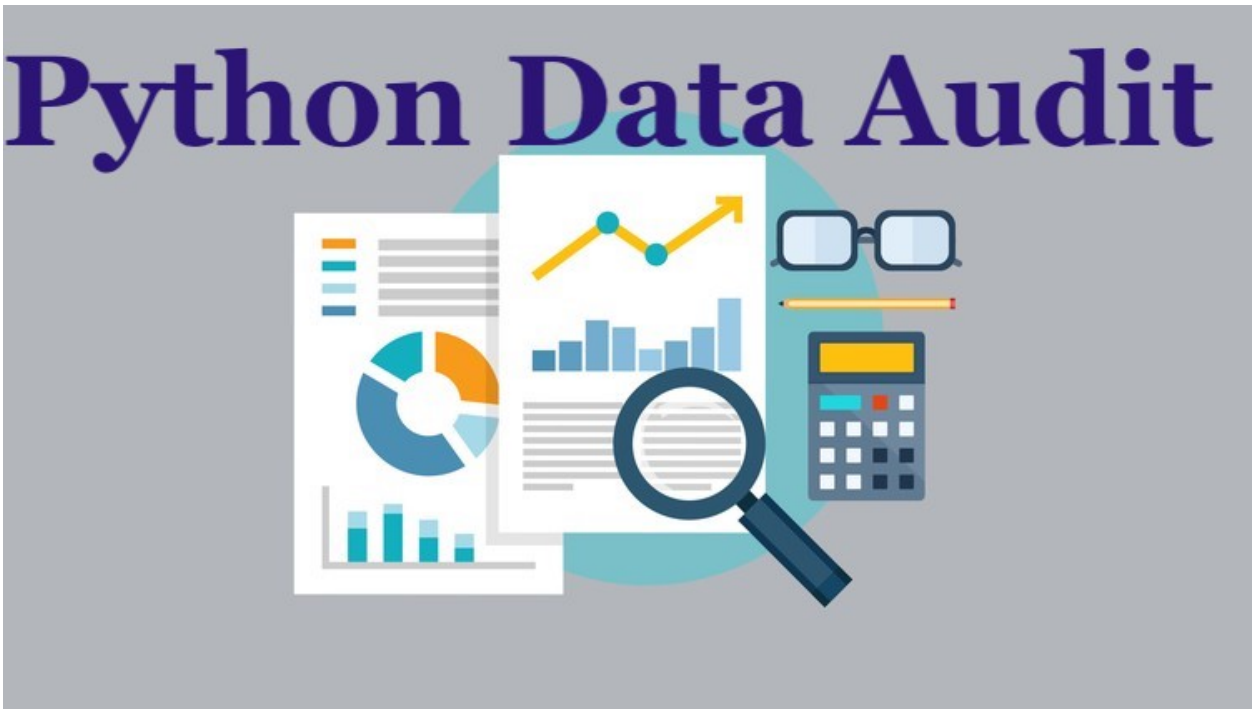


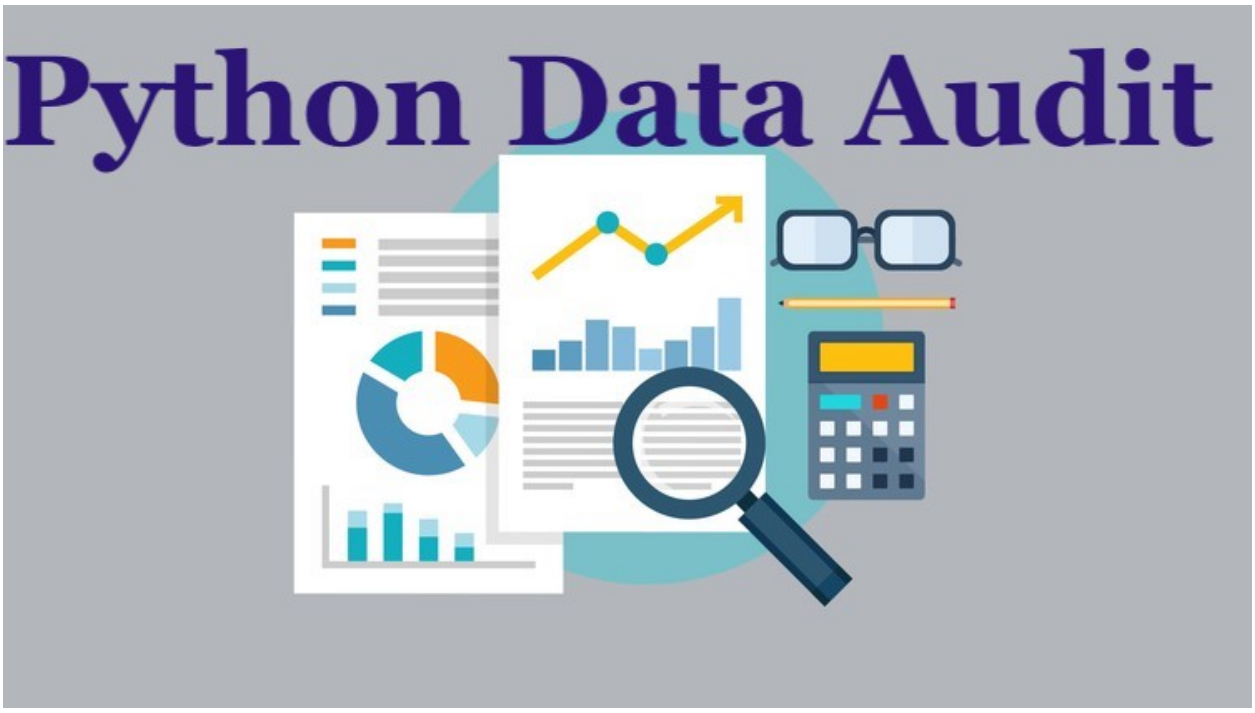
PyAudit: Python Data Audit Library API

Release 1.00

Wenqiang Feng and Ming Chen

May 02, 2019

CONTENTS



Welcome to our **PyAudit: Python Data Audit Library API**! The PDF version can be downloaded from HERE.

You can install the `PyAudit` from [PyPI](https://pypi.org/project/PyAudit):

```
pip install PyAudit
```

CHAPTER

ONE

PREFACE

Chinese proverb

Good tools are prerequisite to the successful execution of a job. – old Chinese proverb

1.1 About

1.1.1 About this API

This document is the `API` book for our PyAudit: Python Data Audit Library [PyAudit] API. The PDF version can be downloaded from HERE. **You may download and distribute it. Please be aware, however, that the note contains typos as well as inaccurate or incorrect description.**

The `API` assumes that the reader has a preliminary knowledge of `python` programing and `Linux`. And this document is generated automatically by using sphinx.

1.1.2 About the author

- **Wenqiang Feng**
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  - Email: von198@gmail.com
- **Ming Chen**
  - Data Scientist and PhD in Genome Science and Technology
  - University of Tennessee at Knoxville

  - Email: ming.chen0919@gmail.com

- **Biography**

  Wenqiang Feng is Data Scientist within DST's Applied Analytics Group. Dr. Feng's responsibilities include providing DST clients with access to cutting-edge skills and technologies, including Big Data analytic solutions, advanced analytic and data enhancement techniques and modeling.

  Dr. Feng has deep analytic expertise in data mining, analytic systems, machine learning algorithms, business intelligence, and applying Big Data tools to strategically solve industry problems in a cross-functional business. Before joining DST, Dr. Feng was an IMA Data Science Fellow at The Institute for Mathematics and its Applications (IMA) at the University of Minnesota. While there, he helped startup companies make marketing decisions based on deep predictive analytics.

  Dr. Feng graduated from University of Tennessee, Knoxville, with Ph.D. in Computational Mathematics and Master's degree in Statistics. He also holds Master's degree in Computational Mathematics from Missouri University of Science and Technology (MST) and Master's degree in Applied Mathematics from the University of Science and Technology of China (USTC).

