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Факультет «Информатика и системы управления»
Кафедра «Системы обработки информации и управления»

Лабораторная работа №2
по дисциплине «Методы машинного обучения»
«Обработка признаков (часть 1)»

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Задание

1. Выбрать набор данных (датасет), содержащий категориальные и числовые признаки и пропуски в данных. Для выполнения следующих пунктов можно использовать несколько различных наборов данных (один для обработки пропусков, другой для категориальных признаков и т.д.) Просьба не использовать датасет, на котором данная задача решалась в лекции.

2. Для выбранного датасета (датасетов) на основе материалов лекций решить следующие задачи:

   - устранение пропусков в данных;
   - кодирование категориальных признаков;
   - нормализация числовых признаков.

Lab2

June 20, 2023

0.1

```
[ ]: import numpy as np
     import pandas as pd
     import matplotlib.pyplot as plt
     import seaborn as sns
     import scipy.stats as stats
```

```
[ ]: data = pd.read_csv("cars2.csv")
```

```
[ ]: data.head()
```

```
[ ]:    mileage        make   model      fuel    gear offerType  price     hp  year
     0   235000         BMW     316    Diesel  Manual      Used   6800  116.0  2011
     1    92800  Volkswagen    Golf  Gasoline  Manual      Used   6877  122.0  2011
     2   149300        SEAT    Exeo  Gasoline  Manual      Used   6900  160.0  2011
     3    96200     Renault  Megane  Gasoline  Manual      Used   6950  110.0  2011
     4   156000     Peugeot     308  Gasoline  Manual      Used   6950  156.0  2011
```

```
[ ]: data_features = list(zip(
     [i for i in data.columns], #
     zip(
         [str(i) for i in data.dtypes], #
         [i for i in data.isnull().sum()] #
     )))
     data_features #
```

```
[ ]: [('mileage', ('int64', 0)),
      ('make', ('object', 0)),
      ('model', ('object', 143)),
      ('fuel', ('object', 0)),
      ('gear', ('object', 182)),
      ('offerType', ('object', 0)),
      ('price', ('int64', 0)),
      ('hp', ('float64', 29)),
      ('year', ('int64', 0))]
```

0.2

```
[ ]: #    (    )
     [(c, data[c].isnull().mean()) for c in data.columns]
```

```
[ ]: [('mileage', 0.0),
      ('make', 0.0),
      ('model', 0.0030815644865854973),
      ('fuel', 0.0),
      ('gear', 0.003921991164745178),
      ('offerType', 0.0),
      ('price', 0.0),
      ('hp', 0.0006249326581187372),
      ('year', 0.0)]
```

```
[ ]: #           ,
     data.dropna(axis=1, how='any')
```

```
[ ]:       mileage        make             fuel      offerType  price  year
     0      235000         BMW           Diesel           Used   6800  2011
     1       92800  Volkswagen         Gasoline           Used   6877  2011
     2      149300        SEAT         Gasoline           Used   6900  2011
     3       96200     Renault         Gasoline           Used   6950  2011
     4      156000     Peugeot         Gasoline           Used   6950  2011
     …           …           …                …              …    …     …
     46400      99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46401      99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46402      99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46403      99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46404      99        Fiat  Electric/Gasoline  Pre-registered  12990  2021

     [46405 rows x 6 columns]
```

```
[ ]: #                               (    50%)
     data.dropna(axis=1, thresh=730)
```

```
[ ]:       mileage        make   model               fuel    gear       offerType  \
     0      235000         BMW     316             Diesel  Manual            Used
     1       92800  Volkswagen    Golf           Gasoline  Manual            Used
     2      149300        SEAT    Exeo           Gasoline  Manual            Used
     3       96200     Renault  Megane           Gasoline  Manual            Used
     4      156000     Peugeot     308           Gasoline  Manual            Used
     …           …           …       …                  …       …               …
     46400      99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46401      99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46402      99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46403      99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46404      99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
```

```
       price     hp  year
0       6800  116.0  2011
1       6877  122.0  2011
2       6900  160.0  2011
3       6950  110.0  2011
4       6950  156.0  2011
…        …     …    …
46400  12990   71.0  2021
46401  12990   71.0  2021
46402  12990   71.0  2021
46403  12990   71.0  2021
46404  12990   71.0  2021

[46405 rows x 9 columns]
```

