Soccerstat

June 24, 2024

```
[590]: from IPython import display
       display.Image("/content/drive/MyDrive/Colab Notebooks/Copy of soccer.jpg",␣
        ↪width = 1800, height = 600)
```

[590]:

https://www.progressivesoccertraining.com/what-age-is-too-old-to-play-soccer/

1 What Age Is Too Old To Play Soccer?

Question from player:

"At what age does a soccer player start being considered old?"

How old is too old to go pro in soccer?

What age do soccer players usually retire?

What age is too late to start playing soccer?

What age is too late to play soccer in general?

To answer this question, I visited “sofifa.com,” a site that publishes the ages of professional footballers. Using its API, I extracted the data and integrated it into Google Sheets. I then used the Python programming language for data cleaning and preprocessing. After preprocessing, I analyzed the data using statistical methods and applied machine learning to determine if a player is likely to secure a contract based on certain characteristics.

Pandas for Data Cleaning and Preprocessing

[591]:

```
!pip install Altair_viewer
from ast import Import
import pandas as pd
import gspread as gs
import matplotlib.pyplot as plt
import csv
import xml
import html
import numpy as np
import seaborn as sns
import plotly.express as px
from scipy.stats import zscore
from scipy.stats import chi2_contingency
import altair as alt
from IPython.display import display
```

```
Requirement already satisfied: Altair_viewer in /usr/local/lib/python3.10/dist-
packages (0.4.0)
Requirement already satisfied: altair in /usr/local/lib/python3.10/dist-packages
(from Altair_viewer) (4.2.2)
Requirement already satisfied: altair-data-server>=0.4.0 in
/usr/local/lib/python3.10/dist-packages (from Altair_viewer) (0.4.1)
Requirement already satisfied: portpicker in /usr/local/lib/python3.10/dist-
packages (from altair-data-server>=0.4.0->Altair_viewer) (1.5.2)
Requirement already satisfied: tornado in /usr/local/lib/python3.10/dist-
packages (from altair-data-server>=0.4.0->Altair_viewer) (6.3.3)
Requirement already satisfied: entrypoints in /usr/local/lib/python3.10/dist-
packages (from altair->Altair_viewer) (0.4)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages
(from altair->Altair_viewer) (3.1.4)
Requirement already satisfied: jsonschema>=3.0 in
/usr/local/lib/python3.10/dist-packages (from altair->Altair_viewer) (4.19.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages
```

```
(from altair->Altair_viewer) (1.25.2)
Requirement already satisfied: pandas>=0.18 in /usr/local/lib/python3.10/dist-
packages (from altair->Altair_viewer) (2.0.3)
Requirement already satisfied: toolz in /usr/local/lib/python3.10/dist-packages
(from altair->Altair_viewer) (0.12.1)
Requirement already satisfied: attrs>=22.2.0 in /usr/local/lib/python3.10/dist-
packages (from jsonschema>=3.0->altair->Altair_viewer) (23.2.0)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in
/usr/local/lib/python3.10/dist-packages (from
jsonschema>=3.0->altair->Altair_viewer) (2023.12.1)
Requirement already satisfied: referencing>=0.28.4 in
/usr/local/lib/python3.10/dist-packages (from
jsonschema>=3.0->altair->Altair_viewer) (0.35.1)
Requirement already satisfied: rpds-py>=0.7.1 in /usr/local/lib/python3.10/dist-
packages (from jsonschema>=3.0->altair->Altair_viewer) (0.18.1)
Requirement already satisfied: python-dateutil>=2.8.2 in
/usr/local/lib/python3.10/dist-packages (from
pandas>=0.18->altair->Altair_viewer) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-
packages (from pandas>=0.18->altair->Altair_viewer) (2023.4)
Requirement already satisfied: tzdata>=2022.1 in /usr/local/lib/python3.10/dist-
packages (from pandas>=0.18->altair->Altair_viewer) (2024.1)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.10/dist-packages (from jinja2->altair->Altair_viewer)
(2.1.5)
Requirement already satisfied: psutil in /usr/local/lib/python3.10/dist-packages
(from portpicker->altair-data-server>=0.4.0->Altair_viewer) (5.9.5)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-
packages (from python-dateutil>=2.8.2->pandas>=0.18->altair->Altair_viewer)
(1.16.0)
```

[592]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

[593]:

```
df = pd.read_excel("/content/drive/MyDrive/Data_Engineering/Soccerplayerstat.
 ↪xlsx")
```

[594]:

```
df.head(2)
```

[594]:

```
   Unnamed: 0                  Name  Age Overall rating Potential  \
0         NaN  Vitor Roque\nSTRWLW   18           *76*      *88*
1         NaN  T. Buchanan\nRBRMLM   24           *72*      *77*

                    Team & Contract   Value  Wage Total stats
```

```
0  FC Barcelona\n2024 ~ 2031  €17.5M  €44K      *1829*
1         Inter\n2024 ~ 2025   €3.3M  €34K      *1931*
```

[594]:

```

```

[595]:

```
# Drop the "Unnamed: 0" column
df = df.drop("Unnamed: 0", axis=1)
```

[596]:

```
df.head(2)
```

[596]:

```
                   Name  Age Overall rating Potential  \
0  Vitor Roque\nSTRWLW   18           *76*      *88*
1  T. Buchanan\nRBRMLM   24           *72*      *77*

              Team & Contract   Value  Wage Total stats
0  FC Barcelona\n2024 ~ 2031  €17.5M  €44K      *1829*
1         Inter\n2024 ~ 2025   €3.3M  €34K      *1931*
```

[597]:

```
# Remove newline characters from both 'Name' and 'Team & Contract' columns
df[['Name', 'Team & Contract']] = df[['Name', 'Team & Contract']].replace('\n',␣
 ↪' ', regex=True)
```

[598]:

```
df.head(2)
```

[598]:

```
                  Name  Age Overall rating Potential            Team & Contract  \
0  Vitor Roque STRWLW   18           *76*      *88*  FC Barcelona 2024 ~ 2031
1  T. Buchanan RBRMLM   24           *72*      *77*         Inter 2024 ~ 2025

    Value  Wage Total stats
0  €17.5M  €44K      *1829*
1   €3.3M  €34K      *1931*
```

[599]:

```
# Select rows where 'Team & Contract' column contains "~"
selectedrowscontaintilde  = df[df['Team & Contract'].str.contains('~')]
selectedrowscontaintilde.head(2)
```

[599]:

```
                  Name  Age Overall rating Potential            Team & Contract  \
0  Vitor Roque STRWLW   18           *76*      *88*  FC Barcelona 2024 ~ 2031
1  T. Buchanan RBRMLM   24           *72*      *77*         Inter 2024 ~ 2025

    Value  Wage Total stats
0  €17.5M  €44K      *1829*
1   €3.3M  €34K      *1931*
```

[600]:

```
# Extract 'Team' and 'Contract' based on the last 12 characters
selectedrowscontaintilde[['Team', 'Contract']] = selectedrowscontaintilde['Team␣
 ↪& Contract'].str.extract(r'(.+) (\d{4} ~ \d{4})$')
```

```
<ipython-input-600-97f155d010f5>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  selectedrowscontaintilde[['Team', 'Contract']] =
selectedrowscontaintilde['Team & Contract'].str.extract(r'(.+) (\d{4} ~
\d{4})$')
<ipython-input-600-97f155d010f5>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  selectedrowscontaintilde[['Team', 'Contract']] =
selectedrowscontaintilde['Team & Contract'].str.extract(r'(.+) (\d{4} ~
\d{4})$')
```

[601]:

```
selectedrowscontaintilde.head(2)
```

[601]:

```
                  Name  Age Overall rating Potential           Team & Contract  \
0  Vitor Roque STRWLW   18           *76*      *88*  FC Barcelona 2024 ~ 2031
1  T. Buchanan RBRMLM   24           *72*      *77*         Inter 2024 ~ 2025

    Value  Wage Total stats          Team    Contract
0  €17.5M  €44K      *1829*  FC Barcelona  2024 ~ 2031
1   €3.3M  €34K      *1931*         Inter  2024 ~ 2025
```

[602]:

```
# Split 'Contract' into 'ContractStart' and 'ContractEnd' based on "~"
selectedrowscontaintilde[['ContractStart', 'ContractEnd']] =␣
 ↪selectedrowscontaintilde['Contract'].str.split(' ~ ', expand=True)
```

```
<ipython-input-602-b04ef4f4d206>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  selectedrowscontaintilde[['ContractStart', 'ContractEnd']] =
selectedrowscontaintilde['Contract'].str.split(' ~ ', expand=True)
<ipython-input-602-b04ef4f4d206>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  selectedrowscontaintilde[['ContractStart', 'ContractEnd']] =
selectedrowscontaintilde['Contract'].str.split(' ~ ', expand=True)
```

[603]:
```
selectedrowscontaintilde.head(2)
```

[603]:
```
                  Name  Age Overall rating Potential            Team & Contract  \
0  Vitor Roque STRWLW   18           *76*      *88*  FC Barcelona 2024 ~ 2031
1  T. Buchanan RBRMLM   24           *72*      *77*         Inter 2024 ~ 2025

    Value  Wage Total stats          Team     Contract ContractStart  \
0  €17.5M  €44K      *1829*  FC Barcelona  2024 ~ 2031          2024
1   €3.3M  €34K      *1931*         Inter  2024 ~ 2025          2024

  ContractEnd
0        2031
1        2025
```

[604]:
```
selectedrowscontaintildecopy = selectedrowscontaintilde.copy()
```

[604]:
```

```

[605]:
```
selectedrowscontaintildecopy['ContractStart'] = '01/01/' +␣
 ↪selectedrowscontaintildecopy['ContractStart']
selectedrowscontaintildecopy['ContractEnd'] = '12/31/' +␣
 ↪selectedrowscontaintildecopy['ContractEnd']
```

[606]:
```
selectedrowscontaintildecopy.head(2)
```

[606]:
```
                  Name  Age Overall rating Potential            Team & Contract  \
0  Vitor Roque STRWLW   18           *76*      *88*  FC Barcelona 2024 ~ 2031
1  T. Buchanan RBRMLM   24           *72*      *77*         Inter 2024 ~ 2025

    Value  Wage Total stats          Team     Contract ContractStart  \
0  €17.5M  €44K      *1829*  FC Barcelona  2024 ~ 2031    01/01/2024
1   €3.3M  €34K      *1931*         Inter  2024 ~ 2025    01/01/2024

  ContractEnd
0  12/31/2031
1  12/31/2025
```

[606]:
```

```

[607]:
```
# Remove "*" from 'Overall rating', 'Potential', and 'Total stats'
columns_to_clean = ['Age','Overall rating', 'Potential', 'Total stats']
selectedrowscontaintildecopy[columns_to_clean] =␣
 ↪selectedrowscontaintildecopy[columns_to_clean].replace('\*', '', regex=True)

# Convert columns to numeric
```

```
selectedrowscontaintildecopy[columns_to_clean] =␣
 ↪selectedrowscontaintildecopy[columns_to_clean].apply(pd.to_numeric,␣
 ↪errors='coerce')
```

[608]:

```
selectedrowscontaintildecopy.head(2)
```

[608]:

```
                 Name  Age  Overall rating  Potential  \
0  Vitor Roque STRWLW   18            76.0       88.0
1  T. Buchanan RBRMLM   24            72.0       77.0

            Team & Contract   Value  Wage  Total stats          Team  \
0  FC Barcelona 2024 ~ 2031  €17.5M  €44K         1829  FC Barcelona
1          Inter 2024 ~ 2025   €3.3M  €34K         1931         Inter

      Contract ContractStart ContractEnd
0  2024 ~ 2031    01/01/2024  12/31/2031
1  2024 ~ 2025    01/01/2024  12/31/2025
```

[608]:

```

```

[609]:

```
# Split 'Contract' into 'ContractStart' and 'ContractEnd' based on "~"
selectedrowscontaintilde[['ContractStart', 'ContractEnd']] =␣
 ↪selectedrowscontaintilde['Team & Contract'].str.split(' ~ ', expand=True)

# Function to convert currency values
def convert_currency(value):
    if isinstance(value, str):
        if 'M' in value:
            return float(value.replace('€', '').replace('M', '')) * 1e6
        elif 'K' in value:
            return float(value.replace('€', '').replace('K', '')) * 1e3
        else:
            return float(value.replace('€', ''))
    else:
        return float(value)

# Apply the conversion function to 'Value' and 'Wage' columns
selectedrowscontaintildecopy['Value'] = selectedrowscontaintildecopy['Value'].
 ↪apply(convert_currency)

# Convert 'Wage' only if it's not an integer
selectedrowscontaintildecopy['Wage'] = selectedrowscontaintildecopy['Wage'].
 ↪apply(lambda x: convert_currency(x) if isinstance(x, str) else x)
```

```
<ipython-input-609-629256c4ceff>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

```
See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  selectedrowscontaintilde[['ContractStart', 'ContractEnd']] =
selectedrowscontaintilde['Team & Contract'].str.split(' ~ ', expand=True)
```

[610]:

```
#selectedrowscontaintildecopy
```

[611]:

```
selectedrowscontaintildecopy['ContractStart'] = pd.
 ↪to_datetime(selectedrowscontaintildecopy['ContractStart'], format='%m/%d/%Y')
selectedrowscontaintildecopy['ContractEnd'] = pd.
 ↪to_datetime(selectedrowscontaintildecopy['ContractEnd'], format='%m/%d/%Y')
```

[612]:

```
selectedrowscontaintildecopy.head(2)
```

[612]:

```
                 Name  Age  Overall rating  Potential  \
0  Vitor Roque STRWLW   18            76.0       88.0
1  T. Buchanan RBRMLM   24            72.0       77.0

            Team & Contract       Value     Wage  Total stats          Team  \
0  FC Barcelona 2024 ~ 2031  17500000.0  44000.0         1829  FC Barcelona
1         Inter 2024 ~ 2025   3300000.0  34000.0         1931         Inter

      Contract ContractStart ContractEnd
0  2024 ~ 2031    2024-01-01  2031-12-31
1  2024 ~ 2025    2024-01-01  2025-12-31
```

[612]:

```

```

[613]:

```
# Calculate the total contract years
selectedrowscontaintildecopy['TotalContractYears'] =␣
 ↪(selectedrowscontaintildecopy['ContractEnd'] -␣
 ↪selectedrowscontaintildecopy['ContractStart']).dt.days / 365

# Round the values to two decimal places
selectedrowscontaintildecopy['TotalContractYears'] =␣
 ↪selectedrowscontaintildecopy['TotalContractYears'].round(0)

selectedrowscontaintildecopy.head(2)
```

[613]:

```
                 Name  Age  Overall rating  Potential  \
0  Vitor Roque STRWLW   18            76.0       88.0
1  T. Buchanan RBRMLM   24            72.0       77.0

            Team & Contract       Value     Wage  Total stats          Team  \
0  FC Barcelona 2024 ~ 2031  17500000.0  44000.0         1829  FC Barcelona
1         Inter 2024 ~ 2025   3300000.0  34000.0         1931         Inter
```

```
     Contract ContractStart ContractEnd  TotalContractYears
0  2024 ~ 2031    2024-01-01  2031-12-31                 8.0
1  2024 ~ 2025    2024-01-01  2025-12-31                 2.0
```

[614]:

```
selectedrowscontaintildecopy['ContractType'] =␣
 ↪selectedrowscontaintildecopy['Team & Contract'].apply(
    lambda x: 'Free' if 'Free' in x else ('Loan' if 'On loan' in x else␣
 ↪'Contract' if '~' in x else 'No Contract')
)

selectedrowscontaintildecopy.head(2)
```

[614]:

```
                 Name  Age  Overall rating  Potential  \
0  Vitor Roque STRWLW   18            76.0       88.0
1  T. Buchanan RBRMLM   24            72.0       77.0

            Team & Contract       Value     Wage  Total stats          Team  \
0  FC Barcelona 2024 ~ 2031  17500000.0  44000.0         1829  FC Barcelona
1         Inter 2024 ~ 2025   3300000.0  34000.0         1931         Inter

     Contract ContractStart ContractEnd  TotalContractYears ContractType
0  2024 ~ 2031    2024-01-01  2031-12-31                 8.0     Contract
1  2024 ~ 2025    2024-01-01  2025-12-31                 2.0     Contract
```

[614]:

```

```

[615]:

```
n = 11  # Number of characters to remove
selectedrowscontaintildecopy['Team'] = selectedrowscontaintildecopy['Team &␣
 ↪Contract'].apply(lambda x: x[:-n] if len(x) > n else '')
selectedrowscontaintildecopy.head(2)
```

[615]:

```
                 Name  Age  Overall rating  Potential  \
0  Vitor Roque STRWLW   18            76.0       88.0
1  T. Buchanan RBRMLM   24            72.0       77.0

            Team & Contract       Value     Wage  Total stats           Team  \
0  FC Barcelona 2024 ~ 2031  17500000.0  44000.0         1829  FC Barcelona
1         Inter 2024 ~ 2025   3300000.0  34000.0         1931         Inter

     Contract ContractStart ContractEnd  TotalContractYears ContractType
0  2024 ~ 2031    2024-01-01  2031-12-31                 8.0     Contract
1  2024 ~ 2025    2024-01-01  2025-12-31                 2.0     Contract
```

[616]:

```
# Drop 'Team & Contract' and 'Contract' columns from the DataFrame
selectedrowscontaintildecopy = selectedrowscontaintildecopy.drop(columns=['Team␣
 ↪& Contract', 'Contract'])
```

```
# Verify the changes
selectedrowscontaintildecopy.head(1)
```

```
[616]:                  Name  Age  Overall rating  Potential       Value     Wage  \
       0  Vitor Roque STRWLW   18            76.0       88.0  17500000.0  44000.0

          Total stats          Team ContractStart ContractEnd  TotalContractYears  \
       0         1829  FC Barcelona     2024-01-01  2031-12-31                 8.0

         ContractType
       0     Contract
```

```
[617]: # Identify the index of the 'ContractEnd' column
       contract_end_index = selectedrowscontaintildecopy.columns.get_loc('ContractEnd')

       # Identify the index of the 'ContractType' column
       contract_type_index = selectedrowscontaintildecopy.columns.
        ↪get_loc('ContractType')

       # Move 'TotalContractYears' column to the desired position
       selectedrowscontaintildecopy.insert(contract_type_index, 'TotalContractYears',␣
        ↪selectedrowscontaintildecopy.pop('TotalContractYears'))

       # Verify the changes
       selectedrowscontaintildecopy.head(1)
```

```
[617]:                  Name  Age  Overall rating  Potential       Value     Wage  \
       0  Vitor Roque STRWLW   18            76.0       88.0  17500000.0  44000.0

          Total stats          Team ContractStart ContractEnd ContractType  \
       0         1829  FC Barcelona     2024-01-01  2031-12-31     Contract

          TotalContractYears
       0                 8.0
```

```
[618]: # Select rows where 'Team & Contract' column contains "Free"
       selectedrowscontainFree  = df[df['Team & Contract'].str.contains('Free')]
       selectedrowscontainFree.head(2)
```

```
[618]:                 Name  Age Overall rating Potential Team & Contract Value Wage  \
       4   M. Ruiz CMCAMCDM   22           *75*      *82*     Mexico Free     0    0
       48    I. Reyes CBCDM   23           *74*      *81*     Mexico Free     0    0

          Total stats
       4       *2013*
       48      *2061*
```

[618]:

```
```

[619]:

```
selectedrowscontainFreecopy=selectedrowscontainFree.copy()
```

[620]:

```
selectedrowscontainFreecopy['ContractType'] = selectedrowscontainFreecopy['Team␣
↪& Contract'].apply(
    lambda x: 'Free' if 'Free' in x else ('Loan' if 'On loan' in x else␣
↪'Contract' if '~' in x else 'No Contract')
)

selectedrowscontainFreecopy.head(2)
```

[620]:

```
                Name  Age Overall rating Potential Team & Contract Value Wage  \
4    M. Ruiz CMCAMCDM   22           *75*      *82*     Mexico Free     0    0
48     I. Reyes CBCDM   23           *74*      *81*     Mexico Free     0    0

   Total stats ContractType
4       *2013*         Free
48      *2061*         Free
```

[621]:

```
# Remove "*" from 'Overall rating', 'Potential', and 'Total stats'
columns_to_clean = ['Age','Overall rating', 'Potential', 'Total stats']
selectedrowscontainFreecopy[columns_to_clean] =␣
↪selectedrowscontainFreecopy[columns_to_clean].replace('\*', '', regex=True)
# Convert columns to numeric
selectedrowscontainFreecopy[columns_to_clean] =␣
↪selectedrowscontainFreecopy[columns_to_clean].apply(pd.to_numeric,␣
↪errors='coerce')
selectedrowscontainFreecopy.head(2)
```

[621]:

```
                Name  Age  Overall rating  Potential Team & Contract Value  \
4    M. Ruiz CMCAMCDM   22              75         82     Mexico Free     0
48     I. Reyes CBCDM   23              74         81     Mexico Free     0

   Wage  Total stats ContractType
4     0         2013         Free
48    0         2061         Free
```

[621]:

```
```

[622]:

```
# Function to convert currency values
def convert_currency(value):
    if isinstance(value, str):
        if 'M' in value:
            return float(value.replace('€', '').replace('M', '')) * 1e6
        elif 'K' in value:
            return float(value.replace('€', '').replace('K', '')) * 1e3
        else:
            return float(value.replace('€', ''))
    else:
        return float(value)

# Apply the conversion function to 'Value' and 'Wage' columns
selectedrowscontainFreecopy['Value'] = selectedrowscontainFreecopy['Value'].
 ↪apply(convert_currency)

# Convert 'Wage' only if it's not an integer
selectedrowscontainFreecopy['Wage'] = selectedrowscontainFreecopy['Wage'].
 ↪apply(lambda x: convert_currency(x) if isinstance(x, str) else x)
selectedrowscontainFreecopy.head(2)
```

[622]:

```
                Name  Age  Overall rating  Potential Team & Contract  Value  \
4   M. Ruiz CMCAMCDM   22              75         82      Mexico Free    0.0
48    I. Reyes CBCDM   23              74         81      Mexico Free    0.0

    Wage  Total stats ContractType
4      0         2013         Free
48     0         2061         Free
```

[622]:

```

```

[623]:

```
selectedrowscontainFreecopy['ContractStart'] = ''
selectedrowscontainFreecopy['ContractEnd'] = ''
selectedrowscontainFreecopy['TotalContractYears'] = ''
selectedrowscontainFreecopy.head(2)
```

[623]:

```
                Name  Age  Overall rating  Potential Team & Contract  Value  \
4   M. Ruiz CMCAMCDM   22              75         82      Mexico Free    0.0
48    I. Reyes CBCDM   23              74         81      Mexico Free    0.0

    Wage  Total stats ContractType ContractStart ContractEnd  \
4      0         2013         Free
48     0         2061         Free

   TotalContractYears
4
48
```

[624]:

```
selectedrowscontainFreecopy['Team'] = selectedrowscontainFreecopy['Team &␣
 ↪Contract'].apply(lambda x: 'Noteam' if 'Free' in x else x)
selectedrowscontainFreecopy.head(2)
```

[624]:

```
                Name  Age  Overall rating  Potential Team & Contract  Value  \
4   M. Ruiz CMCAMCDM   22              75         82      Mexico Free    0.0
```

```
48    I. Reyes CBCDM   23              74          81     Mexico Free    0.0

    Wage  Total stats ContractType ContractStart ContractEnd  \
4      0         2013         Free
48     0         2061         Free

   TotalContractYears    Team
4                      Noteam
48                     Noteam
```

[625]:

```
# Drop the 'Team & Contract' column from the DataFrame
selectedrowscontainFreecopy = selectedrowscontainFreecopy.drop(columns=['Team &␣
 ↪Contract'])
# Verify the changes
selectedrowscontainFreecopy.head(2)
```

[625]:

```
                Name  Age  Overall rating  Potential  Value  Wage  \
4   M. Ruiz CMCAMCDM   22              75          82    0.0     0
48    I. Reyes CBCDM   23              74          81    0.0     0

    Total stats ContractType ContractStart ContractEnd TotalContractYears  \
4          2013         Free
48         2061         Free

      Team
4   Noteam
48  Noteam
```

[626]:

```
# Define the desired column order
desired_column_order = [
    'Name', 'Age', 'Overall rating', 'Potential', 'Value', 'Wage', 'Total␣
 ↪stats',
    'Team', 'ContractStart', 'ContractEnd', 'ContractType', 'TotalContractYears'
]

# Reorder the columns in the DataFrame
selectedrowscontainFreecopy = selectedrowscontainFreecopy[desired_column_order]

# Verify the changes
selectedrowscontainFreecopy.head(1)
```

[626]:

```
               Name  Age  Overall rating  Potential  Value  Wage  Total stats  \
4  M. Ruiz CMCAMCDM   22              75          82    0.0     0         2013

     Team ContractStart ContractEnd ContractType TotalContractYears
4  Noteam                                   Free
```

[626]:

```

```

[627]:

```
### Select rows where 'Team & Contract' column contains "*On loan*"
selectedrowscontainOnloan  = df[df['Team & Contract'].str.contains('On loan')]
selectedrowscontainOnloan.head(2)
```

[627]:

```
                 Name  Age Overall rating Potential  \
41  X. Simons CAMLWLM   20           *82*      *89*
49     W. Weghorst ST   30           *77*      *77*

                          Team & Contract   Value  Wage Total stats
41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*
```

[628]:

```
selectedrowscontainOnloancopy=selectedrowscontainOnloan.copy()
```

[629]:

```
selectedrowscontainOnloancopy.head(2)
```

[629]:

```
                 Name  Age Overall rating Potential  \
41  X. Simons CAMLWLM   20           *82*      *89*
49     W. Weghorst ST   30           *77*      *77*

                          Team & Contract   Value  Wage Total stats
41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*
```

[629]:

```

```

[630]:

```
n = 23   # Number of characters to remove
selectedrowscontainOnloancopy['Team'] = selectedrowscontainOnloancopy['Team &␣
 ↪Contract'].apply(lambda x: x[:-n] if len(x) > n else '')
selectedrowscontainOnloancopy.head(2)
```

[630]:

```
                 Name  Age Overall rating Potential  \
41  X. Simons CAMLWLM   20           *82*      *89*
49     W. Weghorst ST   30           *77*      *77*

                          Team & Contract   Value  Wage Total stats  \
41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*

              Team
41      RB Leipzig
49  TSG Hoffenheim
```

[631]:

```
selectedrowscontainOnloancopy['ContractType'] =␣
 ↪selectedrowscontainOnloancopy['Team & Contract'].apply(
lambda x: 'Free' if 'Free' in x else ('Loan' if 'On loan' in x else 'Contract'␣
 ↪if '~' in x else 'No Contract'))
selectedrowscontainOnloancopy.head(2)
```

```
[631]:                   Name  Age Overall rating Potential  \
        41  X. Simons CAMLWLM   20           *82*      *89*
        49     W. Weghorst ST   30           *77*      *77*

                                 Team & Contract   Value  Wage Total stats  \
        41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
        49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*

                      Team ContractType
        41      RB Leipzig         Loan
        49  TSG Hoffenheim         Loan
```

```
[632]: selectedrowscontainOnloancopy['ContractEnd'] =␣
        ↪selectedrowscontainOnloancopy['Team & Contract'].str.
        ↪extract(r'(\b[A-Za-z]{3} \d{1,2}, \d{4}\b)', expand=False)

       # Convert 'ContractEnd' to datetime format
       selectedrowscontainOnloancopy['ContractEnd'] = pd.
        ↪to_datetime(selectedrowscontainOnloancopy['ContractEnd'], format='%b %d,␣
        ↪%Y', errors='coerce')
       selectedrowscontainOnloancopy.head(2)
```

```
[632]:                   Name  Age Overall rating Potential  \
        41  X. Simons CAMLWLM   20           *82*      *89*
        49     W. Weghorst ST   30           *77*      *77*

                                 Team & Contract   Value  Wage Total stats  \
        41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
        49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*

                      Team ContractType ContractEnd
        41      RB Leipzig         Loan  2024-06-30
        49  TSG Hoffenheim         Loan  2024-06-30
```

```
[633]: selectedrowscontainOnloancopy['ContractStart'] = pd.to_datetime('2023-06-01')
       selectedrowscontainOnloancopy.head(2)
```

```
[633]:                   Name  Age Overall rating Potential  \
        41  X. Simons CAMLWLM   20           *82*      *89*
        49     W. Weghorst ST   30           *77*      *77*

                                 Team & Contract   Value  Wage Total stats  \
        41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
```

```
49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*

              Team ContractType ContractEnd ContractStart
41      RB Leipzig          Loan  2024-06-30    2023-06-01
49  TSG Hoffenheim          Loan  2024-06-30    2023-06-01
```

[634]:

```python
# Calculate the total contract years
selectedrowscontainOnloancopy['TotalContractYears'] =␣
 ↪(selectedrowscontainOnloancopy['ContractEnd'] -␣
 ↪selectedrowscontainOnloancopy['ContractStart']).dt.days / 365
# Round the values to two decimal places
selectedrowscontainOnloancopy['TotalContractYears'] =␣
 ↪selectedrowscontainOnloancopy['TotalContractYears'].round(0)
selectedrowscontainOnloancopy.head(2)
```

[634]:

```
                 Name  Age Overall rating Potential  \
41  X. Simons CAMLWLM   20           *82*      *89*
49     W. Weghorst ST   30           *77*      *77*

                         Team & Contract   Value  Wage Total stats  \
41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K      *2139*
49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K      *1927*

              Team ContractType ContractEnd ContractStart  TotalContractYears
41      RB Leipzig          Loan  2024-06-30    2023-06-01                 1.0
49  TSG Hoffenheim          Loan  2024-06-30    2023-06-01                 1.0
```

[634]:

[635]:

```python
# Remove "*" from 'Overall rating', 'Potential', and 'Total stats'
columns_to_clean = ['Age','Overall rating', 'Potential', 'Total stats']
selectedrowscontainOnloancopy[columns_to_clean] =␣
 ↪selectedrowscontainOnloancopy[columns_to_clean].replace('\*', '', regex=True)
# Convert columns to numeric
selectedrowscontainOnloancopy[columns_to_clean] =␣
 ↪selectedrowscontainOnloancopy[columns_to_clean].apply(pd.to_numeric,␣
 ↪errors='coerce')
selectedrowscontainOnloancopy.head(2)
```

[635]:

```
                 Name  Age  Overall rating  Potential  \
41  X. Simons CAMLWLM   20              82         89
49     W. Weghorst ST   30              77         77

                         Team & Contract   Value  Wage  Total stats  \
41      RB Leipzig Jun 30, 2024 *On loan*  €60.5M  €71K         2139
49  TSG Hoffenheim Jun 30, 2024 *On loan*  €10.5M  €51K         1927
```

```
              Team ContractType ContractEnd ContractStart  TotalContractYears
41      RB Leipzig         Loan  2024-06-30    2023-06-01                 1.0
49  TSG Hoffenheim         Loan  2024-06-30    2023-06-01                 1.0
```

[635]:

```

```

[636]:

```
# Function to convert currency values
def convert_currency(value):
    if isinstance(value, str):
        if 'M' in value:
            return float(value.replace('€', '').replace('M', '')) * 1e6
        elif 'K' in value:
            return float(value.replace('€', '').replace('K', '')) * 1e3
        else:
            return float(value.replace('€', ''))
    else:
        return float(value)

# Apply the conversion function to 'Value' and 'Wage' columns
selectedrowscontainOnloancopy['Value'] = selectedrowscontainOnloancopy['Value'].
 ↪apply(convert_currency)

# Convert 'Wage' only if it's not an integer
selectedrowscontainOnloancopy['Wage'] = selectedrowscontainOnloancopy['Wage'].
 ↪apply(lambda x: convert_currency(x) if isinstance(x, str) else x)
selectedrowscontainOnloancopy.head(1)
```

[636]:

```
                 Name  Age  Overall rating  Potential  \
41  X. Simons CAMLWLM   20              82         89

                      Team & Contract       Value     Wage  Total stats  \
41  RB Leipzig Jun 30, 2024 *On loan*  60500000.0  71000.0         2139

          Team ContractType ContractEnd ContractStart  TotalContractYears
41  RB Leipzig         Loan  2024-06-30    2023-06-01                 1.0
```

[637]:

```
# Drop the 'Team & Contract' column from the DataFrame
selectedrowscontainOnloancopy = selectedrowscontainOnloancopy.
 ↪drop(columns=['Team & Contract'])
# Verify the changes
selectedrowscontainOnloancopy.head(2)
```

[637]:

```
                 Name  Age  Overall rating  Potential       Value     Wage  \
41  X. Simons CAMLWLM   20              82         89  60500000.0  71000.0
49     W. Weghorst ST   30              77         77  10500000.0  51000.0

    Total stats            Team ContractType ContractEnd ContractStart  \
41         2139      RB Leipzig         Loan  2024-06-30    2023-06-01
49         1927  TSG Hoffenheim         Loan  2024-06-30    2023-06-01

    TotalContractYears
41                 1.0
49                 1.0
```

[638]:

```
# Define the desired column order
Desired_Column_Order = [
    'Name', 'Age', 'Overall rating', 'Potential', 'Value', 'Wage', 'Total␣
 ↪stats',
    'Team', 'ContractStart', 'ContractEnd', 'ContractType', 'TotalContractYears'
]

# Reorder the columns in the DataFrame
selectedrowscontainOnloancopy =␣
 ↪selectedrowscontainOnloancopy[Desired_Column_Order]

# Verify the changes
selectedrowscontainOnloancopy.head(1)
```

[638]:

```
                 Name  Age  Overall rating  Potential       Value     Wage  \
41  X. Simons CAMLWLM   20              82         89  60500000.0  71000.0

    Total stats        Team ContractStart ContractEnd ContractType  \
41         2139  RB Leipzig    2023-06-01  2024-06-30         Loan

    TotalContractYears
41                 1.0
```

[639]:

```
# Combine the three DataFrames into one
combined_dataframe = pd.concat([
    selectedrowscontaintildecopy,
    selectedrowscontainOnloancopy,
    selectedrowscontainFreecopy
], axis=0, ignore_index=True)

# Verify the result
combined_dataframe.head(1)
#combined_dataframe
```

[639]:

```
                 Name  Age  Overall rating  Potential       Value     Wage  \
0  Vitor Roque STRWLW   18            76.0       88.0  17500000.0  44000.0

   Total stats            Team          ContractStart            ContractEnd  \
0         1829  FC Barcelona   2024-01-01 00:00:00  2031-12-31 00:00:00
```

```
  ContractType TotalContractYears
0     Contract                8.0
```

Exploratory Data Analysis(EDA)

[640]:
```
# Group by 'ContractType' and count occurrences
contract_type_counts = combined_dataframe['ContractType'].value_counts().
 ↪reset_index()

# Rename columns for clarity
contract_type_counts.columns = ['ContractType', 'Count']

# Print the result
contract_type_counts
```

[640]:
```
  ContractType  Count
0     Contract    873
1         Loan    117
2         Free     30
```

[641]:
```
# Set the quota for each subgroup
quota_per_group = 30

# Create a DataFrame to store the sampled data
sampled_data = pd.DataFrame()

# Define the groups based on 'ContractType'
groups = combined_dataframe['ContractType'].unique()

# Perform quota sampling for each group
for group in groups:
    # Select observations for the current group
    group_data = combined_dataframe[combined_dataframe['ContractType'] == group]

    # Check if there are enough observations to meet the quota
    if len(group_data) >= quota_per_group:
        # Sample the required number of observations
        sampled_group = group_data.sample(quota_per_group, random_state=42)
    else:
        # If there are not enough observations, include all of them
        sampled_group = group_data

    # Append the sampled group to the final sampled data
    sampled_data = pd.concat([sampled_data, sampled_group])
```

```python

# Display the sampled data
sampled_data.head(1)
#sampled_data
```

[641]:

```
                Name  Age  Overall rating  Potential       Value     Wage  \
795  J. Tarkowski CB   30            79.0       79.0  14500000.0  43000.0

     Total stats      Team        ContractStart          ContractEnd  \
795         1827  Everton   2022-01-01 00:00:00  2026-12-31 00:00:00

    ContractType TotalContractYears
795     Contract                5.0
```

[642]:

```python
# Define the conditions and corresponding categories
conditions = [
    (sampled_data['Age'] < 20),
    ((sampled_data['Age'] >= 20) & (sampled_data['Age'] < 30)),
    ((sampled_data['Age'] >= 30) & (sampled_data['Age'] < 40))
]
categories = ['Teenagers', 'Twenties', 'Thirties']

# Create the 'AgeCategory' column based on the conditions
sampled_data['AgeCategory'] = np.select(conditions, categories, default='Other')

# Display the DataFrame with the new column
sampled_data
```

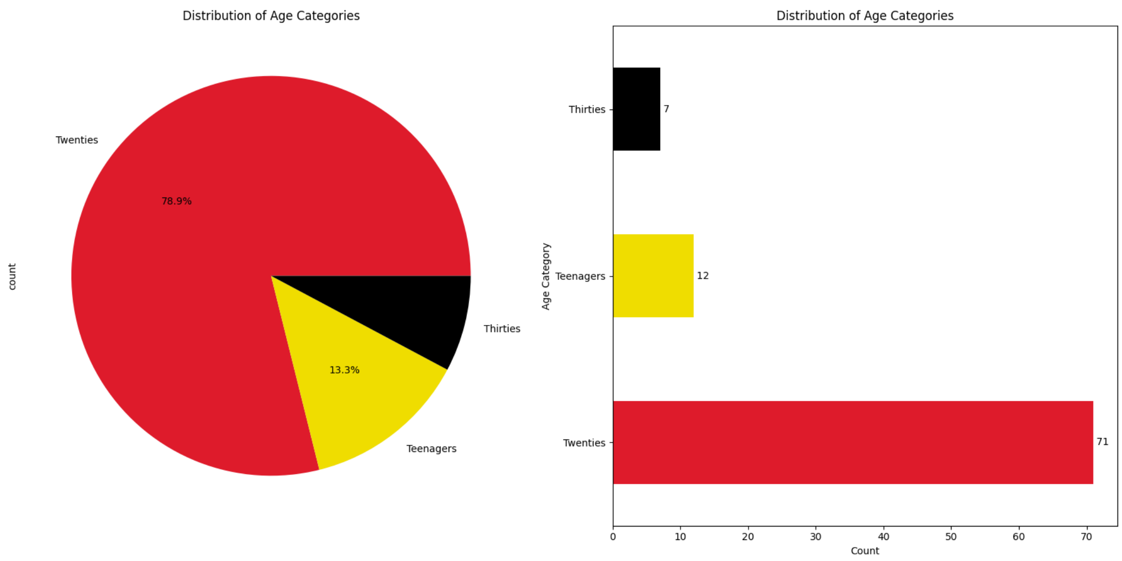
[642]:

```
                   Name  Age  Overall rating  Potential       Value     Wage  \
795     J. Tarkowski CB   30            79.0       79.0  14500000.0  43000.0
319     C. Uzun CFCAMST   17            68.0       84.0   3000000.0   1000.0
382   David Neres RMCAM   26            80.0       81.0  25000000.0  18000.0
737         J. Aidoo CB   27            78.0       80.0  15000000.0  24000.0
422        Parejo CMCDM   34            84.0       84.0  19500000.0  54000.0
…                 …  …              …        …         …      …
997   M. Stamenić CDMCM   21            71.0       83.0         0.0      0.0
1000         D. Zima CB   22            73.0       80.0         0.0      0.0
1004   U. Antuna RMLMRW   25            76.0       77.0         0.0      0.0
1009   S. Boufal CFLMST   29            76.0       76.0         0.0      0.0
996    E. Sánchez CMCDM   23            76.0       81.0         0.0      0.0

      Total stats            Team        ContractStart          ContractEnd   \
795          1827         Everton   2022-01-01 00:00:00  2026-12-31 00:00:00
319          1672        Nürnberg   2023-01-01 00:00:00  2026-12-31 00:00:00
382          1990         Benfica   2022-01-01 00:00:00  2027-12-31 00:00:00
737          1628  Celta de Vigo   2019-01-01 00:00:00  2026-12-31 00:00:00
422          2170      Villarreal   2020-01-01 00:00:00  2024-12-31 00:00:00
```

```
…           …             …                  …                   …
997          1905          Noteam
1000         1713          Noteam
1004         1788          Noteam
1009         1873          Noteam
996          2094          Noteam

     ContractType TotalContractYears  AgeCategory
795      Contract                5.0     Thirties
319      Contract                4.0    Teenagers
382      Contract                6.0     Twenties
737      Contract                8.0     Twenties
422      Contract                5.0     Thirties
…           …                …         …
997          Free                        Twenties
1000         Free                        Twenties
1004         Free                        Twenties
1009         Free                        Twenties
996          Free                        Twenties

[90 rows x 13 columns]
```

[643]:

```python
# Calculate the value counts of 'AgeCategory' column
age_category_counts = sampled_data['AgeCategory'].value_counts()
# Create a figure with subplots
plt.figure(figsize=(16, 8))
# Plot the pie chart
plt.subplot(1, 2, 1)
age_category_counts.plot(kind='pie', autopct='%1.1f%%', colors=['#DE1B2B',␣
 ↪'#EFDD00', '#000000'])
plt.title('Distribution of Age Categories')
# Plot the horizontal bar chart
plt.subplot(1, 2, 2)
age_category_counts_sorted = age_category_counts.sort_values(ascending=False)
age_category_counts_sorted.plot(kind='barh', color=['#DE1B2B', '#EFDD00',␣
 ↪'#000000'])
plt.title('Distribution of Age Categories')
plt.xlabel('Count')
plt.ylabel('Age Category')
# Add value labels on the bars
for index, value in enumerate(age_category_counts_sorted):
    plt.text(value, index, f' {value} ', ha='left', va='center')
# Show the plots
plt.tight_layout()
plt.show()
```



[644]:
```
# Select rows where Age is greater than or equal to 37
selected_data30 = sampled_data[sampled_data['Age'] >= 37]

# Display the selected data
selected_data30
```

[644]:
```
                     Name  Age  Overall rating  Potential      Value     Wage  \
465  *22* Iniesta CAMCM   37            79.0       79.0  5500000.0  10000.0

     Total stats          Team         ContractStart           ContractEnd  \
465         1918  Vissel Kobe   2018-01-01 00:00:00  2024-12-31 00:00:00

    ContractType TotalContractYears AgeCategory
465     Contract                7.0    Thirties
```

[645]:
```
# Select rows where Age is between 30 and 40
selected_data3040 = sampled_data[(sampled_data['Age'] >= 30) &␣
 ↪(sampled_data['Age'] <= 40)]
# Display the selected data
selected_data3040.head(1)
```

[645]:
```
                  Name  Age  Overall rating  Potential       Value     Wage  \
795  J. Tarkowski CB   30            79.0       79.0  14500000.0  43000.0

     Total stats      Team         ContractStart           ContractEnd  \
795         1827  Everton   2022-01-01 00:00:00  2026-12-31 00:00:00

    ContractType TotalContractYears AgeCategory
```

```
795     Contract                  5.0    Thirties
```

[646]:

```
# Select rows where 'ContractType' is 'Loan', 'Contract', or 'Free'
selected_rows = sampled_data[sampled_data['ContractType'].isin(['Loan',␣
 ↪'Contract', 'Free'])]

# Create a new column based on 'ContractType'
selected_rows['ContractOrLoan'] = np.where(selected_rows['ContractType'].
 ↪isin(['Loan', 'Contract']), 'Yes', 'No')

# Display the resulting DataFrame
selected_rows.head(1)
```

[646]:

```
                  Name  Age  Overall rating  Potential       Value     Wage  \
795  J. Tarkowski CB   30            79.0       79.0  14500000.0  43000.0

     Total stats      Team         ContractStart          ContractEnd  \
795         1827   Everton   2022-01-01 00:00:00  2026-12-31 00:00:00

    ContractType TotalContractYears AgeCategory ContractOrLoan
795     Contract                  5.0    Thirties            Yes
```

[647]:

```
#####Round the values in the specified columns to the nearest whole number######
columns_to_round = ['Age', 'Overall rating', 'Potential', 'Value', 'Wage',␣
 ↪'Total stats', 'TotalContractYears']
# Convert selected columns to numeric, coerce non-numeric values to NaN
selected_rows[columns_to_round] = selected_rows[columns_to_round].apply(pd.
 ↪to_numeric, errors='coerce')
# Round the values in the specified columns to the nearest whole number
selected_rows[columns_to_round] = selected_rows[columns_to_round].round().
 ↪astype('Int64')
```

[648]:

```
selected_rows.head(1)
#selected_rows
```

[648]:

```
                  Name  Age  Overall rating  Potential     Value   Wage  \
795  J. Tarkowski CB   30              79         79  14500000  43000

     Total stats      Team         ContractStart          ContractEnd  \
795         1827   Everton   2022-01-01 00:00:00  2026-12-31 00:00:00

    ContractType  TotalContractYears AgeCategory ContractOrLoan
795     Contract                     5    Thirties            Yes
```

[649]:

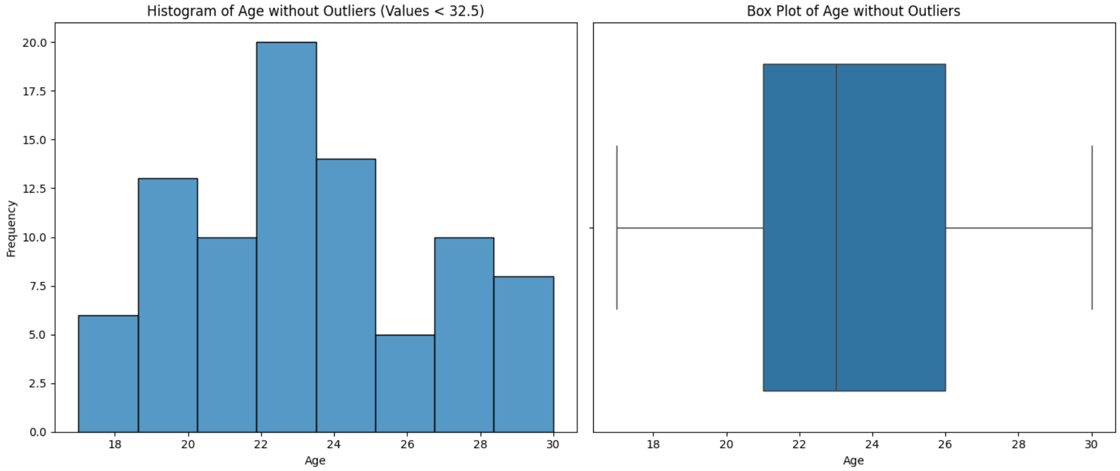
```
Samplepop =selected_rows.copy()
```

[650]:

```
# Name         , Team , ContractStart ,         ContractEnd
```

[651]:

```
# Filter the data to remove values equal to or greater than 32.5
filtered_data = Samplepop[Samplepop['Age'] < 32.5]['Age']

# Create a figure with subplots
fig, axes = plt.subplots(1, 2, figsize=(14, 6))

# Plot histogram
sns.histplot(filtered_data, ax=axes[0])
axes[0].set_title('Histogram of Age without Outliers (Values < 32.5)')
axes[0].set_xlabel('Age')
axes[0].set_ylabel('Frequency')

# Plot box plot
sns.boxplot(x=Samplepop['Age'], showfliers=False, ax=axes[1])
axes[1].set_title('Box Plot of Age without Outliers')
axes[1].set_xlabel('Age')

# Adjust layout
plt.tight_layout()
plt.show()
```



[651]:

Bimodal distribution with two noticeable peaks around ages 18-20 and 22-24.

Highest frequency appearing around age 23.

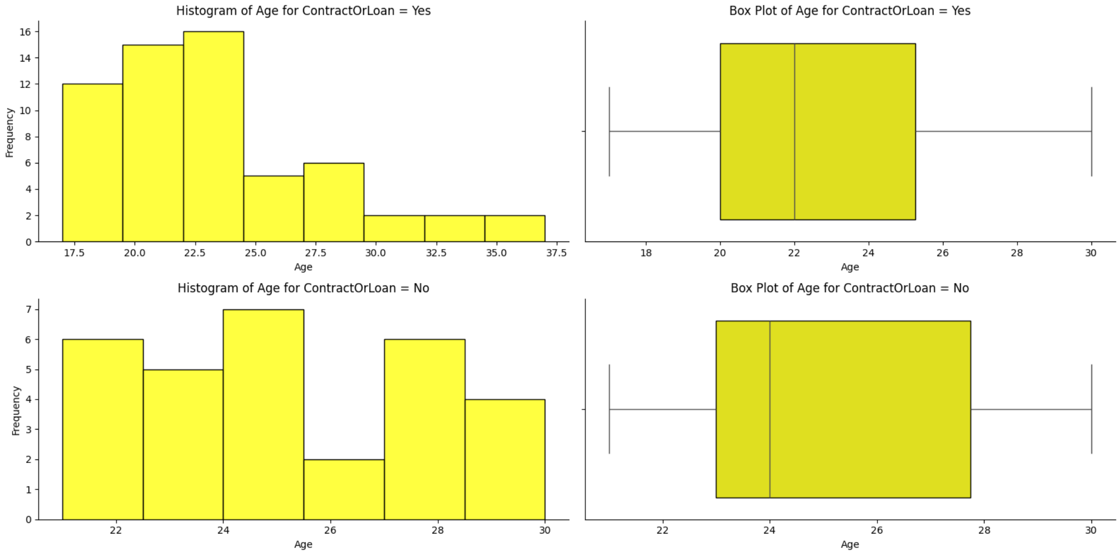
Interpretation: Typically, players make the transition between the ages of 18 and 20, moving from youth training to the competitive world of professional football. Professional clubs first invest heavily in players aged 22 to 24, followed by those aged 20 or younger, and finally in footballers aged 26 to 30. In conclusion, the majority of professional footballers are active between the ages of 18 and 30; after 30, most of them retire.

[651]:

```
```

[652]:

```
import seaborn as sns
import matplotlib.pyplot as plt

# Create a figure with subplots
fig, axes = plt.subplots(2, 2, figsize=(16, 8))

# Iterate over each category and plot histograms and box plots
categories = ['Yes', 'No']
for i, category in enumerate(categories):
    # Filter the data for the current category
    filtered_data_hist = Samplepop[Samplepop['ContractOrLoan'] ==␣
 ↪category]['Age']
    filtered_data_box = Samplepop[Samplepop['ContractOrLoan'] ==␣
 ↪category]['Age']

    # Plot histogram without trend line
    sns.histplot(filtered_data_hist, ax=axes[i, 0], kde=False, color='yellow',␣
 ↪edgecolor='black')
    axes[i, 0].set_title(f'Histogram of Age for ContractOrLoan = {category}')
    axes[i, 0].set_xlabel('Age')
    axes[i, 0].set_ylabel('Frequency')

    # Plot box plot
    sns.boxplot(x=filtered_data_box, ax=axes[i, 1], showfliers=False,␣
 ↪color='yellow',
                boxprops=dict(edgecolor='black'))
    axes[i, 1].set_title(f'Box Plot of Age for ContractOrLoan = {category}')
    axes[i, 1].set_xlabel('Age')

    # Remove outline
    axes[i, 0].spines['top'].set_visible(False)
    axes[i, 0].spines['right'].set_visible(False)
    axes[i, 1].spines['top'].set_visible(False)
    axes[i, 1].spines['right'].set_visible(False)

# Adjust layout
plt.tight_layout()
plt.show()
```

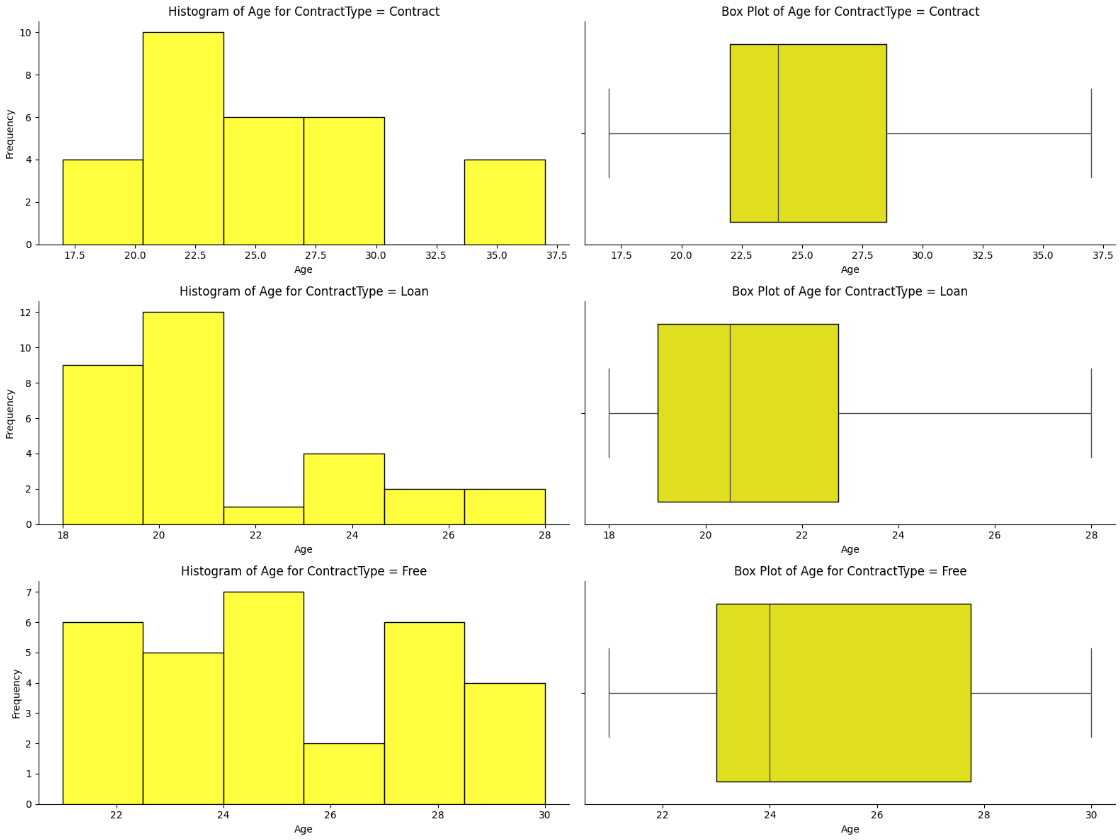


[652]:

```
```

[653]:

```
import seaborn as sns
import matplotlib.pyplot as plt

# Create a figure with subplots
fig, axes = plt.subplots(3, 2, figsize=(16, 12))

# Iterate over each category and plot histograms and box plots
categories = ['Contract', 'Loan', 'Free']
for i, category in enumerate(categories):
    # Filter the data for the current category
    filtered_data_hist = Samplepop[Samplepop['ContractType'] == category]['Age']
    filtered_data_box = Samplepop[Samplepop['ContractType'] == category]['Age']

    # Plot histogram without trend line
    sns.histplot(filtered_data_hist, ax=axes[i, 0], kde=False, color='yellow',␣
 ↪edgecolor='black')
    axes[i, 0].set_title(f'Histogram of Age for ContractType = {category}')
    axes[i, 0].set_xlabel('Age')
    axes[i, 0].set_ylabel('Frequency')

    # Plot box plot
    sns.boxplot(x=filtered_data_box, ax=axes[i, 1], showfliers=False,␣
 ↪color='yellow',
                boxprops=dict(edgecolor='black'))
    axes[i, 1].set_title(f'Box Plot of Age for ContractType = {category}')
    axes[i, 1].set_xlabel('Age')
    # Remove outline
    axes[i, 0].spines['top'].set_visible(False)
    axes[i, 0].spines['right'].set_visible(False)
    axes[i, 1].spines['top'].set_visible(False)
    axes[i, 1].spines['right'].set_visible(False)

# Remove extra subplots if the number of categories is less than the number of␣
 ↪rows
if len(categories) < axes.shape[0]:
    for j in range(len(categories), axes.shape[0]):
        for k in range(2):
            axes[j, k].remove()

# Adjust layout
plt.tight_layout()
plt.show()
```



[653]:

[654]:

```
import pandas as pd

# Select subset of data based on category
categories = ['Contract', 'Loan', 'Free']

# Create an empty DataFrame to store the descriptive statistics
stats_df = pd.DataFrame()

# Iterate over each category and append descriptive statistics to DataFrame
for category in categories:
    # Filter data for the current category
    category_data = Samplepop[Samplepop['ContractType'] == category]['Age']

    # Calculate descriptive statistics
    stats = category_data.describe()

    # Convert to DataFrame and transpose for better display
    stats_df = stats.to_frame().T

    # Rename the index to the category name
    stats_df.index = [category]

    # Print the descriptive statistics DataFrame
    print(f"Descriptive statistics for '{category}':")
stats_df
```

```
Descriptive statistics for 'Contract':
Descriptive statistics for 'Loan':
Descriptive statistics for 'Free':
```

[654]:

```
      count  mean       std   min   25%   50%    75%   max
Free   30.0  25.0  2.703765  21.0  23.0  24.0  27.75  30.0
```

[654]:

In our analysis, we've observed varying standard deviations among different player categories:

For players under contract: standard deviation (std) = 5.292046. For players on loan: std = 2.683282. For free players: std = 2.703765. Comparing these values, it's evident that the standard deviations for players on loan and free players are relatively smaller compared to those for players under contract. This indicates that the ages of players on loan and free players exhibit less variability around the mean compared to players under contract.

To reduce the standard deviation for players under contract ('Contract': std = 5.292046), we can employ an outlier removal strategy. By analyzing the age histogram of players under contract, we've determined that removing age values equal to or greater than 32.5 would be an effective approach.

Here's the rewritten text:

”In our analysis, we’ve noted different standard deviations among player categories:

For contracted players: the standard deviation (std) is 5.292046. For players on loan: std is 2.683282. For free players: std is 2.703765. Comparing these values, we see that players on loan and free players have smaller standard deviations than contracted players, indicating less age variability around the mean.

To decrease the standard deviation for contracted players (5.292046), we propose an outlier removal strategy. Analyzing the age histogram of contracted players, we suggest removing age values equal to or greater than 32.5.”

[655]:
```
# Select subset of data based on category
categories = ['Contract', 'Loan', 'Free']

# Create an empty DataFrame to store the descriptive statistics
stats_df = pd.DataFrame()

# Iterate over each category and append descriptive statistics to DataFrame
for category in categories:
    # Filter data for the current category and remove values equal to or␣
 ↪greater than 32.5
    filtered_data = Samplepop[(Samplepop['ContractType'] == category) &␣
 ↪(Samplepop['Age'] < 32.5)]['Age']

    # Calculate descriptive statistics for the filtered data
    stats = filtered_data.describe()

    # Convert to DataFrame and transpose for better display
    stats_df = stats.to_frame().T

    # Rename the index to the category name
    stats_df.index = [category]

    # Print the descriptive statistics DataFrame
    print(f"Descriptive statistics for '{category}' after removing outliers:")
    display(stats_df)
```

```
Descriptive statistics for 'Contract' after removing outliers:

          count       mean     std   min   25%   50%   75%   max
Contract   26.0  23.615385  3.6669  17.0  22.0  23.0  26.0  30.0

Descriptive statistics for 'Loan' after removing outliers:

      count  mean       std   min   25%   50%    75%   max
Loan   30.0  21.2  2.683282  18.0  19.0  20.5  22.75  28.0

Descriptive statistics for 'Free' after removing outliers:

      count  mean       std   min   25%   50%    75%   max
Free   30.0  25.0  2.703765  21.0  23.0  24.0  27.75  30.0
```

```
[656]: categories = ['Contract', 'Loan', 'Free']

       # Create an empty DataFrame to store the filtered data
       dfFeatureEngwithfreecate = pd.DataFrame()

       # Iterate over each category and filter data, then remove specified columns
       for category in categories:
           # Filter data for the current category and remove age values equal to or␣
        ↪greater than 32.5
           filtered_data = Samplepop[(Samplepop['ContractType'] == category) &␣
        ↪(Samplepop['Age'] < 32.5)]

           # Remove specified columns
           filtered_data = filtered_data.drop(columns=['Name', 'Team',␣
        ↪'ContractStart', 'ContractEnd'])

           # Append filtered data to dfFeatureEngwithfreecate
           dfFeatureEngwithfreecate = pd.concat([dfFeatureEngwithfreecate,␣
        ↪filtered_data])

       # Print the resulting DataFrame
           dfFeatureEngwithfreecate.head(1)
           #dfFeatureEngwithfreecate
```

```
[657]: #dfFeatureEng_numeric1 = dfFeatureEngwithfreecate.
        ↪select_dtypes(include=['int64', 'float64'])
       dfFeatureEng_numeric1 = dfFeatureEngwithfreecate.
        ↪select_dtypes(include=['int64', 'float64'])
       dfFeatureEng_numeric1.head(1)
```

```
[657]:      Age  Overall rating  Potential     Value   Wage  Total stats  \
       795   30              79         79  14500000  43000         1827

            TotalContractYears
       795                   5
```

```
[658]: # Calculate the correlation matrix for the specified columns
       correlation_matrix1 = dfFeatureEng_numeric1[['Age', 'Overall rating',␣
        ↪'Potential', 'Wage', 'Total stats', 'Value']].corr()
       # Display the correlation matrix
       correlation_matrix1
```

```
[658]:                      Age  Overall rating  Potential      Wage  Total stats  \
       Age             1.000000        0.593999  -0.498863  0.168267     0.316196
       Overall rating  0.593999        1.000000   0.284265  0.554545     0.569804
       Potential      -0.498863        0.284265   1.000000  0.465725     0.175169
```

```
Wage            0.168267        0.554545   0.465725  1.000000     0.356842
Total stats     0.316196        0.569804   0.175169  0.356842     1.000000
Value           0.134061        0.717715   0.599920  0.789410     0.430659

                   Value
Age             0.134061
Overall rating  0.717715
Potential       0.599920
Wage            0.789410
Total stats     0.430659
Value           1.000000
```

[659]:

```
categories = ['Contract', 'Loan']

# Create an empty DataFrame to store the filtered data
dfFeatureEngwithoutfreecate  = pd.DataFrame()

# Iterate over each category and filter data, then remove specified columns
for category in categories:
    # Filter data for the current category and remove age values equal to or␣
 ↪greater than 32.5
    filtered_data = Samplepop[(Samplepop['ContractType'] == category) &␣
 ↪(Samplepop['Age'] < 32.5)]

    # Remove specified columns
    filtered_data = filtered_data.drop(columns=['Name', 'Team',␣
 ↪'ContractStart', 'ContractEnd'])

    # Append filtered data to dfFeatureEngwithoutfreecate
dfFeatureEngwithoutfreecate = pd.concat([dfFeatureEngwithoutfreecate,␣
 ↪filtered_data])

# Print the resulting DataFrame
dfFeatureEngwithoutfreecate.head(1)
```

[659]:

```
     Age  Overall rating  Potential    Value  Wage  Total stats ContractType  \
917   18              66         82  2200000  6000         1570         Loan

     TotalContractYears AgeCategory ContractOrLoan
917                   1   Teenagers            Yes
```

[660]:

```
#dfFeatureEng_numeric = dfFeatureEngwithoutfreecate.
 ↪select_dtypes(include=['int64', 'float64'])
dfFeatureEng_numeric = dfFeatureEngwithoutfreecate.
 ↪select_dtypes(include=['int64', 'float64'])
dfFeatureEng_numeric.head(1)
```

```
[660]:      Age  Overall rating  Potential    Value  Wage  Total stats  \
       917   18              66         82  2200000  6000         1570

            TotalContractYears
       917                   1
```

```
[661]: # Calculate the correlation matrix for the specified columns
       correlation_matrix = dfFeatureEng_numeric[['Age', 'Overall rating',␣
        ↪'Potential', 'Wage', 'Total stats', 'Value']].corr()

       # Display the correlation matrix
       correlation_matrix
```

```
[661]:                       Age  Overall rating  Potential      Wage  Total stats  \
       Age             1.000000        0.558063  -0.602628  0.614210     0.257457
       Overall rating  0.558063        1.000000   0.209162  0.601547     0.536613
       Potential      -0.602628        0.209162   1.000000 -0.138895     0.078803
       Wage            0.614210        0.601547  -0.138895  1.000000     0.451289
       Total stats     0.257457        0.536613   0.078803  0.451289     1.000000
       Value           0.173457        0.786826   0.485363  0.372710     0.517881

                          Value
       Age             0.173457
       Overall rating  0.786826
       Potential       0.485363
       Wage            0.372710
       Total stats     0.517881
       Value           1.000000
```

```
[661]:
```

Multiple Linear Regression:

```
[662]: import statsmodels.api as sm
       import numpy as np

       # Convert data types to float
       X = dfFeatureEngwithoutfreecate[['Overall rating', 'Total stats']].
        ↪astype(float)  # Independent variables
       y = dfFeatureEngwithoutfreecate['Value'].astype(float)  # Dependent variable

       # Print shapes of X and y
       print("Shape of X:", X.shape)
       print("Shape of y:", y.shape)

       # Add a constant term to the independent variables matrix
       X = sm.add_constant(X)
```

```
# Fit the multiple linear regression model
model = sm.OLS(y, X).fit()

# Extract coefficients from the model
coefficients = model.params

# Extract the coefficients
slope_x1 = coefficients['Overall rating']
slope_x2 = coefficients['Total stats']
intercept = coefficients['const']

# Print the regression equation
print(f"Regression Equation: y = {slope_x1:.2f}x1 + {slope_x2:.2f}x2 +␣
 ↪{intercept:.2f}")

# Given value of y
y_given = 2200000

# Calculate x1 and x2
x1 = (y_given - intercept) / slope_x1
x2 = (y_given - intercept) / slope_x2

# Print the results
print(f"x1 = {x1:.2f}")
print(f"x2 = {x2:.2f}")
```

```
Shape of X: (30, 2)
Shape of y: (30,)
Regression Equation: y = 1885327.74x1 + 9728.43x2 + -144492515.81
x1 = 77.81
x2 = 15078.74
```

Simple Linear Regression:

[663]:

```
import numpy as np
import statsmodels.api as sm

# Define independent variable
X = dfFeatureEngwithoutfreecate[['Overall rating']]  # Independent variable
# Define dependent variable
y = dfFeatureEngwithoutfreecate['Value']  # Dependent variable

# Print shapes of X and y
print("Shape of X:", X.shape)
print("Shape of y:", y.shape)

# Add a constant term to the independent variables matrix
```

```
X = sm.add_constant(X)

# Fit the simple linear regression model
model = sm.OLS(y.astype(float), X.astype(float)).fit()

# Extract coefficients from the model
coefficients = model.params

# Extract the slope (a) and intercept (b)
slope_x1 = coefficients['Overall rating']
intercept = coefficients['const']

# Print the regression equation
print(f"Regression Equation: y = {slope_x1:.2f}x + {intercept:.2f}")

# Given value of y
y = 2200000

# Calculate x (Overall rating)
x = (y - intercept) / slope_x1

# Print the result
print(f"Overall rating (x) = {x:.2f}")
```

```
Shape of X: (30, 1)
Shape of y: (30,)
Regression Equation: y = 2075489.53x + -140674885.82
Overall rating (x) = 68.84
```

Hypothesis testing

[664]:

```
dfFeatureEngwithfreecate.head(1)
# dfFeatureEngwithfreecate['ContractType'],␣
 ↪dfFeatureEngwithfreecate['AgeCategory'],␣
 ↪dfFeatureEngwithfreecate['ContractOrLoan'],
```

[664]:

```
     Age  Overall rating  Potential     Value   Wage  Total stats  \
795   30              79         79  14500000  43000         1827

    ContractType  TotalContractYears AgeCategory ContractOrLoan
795     Contract                   5    Thirties            Yes
```

[665]:

```
dfFeatureEngwithfreecate2=dfFeatureEngwithfreecate.copy()
```

[666]:

```
# Create a new column OldorYoung
dfFeatureEngwithfreecate2['OldorYoung'] =␣
 ↪dfFeatureEngwithfreecate2['AgeCategory'].apply(lambda x: 'Old' if x ==␣
 ↪'Thirties' else 'Young')
```

```
dfFeatureEngwithfreecate2.head(2)
```

```
[666]:      Age  Overall rating  Potential     Value   Wage  Total stats  \
       795   30              79         79  14500000  43000         1827
       319   17              68         84   3000000   1000         1672

          ContractType  TotalContractYears AgeCategory ContractOrLoan OldorYoung
       795     Contract                   5    Thirties            Yes        Old
       319     Contract                   4   Teenagers            Yes      Young
```

```
[666]:
```

Bivariate Analysis

Crosstabulation: Cross tabulation is usually performed on categorical data — data that can be divided into mutually exclusive groups.

```
[667]: crosstab_result = pd.crosstab(index=dfFeatureEngwithfreecate['ContractType'],
                                     columns=dfFeatureEngwithfreecate['AgeCategory'],
                                    ␣
         ↪values=dfFeatureEngwithfreecate['ContractOrLoan'],
                                     aggfunc='count',
                                     normalize='index').round(4) * 100

       crosstab_result
```

```
[667]: AgeCategory   Teenagers  Thirties  Twenties
       ContractType
       Contract          11.54      7.69     80.77
       Free               0.00      3.33     96.67
       Loan              30.00      0.00     70.00
```

This crosstab performs a bivariate analysis, specifically analyzing the relationship between two categorical variables: ContractType and AgeCategory, with respect to the target variable ContractOrLoan. By creating a crosstabulation, I'm examining how the distribution of ContractOrLoan varies across different levels of ContractType and AgeCategory, which helps in understanding any potential associations or patterns between these variables. This type of analysis is commonly used to explore relationships between categorical variables and is fundamental in descriptive statistics and exploratory data analysis.

