[544] BigQuery Machine Learning

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Learning Objectives

- write "CREATE MODEL" queries to train models on BigQuery query results
- use a BigQuery TRANSFORM clause to pre-process data prior to training
- use BigQuery's "ML.????" tabular functions to inspect models, make predictions, and evaluate performance

Outline

BiqQuery ML Basics

Feature Transformation

Train/Test Split

BigQuery provides a DATA_SPLIT_METHOD config, but its a bit unusual.

Default behavior depends on dataset

- <500 rows: 100% training data
- <50K rows: 80% training data
- bigger: 10K rows for test, rest for training

Documentation: "When there is a data split, you can find the temporary split results (Training Data, Evaluation Data) on the Model Details page in the BigQuery Console and the model API data_split_result field. These split tables will be saved for 48 hours. If you will need them for longer than 48 hours, copy them out of the anonymous dataset for longer retention."

Recommendation:

- split manually using rand()<ratio in SQL (rand gives num between 0 and 1)
- disable BiqQuery splitting: **DATA_SPLIT_METHOD="NO_SPLIT"**

Training

Step 1: write a query to select both features and label

features

label
(to predict)

```
SELECT yesterday_temp, humidity, temp
FROM weather
```

Training

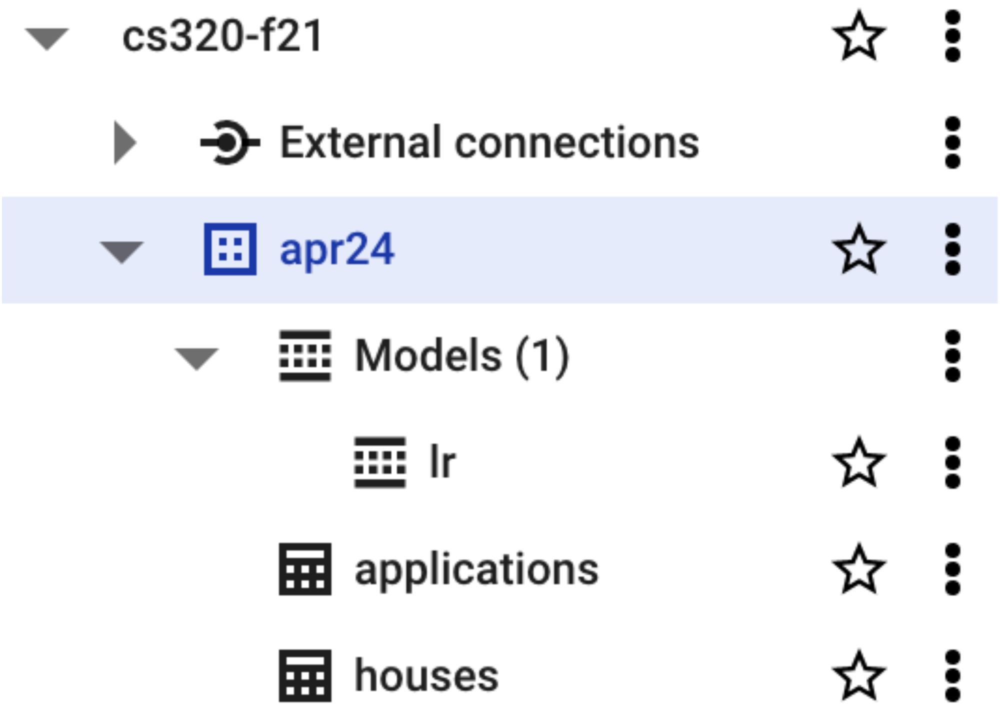
Step 2: choose a model name and create it

```
CREATE OR REPLACE MODEL myproj.mydataset.mymodel
OPTIONS(...)

AS

SELECT yesterday_temp, humidity, temp
FROM weather
```

name

hierarchy:

projects
- datasets
  - tables
  - models



cs320-f21
External connections
apr24
Models (1)
lr
applications
houses

Training

Step 3: choose type of model

```
CREATE OR REPLACE MODEL myproj.mydataset.mymodel
OPTIONS(MODEL_TYPE='LINEAR_REG')

AS

SELECT yesterday_temp, humidity, temp
FROM weather
```

Options: LINEAR_REG, LOGISTIC_REG, KMEANS, MATRIX_FACTORIZATION, PCA, AUTOENCODER, AUTOML_CLASSIFIER, AUTOML_REGRESSOR, BOOSTED_TREE_CLASSIFIER, BOOSTED_TREE_REGRESSOR, RANDOM_FOREST_CLASSIFIER, RANDOM_FOREST_REGRESSOR, DNN_CLASSIFIER, DNN_REGRESSOR, DNN_LINEAR_COMBINED_CLASSIFIER, DNN_LINEAR_COMBINED_REGRESSOR, ARIMA_PLUS, ARIMA_PLUS_XREG, TENSORFLOW, TENSORFLOW_LITE, ONNX, XGBOOST

Training

Step 4: indicate label column (others are assumed features)

```
CREATE OR REPLACE MODEL myproj.mydataset.mymodel
OPTIONS(MODEL_TYPE='LINEAR_REG',
        INPUT_LABEL_COLS=['temp'])
AS

SELECT yesterday_temp, humidity, temp
FROM weather
```

Using Trained Models

Each of these functions return a table related to a model.

what are the coefficients used to multiply features?