- **Declaration**

  The work of Wenqiang Feng was supported by the IMA, while working at IMA. However, any opinion, finding, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the IMA, UTK and DST.

1.2 Acknowledgement

At here, Wenqiang Feng would like to thank **Weiyu Wang** at Missouri University of Science and Technology and **Jiangtao (Lotto) Xie** at Purdue University for the unit testing and valuable disscussion.

1.3 Feedback and suggestions

Your comments and suggestions are highly appreciated. I am more than happy to receive corrections, suggestions or feedbacks through email (Wenqiang Feng: von198@gmail.com and Ming Chen: ming.chen0919@gmail.com) for improvements.

CHAPTER

TWO

HOW TO INSTALL

2.1 Install with `pip`

You can install the `PyAudit` from [PyPI](https://pypi.org/project/PyAudit):

```
pip install PyAudit
```

2.2 Install from Repo

2.2.1 Clone the Repository

```
git clone https://github.com/runawayhorse001/PyAudit.git
```

2.2.2 Install

```
cd PyAudit
pip install -r requirements.txt
python setup.py install
```

2.2.3 Uninstall

```
pip uninstall statspy
```

2.2.4 Test

```
cd PyAudit/test
python test.py
```

test.py

```
from PyAudit.basics import missing_rate, zero_rate, dtypes_class
from PyAudit.basics import feature_variance, freq_items_df, feature_len
from PyAudit.basics import corr_matrix,numeric_summary, category_
↪summary
import pandas as pd
import os, sys

output = os.path.abspath(os.path.join(sys.path[0])) + '/output'
print(output)
d = {'A': [1, 0, None, 3],
     'B': [1, 0, 0, 0],
     'C': ['a', None, 'c', 'd']}

# create DataFrame
df = pd.DataFrame(d)
print(missing_rate(df))
print(zero_rate(df))
print(feature_variance(df))
print(df)
print(feature_len(df))
print(numeric_summary(df, output))
print(category_summary(df, output))
print(corr_matrix(df, output))


d ={
    'num': list('1223334444'),
    'cat': list('wxxyyyzzzz')
}
df = pd.DataFrame(d)
df = df.astype({"num": int, "cat": object})
print(freq_items_df(df, top_n=4))

# read df
df = pd.read_csv('Heart.csv', dtype={'Sex': bool})
print(df.head(5))
(num_fields, cat_fields, bool_fields, data_types, type_class) = dtypes_
↪class(df)
```

