

```
In [3]: import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
In [4]: import numpy as np
import pandas as pd
import seaborn as sns
import plotly.express as px
from matplotlib import pyplot as plt
from sklearn.model_selection import cross_val_score

from sklearn import metrics
from collections import Counter
```

```
In [7]: train_data = pd.read_csv("fraudTest.csv", index_col=0)
```

```
In [8]: train_data.columns
```

```
Out[8]: Index(['trans_date_trans_time', 'cc_num', 'merchant', 'category', 'amt',
              'first', 'last', 'gender', 'street', 'city', 'state', 'zip', 'lat',
              'long', 'city_pop', 'job', 'dob', 'trans_num', 'unix_time', 'merch_lat',
              'merch_long', 'is_fraud'],
              dtype='object')
```

```
In [9]: train_data.head()
```

Out[9]:

	trans_date_trans_time	cc_num	merchant	category	amt	first	last	gender	street	city	...	lat	long
0	2020-06-21 12:14:25	2291163933867244	fraud_Kirlin and Sons	personal_care	2.86	Jeff	Elliott	M	351 Darlene Green	Columbia	...	33.9659	-80.9355
1	2020-06-21 12:14:33	3573030041201292	fraud_Sporer-Keebler	personal_care	29.84	Joanne	Williams	F	3638 Marsh Union	Altonah	...	40.3207	-110.4360
2	2020-06-21 12:14:53	3598215285024754	fraud_Swaniawski, Nitzsche and Welch	health_fitness	41.28	Ashley	Lopez	F	9333 Valentine Point	Bellmore	...	40.6729	-73.5365
3	2020-06-21 12:15:15	3591919803438423	fraud_Haley Group	misc_pos	60.05	Brian	Williams	M	32941 Krystal Mill Apt. 552	Titusville	...	28.5697	-80.8191
4	2020-06-21 12:15:17	3526826139003047	fraud_Johnston-Casper	travel	3.19	Nathan	Massey	M	5783 Evan Roads Apt. 465	Falmouth	...	44.2529	-85.0170

5 rows × 22 columns

In [10]: `subset_data = train_data.copy()`

```
In [11]: import datetime
subset_data = subset_data[["trans_date_trans_time", "dob", "amt", "city_pop", "is_fraud"]]
#subset_data["trans_date"] = datetime.datetime(subset_data["trans_date_trans_time"])
subset_data.head()
```

Out[11]:

	trans_date_trans_time	dob	amt	city_pop	is_fraud
--	-----------------------	-----	-----	----------	----------

0	2020-06-21 12:14:25	1968-03-19	2.86	333497	0
1	2020-06-21 12:14:33	1990-01-17	29.84	302	0
2	2020-06-21 12:14:53	1970-10-21	41.28	34496	0
3	2020-06-21 12:15:15	1987-07-25	60.05	54767	0
4	2020-06-21 12:15:17	1955-07-06	3.19	1126	0

In [12]: subset_data.dtypes

Out[12]:

trans_date_trans_time	object
dob	object
amt	float64
city_pop	int64
is_fraud	int64
dtype:	object

In [13]:

```
subset_data["trans_date"] = pd.to_datetime(pd.to_datetime(subset_data["trans_date_trans_time"], format="%Y-%m-%d %H:%M:%S").dt.date)
subset_data["dob_date"] = pd.to_datetime(subset_data["dob"], format="%Y-%m-%d")
subset_data.head()
```

Out[13]:

	trans_date_trans_time	dob	amt	city_pop	is_fraud	trans_date	dob_date
--	-----------------------	-----	-----	----------	----------	------------	----------

0	2020-06-21 12:14:25	1968-03-19	2.86	333497	0	2020-06-21	1968-03-19
1	2020-06-21 12:14:33	1990-01-17	29.84	302	0	2020-06-21	1990-01-17
2	2020-06-21 12:14:53	1970-10-21	41.28	34496	0	2020-06-21	1970-10-21
3	2020-06-21 12:15:15	1987-07-25	60.05	54767	0	2020-06-21	1987-07-25
4	2020-06-21 12:15:17	1955-07-06	3.19	1126	0	2020-06-21	1955-07-06

