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0.1 CLASSIFICATION EXAMPLE

We'll be working with some California Census Data, we'll be trying to use various features of an individual to predict what class of income they belong in (>50k or <=50k).

The Data:

```
In [8]: import pandas as pd
```

```
In [10]: census = pd.read_csv("C:/Users/DELL/Tensorflow_Project/census_data.csv")
```

```
In [11]: census.head()
```

Out[11]:

	age	workclass	education	education_num	marital_status	occupation	relationship	race	gender	capital_gain	capital_loss	hours_per_week	native_country	income_bracket
0	39	State-gov	Bachelors	13	Never-married	Adm-clerical	Not-in-family	White	Male	2174	0	40	United-States	<=50K
1	50	Self-emp-not-inc	Bachelors	13	Married-civ-spouse	Exec-managerial	Husband	White	Male	0	0	13	United-States	<=50K
2	38	Private	HS-grad	9	Divorced	Handlers-cleaners	Not-in-family	White	Male	0	0	40	United-States	<=50K
3	53	Private	11th	7	Married-civ-spouse	Handlers-cleaners	Husband	Black	Male	0	0	40	United-States	<=50K
4	28	Private	Bachelors	13	Married-civ-spouse	Prof-specialty	Wife	Black	Female	0	0	40	Cuba	<=50K

TensorFlow won't be able to understand strings as labels, so we will convert the Label column to 0s and 1s instead of strings.

```
In [12]: census['income_bracket'].unique()
```

```
Out[12]: array([' <=50K', ' >50K'], dtype=object)
```

```
In [13]: def label_fix(label):
             if label==' <=50K':
                 return 0
             else:
                 return 1
```

```
In [14]: census['income_bracket'] = census['income_bracket'].apply(label_fix)
```

```
In [15]: census['income_bracket'].unique()
```

```
Out[15]: array([0, 1], dtype=int64)
```

0.1.1 Perform a Train Test Split on the Data

```
In [16]: from sklearn.model_selection import train_test_split
```

```
In [17]: x_data = census.drop('income_bracket',axis=1)
         y_labels = census['income_bracket']
         X_train, X_test, y_train, y_test = train_test_split(x_data,y_labels,
                                                             test_size=0.3,
                                                             random_state=101)
```

0.1.2 Create the Feature Columns for tf.esitmator

Take note of categorical vs continuous values!

```
In [18]: census.columns
```

```
Out[18]: Index(['age', 'workclass', 'education', 'education_num', 'marital_status',
                'occupation', 'relationship', 'race', 'gender', 'capital_gain',
                'capital_loss', 'hours_per_week', 'native_country', 'income_bracket'],
               dtype='object')
```

Import Tensorflow

```
In [19]: import tensorflow as tf
```

Create the tf.feature_columns for the categorical values

```
In [20]: gender = tf.feature_column.categorical_column_with_vocabulary_list(
             "gender",["Female", "Male"])
         occupation = tf.feature_column.categorical_column_with_hash_bucket(
             "occupation",hash_bucket_size=1000)
         marital_status = tf.feature_column.categorical_column_with_hash_bucket(
             "marital_status", hash_bucket_size=1000)
         relationship = tf.feature_column.categorical_column_with_hash_bucket(
             "relationship", hash_bucket_size=1000)
         education = tf.feature_column.categorical_column_with_hash_bucket(
```

```
        "education", hash_bucket_size=1000)
    workclass = tf.feature_column.categorical_column_with_hash_bucket(
        "workclass", hash_bucket_size=1000)
    native_country = tf.feature_column.categorical_column_with_hash_bucket(
        "native_country", hash_bucket_size=1000)
```

Create the continuous feature_columns for the continuous values using numeric_column

```
In [21]: age = tf.feature_column.numeric_column("age")
         education_num = tf.feature_column.numeric_column("education_num")
         capital_gain = tf.feature_column.numeric_column("capital_gain")
         capital_loss = tf.feature_column.numeric_column("capital_loss")
         hours_per_week = tf.feature_column.numeric_column("hours_per_week")
```

Put all these variables into a single list with the variable name feat_cols

```
In [22]: feat_cols = [gender,occupation,marital_status,relationship,education,workclass,
                      native_country,age,education_num,capital_gain,capital_loss,
                      hours_per_week]
```

0.1.3 Create Input Function

```
In [23]: input_func = tf.estimator.inputs.pandas_input_fn(x=X_train,y=y_train,
                                                          batch_size=100,
                                                          num_epochs=None,
                                                          shuffle=True)
```