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```
print(num_fields)
print(cat_fields)
print(bool_fields)
print(data_types)
print(type_class)
print(missing_rate(df))
print(zero_rate(df))

print(freq_items_df(df, top_n=4))
print(feature_len(df))
print(numeric_summary(df, output))
print(category_summary(df, output))
print(corr_matrix(df, output))
```

Results:

```
  feature  missing_rate
0       A          0.25
1       B          0.00
2       C          0.25
  feature  zero_rate
0       A   0.333333
1       B   0.750000
2       C   0.000000
  feature  feature_variance
0       A               1.0
1       B               0.5
2       C               1.0
   Age    Sex     ChestPain  RestBP  Chol  ...  Oldpeak  Slope   Ca
↪    Thal  AHD
0   63   True       typical     145   233  ...      2.3      3  0.0
↪   fixed   No
1   67   True  asymptomatic     160   286  ...      1.5      2  3.0
↪  normal  Yes
2   67   True  asymptomatic     120   229  ...      2.6      2  2.0
↪reversable  Yes
3   37   True    nonanginal     130   250  ...      3.5      3  0.0
↪  normal   No
4   41  False    nontypical     130   204  ...      1.4      1  0.0
↪  normal   No

[5 rows x 14 columns]
['Age', 'RestBP', 'Chol', 'Fbs', 'RestECG', 'MaxHR', 'ExAng', 'Oldpeak
↪', 'Slope', 'Ca']
['ChestPain', 'Thal', 'AHD']
```

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```
['Sex']
      feature   dtypes
0         Age    int64
1         Sex     bool
2   ChestPain   object
3      RestBP    int64
4        Chol    int64
5         Fbs    int64
6     RestECG    int64
7       MaxHR    int64
8       ExAng    int64
9     Oldpeak  float64
10      Slope    int64
11         Ca  float64
12       Thal   object
13        AHD   object
      feature   dtypes     class
0         Age    int64   numeric
1         Sex     bool      bool
2   ChestPain   object  category
3      RestBP    int64   numeric
4        Chol    int64   numeric
5         Fbs    int64   numeric
6     RestECG    int64   numeric
7       MaxHR    int64   numeric
8       ExAng    int64   numeric
9     Oldpeak  float64   numeric
10      Slope    int64   numeric
11         Ca  float64   numeric
12       Thal   object  category
13        AHD   object  category
      feature  missing_rate
0         Age      0.000000
1         Sex      0.000000
2   ChestPain      0.000000
3      RestBP      0.000000
4        Chol      0.000000
5         Fbs      0.000000
6     RestECG      0.000000
7       MaxHR      0.000000
8       ExAng      0.000000
9     Oldpeak      0.000000
10      Slope      0.000000
11         Ca      0.013201
12       Thal      0.006601
```

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```
13          AHD       0.000000

Process finished with exit code 0
```

CHAPTER

THREE

PYTHON DATA AUDIT FUNCTIONS

3.1 Basic Functions

3.1.1 dtypes_class

PyAudit.basics.**dtypes_class**(*df_in*)

numerical, categorical and bool name list in the DataFrame

Parameters **df_in** – input pandas DataFrame

Returns numerical, categorical and bool name list

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> from PyAudit.basics import dtypes_class
>>> df = pd.read_csv('Heart.csv', dtype={'Sex': bool})
>>> (num_fields, cat_fields, bool_fields, data_types, type_class)␣
↪= dtypes_class(df)
>>> num_fields
['Age', 'RestBP', 'Chol', 'Fbs', 'RestECG', 'MaxHR', 'ExAng',
↪'Oldpeak', 'Slope', 'Ca']
```

3.1.2 missing_rate

PyAudit.basics.**missing_rate**(*df_in*)

calculate missing rate for each feature in the DataFrame

Parameters **df_in** – input pandas DataFrame

Returns missing rate

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> import pandas as pd
>>> d = {'A': [1, 0, None, 3],
         'B': [1, 0, 0, 0],
         'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> from PyAudit.basics import missing_rate
>>> missing_rate(df)
       feature  missing_rate
    0       A          0.25
    1       B          0.00
    2       C          0.25
```

3.1.3 zero_rate

PyAudit.basics.**zero_rate**(*df_in*)

calculate the percentage of 0 value for each feature in the DataFrame

Parameters **df_in** – input pandas DataFrame

Returns zero rate

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> import pandas as pd
>>> d = {'A': [1, 0, None, 3],
         'B': [1, 0, 0, 0],
         'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> from PyAudit.basics import zero_rate
>>> zero_rate(df)
       feature  zero_rate
    0       A   0.333333
    1       B   0.750000
    2       C   0.000000
```