[ ]:
```
#           hp
def impute_na(df, variable, value):
    df[variable].fillna(value, inplace=True)
impute_na(data, 'hp', data['hp'].mean())
```

[ ]:
```
#      ,         hp
data.isnull().sum()
```

[ ]:
```
mileage        0
make           0
model        143
fuel           0
gear         182
offerType      0
price          0
hp             0
year           0
dtype: int64
```

0.3

[ ]:
```
from sklearn.preprocessing import LabelEncoder
```

[ ]:
```
le = LabelEncoder()
cat_enc_le = le.fit_transform(data['gear'])
```

[ ]:
```
data['gear'].unique()
```

[ ]:
```
array(['Manual', 'Automatic', nan, 'Semi-automatic'], dtype=object)
```

[ ]:
```
np.unique(cat_enc_le)
```

```
[ ]: array([0, 1, 2, 3])
```

```
[ ]: le.inverse_transform([0, 1, 2, 3])
```

```
[ ]: array(['Automatic', 'Manual', 'Semi-automatic', nan], dtype=object)
```

```
[ ]: data['make'].unique()
```

```
[ ]: array(['BMW', 'Volkswagen', 'SEAT', 'Renault', 'Peugeot', 'Toyota',
            'Opel', 'Mazda', 'Ford', 'Mercedes-Benz', 'Chevrolet', 'Audi',
            'Fiat', 'Kia', 'Dacia', 'MINI', 'Hyundai', 'Skoda', 'Citroen',
            'Infiniti', 'Suzuki', 'SsangYong', 'smart', 'Cupra', 'Volvo',
            'Jaguar', 'Porsche', 'Nissan', 'Honda', 'Lada', 'Mitsubishi',
            'Others', 'Lexus', 'Jeep', 'Maserati', 'Bentley', 'Land', 'Alfa',
            'Subaru', 'Dodge', 'Microcar', 'Lamborghini', 'Baic', 'Tesla',
            'Chrysler', '9ff', 'McLaren', 'Aston', 'Rolls-Royce', 'Alpine',
            'Lancia', 'Abarth', 'DS', 'Daihatsu', 'Ligier', 'Ferrari',
            'Caravans-Wohnm', 'Aixam', 'Piaggio', 'Zhidou', 'Morgan',
            'Maybach', 'Tazzari', 'Trucks-Lkw', 'RAM', 'Iveco', 'DAF',
            'Alpina', 'Polestar', 'Brilliance', 'FISKER', 'Cadillac',
            'Trailer-Anhänger', 'Isuzu', 'Corvette', 'DFSK', 'Estrima'],
           dtype=object)
```

```
[ ]: pip install category_encoders
```

```
Requirement already satisfied: category_encoders in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (2.6.1)
Requirement already satisfied: numpy>=1.14.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (1.25.0)
Requirement already satisfied: scikit-learn>=0.20.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (1.2.2)
Requirement already satisfied: scipy>=1.0.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (1.10.1)
Requirement already satisfied: statsmodels>=0.9.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (0.14.0)
Requirement already satisfied: pandas>=1.0.5 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (2.0.2)
Requirement already satisfied: patsy>=0.5.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (0.5.3)
Requirement already satisfied: python-dateutil>=2.8.2 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
pandas>=1.0.5->category_encoders) (2.8.2)
```

```
Requirement already satisfied: pytz>=2020.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
pandas>=1.0.5->category_encoders) (2023.3)
Requirement already satisfied: tzdata>=2022.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
pandas>=1.0.5->category_encoders) (2023.3)
Requirement already satisfied: six in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
patsy>=0.5.1->category_encoders) (1.16.0)
Requirement already satisfied: joblib>=1.1.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from scikit-
learn>=0.20.0->category_encoders) (1.2.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from scikit-
learn>=0.20.0->category_encoders) (3.1.0)
Requirement already satisfied: packaging>=21.3 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
statsmodels>=0.9.0->category_encoders) (23.1)
Note: you may need to restart the kernel to use updated packages.
```

