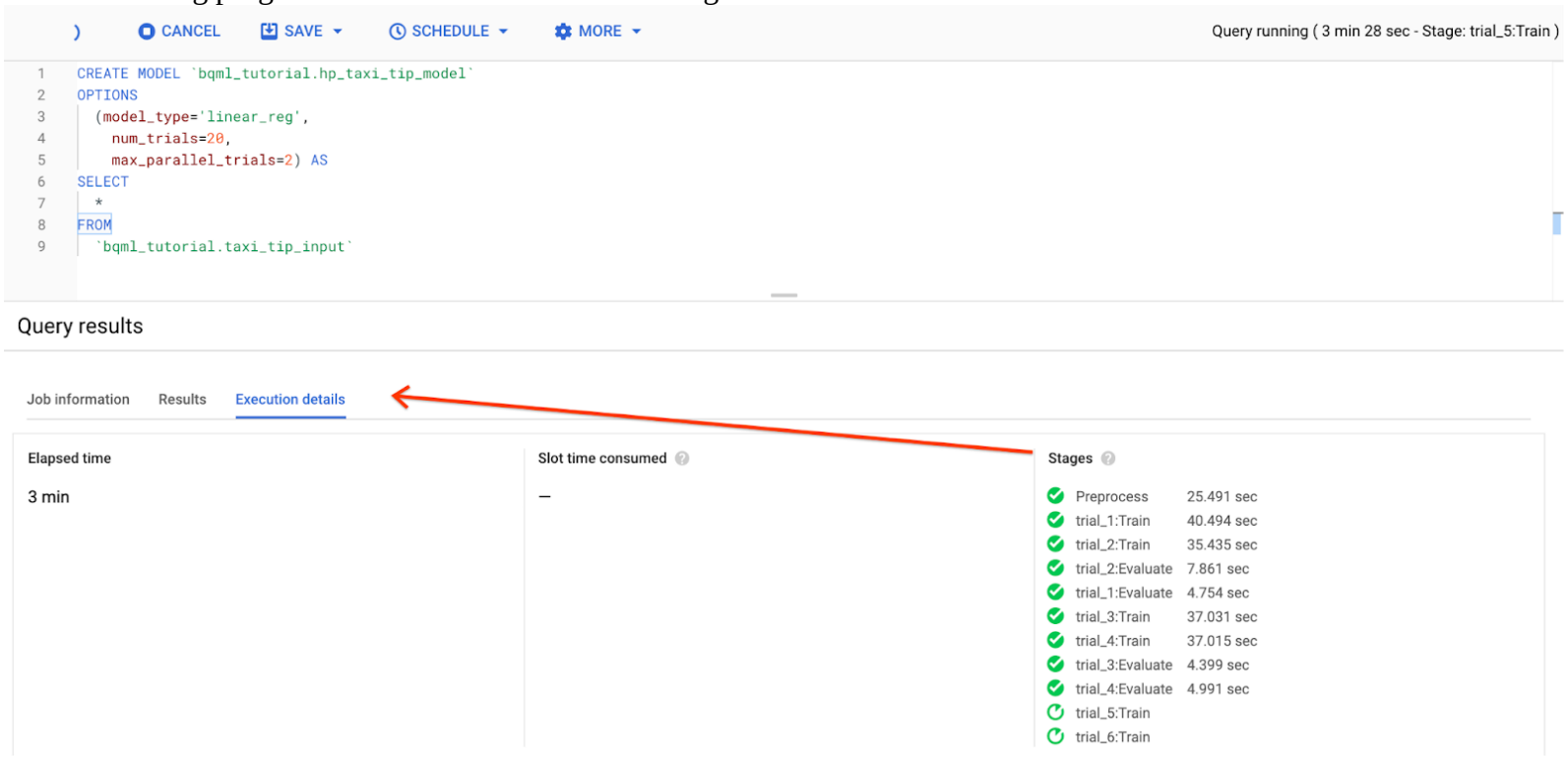
`max_parallel_trials` is set to 2 to accelerate the tuning process. With two trials running at any time, the whole tuning should take approximately as long as 10 serial training jobs instead of 20. Note, however, that the two concurrent trials cannot benefit from each other's training results.