3.1.4 feature_variance

PyAudit.basics.**feature_variance**(*df_in*)

calculate the variance for each feature

Parameters **df_in** – input pandas DataFrame

Returns feature variance

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> import pandas as pd
>>> d = {'A': [1, 0, None, 3],
         'B': [1, 0, 0, 0],
         'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> from PyAudit.basics import zero_rate
>>> zero_rate(df)
        feature  feature_variance
      0       A               1.0
      1       B               0.5
      2       C               1.0
```

3.1.5 freq_items_df

PyAudit.basics.**freq_items_df**(*df_in*, *top_n=3*)

find out the top n values and the corresponding frequency for each feature

Parameters

- **df_in** – input pandas DataFrame
- **top_n** – the number of the top values

Returns top n values and the corresponding frequency for each feature

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> d ={
>>>    'num': list('1223334444'),
>>>    'cat': list('wxxyyyzzzz')
>>>    }
>>> df = pd.DataFrame(d)
>>> df = df.astype({"num": int, "cat": object})
>>> print(freq_items_df(df, top_n=4))
     feature     top_items     top_freqs
    0     num  [4, 3, 2, 1]  [4, 3, 2, 1]
    1     cat  [z, y, x, w]  [4, 3, 2, 1]
```

3.1.6 feature_len

PyAudit.basics.**feature_len**(*df_in*)

find out the min and max length of values for each feature

Parameters **df_in** – input pandas DataFrame

Returns min and max length DataFrame

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> d = {'A': [1, 0, None, 3],
>>>      'B': [1, 0, 0, 0],
>>>      'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> print(df)
     A  B     C
0  1.0  1     a
1  0.0  0  None
2  NaN  0     c
3  3.0  0     d
>>> print(feature_len(df))
   feature  min_length  max_length
0        A           3           3
1        B           1           1
2        C           1           4
```

3.1.7 correlation matrix

PyAudit.basics.**corr_matrix**(*df_in*, *output_dir*)

generate correlation matrix for numerical dataframe

Parameters

- **df_in** – input pandas DataFrame
- **output_dir** – output path

Returns correlation matrix

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> d = {'A': [1, 0, None, 3],
>>>      'B': [1, 0, 0, 0],
```

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```
>>>      'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> print(corr_matrix(df))
          A         B
A  1.000000 -0.188982
B -0.188982  1.000000
```

3.2 Summary Functions

3.2.1 numeric_summary

PyAudit.basics.**numeric_summary**(*df_in*, *output_dir*, *top_n=4*, *deciles=False*)

generate statistical summary for numerical DateFrame

Parameters

- **df_in** – input pandas DataFrame
- **output_dir** – output files directory
- **top_n** – the number of the top item to show
- **deciles** – flag for percentiles style

Returns statistical summary for numerical data

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> d = {'A': [1, 0, None, 3],
>>>      'B': [1, 0, 0, 0],
>>>      'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> print(numeric_summary(df))
  feature data_type  min_digits  ...  zero_rate  pos_rate  neg_
↪rate
0       A         A     float64           3  ...   0.333333  0.666667
↪ 0.0
1       B         B       int64           3  ...   0.750000  0.250000
↪ 0.0
```

3.2.2 category_summary

PyAudit.basics.**category_summary**(*df_in*, *output_dir*, *top_n=4*)
generate statistical summary for numerical DateFrame

Parameters

- **df_in** – input pandas DataFrame
- **output_dir** – output files directory
- **top_n** – the number of the top item to show

Returns statistical summary for numerical data

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> d = {'A': [1, 0, None, 3],
>>>      'B': [1, 0, 0, 0],
>>>      'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> print(numeric_summary(df))
     feature data_type  min_digits  ...  top_values  top_freqs ␣
↪missing_rate
   C       C    object           1  ...   [a, d, c]  [1, 1, 1]    ␣
↪     0.25
```

3.3 Auditing Function

3.3.1 auditing

PyAudit.basics.**auditing**(*df_in*, *output_dir*, *top_n=4*, *deciles=False*)
generate audited results

Parameters

- **df_in** – input pandas DataFrame
- **output_dir** – output files directory
- **top_n** – the number of the top item to show
- **deciles** – flag for percentiles style

Author Wenqiang Feng and Ming Chen

Email von198@gmail.com