[ ]:
```
#CountEncoder
from category_encoders.count import CountEncoder as ce_CountEncoder
```

[ ]:
```
ce_CountEncoder1 = ce_CountEncoder()
data_COUNT_ENC = ce_CountEncoder1.fit_transform(data[data.columns.
 ↪difference(['model'])])
```

[ ]:
```
data_COUNT_ENC.head()
```

[ ]:
```
    fuel   gear     hp  make  mileage  offerType  price  year
0  15244  30380  116.0  2405   235000      40122   6800  2011
1  28864  30380  122.0  6931    92800      40122   6877  2011
2  28864  30380  160.0  1924   149300      40122   6900  2011
3  28864  30380  110.0  2830    96200      40122   6950  2011
4  28864  30380  156.0  1232   156000      40122   6950  2011
```

[ ]:
```
data['offerType'].unique()
```

[ ]:
```
array(['Used', 'Demonstration', "Employee's car", 'Pre-registered', 'New'],
      dtype=object)
```

[ ]:
```
data_COUNT_ENC['offerType'].unique()
```

[ ]:
```
array([40122,  2368,  1122,  2780,    13])
```

[ ]:
```
ce_CountEncoder2 = ce_CountEncoder(normalize=True)
data_FREQ_ENC = ce_CountEncoder2.fit_transform(data[data.columns.
 ↪difference(['model'])])
```

```
[ ]: data_FREQ_ENC['offerType'].unique()
```

```
[ ]: array([8.64605107e-01, 5.10289839e-02, 2.41784290e-02, 5.99073376e-02,
            2.80142226e-04])
```

```
[ ]: from category_encoders.helmert import HelmertEncoder as ce_HelmertEncoder
```

```
[ ]: #HelmetEncoder
     ce_HelmertEncoder1 = ce_HelmertEncoder()
     data_HELM_ENC = ce_HelmertEncoder1.fit_transform(data[data.columns.
      ↪difference(['model'])], data['model'])
```

```
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-
packages/category_encoders/base_contrast_encoder.py:126: FutureWarning:
Intercept column might not be added anymore in future releases (c.f. issue #370)
  warnings.warn("Intercept column might not be added anymore in future releases
(c.f. issue #370)",
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-
packages/category_encoders/base_contrast_encoder.py:126: FutureWarning:
Intercept column might not be added anymore in future releases (c.f. issue #370)
  warnings.warn("Intercept column might not be added anymore in future releases
(c.f. issue #370)",
```

