Lidl Analytics - Consulting Case Study

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```

(1) Setup

```
import numpy as np
import pandas as pd

import math

import seaborn as sns

%matplotlib inline
import matplotlib.pyplot as plt

import statsmodels.api as sm

from scipy import stats

from sklearn import datasets, linear_model
from sklearn.linear_model import LinearRegression
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
from sklearn import metrics
from sklearn.metrics import mean_squared_error
```

(2) Data Preparation

```
#Loading data from github
url = 'https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-ranking/candy-data.csv'
df = pd.read_csv(url, index_col=0)
```

```
#Checking data for missing values
if sum((df.isnull().sum()/len(df)*100).sort_values(ascending=False)) == 0:
    print('No Null values!')

else:
    print('Null values!')
```

```
No Null values!
```

```
#Checking for competitors with no ingredients
df_noing = df[df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard',
'bar', 'pluribus']].sum(axis=1) == 0]

print(df_noing)
```

```
                chocolate  fruity  caramel  peanutyalmondy  nougat  \
competitorname
One dime                0       0        0               0       0
One quarter             0       0        0               0       0

                crispedricewafer  hard  bar  pluribus  sugarpercent  \
competitorname
One dime                       0     0    0         0         0.011
```

```
One quarter                   0     0    0          0         0.011

                pricepercent  winpercent
competitorname
One dime               0.116   32.261086
One quarter            0.511   46.116505
```

```
#Dropping dime and quarter
df = df.drop(['One dime', 'One quarter'])
```

```
#Creating New Metrics for Number of Ingredients
df['number ingredients'] = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat',
'crispedricewafer', 'hard', 'bar']].sum(axis=1)

#Changing the metric pricepercent into € by recalculating value assuming one quarter = 0.25€
df['pricepercent'] = (df['pricepercent']/0.511)*0.25

#Renaming column to price
df = df.rename(columns={'pricepercent': 'price'})
```

(3) Data Analysis

(3.1) Data Exploration

```
#Data exploration (1)
print(df.head())
```

```
                chocolate  fruity  caramel  peanutyalmondy  nougat  \
competitorname
100 Grand               1       0        1               0       0
3 Musketeers            1       0        0               0       1
Air Heads               0       1        0               0       0
Almond Joy              1       0        0               1       0
Baby Ruth               1       0        1               1       1

                crispedricewafer  hard  bar  pluribus  sugarpercent     price  \
competitorname
100 Grand                      1     0    1         0         0.732  0.420744
3 Musketeers                   0     0    1         0         0.604  0.250000
Air Heads                      0     0    0         0         0.906  0.250000
Almond Joy                     0     0    1         0         0.465  0.375245
Baby Ruth                      0     0    1         0         0.604  0.375245

                winpercent  number ingredients
competitorname
100 Grand        66.971725                   4
3 Musketeers     67.602936                   3
Air Heads        52.341465                   1
Almond Joy       50.347546                   3
Baby Ruth        56.914547                   5
```

```
#Data exploration (2)
print (df.shape)
```

```
(83, 13)
```

```
#Data exploration (3)
df.describe()
```

```
.dataframe tbody tr th {
    vertical-align: top;
}

.dataframe thead th {
    text-align: right;
}
```

	chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluril
count	83.000000	83.000000	83.000000	83.000000	83.000000	83.000000	83.000000	83.000000	83.000
mean	0.445783	0.457831	0.168675	0.168675	0.084337	0.084337	0.180723	0.253012	0.5301
std	0.500073	0.501247	0.376741	0.376741	0.279582	0.279582	0.387128	0.437381	0.5021
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000
25%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000
50%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1.0000
75%	1.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.500000	1.0000
max	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.0000

```
#Data exploration (4)
df.sum(axis=0)
```

```
chocolate                37.000000
fruity                   38.000000
caramel                  14.000000
peanutyalmondy           14.000000
nougat                    7.000000
crispedricewafer          7.000000
hard                     15.000000
bar                      21.000000
pluribus                 44.000000
sugarpercent             40.662999
price                    19.191781
winpercent             4198.547333
number ingredients      153.000000
dtype: float64
```

```
#Having a look at top scoring products
df_max= df.sort_values(by=['winpercent'], ascending=False)
df_max.head(5)
```

```
.dataframe tbody tr th {
    vertical-align: top;
}

.dataframe thead th {
    text-align: right;
}
```

	chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	sugarpercent	
competitorname											
ReeseÕs Peanut Butter cup	1	0	0	1	0	0	0	0	0	0.720	0
ReeseÕs Miniatures	1	0	0	1	0	0	0	0	0	0.034	0
Twix	1	0	1	0	0	1	0	1	0	0.546	0
Kit Kat	1	0	0	0	0	1	0	1	0	0.313	0
Snickers	1	0	1	1	1	0	0	1	0	0.546	0

```
#Calculating sum of attributes of candy
Z = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar','pluribus']]
sum = Z.sum()
```

```
#Calculating average values of binary attributes
Attributes = list(Z.columns.values)
avgwinlist = []

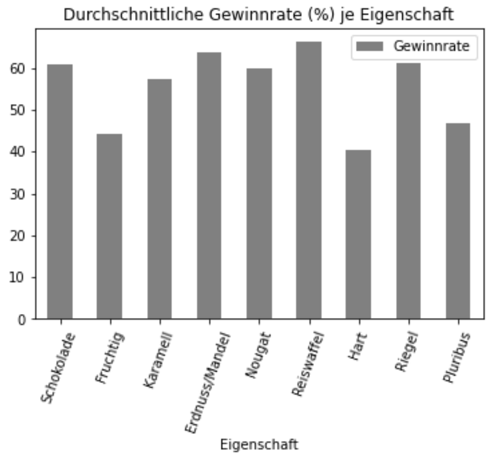
for a in range(len(Attributes)):
    dfa = df[df[Attributes[a]] == 1]
    avg = dfa['winpercent'].mean(axis=0)
    avg = round(avg,2)
    avgwinlist.append(avg)
```

```
#Creating df_explore, assigning columns and integrating averagewinlist
df_explore = pd.DataFrame(sum)
df_explore.columns = ['Anzahl an Süßigkeiten mit Eigenschaft']
df_explore['Anzahl an Süßigkeiten ohne Eigenschaft'] = 83 - df_explore['Anzahl an Süßigkeiten mit Eigenschaft']
df_explore['% Anteil an Süßigkeiten mit Eigenschaft'] = ((df_explore['Anzahl an Süßigkeiten mit Eigenschaft'] / 83) * 100).round(decimals=1)
df_explore = df_explore.assign(Gewinnrate = avgwinlist)
```

```
#Renaming Columns of df_explore and setting index to be a column
df_explore = df_explore.rename(index={'chocolate': 'Schokolade', 'fruity':'Fruchtig', 'caramel':'Karamell', 'peanutyalmondy':
'Erdnuss/Mandel', 'nougat':'Nougat', 'crispedricewafer':'Reiswaffel', 'hard':'Hart', 'bar':'Riegel', 'pluribus':'Pluribus',
'avgwinpercent':'Durchschnittliche Gewinnrate'})
df_explore = df_explore.reset_index()
df_explore.rename(columns={'index':'Eigenschaft'},inplace=True)

#Plotting number of sweets that have each attribute
df_explore.plot.bar(x="Eigenschaft", y="Anzahl an Süßigkeiten mit Eigenschaft", rot=70, title="Anzahl an Süßigkeiten mit bestimmten
Eigenschaften", color='grey');
```


```
#Plot average winrate
df_explore.plot.bar(x="Eigenschaft", y="Gewinnrate", rot=70, title="Durchschnittliche Gewinnrate (%) je Eigenschaft", color='grey');
```