```
>>> d = {'A': [1, 0, None, 3],
>>>      'B': [1, 0, 0, 0],
>>>      'C': ['a', None, 'c', 'd']}
>>> # create DataFrame
>>> df = pd.DataFrame(d)
>>> print(auditing(df,path))
      feature data_type  min_digits  ...  zero_rate  pos_rate  neg_
↪rate
    A       A   float64           3  ...   0.333333  0.666667
↪ 0.0
    B       B     int64           3  ...   0.750000  0.250000
↪ 0.0
```

CHAPTER

FOUR

AUDITING DEMOS

The following demos are designed to show how to use `PyAudit` to aduit `pd.DataFrame`.

4.1 Auditing in one function

For example:

```
# import python libraries
import os
import sys
import pandas as pd

# import PyAudit module
from PyAudit.basics import auditing

# Audit output path
output = os.path.abspath(os.path.join(sys.path[0])) + '/output'

# load DataFrame
df = pd.read_csv('Heart.csv', dtype={'Sex': bool})
print(df.head(5))

# generate the audit results (.csv files in output folder)
num_summary, cat_summary, corr = auditing(df, output)

# the following is optional, since the .csv files are in the output␣
↪folder
print(num_summary)
print(cat_summary)
print(corr)
```

Result:

```
   Age    Sex     ChestPain  RestBP  Chol  ...  Oldpeak  Slope   Ca
↪    Thal  AHD
0   63   True       typical     145   233  ...      2.3      3  0.0
↪   fixed   No
1   67   True  asymptomatic     160   286  ...      1.5      2  3.0
↪  normal  Yes
2   67   True  asymptomatic     120   229  ...      2.6      2  2.0
↪reversable  Yes
3   37   True    nonanginal     130   250  ...      3.5      3  0.0
↪  normal   No
4   41  False    nontypical     130   204  ...      1.4      1  0.0
↪  normal   No

[5 rows x 14 columns]
         feature data_type  min_digits  ...  zero_rate  pos_rate  neg_
↪rate
Age          Age     int64           4  ...   0.000000  1.000000
↪0.0
RestBP    RestBP     int64           4  ...   0.000000  1.000000
↪0.0
Chol        Chol     int64           5  ...   0.000000  1.000000
↪0.0
Fbs          Fbs     int64           3  ...   0.851485  0.148515
↪0.0
RestECG  RestECG     int64           3  ...   0.498350  0.501650
↪0.0
MaxHR      MaxHR     int64           4  ...   0.000000  1.000000
↪0.0
ExAng      ExAng     int64           3  ...   0.673267  0.326733
↪0.0
Oldpeak  Oldpeak   float64           3  ...   0.326733  0.673267
↪0.0
Slope      Slope     int64           3  ...   0.000000  1.000000
↪0.0
Ca            Ca   float64           3  ...   0.588629  0.411371
↪0.0

[10 rows x 21 columns]
             feature data_type  ...          top_freqs  missing_rate
Sex              Sex      bool  ...           [206, 97]      0.000000
ChestPain  ChestPain    object  ...  [144, 86, 50, 23]      0.000000
Thal            Thal    object  ...     [166, 117, 18]      0.006601
AHD              AHD    object  ...          [164, 139]      0.000000

[4 rows x 10 columns]
              Age    RestBP      Chol  ...   Oldpeak     Slope
↪Ca
```

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```
Age       1.000000  0.284946  0.208950  ...  0.203805  0.161770  0.
 ↪362605
RestBP    0.284946  1.000000  0.130120  ...  0.189171  0.117382  0.
 ↪098773
Chol      0.208950  0.130120  1.000000  ...  0.046564 -0.004062  0.
 ↪119000
Fbs       0.118530  0.175340  0.009841  ...  0.005747  0.059894  0.
 ↪145478
RestECG   0.148868  0.146560  0.171043  ...  0.114133  0.133946  0.
 ↪128343
MaxHR    -0.393806 -0.045351 -0.003432  ... -0.343085 -0.385601 -0.
 ↪264246
ExAng     0.091661  0.064762  0.061310  ...  0.288223  0.257748  0.
 ↪145570
Oldpeak   0.203805  0.189171  0.046564  ...  1.000000  0.577537  0.
 ↪295832
Slope     0.161770  0.117382 -0.004062  ...  0.577537  1.000000  0.
 ↪110119
Ca        0.362605  0.098773  0.119000  ...  0.295832  0.110119  1.
 ↪000000

[10 rows x 10 columns]

Process finished with exit code 0
```

and

4.2 Auditing function by function

For example:

```
# import python libraries
import os
import sys
import pandas as pd

# import PyAudit module
from PyAudit.basics import corr_matrix, numeric_summary, category_
 ↪summary

# Audit output path
output = os.path.abspath(os.path.join(sys.path[0])) + '/output'
```