In [14]: subset_data.dtypes

```
Out[14]: trans_date_trans_time    object
         dob                  object
         amt                  float64
         city_pop             int64
         is_fraud             int64
         trans_date           datetime64[ns]
         dob_date             datetime64[ns]
         dtype: object
```

```
In [15]: subset_data["age"] = (subset_data["trans_date"]-subset_data["dob_date"]) / (np.timedelta64(1, 'D')*365)
         subset_data.head()
```

```
Out[15]:
```

	trans_date_trans_time	dob	amt	city_pop	is_fraud	trans_date	dob_date	age
0	2020-06-21 12:14:25	1968-03-19	2.86	333497	0	2020-06-21	1968-03-19	52.293151
1	2020-06-21 12:14:33	1990-01-17	29.84	302	0	2020-06-21	1990-01-17	30.446575
2	2020-06-21 12:14:53	1970-10-21	41.28	34496	0	2020-06-21	1970-10-21	49.701370
3	2020-06-21 12:15:15	1987-07-25	60.05	54767	0	2020-06-21	1987-07-25	32.931507
4	2020-06-21 12:15:17	1955-07-06	3.19	1126	0	2020-06-21	1955-07-06	65.005479

```
In [16]: import numpy as np
         import pandas as pd
         import math

         def f1_score(data, y, mask, total_frd, min_recall):
             """
             It returns the Information Gain of a variable given a loss function.
             y: target variable.
             mask: split choice.
             total_frd: Total Fraud that can be captured in the starting population
             min_recall: Minimum recall set to be achieved
             """

             hit_data = data[mask]

             capture = hit_data['fraud_amount'].sum()
             temp_tot_frd = data['fraud_amount'].sum()
             hit_rate = capture/hit_data['transaction_amount'].sum()
             capture_rate = capture/temp_tot_frd
```

```

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

if f1 is None:
    return 0

if capture_rate < min_recall:
    return 0

return f1

def max_f1_score_split(data, x, y, total_frd, subset_x, min_recall):
    """
    Given a predictor & target variable, returns the best split, the error and the type of variable based on a selected cost
    x: predictor variable as Pandas Series.
    y: target variable as Pandas Series.
    total_frd: Total Fraud that can be captured in the starting population
    min_recall: Minimum recall set to be achieved
    """

    split_value = []
    f1 = []
    le_gr = []
    print("Checking threshold for {}".format(x.name))
    options = subset_x.sort_values().unique()[1:]
    print("Old size was {}".format(len(options)))
    subset_x = subset_x[subset_x >= 0]

    options = subset_x.sort_values().unique()[1:]

    if len(options) > 100:
        arr_percentiles = np.arange(0,100)
        final_options = np.zeros(100)
        np.percentile(options, arr_percentiles, out = final_options)
    else:
        final_options = options
    print("Current size is {}".format(len(final_options)))

    # Calculate ig for all values
    for ind, val in enumerate(options):
        nonull_data = data[x>=9998]
        mask = x < val
        val_f1 = f1_score(nonull_data, y, mask, total_frd, min_recall)
        mask_2 = x > val
        val_new_f1 = f1_score(nonull_data, y, mask_2, total_frd, min_recall)

```

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        # Append results
        if val_new_f1 < val_f1:
            le_gr.append(1)
            f1.append(val_f1)
        else:
            le_gr.append(0)
            f1.append(val_new_f1)
        split_value.append(val)

    # Check if there are more than 1 results if not, return False
    if len(f1) == 0:
        return(None, None, None, False)

    else:
        # Get results with highest IG
        best_f1 = max(f1)
        best_f1_index = f1.index(best_f1)
        best_split = split_value[best_f1_index]
        best_ineq = le_gr[best_f1_index]
        return(best_f1, best_split, best_ineq, True)

def get_best_split(y, data, x_vars, total_frd, min_recall):
    """
    Given a data, select the best split and return the variable, the value, the variable type and the information gain.
    y: name of the target variable
    data: dataframe where to find the best split.
    x_vars: The variables used for decision making
    total_frd: Total fraud that can be captured in the starting population
    min_recall: Minimum recall set to be achieved
    """

    split_value = []
    f1 = []
    le_gr = []

    for x in x_vars:
        dropped_data = data.dropna(axis=0, subset = [x])
        subset_data = dropped_data[dropped_data[y]==1]
        f1_score, split, ineq, _ = max_f1_score_split(dropped_data, dropped_data[x], dropped_data[y], total_frd, subset_c
        if f1_score is None:
            print("Found None")
            f1_score = 0
        le_gr.append(ineq)
        f1.append(f1_score)

```