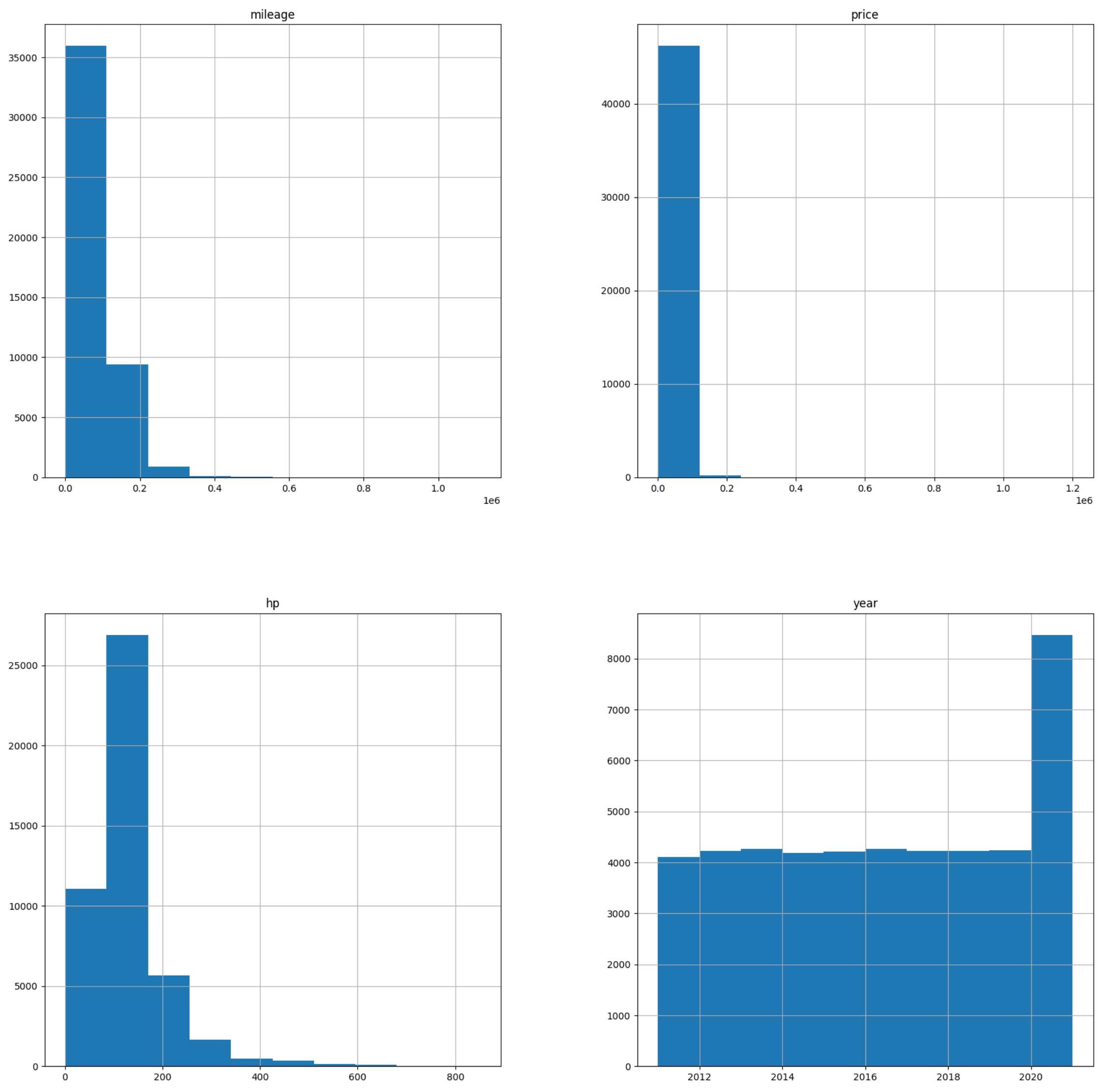
```
[ ]: data_HELM_ENC.head()
```

```
[ ]:    intercept  fuel_0  fuel_1  fuel_2  fuel_3  fuel_4  fuel_5  fuel_6  fuel_7  \
     0          1    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0
     1          1     1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0
     2          1     1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0
     3          1     1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0
     4          1     1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0    -1.0

        fuel_8  …  make_73  make_74  make_75  mileage  offerType_0  offerType_1  \
     0    -1.0  …     -1.0     -1.0     -1.0   235000         -1.0         -1.0
     1    -1.0  …     -1.0     -1.0     -1.0    92800         -1.0         -1.0
     2    -1.0  …     -1.0     -1.0     -1.0   149300         -1.0         -1.0
     3    -1.0  …     -1.0     -1.0     -1.0    96200         -1.0         -1.0
     4    -1.0  …     -1.0     -1.0     -1.0   156000         -1.0         -1.0

        offerType_2  offerType_3  price  year
     0         -1.0         -1.0   6800  2011
     1         -1.0         -1.0   6877  2011
     2         -1.0         -1.0   6900  2011
     3         -1.0         -1.0   6950  2011
     4         -1.0         -1.0   6950  2011

     [5 rows x 98 columns]
```