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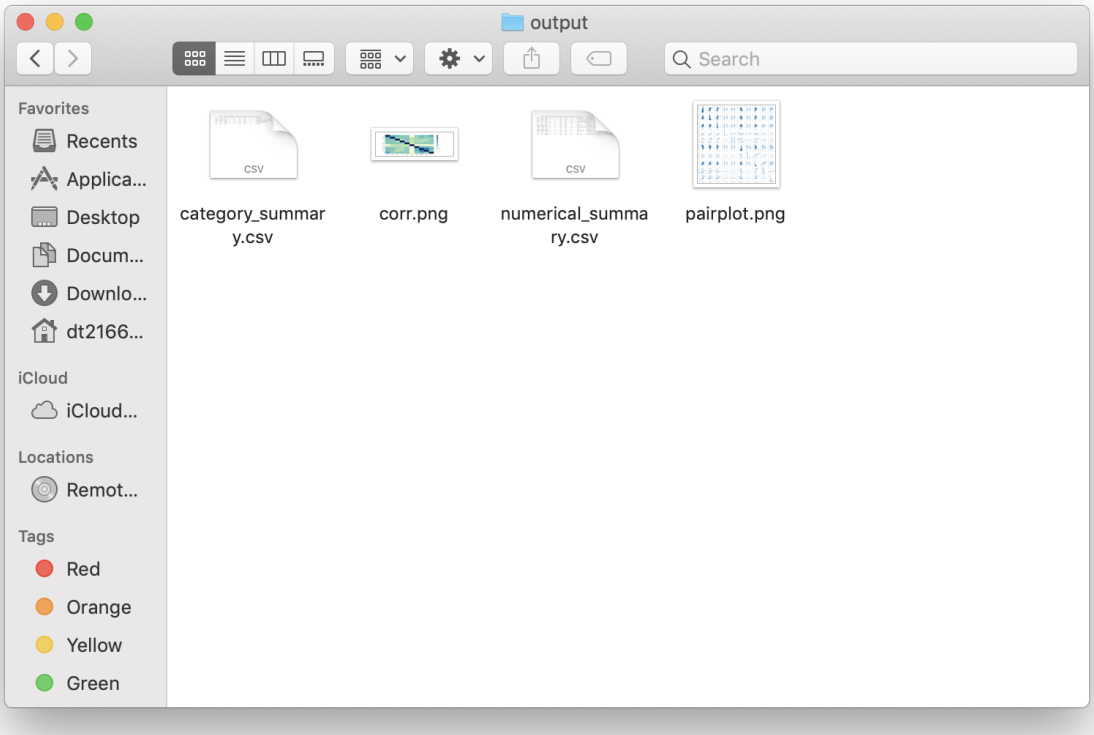
output
Search
Favorites
Recents
Applica...
Desktop
Docum...
Downlo...
dt2166...
iCloud
iCloud...
Locations
Remot...
Tags
Red
Orange
Yellow
Green
CSV
category_summary.csv
corr.png
CSV
numerical_summary.csv
pairplot.png

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```
# load DataFrame
df = pd.read_csv('Heart.csv', dtype={'Sex': bool})
print(df.head(5))

# generate the audit results (.csv files in output folder)
print(numeric_summary(df, output))
print(category_summary(df, output))
print(corr_matrix(df, output))
```

Result:

```
   Age    Sex     ChestPain  RestBP  Chol  ...  Oldpeak  Slope   Ca
↪    Thal  AHD
0   63   True       typical     145   233  ...      2.3      3  0.0
↪   fixed   No
1   67   True  asymptomatic     160   286  ...      1.5      2  3.0
↪  normal  Yes
2   67   True  asymptomatic     120   229  ...      2.6      2  2.0
↪reversable  Yes
3   37   True    nonanginal     130   250  ...      3.5      3  0.0
↪  normal   No
4   41  False    nontypical     130   204  ...      1.4      1  0.0
↪  normal   No

