1.0 Common Commands

1.1 Mount drive

In [ ]:

```
#Mount Google Drive to acess data.
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

1.2 Install packages

In [ ]:

```
#Install required packages
!pip install lime
!pip install pycaret
!pip install --upgrade pycaret
!pip install shap
```

```
Collecting lime
  Downloading lime-0.2.0.1.tar.gz (275 kB)
     |████████████████████████████████| 275 kB 5.5 MB/s
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/dist-packages (from
lime) (3.2.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (from lime
) (1.19.5)
Requirement already satisfied: scipy in /usr/local/lib/python3.7/dist-packages (from lime
) (1.4.1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (from lime)
(4.62.3)
Requirement already satisfied: scikit-learn>=0.18 in /usr/local/lib/python3.7/dist-packag
es (from lime) (1.0.2)
Requirement already satisfied: scikit-image>=0.12 in /usr/local/lib/python3.7/dist-packag
es (from lime) (0.18.3)
Requirement already satisfied: pillow!=7.1.0,!=7.1.1,>=4.3.0 in /usr/local/lib/python3.7/
dist-packages (from scikit-image>=0.12->lime) (7.1.2)
Requirement already satisfied: tifffile>=2019.7.26 in /usr/local/lib/python3.7/dist-packa
ges (from scikit-image>=0.12->lime) (2021.11.2)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.7/dist-packages (
from scikit-image>=0.12->lime) (2.4.1)
Requirement already satisfied: PyWavelets>=1.1.1 in /usr/local/lib/python3.7/dist-package
s (from scikit-image>=0.12->lime) (1.2.0)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.7/dist-packages (f
rom scikit-image>=0.12->lime) (2.6.3)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/dist-package
s (from matplotlib->lime) (1.3.2)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib
/python3.7/dist-packages (from matplotlib->lime) (3.0.7)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-packages (fr
om matplotlib->lime) (0.11.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.7/dist-pack
ages (from matplotlib->lime) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from p
ython-dateutil>=2.1->matplotlib->lime) (1.15.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-packages (fr
om scikit-learn>=0.18->lime) (1.1.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.7/dist-pack
ages (from scikit-learn>=0.18->lime) (3.0.0)
Building wheels for collected packages: lime
  Building wheel for lime (setup.py) ... done
  Created wheel for lime: filename=lime-0.2.0.1-py3-none-any.whl size=283857 sha256=48625
```

```
e249e8da2085c28dd396fb6b3fe1f24ddfe246cf531018eb0689de10a4e
  Stored in directory: /root/.cache/pip/wheels/ca/cb/e5/ac701e12d365a08917bf4c6171c0961bc
880a8181359c66aa7
Successfully built lime
Installing collected packages: lime
Successfully installed lime-0.2.0.1
Collecting pycaret
  Downloading pycaret-2.3.6-py3-none-any.whl (301 kB)
     |████████████████████████████████| 301 kB 5.2 MB/s
Collecting pandas-profiling>=2.8.0
  Downloading pandas_profiling-3.1.0-py2.py3-none-any.whl (261 kB)
     |████████████████████████████████| 261 kB 30.1 MB/s
Requirement already satisfied: cufflinks>=0.17.0 in /usr/local/lib/python3.7/dist-package
s (from pycaret) (0.17.3)
Collecting mlxtend>=0.17.0
  Downloading mlxtend-0.19.0-py2.py3-none-any.whl (1.3 MB)
     |████████████████████████████████| 1.3 MB 40.3 MB/s
Requirement already satisfied: plotly>=4.4.1 in /usr/local/lib/python3.7/dist-packages (f
rom pycaret) (5.5.0)
Requirement already satisfied: yellowbrick>=1.0.1 in /usr/local/lib/python3.7/dist-packag
es (from pycaret) (1.3.post1)
Collecting umap-learn
  Downloading umap-learn-0.5.2.tar.gz (86 kB)
     |████████████████████████████████| 86 kB 4.6 MB/s
Collecting imbalanced-learn==0.7.0
  Downloading imbalanced_learn-0.7.0-py3-none-any.whl (167 kB)
     |████████████████████████████████| 167 kB 35.6 MB/s
Requirement already satisfied: seaborn in /usr/local/lib/python3.7/dist-packages (from py
caret) (0.11.2)
Collecting kmodes>=0.10.1
  Downloading kmodes-0.11.1-py2.py3-none-any.whl (19 kB)
Requirement already satisfied: spacy<2.4.0 in /usr/local/lib/python3.7/dist-packages (fro
m pycaret) (2.2.4)
Requirement already satisfied: scipy<=1.5.4 in /usr/local/lib/python3.7/dist-packages (fr
om pycaret) (1.4.1)
Collecting scikit-plot
  Downloading scikit_plot-0.3.7-py3-none-any.whl (33 kB)
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (from pyc
aret) (1.3.5)
Requirement already satisfied: pyyaml<6.0.0 in /usr/local/lib/python3.7/dist-packages (fr
om pycaret) (3.13)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/dist-packages (from
pycaret) (3.2.2)
Requirement already satisfied: nltk in /usr/local/lib/python3.7/dist-packages (from pycar
et) (3.2.5)
Requirement already satisfied: joblib in /usr/local/lib/python3.7/dist-packages (from pyc
aret) (1.1.0)
Collecting pyod
  Downloading pyod-0.9.7.tar.gz (114 kB)
     |████████████████████████████████| 114 kB 48.0 MB/s
Collecting Boruta
  Downloading Boruta-0.3-py3-none-any.whl (56 kB)
     |████████████████████████████████| 56 kB 3.8 MB/s
Collecting mlflow
  Downloading mlflow-1.23.1-py3-none-any.whl (15.6 MB)
     |████████████████████████████████| 15.6 MB 22.1 MB/s
Requirement already satisfied: IPython in /usr/local/lib/python3.7/dist-packages (from py
caret) (5.5.0)
Collecting lightgbm>=2.3.1
  Downloading lightgbm-3.3.2-py3-none-manylinux1_x86_64.whl (2.0 MB)
     |████████████████████████████████| 2.0 MB 37.2 MB/s
Requirement already satisfied: gensim<4.0.0 in /usr/local/lib/python3.7/dist-packages (fr
om pycaret) (3.6.0)
Requirement already satisfied: textblob in /usr/local/lib/python3.7/dist-packages (from p
ycaret) (0.15.3)
Requirement already satisfied: ipywidgets in /usr/local/lib/python3.7/dist-packages (from
pycaret) (7.6.5)
Collecting pyLDAvis
  Downloading pyLDAvis-3.3.1.tar.gz (1.7 MB)
     |████████████████████████████████| 1.7 MB 45.4 MB/s
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
```

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  Installing backend dependencies ... done
    Preparing wheel metadata ... done
Requirement already satisfied: wordcloud in /usr/local/lib/python3.7/dist-packages (from
pycaret) (1.5.0)
Collecting scikit-learn==0.23.2
  Downloading scikit_learn-0.23.2-cp37-cp37m-manylinux1_x86_64.whl (6.8 MB)
     |████████████████████████████████| 6.8 MB 42.6 MB/s
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib/python3.7/dist-packages (f
rom imbalanced-learn==0.7.0->pycaret) (1.19.5)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.7/dist-pack
ages (from scikit-learn==0.23.2->pycaret) (3.0.0)
Requirement already satisfied: colorlover>=0.2.1 in /usr/local/lib/python3.7/dist-package
s (from cufflinks>=0.17.0->pycaret) (0.3.0)
Requirement already satisfied: setuptools>=34.4.1 in /usr/local/lib/python3.7/dist-packag
es (from cufflinks>=0.17.0->pycaret) (57.4.0)
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.7/dist-packages (from
cufflinks>=0.17.0->pycaret) (1.15.0)
Requirement already satisfied: smart-open>=1.2.1 in /usr/local/lib/python3.7/dist-package
s (from gensim<4.0.0->pycaret) (5.2.1)
Requirement already satisfied: prompt-toolkit<2.0.0,>=1.0.4 in /usr/local/lib/python3.7/d
ist-packages (from IPython->pycaret) (1.0.18)
Requirement already satisfied: traitlets>=4.2 in /usr/local/lib/python3.7/dist-packages (
from IPython->pycaret) (5.1.1)
Requirement already satisfied: decorator in /usr/local/lib/python3.7/dist-packages (from
IPython->pycaret) (4.4.2)
Requirement already satisfied: pexpect in /usr/local/lib/python3.7/dist-packages (from IP
ython->pycaret) (4.8.0)
Requirement already satisfied: pygments in /usr/local/lib/python3.7/dist-packages (from I
Python->pycaret) (2.6.1)
Requirement already satisfied: simplegeneric>0.8 in /usr/local/lib/python3.7/dist-package
s (from IPython->pycaret) (0.8.1)
Requirement already satisfied: pickleshare in /usr/local/lib/python3.7/dist-packages (fro
m IPython->pycaret) (0.7.5)
Requirement already satisfied: ipykernel>=4.5.1 in /usr/local/lib/python3.7/dist-packages
(from ipywidgets->pycaret) (4.10.1)
Requirement already satisfied: jupyterlab-widgets>=1.0.0 in /usr/local/lib/python3.7/dist
-packages (from ipywidgets->pycaret) (1.0.2)
Requirement already satisfied: nbformat>=4.2.0 in /usr/local/lib/python3.7/dist-packages
(from ipywidgets->pycaret) (5.1.3)
Requirement already satisfied: ipython-genutils~=0.2.0 in /usr/local/lib/python3.7/dist-p
ackages (from ipywidgets->pycaret) (0.2.0)
Requirement already satisfied: widgetsnbextension~=3.5.0 in /usr/local/lib/python3.7/dist
-packages (from ipywidgets->pycaret) (3.5.2)
Requirement already satisfied: jupyter-client in /usr/local/lib/python3.7/dist-packages (
from ipykernel>=4.5.1->ipywidgets->pycaret) (5.3.5)
Requirement already satisfied: tornado>=4.0 in /usr/local/lib/python3.7/dist-packages (fr
om ipykernel>=4.5.1->ipywidgets->pycaret) (5.1.1)
Requirement already satisfied: wheel in /usr/local/lib/python3.7/dist-packages (from ligh
tgbm>=2.3.1->pycaret) (0.37.1)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.7/dist-pack
ages (from matplotlib->pycaret) (2.8.2)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-packages (fr
om matplotlib->pycaret) (0.11.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib
/python3.7/dist-packages (from matplotlib->pycaret) (3.0.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/dist-package
s (from matplotlib->pycaret) (1.3.2)
Requirement already satisfied: jsonschema!=2.5.0,>=2.4 in /usr/local/lib/python3.7/dist-p
ackages (from nbformat>=4.2.0->ipywidgets->pycaret) (4.3.3)
Requirement already satisfied: jupyter-core in /usr/local/lib/python3.7/dist-packages (fr
om nbformat>=4.2.0->ipywidgets->pycaret) (4.9.1)
Requirement already satisfied: importlib-metadata in /usr/local/lib/python3.7/dist-packag
es (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (4.10.1)
Requirement already satisfied: importlib-resources>=1.4.0 in /usr/local/lib/python3.7/dis
t-packages (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (5.4.0)
Requirement already satisfied: attrs>=17.4.0 in /usr/local/lib/python3.7/dist-packages (f
rom jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (21.4.0)
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.7/dist-package
s (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (3.10.0.2)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.0 in /usr/loca
l/lib/python3.7/dist-packages (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets-
>pycaret) (0.18.1)
```

```
Requirement already satisfied: zipp>=3.1.0 in /usr/local/lib/python3.7/dist-packages (fro
m importlib-resources>=1.4.0->jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycar
et) (3.7.0)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (fr
om pandas->pycaret) (2018.9)
Collecting multimethod>=1.4
  Downloading multimethod-1.7-py3-none-any.whl (9.5 kB)
Collecting pyyaml<6.0.0
  Downloading PyYAML-5.4.1-cp37-cp37m-manylinux1_x86_64.whl (636 kB)
     |████████████████████████████████| 636 kB 46.8 MB/s
Collecting tangled-up-in-unicode==0.1.0
  Downloading tangled_up_in_unicode-0.1.0-py3-none-any.whl (3.1 MB)
     |████████████████████████████████| 3.1 MB 50.1 MB/s
Collecting requests>=2.24.0
  Downloading requests-2.27.1-py2.py3-none-any.whl (63 kB)
     |████████████████████████████████| 63 kB 1.5 MB/s
Collecting htmlmin>=0.1.12
  Downloading htmlmin-0.1.12.tar.gz (19 kB)
Collecting pydantic>=1.8.1
  Downloading pydantic-1.9.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1
0.9 MB)
     |████████████████████████████████| 10.9 MB 42.8 MB/s
Requirement already satisfied: missingno>=0.4.2 in /usr/local/lib/python3.7/dist-packages
(from pandas-profiling>=2.8.0->pycaret) (0.5.0)
Requirement already satisfied: markupsafe~=2.0.1 in /usr/local/lib/python3.7/dist-package
s (from pandas-profiling>=2.8.0->pycaret) (2.0.1)
Collecting visions[type_image_path]==0.7.4
  Downloading visions-0.7.4-py3-none-any.whl (102 kB)
     |████████████████████████████████| 102 kB 10.3 MB/s
Requirement already satisfied: jinja2>=2.11.1 in /usr/local/lib/python3.7/dist-packages (
from pandas-profiling>=2.8.0->pycaret) (2.11.3)
Collecting phik>=0.11.1
  Downloading phik-0.12.0-cp37-cp37m-manylinux2010_x86_64.whl (675 kB)
     |████████████████████████████████| 675 kB 71.6 MB/s
Collecting joblib
  Downloading joblib-1.0.1-py3-none-any.whl (303 kB)
     |████████████████████████████████| 303 kB 70.0 MB/s
Requirement already satisfied: tqdm>=4.48.2 in /usr/local/lib/python3.7/dist-packages (fr
om pandas-profiling>=2.8.0->pycaret) (4.62.3)
Requirement already satisfied: networkx>=2.4 in /usr/local/lib/python3.7/dist-packages (f
rom visions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (2.6.3)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/dist-packages (from vis
ions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (7.1.2)
Collecting imagehash
  Downloading ImageHash-4.2.1.tar.gz (812 kB)
     |████████████████████████████████| 812 kB 47.8 MB/s
Collecting scipy<=1.5.4
  Downloading scipy-1.5.4-cp37-cp37m-manylinux1_x86_64.whl (25.9 MB)
     |████████████████████████████████| 25.9 MB 1.9 MB/s
Requirement already satisfied: tenacity>=6.2.0 in /usr/local/lib/python3.7/dist-packages
(from plotly>=4.4.1->pycaret) (8.0.1)
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages (from pr
ompt-toolkit<2.0.0,>=1.0.4->IPython->pycaret) (0.2.5)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-packag
es (from requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (2021.10.8)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.7/dist
-packages (from requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (2.0.11)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/dist-packages (fr
om requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (2.10)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.7/dist-pac
kages (from requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (1.24.3)
Requirement already satisfied: wasabi<1.1.0,>=0.4.0 in /usr/local/lib/python3.7/dist-pack
ages (from spacy<2.4.0->pycaret) (0.9.0)
Requirement already satisfied: srsly<1.1.0,>=1.0.2 in /usr/local/lib/python3.7/dist-packa
ges (from spacy<2.4.0->pycaret) (1.0.5)
Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in /usr/local/lib/python3.7/dist
-packages (from spacy<2.4.0->pycaret) (1.0.6)
Requirement already satisfied: plac<1.2.0,>=0.9.6 in /usr/local/lib/python3.7/dist-packag
es (from spacy<2.4.0->pycaret) (1.1.3)
Requirement already satisfied: preshed<3.1.0,>=3.0.2 in /usr/local/lib/python3.7/dist-pac
kages (from spacy<2.4.0->pycaret) (3.0.6)
Requirement already satisfied: blis<0.5.0,>=0.4.0 in /usr/local/lib/python3.7/dist-packag
```

