This notebook explores Chicago Crime public dataset (bigquery-public-data.chicago_crime.crime)

```
query = """
SELECT count(arrest) FROM `bigquery-public-data.chicago_crime.crime` where arrest IS true
"""
```

```
# Call BigQuery and examine in dataframe
import google.datalab.bigquery as bq
df = bq.Query(query + " LIMIT 100").execute().result().to_dataframe()
```

```
print("There were " + str(df.at[0,"f0_"]) + " arrests in Chicago")
```

```
There were 1874936 arrests in Chicago
```

Chicago coordinates are: latitude 41.8781° N, longitude 87.6298° W

```
#example row
```

I create a table with ~ 1/5 of data : SELECT * FROM bigquery-public-data.chicago_crime.crime where MOD(unique_key, 5) = 0

```
################################ THIS
query = """
SELECT * FROM `ml-sme-223918.bqml_tutorial_us.chicago_crime_subset`
"""
```

```
################################ THIS
import google.datalab.bigquery as bq
df = bq.Query(query + " LIMIT 10000").execute().result().to_dataframe()
```

```
df.describe()
```

	unique_key	beat	district	ward	community_area	x_coordinate	y_coordi
count	1.000000e+04	10000.000000	10000.000000	9094.000000	9093.000000	9.880000e+03	9.880000e
mean	6.019879e+06	957.668400	8.809300	25.222784	37.324645	1.169884e+06	1.862125e
std	2.959119e+06	624.775001	5.129304	12.797437	17.621808	1.009025e+04	3.898737e
min	6.400000e+02	512.000000	5.000000	2.000000	3.000000	1.145015e+06	1.818775e
25%	3.354052e+06	522.000000	5.000000	9.000000	30.000000	1.162321e+06	1.828462e
50%	5.864905e+06	531.000000	5.000000	25.000000	49.000000	1.173140e+06	1.835508e
75%	8.407878e+06	1033.000000	10.000000	34.000000	53.000000	1.178061e+06	1.888487e
max	1.152740e+07	2323.000000	19.000000	48.000000	56.000000	1.188194e+06	1.932093e

I observe that latitude is between (41.658132, 41.969159) and longitude is between (-87.743523, -87.586439)

Also I see that year is between 2001 and 2018

```
df.head()
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_descript
0	3045	HL177967	2005-02-12 20:47:00	007XX E 103RD ST	0110	HOMICIDE	FIRST DEGREE MURDER	RETAIL STORE
1	3205	HL435664	2005-06-21 21:28:00	103XX S INDIANA AVE	0110	HOMICIDE	FIRST DEGREE MURDER	STREET
2	20900	HW295447	2013-05-29 15:11:00	000XX W 107TH ST	0110	HOMICIDE	FIRST DEGREE MURDER	STREET
3	1710710	G513455	2001-08-27 23:55:00	104XX S STATE ST	0265	CRIM SEXUAL ASSAULT	AGGRAVATED: OTHER	RESIDENCE
4	11363170	JB327133	2018-06-29 00:44:13	002XX W 104TH ST	0281	CRIM SEXUAL ASSAULT	NON-AGGRAVATED	RESIDENCE

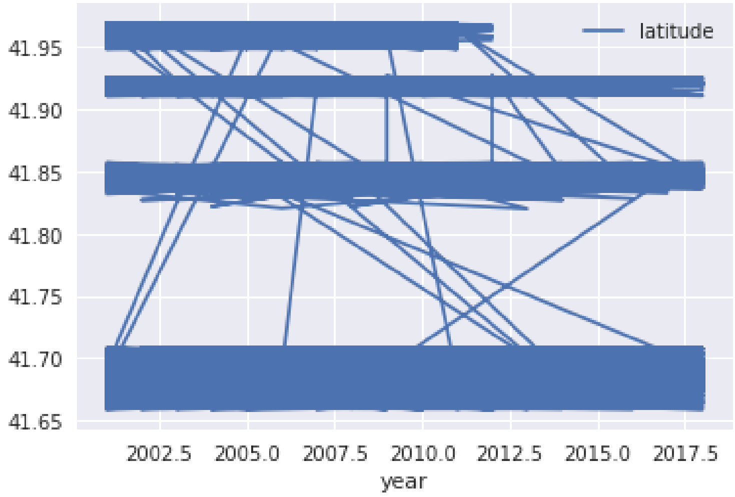
5 rows × 22 columns

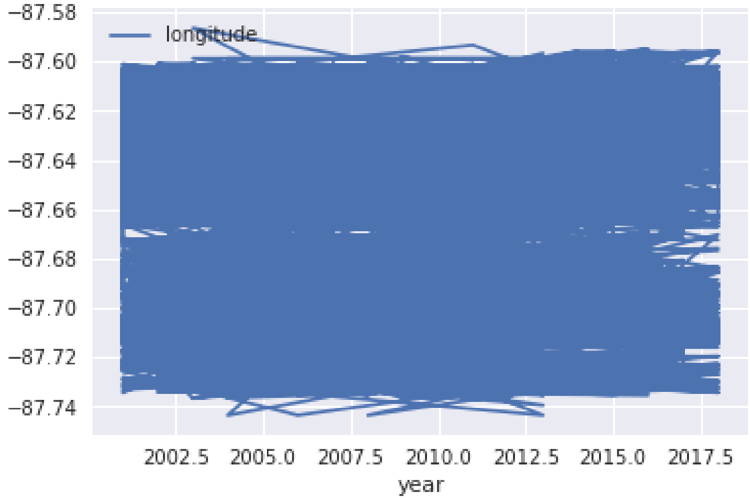
I see in BigQuery: Table size 271.74 MB

Number of rows 1,353,959

```
df.plot(x='year', y='latitude')
df.plot(x='year', y='longitude')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8bfc245250>
```





I see a lot of crime activity happening between 41.66 : 41.71 latitude in Chicago.

```
print(df['location'][0])
```

```
(41.707455731, -87.605637491)
```

```
print(df['location'])
```

```
for x in df['location'][0]:
  print(x)
```

```
(
4
1
.
7
0
7
4
5
5
7
3
1
,
 
-
8
7
.
6
0
5
6
3
7
4
9
1
)
```

```
print(df['location'][0].find(","))
```

```
13
```

so it's a string

```
############################### THIS
import copy
df2=copy.deepcopy(df)
```

https://docs.python.org/2/library/copy.html (https://docs.python.org/2/library/copy.html)

Now, considering first element is (41.707455731, -87.605637491)

```
print(df2['location'][0][8:13])
```

```
55731
```

```
print(len(df2['location'][0]))
```

```
29
```

```
print(df2['location'][0][23:28])
```

```
37491
```

```
df2['location'][0][8:13]="00000"
print(df2['location'][0])
```

```
TypeErrorTraceback (most recent call last)
<ipython-input-25-6dbf6f697f44> in <module>()
----> 1 df2['location'][0][8:13]="00000"
      2 print(df2['location'][0])

TypeError: 'newstr' object does not support item assignment
```

```
for index, row in df2.iterrows():
  print(row)
  print(row['location'])
  break
```

```
unique_key                                  3045
case_number                             HL177967
date                         2005-02-12 20:47:00
block                            007XX E 103RD ST
iucr                                        0110
primary_type                           HOMICIDE
description                 FIRST DEGREE MURDER
location_description               RETAIL STORE
arrest                                      True
domestic                                   False
beat                                         512
district                                       5
ward                                           9
community_area                                50
fbi_code                                     01A
x_coordinate                         1.18295e+06
y_coordinate                         1.83683e+06
year                                        2005
updated_on                   2015-08-17 15:03:40
latitude                                 41.7075
longitude                               -87.6056
location            (41.707455731, -87.605637491)
Name: 0, dtype: object
(41.707455731, -87.605637491)
```

```
for index, row in df2.iterrows():
  print(row['location'])
  tmp = row['location'][0:8] + "00000" + row['location'][13:23] + "00000)"
  print(tmp)
  print(row['location'])
  row['location'] = tmp
  print(row['location'])
  break
```

```
(41.707455731, -87.605637491)
(41.707400000, -87.605600000)
(41.707455731, -87.605637491)
(41.707400000, -87.605600000)
```

```
for index, row in df2.iterrows():
  try:
    tmp = row['location'][0:8] + "00000" + row['location'][13:23] + "00000)"
    row['location'] = tmp
  except TypeError:
    print(row)
    break
print(df2.head(1))
```

So there are rows for which there is no location set. Need to clean it up.