Create the model with tf.estimator (LinearClassifier)

```
In [24]: model = tf.estimator.LinearClassifier(feature_columns=feat_cols)
```

```
INFO:tensorflow:Using default config.
WARNING:tensorflow:Using temporary folder as model directory: C:\Users\DELL\AppData\Local\Temp\t
INFO:tensorflow:Using config: {'_model_dir': 'C:\\Users\\DELL\\AppData\\Local\\Temp\\tmphd39etm0
```

Train the model on the Data, for 5000 steps

```
In [25]: model.train(input_fn = input_func,steps=5000)
```

```
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Saving checkpoints for 1 into C:\Users\DELL\AppData\Local\Temp\tmphd39etm0\model
INFO:tensorflow:loss = 69.3147, step = 1
INFO:tensorflow:global_step/sec: 168.08
INFO:tensorflow:loss = 343.425, step = 101 (0.599 sec)
INFO:tensorflow:global_step/sec: 281.338
INFO:tensorflow:loss = 113.153, step = 201 (0.355 sec)
INFO:tensorflow:global_step/sec: 254.424
INFO:tensorflow:loss = 78.6489, step = 301 (0.394 sec)
```

```
INFO:tensorflow:global_step/sec: 264.268
INFO:tensorflow:loss = 60.7092, step = 401 (0.378 sec)
INFO:tensorflow:global_step/sec: 285.362
INFO:tensorflow:loss = 56.0403, step = 501 (0.350 sec)
INFO:tensorflow:global_step/sec: 295.071
INFO:tensorflow:loss = 91.9415, step = 601 (0.339 sec)
INFO:tensorflow:global_step/sec: 300.854
INFO:tensorflow:loss = 27.7362, step = 701 (0.332 sec)
INFO:tensorflow:global_step/sec: 284.953
INFO:tensorflow:loss = 202.947, step = 801 (0.351 sec)
INFO:tensorflow:global_step/sec: 286.276
INFO:tensorflow:loss = 133.695, step = 901 (0.349 sec)
INFO:tensorflow:global_step/sec: 295.071
INFO:tensorflow:loss = 311.527, step = 1001 (0.339 sec)
INFO:tensorflow:global_step/sec: 271.284
INFO:tensorflow:loss = 56.3449, step = 1101 (0.369 sec)
INFO:tensorflow:global_step/sec: 250.588
INFO:tensorflow:loss = 47.9128, step = 1201 (0.401 sec)
INFO:tensorflow:global_step/sec: 242.957
INFO:tensorflow:loss = 34.5754, step = 1301 (0.414 sec)
INFO:tensorflow:global_step/sec: 287.418
INFO:tensorflow:loss = 51.5021, step = 1401 (0.344 sec)
INFO:tensorflow:global_step/sec: 300.401
INFO:tensorflow:loss = 56.6525, step = 1501 (0.333 sec)
INFO:tensorflow:global_step/sec: 299.484
INFO:tensorflow:loss = 129.215, step = 1601 (0.332 sec)
INFO:tensorflow:global_step/sec: 297.269
INFO:tensorflow:loss = 95.1743, step = 1701 (0.338 sec)
INFO:tensorflow:global_step/sec: 251.311
INFO:tensorflow:loss = 157.886, step = 1801 (0.398 sec)
INFO:tensorflow:global_step/sec: 262.811
INFO:tensorflow:loss = 97.9833, step = 1901 (0.380 sec)
INFO:tensorflow:global_step/sec: 293.334
INFO:tensorflow:loss = 47.5423, step = 2001 (0.340 sec)
INFO:tensorflow:global_step/sec: 281.338
INFO:tensorflow:loss = 36.3391, step = 2101 (0.356 sec)
INFO:tensorflow:global_step/sec: 282.133
INFO:tensorflow:loss = 425.897, step = 2201 (0.354 sec)
INFO:tensorflow:global_step/sec: 294.2
INFO:tensorflow:loss = 274.893, step = 2301 (0.343 sec)
INFO:tensorflow:global_step/sec: 275.129
INFO:tensorflow:loss = 176.666, step = 2401 (0.361 sec)
INFO:tensorflow:global_step/sec: 290.16
INFO:tensorflow:loss = 70.1193, step = 2501 (0.345 sec)
INFO:tensorflow:global_step/sec: 283.886
INFO:tensorflow:loss = 227.321, step = 2601 (0.352 sec)
INFO:tensorflow:global_step/sec: 295.2
INFO:tensorflow:loss = 339.602, step = 2701 (0.339 sec)
```

```
INFO:tensorflow:global_step/sec: 298.159
INFO:tensorflow:loss = 56.6977, step = 2801 (0.335 sec)
INFO:tensorflow:global_step/sec: 292.904
INFO:tensorflow:loss = 42.8753, step = 2901 (0.342 sec)
INFO:tensorflow:global_step/sec: 290.429
INFO:tensorflow:loss = 39.4871, step = 3001 (0.343 sec)
INFO:tensorflow:global_step/sec: 273.244
INFO:tensorflow:loss = 37.2008, step = 3101 (0.367 sec)
INFO:tensorflow:global_step/sec: 292.475
INFO:tensorflow:loss = 608.344, step = 3201 (0.342 sec)
INFO:tensorflow:global_step/sec: 266.668
INFO:tensorflow:loss = 38.7863, step = 3301 (0.373 sec)
INFO:tensorflow:global_step/sec: 269.916
INFO:tensorflow:loss = 97.2443, step = 3401 (0.370 sec)
INFO:tensorflow:global_step/sec: 292.047
INFO:tensorflow:loss = 97.0952, step = 3501 (0.343 sec)
INFO:tensorflow:global_step/sec: 260.062
INFO:tensorflow:loss = 41.7583, step = 3601 (0.387 sec)
INFO:tensorflow:global_step/sec: 289.504
INFO:tensorflow:loss = 42.4794, step = 3701 (0.342 sec)
INFO:tensorflow:global_step/sec: 289.085
INFO:tensorflow:loss = 81.957, step = 3801 (0.347 sec)
INFO:tensorflow:global_step/sec: 273.243
INFO:tensorflow:loss = 29.4515, step = 3901 (0.365 sec)
INFO:tensorflow:global_step/sec: 280.938
INFO:tensorflow:loss = 33.5829, step = 4001 (0.357 sec)
INFO:tensorflow:global_step/sec: 299.459
INFO:tensorflow:loss = 103.37, step = 4101 (0.333 sec)
INFO:tensorflow:global_step/sec: 273.995
INFO:tensorflow:loss = 67.7202, step = 4201 (0.364 sec)
INFO:tensorflow:global_step/sec: 280.546
INFO:tensorflow:loss = 71.9568, step = 4301 (0.357 sec)
INFO:tensorflow:global_step/sec: 272.126
INFO:tensorflow:loss = 35.866, step = 4401 (0.368 sec)
INFO:tensorflow:global_step/sec: 269.916
INFO:tensorflow:loss = 83.3985, step = 4501 (0.369 sec)
INFO:tensorflow:global_step/sec: 288.665
INFO:tensorflow:loss = 69.2387, step = 4601 (0.346 sec)
INFO:tensorflow:global_step/sec: 297.713
INFO:tensorflow:loss = 78.3916, step = 4701 (0.337 sec)
INFO:tensorflow:global_step/sec: 261.638
INFO:tensorflow:loss = 41.9503, step = 4801 (0.382 sec)
INFO:tensorflow:global_step/sec: 264.898
INFO:tensorflow:loss = 126.531, step = 4901 (0.377 sec)
INFO:tensorflow:Saving checkpoints for 5000 into C:\Users\DELL\AppData\Local\Temp\tmphd39etm0\mo
INFO:tensorflow:Loss for final step: 58.3278.
```

```
Out[25]: <tensorflow.python.estimator.canned.linear.LinearClassifier at 0x2a34dab748>
```

