ML Report Phase V: Credit Card Transaction Fraud Detection*

Model & Utility Application Implementation

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ABSTRACT

Fraud detection is a critical application of machine learning that helps businesses and organizations identify and prevent fraudulent activities. In this report, we outline our implementation choices, APIs, preprocessing components, and retraining method for our model and application.

CCS CONCEPTS

• Computing methodologies → Machine learning.

KEYWORDS

financial fraud detection, report, machine learning, Server-client, online training, preprocessing

1 The model

As discussed in the previous phase, I tuned my hyperparameters on the data and chose the model that performed the best in terms of recall on the validation set.

Unfortunately, hyperband search only managed to find a local optimum for our model while random search managed to luckily find a model with better performance than the model chosen by hyperband.

A summary of the results can be found in the notebook.

The model was then saved using keras' ability to save a model. The only addition we had to add was a method to serialize and store our custom focal loss function into our model.

Here is the top 3 models found by random search:

```
Results summary
Results in Random_tuner_2_layer/fraud_detection_tuning_with_recall_objective
Showing 10 best trials
Objective(name="val_recall", direction="max")

Trial 065 summary
Hyperparameters:
num_layers: 1
units_0: 256
activation: tanh
loss_function: focal_loss
learning_rate: 0.0044791885334340125
units_1: 160
alpha: 0.9
gamma: 4.0
pos_weight: 6.0
Score: 0.9383260011672974

Trial 123 summary
Hyperparameters:
num_layers: 1
units_0: 256
activation: tanh
loss_function: focal_loss
learning_rate: 0.00595824198225588
units_1: 256
```

alpha: 0.7000000000000001

gamma: 5.0

pos_weight: 7.0

Score: 0.9136564135551453

Trial 021 summary

Hyperparameters:

num_layers: 2

units_0: 192

activation: tanh

loss_function: focal_loss

learning_rate: 0.0022820322663096213

units_1: 224

alpha: 0.8

gamma: 3.5

pos_weight: 3.0

Score: 0.8387665152549744

Here are the top 3 models found by Hyperband:

Results summary

Results in Hyperband_2_layer/fraud_detection_tuning_with_recall_objective

Showing 10 best trials

Objective(name="val_recall", direction="max")

Trial 0208 summary

Hyperparameters:

num_layers: 1

units_0: 224

activation: tanh

loss_function: focal_loss

learning_rate: 0.0029110238976895516

alpha: 0.7000000000000001

gamma: 4.5

units_1: 160

pos_weight: 1.0

tuner/epochs: 100

tuner/initial_epoch: 34

tuner/bracket: 3

tuner/round: 3

tuner/trial_id: 0206

Score: 0.8872246742248535

Trial 0206 summary

Hyperparameters:

num_layers: 1

units_0: 224

activation: tanh

loss_function: focal_loss

learning_rate: 0.0029110238976895516

alpha: 0.7000000000000001

gamma: 4.5

units_1: 160

pos_weight: 1.0

tuner/epochs: 34

tuner/initial_epoch: 12

tuner/bracket: 3

tuner/round: 2

tuner/trial_id: 0190

Score: 0.8731277585029602

Trial 0209 summary

Hyperparameters:

num_layers: 1

units_0: 160

activation: tanh

loss_function: focal_loss

learning_rate: 0.004079042565506928

alpha: 0.5

gamma: 4.0

units_1: 256

pos_weight: 8.0

tuner/epochs: 100

tuner/initial_epoch: 34

tuner/bracket: 3

tuner/round: 3

tuner/trial_id: 0205

Score: 0.8590308427810669

2 Client and Server

I decided to settle on using a Reactjs frontend and a flask backend for their simplicity