(3.2) Multiple Linear Regression Model

```
#Building linear regression model
lm = LinearRegression()
```

```
# Defining winpercent as Response Variable
y = df['winpercent']
```

```
#Defining predictor variables for multiple linear regression model
Z = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar','pluribus']]
W = df[[ 'sugarpercent', 'price', 'number ingredients', 'pluribus']]
X = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar', 'pluribus', 'sugarpercent', 'price',
'number ingredients' ]]
N = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar','winpercent']]
```

```
#Add column of ones to array to calculate constant
X2 = sm.add_constant(Z)

#Creating Multiple Linear Regression Model with Ordinary Least Squares Method
#MLRS for binary attributes
est = sm.OLS(y, X2)
est2 = est.fit()
print(est2.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             winpercent   R-squared:                       0.513
Model:                            OLS   Adj. R-squared:                  0.453
Method:                 Least Squares   F-statistic:                     8.558
Date:                Tue, 01 Sep 2020   Prob (F-statistic):           1.26e-08
Time:                        22:56:55   Log-Likelihood:                -310.74
No. Observations:                  83   AIC:                             641.5
Df Residuals:                      73   BIC:                             665.7
Df Model:                           9
Covariance Type:            nonrobust
====================================================================================
                       coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------
const               33.3706      4.841      6.894      0.000      23.723      43.018
chocolate           20.7838      4.152      5.006      0.000      12.509      29.059
fruity              11.3188      4.149      2.728      0.008       3.051      19.587
caramel              3.7865      3.677      1.030      0.306      -3.541      11.114
peanutyalmondy      10.4836      3.653      2.870      0.005       3.203      17.765
nougat               2.3604      5.720      0.413      0.681      -9.040      13.761
crispedricewafer     8.9510      5.356      1.671      0.099      -1.724      19.626
hard                -4.5835      3.487     -1.314      0.193     -11.533       2.366
bar                 -0.1506      4.977     -0.030      0.976     -10.070       9.769
pluribus             0.5142      3.206      0.160      0.873      -5.875       6.904
==============================================================================
Omnibus:                        1.753   Durbin-Watson:                   1.795
Prob(Omnibus):                  0.416   Jarque-Bera (JB):                1.688
Skew:                          -0.258   Prob(JB):                        0.430
Kurtosis:                       2.530   Cond. No.                         8.81
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
#Add column of ones to array to calculate constant
X2 = sm.add_constant(W)

#Creating Multiple Linear Regression Model with Ordinary Least Squares Method
#MLRS for non-binary attributes
est = sm.OLS(y, X2)
est2 = est.fit()
print(est2.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             winpercent   R-squared:                       0.271
Model:                            OLS   Adj. R-squared:                  0.234
Method:                 Least Squares   F-statistic:                     7.258
Date:                Tue, 01 Sep 2020   Prob (F-statistic):           5.07e-05
Time:                        22:56:56   Log-Likelihood:                -327.51
No. Observations:                  83   AIC:                             665.0
Df Residuals:                      78   BIC:                             677.1
Df Model:                           4
Covariance Type:            nonrobust
======================================================================================
                         coef    std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------------
const                 34.3816      4.934      6.969      0.000      24.559      44.204
sugarpercent           4.4230      5.521      0.801      0.425      -6.568      15.414