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es (from spacy<2.4.0->pycaret) (0.4.1)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in /usr/local/lib/python3.7/dist-packa
ges (from spacy<2.4.0->pycaret) (2.0.6)
Requirement already satisfied: thinc==7.4.0 in /usr/local/lib/python3.7/dist-packages (fr
om spacy<2.4.0->pycaret) (7.4.0)
Requirement already satisfied: catalogue<1.1.0,>=0.0.7 in /usr/local/lib/python3.7/dist-p
ackages (from spacy<2.4.0->pycaret) (1.0.0)
Requirement already satisfied: notebook>=4.4.1 in /usr/local/lib/python3.7/dist-packages
(from widgetsnbextension~=3.5.0->ipywidgets->pycaret) (5.3.1)
Requirement already satisfied: nbconvert in /usr/local/lib/python3.7/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (5.6.1)
Requirement already satisfied: terminado>=0.8.1 in /usr/local/lib/python3.7/dist-packages
(from notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.13.1)
Requirement already satisfied: Send2Trash in /usr/local/lib/python3.7/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (1.8.0)
Requirement already satisfied: pyzmq>=13 in /usr/local/lib/python3.7/dist-packages (from
jupyter-client->ipykernel>=4.5.1->ipywidgets->pycaret) (22.3.0)
Requirement already satisfied: ptyprocess in /usr/local/lib/python3.7/dist-packages (from
terminado>=0.8.1->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.7.0
)
Requirement already satisfied: PyWavelets in /usr/local/lib/python3.7/dist-packages (from
imagehash->visions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (1.2.0)
Requirement already satisfied: click>=7.0 in /usr/local/lib/python3.7/dist-packages (from
mlflow->pycaret) (7.1.2)
Requirement already satisfied: packaging in /usr/local/lib/python3.7/dist-packages (from
mlflow->pycaret) (21.3)
Requirement already satisfied: Flask in /usr/local/lib/python3.7/dist-packages (from mlfl
ow->pycaret) (1.1.4)
Collecting gunicorn
  Downloading gunicorn-20.1.0-py3-none-any.whl (79 kB)
     |████████████████████████████████| 79 kB 6.4 MB/s
Requirement already satisfied: protobuf>=3.7.0 in /usr/local/lib/python3.7/dist-packages
(from mlflow->pycaret) (3.17.3)
Collecting prometheus-flask-exporter
  Downloading prometheus_flask_exporter-0.18.7-py3-none-any.whl (17 kB)
Collecting databricks-cli>=0.8.7
  Downloading databricks-cli-0.16.2.tar.gz (58 kB)
     |████████████████████████████████| 58 kB 4.9 MB/s
Collecting gitpython>=2.1.0
  Downloading GitPython-3.1.26-py3-none-any.whl (180 kB)
     |████████████████████████████████| 180 kB 50.5 MB/s
Requirement already satisfied: sqlparse>=0.3.1 in /usr/local/lib/python3.7/dist-packages
(from mlflow->pycaret) (0.4.2)
Collecting docker>=4.0.0
  Downloading docker-5.0.3-py2.py3-none-any.whl (146 kB)
     |████████████████████████████████| 146 kB 62.8 MB/s
Requirement already satisfied: sqlalchemy in /usr/local/lib/python3.7/dist-packages (from
mlflow->pycaret) (1.4.31)
Requirement already satisfied: cloudpickle in /usr/local/lib/python3.7/dist-packages (fro
m mlflow->pycaret) (1.3.0)
Collecting querystring-parser
  Downloading querystring_parser-1.2.4-py2.py3-none-any.whl (7.9 kB)
Requirement already satisfied: entrypoints in /usr/local/lib/python3.7/dist-packages (fro
m mlflow->pycaret) (0.3)
Collecting alembic
  Downloading alembic-1.7.6-py3-none-any.whl (210 kB)
     |████████████████████████████████| 210 kB 55.9 MB/s
Requirement already satisfied: tabulate>=0.7.7 in /usr/local/lib/python3.7/dist-packages
(from databricks-cli>=0.8.7->mlflow->pycaret) (0.8.9)
Collecting websocket-client>=0.32.0
  Downloading websocket_client-1.2.3-py3-none-any.whl (53 kB)
     |████████████████████████████████| 53 kB 1.7 MB/s
Collecting gitdb<5,>=4.0.1
  Downloading gitdb-4.0.9-py3-none-any.whl (63 kB)
     |████████████████████████████████| 63 kB 1.4 MB/s
Collecting smmap<6,>=3.0.1
  Downloading smmap-5.0.0-py3-none-any.whl (24 kB)
Collecting Mako
  Downloading Mako-1.1.6-py2.py3-none-any.whl (75 kB)
     |████████████████████████████████| 75 kB 3.7 MB/s
Requirement already satisfied: greenlet!=0.4.17 in /usr/local/lib/python3.7/dist-packages
(from sqlalchemy->mlflow->pycaret) (1.1.2)
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Requirement already satisfied: Werkzeug<2.0,>=0.15 in /usr/local/lib/python3.7/dist-packa
ges (from Flask->mlflow->pycaret) (1.0.1)
Requirement already satisfied: itsdangerous<2.0,>=0.24 in /usr/local/lib/python3.7/dist-p
ackages (from Flask->mlflow->pycaret) (1.1.0)
Requirement already satisfied: pandocfilters>=1.4.1 in /usr/local/lib/python3.7/dist-pack
ages (from nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (1
.5.0)
Requirement already satisfied: bleach in /usr/local/lib/python3.7/dist-packages (from nbc
onvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (4.1.0)
Requirement already satisfied: mistune<2,>=0.8.1 in /usr/local/lib/python3.7/dist-package
s (from nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.8.
4)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.7/dist-packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.7.1)
Requirement already satisfied: testpath in /usr/local/lib/python3.7/dist-packages (from n
bconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.5.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.7/dist-packages (fr
om bleach->nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0
.5.1)
Requirement already satisfied: prometheus-client in /usr/local/lib/python3.7/dist-package
s (from prometheus-flask-exporter->mlflow->pycaret) (0.13.1)
Requirement already satisfied: future in /usr/local/lib/python3.7/dist-packages (from pyL
DAvis->pycaret) (0.16.0)
Collecting pyLDAvis
  Downloading pyLDAvis-3.3.0.tar.gz (1.7 MB)
     |████████████████████████████████| 1.7 MB 65.2 MB/s
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Installing backend dependencies ... done
    Preparing wheel metadata ... done
  Downloading pyLDAvis-3.2.2.tar.gz (1.7 MB)
     |████████████████████████████████| 1.7 MB 44.6 MB/s
Requirement already satisfied: numexpr in /usr/local/lib/python3.7/dist-packages (from py
LDAvis->pycaret) (2.8.1)
Collecting funcy
  Downloading funcy-1.17-py2.py3-none-any.whl (33 kB)
Requirement already satisfied: numba>=0.35 in /usr/local/lib/python3.7/dist-packages (fro
m pyod->pycaret) (0.51.2)
Requirement already satisfied: statsmodels in /usr/local/lib/python3.7/dist-packages (fro
m pyod->pycaret) (0.10.2)
Requirement already satisfied: llvmlite<0.35,>=0.34.0.dev0 in /usr/local/lib/python3.7/di
st-packages (from numba>=0.35->pyod->pycaret) (0.34.0)
Requirement already satisfied: patsy>=0.4.0 in /usr/local/lib/python3.7/dist-packages (fr
om statsmodels->pyod->pycaret) (0.5.2)
Collecting pynndescent>=0.5
  Downloading pynndescent-0.5.6.tar.gz (1.1 MB)
     |████████████████████████████████| 1.1 MB 42.6 MB/s
Building wheels for collected packages: htmlmin, imagehash, databricks-cli, pyLDAvis, pyo
d, umap-learn, pynndescent
  Building wheel for htmlmin (setup.py) ... done
  Created wheel for htmlmin: filename=htmlmin-0.1.12-py3-none-any.whl size=27098 sha256=6
fc3baffe5d323327e640310a7fcf21dabe1a66b34e699cde3d6d11a880c4f78
  Stored in directory: /root/.cache/pip/wheels/70/e1/52/5b14d250ba868768823940c3229e9950d
201a26d0bd3ee8655
  Building wheel for imagehash (setup.py) ... done
  Created wheel for imagehash: filename=ImageHash-4.2.1-py2.py3-none-any.whl size=295206
sha256=97093f471bda0c757da672506dd2017126e49ec6a37d0a4736edbef486531247
  Stored in directory: /root/.cache/pip/wheels/4c/d5/59/5e3e297533ddb09407769762985d13413
5064c6831e29a914e
  Building wheel for databricks-cli (setup.py) ... done
  Created wheel for databricks-cli: filename=databricks_cli-0.16.2-py3-none-any.whl size=
106811 sha256=d673800c5580449ee9303de6f761d38f1e842d9d5be09ca75ccf421f31f45d82
  Stored in directory: /root/.cache/pip/wheels/f4/5c/ed/e1ce20a53095f63b27b4964abbad03e59
cf3472822addf7d29
  Building wheel for pyLDAvis (setup.py) ... done
  Created wheel for pyLDAvis: filename=pyLDAvis-3.2.2-py2.py3-none-any.whl size=135617 sh
a256=74c4c96535694432d4e5b2c02667838b362db6bd50e74f0887dc6242e797a549
  Stored in directory: /root/.cache/pip/wheels/f8/b1/9b/560ac1931796b7303f7b517b949d2d31a
4fbc512aad3b9f284
  Building wheel for pyod (setup.py) ... done
  Created wheel for pyod: filename=pyod-0.9.7-py3-none-any.whl size=136279 sha256=5781caa
7074c914f6416c05a988444d6620752749252aee5d555531cda567283
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  Stored in directory: /root/.cache/pip/wheels/ce/14/ae/60cbb36511e59bc12f8f0883805f586db
3b315972b54865d33
  Building wheel for umap-learn (setup.py) ... done
  Created wheel for umap-learn: filename=umap_learn-0.5.2-py3-none-any.whl size=82708 sha
256=2b24288262b37e89fe143b302cbb74ab24ead6a5266c8bf6fd99d32d9b1af8b0
  Stored in directory: /root/.cache/pip/wheels/84/1b/c6/aaf68a748122632967cef4dffef68224e
b16798b6793257d82
  Building wheel for pynndescent (setup.py) ... done
  Created wheel for pynndescent: filename=pynndescent-0.5.6-py3-none-any.whl size=53943 s
ha256=62bfc76445b12628c49eea696143118d6817e2838b58b9ef84e735b0f8b266bf
  Stored in directory: /root/.cache/pip/wheels/03/f1/56/f80d72741e400345b5a5b50ec3d929aca
581bf45e0225d5c50
Successfully built htmlmin imagehash databricks-cli pyLDAvis pyod umap-learn pynndescent
Installing collected packages: tangled-up-in-unicode, smmap, scipy, multimethod, joblib,
websocket-client, visions, scikit-learn, requests, Mako, imagehash, gitdb, querystring-pa
rser, pyyaml, pynndescent, pydantic, prometheus-flask-exporter, phik, htmlmin, gunicorn,
gitpython, funcy, docker, databricks-cli, alembic, umap-learn, scikit-plot, pyod, pyLDAvi
s, pandas-profiling, mlxtend, mlflow, lightgbm, kmodes, imbalanced-learn, Boruta, pycaret
  Attempting uninstall: scipy
    Found existing installation: scipy 1.4.1
    Uninstalling scipy-1.4.1:
      Successfully uninstalled scipy-1.4.1
  Attempting uninstall: joblib
    Found existing installation: joblib 1.1.0
    Uninstalling joblib-1.1.0:
      Successfully uninstalled joblib-1.1.0
  Attempting uninstall: scikit-learn
    Found existing installation: scikit-learn 1.0.2
    Uninstalling scikit-learn-1.0.2:
      Successfully uninstalled scikit-learn-1.0.2
  Attempting uninstall: requests
    Found existing installation: requests 2.23.0
    Uninstalling requests-2.23.0:
      Successfully uninstalled requests-2.23.0
  Attempting uninstall: pyyaml
    Found existing installation: PyYAML 3.13
    Uninstalling PyYAML-3.13:
      Successfully uninstalled PyYAML-3.13
  Attempting uninstall: pandas-profiling
    Found existing installation: pandas-profiling 1.4.1
    Uninstalling pandas-profiling-1.4.1:
      Successfully uninstalled pandas-profiling-1.4.1
  Attempting uninstall: mlxtend
    Found existing installation: mlxtend 0.14.0
    Uninstalling mlxtend-0.14.0:
      Successfully uninstalled mlxtend-0.14.0
  Attempting uninstall: lightgbm
    Found existing installation: lightgbm 2.2.3
    Uninstalling lightgbm-2.2.3:
      Successfully uninstalled lightgbm-2.2.3
  Attempting uninstall: imbalanced-learn
    Found existing installation: imbalanced-learn 0.8.1
    Uninstalling imbalanced-learn-0.8.1:
      Successfully uninstalled imbalanced-learn-0.8.1
ERROR: pip's dependency resolver does not currently take into account all the packages th
at are installed. This behaviour is the source of the following dependency conflicts.
google-colab 1.0.0 requires requests~=2.23.0, but you have requests 2.27.1 which is incom
patible.
datascience 0.10.6 requires folium==0.2.1, but you have folium 0.8.3 which is incompatibl
e.
albumentations 0.1.12 requires imgaug<0.2.7,>=0.2.5, but you have imgaug 0.2.9 which is i
ncompatible.
Successfully installed Boruta-0.3 Mako-1.1.6 alembic-1.7.6 databricks-cli-0.16.2 docker-5
.0.3 funcy-1.17 gitdb-4.0.9 gitpython-3.1.26 gunicorn-20.1.0 htmlmin-0.1.12 imagehash-4.2
.1 imbalanced-learn-0.7.0 joblib-1.0.1 kmodes-0.11.1 lightgbm-3.3.2 mlflow-1.23.1 mlxtend
-0.19.0 multimethod-1.7 pandas-profiling-3.1.0 phik-0.12.0 prometheus-flask-exporter-0.18
.7 pyLDAvis-3.2.2 pycaret-2.3.6 pydantic-1.9.0 pynndescent-0.5.6 pyod-0.9.7 pyyaml-5.4.1
querystring-parser-1.2.4 requests-2.27.1 scikit-learn-0.23.2 scikit-plot-0.3.7 scipy-1.5.
4 smmap-5.0.0 tangled-up-in-unicode-0.1.0 umap-learn-0.5.2 visions-0.7.4 websocket-client
-1.2.3
Requirement already satisfied: pycaret in /usr/local/lib/python3.7/dist-packages (2.3.6)
Requirement already satisfied: textblob in /usr/local/lib/python3.7/dist-packages (from p
```

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ycaret) (0.15.3)
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (from pyc
aret) (1.3.5)
Requirement already satisfied: wordcloud in /usr/local/lib/python3.7/dist-packages (from
pycaret) (1.5.0)
Requirement already satisfied: gensim<4.0.0 in /usr/local/lib/python3.7/dist-packages (fr
om pycaret) (3.6.0)
Requirement already satisfied: yellowbrick>=1.0.1 in /usr/local/lib/python3.7/dist-packag
es (from pycaret) (1.3.post1)
Requirement already satisfied: mlflow in /usr/local/lib/python3.7/dist-packages (from pyc
aret) (1.23.1)
Requirement already satisfied: IPython in /usr/local/lib/python3.7/dist-packages (from py
caret) (5.5.0)
Requirement already satisfied: scikit-learn==0.23.2 in /usr/local/lib/python3.7/dist-pack
ages (from pycaret) (0.23.2)
Requirement already satisfied: mlxtend>=0.17.0 in /usr/local/lib/python3.7/dist-packages
(from pycaret) (0.19.0)
Requirement already satisfied: scikit-plot in /usr/local/lib/python3.7/dist-packages (fro
m pycaret) (0.3.7)
Requirement already satisfied: kmodes>=0.10.1 in /usr/local/lib/python3.7/dist-packages (
from pycaret) (0.11.1)
Requirement already satisfied: umap-learn in /usr/local/lib/python3.7/dist-packages (from
pycaret) (0.5.2)
Requirement already satisfied: pyod in /usr/local/lib/python3.7/dist-packages (from pycar
et) (0.9.7)
Requirement already satisfied: ipywidgets in /usr/local/lib/python3.7/dist-packages (from
pycaret) (7.6.5)
Requirement already satisfied: cufflinks>=0.17.0 in /usr/local/lib/python3.7/dist-package
s (from pycaret) (0.17.3)
Requirement already satisfied: pyLDAvis in /usr/local/lib/python3.7/dist-packages (from p
ycaret) (3.2.2)
Requirement already satisfied: Boruta in /usr/local/lib/python3.7/dist-packages (from pyc
aret) (0.3)
Requirement already satisfied: pyyaml<6.0.0 in /usr/local/lib/python3.7/dist-packages (fr
om pycaret) (5.4.1)
Requirement already satisfied: joblib in /usr/local/lib/python3.7/dist-packages (from pyc
aret) (1.0.1)
Requirement already satisfied: scipy<=1.5.4 in /usr/local/lib/python3.7/dist-packages (fr
om pycaret) (1.5.4)
Requirement already satisfied: pandas-profiling>=2.8.0 in /usr/local/lib/python3.7/dist-p
ackages (from pycaret) (3.1.0)
Requirement already satisfied: lightgbm>=2.3.1 in /usr/local/lib/python3.7/dist-packages
(from pycaret) (3.3.2)
Requirement already satisfied: seaborn in /usr/local/lib/python3.7/dist-packages (from py
caret) (0.11.2)
Requirement already satisfied: spacy<2.4.0 in /usr/local/lib/python3.7/dist-packages (fro
m pycaret) (2.2.4)
Requirement already satisfied: plotly>=4.4.1 in /usr/local/lib/python3.7/dist-packages (f
rom pycaret) (5.5.0)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/dist-packages (from
pycaret) (3.2.2)
Requirement already satisfied: imbalanced-learn==0.7.0 in /usr/local/lib/python3.7/dist-p
ackages (from pycaret) (0.7.0)
Requirement already satisfied: nltk in /usr/local/lib/python3.7/dist-packages (from pycar
et) (3.2.5)
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib/python3.7/dist-packages (f
rom imbalanced-learn==0.7.0->pycaret) (1.19.5)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.7/dist-pack
ages (from scikit-learn==0.23.2->pycaret) (3.0.0)
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.7/dist-packages (from
cufflinks>=0.17.0->pycaret) (1.15.0)
Requirement already satisfied: colorlover>=0.2.1 in /usr/local/lib/python3.7/dist-package
s (from cufflinks>=0.17.0->pycaret) (0.3.0)