```
[668]: crosstab = pd.crosstab(dfFeatureEngwithfreecate['AgeCategory'],
                              dfFeatureEngwithfreecate['ContractOrLoan'],
                              normalize='index', margins=True).round(4) * 100

       crosstab
```

```
[668]: ContractOrLoan     No     Yes
       AgeCategory
```

```
Teenagers        0.00  100.00
Thirties        33.33   66.67
Twenties        40.85   59.15
All             34.88   65.12
```

[669]:

```
crosstabagecontloan = pd.crosstab(dfFeatureEngwithfreecate2['OldorYoung'],
                          dfFeatureEngwithfreecate['ContractOrLoan'],
                          normalize='index', margins=True).round(4) * 100

crosstabagecontloan
```

[669]:

```
ContractOrLoan     No    Yes
OldorYoung
Old             33.33  66.67
Young           34.94  65.06
All             34.88  65.12
```

This analysis aids in identifying any patterns or trends in the distribution of ContractOrLoan across different age categories, providing insights into potential relationships between these variables.

Pivot tables: Pivot tables can analyze the relationships between multiple variables, both categorical and numerical.

PivotTable Conditional Average

[670]:

```
# Creating the PivotTable
pivot_table = pd.pivot_table(dfFeatureEngwithfreecate, values='Age',␣
  ↪index='ContractOrLoan', aggfunc='mean').round()
pivot_table
```

[670]:

```
                 Age
ContractOrLoan
No              25.0
Yes             22.0
```

Interpretation of results: For soccer players who do not have a contract or *** loan (ContractOrLoan = 'No'), the average age is 25.0 years. For soccer players who have a contract or loan (ContractOrLoan = 'Yes'), the average age is 22.0 years. The interpretation of the PivotTable suggests that as the age of soccer players increases, their likelihood of being signed to a regular contract or loan contract decreases. This implies that younger soccer players are more likely to secure regular contracts or loan contracts compared to older players.

Compare Dependency of Categorical Variables with Chi-Square Test

[671]:

```
from scipy.stats import chi2_contingency

chi2_statistic, p_value, dof, expected = chi2_contingency(crosstabagecontloan)

# Print the chi-square statistic and p-value
```

```
print("Chi-square Statistic:", chi2_statistic)
print("P-value:", p_value)
```

```
Chi-square Statistic: 0.07384655389766431
P-value: 0.963750074358872
```

Interpretation of results: Null Hypothesis (H0): There is no association between age category (Old or Young) and having a contract or loan.

Alternative Hypothesis (H1): There is an association between age category (Old or Young) and having a contract or loan.

P-value Interpretation: The p-value obtained from the chi-square test is approximately 0.9638. This p-value represents the probability of observing the data (or data more extreme) if the null hypothesis were true. Since the p-value (0.9638) is greater than the significance level (5%), we fail to reject the null hypothesis.

Shapiro-Wilk test

The ***Shapiro-Wilk*** test checks if a dataset follows a normal distribution. It looks at a sample of data and assumes the data is normally distributed. If the p-value is **high**, it means the data is likely **normally distributed**. A **low p-value** suggests it's **not normally distributed**. The ***Shapiro-Wilk*** test is typically used for *numerical data*, not categorical data. It evaluates whether a given numerical dataset follows a normal distribution.

[672]:

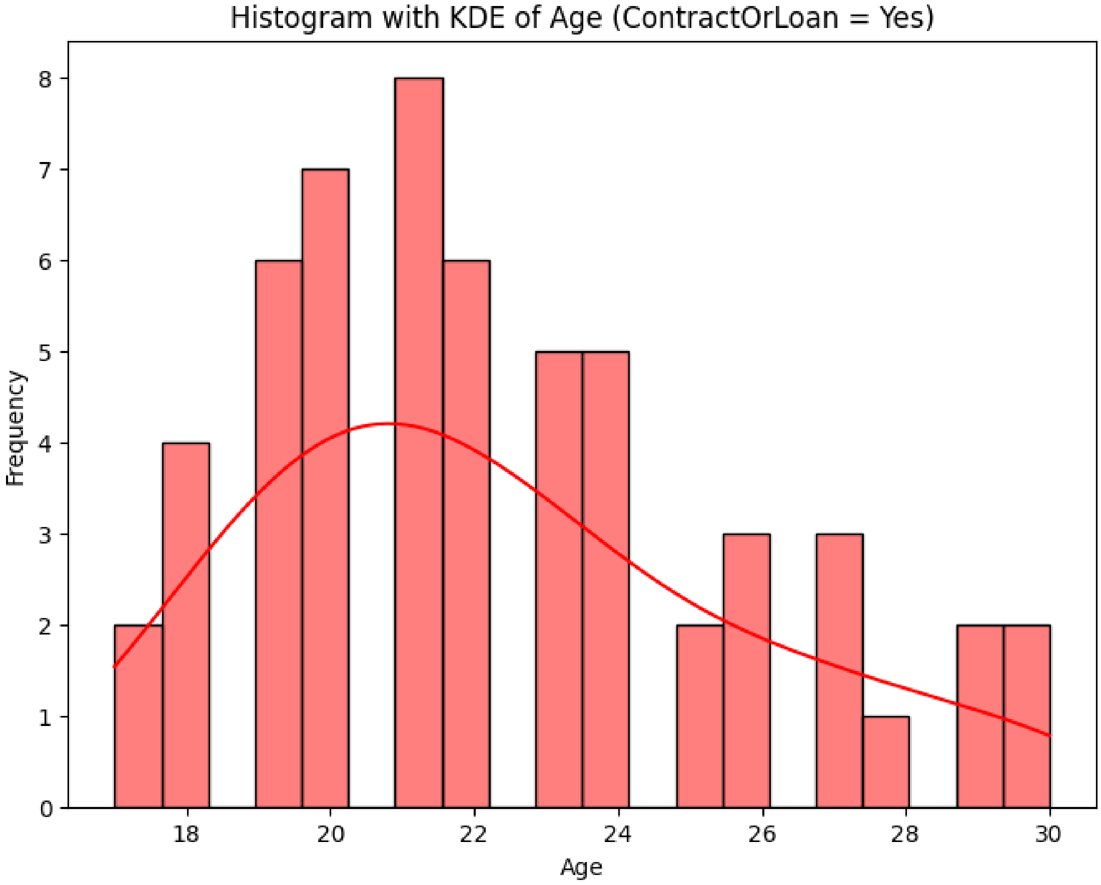
```
from scipy.stats import shapiro

# Filter the data where 'ContractOrLoan' is 'Yes'
subset_data =␣
 ↪dfFeatureEngwithfreecate2[dfFeatureEngwithfreecate2['ContractOrLoan'] ==␣
 ↪'Yes']

# Extract the 'age' column from the subset
age_data = subset_data['Age']

# Perform the Shapiro-Wilk test
statistic, p_value = shapiro(age_data)

# Output the results
print("Shapiro-Wilk Test Results:")
print("Statistic:", statistic)
print("p-value:", p_value)
if p_value > 0.05:
    print("The data is likely normally distributed.")
else:
    print("The data is not likely normally distributed.")
```

```
Shapiro-Wilk Test Results:
Statistic: 0.9470644593238831
p-value: 0.01574835740029812
```

```
The data is not likely normally distributed.
```

[673]:

```python
# Set up the plot
plt.figure(figsize=(8, 6))
# Plot the histogram
sns.histplot(age_data, bins=20, color='red', edgecolor='black', kde=True)
# Add labels and title
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.title('Histogram with KDE of Age (ContractOrLoan = Yes)')
# Show the plot
plt.show()
```



Interpretation of results: The p-value (0.0157) being less than the significance level (0.05) leads us to reject the null hypothesis, indicating that the data likely ***isn't normally distributed***. By observing the histogram, we determine the skewness. A left-skewed histogram suggests more data points on the right side, meaning more younger players compared to older ones. Thus, the distribution of age for players with a contract or loan is left skewed.

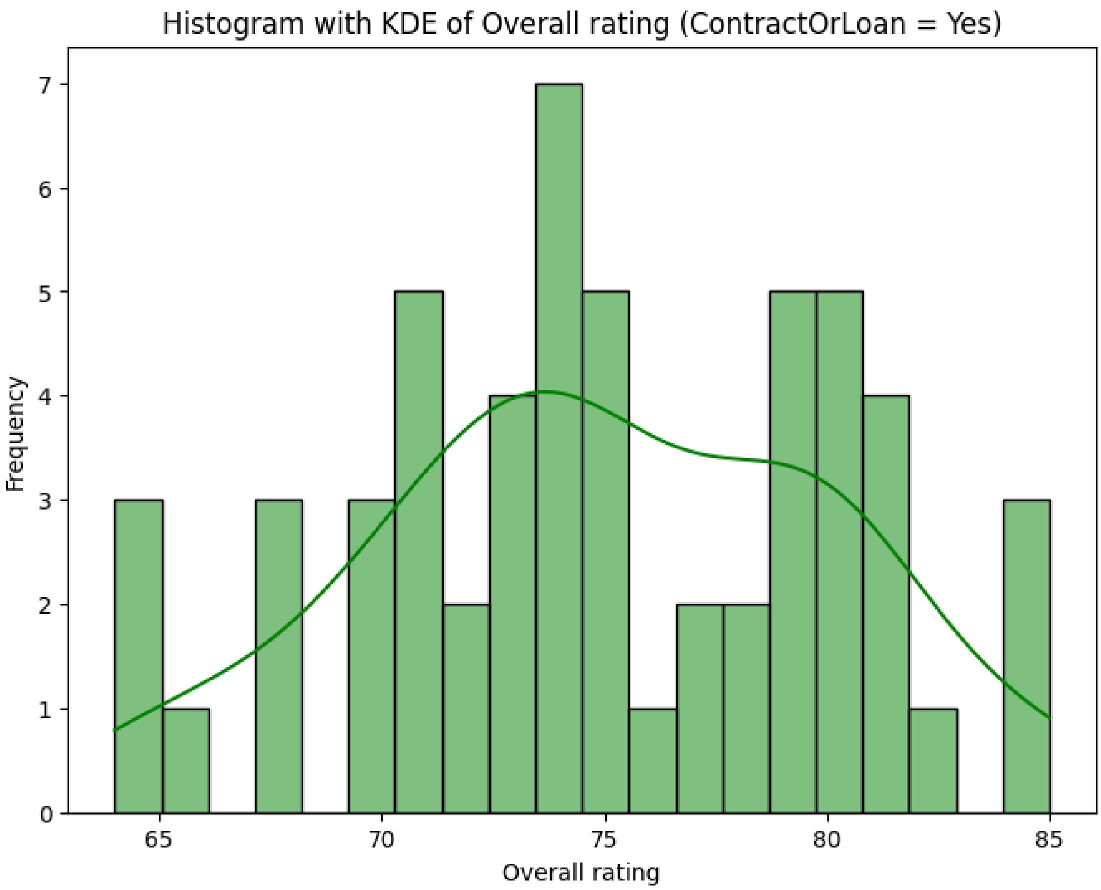
[674]:

```
# Filter the data where 'ContractOrLoan' is 'Yes'
subset_data =␣
 ↪dfFeatureEngwithfreecate2[dfFeatureEngwithfreecate2['ContractOrLoan'] ==␣
 ↪'Yes']

# Extract the 'Overall rating' column from the subset
Overall_rating_data = subset_data['Overall rating']

# Perform the Shapiro-Wilk test
statistic, p_value = shapiro(Overall_rating_data)

# Output the results
print("Shapiro-Wilk Test Results:")
print("Statistic:", statistic)
print("p-value:", p_value)
if p_value > 0.05:
    print("The data is likely normally distributed.")
else:
    print("The data is not likely normally distributed.")
```

```
Shapiro-Wilk Test Results:
Statistic: 0.9755953550338745
p-value: 0.31262221932411194
The data is likely normally distributed.
```

[675]:

```
# Set up the plot
plt.figure(figsize=(8, 6))
# Plot the histogram
sns.histplot(Overall_rating_data, bins=20, color='green', edgecolor='black',␣
 ↪kde=True)
# Add labels and title
plt.xlabel('Overall rating')
plt.ylabel('Frequency')
plt.title('Histogram with KDE of Overall rating (ContractOrLoan = Yes)')
# Show the plot
plt.show()
```



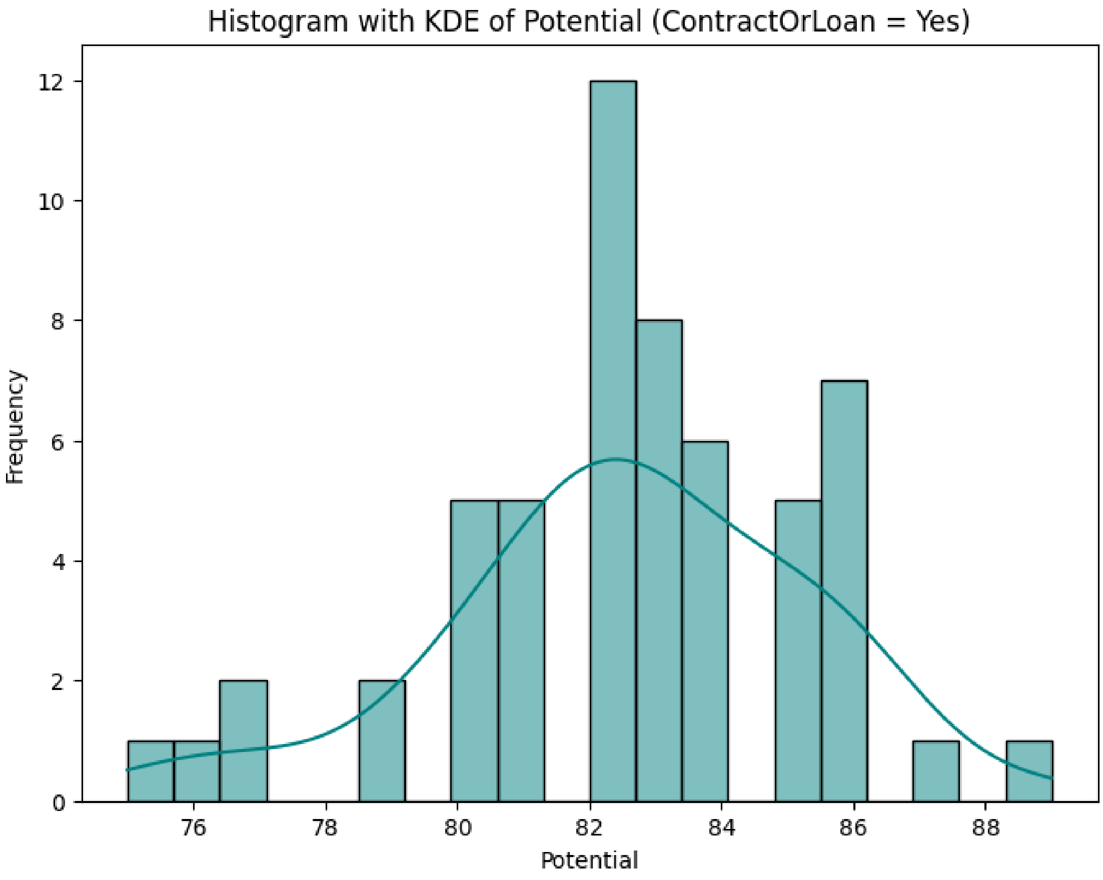
Interpretation of results: The interpretation of the Shapiro-Wilk test results indicates that the p-value (0.3126) is greater than the significance level (0.05), suggesting that we fail to reject the null hypothesis. Therefore, based on this test alone, we conclude that the data is ***likely normally distributed***.

[676]:
```
# Filter the data where 'ContractOrLoan' is 'Yes'
subset_data =␣
 ↪dfFeatureEngwithfreecate2[dfFeatureEngwithfreecate2['ContractOrLoan'] ==␣
 ↪'Yes']

# Extract the 'Potential' column from the subset
Potential_data = subset_data['Potential']

# Perform the Shapiro-Wilk test
statistic, p_value = shapiro(Potential_data)

# Output the results
print("Shapiro-Wilk Test Results:")
print("Statistic:", statistic)
print("p-value:", p_value)
if p_value > 0.05:
    print("The data is likely normally distributed.")
else:
    print("The data is not likely normally distributed.")
```

```
Shapiro-Wilk Test Results:
Statistic: 0.9658219814300537
p-value: 0.11284962296485901
The data is likely normally distributed.
```

[677]:

```
# Set up the plot
plt.figure(figsize=(8, 6))
# Plot the histogram
sns.histplot(Potential_data, bins=20, color='teal', edgecolor='black', kde=True)
# Add labels and title
plt.xlabel('Potential')
plt.ylabel('Frequency')
plt.title('Histogram with KDE of Potential (ContractOrLoan = Yes)')
# Show the plot
plt.show()
```



Interpretation of results: With a p-value of 0.1128, which is greater than the typical significance level of 0.05, we fail to reject the null hypothesis. This suggests that there isn't sufficient evidence to conclude that the "Potential" variable is not normally distributed within each category of "ContractOrLoan." ***There is normally distributed.***

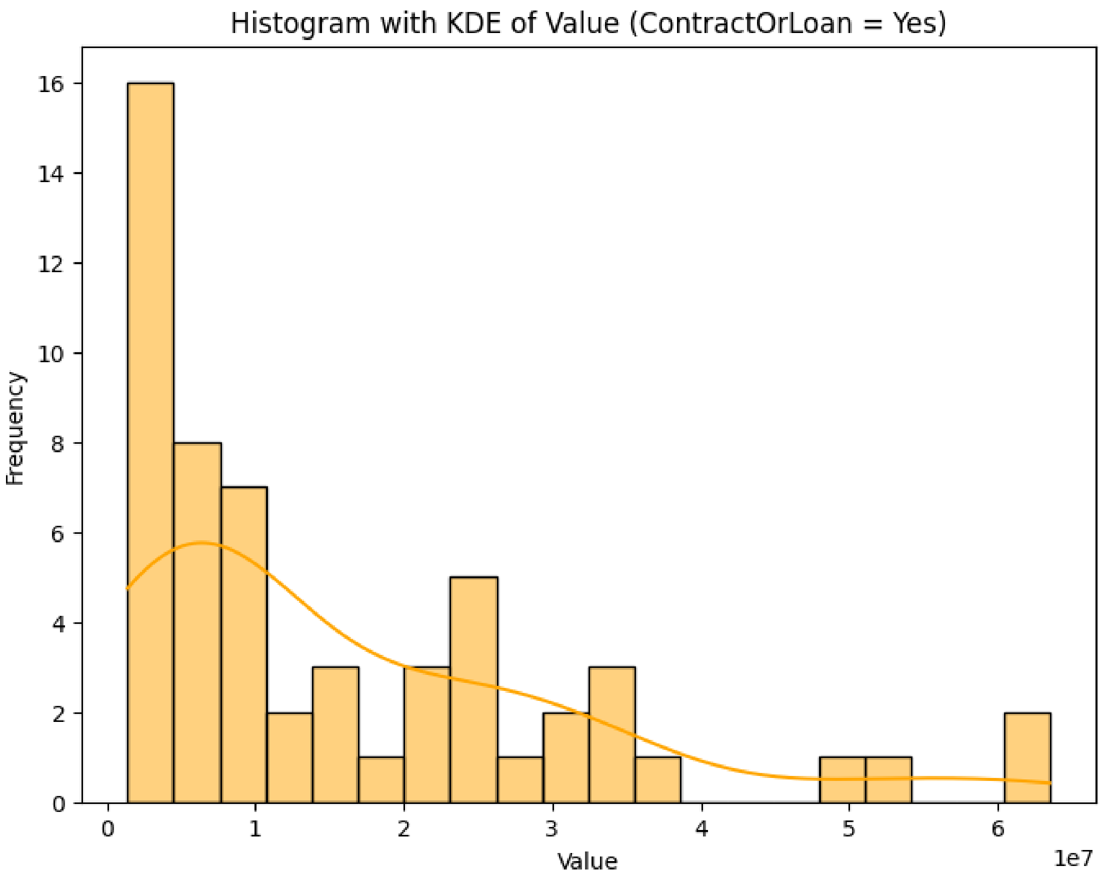
[678]:

```
# Filter the data where 'ContractOrLoan' is 'Yes'
subset_data =␣
 ↪dfFeatureEngwithfreecate2[dfFeatureEngwithfreecate2['ContractOrLoan'] ==␣
 ↪'Yes']

# Extract the 'Value' column from the subset
Value_data = subset_data['Value']

# Perform the Shapiro-Wilk test
statistic, p_value = shapiro(Value_data)

# Output the results
print("Shapiro-Wilk Test Results:")
print("Statistic:", statistic)
print("p-value:", p_value)
if p_value > 0.05:
    print("The data is likely normally distributed.")
else:
    print("The data is not likely normally distributed.")
```

```
Shapiro-Wilk Test Results:
Statistic: 0.824853777885437
p-value: 1.1818838174804114e-06
The data is not likely normally distributed.
```

[679]:

```
# Set up the plot
plt.figure(figsize=(8, 6))
# Plot the histogram
sns.histplot(Value_data, bins=20, color='Orange', edgecolor='black', kde=True)
# Add labels and title
plt.xlabel('Value')
plt.ylabel('Frequency')
plt.title('Histogram with KDE of Value (ContractOrLoan = Yes)')
# Show the plot
plt.show()
```



Interpretation of results: The exceptionally low p-value (1.1819e-06), significantly smaller than the conventional significance level of 0.05, offers compelling evidence to reject the null hypothesis. Thus, we deduce that the “Value” variable is ***unlikely to adhere to a normal distribution*** within each category of “ContractOrLoan.” Given such deviation from normality, there is left-skewness.

[679]:

```
```

[680]:

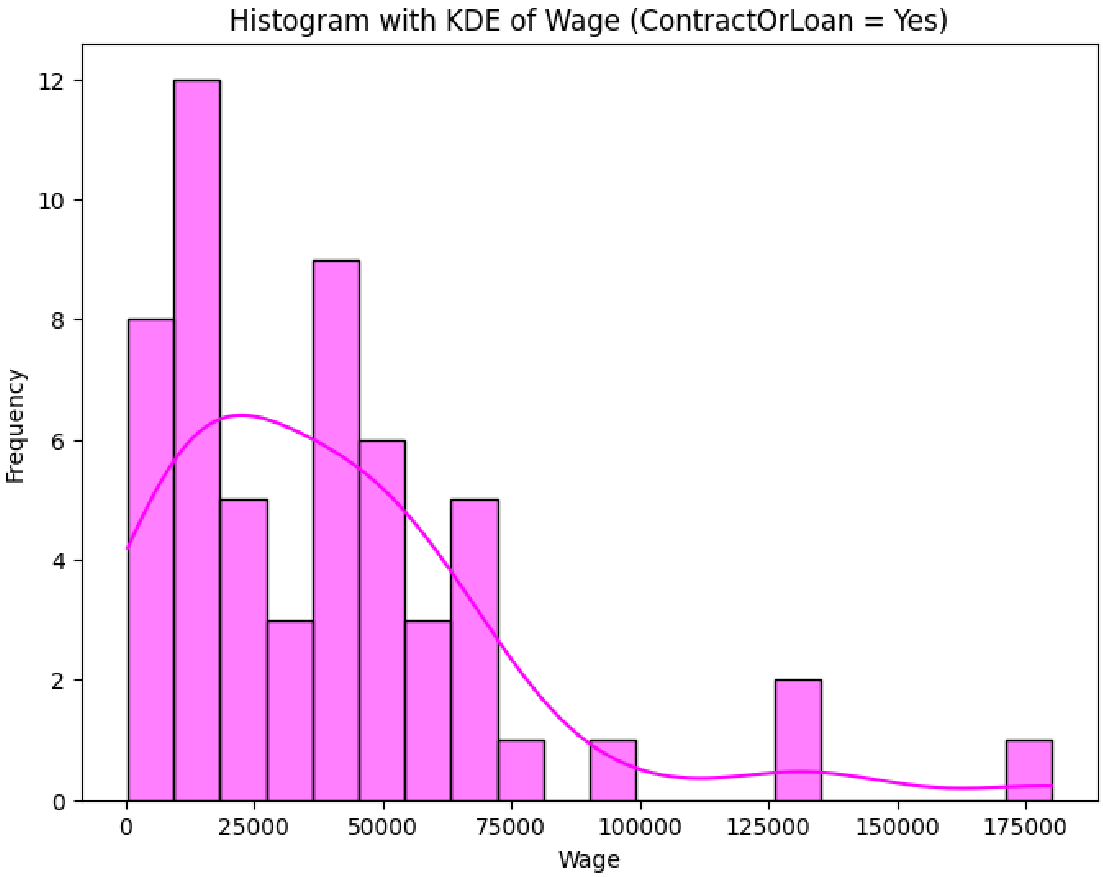
```
# Filter the data where 'ContractOrLoan' is 'Yes'
subset_data =␣
 ↪dfFeatureEngwithfreecate2[dfFeatureEngwithfreecate2['ContractOrLoan'] ==␣
 ↪'Yes']

# Extract the 'Wage' column from the subset
Wage_data = subset_data['Wage']

# Perform the Shapiro-Wilk test
statistic, p_value = shapiro(Wage_data)

# Output the results
```

```
print("Shapiro-Wilk Test Results:")
print("Statistic:", statistic)
print("p-value:", p_value)
if p_value > 0.05:
    print("The data is likely normally distributed.")
else:
    print("The data is not likely normally distributed.")
```

```
Shapiro-Wilk Test Results:
Statistic: 0.8391015529632568
p-value: 2.847790938176331e-06
The data is not likely normally distributed.
```

[681]:

```
# Set up the plot
plt.figure(figsize=(8, 6))
# Plot the histogram
sns.histplot(Wage_data, bins=20, color='magenta', edgecolor='black', kde=True)
# Add labels and title
plt.xlabel('Wage')
plt.ylabel('Frequency')
plt.title('Histogram with KDE of Wage (ContractOrLoan = Yes)')
# Show the plot
plt.show()
```



Interpretation of results: The very low p-value (2.8478e-06), substantially smaller than the conventional significance level of 0.05, provides strong evidence to reject the null hypothesis. Therefore, we conclude that the "Wage" variable is ***unlikely to follow a normal distribution*** within each category of "ContractOrLoan."Given such deviation from normality, there is left-skewness.

[681]:

```
```

[682]:

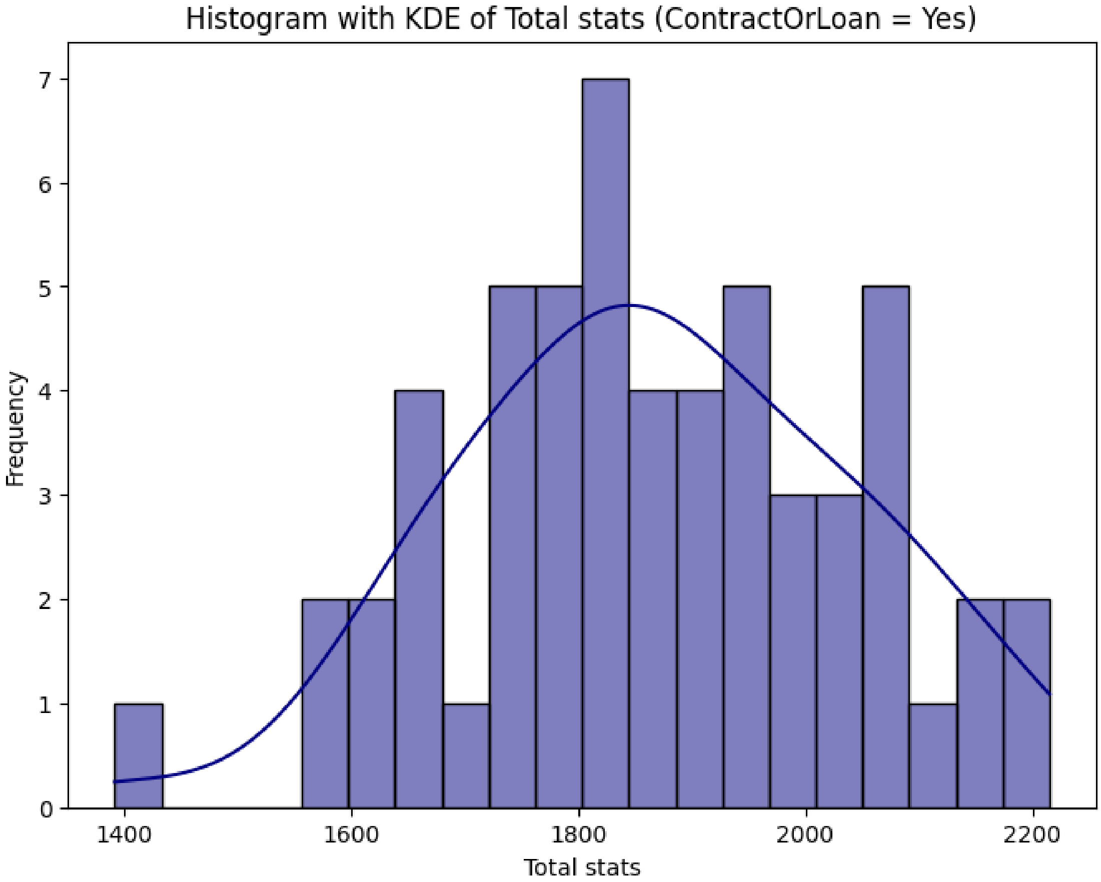
```
# Filter the data where 'ContractOrLoan' is 'Yes'
subset_data =␣
 ↪dfFeatureEngwithfreecate2[dfFeatureEngwithfreecate2['ContractOrLoan'] ==␣
 ↪'Yes']

# Extract the 'Total stats' column from the subset
Total_stats_data = subset_data['Total stats']

# Perform the Shapiro-Wilk test
statistic, p_value = shapiro(Total_stats_data)

# Output the results
```

```
print("Shapiro-Wilk Test Results:")
print("Statistic:", statistic)
print("p-value:", p_value)
if p_value > 0.05:
    print("The data is likely normally distributed.")
else:
    print("The data is not likely normally distributed.")
```

```
Shapiro-Wilk Test Results:
Statistic: 0.9887834191322327
p-value: 0.8810950517654419
The data is likely normally distributed.
```

[683]:

```
# Set up the plot
plt.figure(figsize=(8, 6))
# Plot the histogram
sns.histplot(Total_stats_data, bins=20, color='navy', edgecolor='black',␣
  ↪kde=True)
# Add labels and title
plt.xlabel('Total stats')
plt.ylabel('Frequency')
plt.title('Histogram with KDE of Total stats (ContractOrLoan = Yes)')
# Show the plot
plt.show()
```



Interpretation of results: With a p-value of 0.8811, which is substantially greater than the conventional significance level of 0.05, we fail to reject the null hypothesis. Therefore, based on this statistical test alone, there isn't strong evidence to suggest that the "Total stats" variable deviates from a ***normal distribution*** across the different categories of "ContractOrLoan."

Mann-Whitney U-Test

The Mann-Whitney U-Test can be used to test whether there is a difference between two samples (groups), and the data need not be normally distributed.

"The Mann-Whitney U test, also known as the Wilcoxon rank-sum test, is typically ***used with numerical (continuous) variables, not with text or categorical variables***. Therefore, before using the Mann-Whitney U test, categorical variables can be transformed into numerical variables. However, it's essential to ensure that this transformation maintains the meaningful order or ranking within the categories.