ML.WEIGHTS(MODEL ????)

what are the predictions given the features?

ML.PREDICT(MODEL ????, (????))

SQL query to get features

how well do we predict (various metrics) given the features+label?

ML.EVALUATE(MODEL ????, (????))

SQL query to get features and label

Using Trained Models

Each of these functions return a table related to a model.

what are the coefficients used to multiply features?

ML.WEIGHTS(MODEL ????)

example:

```
SELECT *
FROM ML.WEIGHTS(MODEL mymodel)
```

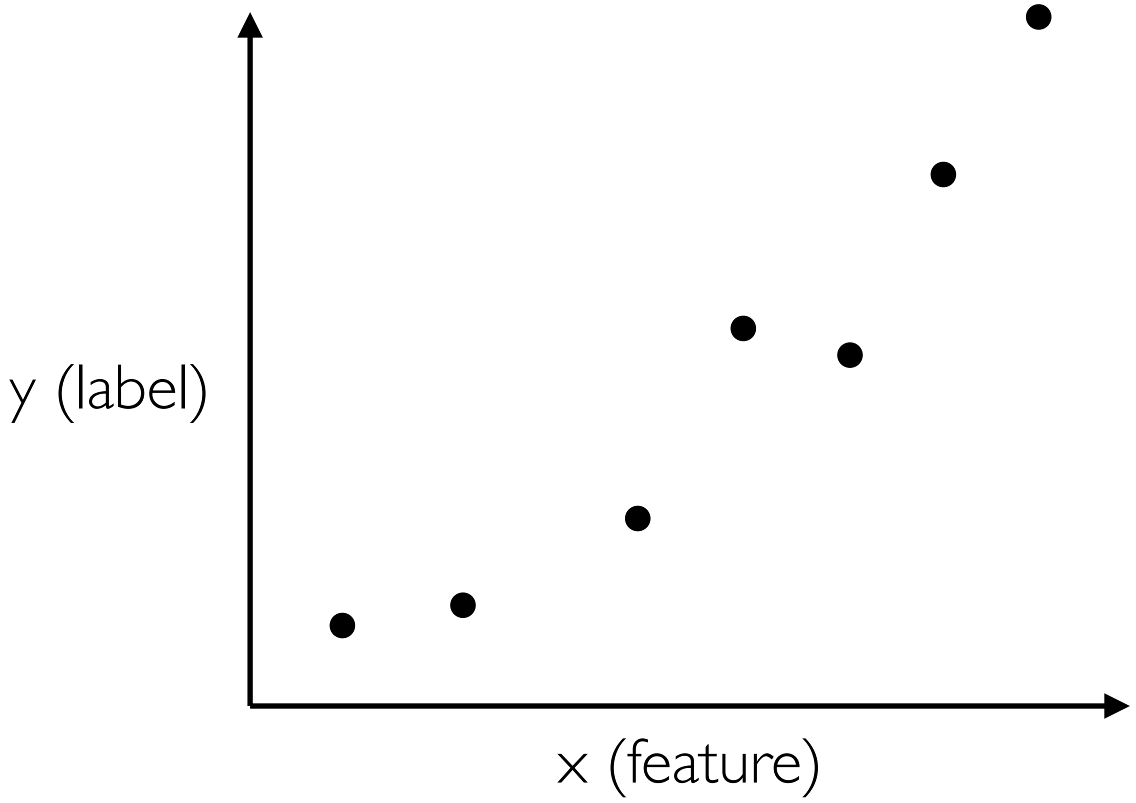
TopHat, Demos

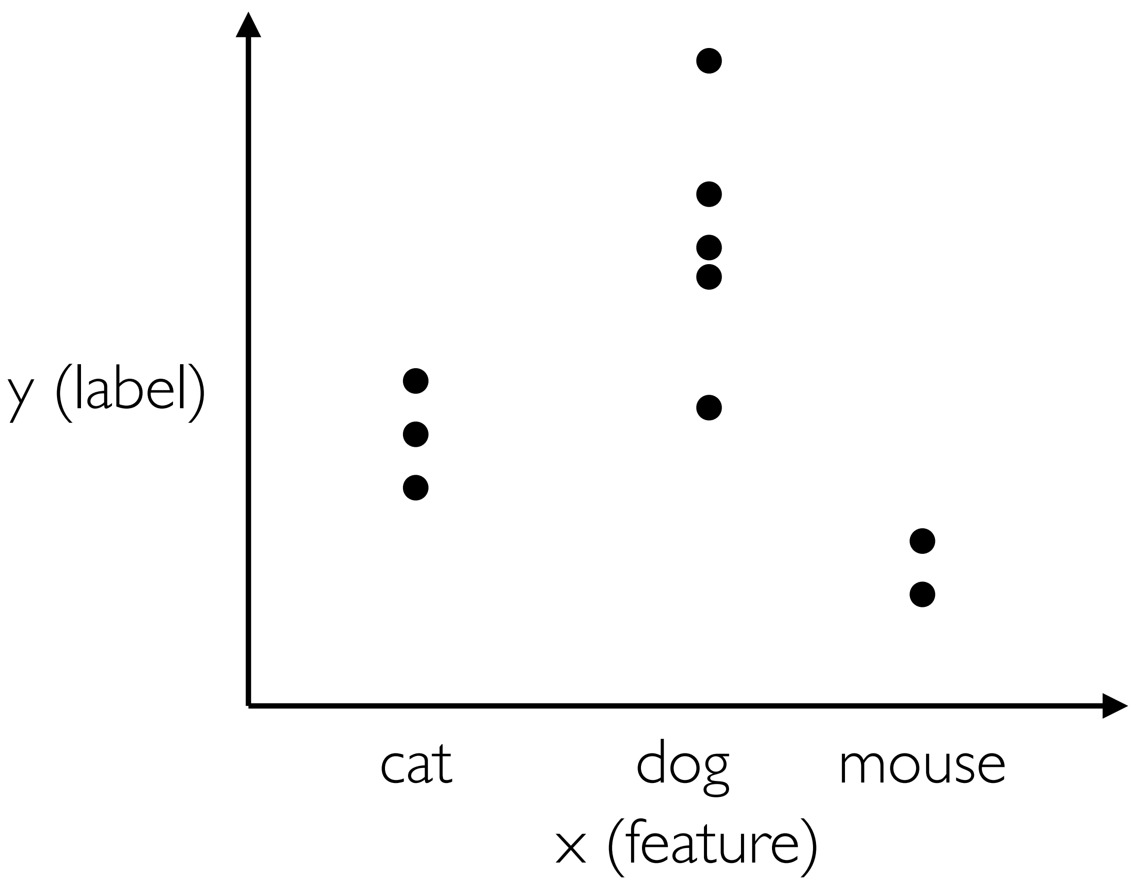
Outline

BiqQuery ML Basics

Feature Transformation

Patterns and Features





non-linear patterns

- some models (e.g., DNNs) naturally handle this
- others (e.g., LinearRegression) do not