```

        split_value.append(split)

    best_f1 = max(f1)
    best_f1_index = f1.index(best_f1)
    best_split = split_value[best_f1_index]
    best_ineq = le_gr[best_f1_index]
    best_var = x_vars[best_f1_index]
    return(best_var, best_split, best_f1, best_ineq)

def make_split(variable, value, data, ineq):
    """
    Given a data and a split conditions, do the split.
    variable: variable with which make the split.
    value: value of the variable to make the split.
    data: data to be splitted.
    ineq: Greater than or less than inequality
    """
    print(variable)
    print(value)
    if(ineq==1):
        data_1 = data[data[variable] < value]
    else:
        data_1 = data[data[variable] > value]

    return data_1

def calc_metrics(data, total_frd):
    """
    Given the target variable, make a prediction.
    data: pandas series for target variable
    total_frd: Total Fraud that can be captured in the starting population
    """

    hit_data = data

    capture = hit_data['fraud_amount'].sum()
    hit_rate = capture/hit_data['transaction_amount'].sum()
    capture_rate = capture/total_frd

    return hit_rate, capture_rate

def train_tree(data,y, total_frd, x_vars, max_depth = None, min_samples_split = None, min_recall = None, min_recall_overall = None):
    """
    Trains a Decision Tree

```

```
data: Data to be used to train the Decision Tree
y: target variable column name
total_frd: Total fraud that can be captured in the starting population
x_vars: The variables used for decision making
max_depth: maximum depth to stop splitting.
min_samples_split: minimum number of observations to make a split.
min_recall: minimum recall for each threshold selection
min_recall_overall: minimum recall for the overall rule
min_precision: Stop once minimum precision reaches a certain level
'''

# check for depth conditions
print(counter)
precision, recall = calc_metrics(data, total_frd)

if max_depth == None:
    depth_cond = True

else:
    if counter < max_depth:
        depth_cond = True

    else:
        depth_cond = False

# Check for sample conditions
if min_samples_split == None:
    sample_cond = True

else:
    if data.shape[0] > min_samples_split:
        sample_cond = True

    else:
        sample_cond = False

# Check for recall condition
if min_recall_overall == None:
    recall_cond = True

else:
    if min_recall_overall < recall:
        recall_cond = True
```



```

        else:
            recall_cond = False

    # Check for condition
    if depth_cond & sample_cond & recall_cond:

        var, val, f1, ineq = get_best_split(y, data, x_vars, total_frd, min_recall)
        counter += 1

        new_data = make_split(var, val, data, ineq)

        # Instantiate sub-tree
        if ineq == 1:
            split_type = "<"
        else:
            split_type = ">"
        question = "{} {} {}".format(var, split_type, val)
        new_precision, new_recall = calc_metrics(new_data, total_frd)
        question = question + " Precision:{}, Recall:{}".format(new_precision, new_recall)
        path = [question]
        print(question)

    #Find answers (recursion)

    next_path = train_tree(new_data, y, total_frd, x_vars, max_depth, min_samples_split, min_recall, min_recall_overall)

    path.append(next_path)