Requirement already satisfied: setuptools>=34.4.1 in /usr/local/lib/python3.7/dist-packag
es (from cufflinks>=0.17.0->pycaret) (57.4.0)
Requirement already satisfied: smart-open>=1.2.1 in /usr/local/lib/python3.7/dist-package
s (from gensim<4.0.0->pycaret) (5.2.1)
Requirement already satisfied: pickleshare in /usr/local/lib/python3.7/dist-packages (fro
m IPython->pycaret) (0.7.5)
Requirement already satisfied: traitlets>=4.2 in /usr/local/lib/python3.7/dist-packages (
from IPython->pycaret) (5.1.1)
Requirement already satisfied: prompt-toolkit<2.0.0,>=1.0.4 in /usr/local/lib/python3.7/d
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ist-packages (from IPython->pycaret) (1.0.18)
Requirement already satisfied: pygments in /usr/local/lib/python3.7/dist-packages (from I
Python->pycaret) (2.6.1)
Requirement already satisfied: decorator in /usr/local/lib/python3.7/dist-packages (from
IPython->pycaret) (4.4.2)
Requirement already satisfied: pexpect in /usr/local/lib/python3.7/dist-packages (from IP
ython->pycaret) (4.8.0)
Requirement already satisfied: simplegeneric>0.8 in /usr/local/lib/python3.7/dist-package
s (from IPython->pycaret) (0.8.1)
Requirement already satisfied: widgetsnbextension~=3.5.0 in /usr/local/lib/python3.7/dist
-packages (from ipywidgets->pycaret) (3.5.2)
Requirement already satisfied: jupyterlab-widgets>=1.0.0 in /usr/local/lib/python3.7/dist
-packages (from ipywidgets->pycaret) (1.0.2)
Requirement already satisfied: ipython-genutils~=0.2.0 in /usr/local/lib/python3.7/dist-p
ackages (from ipywidgets->pycaret) (0.2.0)
Requirement already satisfied: ipykernel>=4.5.1 in /usr/local/lib/python3.7/dist-packages
(from ipywidgets->pycaret) (4.10.1)
Requirement already satisfied: nbformat>=4.2.0 in /usr/local/lib/python3.7/dist-packages
(from ipywidgets->pycaret) (5.1.3)
Requirement already satisfied: tornado>=4.0 in /usr/local/lib/python3.7/dist-packages (fr
om ipykernel>=4.5.1->ipywidgets->pycaret) (5.1.1)
Requirement already satisfied: jupyter-client in /usr/local/lib/python3.7/dist-packages (
from ipykernel>=4.5.1->ipywidgets->pycaret) (5.3.5)
Requirement already satisfied: wheel in /usr/local/lib/python3.7/dist-packages (from ligh
tgbm>=2.3.1->pycaret) (0.37.1)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.7/dist-pack
ages (from matplotlib->pycaret) (2.8.2)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-packages (fr
om matplotlib->pycaret) (0.11.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib
/python3.7/dist-packages (from matplotlib->pycaret) (3.0.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/dist-package
s (from matplotlib->pycaret) (1.3.2)
Requirement already satisfied: jsonschema!=2.5.0,>=2.4 in /usr/local/lib/python3.7/dist-p
ackages (from nbformat>=4.2.0->ipywidgets->pycaret) (4.3.3)
Requirement already satisfied: jupyter-core in /usr/local/lib/python3.7/dist-packages (fr
om nbformat>=4.2.0->ipywidgets->pycaret) (4.9.1)
Requirement already satisfied: importlib-metadata in /usr/local/lib/python3.7/dist-packag
es (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (4.10.1)
Requirement already satisfied: attrs>=17.4.0 in /usr/local/lib/python3.7/dist-packages (f
rom jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (21.4.0)
Requirement already satisfied: importlib-resources>=1.4.0 in /usr/local/lib/python3.7/dis
t-packages (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (5.4.0)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.0 in /usr/loca
l/lib/python3.7/dist-packages (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets-
>pycaret) (0.18.1)
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.7/dist-package
s (from jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycaret) (3.10.0.2)
Requirement already satisfied: zipp>=3.1.0 in /usr/local/lib/python3.7/dist-packages (fro
m importlib-resources>=1.4.0->jsonschema!=2.5.0,>=2.4->nbformat>=4.2.0->ipywidgets->pycar
et) (3.7.0)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (fr
om pandas->pycaret) (2018.9)
Requirement already satisfied: tqdm>=4.48.2 in /usr/local/lib/python3.7/dist-packages (fr
om pandas-profiling>=2.8.0->pycaret) (4.62.3)
Requirement already satisfied: jinja2>=2.11.1 in /usr/local/lib/python3.7/dist-packages (
from pandas-profiling>=2.8.0->pycaret) (2.11.3)
Requirement already satisfied: phik>=0.11.1 in /usr/local/lib/python3.7/dist-packages (fr
om pandas-profiling>=2.8.0->pycaret) (0.12.0)
Requirement already satisfied: htmlmin>=0.1.12 in /usr/local/lib/python3.7/dist-packages
(from pandas-profiling>=2.8.0->pycaret) (0.1.12)
Requirement already satisfied: pydantic>=1.8.1 in /usr/local/lib/python3.7/dist-packages
(from pandas-profiling>=2.8.0->pycaret) (1.9.0)
Requirement already satisfied: requests>=2.24.0 in /usr/local/lib/python3.7/dist-packages
(from pandas-profiling>=2.8.0->pycaret) (2.27.1)
Requirement already satisfied: multimethod>=1.4 in /usr/local/lib/python3.7/dist-packages
(from pandas-profiling>=2.8.0->pycaret) (1.7)
Requirement already satisfied: markupsafe~=2.0.1 in /usr/local/lib/python3.7/dist-package
s (from pandas-profiling>=2.8.0->pycaret) (2.0.1)
Requirement already satisfied: visions[type_image_path]==0.7.4 in /usr/local/lib/python3.
7/dist-packages (from pandas-profiling>=2.8.0->pycaret) (0.7.4)
Requirement already satisfied: tangled-up-in-unicode==0.1.0 in /usr/local/lib/python3.7/d
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ist-packages (from pandas-profiling>=2.8.0->pycaret) (0.1.0)
Requirement already satisfied: missingno>=0.4.2 in /usr/local/lib/python3.7/dist-packages
(from pandas-profiling>=2.8.0->pycaret) (0.5.0)
Requirement already satisfied: networkx>=2.4 in /usr/local/lib/python3.7/dist-packages (f
rom visions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (2.6.3)
Requirement already satisfied: imagehash in /usr/local/lib/python3.7/dist-packages (from
visions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (4.2.1)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/dist-packages (from vis
ions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (7.1.2)
Requirement already satisfied: tenacity>=6.2.0 in /usr/local/lib/python3.7/dist-packages
(from plotly>=4.4.1->pycaret) (8.0.1)
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages (from pr
ompt-toolkit<2.0.0,>=1.0.4->IPython->pycaret) (0.2.5)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.7/dist
-packages (from requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (2.0.11)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/dist-packages (fr
om requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (2.10)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.7/dist-pac
kages (from requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (1.24.3)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-packag
es (from requests>=2.24.0->pandas-profiling>=2.8.0->pycaret) (2021.10.8)
Requirement already satisfied: cymem<2.1.0,>=2.0.2 in /usr/local/lib/python3.7/dist-packa
ges (from spacy<2.4.0->pycaret) (2.0.6)
Requirement already satisfied: blis<0.5.0,>=0.4.0 in /usr/local/lib/python3.7/dist-packag
es (from spacy<2.4.0->pycaret) (0.4.1)
Requirement already satisfied: preshed<3.1.0,>=3.0.2 in /usr/local/lib/python3.7/dist-pac
kages (from spacy<2.4.0->pycaret) (3.0.6)
Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in /usr/local/lib/python3.7/dist
-packages (from spacy<2.4.0->pycaret) (1.0.6)
Requirement already satisfied: wasabi<1.1.0,>=0.4.0 in /usr/local/lib/python3.7/dist-pack
ages (from spacy<2.4.0->pycaret) (0.9.0)
Requirement already satisfied: catalogue<1.1.0,>=0.0.7 in /usr/local/lib/python3.7/dist-p
ackages (from spacy<2.4.0->pycaret) (1.0.0)
Requirement already satisfied: plac<1.2.0,>=0.9.6 in /usr/local/lib/python3.7/dist-packag
es (from spacy<2.4.0->pycaret) (1.1.3)
Requirement already satisfied: srsly<1.1.0,>=1.0.2 in /usr/local/lib/python3.7/dist-packa
ges (from spacy<2.4.0->pycaret) (1.0.5)
Requirement already satisfied: thinc==7.4.0 in /usr/local/lib/python3.7/dist-packages (fr
om spacy<2.4.0->pycaret) (7.4.0)
Requirement already satisfied: notebook>=4.4.1 in /usr/local/lib/python3.7/dist-packages
(from widgetsnbextension~=3.5.0->ipywidgets->pycaret) (5.3.1)
Requirement already satisfied: nbconvert in /usr/local/lib/python3.7/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (5.6.1)
Requirement already satisfied: Send2Trash in /usr/local/lib/python3.7/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (1.8.0)
Requirement already satisfied: terminado>=0.8.1 in /usr/local/lib/python3.7/dist-packages
(from notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.13.1)
Requirement already satisfied: pyzmq>=13 in /usr/local/lib/python3.7/dist-packages (from
jupyter-client->ipykernel>=4.5.1->ipywidgets->pycaret) (22.3.0)
Requirement already satisfied: ptyprocess in /usr/local/lib/python3.7/dist-packages (from
terminado>=0.8.1->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.7.0
)
Requirement already satisfied: PyWavelets in /usr/local/lib/python3.7/dist-packages (from
imagehash->visions[type_image_path]==0.7.4->pandas-profiling>=2.8.0->pycaret) (1.2.0)
Requirement already satisfied: databricks-cli>=0.8.7 in /usr/local/lib/python3.7/dist-pac
kages (from mlflow->pycaret) (0.16.2)
Requirement already satisfied: alembic in /usr/local/lib/python3.7/dist-packages (from ml
flow->pycaret) (1.7.6)
Requirement already satisfied: packaging in /usr/local/lib/python3.7/dist-packages (from
mlflow->pycaret) (21.3)
Requirement already satisfied: sqlparse>=0.3.1 in /usr/local/lib/python3.7/dist-packages
(from mlflow->pycaret) (0.4.2)
Requirement already satisfied: protobuf>=3.7.0 in /usr/local/lib/python3.7/dist-packages
(from mlflow->pycaret) (3.17.3)
Requirement already satisfied: entrypoints in /usr/local/lib/python3.7/dist-packages (fro
m mlflow->pycaret) (0.3)
Requirement already satisfied: cloudpickle in /usr/local/lib/python3.7/dist-packages (fro
m mlflow->pycaret) (1.3.0)
Requirement already satisfied: prometheus-flask-exporter in /usr/local/lib/python3.7/dist
-packages (from mlflow->pycaret) (0.18.7)
Requirement already satisfied: sqlalchemy in /usr/local/lib/python3.7/dist-packages (from
mlflow->pycaret) (1.4.31)
```

```
Requirement already satisfied: Flask in /usr/local/lib/python3.7/dist-packages (from mlfl
ow->pycaret) (1.1.4)
Requirement already satisfied: docker>=4.0.0 in /usr/local/lib/python3.7/dist-packages (f
rom mlflow->pycaret) (5.0.3)
Requirement already satisfied: click>=7.0 in /usr/local/lib/python3.7/dist-packages (from
mlflow->pycaret) (7.1.2)
Requirement already satisfied: gunicorn in /usr/local/lib/python3.7/dist-packages (from m
lflow->pycaret) (20.1.0)
Requirement already satisfied: gitpython>=2.1.0 in /usr/local/lib/python3.7/dist-packages
(from mlflow->pycaret) (3.1.26)
Requirement already satisfied: querystring-parser in /usr/local/lib/python3.7/dist-packag
es (from mlflow->pycaret) (1.2.4)
Requirement already satisfied: tabulate>=0.7.7 in /usr/local/lib/python3.7/dist-packages
(from databricks-cli>=0.8.7->mlflow->pycaret) (0.8.9)
Requirement already satisfied: websocket-client>=0.32.0 in /usr/local/lib/python3.7/dist-
packages (from docker>=4.0.0->mlflow->pycaret) (1.2.3)
Requirement already satisfied: gitdb<5,>=4.0.1 in /usr/local/lib/python3.7/dist-packages
(from gitpython>=2.1.0->mlflow->pycaret) (4.0.9)
Requirement already satisfied: smmap<6,>=3.0.1 in /usr/local/lib/python3.7/dist-packages
(from gitdb<5,>=4.0.1->gitpython>=2.1.0->mlflow->pycaret) (5.0.0)
Requirement already satisfied: Mako in /usr/local/lib/python3.7/dist-packages (from alemb
ic->mlflow->pycaret) (1.1.6)
Requirement already satisfied: greenlet!=0.4.17 in /usr/local/lib/python3.7/dist-packages
(from sqlalchemy->mlflow->pycaret) (1.1.2)
Requirement already satisfied: itsdangerous<2.0,>=0.24 in /usr/local/lib/python3.7/dist-p
ackages (from Flask->mlflow->pycaret) (1.1.0)
Requirement already satisfied: Werkzeug<2.0,>=0.15 in /usr/local/lib/python3.7/dist-packa
ges (from Flask->mlflow->pycaret) (1.0.1)
Requirement already satisfied: pandocfilters>=1.4.1 in /usr/local/lib/python3.7/dist-pack
ages (from nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (1
.5.0)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.7/dist-packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.7.1)
Requirement already satisfied: bleach in /usr/local/lib/python3.7/dist-packages (from nbc
onvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (4.1.0)
Requirement already satisfied: testpath in /usr/local/lib/python3.7/dist-packages (from n
bconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.5.0)
Requirement already satisfied: mistune<2,>=0.8.1 in /usr/local/lib/python3.7/dist-package
s (from nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0.8.
4)
Requirement already satisfied: webencodings in /usr/local/lib/python3.7/dist-packages (fr
om bleach->nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets->pycaret) (0
.5.1)
Requirement already satisfied: prometheus-client in /usr/local/lib/python3.7/dist-package
s (from prometheus-flask-exporter->mlflow->pycaret) (0.13.1)
Requirement already satisfied: funcy in /usr/local/lib/python3.7/dist-packages (from pyLD
Avis->pycaret) (1.17)
Requirement already satisfied: future in /usr/local/lib/python3.7/dist-packages (from pyL
DAvis->pycaret) (0.16.0)
Requirement already satisfied: numexpr in /usr/local/lib/python3.7/dist-packages (from py
LDAvis->pycaret) (2.8.1)
Requirement already satisfied: numba>=0.35 in /usr/local/lib/python3.7/dist-packages (fro
m pyod->pycaret) (0.51.2)
Requirement already satisfied: statsmodels in /usr/local/lib/python3.7/dist-packages (fro
m pyod->pycaret) (0.10.2)
Requirement already satisfied: llvmlite<0.35,>=0.34.0.dev0 in /usr/local/lib/python3.7/di
st-packages (from numba>=0.35->pyod->pycaret) (0.34.0)
Requirement already satisfied: patsy>=0.4.0 in /usr/local/lib/python3.7/dist-packages (fr
om statsmodels->pyod->pycaret) (0.5.2)
Requirement already satisfied: pynndescent>=0.5 in /usr/local/lib/python3.7/dist-packages
(from umap-learn->pycaret) (0.5.6)
Collecting shap
  Downloading shap-0.40.0-cp37-cp37m-manylinux2010_x86_64.whl (564 kB)
     |████████████████████████████████| 564 kB 5.4 MB/s
Collecting slicer==0.0.7
  Downloading slicer-0.0.7-py3-none-any.whl (14 kB)
Requirement already satisfied: cloudpickle in /usr/local/lib/python3.7/dist-packages (fro
m shap) (1.3.0)
Requirement already satisfied: numba in /usr/local/lib/python3.7/dist-packages (from shap
) (0.51.2)
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (from sha
p) (1.3.5)
```

```
Requirement already satisfied: tqdm>4.25.0 in /usr/local/lib/python3.7/dist-packages (fro
m shap) (4.62.3)
Requirement already satisfied: scipy in /usr/local/lib/python3.7/dist-packages (from shap
) (1.5.4)
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (from shap
) (1.19.5)
Requirement already satisfied: packaging>20.9 in /usr/local/lib/python3.7/dist-packages (
from shap) (21.3)
Requirement already satisfied: scikit-learn in /usr/local/lib/python3.7/dist-packages (fr
om shap) (0.23.2)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/dist-
packages (from packaging>20.9->shap) (3.0.7)
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/dist-packages (from
numba->shap) (57.4.0)
Requirement already satisfied: llvmlite<0.35,>=0.34.0.dev0 in /usr/local/lib/python3.7/di
st-packages (from numba->shap) (0.34.0)
Requirement already satisfied: python-dateutil>=2.7.3 in /usr/local/lib/python3.7/dist-pa
ckages (from pandas->shap) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (fr
om pandas->shap) (2018.9)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from p
ython-dateutil>=2.7.3->pandas->shap) (1.15.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-packages (fr
om scikit-learn->shap) (1.0.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.7/dist-pack
ages (from scikit-learn->shap) (3.0.0)
Installing collected packages: slicer, shap
Successfully installed shap-0.40.0 slicer-0.0.7
```