categorical features

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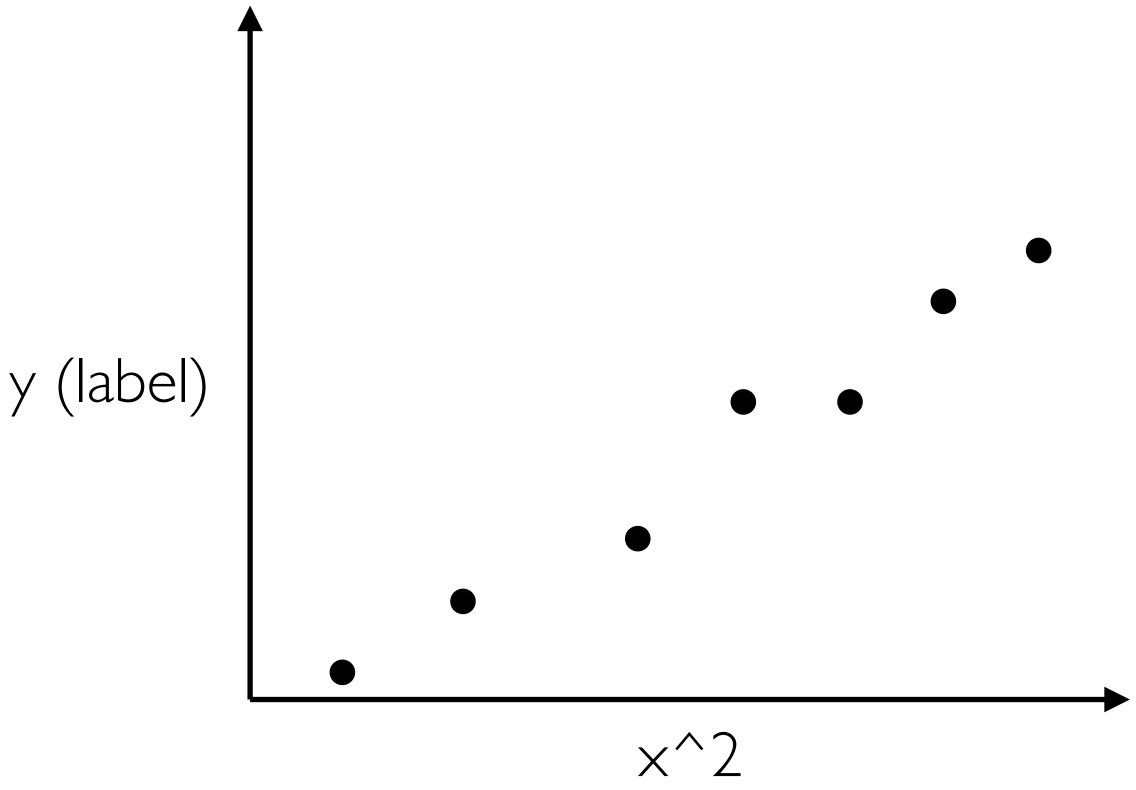
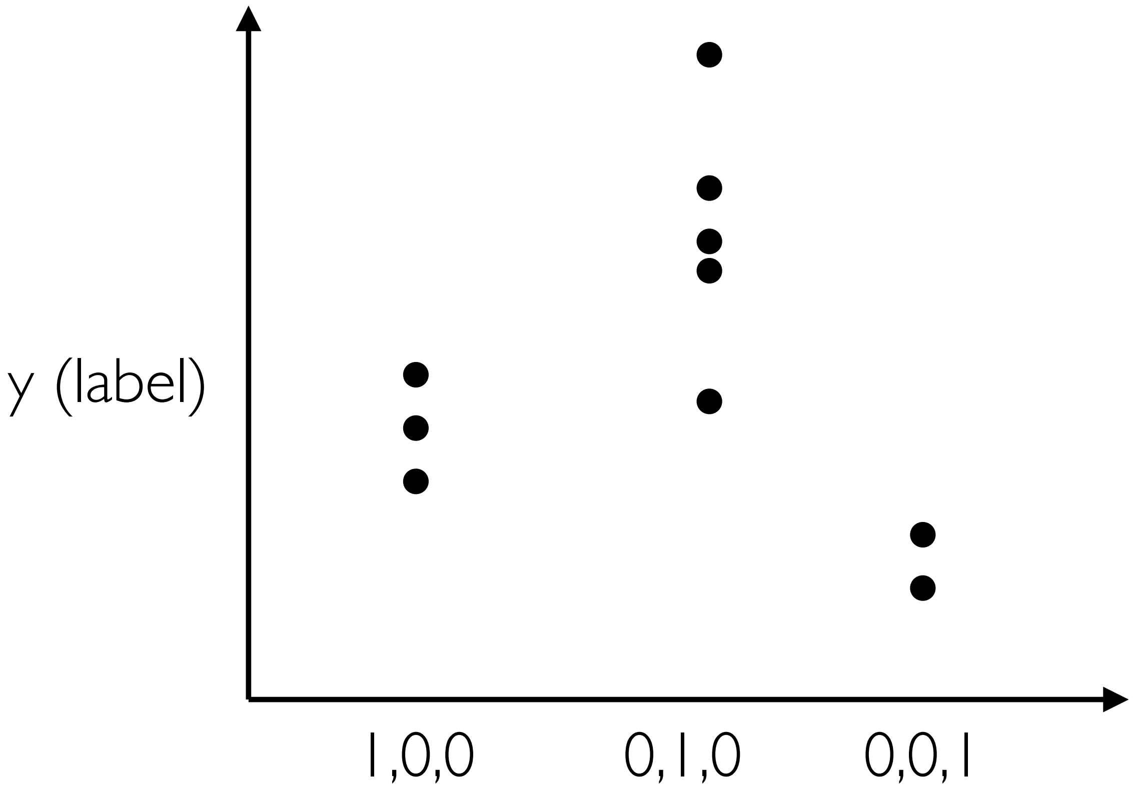
- others (e.g., LinearRegression) do not

Feature Transformation





non-linear patterns

- can introduce new features than are computed as functions of originals (e.g., x2=x^2)
- a linear model over the new features corresponds to a non-linear model over the originals

categorical features

- encode categorical features as numbers (e.g., as matrix of zeros and ones for OneHot encoding

Demos