    return path

print("Run Complete")
return None

```

```

In [17]: algo_data = subset_data.copy()
         algo_data["transaction_amount"] = algo_data["amt"]
         algo_data["fraud_amount"] = np.where(algo_data["is_fraud"]==1, algo_data["amt"], 0)
         algo_data = algo_data[["transaction_amount", "city_pop", "age", "fraud_amount", "is_fraud"]]
         algo_data.head()

```

Out[17]:

	transaction_amount	city_pop	age	fraud_amount	is_fraud
0	2.86	333497	52.293151	0.0	0
1	29.84	302	30.446575	0.0	0
2	41.28	34496	49.701370	0.0	0
3	60.05	54767	32.931507	0.0	0
4	3.19	1126	65.005479	0.0	0

In [18]: `total_frd = algo_data[algo_data["is_fraud"]==1]["transaction_amount"].sum()
print(total_frd)`

1133324.6800000002

In [19]: `print(algo_data["fraud_amount"].sum())`

1133324.6799999997

In [20]: `algo_data.shape`

Out[20]: (555719, 5)

In [21]: `rf_vars = ["transaction_amount", "city_pop", "age"]
decisions = train_tree(algo_data, "is_fraud", total_frd, rf_vars, max_depth = 50, min_samples_split = None, min_recall = 0.9, min_`

0
Checking threshold for transaction_amount
Old size was 2060
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop
Old size was 213
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for age
Old size was 428
Current size is 100

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
transaction_amount
298.13
transaction_amount > 298.13 Precision:0.12689186051513052, Recall:0.9395549031897901
1
Checking threshold for transaction_amount
Old size was 1397
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 212
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for age
Old size was 402
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
transaction_amount
1187.73
transaction_amount < 1187.73 Precision:0.17292532564730886, Recall:0.9285229542517329
2
Checking threshold for transaction_amount
Old size was 1387
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 212
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for age
Old size was 401
Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

transaction_amount

359.26

transaction_amount > 359.26 Precision:0.18045184836526054, Recall:0.8358548408210785

3

Checking threshold for transaction_amount

Old size was 1067

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 211

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for age

Old size was 385

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

723.15

transaction_amount > 723.15 Precision:0.4276667793129999, Recall:0.7539324300252597

4

Checking threshold for transaction_amount

Old size was 905

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 207

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for age

Old size was 365

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

```
transaction_amount
749.59
transaction_amount > 749.59 Precision:0.4417347181536312, Recall:0.7279283550059104
5
Checking threshold for transaction_amount
Old size was 865
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 206
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for age
Old size was 360
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
transaction_amount
1155.37
transaction_amount < 1155.37 Precision:0.4514948250633085, Recall:0.7113802198325019
6
Checking threshold for transaction_amount
Old size was 849
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 206
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for age
Old size was 358
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
city_pop
63
city_pop > 63 Precision:0.4527688531437108, Recall:0.7090229606576642
7
Checking threshold for transaction_amount
Old size was 846
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 204
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for age
Old size was 356
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
city_pop
1312922
city_pop < 1312922 Precision:0.45614004560971844, Recall:0.6990092547883099
8
Checking threshold for transaction_amount
Old size was 834
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 202
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 352
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

transaction_amount

1153.76

transaction_amount < 1153.76 Precision:0.4563854380533152, Recall:0.6979912234859298

9

Checking threshold for transaction_amount

Old size was 833

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 202

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 352

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

805.5

transaction_amount > 805.5 Precision:0.47965719327854006, Recall:0.6307482424189332

10

Checking threshold for transaction_amount

Old size was 736

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 199

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 335

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

```
transaction_amount
809.15
transaction_amount > 809.15 Precision:0.4823821097271194, Recall:0.6250492047874576
11
Checking threshold for transaction_amount
Old size was 728
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
Old size was 199
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 335
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
820.97
transaction_amount > 820.97 Precision:0.4883472637990384, Recall:0.6092547724276153
12
Checking threshold for transaction_amount
Old size was 706
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
Old size was 199
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 332
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```



```
age
95.82739726027397
age < 95.82739726027397 Precision:0.4883852060133828, Recall:0.6084458780161744
13
Checking threshold for transaction_amount
Old size was 705
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 199
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 331
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
transaction_amount
1153.43
transaction_amount < 1153.43 Precision:0.48836630226949035, Recall:0.6074281378924881
14
Checking threshold for transaction_amount
Old size was 704
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 199
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 331
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

transaction_amount

1153.08

transaction_amount < 1153.08 Precision:0.4883473249896687, Recall:0.6064107065946891

15

Checking threshold for transaction_amount

Old size was 703

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for city_pop

Old size was 199

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 331

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

transaction_amount

1148.36

transaction_amount < 1148.36 Precision:0.48911230690414464, Recall:0.6043805293289827