```
(df2[df2["location"] != False]).head()
#df2.head()
```

```
NameErrorTraceback (most recent call last)
<ipython-input-1-74cf8e19ee0e> in <module>()
----> 1 (df2[df2["location"] != False]).head()
      2 #df2.head()

NameError: name 'df2' is not defined
```

```
#checking if there still are any rows with no location data set
for index, row in df2.iterrows():
  try:
    tmp = row['location'][0:8]
  except TypeError:
    print(row['location'])
```

No rows with empty coordinates left (good) but also no change in location (bad).

```
############################### THIS
#df2.head()
df3=copy.deepcopy(df)
df3.head()
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_descript
0	3045	HL177967	2005-02-12 20:47:00	007XX E 103RD ST	0110	HOMICIDE	FIRST DEGREE MURDER	RETAIL STORE
1	3205	HL435664	2005-06-21 21:28:00	103XX S INDIANA AVE	0110	HOMICIDE	FIRST DEGREE MURDER	STREET
2	20900	HW295447	2013-05-29 15:11:00	000XX W 107TH ST	0110	HOMICIDE	FIRST DEGREE MURDER	STREET
3	1710710	G513455	2001-08-27 23:55:00	104XX S STATE ST	0265	CRIM SEXUAL ASSAULT	AGGRAVATED: OTHER	RESIDENCE
4	11363170	JB327133	2018-06-29 00:44:13	002XX W 104TH ST	0281	CRIM SEXUAL ASSAULT	NON-AGGRAVATED	RESIDENCE

5 rows × 22 columns

```
print((df3[df3["location"] != False]).shape[0])
print((df3[df3["location"] == False]).shape[0])
print((df3[df3["location"].notnull()]).shape[0])
```

```
10000
0
9880
```

```
############################### THIS
#this is how to filter rows with None in location
df3 = df3[df3["location"].notnull()]
print(df3.shape[0])
```

```
9880
```

```
############################### THIS
#let's really change the location
for index, row in df3.iterrows():
  try:
    #print("index="+index)
    tmp = row['location'][0:7] + "000000" + row['location'][12:23] + "000000)"
    #print("tmp="+tmp)
    df3.set_value(index, 'location', tmp)
    #break
  except TypeError:
    print("TypeError in:" + row)
#print(df3.head())
```

```
/usr/local/envs/py2env/lib/python2.7/site-packages/ipykernel/__main__.py:8: FutureWarning: set_valu
e is deprecated and will be removed in a future release. Please use .at[] or .iat[] accessors instead
```

```
print(df3.head(1))
```

```
   unique_key case_number                date            block  iucr  \
0        3045    HL177967 2005-02-12 20:47:00  007XX E 103RD ST  0110

  primary_type          description location_description  arrest  domestic  \
0     HOMICIDE  FIRST DEGREE MURDER         RETAIL STORE    True     False

               ...                ward  community_area  fbi_code  \
0              ...                 9.0            50.0       01A

   x_coordinate y_coordinate  year          updated_on   latitude  longitude  \
0     1182951.0    1836828.0  2005 2015-08-17 15:03:40  41.707456 -87.605637

                      location
0  (41.70700000001, -87.605000000)

[1 rows x 22 columns]
```

```
#let's plot the crime area
#first, sum up crime # in same location
df4 = df3.groupby('location').count()
df4.head(1)
#df4.plot(x='location', y='count', logy=True, kind='bar');
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_descrip
location								
(41.6580000000, -87.6340000000)	2	2	2	2	2	2	2	2
(41.6580000000, -87.6357000000)	1	1	1	1	1	1	1	1
(41.6580000000, -87.6380000000)	1	1	1	1	1	1	1	1
(41.6580000000, -87.6393000000)	1	1	1	1	1	1	1	1
(41.6580000000, -87.6404000000)	3	3	3	3	3	3	3	3

5 rows × 21 columns

```
df5=df4.sort_values(by='case_number', ascending=False)
df5.head(3)
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_descrip
location								
(41.7050000000, -87.6009000000)	40	40	40	40	40	40	40	40
(41.6920000000, -87.6043000000)	39	39	39	39	39	39	39	39
(41.7070000000, -87.6018000000)	39	39	39	39	39	39	39	39
(41.9640000000, -87.6547000000)	33	33	33	33	33	33	33	33
(41.8490000000, -87.7088000000)	33	33	33	33	33	33	33	33

5 rows × 21 columns

```
df5.plot(x='location', y='case_number', kind='bar')
```

The above is because index was set to location , need to be reset https://stackoverflow.com/questions/31167896/keyerror-in-dataframe (https://stackoverflow.com/questions/31167896/keyerror-in-dataframe)

```
df5 = df5.reset_index()
df5.head(1)
```

	index	location	unique_key	case_number	date	block	iucr	primary_type	description	locatic
0	0	(41.7050000000, -87.6009000000)	40	40	40	40	40	40	40	40

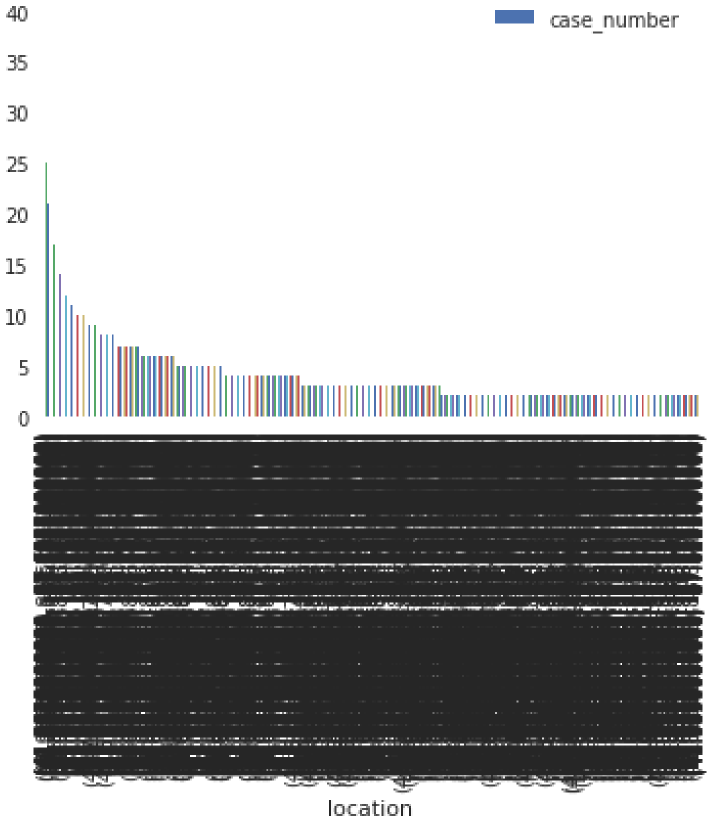
1 rows × 23 columns

```
print(df5.shape[0])
df5 = df5[df5['case_number']>1]
print(df5.shape[0])
```

```
4174
1784
```

```
df5.plot(x='location', y='case_number', kind='bar')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9538462f90>
```



Cant' see much from the chart.
Anyway, this is the area with most crimes: https://goo.gl/maps/sG6bqFV9Xcm (https://goo.gl/maps/sG6bqFV9Xcm)
in my dataframe (**not** in Chicago - since I only took 10,000 rows from the > 1 M rows)
(after removing 6xzeros from both latitude and longitude)