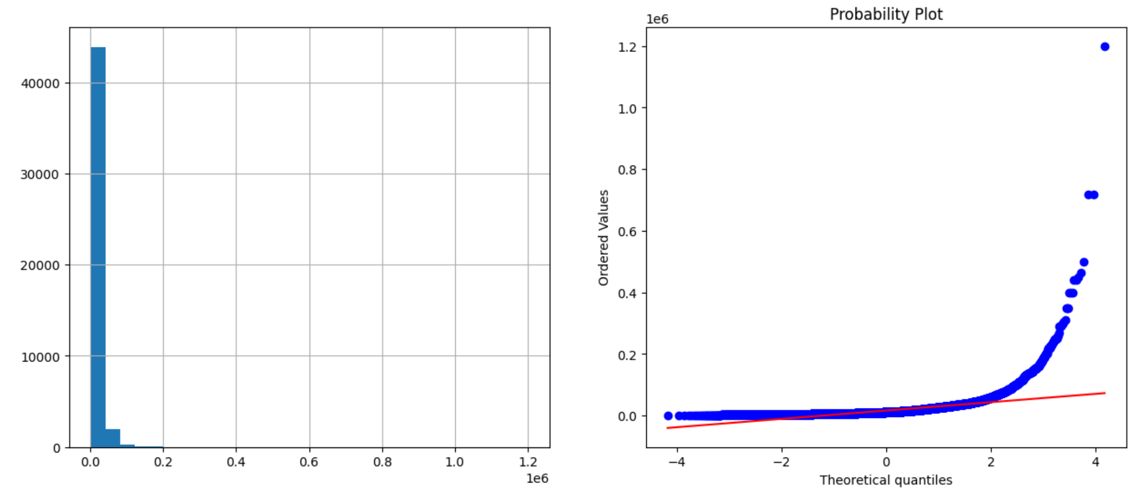
0.4

[ ]:
```python
def diagnostic_plots(df, variable):
    plt.figure(figsize=(15,6))
    #
    plt.subplot(1, 2, 1)
    df[variable].hist(bins=30)
    ## Q-Q plot
    plt.subplot(1, 2, 2)
    stats.probplot(df[variable], dist="norm", plot=plt)
    plt.show()
```

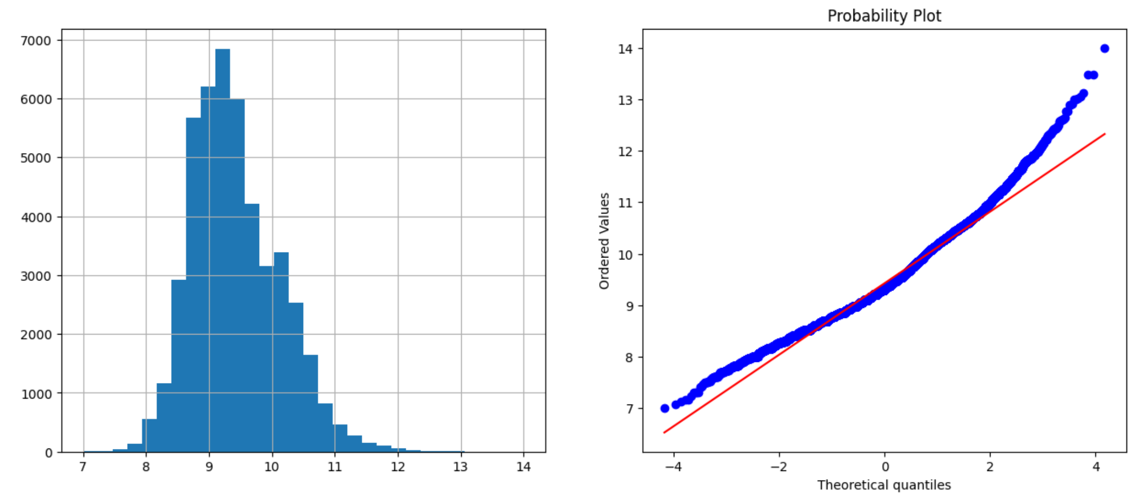
[ ]:
```python
data.hist(figsize=(20,20))
plt.show()
```