price                 11.6091     11.828      0.981      0.329     -11.939      35.157
number ingredients     5.9840      1.784      3.354      0.001       2.432       9.536
pluribus               0.6064      3.592      0.169      0.866      -6.545       7.757
```

```
==============================================================================
Omnibus:                        1.812   Durbin-Watson:                   1.507
Prob(Omnibus):                  0.404   Jarque-Bera (JB):                1.836
Skew:                           0.329   Prob(JB):                        0.399
Kurtosis:                       2.687   Cond. No.                         20.3
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
#Redefining X
X = Z

#Fitting linear model to variables.
lm.fit(X, y)

#Prediction of winpercentage through multiple linear regression model
Yhat = lm.predict(X)

#Define coefficients in multiple linear regression model
c = lm.coef_
b = lm.intercept_

#Calculation of r2 to evaluate strength of relationship
r2 = lm.score(X, df['winpercent'])

#Calculate mse and square-root mse
mse = mean_squared_error(df['winpercent'], Yhat)
msesqrt = math.sqrt(mse)

print('r2 = ' , r2)
print('mse = ', mse)
print('msesqrt = ', msesqrt)
```

```
r2 =  0.5134035516572544
mse =  104.57377974880045
msesqrt =  10.226132198871696
```

```
#Appending df_explore from data exploration for integrated view of binary attributes
df_explore = df_explore.assign(Coefficient = c.round(2)/100)
df_explore= df_explore.sort_values(by=['Coefficient'], ascending=False)
```

```
#Visualization of contribution to winpercent (coefficient) in bar chart

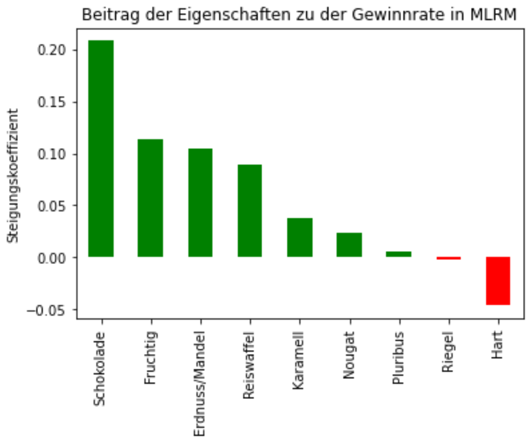
#Add to x-label and y-label to the plot
plt.ylabel('Steigungskoeffizient')

#Plot title
plt.title('Beitrag der Eigenschaften zu der Gewinnrate in MLRM')

#Plotting Data
df_explore['Coefficient'].plot(kind='bar', color=(df_explore['Coefficient'] > 0).map({True: 'G',False:
'r'})).set_xticklabels(df_explore['Eigenschaft'])
```

```
C:\Users\jonat\anaconda3\lib\site-packages\pandas\plotting\_matplotlib\core.py:1330: MatplotlibDeprecationWarning: Support for uppercase
single-letter colors is deprecated since Matplotlib 3.1 and will be removed in 3.3; please use lowercase instead.
  return ax.bar(x, y, w, bottom=start, log=log, **kwds)
```

```
[Text(0, 0, 'Schokolade'),
 Text(0, 0, 'Fruchtig'),
 Text(0, 0, 'Erdnuss/Mandel'),
 Text(0, 0, 'Reiswaffel'),
 Text(0, 0, 'Karamell'),
 Text(0, 0, 'Nougat'),
 Text(0, 0, 'Pluribus'),
 Text(0, 0, 'Riegel'),
 Text(0, 0, 'Hart')]
```




```
# Plotting data and regression for each ingredient attribute
plt.plot(df['chocolate'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[0]*x + b)(x_plot).reshape(-1))
plt.title('chocolate')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

plt.plot(df['fruity'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[1]*x + b)(x_plot).reshape(-1))
plt.title('fruity')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

plt.plot(df['caramel'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[2]*x + b)(x_plot).reshape(-1))
plt.title('caramel')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

plt.plot(df['peanutyalmondy'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[3]*x + b)(x_plot).reshape(-1))
plt.title('peanutyalmondy')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

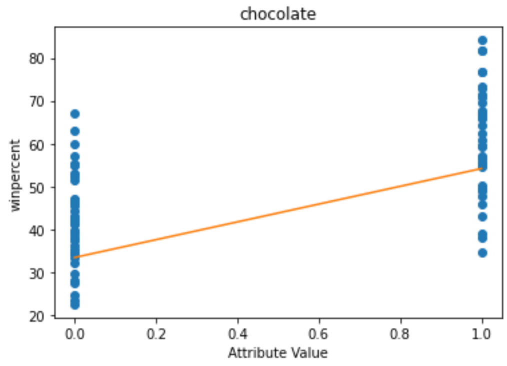
plt.plot(df['crispedricewafer'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[4]*x + b)(x_plot).reshape(-1))
plt.title('crispedricewafer')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

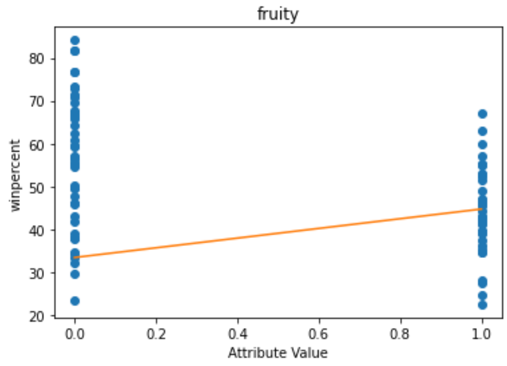
plt.plot(df['nougat'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[5]*x + b)(x_plot).reshape(-1))
plt.title('nougat')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

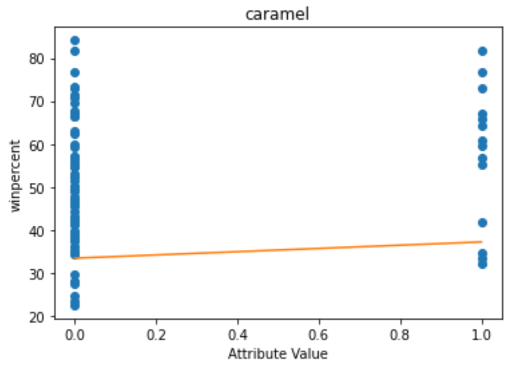
plt.plot(df['hard'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[6]*x + b)(x_plot).reshape(-1))
plt.title('hard')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()

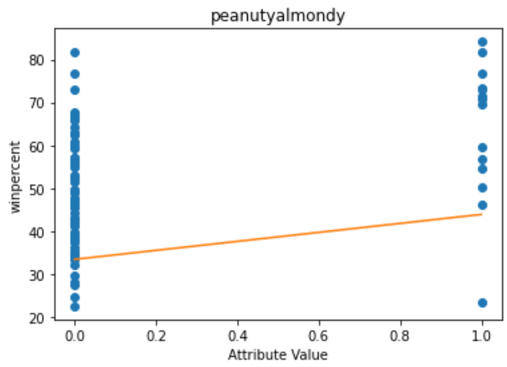
plt.plot(df['bar'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[7]*x + b)(x_plot).reshape(-1))
plt.title('bar')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()
```