This phase was done alone due to my partner withdrawing

2.1 The client

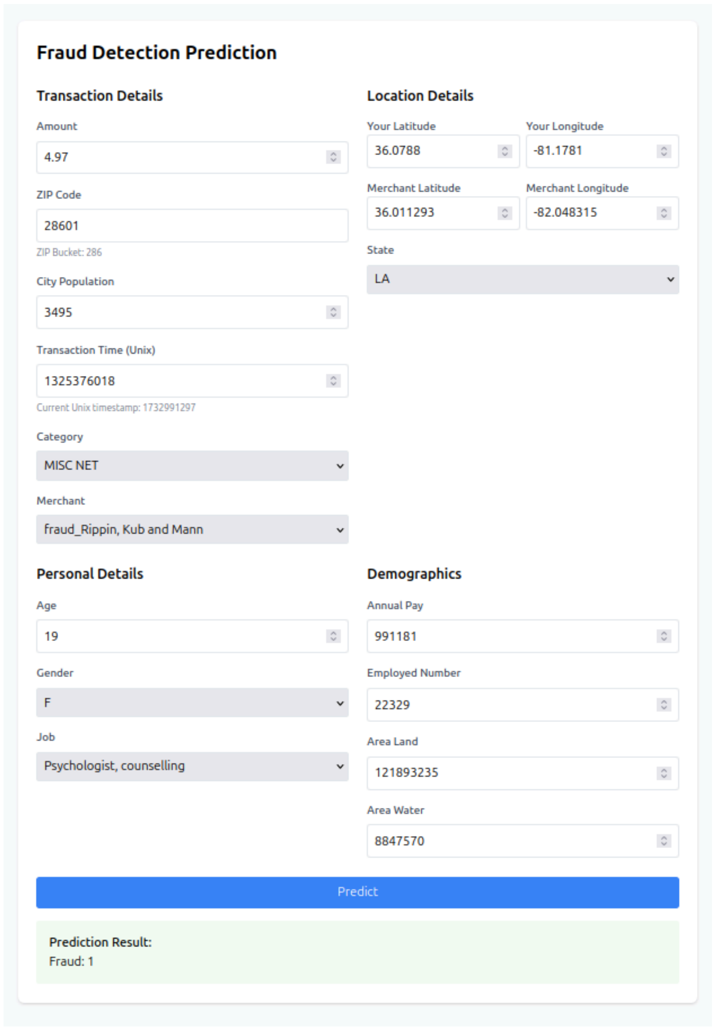
The client provides a simple User interface for the user to use to enter their data.

To simplify the input process the program will query the US census to retrieve information that is hard for a user to know such as the land area, water area, employee number, and average income.

The program will only accept data that the model is trained on i.e. any data that is not present in the one hot encoding of the model cannot be used.

The frontend provides a drop down box for categorical data to restrict the inputs to valid items.

After the user has inputted their data they will be able to click predict to receive the model's prediction.



Fraud Detection Prediction

Transaction Details

Amount: 4.97

ZIP Code: 28601

ZIP Bucket: 286

City Population: 3495

Transaction Time (Unix): 1325376018

Current Unix timestamp: 1732991297

Category: MISC NET

Merchant: fraud_Rippin, Kub and Mann

Location Details

Your Latitude: 36.0788

Your Longitude: -81.1781

Merchant Latitude: 36.011293

Merchant Longitude: -82.048315

State: LA

Personal Details

Age: 19

Gender: F

Job: Psychologist, counselling

Demographics

Annual Pay: 991181

Employed Number: 22329

Area Land: 121893235

Area Water: 8847570

Prediction Result:
Fraud: 1

2.2 The server

The server was implemented using flask and follows the following flow:

Loads all categorical data from local files in order to be aware of the possible rows and correctly form our data row.

The model is then loaded and our feature counts are verified.

A retraining thread is started that will check every hour if there are more than 100 new entries, at which point it will retrain and load the new model.

2.2 APIs

2.2.1 /predict

This api is the most essential of our APIs. Its responsible for taking the data sent by the client, preforming preprocessing, then sending the data to the model, and replying with whether or not the model predicted fraud.

Preprocessing involves using our distributions and fits to map it to the corresponding distribution. These fits are updated every 100 new items during the retraining of the model. Categorical data is also mapped into its one hot encoding format.

2.2.2 **/feedback**

Takes the label the user provided and adds it to the training data produced so far.

2.2.3 **/status**

Returns the training samples so far and the timestamp of the last training time.

2.2.3 **/get_metadata**

Gets the domain for each categorical data so that the client can use them in its drop down menus.

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