http://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.drop_duplicates.html (http://pandas.pydata.org/pandas-docs/stable/generated/pandas.DataFrame.drop_duplicates.html)

```
############################### THIS
#df3 has the rows that have location set
print(df3.shape[0])
df31=df3.drop_duplicates(subset="primary_type")
print(df31.shape[0])
```

```
9880
25
```

```
print(df31["primary_type"])
```

```
0                               HOMICIDE
3                    CRIM SEXUAL ASSAULT
7                                ROBBERY
43                               BATTERY
174               PUBLIC PEACE VIOLATION
289                              ASSAULT
375                             STALKING
376                             BURGLARY
441                                THEFT
576                  MOTOR VEHICLE THEFT
625                                ARSON
626                   DECEPTIVE PRACTICE
655                      CRIMINAL DAMAGE
755                    CRIMINAL TRESPASS
770                    WEAPONS VIOLATION
786                         PROSTITUTION
803                          SEX OFFENSE
805                             GAMBLING
806           OFFENSE INVOLVING CHILDREN
816                           KIDNAPPING
817                            NARCOTICS
935                 LIQUOR LAW VIOLATION
936                        OTHER OFFENSE
975     INTERFERENCE WITH PUBLIC OFFICER
1614                        INTIMIDATION
Name: primary_type, dtype: object
```

```
############################### THIS
LIST_PRIMARY_TYPE = df31["primary_type"].tolist()
print(LIST_PRIMARY_TYPE)
```

```
['HOMICIDE', 'CRIM SEXUAL ASSAULT', 'ROBBERY', 'BATTERY', 'PUBLIC PEACE VIOLATIO
N', 'ASSAULT', 'STALKING', 'BURGLARY', 'THEFT', 'MOTOR VEHICLE THEFT', 'ARSON', 'DE
CEPTIVE PRACTICE', 'CRIMINAL DAMAGE', 'CRIMINAL TRESPASS', 'WEAPONS VIOLATIO
N', 'PROSTITUTION', 'SEX OFFENSE', 'GAMBLING', 'OFFENSE INVOLVING CHILDREN', 'KID
NAPPING', 'NARCOTICS', 'LIQUOR LAW VIOLATION', 'OTHER OFFENSE', 'INTERFERENCE
WITH PUBLIC OFFICER', 'INTIMIDATION']
```

```
print(df31.head(1))
```

```
   unique_key case_number                date             block  iucr  \
0        3045    HL177967 2005-02-12 20:47:00  007XX E 103RD ST  0110

  primary_type          description location_description  arrest  domestic  \
0     HOMICIDE  FIRST DEGREE MURDER         RETAIL STORE    True     False

                ...                ward  community_area  fbi_code  \
0               ...                 9.0            50.0       01A

   x_coordinate y_coordinate  year          updated_on   latitude  longitude  \
0     1182951.0    1836828.0  2005 2015-08-17 15:03:40  41.707456 -87.605637

                        location
0  (41.7070000000, -87.6056000000)

[1 rows x 22 columns]
```

So things of interest: primary_type ; location_description ; arrest ; domestic ; year ; location

```
############################# THIS
df32=df3.drop_duplicates(subset="location_description")
print(df32.shape[0])
print(df32["location_description"])
```

```
81
0                RETAIL STORE
1                STREET
3                RESIDENCE
5                VEHICLE NON-COMMERCIAL
7                HOTEL/MOTEL
8                SIDEWALK
10               GAS STATION
13               PARKING LOT/GARAGE(NON.RESID.)
15               RESIDENCE-GARAGE
19               TAXICAB
32               SMALL RETAIL STORE
37               SCHOOL, PUBLIC, BUILDING
44               SCHOOL, PUBLIC, GROUNDS
45               RESIDENCE PORCH/HALLWAY
53               APARTMENT
70               OTHER
84               VEHICLE-COMMERCIAL
88               CTA BUS
120              ALLEY
136              RESTAURANT
216              RESIDENTIAL YARD (FRONT/BACK)
297              POLICE FACILITY/VEH PARKING LOT
323              GROCERY FOOD STORE
327              TAVERN/LIQUOR STORE
352              CHA PARKING LOT/GROUNDS
388              CONSTRUCTION SITE
392              VACANT LOT/LAND
418              CHA APARTMENT
455              DRUG STORE
460              ABANDONED BUILDING
            ...
2517             HOUSE
2826             FACTORY/MANUFACTURING BUILDING
2915             CAR WASH
2994             OTHER RAILROAD PROP / TRAIN DEPOT
2996             SCHOOL, PRIVATE, BUILDING
3116             AUTO
3148             COLLEGE/UNIVERSITY GROUNDS
3161             NURSING HOME/RETIREMENT HOME
3194             OTHER COMMERCIAL TRANSPORTATION
3427             CTA GARAGE / OTHER PROPERTY
3665             FEDERAL BUILDING
3907             HOSPITAL BUILDING/GROUNDS
3955             MEDICAL/DENTAL OFFICE
3979             CLEANING STORE
4178             JAIL / LOCK-UP FACILITY
4330             FIRE STATION
4759             APPLIANCE STORE
```

```
4824      CHA HALLWAY/STAIRWELL/ELEVATOR
4899                   VACANT LOT
5556                DAY CARE CENTER
5880                  LAUNDRY ROOM
6101                BOAT/WATERCRAFT
6161                  ATHLETIC CLUB
6349          SCHOOL, PRIVATE, GROUNDS
7253                  BOWLING ALLEY
7389                ANIMAL HOSPITAL
8223                       YARD
8948             MOVIE HOUSE/THEATER
9027                       None
9151    COLLEGE/UNIVERSITY RESIDENCE HALL
Name: location_description, Length: 81, dtype: object
```

```
############################### THIS
LIST_LOCATION_DESCRIPTION = df32["location_description"].tolist()
print(LIST_LOCATION_DESCRIPTION)
```

```
['RETAIL STORE', 'STREET', 'RESIDENCE', 'VEHICLE NON-COMMERCIAL', 'HOTEL/MOTEL',
'SIDEWALK', 'GAS STATION', 'PARKING LOT/GARAGE(NON.RESID.)', 'RESIDENCE-GARAG
E', 'TAXICAB', 'SMALL RETAIL STORE', 'SCHOOL, PUBLIC, BUILDING', 'SCHOOL, PUBLIC,
GROUNDS', 'RESIDENCE PORCH/HALLWAY', 'APARTMENT', 'OTHER', 'VEHICLE-COMMER
CIAL', 'CTA BUS', 'ALLEY', 'RESTAURANT', 'RESIDENTIAL YARD (FRONT/BACK)', 'POLICE
FACILITY/VEH PARKING LOT', 'GROCERY FOOD STORE', 'TAVERN/LIQUOR STORE', 'CHA P
ARKING LOT/GROUNDS', 'CONSTRUCTION SITE', 'VACANT LOT/LAND', 'CHA APARTMEN
T', 'DRUG STORE', 'ABANDONED BUILDING', 'DEPARTMENT STORE', 'CHURCH/SYNAGOG
UE/PLACE OF WORSHIP', 'BARBERSHOP', 'POOL ROOM', 'DRIVEWAY - RESIDENTIAL', 'BA
NK', 'ATM (AUTOMATIC TELLER MACHINE)', 'CONVENIENCE STORE', 'SPORTS ARENA/ST
ADIUM', 'COMMERCIAL / BUSINESS OFFICE', 'PARK PROPERTY', 'CTA TRAIN', 'BAR OR TA
VERN', 'CURRENCY EXCHANGE', 'GOVERNMENT BUILDING/PROPERTY', 'CTA PLATFOR
M', 'LIBRARY', 'CTA BUS STOP', 'PAWN SHOP', 'WAREHOUSE', 'HIGHWAY/EXPRESSWAY', 'H
OUSE', 'FACTORY/MANUFACTURING BUILDING', 'CAR WASH', 'OTHER RAILROAD PROP /
TRAIN DEPOT', 'SCHOOL, PRIVATE, BUILDING', 'AUTO', 'COLLEGE/UNIVERSITY GROUND
S', 'NURSING HOME/RETIREMENT HOME', 'OTHER COMMERCIAL TRANSPORTATION', 'CT
A GARAGE / OTHER PROPERTY', 'FEDERAL BUILDING', 'HOSPITAL BUILDING/GROUNDS',
'MEDICAL/DENTAL OFFICE', 'CLEANING STORE', 'JAIL / LOCK-UP FACILITY', 'FIRE STATIO
N', 'APPLIANCE STORE', 'CHA HALLWAY/STAIRWELL/ELEVATOR', 'VACANT LOT', 'DAY CA
RE CENTER', 'LAUNDRY ROOM', 'BOAT/WATERCRAFT', 'ATHLETIC CLUB', 'SCHOOL, PRIVA
TE, GROUNDS', 'BOWLING ALLEY', 'ANIMAL HOSPITAL', 'YARD', 'MOVIE HOUSE/THEATE
R', None, 'COLLEGE/UNIVERSITY RESIDENCE HALL']
```

We could first test a simple ML model: given primary_type, location_description => predict arrest (Y/N).
BUT it's NOT ENOUGH - these will be memorized! Need to add another feature.
even so, I can do it like this first, just to see the result.