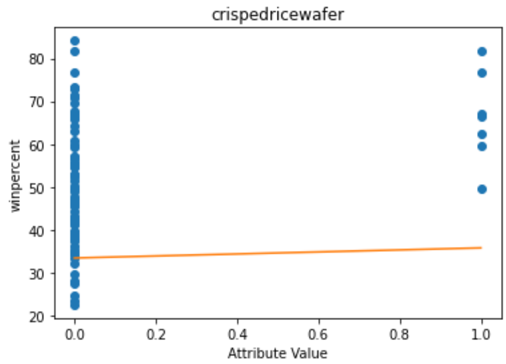
```
plt.plot(df['pluribus'].to_numpy(),df['winpercent'].to_numpy(),ls='',marker='o')
x_plot=np.linspace(0,1,100)
plt.plot(x_plot,(lambda x:c[8]*x + b)(x_plot).reshape(-1))
plt.title('pluribus')
plt.xlabel('Attribute Value')
plt.ylabel('winpercent')
plt.show()
```

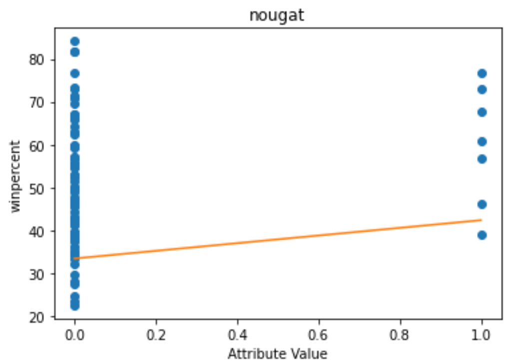


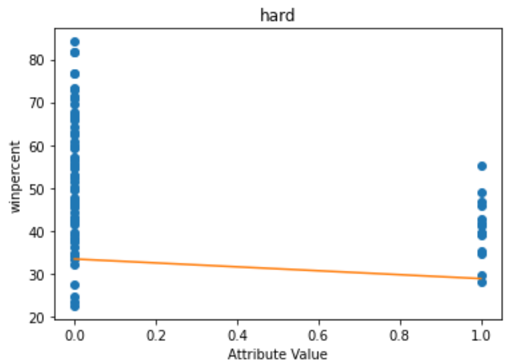


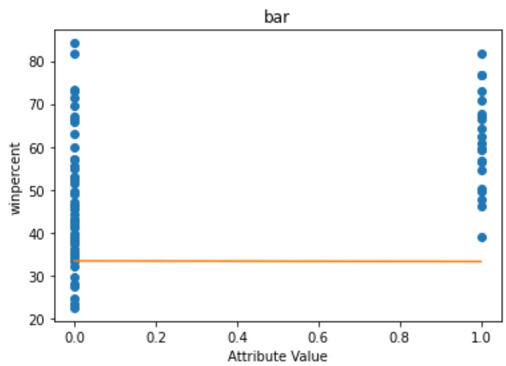


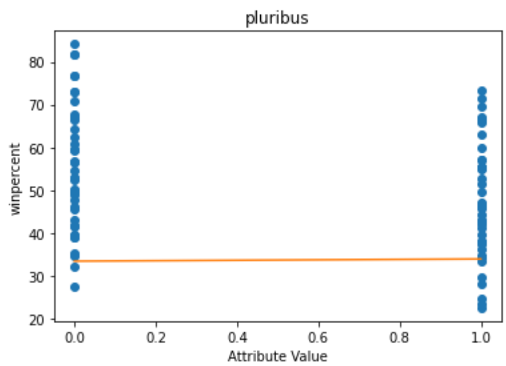



crispedricewafer
winpercent
Attribute Value


nougat
winpercent
Attribute Value


hard
winpercent
Attribute Value


bar
winpercent
Attribute Value


pluribus
winpercent
Attribute Value

(3.3) Analyzing Correlation of Data

```
#Preparing N as correlation df
N = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar', 'sugarpercent','pluribus', 'price',
'number ingredients','winpercent']]
N = N.rename(columns={'chocolate': 'Schokolade', 'fruity':'Fruchtig', 'caramel':'Karamell', 'peanutyalmondy': 'Erdnuss/Mandel',
'nougat':'Nougat', 'crispedricewafer':'Reiswaffel', 'hard':'Hart', 'bar':'Riegel', 'price':'Preis','sugarpercent':'Zuckeranteil', 'number
ingredients':'Anzahl an Zutaten', 'pluribus':'Pluribus', 'winpercent':'Gewinnrate'})

#Calculating Pearson correlation
N = N.corr(method='pearson')
```

```
#visualization of correllation in bar chart

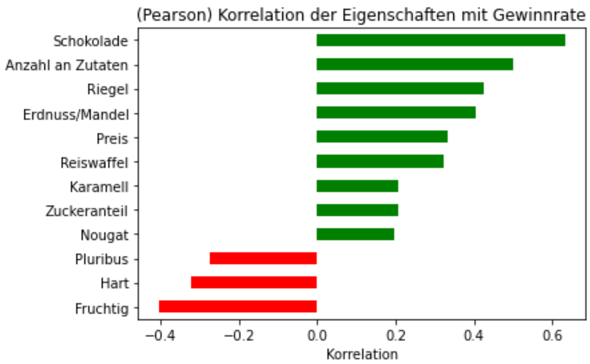
#Prepping Data for barplot
dfcorr_win = pd.DataFrame(data=N['Gewinnrate'])
dfcorr_win = dfcorr_win.sort_values(by=['Gewinnrate'])
dfcorr_win = dfcorr_win.drop('Gewinnrate', axis=0)

# add to x-label and y-label to the plot
plt.xlabel('Korrelation')


#Plot title
plt.title('(Pearson) Korrelation der Eigenschaften mit Gewinnrate')

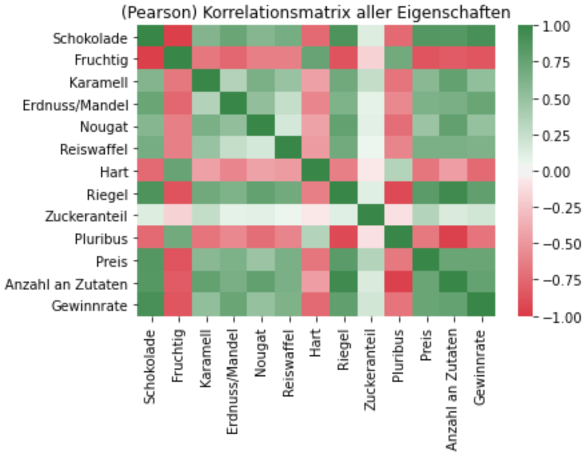
#Plotting Data
dfcorr_win['Gewinnrate'].plot(kind='barh', color=(dfcorr_win['Gewinnrate'] > 0).map({True: 'G',False: 'r'}))
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x19688390e50>
```




```
#Creating Red-green Correlation Heatmap
cmap = sns.diverging_palette(10, 133, as_cmap=True)
sns.heatmap(N.corr(method='pearson'), vmin=-1, vmax=1, center= 0, cmap=cmap)
plt.title('(Pearson) Korrelationsmatrix aller Eigenschaften')
```

```
Text(0.5, 1.0, '(Pearson) Korrelationsmatrix aller Eigenschaften')
```