1.3 Import libraries

In [ ]:

```
#Import all required libraries. Some reduntant libraries may be found which were
#used during experimentation.
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

from lime.lime_tabular import LimeTabularExplainer

from pycaret.classification import *
from pycaret.utils import enable_colab
enable_colab()

import re

from sklearn.decomposition import PCA
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from sklearn.metrics import accuracy_score

import seaborn as sns

from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Dropout
from keras.layers import BatchNormalization
```

```
Colab mode enabled.
```

1.4 Import data

In [ ]:

```
#Function named dataframe_optimizer is defined. This will reduce space consumption by dat
```

```
#Function named dataframe_optimizer is defined. This will reduce space consumption by dat
aframes.
#Credit - https://www.kaggle.com/rinnqd/reduce-memory-usage and
#https://www.analyticsvidhya.com/blog/2021/04/how-to-reduce-memory-usage-in-python-pandas
/
def dataframe_optimizer(df):
  '''This is a dataframe optimizer'''
  start_mem=np.round(df.memory_usage().sum()/1024**2,2)
  for col in df.columns:
    col_type=df[col].dtype
    if col_type!=object:
      c_min=df[col].min()
      c_max=df[col].max()
      if str(col_type)[:3]=='int':
        if c_min>np.iinfo(np.int8).min and c_max<np.iinfo(np.int8).max:
            df[col]=df[col].astype(np.int8)
        elif c_min>np.iinfo(np.int16).min and c_max<np.iinfo(np.int16).max:
            df[col]=df[col].astype(np.int16)
        elif c_min>np.iinfo(np.int32).min and c_max<np.iinfo(np.int32).max:
            df[col]=df[col].astype(np.int32)
        elif c_min>np.iinfo(np.int64).min and c_max<np.iinfo(np.int64).max:
            df[col]=df[col].astype(np.int64)
      else:
        if c_min>np.finfo(np.float16).min and c_max<np.finfo(np.float16).max:
            df[col]=df[col].astype(np.float16)
        elif c_min>np.finfo(np.float32).min and c_max<np.finfo(np.float32).max:
            df[col]=df[col].astype(np.float32)
        else:
            df[col]=df[col].astype(np.float64)
  end_mem=np.round(df.memory_usage().sum()/1024**2,2)
  return df
```

All the relevant files can be accessed through the following link:
https://drive.google.com/drive/folders/1evFZRwFWh4zkR9CiT46llB9PlaXFLfLA?usp=sharing

In [ ]:

```
#Import data

#Read X_train_final_feature_selected
X_train_feature_selected = dataframe_optimizer(pd.read_csv('/content/drive/MyDrive/AI_ML_
Project/Data/X_train_final_feature_selected.csv'))

#Read y_train_final_feature_selected
y_train_feature_selected = dataframe_optimizer(pd.read_csv('/content/drive/MyDrive/AI_ML_
Project/Data/y_train_final_feature_selected.csv'))

#Read X_test_final_feature_selected
X_test_feature_selected = dataframe_optimizer(pd.read_csv('/content/drive/MyDrive/AI_ML_P
roject/Data/X_test_final_feature_selected.csv'))

#Read y_test_final_feature_selected
y_test_feature_selected = dataframe_optimizer(pd.read_csv('/content/drive/MyDrive/AI_ML_P
roject/Data/y_test_final_feature_selected.csv'))

#Read predict_test
predict_test = dataframe_optimizer(pd.read_csv('/content/drive/MyDrive/AI_ML_Project/Data
/predict_test.csv'))
```