First - need to create 3 datasets: train, eval, test https://en.wikipedia.org/wiki/Random_seed (https://en.wikipedia.org/wiki/Random_seed) If the same random seed is deliberately shared, it becomes a secret key, so two or more systems using matching pseudorandom number algorithms and matching seeds can generate matching sequences of non-repeating numbers which can be used to synchronize remote systems https://docs.scipy.org/doc/numpy-1.15.1/reference/generated/numpy.random.RandomState.rand.html#numpy.random.RandomState.rand (https://docs.scipy.org/doc/numpy-1.15.1/reference/generated/numpy.random.RandomState.rand.html#numpy.random.RandomState.rand)

```
print(df3.shape[0])
```

```
9880
```

```
############################### THIS
import numpy as np
np.random.seed(seed=1) #makes result reproducible

msk = np.random.rand(10) < 0.5
print(msk)
print(~msk)
```

```
[ True False  True  True  True  True  True  True  True False]
[False  True False False False False False False False  True]
```

```
############################### THIS
#keeping the last ones for
testdf=df3[9000:]
print(testdf.shape[0])
df3new=df3[0:9000]
print(df3new.shape[0])
```

```
880
9000
```

```
############################### THIS
msk = np.random.rand(len(df3new)) < 0.8
traindf = df3new[msk]
evaldf = df3new[~msk]
```

```
############################### THIS
import pandas as pd
import tensorflow as tf
```

```
traindf.head(1)
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_description	arr
0	3045	HL177967	2005-02-12 20:47:00	007XXE 103RD ST	0110	HOMICIDE	FIRST DEGREE MURDER	RETAIL STORE	Tru

1 rows × 22 columns

https://www.tensorflow.org/api_docs/python/tf/estimator/inputs/pandas_input_fn (https://www.tensorflow.org/api_docs/python/tf/estimator/inputs/pandas_input_fn)

```
################################ THIS
# Define your feature columns
def create_feature_cols():
  return [
    tf.feature_column.categorical_column_with_vocabulary_list(key='primary_type', vocabulary_list=LIST_
PRIMARY_TYPE, num_oov_buckets=0),
    tf.feature_column.categorical_column_with_vocabulary_list(key='location_description', vocabulary_list=
LIST_LOCATION_DESCRIPTION, num_oov_buckets=0),
  ]
```

https://www.tensorflow.org/api_docs/python/tf/estimator/inputs/pandas_input_fn (https://www.tensorflow.org/api_docs/python/tf/estimator/inputs/pandas_input_fn)

```
################################ THIS
#https://stackoverflow.com/questions/3765533/python-array-with-string-indices
#def input_fn_train: # returns x, y (where y represents label's class index).
label_arrest_dict={True:0, False:1}
print(label_arrest_dict.keys())
print(label_arrest_dict[False])
```

```
[False, True]
1
```

```
import numpy as np
x = np.array([1, 2, 3, 4, 5])
f = lambda x: x ** 2
squares = f(x)
print(squares)
```

```
[ 1  4  9 16 25]
```

```
#NOT GOOD
tmptestdf=copy.deepcopy(testdf)
ox = tmptestdf["arrest"][0:5]
print(type(ox))
print(ox)
print(ox.data)
#ox=[True, False]
#print(ox)
func = lambda x: label_arrest_dict[x]
from numpy import vectorize
vfunc = vectorize(func)
#sy = f(ox)
sy = np.apply_along_axis(vfunc, 0, ox)
print(type(sy))
print(sy)
#NOT GOOD
```

```
<class 'pandas.core.series.Series'>
9109    False
9110     True
9111     True
9112     True
9113    False
Name: arrest, dtype: bool

<type 'numpy.ndarray'>
[1 0 0 0 1]
<class 'pandas.core.series.Series'>
9109    False
9110     True
9111     True
9112     True
9113    False
Name: arrest, dtype: bool

<type 'numpy.ndarray'>
[1 0 0 0 1]
```

```
#THIS is what I need
#https://pandas.pydata.org/pandas-docs/version/0.23.4/generated/pandas.Series.apply.html#pandas.Series.a
pply
tmptestdf=copy.deepcopy(testdf)
ox = tmptestdf["arrest"][0:5]
print(type(ox))
print(ox)
func = lambda x: label_arrest_dict[x]
sy = ox.apply(func)
print(type(sy))
print(sy)
```

```
<class 'pandas.core.series.Series'>
9109    False
9110     True
9111     True
9112     True
9113    False
Name: arrest, dtype: bool
<class 'pandas.core.series.Series'>
9109    1
9110    0
9111    0
9112    0
9113    1
Name: arrest, dtype: int64
```

```
############################### THIS
# Create pandas input function
def make_input_fn(df, num_epochs, predictMode=False):
    print("in make_input_fn")
    print("got df of length " + str(df.shape[0]))
    df=df[['primary_type','location_description','arrest']]
    df=df.dropna(how='any')#this is critical as I was getting some strange Internal Errors https://stackoverflow.com/questions/45974009/tensorflow-python-framework-errors-impl-internalerror-unable-to-get-element-fro
    print("after removing null, df has length " + str(df.shape[0]))

    if (not predictMode):
        print("train/evaluate mode")
        func = lambda x: label_arrest_dict[x]
        y = df['arrest'].apply(func)
        shuffle = True
    else:
        print("predict mode")
        y = None
        shuffle = False

    return tf.estimator.inputs.pandas_input_fn(
        x = df[['primary_type','location_description']],
        y = y,
        batch_size = 128,
        num_epochs = num_epochs,
        shuffle = shuffle,
        queue_capacity = 1000,
        num_threads = 1
    )
```

https://stackoverflow.com/questions/45974009/tensorflow-python-framework-errors-impl-internalerror-unable-to-get-element-fro (https://stackoverflow.com/questions/45974009/tensorflow-python-framework-errors-impl-internalerror-unable-to-get-element-fro)

https://www.tensorflow.org/api_docs/python/tf/feature_column (https://www.tensorflow.org/api_docs/python/tf/feature_column)

```
############################### THIS
# Create estimator train and evaluate function
def train_and_evaluate(output_dir, num_train_steps):
  estimator = tf.estimator.LinearClassifier(model_dir = output_dir, feature_columns = create_feature_cols())
  train_spec = tf.estimator.TrainSpec(input_fn = make_input_fn(traindf, None),
                                    max_steps = num_train_steps)
  eval_spec = tf.estimator.EvalSpec(input_fn = make_input_fn(evaldf, 1),
                                  steps = None,
                                  start_delay_secs = 1, # start evaluating after N seconds,
                                  throttle_secs = 5)  # evaluate every N seconds
  tf.estimator.train_and_evaluate(estimator, train_spec, eval_spec)
```

```
############################### THIS
# Launch tensorboard
from google.datalab.ml import TensorBoard

OUTDIR = './trained_model'
TensorBoard().start(OUTDIR)
```

TensorBoard was started successfully with pid 3460. Click here (/_proxy/45643/) to access it.

```
3460
```

```
traindf.head(1)
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_description	arr
0	3045	HL177967	2005-02-12 20:47:00	007XX E 103RD ST	0110	HOMICIDE	FIRST DEGREE MURDER	RETAIL STORE	Tru

1 rows × 22 columns

```
traindf[['primary_type','location_description']].head(2)
```