[5 rows x 14 columns]
         feature data_type  min_digits  ...  zero_rate  pos_rate  neg_
↪rate
Age          Age     int64           4  ...   0.000000  1.000000
↪0.0
RestBP    RestBP     int64           4  ...   0.000000  1.000000
↪0.0
Chol        Chol     int64           5  ...   0.000000  1.000000
↪0.0
Fbs          Fbs     int64           3  ...   0.851485  0.148515
↪0.0
RestECG  RestECG     int64           3  ...   0.498350  0.501650
↪0.0
MaxHR      MaxHR     int64           4  ...   0.000000  1.000000
↪0.0
ExAng      ExAng     int64           3  ...   0.673267  0.326733
↪0.0
Oldpeak  Oldpeak   float64           3  ...   0.326733  0.673267
↪0.0
Slope      Slope     int64           3  ...   0.000000  1.000000
↪0.0
```

(continues on next page)

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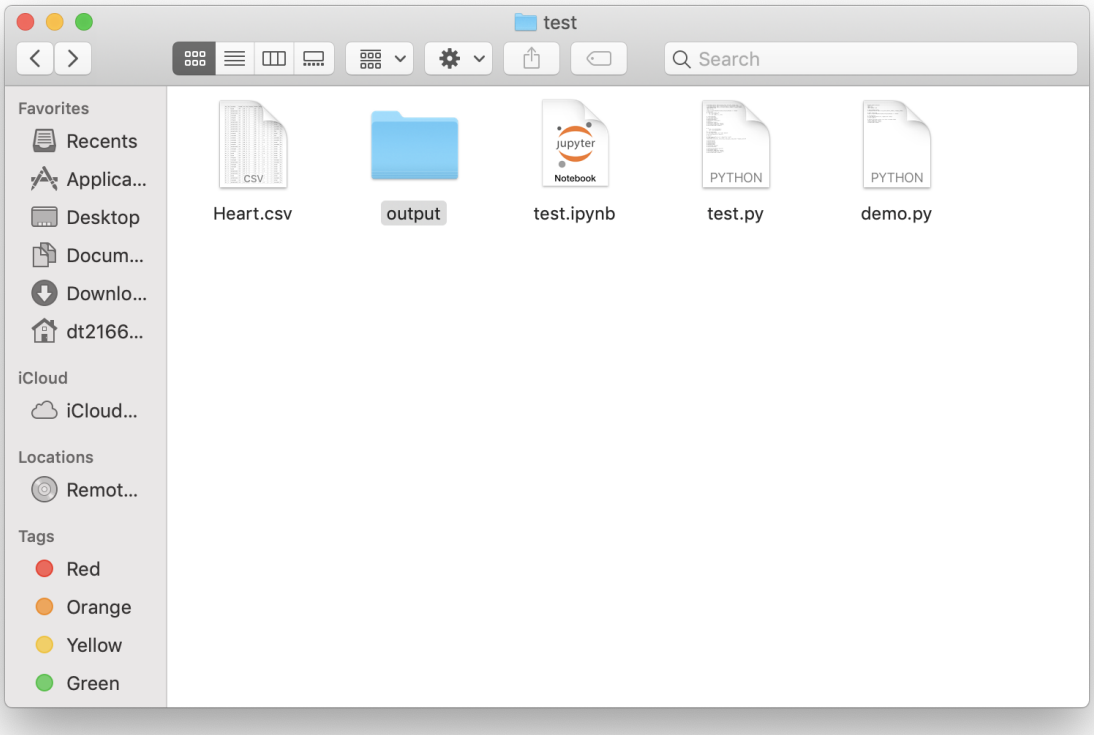
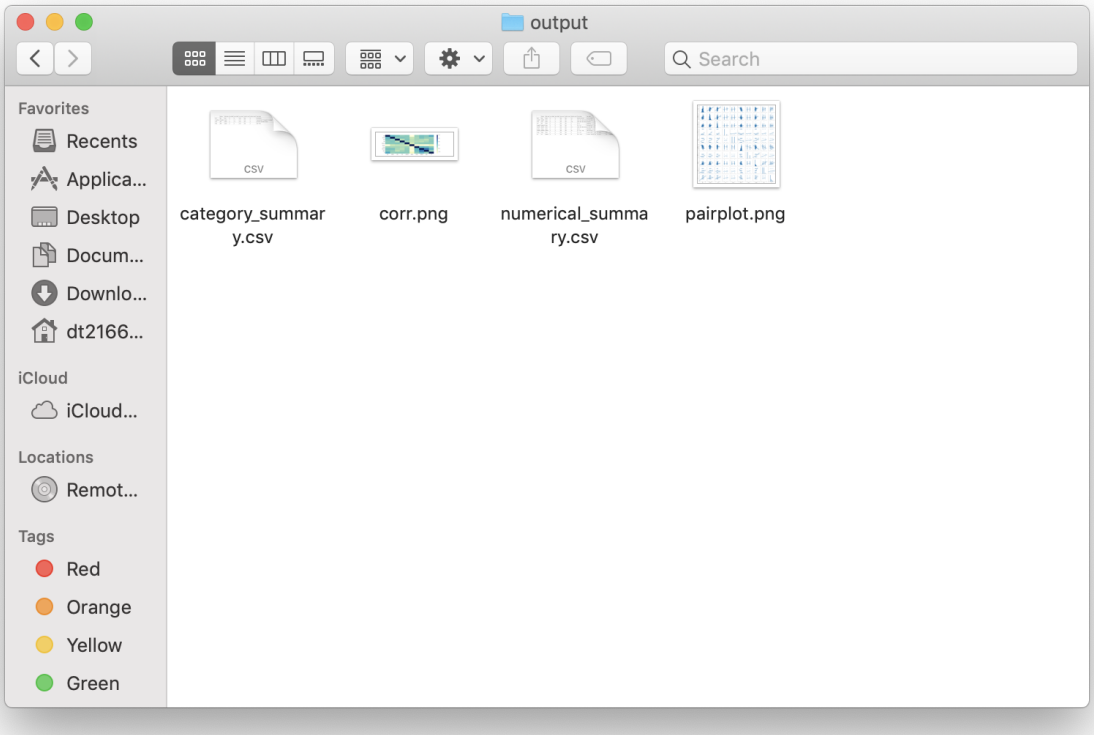
```
Ca            Ca   float64           3  ...   0.588629  0.411371
↪0.0