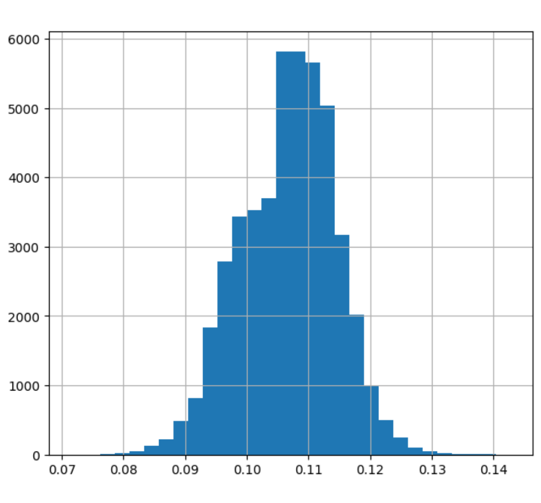
[ ]:
```
diagnostic_plots(data, 'price')
```

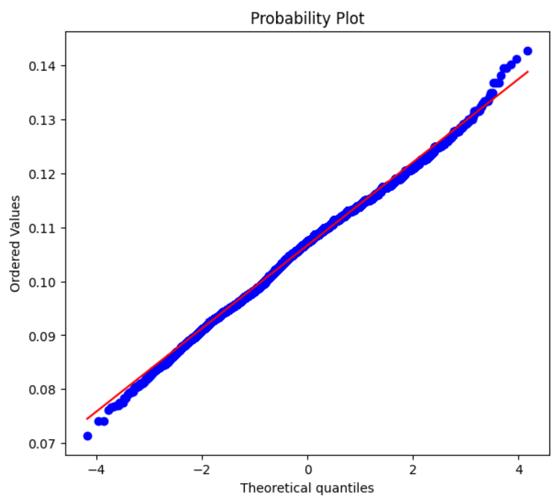


[ ]:
```
#
data['price'] = np.log(data['price'])
diagnostic_plots(data, 'price')
```

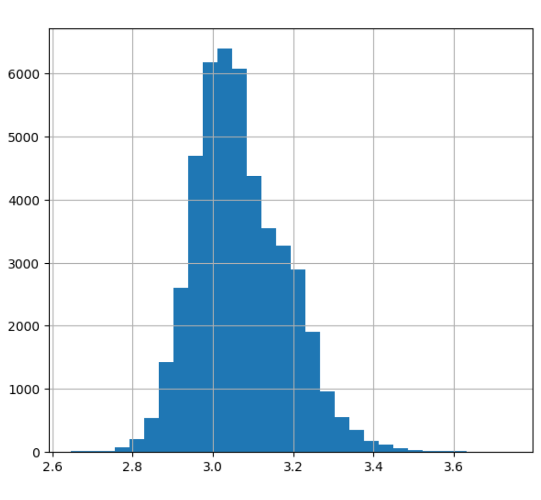


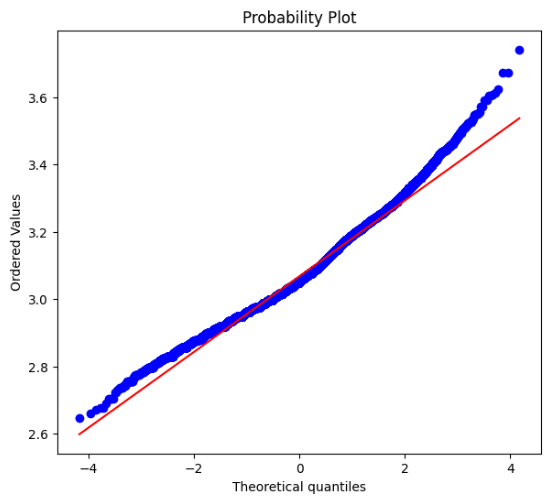
[ ]:
```
#
data['price_reciprocal'] = 1 / (data['price'])
diagnostic_plots(data, 'price_reciprocal')
```