(3.4) K-Means Clustering

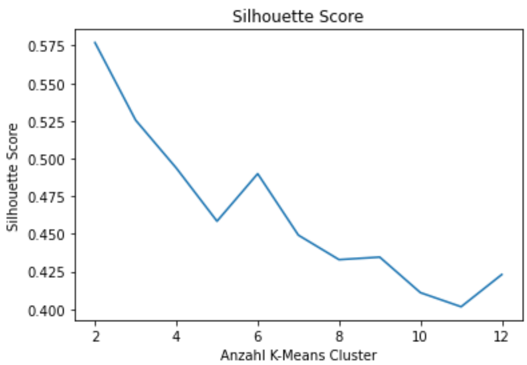
```
#Silhouette Ceofficient: Implicates how close one cluster is to other clusters.
# Near 1 - CLuster is far away from Neighbouring Clusters and clearly distinguishable.
# Near 0 - On the verge of not being distinguishable
# <0 - Samples may have been assigned to wrong clusters


# silhouette scores to choose number of clusters.
from sklearn.metrics import silhouette_score
def sil_score(df):
    sse_ = []
    for k in range(2, 13):
        kmeans = KMeans(n_clusters=k, random_state=123).fit(df) # fit.
        sse_.append([k, silhouette_score(df, kmeans.labels_)])
    plt.plot(pd.DataFrame(sse_)[0], pd.DataFrame(sse_)[1])

    #Plot title
    plt.title('Silhouette Score')

    #Plot x and y lables
    plt.ylabel('Silhouette Score')
    plt.xlabel('Anzahl K-Means Cluster')

sil_score(df)
```



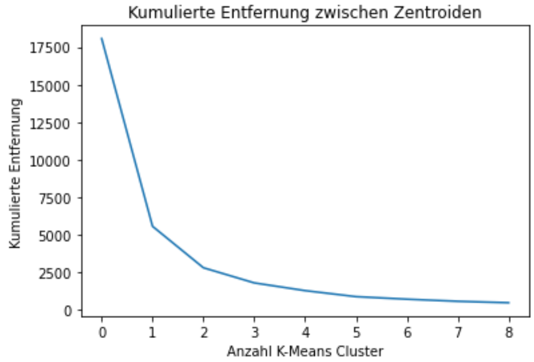

```
#ELbow Method: Where rate of decrease sharply shifts.
#Effectiveness of k-means algorithm measured in distance
#from data points to centroids
#Elbow Point at 2 or 3

def plot_ssd(df):
    ssd = []
    for num_clusters in list(range(1,10)):
        model_clus = KMeans(n_clusters = num_clusters, max_iter=50, random_state=123)
        model_clus.fit(df)
        ssd.append(model_clus.inertia_)
    plt.plot(ssd)

    #Plot title
    plt.title('Kumulierte Entfernung zwischen Zentroiden')

    #Plot x and y lables
    plt.ylabel('Kumulierte Entfernung')
    plt.xlabel('Anzahl K-Means Cluster')

plot_ssd(df)
```




```
#Assigning data to X and y
X = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar', 'pluribus', 'sugarpercent', 'price',
'number ingredients' ]].values
y = df['winpercent'].values
```

```
#Transforming pandas dataframe to numpy array
X = np.nan_to_num(X)

#Fitting Dataset
Clus_dataSet = StandardScaler().fit_transform(X)
```