[10 rows x 21 columns]
            feature data_type  ...          top_freqs  missing_rate
Sex             Sex      bool  ...           [206, 97]      0.000000
ChestPain  ChestPain    object  ...  [144, 86, 50, 23]      0.000000
Thal           Thal    object  ...     [166, 117, 18]      0.006601
AHD             AHD    object  ...          [164, 139]      0.000000

[4 rows x 10 columns]
              Age    RestBP      Chol  ...   Oldpeak     Slope
↪Ca
Age      1.000000  0.284946  0.208950  ...  0.203805  0.161770  0.
↪362605
RestBP   0.284946  1.000000  0.130120  ...  0.189171  0.117382  0.
↪098773
Chol     0.208950  0.130120  1.000000  ...  0.046564 -0.004062  0.
↪119000
Fbs      0.118530  0.175340  0.009841  ...  0.005747  0.059894  0.
↪145478
RestECG  0.148868  0.146560  0.171043  ...  0.114133  0.133946  0.
↪128343
MaxHR   -0.393806 -0.045351 -0.003432  ... -0.343085 -0.385601 -0.
↪264246
ExAng    0.091661  0.064762  0.061310  ...  0.288223  0.257748  0.
↪145570
Oldpeak  0.203805  0.189171  0.046564  ...  1.000000  0.577537  0.
↪295832
Slope    0.161770  0.117382 -0.004062  ...  0.577537  1.000000  0.
↪110119
Ca       0.362605  0.098773  0.119000  ...  0.295832  0.110119  1.
↪000000

[10 rows x 10 columns]

Process finished with exit code 0
```

and

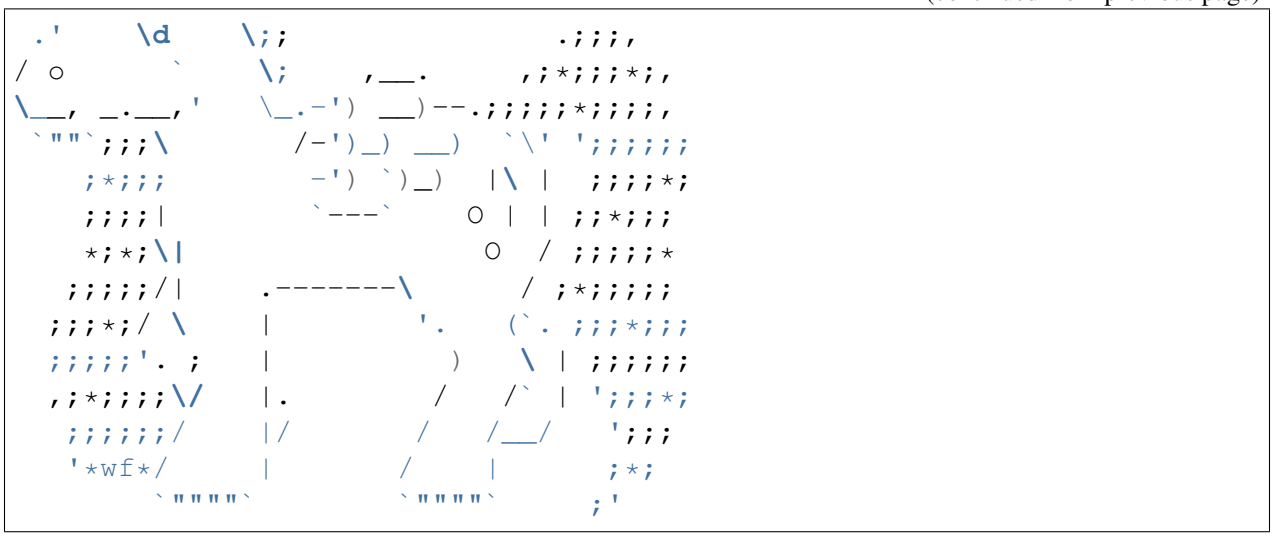
```
      .,,.
    ,;;*;;;;,
   .-'``;-');;.
  /'  .-.  /*;;
```

(continues on next page)


test
Search
Favorites
Recents
Applica...
Desktop
Docum...
Downlo...
dt2166...
iCloud
iCloud...
Locations
Remot...
Tags
Red
Orange
Yellow
Green
Heart.csv
output
test.ipynb
test.py
demo.py
CSV
jupyter
Notebook
PYTHON
PYTHON


output
Search
Favorites
Recents
Applica...
Desktop
Docum...
Downlo...
dt2166...
iCloud
iCloud...
Locations
Remot...
Tags
Red
Orange
Yellow
Green
CSV
category_summary.csv
corr.png
CSV
numerical_summary.csv
pairplot.png

(continued from previous page)



CHAPTER

FIVE

MAIN REFERENCE

BIBLIOGRAPHY

[PyAudit] Wenqiang Feng and Ming Chen. Python Data Audit Library API, 2019.

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