In [ ]:

```
#Print the shape of imported data
print(X_train_feature_selected.shape)
print(y_train_feature_selected.shape)
print(X_test_feature_selected.shape)
print(y_test_feature_selected.shape)
print(predict_test.shape)
```

```
(204494, 176)
```

```
(204494, 1)
(46127, 176)
(46127, 1)
(46127, 179)
```

2.0 PCA

2.1 Data Preparation

In [ ]:

```
#Prepare data frame of correctly predicted data points
predict_test_without_labels = predict_test.drop(columns=['TARGET', 'Label', 'Score'])
```

2.2 PCA with 5 features

In [ ]:

```
#Define PCA analyser
pca = PCA(n_components=5, random_state=42)
#Fit PCA analyser to data and transform
predict_test_without_labels_PCA = pca.fit_transform(predict_test_without_labels)
```

In [ ]:

```
#Convert PCA features to data frame
predict_test_without_labels_PCA_df = pd.DataFrame(predict_test_without_labels_PCA,
                                                  columns=['PCA_1', 'PCA_2', 'PCA_3', '
PCA_4', 'PCA_5'])
```

In [ ]:

```
#Add TARGET, LABEL and Score from predict_test (data set with predictions from lightgbm f
rom phase 3)
#to predict_test_PCA (copy of data frame with PCA features)
predict_test_PCA = predict_test_without_labels_PCA_df
predict_test_PCA['TARGET'] = predict_test['TARGET']
predict_test_PCA['Label'] = predict_test['Label']
predict_test_PCA['Score'] = predict_test['Score']
```

In [ ]:

```
#Add new column PRED to predict_test_PCA to indicate correct and wrong predictions
predict_test_PCA['PRED'] = np.where(predict_test_PCA['Label'] == predict_test_PCA['TARGE
T'], 'Correct', 'Wrong')
```

In [ ]:

```
#Add new column TYPE to indicate coorrect or wrong predictions with predicted label
conditions = [(predict_test_PCA['Label'] == 0) & (predict_test_PCA['TARGET'] == 0),
              (predict_test_PCA['Label'] == 0) & (predict_test_PCA['TARGET'] != 0),
              (predict_test_PCA['Label'] == 1) & (predict_test_PCA['TARGET'] == 1),
              (predict_test_PCA['Label'] == 1) & (predict_test_PCA['TARGET'] != 1)]
values = ['Correct_0', 'Wrong_0', 'Correct_1', 'Wrong_1']
predict_test_PCA['TYPE'] = np.select(conditions, values)
```

In [ ]:

```
#Visualise prepared data (predict_test_PCA)
predict_test_PCA
```

Out[ ]:

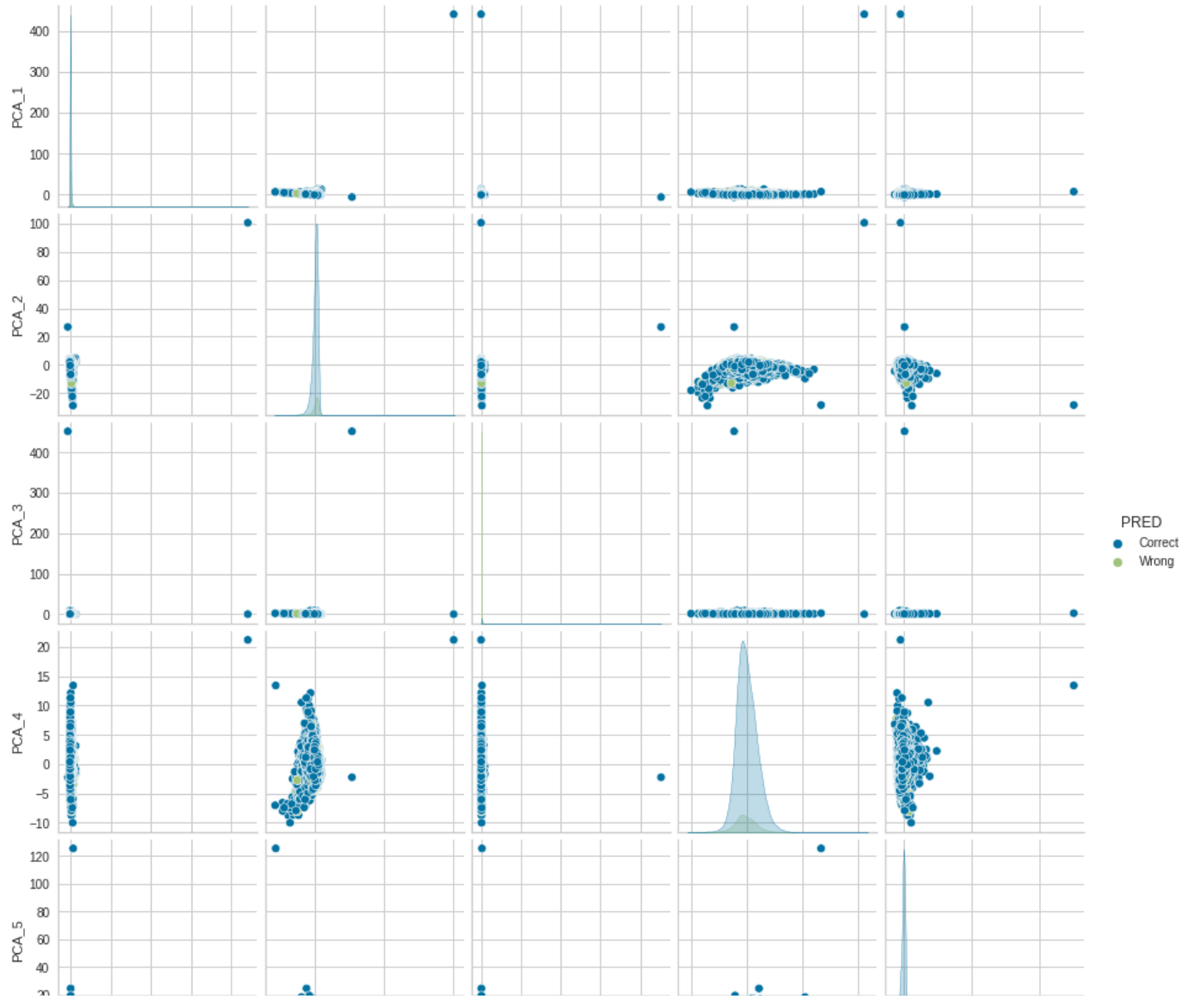
Out[ ]:

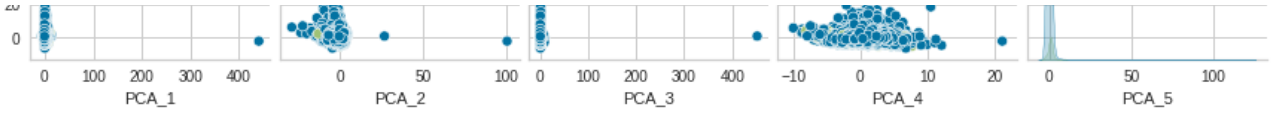
	PCA_1	PCA_2	PCA_3	PCA_4	PCA_5	TARGET	Label	Score	PRED	TYPE
0	-0.209067	-0.215435	-0.055012	-2.110336	1.819279	0	0	0.916992	Correct	Correct_0
1	-0.592355	0.220897	-0.049107	4.366656	1.733112	1	0	0.989258	Wrong	Wrong_0
2	-0.811488	1.378064	-0.129424	0.816070	0.098646	0	0	0.981934	Correct	Correct_0
3	-0.528224	0.290019	-0.074503	-0.069695	-1.369410	0	0	0.878906	Correct	Correct_0
4	-0.700191	1.389497	-0.100734	-1.512738	-0.169575	0	0	0.988281	Correct	Correct_0
...	...	...	...	...	...	...	...	...	...	...
46122	1.132460	-6.799003	0.383555	1.144528	1.499903	0	0	0.983887	Correct	Correct_0
46123	-0.511724	0.411148	-0.043587	-0.833651	-0.770652	0	0	0.991211	Correct	Correct_0
46124	-0.960438	2.456582	-0.239177	-0.126670	2.895933	0	0	0.678223	Correct	Correct_0
46125	-0.925650	1.866706	-0.128450	0.367610	-0.649871	0	0	0.973145	Correct	Correct_0
46126	-0.343592	-0.448144	-0.004841	2.400511	0.805485	0	0	0.957520	Correct	Correct_0

46127 rows × 10 columns

In [ ]:

```
#Pair plot for PCA features
sns.pairplot(predict_test_PCA.drop(columns=['TARGET', 'Label', 'Score', 'TYPE']), hue='PRED')
plt.show()
```





2.3 PCA with 2 features

In [ ]:

```
#Define PCA analyser
pca1 = PCA(n_components=2, random_state=42)
#Fit PCA analyser to data and transform
predict_test_without_labels_PCA1 = pca1.fit_transform(predict_test_without_labels)
```

In [ ]:

```
#Convert PCA features to data frame
predict_test_without_labels_PCA1_df = pd.DataFrame(predict_test_without_labels_PCA1, colu
mns=['PCA_1', 'PCA_2'])
```

In [ ]:

```
#Add TARGET, LABEL and Score from predict_test (data set with predictions from lightgbm f
rom phase 3)
#to predict_test_PCA1 (copy of data frame with PCA features)
predict_test_PCA1 = predict_test_without_labels_PCA1_df
predict_test_PCA1['TARGET'] = predict_test['TARGET']
predict_test_PCA1['Label'] = predict_test['Label']
predict_test_PCA1['Score'] = predict_test['Score']
```

In [ ]:

```
#Add new column PRED to predict_test_PCA1 to indicate correct and wrong predictions
predict_test_PCA1['PRED'] = np.where(predict_test_PCA1['Label'] == predict_test_PCA1['TA
RGET'], 'Correct', 'Wrong')
```

In [ ]:

```
#Add new column TYPE to indicate coorrect or wrong predictions with predicted label
conditions = [(predict_test_PCA1['Label'] == 0) & (predict_test_PCA1['TARGET'] == 0),
              (predict_test_PCA1['Label'] == 0) & (predict_test_PCA1['TARGET'] != 0),
              (predict_test_PCA1['Label'] == 1) & (predict_test_PCA1['TARGET'] == 1),
              (predict_test_PCA1['Label'] == 1) & (predict_test_PCA1['TARGET'] != 1)]
values = ['Correct_0', 'Wrong_0', 'Correct_1', 'Wrong_1']
predict_test_PCA1['TYPE'] = np.select(conditions, values)
```

In [ ]:

```
#Visualise prepared data (predict_test_PCA)
predict_test_PCA1
```

Out[ ]:

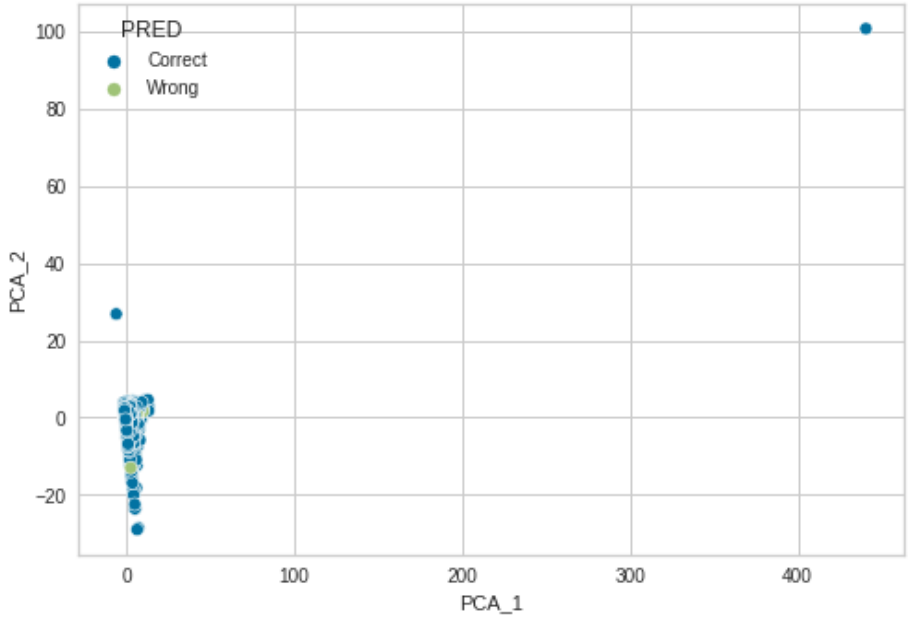
	PCA_1	PCA_2	TARGET	Label	Score	PRED	TYPE
0	-0.209081	-0.215421	0	0	0.916992	Correct	Correct_0
1	-0.592373	0.220935	1	0	0.989258	Wrong	Wrong_0
2	-0.811517	1.378032	0	0	0.981934	Correct	Correct_0
3	-0.528214	0.290033	0	0	0.878906	Correct	Correct_0
4	-0.700219	1.389461	0	0	0.988281	Correct	Correct_0
...	...	...	...	...	...	...	...
46122	1.132458	-6.798999	0	0	0.983887	Correct	Correct_0

	PCA_1	PCA_2	TARGET	Label	Score	PRED	TYPE
46123	-0.511723	0.411437	0	0	0.991211	Correct	Correct_0
46124	-0.960446	2.456621	0	0	0.678223	Correct	Correct_0
46125	-0.925650	1.866706	0	0	0.973145	Correct	Correct_0
46126	-0.343602	-0.448166	0	0	0.957520	Correct	Correct_0

46127 rows × 7 columns

In [ ]:

```
#Scatter plot
sns.scatterplot(data=predict_test_PCA1, x="PCA_1", y="PCA_2", hue='PRED')
plt.show()
```



3.0 Train model with CONFIDENCE as output

3.1 Add confidence columns

In [ ]:

```
#Data preparation
X_train_feature_selected_with_target = X_train_feature_selected
X_train_feature_selected_with_target["TARGET"] = y_train_feature_selected.to_numpy().flat
ten()
X_test_feature_selected_with_target = X_test_feature_selected
X_test_feature_selected_with_target["TARGET"] = y_test_feature_selected.to_numpy().flatte
n()
```

In [ ]:

```
#Rename columns to enable pycaret to read them
X_train_feature_selected_with_target = X_train_feature_selected_with_target.rename(column
s = lambda x:re.sub('[^A-Za-z0-9_]+', '', x))
X_test_feature_selected_with_target = X_test_feature_selected_with_target.rename(columns
= lambda x:re.sub('[^A-Za-z0-9_]+', '', x))
```

In [ ]:

```
#Setup the dataset
data_feature_selected = setup(data=X_train_feature_selected_with_target, target="TARGET",
test_data=X_test_feature_selected_with_target, preprocess=False, silent=True)
```

	Description	Value
	Description	Value
0	session_id	3987
1	Target	TARGET
2	Target Type	Binary
3	Label Encoded	None
4	Original Data	(204494, 177)
5	Missing Values	False
6	Numeric Features	176
7	Categorical Features	0
8	Transformed Train Set	(204494, 176)
9	Transformed Test Set	(46127, 176)
10	Shuffle Train-Test	True
11	Stratify Train-Test	False
12	Fold Generator	StratifiedKFold
13	Fold Number	10
14	CPU Jobs	-1
15	Use GPU	False
16	Log Experiment	False
17	Experiment Name	clf-default-name
18	USI	2ad8
19	Fix Imbalance	False
20	Fix Imbalance Method	SMOTE

At the time this code was executed, use of saved best model (best_model_auc) was throwing error. Hence, lightgbm is again trained with tuned parameters obtained in section 3.3 of phase 3 notebook.