(3.5.1) Cluster Analysis with 2 - 6 Clusters

```
#Defining Clusteranalysis function
def clusteranalysis(clusterNum, n_init):

    #defining X anew
    X = df[['chocolate','fruity','caramel', 'peanutyalmondy', 'nougat', 'crispedricewafer', 'hard', 'bar', 'pluribus', 'sugarpercent',
'price', 'number ingredients' ]].values

    #Initiating k-means model
    k_means = KMeans(init = "k-means++", n_clusters = clusterNum, n_init = n_init)

    #Fitting Model and making array with cluster numbers
    k_means.fit(X)
    labels = k_means.labels_

    #Merging Cluster Array with Halloween Candy in df
    dfclus = df
    dfclus['Cluster'] = labels

    #Creating single dfs for each cluster
    for a in range(clusterNum):
        dfc = dfclus[df['Cluster'] == a]
        dfm = dfc.mean()
        print('Total Number of Candy in Cluster ', a,': ',dfc.shape[0])
        print('Average Attribute Values of Cluster ',a,':')
        print(dfm)
        print('')
        print('-----------------------------------------------------------------------------------------------')
        print('');
```

```
#K-Means Clusteranalysis with K=2 and Iterations=20
clusteranalysis(2,20)
```

```
Total Number of Candy in Cluster  0 :  22
Average Attribute Values of Cluster  0 :
chocolate              0.954545
fruity                 0.045455
caramel                0.363636
peanutyalmondy         0.318182
nougat                 0.318182
crispedricewafer       0.272727
hard                   0.045455
bar                    0.954545
pluribus               0.000000
sugarpercent           0.531182
price                  0.346246
winpercent            60.735742
number ingredients     3.272727
Cluster                0.000000
dtype: float64

-----------------------------------------------------------------------------------------------
```

```
Total Number of Candy in Cluster  1 :  61
Average Attribute Values of Cluster  1 :
chocolate              0.262295
fruity                 0.606557
caramel                0.098361
peanutyalmondy         0.114754
nougat                 0.000000
crispedricewafer       0.016393
hard                   0.229508
bar                    0.000000
pluribus               0.721311
sugarpercent           0.475033
price                  0.189744
winpercent            46.923951
number ingredients     1.327869
Cluster                1.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
#K-Means Clusteranalysis with K=3 and Iterations=20
clusteranalysis (3,20)
```

```
Total Number of Candy in Cluster  0 :  21
Average Attribute Values of Cluster  0 :
chocolate              0.952381
fruity                 0.000000
caramel                0.095238
peanutyalmondy         0.333333
nougat                 0.000000
crispedricewafer       0.047619
hard                   0.000000
bar                    0.190476
pluribus               0.619048
sugarpercent           0.460667
price                  0.282336
winpercent            57.182599
number ingredients     1.619048
Cluster                0.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  1 :  18
Average Attribute Values of Cluster  1 :
chocolate              0.944444
fruity                 0.055556
caramel                0.444444
peanutyalmondy         0.388889
nougat                 0.388889
crispedricewafer       0.333333
hard                   0.055556
bar                    0.944444
pluribus               0.000000
sugarpercent           0.558222
price                  0.341080
winpercent            62.387580
number ingredients     3.555556
Cluster                1.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  2 :  44
Average Attribute Values of Cluster  2 :
chocolate              0.000000
fruity                 0.840909
caramel                0.090909
peanutyalmondy         0.000000
nougat                 0.000000
crispedricewafer       0.000000
hard                   0.318182
bar                    0.000000
pluribus               0.704545
sugarpercent           0.475932
price                  0.161893
winpercent            42.607644
number ingredients     1.250000
Cluster                2.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
#K-Means Clusteranalysis with K=4 and Iterations=20
clusteranalysis (4,20)
```

```
Total Number of Candy in Cluster  0 :  17
Average Attribute Values of Cluster  0 :
chocolate             0.941176
fruity                0.000000
caramel               0.470588
peanutyalmondy        0.411765
nougat                0.411765
crispedricewafer      0.352941
hard                  0.000000
bar                   1.000000
pluribus              0.000000
sugarpercent          0.555529
price                 0.351790
winpercent           63.176105
number ingredients    3.588235
Cluster               0.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  1 :  31
Average Attribute Values of Cluster  1 :
chocolate             0.000000
fruity                0.774194
caramel               0.064516
peanutyalmondy        0.032258
nougat                0.000000
crispedricewafer      0.000000
hard                  0.032258
bar                   0.000000
pluribus              0.806452
sugarpercent          0.450645
price                 0.163437
winpercent           43.054454
number ingredients    0.903226
Cluster               1.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  2 :  15
Average Attribute Values of Cluster  2 :
chocolate             0.066667
fruity                0.933333
caramel               0.133333
peanutyalmondy        0.000000
nougat                0.000000
crispedricewafer      0.000000
hard                  0.933333
bar                   0.000000
pluribus              0.466667
sugarpercent          0.525867
price                 0.164384
winpercent           40.829914
number ingredients    2.066667
Cluster               2.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  3 :  20
Average Attribute Values of Cluster  3 :
chocolate             1.000000
fruity                0.000000
caramel               0.100000
peanutyalmondy        0.300000
nougat                0.000000
crispedricewafer      0.050000
hard                  0.000000
bar                   0.200000
pluribus              0.600000
sugarpercent          0.468050
price                 0.283953
winpercent           58.870837
number ingredients    1.650000
Cluster               3.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
#K-Means Clusteranalysis with K=5 and Iterations=20
clusteranalysis (5,20)
```

```
Total Number of Candy in Cluster  0 :  31
Average Attribute Values of Cluster  0 :
chocolate              0.000000
fruity                 0.774194
caramel                0.064516
peanutyalmondy         0.032258
nougat                 0.000000
crispedricewafer       0.000000
hard                   0.032258
bar                    0.000000
pluribus               0.806452
sugarpercent           0.450645
price                  0.163437
winpercent            43.054454
number ingredients     0.903226
Cluster                0.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  1 :  14
Average Attribute Values of Cluster  1 :
chocolate              0.928571
fruity                 0.000000
caramel                0.071429
peanutyalmondy         0.285714
nougat                 0.214286
crispedricewafer       0.214286
hard                   0.000000
bar                    1.000000
pluribus               0.000000
sugarpercent           0.479571
price                  0.360568
winpercent            57.969371
number ingredients     2.714286
Cluster                1.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  2 :  7
Average Attribute Values of Cluster  2 :
chocolate              1.000000
fruity                 0.000000
caramel                1.000000
peanutyalmondy         0.428571
nougat                 0.571429
crispedricewafer       0.428571