	primary_type	location_description
0	HOMICIDE	RETAIL STORE
1	HOMICIDE	STREET

```
for i in LIST_PRIMARY_TYPE:
  print(str(LIST_PRIMARY_TYPE.index(i)) + "  " + i)
```

```
0  HOMICIDE
1  CRIM SEXUAL ASSAULT
2  ROBBERY
3  BATTERY
4  PUBLIC PEACE VIOLATION
5  ASSAULT
6  STALKING
7  BURGLARY
8  THEFT
9  MOTOR VEHICLE THEFT
10  ARSON
11  DECEPTIVE PRACTICE
12  CRIMINAL DAMAGE
13  CRIMINAL TRESPASS
14  WEAPONS VIOLATION
15  PROSTITUTION
16  SEX OFFENSE
17  GAMBLING
18  OFFENSE INVOLVING CHILDREN
19  KIDNAPPING
20  NARCOTICS
21  LIQUOR LAW VIOLATION
22  OTHER OFFENSE
23  INTERFERENCE WITH PUBLIC OFFICER
24  INTIMIDATION
```

```
# Run the model
import shutil
shutil.rmtree(OUTDIR, ignore_errors = True)
train_and_evaluate(OUTDIR, 2000)
```

```
INFO:tensorflow:Saving checkpoints for 2 into ./trained_model/model.ckpt.
INFO:tensorflow:loss = 76.45322, step = 2
INFO:tensorflow:global_step/sec: 66.7835
INFO:tensorflow:loss = 47.88486, step = 102 (1.498 sec)
INFO:tensorflow:Saving checkpoints for 184 into ./trained_model/model.ckpt.
INFO:tensorflow:Loss for final step: 48.669632.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2018-12-25-11:52:50
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-184
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2018-12-25-11:52:53
INFO:tensorflow:Saving dict for global step 184: accuracy = 0.84891677, accuracy_baseline = 0.6995
439, auc = 0.8444734, auc_precision_recall = 0.90213645, average_loss = 0.393542, global_step = 18
4, label/mean = 0.6995439, loss = 49.305187, precision = 0.8406516, prediction/mean = 0.6844185, re
call = 0.96740013
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-184
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 185 into ./trained_model/model.ckpt.
INFO:tensorflow:loss = 54.28233, step = 185
INFO:tensorflow:global_step/sec: 180.828
INFO:tensorflow:loss = 43.465343, step = 285 (0.557 sec)
INFO:tensorflow:global_step/sec: 271.662
INFO:tensorflow:loss = 60.615414, step = 385 (0.368 sec)
INFO:tensorflow:global_step/sec: 312.029
INFO:tensorflow:loss = 35.615685, step = 485 (0.320 sec)
INFO:tensorflow:global_step/sec: 223.729
INFO:tensorflow:loss = 58.584946, step = 585 (0.448 sec)
INFO:tensorflow:global_step/sec: 104.313
INFO:tensorflow:loss = 42.10739, step = 685 (0.959 sec)
INFO:tensorflow:global_step/sec: 104.045
INFO:tensorflow:loss = 40.585495, step = 785 (0.961 sec)
INFO:tensorflow:Saving checkpoints for 805 into ./trained_model/model.ckpt.
INFO:tensorflow:Loss for final step: 48.950504.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
```

```
eful_interpolation" instead.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2018-12-25-11:53:04
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-805
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2018-12-25-11:53:07
INFO:tensorflow:Saving dict for global step 805: accuracy = 0.8472064, accuracy_baseline = 0.69954
39, auc = 0.847172, auc_precision_recall = 0.9050649, average_loss = 0.3903024, global_step = 805, l
abel/mean = 0.6995439, loss = 48.899315, precision = 0.8388693, prediction/mean = 0.6878698, recall
= 0.96740013
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-805
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 806 into ./trained_model/model.ckpt.
INFO:tensorflow:loss = 53.863503, step = 806
INFO:tensorflow:global_step/sec: 180.103
INFO:tensorflow:loss = 30.358458, step = 906 (0.560 sec)
INFO:tensorflow:global_step/sec: 262.041
INFO:tensorflow:loss = 45.376297, step = 1006 (0.381 sec)
INFO:tensorflow:global_step/sec: 255.385
INFO:tensorflow:loss = 39.570805, step = 1106 (0.392 sec)
INFO:tensorflow:global_step/sec: 256.42
INFO:tensorflow:loss = 43.170433, step = 1206 (0.390 sec)
INFO:tensorflow:global_step/sec: 284.199
INFO:tensorflow:loss = 41.762203, step = 1306 (0.352 sec)
INFO:tensorflow:global_step/sec: 252.268
INFO:tensorflow:loss = 54.657562, step = 1406 (0.396 sec)
INFO:tensorflow:global_step/sec: 280.675
INFO:tensorflow:loss = 55.234707, step = 1506 (0.355 sec)
INFO:tensorflow:global_step/sec: 263.675
INFO:tensorflow:loss = 42.038834, step = 1606 (0.380 sec)
INFO:tensorflow:global_step/sec: 277.7
INFO:tensorflow:loss = 52.49805, step = 1706 (0.360 sec)
INFO:tensorflow:global_step/sec: 277.667
INFO:tensorflow:loss = 61.475388, step = 1806 (0.360 sec)
INFO:tensorflow:Saving checkpoints for 1846 into ./trained_model/model.ckpt.
INFO:tensorflow:Loss for final step: 54.05728.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2018-12-25-11:53:15
```

```
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-1846
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2018-12-25-11:53:15
INFO:tensorflow:Saving dict for global step 1846: accuracy = 0.8449259, accuracy_baseline = 0.6995
439, auc = 0.844983, auc_precision_recall = 0.9037896, average_loss = 0.3934129, global_step = 184
6, label/mean = 0.6995439, loss = 49.289013, precision = 0.8379335, prediction/mean = 0.69625634, r
ecall = 0.96495515
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-1846
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 1847 into ./trained_model/model.ckpt.
INFO:tensorflow:loss = 46.124084, step = 1847
INFO:tensorflow:global_step/sec: 168.554
INFO:tensorflow:loss = 48.816284, step = 1947 (0.597 sec)
INFO:tensorflow:Saving checkpoints for 2000 into ./trained_model/model.ckpt.
INFO:tensorflow:Loss for final step: 46.2726.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2018-12-25-11:53:19
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-2000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2018-12-25-11:53:20
INFO:tensorflow:Saving dict for global step 2000: accuracy = 0.8460661, accuracy_baseline = 0.6995
439, auc = 0.8448546, auc_precision_recall = 0.90349704, average_loss = 0.39417997, global_step =
2000, label/mean = 0.6995439, loss = 49.38512, precision = 0.83912116, prediction/mean = 0.6897616
4, recall = 0.96495515
```

```
for i in LIST_LOCATION_DESCRIPTION:
  print(str(LIST_LOCATION_DESCRIPTION.index(i)) + "   " + i)
#LIST_LOCATION_DESCRIPTION[None]
```

```
0  RETAIL STORE
1  STREET
2  RESIDENCE
3  VEHICLE NON-COMMERCIAL
4  HOTEL/MOTEL
5  SIDEWALK
6  GAS STATION
7  PARKING LOT/GARAGE(NON.RESID.)
8  RESIDENCE-GARAGE
9  TAXICAB
10  SMALL RETAIL STORE
11  SCHOOL, PUBLIC, BUILDING
12  SCHOOL, PUBLIC, GROUNDS
13  RESIDENCE PORCH/HALLWAY
14  APARTMENT
15  OTHER
16  VEHICLE-COMMERCIAL
17  CTA BUS
18  ALLEY
19  RESTAURANT
20  RESIDENTIAL YARD (FRONT/BACK)
21  POLICE FACILITY/VEH PARKING LOT
22  GROCERY FOOD STORE
23  TAVERN/LIQUOR STORE
24  CHA PARKING LOT/GROUNDS
25  CONSTRUCTION SITE
26  VACANT LOT/LAND
27  CHA APARTMENT
28  DRUG STORE
29  ABANDONED BUILDING
30  DEPARTMENT STORE
31  CHURCH/SYNAGOGUE/PLACE OF WORSHIP
32  BARBERSHOP
33  POOL ROOM
34  DRIVEWAY - RESIDENTIAL
35  BANK
36  ATM (AUTOMATIC TELLER MACHINE)
37  CONVENIENCE STORE
38  SPORTS ARENA/STADIUM
39  COMMERCIAL / BUSINESS OFFICE
40  PARK PROPERTY
41  CTA TRAIN
42  BAR OR TAVERN
43  CURRENCY EXCHANGE
44  GOVERNMENT BUILDING/PROPERTY
45  CTA PLATFORM
46  LIBRARY
47  CTA BUS STOP
48  PAWN SHOP
```

```
49  WAREHOUSE
50  HIGHWAY/EXPRESSWAY
51  HOUSE
52  FACTORY/MANUFACTURING BUILDING
53  CAR WASH
54  OTHER RAILROAD PROP / TRAIN DEPOT
55  SCHOOL, PRIVATE, BUILDING
56  AUTO
57  COLLEGE/UNIVERSITY GROUNDS
58  NURSING HOME/RETIREMENT HOME
59  OTHER COMMERCIAL TRANSPORTATION
60  CTA GARAGE / OTHER PROPERTY
61  FEDERAL BUILDING
62  HOSPITAL BUILDING/GROUNDS
63  MEDICAL/DENTAL OFFICE
64  CLEANING STORE
65  JAIL / LOCK-UP FACILITY
66  FIRE STATION
67  APPLIANCE STORE
68  CHA HALLWAY/STAIRWELL/ELEVATOR
69  VACANT LOT
70  DAY CARE CENTER
71  LAUNDRY ROOM
72  BOAT/WATERCRAFT
73  ATHLETIC CLUB
74  SCHOOL, PRIVATE, GROUNDS
75  BOWLING ALLEY
76  ANIMAL HOSPITAL
77  YARD
78  MOVIE HOUSE/THEATER


TypeErrorTraceback (most recent call last)
<ipython-input-40-79e021edda86> in <module>()
      1 for i in LIST_LOCATION_DESCRIPTION:
----> 2   print(str(LIST_LOCATION_DESCRIPTION.index(i)) + "  " + i)
      3 #LIST_LOCATION_DESCRIPTION[None]

TypeError: cannot concatenate 'str' and 'NoneType' objects
```

```
############################## THIS
print(LIST_LOCATION_DESCRIPTION[79])
LIST_LOCATION_DESCRIPTION[79]='None'
print(LIST_LOCATION_DESCRIPTION[79])
```

```
None
None
```

```
################################ THIS
# Run the model
import shutil
OUTDIR = './trained_model'
shutil.rmtree(OUTDIR, ignore_errors = True)
train_and_evaluate(OUTDIR, 2000)
```

```
INFO:tensorflow:Using default config.
INFO:tensorflow:Using config: {'_save_checkpoints_secs': 600, '_session_config': None, '_keep_check
point_max': 5, '_task_type': 'worker', '_train_distribute': None, '_is_chief': True, '_cluster_spec': <tensor
flow.python.training.server_lib.ClusterSpec object at 0x7f203e47bfd0>, '_evaluation_master': '', '_save
_checkpoints_steps': None, '_keep_checkpoint_every_n_hours': 10000, '_service': None, '_num_ps_rep
licas': 0, '_tf_random_seed': None, '_master': '', '_num_worker_replicas': 1, '_task_id': 0, '_log_step_cou
nt_steps': 100, '_model_dir': './trained_model', '_global_id_in_cluster': 0, '_save_summary_steps': 100}
in make_input_fn
got df of length 7246
after removing null, df has length 7244
train/evaluate mode
in make_input_fn
got df of length 1754
after removing null, df has length 1754
train/evaluate mode
INFO:tensorflow:Running training and evaluation locally (non-distributed).
INFO:tensorflow:Start train and evaluate loop. The evaluate will happen after 5 secs (eval_spec.throttle
_secs) or training is finished.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 1 into ./trained_model/model.ckpt.
INFO:tensorflow:loss = 88.722855, step = 1
INFO:tensorflow:global_step/sec: 199.716
INFO:tensorflow:loss = 39.79486, step = 101 (0.505 sec)
INFO:tensorflow:global_step/sec: 335.006
INFO:tensorflow:loss = 50.90493, step = 201 (0.298 sec)
INFO:tensorflow:global_step/sec: 342.503
INFO:tensorflow:loss = 45.327618, step = 301 (0.292 sec)
INFO:tensorflow:global_step/sec: 312.776
INFO:tensorflow:loss = 43.32466, step = 401 (0.320 sec)
INFO:tensorflow:global_step/sec: 352.972
INFO:tensorflow:loss = 45.720856, step = 501 (0.283 sec)
INFO:tensorflow:global_step/sec: 337.533
INFO:tensorflow:loss = 48.32393, step = 601 (0.299 sec)
INFO:tensorflow:global_step/sec: 356.561
INFO:tensorflow:loss = 45.16932, step = 701 (0.279 sec)
INFO:tensorflow:global_step/sec: 321.088
INFO:tensorflow:loss = 42.367653, step = 801 (0.311 sec)
INFO:tensorflow:global_step/sec: 363.011
INFO:tensorflow:loss = 41.64128, step = 901 (0.275 sec)
INFO:tensorflow:global_step/sec: 347.941
INFO:tensorflow:loss = 49.06259, step = 1001 (0.288 sec)
INFO:tensorflow:global_step/sec: 295.572
INFO:tensorflow:loss = 46.48625, step = 1101 (0.339 sec)
INFO:tensorflow:global_step/sec: 327.573
```

```
INFO:tensorflow:loss = 50.491714, step = 1201 (0.305 sec)
INFO:tensorflow:Saving checkpoints for 1251 into ./trained_model/model.ckpt.
INFO:tensorflow:Loss for final step: 29.640606.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2018-12-25-12:17:59
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-1251
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2018-12-25-12:18:00
INFO:tensorflow:Saving dict for global step 1251: accuracy = 0.84663624, accuracy_baseline = 0.699
5439, auc = 0.8465388, auc_precision_recall = 0.904173, average_loss = 0.39155462, global_step = 1
251, label/mean = 0.6995439, loss = 49.056202, precision = 0.8392351, prediction/mean = 0.6901930
6, recall = 0.9657702
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-1251
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 1252 into ./trained_model/model.ckpt.
INFO:tensorflow:loss = 49.580597, step = 1252
INFO:tensorflow:global_step/sec: 220.915
INFO:tensorflow:loss = 35.716206, step = 1352 (0.456 sec)
INFO:tensorflow:global_step/sec: 330.115
INFO:tensorflow:loss = 42.335045, step = 1452 (0.303 sec)
INFO:tensorflow:global_step/sec: 300.052
INFO:tensorflow:loss = 43.848114, step = 1552 (0.333 sec)
INFO:tensorflow:global_step/sec: 339.156
INFO:tensorflow:loss = 44.315094, step = 1652 (0.295 sec)
INFO:tensorflow:global_step/sec: 326.282
INFO:tensorflow:loss = 52.973618, step = 1752 (0.308 sec)
INFO:tensorflow:global_step/sec: 303.292
INFO:tensorflow:loss = 37.343773, step = 1852 (0.328 sec)
INFO:tensorflow:global_step/sec: 316.617
INFO:tensorflow:loss = 42.67659, step = 1952 (0.316 sec)
INFO:tensorflow:Saving checkpoints for 2000 into ./trained_model/model.ckpt.
INFO:tensorflow:Loss for final step: 39.020844.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
WARNING:tensorflow:Trapezoidal rule is known to produce incorrect PR-AUCs; please switch to "car
eful_interpolation" instead.
INFO:tensorflow:Done calling model_fn.
```

```
INFO:tensorflow:Starting evaluation at 2018-12-25-12:18:06
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-2000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2018-12-25-12:18:06
INFO:tensorflow:Saving dict for global step 2000: accuracy = 0.845496, accuracy_baseline = 0.69954
39, auc = 0.84496135, auc_precision_recall = 0.9007598, average_loss = 0.39374632, global_step = 2
000, label/mean = 0.6995439, loss = 49.330788, precision = 0.8385269, prediction/mean = 0.6945196,
recall = 0.96495515
```