Run the CREATE MODEL query

To run the `CREATE MODEL` query to create and train your model:

1. In the Cloud Console, click **Compose New Query**.
2. Enter the standard SQL query (above) in the Query Editor text area.
3. Click **Run**. The query takes about 17 minutes to complete.

4. Track the tuning progress in execution details under Stages:



Task 4. Get trials information

- To see the overview of all trials, including their hyperparameters, objectives, status, and the optimal trial, use the `ML.TRIAL_INFO` function, and view the result in the Cloud Console after running the SQL:

```
SELECT * FROM ML.TRIAL_INFO(MODEL `bqml_tutorial.hp_taxi_tip_model`)
```

You can run this SQL query as soon as one trial is done. If the tuning is stopped in the middle, all already-completed trials will remain available to use.

Task 5. Evaluate your model

After creating your model, view the evaluation metrics of all trials either by using the `ML.EVALUATE` function or through the Google Cloud Console.

1. Run ML.EVALUATE:

SELECT * FROM ML.EVALUATE(MODEL `bqml_tutorial.hp_taxi_tip_model`)

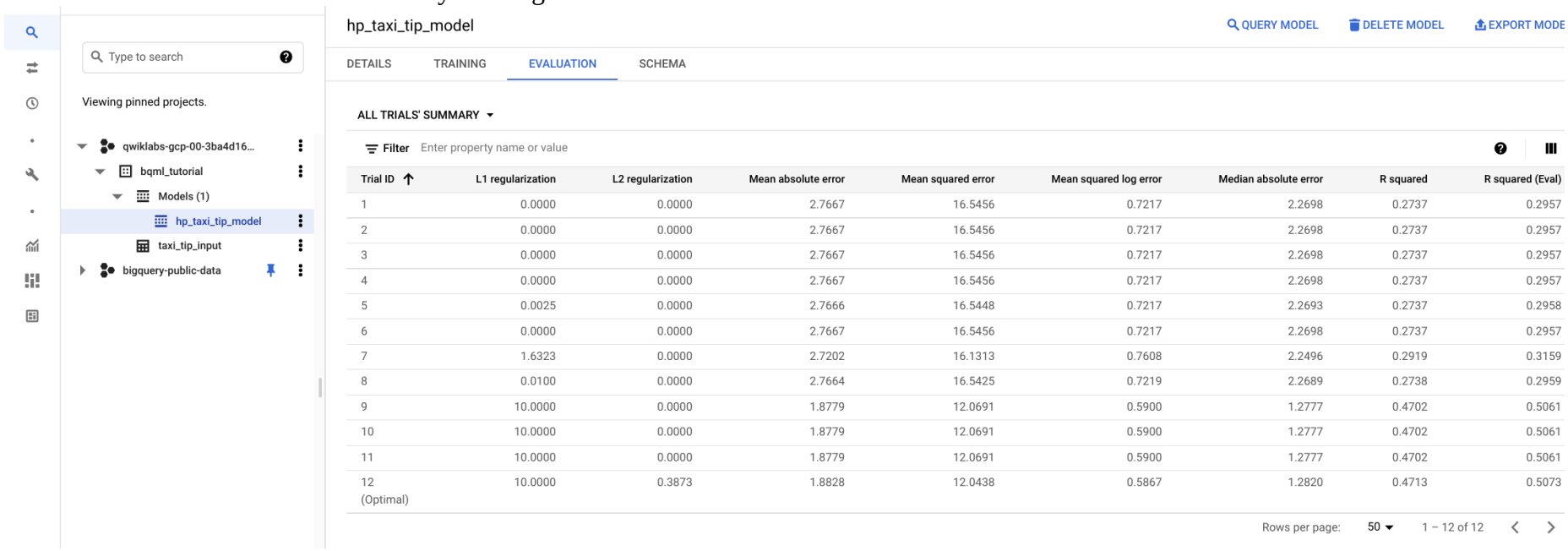
This SQL fetches evaluation metrics for all trials calculated from the TEST data.

2. Check the Data Split section to see the difference between `ML.TRIAL_INFO` objectives and `ML.EVALUATE` evaluation metrics.