```
[684]: dfFeatureEngwithfreecate3=dfFeatureEngwithfreecate2.copy()
```

```
[685]: dfFeatureEngwithfreecate3.tail(30)
```

```
[685]:      Age  Overall rating  Potential  Value  Wage  Total stats ContractType  \
       1017   23              73         79      0     0         1184         Free
       1005   28              75         75      0     0         1940         Free
       1013   21              67         78      0     0         1805         Free
       1007   25              78         81      0     0         1969         Free
       998    24              77         80      0     0         2012         Free
       999    23              74         82      0     0         1860         Free
       1018   22              68         73      0     0         1730         Free
       1014   24              72         74      0     0         1795         Free
       1002   24              73         76      0     0         1803         Free
       990    22              75         82      0     0         2013         Free
       994    26              76         76      0     0         1841         Free
       1006   29              76         76      0     0         1873         Free
       995    30              79         79      0     0         1962         Free
       1003   28              75         75      0     0         2021         Free
       1001   26              78         80      0     0         1987         Free
       1012   29              76         76      0     0         1873         Free
       991    23              74         81      0     0         2061         Free
       992    22              75         81      0     0         1918         Free
       1015   28              75         75      0     0         2016         Free
       993    27              79         79      0     0         2133         Free
       1011   24              72         74      0     0         1795         Free
       1016   27              69         71      0     0         1716         Free
       1008   23              73         79      0     0         1184         Free
       1019   28              73         73      0     0         1894         Free
       1010   24              77         80      0     0         2012         Free
       997    21              71         83      0     0         1905         Free
       1000   22              73         80      0     0         1713         Free
       1004   25              76         77      0     0         1788         Free
       1009   29              76         76      0     0         1873         Free
       996    23              76         81      0     0         2094         Free

             TotalContractYears AgeCategory ContractOrLoan OldorYoung
       1017                <NA>    Twenties             No      Young
       1005                <NA>    Twenties             No      Young
       1013                <NA>    Twenties             No      Young
       1007                <NA>    Twenties             No      Young
       998                 <NA>    Twenties             No      Young
       999                 <NA>    Twenties             No      Young
       1018                <NA>    Twenties             No      Young
       1014                <NA>    Twenties             No      Young
       1002                <NA>    Twenties             No      Young
       990                 <NA>    Twenties             No      Young
       994                 <NA>    Twenties             No      Young
       1006                <NA>    Twenties             No      Young
       995                 <NA>    Thirties             No        Old
       1003                <NA>    Twenties             No      Young
```

```
1001                  <NA>    Twenties            No       Young
1012                  <NA>    Twenties            No       Young
991                   <NA>    Twenties            No       Young
992                   <NA>    Twenties            No       Young
1015                  <NA>    Twenties            No       Young
993                   <NA>    Twenties            No       Young
1011                  <NA>    Twenties            No       Young
1016                  <NA>    Twenties            No       Young
1008                  <NA>    Twenties            No       Young
1019                  <NA>    Twenties            No       Young
1010                  <NA>    Twenties            No       Young
997                   <NA>    Twenties            No       Young
1000                  <NA>    Twenties            No       Young
1004                  <NA>    Twenties            No       Young
1009                  <NA>    Twenties            No       Young
996                   <NA>    Twenties            No       Young
```

[686]:

```
dfFeatureEngwithfreecate3['Contract'] =␣
 ↪dfFeatureEngwithfreecate3['ContractOrLoan'].apply(lambda x: 1 if x == 'Yes'␣
 ↪else 0)
dfFeatureEngwithfreecate3.head(1)
```

[686]:

```
     Age  Overall rating  Potential     Value   Wage  Total stats  \
795   30              79         79  14500000  43000         1827

    ContractType  TotalContractYears AgeCategory ContractOrLoan OldorYoung  \
795     Contract                   5    Thirties            Yes        Old

     Contract
795         1
```

[687]:

```
dfFeatureEngwithfreecate3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 86 entries, 795 to 996
Data columns (total 12 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   Age                 86 non-null     Int64
 1   Overall rating      86 non-null     Int64
 2   Potential           86 non-null     Int64
 3   Value               86 non-null     Int64
 4   Wage                86 non-null     Int64
 5   Total stats         86 non-null     Int64
 6   ContractType        86 non-null     object
 7   TotalContractYears  56 non-null     Int64
 8   AgeCategory         86 non-null     object
 9   ContractOrLoan      86 non-null     object
 10  OldorYoung          86 non-null     object
 11  Contract            86 non-null     int64
dtypes: Int64(7), int64(1), object(4)
memory usage: 11.4+ KB
```

[688]:

```
dfFeatureEngwithfreecate3['Age'].info()
dfFeatureEngwithfreecate3['Contract'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 86 entries, 795 to 996
Series name: Age
Non-Null Count  Dtype
--------------  -----
86 non-null     Int64
dtypes: Int64(1)
memory usage: 3.5 KB
<class 'pandas.core.series.Series'>
Index: 86 entries, 795 to 996
Series name: Contract
Non-Null Count  Dtype
--------------  -----
86 non-null     int64
dtypes: int64(1)
memory usage: 3.4 KB
```

[689]:

```
from scipy.stats import mannwhitneyu

# Convert 'Age' and 'Contract' columns to integer
dfFeatureEngwithfreecate3['Age'] = dfFeatureEngwithfreecate3['Age'].astype(int)
dfFeatureEngwithfreecate3['Contract'] = dfFeatureEngwithfreecate3['Contract'].
  ↪astype(int)

# Perform Mann-Whitney U test between "Age" and "Contract"
result1 = mannwhitneyu(dfFeatureEngwithfreecate3['Age'],␣
  ↪dfFeatureEngwithfreecate3['Contract'])
# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two␣
  ↪samples)')
# Print the test statistic and p-value
print("Mann-Whitney U Test Results:")
print("Statistic:", result1.statistic)
print("p-value:", result1.pvalue)

# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two␣
 ↪samples)')
```

```
Do not Reject Null Hypothesis (No significant difference between two samples)
Mann-Whitney U Test Results:
Statistic: 7396.0
p-value: 6.4343117952933815e-31
Do not Reject Null Hypothesis (No significant difference between two samples)
```

[690]:
```
from scipy.stats import mannwhitneyu

# Convert 'Value' and 'Contract' columns to integer
dfFeatureEngwithfreecate3['Value'] = dfFeatureEngwithfreecate3['Value'].
 ↪astype(int)
dfFeatureEngwithfreecate3['Contract'] = dfFeatureEngwithfreecate3['Contract'].
 ↪astype(int)

# Perform Mann-Whitney U test between "Value" and "Contract"
result2 = mannwhitneyu(dfFeatureEngwithfreecate3['Value'],␣
 ↪dfFeatureEngwithfreecate3['Contract'])
# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two␣
 ↪samples)')
# Print the test statistic and p-value
print("Mann-Whitney U Test Results:")
print("Statistic:", result2.statistic)
print("p-value:", result2.pvalue)

# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two␣
  ↪samples)')
```

```
Do not Reject Null Hypothesis (No significant difference between two samples)
Mann-Whitney U Test Results:
Statistic: 5266.0
p-value: 5.837317993687533e-07
Do not Reject Null Hypothesis (No significant difference between two samples)
```

[691]:

```
from scipy.stats import mannwhitneyu

# Convert 'Wage' and 'Contract' columns to integer
dfFeatureEngwithfreecate3['Wage'] = dfFeatureEngwithfreecate3['Wage'].
  ↪astype(int)
dfFeatureEngwithfreecate3['Contract'] = dfFeatureEngwithfreecate3['Contract'].
  ↪astype(int)

# Perform Mann-Whitney U test between "Wage" and "Contract"
result3 = mannwhitneyu(dfFeatureEngwithfreecate3['Wage'],␣
  ↪dfFeatureEngwithfreecate3['Contract'])
# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two␣
  ↪samples)')
# Print the test statistic and p-value
print("Mann-Whitney U Test Results:")
print("Statistic:", result3.statistic)
print("p-value:", result3.pvalue)

# Level of significance
alpha = 0.05
# conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference between two samples)')
else:
    print('Do not Reject Null Hypothesis (No significant difference between two␣
  ↪samples)')
```

```
Do not Reject Null Hypothesis (No significant difference between two samples)
Mann-Whitney U Test Results:
Statistic: 5266.0
p-value: 5.837414556602495e-07
Do not Reject Null Hypothesis (No significant difference between two samples)
```

Student’s t-test

Student’s t-test, in statistics, a method of testing hypotheses about the mean of a small sample drawn from a normally distributed population when the population standard deviation is unknown.

[692]:

```
from scipy.stats import ttest_ind

# Ensure both variables are numeric
dfFeatureEngwithfreecate3['Overall rating'] =␣
 ↪dfFeatureEngwithfreecate3['Overall rating'].astype(int)
dfFeatureEngwithfreecate3['Contract'] = dfFeatureEngwithfreecate3['Contract'].
 ↪astype(int)

# Perform t-test
t_statistic, p_value = ttest_ind(dfFeatureEngwithfreecate3['Overall rating'],␣
 ↪dfFeatureEngwithfreecate3['Contract'])

# Print the test statistic and p-value
print("T-test Results:")
print("Statistic:", t_statistic)
print("p-value:", p_value)

# Level of significance
alpha = 0.05

# Conclusion
if p_value < alpha:
    print('Reject Null Hypothesis (Significant difference in means between␣
 ↪Overall rating and Contract)')
else:
    print('Do not Reject Null Hypothesis (No significant difference in means␣
 ↪between Overall rating and Contract)')
```

```
T-test Results:
Statistic: 151.31566434376472
p-value: 3.330349013324463e-183
Reject Null Hypothesis (Significant difference in means between Overall rating
and Contract)
```

[693]:

```
# Define columns to convert to dummy variables
qualitative_columns = ['ContractType', 'AgeCategory', 'ContractOrLoan',␣
 ↪'OldorYoung']
# Drop specified columns
dfFeatureEngwithfreecate3.drop(['Value', 'Wage', 'TotalContractYears'], axis=1,␣
 ↪inplace=True)
# Create new DataFrame with dummy variables
dfFeatureEngwithfreecate4 = pd.DataFrame(dfFeatureEngwithfreecate3)  # Copy␣
 ↪original DataFrame
```

```
for column in qualitative_columns:
    dummies = pd.get_dummies(dfFeatureEngwithfreecate4[column], prefix=column,␣
 ↪drop_first=True)
    dummies = dummies.replace({True: 1, False: 0})  # Replace True by 1 and␣
 ↪False by 0
    dfFeatureEngwithfreecate4 = pd.concat([dfFeatureEngwithfreecate4, dummies],␣
 ↪axis=1)
    dfFeatureEngwithfreecate4.drop(column, axis=1, inplace=True)
dfFeatureEngwithfreecate4
```

```
[693]:       Age  Overall rating  Potential  Total stats  Contract  \
       795    30              79         79         1827         1
       319    17              68         84         1672         1
       382    26              80         81         1990         1
       737    27              78         80         1628         1
       804    30              81         81         2025         1
       …     …               …          …            …         …
       997    21              71         83         1905         0
       1000   22              73         80         1713         0
       1004   25              76         77         1788         0
       1009   29              76         76         1873         0
       996    23              76         81         2094         0

             ContractType_Free  ContractType_Loan  AgeCategory_Thirties  \
       795                   0                  0                     1
       319                   0                  0                     0
       382                   0                  0                     0
       737                   0                  0                     0
       804                   0                  0                     1
       …                   …                  …                     …
       997                   1                  0                     0
       1000                  1                  0                     0
       1004                  1                  0                     0
       1009                  1                  0                     0
       996                   1                  0                     0

             AgeCategory_Twenties  ContractOrLoan_Yes  OldorYoung_Young
       795                      0                   1                 0
       319                      0                   1                 1
       382                      1                   1                 1
       737                      1                   1                 1
       804                      0                   1                 0
       …                      …                   …                 …
       997                      1                   0                 1
       1000                     1                   0                 1
       1004                     1                   0                 1
       1009                     1                   0                 1
```

```
996                         1                   0                  1

[86 rows x 11 columns]
```

[694]:

```python
from sklearn.model_selection import train_test_split

# Splitting the DataFrame into features (X) and target variable (y)
X = dfFeatureEngwithfreecate4.drop('ContractOrLoan_Yes', axis=1)  # Features (independent variables)
y = dfFeatureEngwithfreecate4['ContractOrLoan_Yes']  # Target variable (dependent variable)

# Splitting the data into train and test sets (80% train, 20% test)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Printing the shapes of train and test sets
print("Shape of X_train:", X_train.shape)
print("Shape of X_test:", X_test.shape)
print("Shape of y_train:", y_train.shape)
print("Shape of y_test:", y_test.shape)
```

```
Shape of X_train: (68, 10)
Shape of X_test: (18, 10)
Shape of y_train: (68,)
Shape of y_test: (18,)
```

[695]:

```python
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score
# Step 2: Split the data into train and test sets (already done in the previous code snippet)
# Step 3: Create a logistic regression model
logistic_model = LogisticRegression(max_iter=1000, random_state=42)
# Step 4: Train the model
logistic_model.fit(X_train, y_train)
y_pred = logistic_model.predict(X_test)
```

[696]:

```python
# Create a DataFrame with actual and predicted values
comparison_df = pd.DataFrame({'Actual': y_test, 'Predicted': y_pred})

# Print the comparison table
comparison_df
```

[696]:

```
      Actual  Predicted
993        0          0
795        1          1
1001       0          0
```

```
23          1          1
404         1          1
1017        0          1
227         1          1
462         1          1
804         1          1
1006        0          0
999         0          0
1002        0          0
897         1          1
992         0          0
1018        0          0
994         0          0
967         1          1
1008        0          1
```

[697]:

```
# Evaluate the model's performance on the scaled test data
y_pred = logistic_model.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
```

[698]:

```
print("Accuracy:", accuracy)
```

```
Accuracy: 0.8888888888888888
```