lets try to predict now

```
############################### THIS
print(label_arrest_dict)
reverse_label_dict={}
for key, value in label_arrest_dict.iteritems():
  print(str(key)+","+str(value))
  reverse_label_dict[value]=key
print(reverse_label_dict)
```

```
{False: 1, True: 0}
False,1
True,0
{0: True, 1: False}
```

```
############################### THIS
OUTDIR = './trained_model'
estimator = tf.estimator.LinearClassifier(model_dir = OUTDIR, feature_columns = create_feature_cols())
# set steps to None to run evaluation until all data consumed.
results = estimator.predict(
    input_fn = make_input_fn(testdf, 1, predictMode=True))
print("model directory = %s" % OUTDIR)
```

```
INFO:tensorflow:Using default config.
INFO:tensorflow:Using config: {'_save_checkpoints_secs': 600, '_session_config': None, '_keep_check
point_max': 5, '_task_type': 'worker', '_train_distribute': None, '_is_chief': True, '_cluster_spec': <tensor
flow.python.training.server_lib.ClusterSpec object at 0x7f20453aa1d0>, '_evaluation_master': '', '_save
_checkpoints_steps': None, '_keep_checkpoint_every_n_hours': 10000, '_service': None, '_num_ps_rep
licas': 0, '_tf_random_seed': None, '_master': '', '_num_worker_replicas': 1, '_task_id': 0, '_log_step_cou
nt_steps': 100, '_model_dir': './trained_model', '_global_id_in_cluster': 0, '_save_summary_steps': 100}
in make_input_fn
got df of length 880
after removing null, df has length 880
predict mode
model directory = ./trained_model
```

```
print(type(results))
```

```
<type 'generator'>
```

```
print(testdf.loc[[0]])
```

```
print(testdf.iloc[[0]])
```

```
print(testdf.loc[0:0])
```

```
print(testdf.loc[0])
print(testdf.iloc[0])
```

```
unique_key                                  8457875
case_number                                HV134540
date                            2012-01-27 16:20:00
block                            010XX W NORTH AVE
iucr                                           0860
primary_type                                  THEFT
description                           RETAIL THEFT
location_description                          OTHER
arrest                                        False
domestic                                      False
beat                                           1811
district                                         18
ward                                             32
community_area                                    7
fbi_code                                         06
x_coordinate                            1.16934e+06
y_coordinate                            1.91083e+06
year                                           2012
updated_on                      2018-02-10 15:50:01
latitude                                    41.9108
longitude                                  -87.6534
location              (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                                  8457875
case_number                                HV134540
date                            2012-01-27 16:20:00
block                            010XX W NORTH AVE
iucr                                           0860
primary_type                                  THEFT
description                           RETAIL THEFT
location_description                          OTHER
arrest                                        False
domestic                                      False
beat                                           1811
district                                         18
ward                                             32
community_area                                    7
fbi_code                                         06
x_coordinate                            1.16934e+06
y_coordinate                            1.91083e+06
year                                           2012
updated_on                      2018-02-10 15:50:01
latitude                                    41.9108
longitude                                  -87.6534
location              (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                                  8457875
case_number                                HV134540
date                            2012-01-27 16:20:00
```

```
block                                  010XX W NORTH AVE
iucr                                                0860
primary_type                                       THEFT
description                                 RETAIL THEFT
location_description                               OTHER
arrest                                             False
domestic                                           False
beat                                                1811
district                                              18
ward                                                  32
community_area                                         7
fbi_code                                              06
x_coordinate                                 1.16934e+06
y_coordinate                                 1.91083e+06
year                                                2012
updated_on                           2018-02-10 15:50:01
latitude                                         41.9108
longitude                                       -87.6534
location               (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                                       8457875
case_number                                     HV134540
date                                 2012-01-27 16:20:00
block                                  010XX W NORTH AVE
iucr                                                0860
primary_type                                       THEFT
description                                 RETAIL THEFT
location_description                               OTHER
arrest                                             False
domestic                                           False
beat                                                1811
district                                              18
ward                                                  32
community_area                                         7
fbi_code                                              06
x_coordinate                                 1.16934e+06
y_coordinate                                 1.91083e+06
year                                                2012
updated_on                           2018-02-10 15:50:01
latitude                                         41.9108
longitude                                       -87.6534
location               (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                                       8457875
case_number                                     HV134540
date                                 2012-01-27 16:20:00
block                                  010XX W NORTH AVE
iucr                                                0860
primary_type                                       THEFT
description                                 RETAIL THEFT
```

```
location_description                              OTHER
arrest                                            False
domestic                                          False
beat                                               1811
district                                             18
ward                                                 32
community_area                                        7
fbi_code                                             06
x_coordinate                                1.16934e+06
y_coordinate                                1.91083e+06
year                                               2012
updated_on                          2018-02-10 15:50:01
latitude                                        41.9108
longitude                                      -87.6534
location                (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                                      8457875
case_number                                    HV134540
date                                2012-01-27 16:20:00
block                                 010XX W NORTH AVE
iucr                                               0860
primary_type                                      THEFT
description                                RETAIL THEFT
location_description                              OTHER
arrest                                            False
domestic                                          False
beat                                               1811
district                                             18
ward                                                 32
community_area                                        7
fbi_code                                             06
x_coordinate                                1.16934e+06
y_coordinate                                1.91083e+06
year                                               2012
updated_on                          2018-02-10 15:50:01
latitude                                        41.9108
longitude                                      -87.6534
location                (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                                      8457875
case_number                                    HV134540
date                                2012-01-27 16:20:00
block                                 010XX W NORTH AVE
iucr                                               0860
primary_type                                      THEFT
description                                RETAIL THEFT
location_description                              OTHER
arrest                                            False
domestic                                          False
beat                                               1811
```

```
district                                 18
ward                                     32
community_area                            7
fbi_code                                 06
x_coordinate                    1.16934e+06
y_coordinate                    1.91083e+06
year                                   2012
updated_on              2018-02-10 15:50:01
latitude                            41.9108
longitude                          -87.6534
location       (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
unique_key                          8457875
case_number                        HV134540
date                    2012-01-27 16:20:00
block                    010XX W NORTH AVE
iucr                                   0860
primary_type                          THEFT
description                    RETAIL THEFT
location_description                  OTHER
arrest                                False
domestic                              False
beat                                   1811
district                                 18
ward                                     32
community_area                            7
fbi_code                                 06
x_coordinate                    1.16934e+06
y_coordinate                    1.91083e+06
year                                   2012
updated_on              2018-02-10 15:50:01
latitude                            41.9108
longitude                          -87.6534
location       (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
```