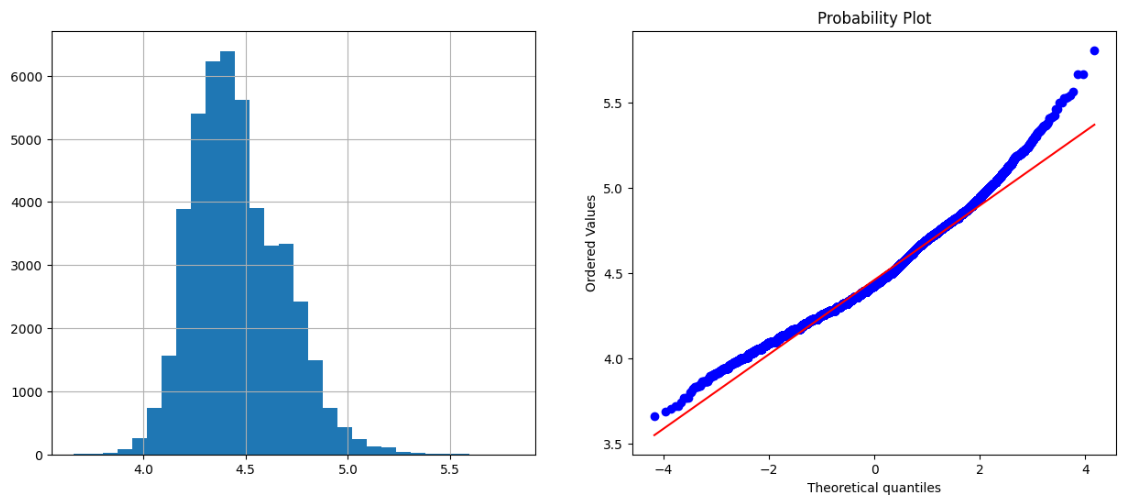


```
[ ]: #
     data['price_sqr'] = data['price']**(1/2)
     diagnostic_plots(data, 'price_sqr')
```