You can also evaluate a specific trial by providing your own data. See ML.EVALUATE for more details.

Check evaluation metrics through the Google Cloud Console

You can also check evaluation metrics by viewing the **Evaluation** tab of the model.



Trial ID	L1 regularization	L2 regularization	Mean absolute error	Mean squared error	Mean squared log error	Median absolute error	R squared	R squared (Eval)
1	0.0000	0.0000	2.7667	16.5456	0.7217	2.2698	0.2737	0.2957
2	0.0000	0.0000	2.7667	16.5456	0.7217	2.2698	0.2737	0.2957
3	0.0000	0.0000	2.7667	16.5456	0.7217	2.2698	0.2737	0.2957
4	0.0000	0.0000	2.7667	16.5456	0.7217	2.2698	0.2737	0.2957
5	0.0025	0.0000	2.7666	16.5448	0.7217	2.2693	0.2737	0.2958
6	0.0000	0.0000	2.7667	16.5456	0.7217	2.2698	0.2737	0.2957
7	1.6323	0.0000	2.7202	16.1313	0.7608	2.2496	0.2919	0.3159
8	0.0100	0.0000	2.7664	16.5425	0.7219	2.2689	0.2738	0.2959
9	10.0000	0.0000	1.8779	12.0691	0.5900	1.2777	0.4702	0.5061
10	10.0000	0.0000	1.8779	12.0691	0.5900	1.2777	0.4702	0.5061
11	10.0000	0.0000	1.8779	12.0691	0.5900	1.2777	0.4702	0.5061
12 (Optimal)	10.0000	0.3873	1.8828	12.0438	0.5867	1.2820	0.4713	0.5073

Task 6. Use your model to predict taxi tips

After evaluating your model, the next step is to use it to predict the taxi tip.

- Use this query to predict the tip:

SELECT * FROM ML.PREDICT(MODEL `bqml_tutorial.hp_taxi_tip_model`, (SELECT * FROM `bqml_tutorial.taxi_tip_input` LIMIT 10))

Query details

The first `SELECT` statement retrieves all columns, including the `predicted_label` column. This column is generated by the `ML.PREDICT` function. When you use the `ML.PREDICT` function, the output column name for the model is `predicted_label_column_name`.

The prediction is made against the optimal trial by default.

- You can select another trial by specifying the `trial_id` parameter.

SELECT * FROM ML.PREDICT(MODEL `bqml_tutorial.hp_taxi_tip_model`, (SELECT * FROM `bqml_tutorial.taxi_tip_input` LIMIT 10), STRUCT(3 AS trial_id))

For more information about using model serving functions, refer to ML.PREDICT.

Task 7. Clean up

To avoid incurring charges to your Google Cloud account for the resources used in this tutorial, either delete the project that contains the resources, or keep the project and delete the individual resources.

Deleting your dataset

Deleting your project removes all datasets and all tables in the project. If you prefer to reuse the project, you can delete the dataset you created in this tutorial:

1. If necessary, open the BigQuery page in the Cloud Console.
2. In the **Explorer** panel, click **View actions** (⋮) next to your dataset, and then click **Delete**.
3. In the Delete dataset dialog, to confirm the delete command, type **delete**, and then click **Delete**.

Congratulations!

You've learned how to use BigQuery ML to:

- Create a linear regression model using the `CREATE MODEL` statement with the `num_trials` set to 20.
- Check the overview of all 20 trials using the `ML.TRIAL_INFO` function.
- Evaluate the ML model using the `ML.EVALUATE` function.
- Make predictions using the ML model and `ML.PREDICT` function.

End your lab

When you have completed your lab, click **End Lab**. Qwiklabs removes the resources you've used and cleans the account for you.

You will be given an opportunity to rate the lab experience. Select the applicable number of stars, type a comment, and then click **Submit**.

The number of stars indicates the following:

- 1 star = Very dissatisfied
- 2 stars = Dissatisfied
- 3 stars = Neutral
- 4 stars = Satisfied
- 5 stars = Very satisfied

You can close the dialog box if you don't want to provide feedback.

For feedback, suggestions, or corrections, please use the **Support** tab.