hard                   0.000000
bar                    1.000000
pluribus               0.000000
sugarpercent           0.624000
price                  0.344353
winpercent            67.947497
number ingredients     4.428571
Cluster                2.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  3 :  16
Average Attribute Values of Cluster  3 :
chocolate              1.000000
fruity                 0.000000
caramel                0.125000
peanutyalmondy         0.375000
nougat                 0.000000
crispedricewafer       0.062500
hard                   0.000000
bar                    0.000000
pluribus               0.750000
sugarpercent           0.482687
price                  0.262567
winpercent            60.262929
number ingredients     1.562500
Cluster                3.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
Total Number of Candy in Cluster  4 :  15
Average Attribute Values of Cluster  4 :
chocolate              0.066667
fruity                 0.933333
caramel                0.133333
peanutyalmondy         0.000000
nougat                 0.000000
crispedricewafer       0.000000
hard                   0.933333
bar                    0.000000
pluribus               0.466667
sugarpercent           0.525867
price                  0.164384
winpercent            40.829914
number ingredients     2.066667
Cluster                4.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
#K-Means Clusteranalysis with K=6 and Iterations=20
clusteranalysis (5,20)
```

```
Total Number of Candy in Cluster  0 :  15
Average Attribute Values of Cluster  0 :
chocolate              0.066667
fruity                 0.933333
caramel                0.133333
peanutyalmondy         0.000000
nougat                 0.000000
crispedricewafer       0.000000
hard                   0.933333
bar                    0.000000
pluribus               0.466667
sugarpercent           0.525867
price                  0.164384
winpercent            40.829914
number ingredients     2.066667
Cluster                0.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  1 :  14
Average Attribute Values of Cluster  1 :
chocolate              0.928571
fruity                 0.000000
caramel                0.071429
peanutyalmondy         0.285714
nougat                 0.214286
crispedricewafer       0.214286
hard                   0.000000
bar                    1.000000
pluribus               0.000000
sugarpercent           0.479571
price                  0.360568
winpercent            57.969371
number ingredients     2.714286
Cluster                1.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  2 :  31
Average Attribute Values of Cluster  2 :
chocolate              0.000000
fruity                 0.774194
caramel                0.064516
peanutyalmondy         0.032258
nougat                 0.000000
crispedricewafer       0.000000
hard                   0.032258
bar                    0.000000
pluribus               0.806452
sugarpercent           0.450645
price                  0.163437
winpercent            43.054454
number ingredients     0.903226
Cluster                2.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
Total Number of Candy in Cluster  3 :  16
Average Attribute Values of Cluster  3 :
chocolate              1.000000
fruity                 0.000000
caramel                0.125000
peanutyalmondy         0.375000
nougat                 0.000000
crispedricewafer       0.062500
hard                   0.000000
bar                    0.000000
pluribus               0.750000
sugarpercent           0.482687
price                  0.262567
winpercent            60.262929
number ingredients     1.562500
Cluster                3.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  4 :  7
Average Attribute Values of Cluster  4 :
chocolate              1.000000
fruity                 0.000000
caramel                1.000000
peanutyalmondy         0.428571
nougat                 0.571429
crispedricewafer       0.428571
hard                   0.000000
bar                    1.000000
pluribus               0.000000
sugarpercent           0.624000
price                  0.344353
winpercent            67.947497
number ingredients     4.428571
Cluster                4.000000
dtype: float64

---------------------------------------------------------------------------------------------
```

```
clusteranalysis (6,20)
```

```
Total Number of Candy in Cluster  0 :  24
Average Attribute Values of Cluster  0 :
chocolate              0.000000
fruity                 1.000000
caramel                0.000000
peanutyalmondy         0.000000
nougat                 0.000000
crispedricewafer       0.000000
hard                   0.000000
bar                    0.000000
pluribus               0.791667
sugarpercent           0.419917
price                  0.160449
winpercent            46.083574
number ingredients     1.000000
Cluster                0.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  1 :  14
Average Attribute Values of Cluster  1 :
chocolate              0.928571
fruity                 0.000000
caramel                0.071429
peanutyalmondy         0.285714
nougat                 0.214286
crispedricewafer       0.214286
hard                   0.000000
bar                    1.000000
pluribus               0.000000
sugarpercent           0.479571
price                  0.360568
winpercent            57.969371
number ingredients     2.714286
Cluster                1.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  2 :  14
```

```
Average Attribute Values of Cluster  2 :
chocolate             0.500000
fruity                0.000000
caramel               0.142857
peanutyalmondy        0.071429
nougat                0.000000
crispedricewafer      0.000000
hard                  0.071429
bar                   0.000000
pluribus              0.857143
sugarpercent          0.429643
price                 0.185875
winpercent           40.661888
number ingredients     0.785714
Cluster               2.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  3 :  7
Average Attribute Values of Cluster  3 :
chocolate             1.000000
fruity                0.000000
caramel               1.000000
peanutyalmondy        0.428571
nougat                0.571429
crispedricewafer      0.428571
hard                  0.000000
bar                   1.000000
pluribus              0.000000
sugarpercent          0.624000
price                 0.344353
winpercent           67.947497
number ingredients     4.428571
Cluster               3.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  4 :  15
Average Attribute Values of Cluster  4 :
chocolate             0.066667
fruity                0.933333
caramel               0.133333
peanutyalmondy        0.000000
nougat                0.000000
crispedricewafer      0.000000
hard                  0.933333
bar                   0.000000
pluribus              0.466667
sugarpercent          0.525867
price                 0.164384
winpercent           40.829914
number ingredients     2.066667
Cluster               4.000000
dtype: float64

---------------------------------------------------------------------------------------------

Total Number of Candy in Cluster  5 :  9
Average Attribute Values of Cluster  5 :
chocolate             1.000000
fruity                0.000000
caramel               0.222222
peanutyalmondy        0.666667
nougat                0.000000
crispedricewafer      0.111111
hard                  0.000000
bar                   0.000000
pluribus              0.666667
sugarpercent          0.622222
price                 0.312731
winpercent           69.291416
number ingredients     2.000000
Cluster               5.000000
dtype: float64

---------------------------------------------------------------------------------------------
```