16

Checking threshold for transaction_amount

Old size was 701

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 199

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 330

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

```
transaction_amount
```

```
1147.88
```

```
transaction_amount < 1147.88 Precision:0.4890944394093804, Recall:0.6033676863015106
```

```
17
```

```
Checking threshold for transaction_amount
```

```
Old size was 700
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
```

```
Old size was 199
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 330
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
transaction_amount
```

```
1144.18
```

```
transaction_amount < 1144.18 Precision:0.48907692493851446, Recall:0.6023581080048481
```

```
18
```

```
Checking threshold for transaction_amount
```

```
Old size was 699
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
```

```
Old size was 199
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 329
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

transaction_amount

1143.96

transaction_amount < 1143.96 Precision:0.4890589948982884, Recall:0.6013487238273147

19

Checking threshold for transaction_amount

Old size was 698

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 199

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 329

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

transaction_amount

1142.66

transaction_amount < 1142.66 Precision:0.4894431651947633, Recall:0.6003404867173632

20

Checking threshold for transaction_amount

Old size was 697

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 199

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 328

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

```
transaction_amount
1141.38
transaction_amount < 1141.38 Precision:0.48942590313506207, Recall:0.5993333790277998
21
Checking threshold for transaction_amount
Old size was 696
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 199
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 328
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
transaction_amount
1140.88
transaction_amount < 1140.88 Precision:0.489811981107617, Recall:0.5983267125180755
22
Checking threshold for transaction_amount
Old size was 695
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for city_pop
Old size was 199
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 328
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
age
92.8986301369863
age < 92.8986301369863 Precision:0.49102191515476024, Recall:0.5939650586273298
23
Checking threshold for transaction_amount
Old size was 690
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
Old size was 196
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 325
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
age
91.24657534246575
age < 91.24657534246575 Precision:0.491014378482196, Recall:0.5923191401779055
24
Checking threshold for transaction_amount
Old size was 688
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
Old size was 195
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 324
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

transaction_amount

1140.55

transaction_amount < 1140.55 Precision:0.49058940052662325, Recall:0.591312764846875

25

Checking threshold for transaction_amount

Old size was 687

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 323

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1135.26

transaction_amount < 1135.26 Precision:0.4913773977547222, Recall:0.5893051936361254

26

Checking threshold for transaction_amount

Old size was 685

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 323

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1135.07

transaction_amount < 1135.07 Precision:0.49136300462427535, Recall:0.5883036536361318

27

Checking threshold for transaction_amount

Old size was 684

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 322

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1134.41

transaction_amount < 1134.41 Precision:0.49176059972387715, Recall:0.5873026959935258

28

Checking threshold for transaction_amount

Old size was 683

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 322

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1134.02

transaction_amount < 1134.02 Precision:0.49216005838691074, Recall:0.5863020824711943

29

Checking threshold for transaction_amount

Old size was 682

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 322

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1133.57

transaction_amount < 1133.57 Precision:0.49173331129194364, Recall:0.5853018660107181

30

Checking threshold for transaction_amount

Old size was 681

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 322

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1133.52

transaction_amount < 1133.52 Precision:0.4913058652578367, Recall:0.5843016936682257

31

Checking threshold for transaction_amount

Old size was 680

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 322

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1133.22

transaction_amount < 1133.22 Precision:0.4912913015082816, Recall:0.5833017860336368

32

Checking threshold for transaction_amount

Old size was 679

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 195

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 322

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

```
transaction_amount
1132.88
transaction_amount < 1132.88 Precision:0.491691382399572, Recall:0.5823021784013386
33
Checking threshold for transaction_amount
Old size was 678
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
Old size was 195
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 322
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
1130.56
transaction_amount < 1130.56 Precision:0.49209369859301877, Recall:0.5813046178434937
34
Checking threshold for transaction_amount
Old size was 677
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
Old size was 195
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 321
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
1129.96
transaction_amount < 1129.96 Precision:0.49208047714432634, Recall:0.580307586701456
35
Checking threshold for transaction_amount
Old size was 676
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
Old size was 194
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 320
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
1118.62
transaction_amount < 1118.62 Precision:0.49575511481169315, Recall:0.5703808373783935
36
Checking threshold for transaction_amount
Old size was 666
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
Old size was 194
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
Old size was 320
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

transaction_amount

1118.24

transaction_amount < 1118.24 Precision:0.49532230503267977, Recall:0.5693941474917849

37

Checking threshold for transaction_amount

Old size was 665

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 194

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 320

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1117.83

transaction_amount < 1117.83 Precision:0.49574059734257464, Recall:0.5684078193726443

38

Checking threshold for transaction_amount

Old size was 664

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for city_pop

Old size was 194

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 319

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