NO IDEA WHY it has 8 times the same element

```
print(testdf.iloc[0]["arrest"])
```

```
False
False
False
False
False
False
False
False
```

```
print(type(testdf.iloc[0]))
```

```
<class 'pandas.core.series.Series'>
```

```
print(testdf.iloc[0].iloc[0])
```

```
8457875
```

```
jsn_str=testdf.iloc[0].to_json()
print((testdf.iloc[0])["arrest"])

print(jsn_str)
print(type(jsn_str))
import json
jsn = json.loads(jsn_str)
print(jsn["arrest"])
```

```
False
{"unique_key":8457875,"case_number":"HV134540","date":1327681200000,"block":"010XX W NO
RTH AVE","iucr":"0860","primary_type":"THEFT","description":"RETAIL THEFT","location_descri
ption":"OTHER","arrest":false,"domestic":false,"beat":1811,"district":18,"ward":32.0,"community_are
a":7.0,"fbi_code":"06","x_coordinate":1169336.0,"y_coordinate":1910832.0,"year":2012,"updated_o
n":1518277801000,"latitude":41.910835515,"longitude":-87.653351515,"location":"(41.9100000005, -
87.6533000000)"}
<type 'str'>
False
```

```
print(testdf.iloc[0])
```

```
unique_key                                    8457875
case_number                                  HV134540
date                              2012-01-27 16:20:00
block                               010XX W NORTH AVE
iucr                                             0860
primary_type                                    THEFT
description                              RETAIL THEFT
location_description                            OTHER
arrest                                          False
domestic                                        False
beat                                             1811
district                                           18
ward                                               32
community_area                                      7
fbi_code                                           06
x_coordinate                              1.16934e+06
y_coordinate                              1.91083e+06
year                                             2012
updated_on                        2018-02-10 15:50:01
latitude                                      41.9108
longitude                                    -87.6534
location              (41.9100000005, -87.6533000000)
Name: 9109, dtype: object
```

```
testdf_tmp=copy.deepcopy(testdf)
testdf_tmp.head(1)
testdf_tmp.reset_index()
testdf_tmp.head(1)
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_description
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER

1 rows × 22 columns

	unique_key	case_number	date	block	iucr	primary_type	description	location_description
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER

1 rows × 22 columns

	unique_key	case_number	date	block	iucr	primary_type	description	location_description
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER

1 rows × 22 columns

	unique_key	case_number	date	block	iucr	primary_type	description	location_description
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER

1 rows × 22 columns

	unique_key	case_number	date	block	iucr	primary_type	description	location_description
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER

1 rows × 22 columns

	unique_key	case_number	date	block	iucr	primary_type	description	location_description
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER

1 rows × 22 columns

https://wiki.python.org/moin/Generators (https://wiki.python.org/moin/Generators)

```
numberofprintedtimes=0
def printmax5times(stringg):
  global numberofprintedtimes
  if (numberofprintedtimes<40):
    print(stringg)
    numberofprintedtimes = numberofprintedtimes + 1
```

Generators are iterators, a kind of iterable **you can only iterate over once**. Generators do not store all the values in memory, they generate the values on the fly.
https://stackoverflow.com/questions/231767/what-does-the-yield-keyword-do
(https://stackoverflow.com/questions/231767/what-does-the-yield-keyword-do)

https://stackoverflow.com/questions/1663807/how-to-iterate-through-two-lists-in-parallel
(https://stackoverflow.com/questions/1663807/how-to-iterate-through-two-lists-in-parallel)
https://docs.python.org/2/library/functions.html#zip
(https://docs.python.org/2/library/functions.html#zip)

```
############################### THIS
#this can only be ran ONCE bcs results is a generator
correct_results=0
for idx,result in enumerate(results):
  printmax5times("\n")
  printmax5times("###################")
  printmax5times('result: '+str(result))
  printmax5times(result['classes'][0])

  prediction_label = str(reverse_label_dict[int(result['classes'][0])])
  actual_label = str((testdf.iloc[idx])["arrest"])

  printmax5times("prediction was: arrest? "+ prediction_label)
  printmax5times("index is " + str(idx))
  printmax5times("and in reality arrest was " + actual_label)
  printmax5times("data was " + str(testdf.iloc[idx]))

  if (prediction_label == actual_label):
    correct_results = correct_results + 1

print("\n")
print("###################")
print("###################")
print("Number of correct results: " + str(correct_results) + " out of a total of " + str(testdf.shape[0]))
```

```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./trained_model/model.ckpt-2000
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.