In [ ]:

```
#Train lightgbm with parameters obtained after tuning (best_model_auc in section 3.3 of p
hase 3)
best_model = create_model('lightgbm', bagging_fraction=0.7, bagging_freq=5,
                                  boosting_type='gbdt', class_weight=None,
                                  colsample_bytree=1.0, feature_fraction=0.4,
                                  importance_type='split', learning_rate=0.05,
                                  max_depth=-1, min_child_samples=81,
                                  min_child_weight=0.001, min_split_gain=0.2,
                                  n_estimators=300, n_jobs=-1, num_leaves=200,
                                  objective=None, random_state=3067,
                                  reg_alpha=0.0005, reg_lambda=0.0005,
                                  silent='warn', subsample=1.0,
                                  subsample_for_bin=200000, subsample_freq=0)
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.9169	0.7662	0.0287	0.3902	0.0535	0.0427	0.0875
1	0.9187	0.7720	0.0454	0.5390	0.0838	0.0720	0.1390
2	0.9194	0.7662	0.0460	0.5923	0.0854	0.0745	0.1490
3	0.9181	0.7624	0.0335	0.4956	0.0627	0.0529	0.1125
4	0.9185	0.7657	0.0371	0.5254	0.0693	0.0591	0.1234
5	0.9182	0.7689	0.0329	0.5000	0.0617	0.0522	0.1123
6	0.9191	0.7643	0.0425	0.5680	0.0790	0.0684	0.1392
7	0.9174	0.7542	0.0275	0.4220	0.0517	0.0421	0.0909
8	0.9188	0.7589	0.0389	0.5508	0.0726	0.0625	0.1304

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
9	[illegible]	[illegible]	[illegible]	[illegible]	0.0714	[illegible]	[illegible]
Mean	0.9184	0.7647	0.0371	0.5117	0.0691	0.0588	0.1211
SD	0.0007	0.0049	0.0061	0.0598	0.0111	0.0107	0.0193

In [ ]:

```
#Predict on train data
predict_train = predict_model(best_model, X_train_feature_selected_with_target)
print(predict_train)
```

```
        NAME_HOUSING_TYPE_Municipalapartment  ...   Score
0                                          0  ...  0.9628
1                                          0  ...  0.9454
2                                          0  ...  0.9823
3                                          0  ...  0.9801
4                                          0  ...  0.7530
...                                      ...  ...     ...
204489                                     0  ...  0.9930
204490                                     0  ...  0.9464
204491                                     0  ...  0.9116
204492                                     0  ...  0.9868
204493                                     0  ...  0.5541

[204494 rows x 179 columns]
```

In [ ]:

```
#Add CONFIDENCE column to train data with predictions (predict_train)
conditions = [(predict_train['Label'] == predict_train['TARGET']) & (predict_train['Score'] <= 0.75),
              (predict_train['Label'] == predict_train['TARGET']) & (predict_train['Score'] > 0.75),
              (predict_train['Label'] != predict_train['TARGET']) & (predict_train['Score'] <= 0.75),
              (predict_train['Label'] != predict_train['TARGET']) & (predict_train['Score'] > 0.75)]
values = ['Correct_Low', 'Correct_High', 'Wrong_Low', 'Wrong_High']
predict_train['CONFIDENCE'] = np.select(conditions, values)
```

In [ ]:

```
#Predict on test data
predict_test = predict_model(best_model, X_test_feature_selected_with_target)
print(predict_test)
```

```
       NAME_HOUSING_TYPE_Municipalapartment  ...   Score
0                                         0  ...  0.9169
1                                         0  ...  0.9894
2                                         0  ...  0.9818
3                                         0  ...  0.8791
4                                         0  ...  0.9881
...                                     ...  ...     ...
46122                                     0  ...  0.9839
46123                                     0  ...  0.9912
46124                                     0  ...  0.6782
46125                                     0  ...  0.9731
46126                                     0  ...  0.9577

[46127 rows x 179 columns]
```

In [ ]:

```
#Add CONFIDENCE column to test data with predictions (predict_test)
conditions = [(predict_test['Label'] == predict_test['TARGET']) & (predict_test['Score'] <= 0.75),
              (predict_test['Label'] == predict_test['TARGET']) & (predict_test['Score'] > 0.75),
```

```
                (predict_test['Label'] != predict_test['TARGET']) & (predict_test['Score']
<= 0.75),
                (predict_test['Label'] != predict_test['TARGET']) & (predict_test['Score']
> 0.75)]
values = ['Correct_Low', 'Correct_High', 'Wrong_Low', 'Wrong_High']
predict_test['CONFIDENCE'] = np.select(conditions, values)
```

3.2 Prepare data

In [ ]:

```
#Prepare data
X_predict_train = predict_train.drop(columns=['TARGET', 'Label', 'Score'])
X_predict_test = predict_test.drop(columns=['TARGET', 'Label', 'Score'])
```

In [ ]:

```
#Setup the dataset
data_confidence = setup(data=X_predict_train, target="CONFIDENCE", test_data=X_predict_t
est, preprocess=False, silent=True)
```

	Description	Value
0	session_id	2792
1	Target	CONFIDENCE
2	Target Type	Multiclass
3	Label Encoded	Correct_High: 0, Correct_Low: 1, Wrong_High: 2...
4	Original Data	(204494, 177)
5	Missing Values	False
6	Numeric Features	176
7	Categorical Features	0
8	Transformed Train Set	(204494, 176)
9	Transformed Test Set	(46127, 176)
10	Shuffle Train-Test	True
11	Stratify Train-Test	False
12	Fold Generator	StratifiedKFold
13	Fold Number	10
14	CPU Jobs	-1
15	Use GPU	False
16	Log Experiment	False
17	Experiment Name	clf-default-name
18	USI	9ad9
19	Fix Imbalance	False
20	Fix Imbalance Method	SMOTE

3.3 Train model

In [ ]:

```
#Train lightgbm on train data with CONFIDENCE as TARGET
M2 = create_model('lightgbm')
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.9136	0.8107	0.3629	0.8517	0.8803	0.2464	0.3328
1	0.9136	0.8165	0.3696	0.8518	0.8807	0.2546	0.3353
2	0.9137	0.8060	0.3667	0.8519	0.8806	0.2517	0.3353
3	0.9141	0.8117	0.3649	0.8523	0.8808	0.2496	0.3377
4	0.9120	0.8165	0.3597	0.8498	0.8787	0.2347	0.3138
5	0.9143	0.8117	0.3655	0.8529	0.8810	0.2477	0.3379
6	0.9137	0.8047	0.3646	0.8519	0.8804	0.2471	0.3327
7	0.9140	0.8135	0.3690	0.8523	0.8810	0.2552	0.3383
8	0.9134	0.8103	0.3629	0.8514	0.8801	0.2448	0.3297
9	0.9137	0.8110	0.3626	0.8517	0.8804	0.2470	0.3334
Mean	0.9136	0.8113	0.3648	0.8518	0.8804	0.2479	0.3326
SD	0.0006	0.0036	0.0029	0.0008	0.0006	0.0055	0.0068

In [ ]:

```
#Predict on train data
M2_predict_train = predict_model(M2, X_predict_train, raw_score=True)
print(M2_predict_train)
```

```
        NAME_HOUSING_TYPE_Municipalapartment  ...  Score_Wrong_Low
0                                          0  ...           0.0230
1                                          0  ...           0.0239
2                                          0  ...           0.0178
3                                          0  ...           0.0231
4                                          0  ...           0.1140
...                                      ...  ...              ...
204489                                     0  ...           0.0025
204490                                     0  ...           0.0222
204491                                     0  ...           0.0221
204492                                     0  ...           0.0014
204493                                     0  ...           0.0628

[204494 rows x 182 columns]
```

In [ ]:

```
#Predict on test data
M2_predict_test = predict_model(M2, X_predict_test, raw_score=True)
print(M2_predict_test)
```

```
       NAME_HOUSING_TYPE_Municipalapartment  ...  Score_Wrong_Low
0                                         0  ...           0.0266
1                                         0  ...           0.0116
2                                         0  ...           0.0076
3                                         0  ...           0.0492
4                                         0  ...           0.0096
...                                     ...  ...              ...
46122                                     0  ...           0.0017
46123                                     0  ...           0.0012
46124                                     0  ...           0.2064
46125                                     0  ...           0.0089
46126                                     0  ...           0.0262

[46127 rows x 182 columns]
```

3.4 Add probability outputs as new features

In [ ]:

```
#Add columns for probability values for each TARGET class to train data
X_train_data3 = X_train_feature_selected_with_target
```

```
X_train_data3['Score_Wrong_Low'] = M2_predict_train['Score_Wrong_Low'].to_numpy().flatte
n()
X_train_data3['Score_Wrong_High'] = M2_predict_train['Score_Wrong_High'].to_numpy().flatt
en()
X_train_data3['Score_Correct_Low'] = M2_predict_train['Score_Correct_Low'].to_numpy().fla
tten()
X_train_data3['Score_Correct_High'] = M2_predict_train['Score_Correct_High'].to_numpy().f
latten()

#Add columns for probability values for each TARGET class to test data
X_test_data3 = X_test_feature_selected_with_target
X_test_data3['Score_Wrong_Low'] = M2_predict_test['Score_Wrong_Low'].to_numpy().flatten(
)
X_test_data3['Score_Wrong_High'] = M2_predict_test['Score_Wrong_High'].to_numpy().flatten
()
X_test_data3['Score_Correct_Low'] = M2_predict_test['Score_Correct_Low'].to_numpy().flatt
en()
X_test_data3['Score_Correct_High'] = M2_predict_test['Score_Correct_High'].to_numpy().fla
tten()
```

4.0 LDA and new feature

4.1 Perform LDA on X_train_data3 and X_test_data3

In [ ]:

```
#Define LDA analyser
lda = LinearDiscriminantAnalysis()
#Fit LDA analyser to X_train_data3 and transform
lda_train = lda.fit_transform(X_train_data3.drop(columns=['TARGET']).to_numpy(), X_train_
data3['TARGET'].to_numpy())
#Fit LDA analyser to X_test_data3 and transform
lda_test = lda.fit_transform(X_test_data3.drop(columns=['TARGET']).to_numpy(), X_test_dat
a3['TARGET'].to_numpy())
```

In [ ]:

```
#Add new column LDA with LDA feature to X_train_data3
X_train_data3['LDA'] = lda_train

#Add new column LDA with LDA feature to X_test_data3
X_test_data3['LDA'] = lda_test
```

5.0 Train models with new features

5.1 LGBM

In [ ]:

```
#Setup the dataset
data_lgbm = setup(data=X_train_data3, target="TARGET", test_data=X_test_data3, preprocess
=False, silent=True)
```

	Description	Value
0	session_id	2722
1	Target	TARGET
2	Target Type	Binary
3	Label Encoded	None
4	Original Data	(204494, 182)

	Description	Value
5	Missing Values	False
6	Numeric Features	181
7	Categorical Features	0
8	Transformed Train Set	(204494, 181)
9	Transformed Test Set	(46127, 181)
10	Shuffle Train-Test	True
11	Stratify Train-Test	False
12	Fold Generator	StratifiedKFold
13	Fold Number	10
14	CPU Jobs	-1
15	Use GPU	False
16	Log Experiment	False
17	Experiment Name	clf-default-name
18	USI	0972
19	Fix Imbalance	False
20	Fix Imbalance Method	SMOTE

In [ ]:

```
#Train model
lgbm = create_model('lightgbm')

#Tune hyperparameters of decision tree
lgbm_added_features = tune_model(lgbm)
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.9286	0.8966	0.2493	0.6704	0.3634	0.3339	0.3804
1	0.9289	0.8951	0.2493	0.6780	0.3645	0.3353	0.3831
2	0.9313	0.8966	0.2636	0.7194	0.3858	0.3576	0.4090
3	0.9319	0.8927	0.2684	0.7277	0.3921	0.3641	0.4157
4	0.9299	0.9010	0.2488	0.7015	0.3673	0.3390	0.3909
5	0.9320	0.9055	0.2614	0.7382	0.3860	0.3586	0.4136
6	0.9294	0.8955	0.2566	0.6820	0.3729	0.3435	0.3903
7	0.9297	0.8945	0.2548	0.6893	0.3721	0.3431	0.3914
8	0.9288	0.8924	0.2291	0.6964	0.3447	0.3171	0.3729
9	0.9296	0.8937	0.2428	0.7012	0.3607	0.3327	0.3859
Mean	0.9300	0.8964	0.2524	0.7004	0.3710	0.3425	0.3933
SD	0.0012	0.0038	0.0107	0.0210	0.0134	0.0136	0.0139

In [ ]:

```
#Print tuned parameter values
lgbm_added_features
```

Out[ ]:

```
LGBMClassifier(bagging_fraction=0.4, bagging_freq=2, boosting_type='gbdt',
               class_weight=None, colsample_bytree=1.0, feature_fraction=0.8,
               importance_type='split', learning_rate=0.1, max_depth=-1,
               min_child_samples=26, min_child_weight=0.001, min_split_gain=0,
               n_estimators=210, n_jobs=-1, num_leaves=4, objective=None,
               random_state=2722, reg_alpha=0.3, reg_lambda=0.005,
               silent='warn', subsample=1.0, subsample_for_bin=200000,
```

```
                subsample_freq=0)
```

In [ ]:

```
#Predict on test data
predict_test_data3 = predict_model(lgbm_added_features)
print(predict_test_data3)
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	**Light Gradient Boosting Machine**	**0.9155**	**0.772**	**0.0787**	**0.385**	**0.1307**	**0.1062**	**0.1447**

```
       NAME_HOUSING_TYPE_Municipalapartment  ...   Score
0                                         0  ...  0.9388
1                                         0  ...  0.9941
2                                         0  ...  0.9946
3                                         0  ...  0.9359
4                                         0  ...  0.9911
...                                     ...  ...     ...
46122                                     0  ...  0.9987
46123                                     0  ...  0.9972
46124                                     0  ...  0.6988
46125                                     0  ...  0.9870
46126                                     0  ...  0.9893

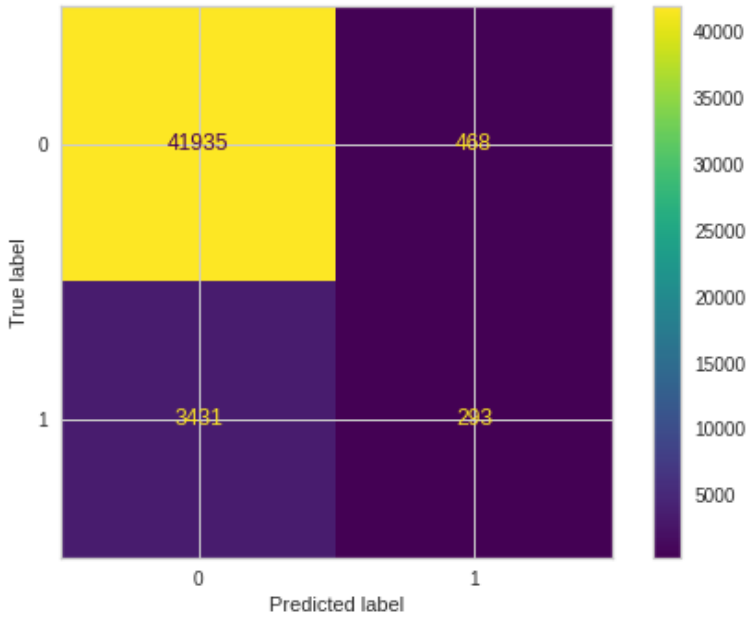
[46127 rows x 184 columns]
```

In [ ]:

```
#Print confusion matrix
cm_lgbm_test_data3 = confusion_matrix(X_test_data3["TARGET"], predict_test_data3["Label"]
)
disp = ConfusionMatrixDisplay(confusion_matrix=cm_lgbm_test_data3)
disp.plot()
```

Out[ ]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7f12a50a0450>
```



Observations and conclusion

- **Overfitting is observed with substantial difference in accuracy & AUC values between predictions on train data and test data.**
- **Although AUC has increased compared to best_model, accuracy has decreased. Based on the above observations, it is concluded that lgbm_added_features is not better than best_model.**

5.2 Stacked Model

In [ ]:

```
#Setup the dataset
data_stacking = setup(data=X_train_data3, target="TARGET", test_data=X_test_data3, prepro
cess=False, silent=True)
```

	Description	Value
0	session_id	7319
1	Target	TARGET
2	Target Type	Binary
3	Label Encoded	None
4	Original Data	(204494, 181)
5	Missing Values	False
6	Numeric Features	180
7	Categorical Features	0
8	Transformed Train Set	(204494, 180)
9	Transformed Test Set	(46127, 180)
10	Shuffle Train-Test	True
11	Stratify Train-Test	False
12	Fold Generator	StratifiedKFold
13	Fold Number	10
14	CPU Jobs	-1
15	Use GPU	False
16	Log Experiment	False
17	Experiment Name	clf-default-name
18	USI	0ef7
19	Fix Imbalance	False
20	Fix Imbalance Method	SMOTE

In [ ]:

```
# create individual models for stacking
lr = create_model('lr')
rf = create_model('rf')
lightgbm = create_model('lightgbm')

# stacking models
stacker = stack_models(estimator_list = [lr, rf, lightgbm], meta_model = lr)
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.9281	0.8899	0.2732	0.6419	0.3832	0.3516	0.3881
1	0.9305	0.8971	0.2875	0.6765	0.4035	0.3729	0.4118
2	0.9319	0.8935	0.2995	0.6949	0.4185	0.3884	0.4276
3	0.9302	0.8850	0.2947	0.6662	0.4086	0.3774	0.4132
4	0.9316	0.8915	0.3020	0.6861	0.4194	0.3889	0.4262
5	0.9319	0.8949	0.2967	0.6966	0.4161	0.3861	0.4262
6	0.9313	0.8935	0.3098	0.6745	0.4246	0.3934	0.4273
7	0.9297	0.8849	0.2907	0.6594	0.4035	0.3721	0.4076
8	0.9315	0.8912	0.2883	0.6955	0.4076	0.3778	0.4195

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
9	0.9299	0.8924	0.2739	0.6755	0.3898	0.3596	0.4013
Mean	0.9307	0.8914	0.2916	0.6767	0.4075	0.3768	0.4149
SD	0.0012	0.0037	0.0110	0.0167	0.0125	0.0127	0.0125

In [ ]:

```
#Predict on test data
predict_stack_test_data3 = predict_model(stacker)
print(predict_stack_test_data3)
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	**Stacking Classifier**	0.9078	0.7429	0.0921	0.2823	0.1389	0.1033	0.1217

```
       NAME_HOUSING_TYPE_Municipalapartment  ...   Score
0                                         0  ...  0.9830
1                                         0  ...  0.9830
2                                         0  ...  0.9744
3                                         0  ...  0.9632
4                                         0  ...  0.9854
...                                     ...  ...     ...
46122                                     0  ...  0.9880
46123                                     0  ...  0.9913
46124                                     0  ...  0.6027
46125                                     0  ...  0.9867
46126                                     0  ...  0.9803

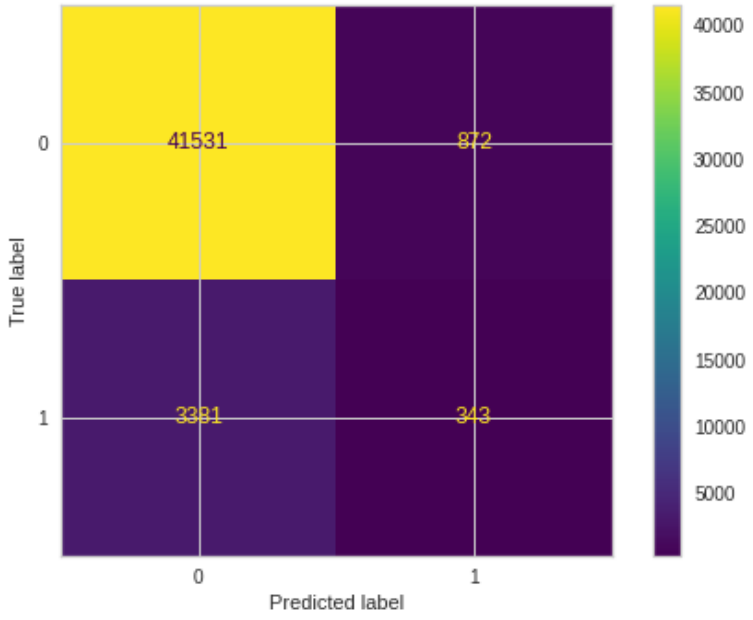
[46127 rows x 183 columns]
```

In [ ]:

```
#Print confusion matrix
cm_stack_test_data3 = confusion_matrix(X_test_data3["TARGET"], predict_stack_test_data3["
Label"])
disp = ConfusionMatrixDisplay(confusion_matrix=cm_stack_test_data3)
disp.plot()
```

Out[ ]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7f75b20dca50>
```



Observations and conclusion

- **Overfitting is observed with substantial difference in accuracy & AUC values between predictions on train data and test data.**
- **Accuracy and AUC have decreased compared to best_model. Based on the above observations, it is concluded that stacker is not better than best_model.**

5.3 Neural Network

In [ ]:

```
#Define the keras model
NN_model = Sequential()
NN_model.add(Dense(128, input_dim=180, activation='relu'))
NN_model.add(Dropout(0.5))
NN_model.add(BatchNormalization())
NN_model.add(Dense(64, activation='relu'))
NN_model.add(Dropout(0.5))
NN_model.add(BatchNormalization())
NN_model.add(Dense(32, activation='relu'))
NN_model.add(Dropout(0.5))
NN_model.add(BatchNormalization())
NN_model.add(Dense(1, activation='sigmoid'))
#Compile the keras model
NN_model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
#Fit the keras model on the dataset
NN_model.fit(X_train_data3.drop(columns=['TARGET']), X_train_data3['TARGET'], epochs=25,
batch_size=1024)
```

```
Epoch 1/25
200/200 [==============================] - 7s 23ms/step - loss: 0.5694 - accuracy: 0.7603
Epoch 2/25
200/200 [==============================] - 4s 22ms/step - loss: 0.3112 - accuracy: 0.9074
Epoch 3/25
200/200 [==============================] - 5s 23ms/step - loss: 0.2752 - accuracy: 0.9148
Epoch 4/25
200/200 [==============================] - 4s 20ms/step - loss: 0.2649 - accuracy: 0.9156
Epoch 5/25
200/200 [==============================] - 3s 17ms/step - loss: 0.2572 - accuracy: 0.9166
Epoch 6/25
200/200 [==============================] - 3s 16ms/step - loss: 0.2508 - accuracy: 0.9169
Epoch 7/25
200/200 [==============================] - 3s 16ms/step - loss: 0.2431 - accuracy: 0.9173
Epoch 8/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2326 - accuracy: 0.9188
Epoch 9/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2237 - accuracy: 0.9197
Epoch 10/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2178 - accuracy: 0.9211
Epoch 11/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2159 - accuracy: 0.9210
Epoch 12/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2126 - accuracy: 0.9218
Epoch 13/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2109 - accuracy: 0.9221
Epoch 14/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2088 - accuracy: 0.9226
Epoch 15/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2083 - accuracy: 0.9225
Epoch 16/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2065 - accuracy: 0.9228
Epoch 17/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2054 - accuracy: 0.9234
Epoch 18/25
200/200 [==============================] - 3s 16ms/step - loss: 0.2052 - accuracy: 0.9233
Epoch 19/25
200/200 [==============================] - 4s 18ms/step - loss: 0.2044 - accuracy: 0.9236
Epoch 20/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2032 - accuracy: 0.9240
Epoch 21/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2030 - accuracy: 0.9238
Epoch 22/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2020 - accuracy: 0.9236
Epoch 23/25
```

```
Epoch 23/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2019 - accuracy: 0.9240
Epoch 24/25
200/200 [==============================] - 3s 15ms/step - loss: 0.2008 - accuracy: 0.9241
Epoch 25/25
200/200 [==============================] - 3s 16ms/step - loss: 0.2001 - accuracy: 0.9240
```

Out[ ]:

```
<keras.callbacks.History at 0x7f753eb1e850>
```

In [ ]:

```
#Print model parameters
print(NN_model.summary())
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_5 (Dense)             (None, 128)               23168

 dropout_4 (Dropout)         (None, 128)               0

 batch_normalization_4 (Batc  (None, 128)              512
 hNormalization)

 dense_6 (Dense)             (None, 64)                8256

 dropout_5 (Dropout)         (None, 64)                0

 batch_normalization_5 (Batc  (None, 64)               256
 hNormalization)

 dense_7 (Dense)             (None, 32)                2080

 dropout_6 (Dropout)         (None, 32)                0

 batch_normalization_6 (Batc  (None, 32)               128
 hNormalization)

 dense_8 (Dense)             (None, 1)                 33

=================================================================
Total params: 34,433
Trainable params: 33,985
Non-trainable params: 448
_________________________________________________________________
None
```