0.1.4 Evaluation

Create a prediction input function

```
In [26]: pred_fn = tf.estimator.inputs.pandas_input_fn(x=X_test,batch_size=len(X_test),
                                                       shuffle=False)
```

We will use model.predict() and pass in the input function. This will produce a generator of predictions, which we can then transform into a list, with list()

```
In [27]: predictions = list(model.predict(input_fn=pred_fn))
```

```
INFO:tensorflow:Restoring parameters from C:\Users\DELL\AppData\Local\Temp\tmphd39etm0\model.ckp
```

Each item in the list will look like this:

```
In [28]: predictions[0]
```

```
Out[28]: {'class_ids': array([0], dtype=int64),
          'classes': array([b'0'], dtype=object),
          'logistic': array([ 0.37067723], dtype=float32),
          'logits': array([-0.52931267], dtype=float32),
          'probabilities': array([ 0.62932283,  0.3706772 ], dtype=float32)}
```

Create a list of only the class_ids key values from the prediction list of dictionaries, these are the predictions we will use to compare against the real y_test values.

```
In [29]: final_preds = []
         for pred in predictions:
             final_preds.append(pred['class_ids'][0])
```

```
In [30]: final_preds[:10]
```

```
Out[30]: [0, 0, 0, 0, 1, 0, 0, 0, 0, 0]
```

Import classification_report from sklearn.metrics and then see if we can figure out how to use it to easily get a full report of our model's performance on the test data

```
In [31]: from sklearn.metrics import classification_report
```

```
In [52]: print(classification_report(y_test,final_preds))
```

```
             precision    recall  f1-score   support

          0       0.88      0.93      0.91      7436
          1       0.73      0.60      0.66      2333

avg / total       0.85      0.85      0.85      9769
```