```
transaction_amount
1117.27
transaction_amount < 1117.27 Precision:0.4953066612180419, Recall:0.5674219853749236
39
Checking threshold for transaction_amount
Old size was 663
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
Checking threshold for city_pop
Old size was 194
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 319
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
transaction_amount
1116.06
transaction_amount < 1116.06 Precision:0.4957259670595047, Recall:0.5664372190324135
40
Checking threshold for transaction_amount
Old size was 662
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for city_pop
Old size was 194
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 318
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
1115.94
transaction_amount < 1115.94 Precision:0.49529103902643934, Recall:0.5654525585730648
41
Checking threshold for transaction_amount
Old size was 661
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for city_pop
Old size was 194
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 318
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
transaction_amount
1115.75
transaction_amount < 1115.75 Precision:0.4948554343519806, Recall:0.564468065762055
42
Checking threshold for transaction_amount
Old size was 660
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for city_pop
Old size was 194
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
  hit_rate = capture/hit_data['transaction_amount'].sum()
Checking threshold for age
Old size was 318
Current size is 100
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
  f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
```

```
1115.73
```

```
transaction_amount < 1115.73 Precision:0.4944190849323542, Recall:0.5634835905982387
```

```
43
```

```
Checking threshold for transaction_amount
```

```
Old size was 659
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
```

```
Old size was 193
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 317
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
```

```
1114.79
```

```
transaction_amount < 1114.79 Precision:0.49482827942206425, Recall:0.5615156373370427
```

```
44
```

```
Checking threshold for transaction_amount
```

```
Old size was 657
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
```

```
Old size was 193
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 317
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```


transaction_amount

1113.91

transaction_amount < 1113.91 Precision:0.49524927877418384, Recall:0.5605327680678408

45

Checking threshold for transaction_amount

Old size was 656

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for city_pop

Old size was 193

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 316

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

transaction_amount

1113.85

transaction_amount < 1113.85 Precision:0.49481059715221015, Recall:0.5595499517402197

46

Checking threshold for transaction_amount

Old size was 655

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

Checking threshold for city_pop

Old size was 193

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide

hit_rate = capture/hit_data['transaction_amount'].sum()

Checking threshold for age

Old size was 316

Current size is 100

C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide

f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)

```
transaction_amount
```

```
1113.48
```

```
transaction_amount < 1113.48 Precision:0.49480161058578165, Recall:0.5585674618856795
```

```
47
```

```
Checking threshold for transaction_amount
```

```
Old size was 654
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
```

```
Old size was 193
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 315
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
```

```
1113.08
```

```
transaction_amount < 1113.08 Precision:0.4943616969036566, Recall:0.5575853249750106
```

```
48
```

```
Checking threshold for transaction_amount
```

```
Old size was 653
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for city_pop
```

```
Old size was 193
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 315
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
transaction_amount
```

```
1111.57
```

```
transaction_amount < 1111.57 Precision:0.49477408239674014, Recall:0.5556230452865457
```

```
49
```

```
Checking threshold for transaction_amount
```

```
Old size was 651
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
Checking threshold for city_pop
```

```
Old size was 193
```

```
Current size is 100
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:18: RuntimeWarning: invalid value encountered in scalar divide
```

```
    hit_rate = capture/hit_data['transaction_amount'].sum()
```

```
Checking threshold for age
```

```
Old size was 315
```

```
Current size is 100
```

```
transaction_amount
```

```
1111.35
```

```
transaction_amount < 1111.35 Precision:0.4947649825254104, Recall:0.5546424348581203
```

```
50
```

```
Run Complete
```

```
C:\Users\DIVYA\AppData\Local\Temp\ipykernel_243380\1007425240.py:21: RuntimeWarning: invalid value encountered in scalar divide
```

```
    f1 = (2*hit_rate*capture_rate)/(hit_rate+capture_rate)
```

```
In [ ]:
```