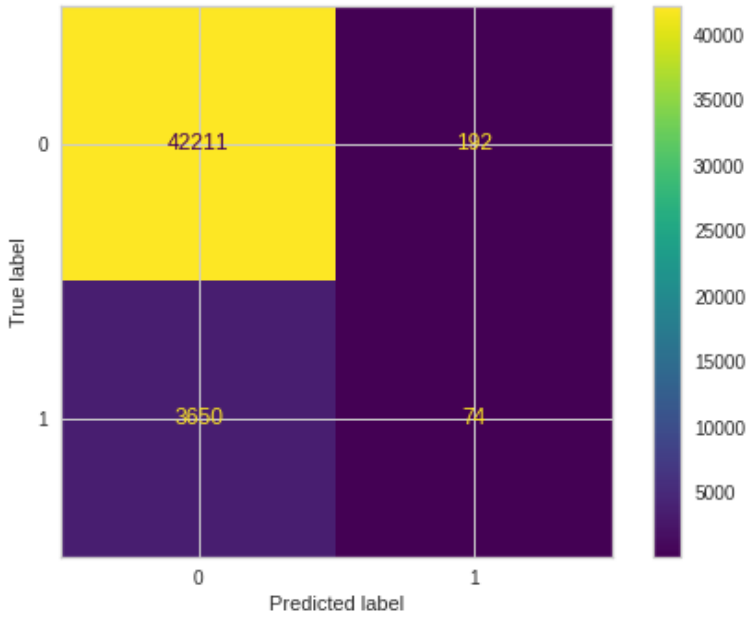
In [ ]:

```
#Print accuracy on training data
NN_pred_X_train = (NN_model.predict(X_train_data3.drop(columns=['TARGET'])) > 0.5).astype
(int)
print("Accuracy on train data: ", np.around(accuracy_score(X_train_data3['TARGET'], NN_pr
ed_X_train)*100, 2))

#Print confusion matrix
NN_pred_X_test = (NN_model.predict(X_test_data3.drop(columns=['TARGET'])) > 0.5).astype(
int)
cm_NN_test_data3 = confusion_matrix(X_test_data3["TARGET"], NN_pred_X_test)
disp = ConfusionMatrixDisplay(confusion_matrix=cm_NN_test_data3)
disp.plot()

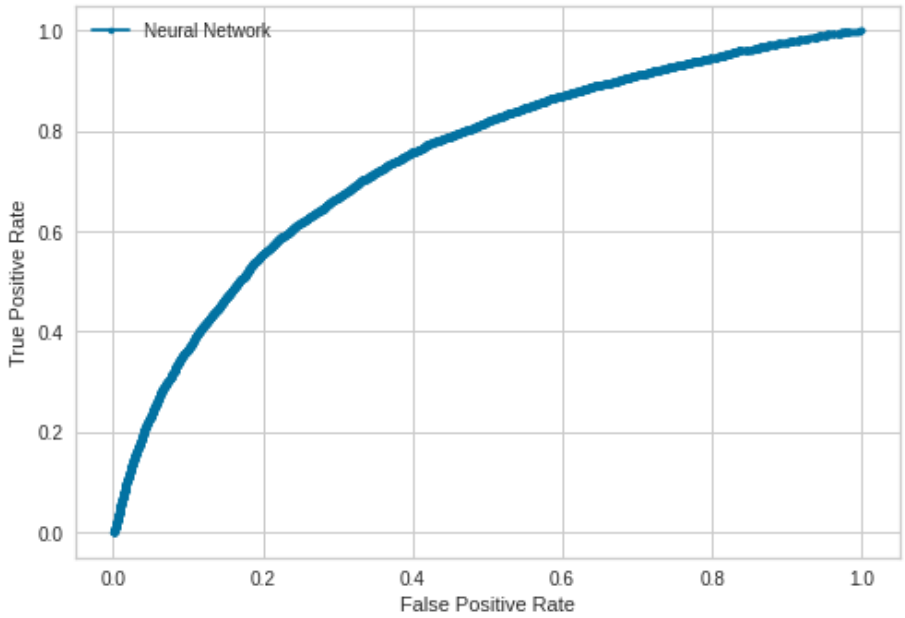
#Print accuracy on test data
print("Accuracy on test data: ", np.around(accuracy_score(X_test_data3['TARGET'], NN_pre
d_X_test)*100, 2))
```

```
Accuracy on train data:  92.54
Accuracy on test data:  91.67
```



In [ ]:

```
#Plot AUC (area under curve) for ROC (receiver operating characteristic) curve and print value
probabilities = NN_model.predict(X_test_data3.drop(columns=['TARGET']))
fpr, tpr, _ = roc_curve(X_test_data3['TARGET'], probabilities)
plt.plot(fpr, tpr, marker='.', label='Neural Network')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend()
plt.show()
print("ROC AUC on test data: ", np.around(roc_auc_score(X_test_data3['TARGET'], probabilities), 2))
```




```
ROC AUC on test data:  0.74
```

Observations and conclusion

- **Overfitting is observed although not major.**
- **Accuracy and AUC have decreased compared to best_model. Based on the above observations, it is concluded that NN_model is not better than best_model.**

5.4 Neural Network for original data (without additional features)

In [ ]:

```
#Define the keras model
model_feature_selected = Sequential()
model_feature_selected.add(Dense(256, input_dim=176, activation='relu'))
model_feature_selected.add(Dropout(0.5))
model_feature_selected.add(BatchNormalization())
model_feature_selected.add(Dense(128, activation='relu'))
model_feature_selected.add(Dropout(0.5))
model_feature_selected.add(BatchNormalization())
model_feature_selected.add(Dense(64, activation='relu'))
model_feature_selected.add(Dropout(0.5))
model_feature_selected.add(BatchNormalization())
model_feature_selected.add(Dense(32, activation='relu'))
model_feature_selected.add(Dropout(0.5))
model_feature_selected.add(BatchNormalization())
model_feature_selected.add(Dense(1, activation='sigmoid'))
#Compile the keras model
model_feature_selected.compile(loss='binary_crossentropy', optimizer='adam', metrics=['a
ccuracy'])
#Fit the keras model on the dataset
model_feature_selected.fit(X_train_feature_selected.drop(columns=['TARGET']), y_train_fea
ture_selected, epochs=25, batch_size=1024)
```

```
Epoch 1/25
200/200 [==============================] - 12s 49ms/step - loss: 0.5594 - accuracy: 0.765
4
Epoch 2/25
200/200 [==============================] - 9s 45ms/step - loss: 0.3036 - accuracy: 0.9136
Epoch 3/25
200/200 [==============================] - 7s 33ms/step - loss: 0.2730 - accuracy: 0.9161
Epoch 4/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2649 - accuracy: 0.9171
Epoch 5/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2610 - accuracy: 0.9171
Epoch 6/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2589 - accuracy: 0.9175
Epoch 7/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2567 - accuracy: 0.9177
Epoch 8/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2557 - accuracy: 0.9177
Epoch 9/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2541 - accuracy: 0.9179
Epoch 10/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2531 - accuracy: 0.9177
Epoch 11/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2521 - accuracy: 0.9180
Epoch 12/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2511 - accuracy: 0.9178
Epoch 13/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2507 - accuracy: 0.9179
Epoch 14/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2504 - accuracy: 0.9179
Epoch 15/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2494 - accuracy: 0.9180
Epoch 16/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2487 - accuracy: 0.9180
Epoch 17/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2482 - accuracy: 0.9180
Epoch 18/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2476 - accuracy: 0.9181
Epoch 19/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2469 - accuracy: 0.9180
Epoch 20/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2463 - accuracy: 0.9181
Epoch 21/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2461 - accuracy: 0.9180
```

```
Epoch 22/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2451 - accuracy: 0.9181
Epoch 23/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2450 - accuracy: 0.9181
Epoch 24/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2442 - accuracy: 0.9180
Epoch 25/25
200/200 [==============================] - 6s 29ms/step - loss: 0.2431 - accuracy: 0.9181
```

Out[ ]:

```
<keras.callbacks.History at 0x7f753c80f450>
```

In [ ]:

```
#Print model parameters
print(model_feature_selected.summary())
```

```
Model: "sequential_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_17 (Dense)            (None, 256)               45312

 dropout_13 (Dropout)        (None, 256)               0

 batch_normalization_13 (Bat  (None, 256)              1024
 chNormalization)

 dense_18 (Dense)            (None, 128)               32896

 dropout_14 (Dropout)        (None, 128)               0

 batch_normalization_14 (Bat  (None, 128)              512
 chNormalization)

 dense_19 (Dense)            (None, 64)                8256

 dropout_15 (Dropout)        (None, 64)                0

 batch_normalization_15 (Bat  (None, 64)               256
 chNormalization)

 dense_20 (Dense)            (None, 32)                2080

 dropout_16 (Dropout)        (None, 32)                0

 batch_normalization_16 (Bat  (None, 32)               128
 chNormalization)

 dense_21 (Dense)            (None, 1)                 33

=================================================================
Total params: 90,497
Trainable params: 89,537
Non-trainable params: 960
_________________________________________________________________
None
```

In [ ]:

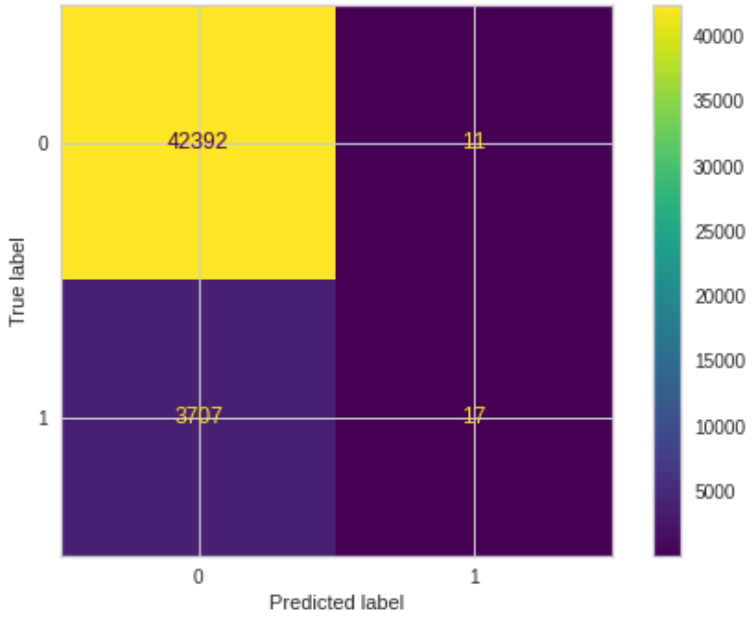
```
#Print accuracy on training data
NN_pred_y_train_feature_selected = (model_feature_selected.predict(X_train_feature_selec
ted.drop(columns=['TARGET'])) > 0.5).astype(int)
print("Accuracy on train data: ", np.around(accuracy_score(y_train_feature_selected, NN_p
red_y_train_feature_selected)*100, 2))

#Print confusion matrix
NN_pred_y_test_feature_selected = (model_feature_selected.predict(X_test_feature_selected
.drop(columns=['TARGET'])) > 0.5).astype(int)
```

```
NN_cm_feature_selected = confusion_matrix(y_test_feature_selected, NN_pred_y_test_feature
_selected)
disp = ConfusionMatrixDisplay(confusion_matrix=NN_cm_feature_selected)
disp.plot()

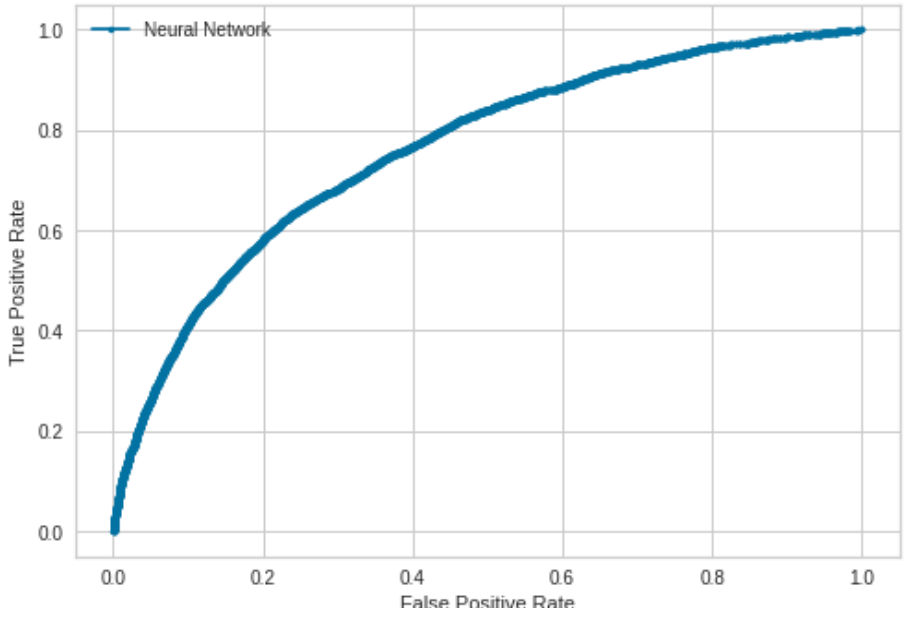
#Print accuracy on test data
print("Accuracy on test data: ", np.around(accuracy_score(y_test_feature_selected, NN_pre
d_y_test_feature_selected)*100, 2))
```

```
Accuracy on train data:  91.85
Accuracy on test data:  91.94
```



In [ ]:

```
#Plot AUC (area under curve) for ROC (receiver operating characteristic) curve and print
value
probabilities = model_feature_selected.predict(X_test_feature_selected.drop(columns=['TAR
GET']))
fpr, tpr, _ = roc_curve(y_test_feature_selected, probabilities)
plt.plot(fpr, tpr, marker='.', label='Neural Network')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend()
plt.show()
print("ROC AUC on test data: ", np.around(roc_auc_score(y_test_feature_selected, probabil
ities), 2))
```



```
ROC AUC on test data:  0.76
```

Observations and conclusion:

- **Overfitting is not observed.**
- **Accuracy and AUC have decreased only slightly compared to best_model.**
- **The number of people who should have been rejected for loan but are predicted as eligible for loan is huge. Based on the above observations, it is concluded that model_feature_selected is not better than best_model.**

6.0 Conclusion

- **After trying so many models with so many different conditions (across phase 3 and phase 4), it is observed that tuned lightgbm is the best performer. Even deep learning models fare poorly as compared to tuned lightgbm. Also best results are obtained on feature selected data.**
- **Many permutations and combinations are applied to reach this conclusion. However, more approaches can be tried which may or may not give better results. Such approaches can be tried with availability of time and resources.**
- **This phase concludes the model training step. Further the trained model shall be deployed in the coming phase.**