##################
result: {'probabilities': array([0.08003888, 0.9199611 ], dtype=float32), 'logits': array([2.441819], dtype
=float32), 'classes': array(['1'], dtype=object), 'class_ids': array([1]), 'logistic': array([0.9199611], dtype
=float32)}
1
prediction was: arrest? False
index is 0
and in reality arrest was False
data was unique_key                              8457875
case_number                            HV134540
date                         2012-01-27 16:20:00
block                          010XX W NORTH AVE
iucr                                       0860
primary_type                              THEFT
description                       RETAIL THEFT
location_description                      OTHER
arrest                                    False
domestic                                  False
beat                                       1811
district                                     18
ward                                         32
community_area                                7
fbi_code                                     06
x_coordinate                        1.16934e+06
y_coordinate                        1.91083e+06
year                                       2012
updated_on                   2018-02-10 15:50:01
latitude                                41.9108
longitude                              -87.6534
location          (41.9100000005, -87.6533000000)
Name: 9109, dtype: object


##################
result: {'probabilities': array([0.30248347, 0.69751656], dtype=float32), 'logits': array([0.8354996], dty
pe=float32), 'classes': array(['1'], dtype=object), 'class_ids': array([1]), 'logistic': array([0.69751656], dt
ype=float32)}
1
prediction was: arrest? False
index is 1
and in reality arrest was True
```

```
data was unique_key                                2659165
case_number                                HJ270211
date                           2003-03-30 21:15:00
block                          020XX N CLYBOURN AVE
iucr                                     0860
primary_type                               THEFT
description                          RETAIL THEFT
location_description                 SMALL RETAIL STORE
arrest                                    True
domestic                                   False
beat                                     1811
district                                   18
ward                                        43
community_area                                   7
fbi_code                                    06
x_coordinate                         1.16745e+06
y_coordinate                         1.91364e+06
year                                     2003
updated_on                       2018-02-28 15:56:25
latitude                               41.9186
longitude                              -87.6602
location               (41.9180000008, -87.6601000000)
Name: 9110, dtype: object


###################
result: {'probabilities': array([0.30248347, 0.69751656], dtype=float32), 'logits': array([0.8354996], dty
pe=float32), 'classes': array(['1'], dtype=object), 'class_ids': array([1]), 'logistic': array([0.69751656], dt
ype=float32)}
1
prediction was: arrest? False
index is 2
and in reality arrest was True
data was unique_key                                6041120
case_number                                HP142752
date                           2008-01-25 15:00:00
block                         017XX W FULLERTON AVE
iucr                                     0860
primary_type                               THEFT
description                          RETAIL THEFT
location_description                 SMALL RETAIL STORE
arrest                                    True
domestic                                   False
beat                                     1811
district                                   18
ward                                        32
community_area                                   7
fbi_code                                    06
x_coordinate                         1.16414e+06
y_coordinate                         1.91599e+06
```

```
year                                      2008
updated_on                 2018-02-28 15:56:25
latitude                               41.9251
longitude                             -87.6723
location        (41.9250000006, -87.6722000000)
Name: 9111, dtype: object


##################
result: {'probabilities': array([0.30248347, 0.69751656], dtype=float32), 'logits': array([0.8354996], dty
pe=float32), 'classes': array(['1'], dtype=object), 'class_ids': array([1]), 'logistic': array([0.69751656], dt
ype=float32)}
1
prediction was: arrest? False
index is 3
and in reality arrest was True
data was unique_key                          3422835
case_number                         HK483188
date                     2004-07-08 21:15:00
block                      010XX W NORTH AVE
iucr                                    0860
primary_type                           THEFT
description                     RETAIL THEFT
location_description       SMALL RETAIL STORE
arrest                                  True
domestic                               False
beat                                    1811
district                                  18
ward                                      32
community_area                             7
fbi_code                                  06
x_coordinate                     1.16934e+06
y_coordinate                     1.91083e+06
year                                    2004
updated_on               2018-02-28 15:56:25
latitude                             41.9108
longitude                           -87.6534
location        (41.9100000005, -87.6533000000)
Name: 9112, dtype: object


##################
result: {'probabilities': array([0.09117065, 0.9088294 ], dtype=float32), 'logits': array([2.2994244], dty
pe=float32), 'classes': array(['1'], dtype=object), 'class_ids': array([1]), 'logistic': array([0.9088294], dty
pe=float32)}
1
prediction was: arrest? False
index is 4
and in reality arrest was False
data was unique_key                          6545005
```

```
case_number                          HP617629
date                      2008-10-07 11:45:00
block                     023XX N SHEFFIELD AVE
iucr                                     0870
primary_type                            THEFT
description                     POCKET-PICKING
location_description                 SIDEWALK
arrest                                  False
domestic                                False
beat                                     1811
district                                   18
ward                                       32
community_area                              7
fbi_code                                   06
x_coordinate                      1.16924e+06
y_coordinate                       1.9158e+06
year                                     2008
updated_on                2018-02-28 15:56:25
latitude                              41.9245
longitude                            -87.6536
location          (41.924000000, -87.65357000000)
Name: 9113, dtype: object


###################
###################
Number of correct results: 766 out of a total of 880
```

Number of correct results: 766 out of a total of 880

```
print(str((766.0/880)*100) + "% accuracy")
```

```
87.0454545455% accuracy
```

############
############
############
############
############
############
############
############
############

** From https://stackoverflow.com/questions/46948172/predict-in-tensorflow-estimator-using-input-fn (https://stackoverflow.com/questions/46948172/predict-in-tensorflow-estimator-using-input-fn)

The prediction result for one sample is below:
{
'probabilities': array([0.78595656, 0.21404342], dtype = float32),
'logits': array([-1.3007226], dtype = float32),
'classes': array(['0'], dtype = object),
'class_ids': array([0]),
'logistic': array([0.21404341], dtype = float32)
}
What each field means are

'probabilities': array([0.78595656, 0.21404342], dtype = float32).
It predicts the output label is class-0 (in this case <=50K) with confidence 0.78595656
'logits': array([-1.3007226], dtype = float32)
The value of z in equation 1/(1+e^(-z)) is -1.3.
'classes': array(['0'], dtype = object)
The class label is 0

result: {'probabilities': array([0.31800354, 0.68199646], dtype=float32), 'logits': array([0.762962], dtype=float32), 'classes': array(['1'], dtype=object), 'class_ids': array([1]), 'logistic': array([0.68199646], dtype=float32)} result: {'probabilities': array([0.83636373, 0.1636363], dtype=float32), 'logits': array([-1.6314174], dtype=float32), 'classes': array(['0'], dtype=object), 'class_ids': array([0]), 'logistic': array([0.16363628], dtype=float32)}

```
############################### THIS
df321=df3.drop_duplicates(subset="arrest")
print(df32.shape[0])
print(df32["arrest"])
```

```
81
0        True
1        True
3       False
5        True
7       False
8       False
10       True
13      False
15      False
19      False
32      False
37       True
44      False
45      False
53      False
70       True
84      False
88      False
120     False
136      True
216     False
297     False
323      True
327     False
352     False
388     False
392     False
418     False
455      True
460     False
        ...
2517    False
2826    False
2915     True
2994     True
2996    False
3116     True
3148     True
3161    False
3194    False
3427     True
3665    False
3907     True
3955    False
3979    False
4178     True
4330    False
4759    False
```

```
4824     True
4899    False
5556    False
5880     True
6101    False
6161    False
6349     True
7253    False
7389    False
8223    False
8948    False
9027    False
9151    False
Name: arrest, Length: 81, dtype: bool
```

```
testdf.head(3)
```

	unique_key	case_number	date	block	iucr	primary_type	description	location_descri
9109	8457875	HV134540	2012-01-27 16:20:00	010XX W NORTH AVE	0860	THEFT	RETAIL THEFT	OTHER
9110	2659165	HJ270211	2003-03-30 21:15:00	020XX N CLYBOURN AVE	0860	THEFT	RETAIL THEFT	SMALL RETAI STORE
9111	6041120	HP142752	2008-01-25 15:00:00	017XX W FULLERTON AVE	0860	THEFT	RETAIL THEFT	SMALL RETAI STORE

3 rows × 22 columns

```
result: {'probabilities': array([0.91876584, 0.0812341 ], dtype=float32), 'logits': array([-2.4256961],
dtype=float32), 'classes': array(['0'], dtype=object), 'class_ids': array([0]), 'logistic': array([0.0812341],
dtype=float32)} result: {'probabilities': array([0.69484776, 0.30515227], dtype=float32), 'logits':
array([-0.82288194], dtype=float32), 'classes': array(['0'], dtype=object), 'class_ids': array([0]),
'logistic': array([0.30515227], dtype=float32)} result: {'probabilities': array([0.69484776,
0.30515227], dtype=float32), 'logits': array([-0.82288194], dtype=float32), 'classes': array(['0'],
dtype=object), 'class_ids': array([0]), 'logistic': array([0.30515227], dtype=float32)}
```