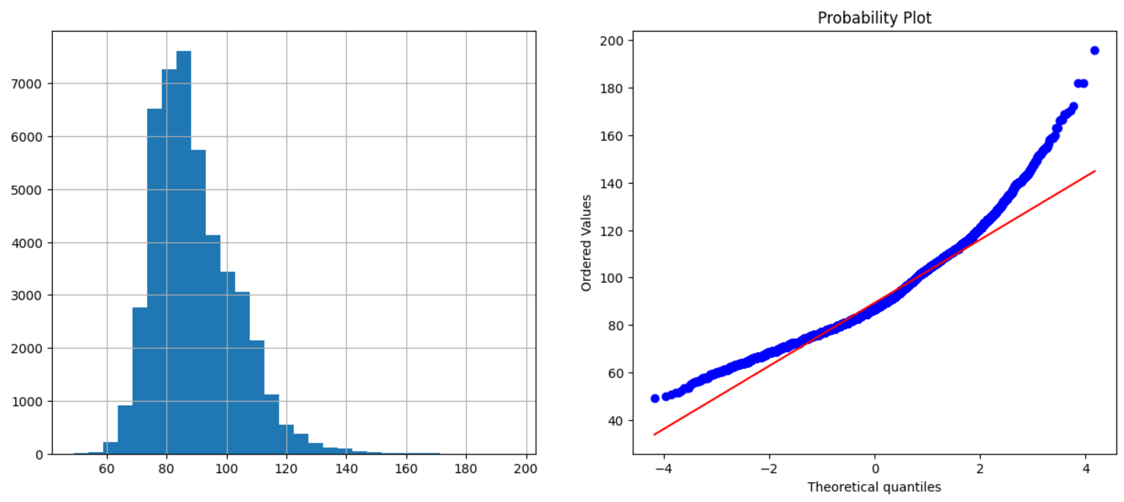




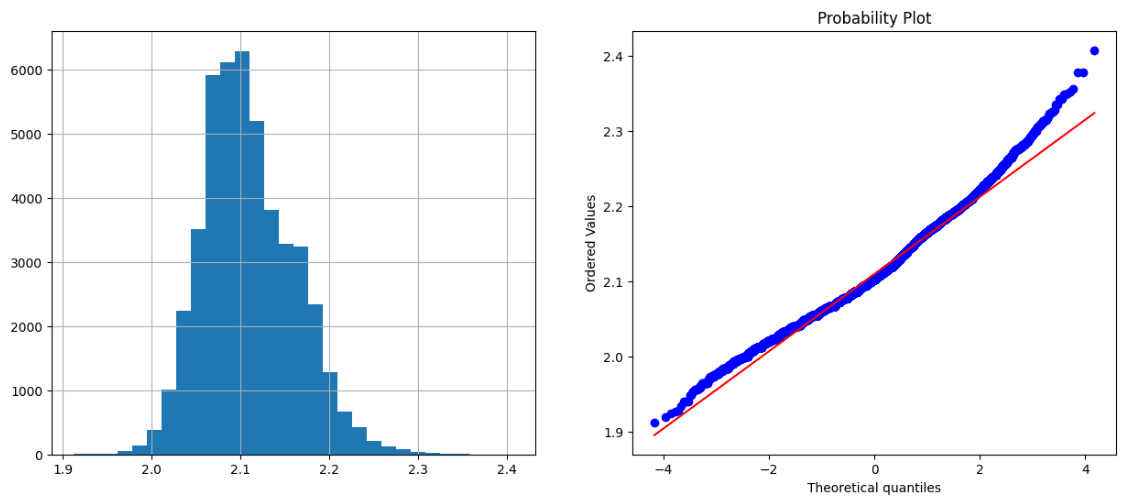
```
[ ]: #
     data['price_exp1'] = data['price']**(1/1.5)
     diagnostic_plots(data, 'price_exp1')
```



```
[ ]: data['price_exp2'] = data['price']**(2)
     diagnostic_plots(data, 'price_exp2')
```

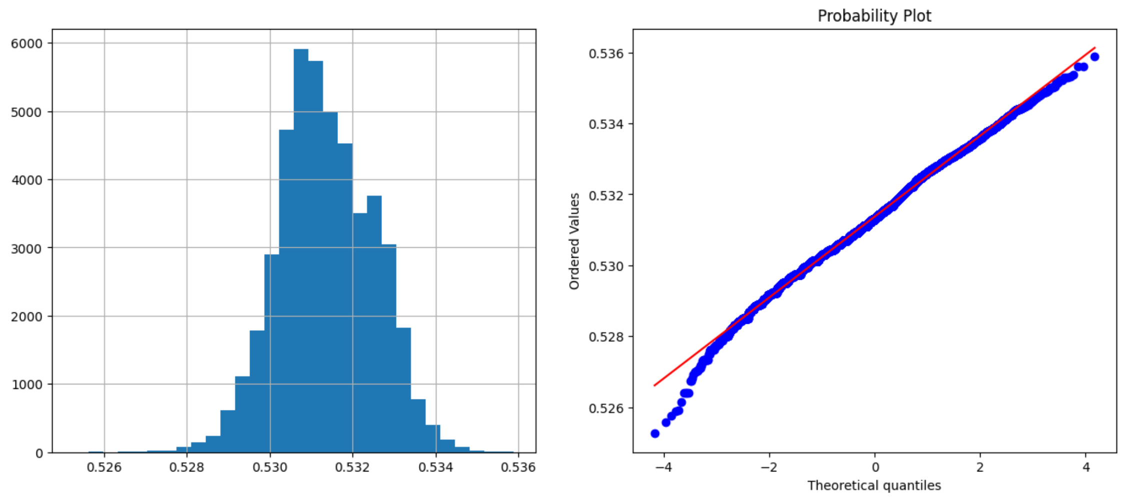


```
[ ]: data['price_exp3'] = data['price']**(0.333)
     diagnostic_plots(data, 'price_exp3')
```



```
[ ]: #            –
     data['price_boxcox'], param = stats.boxcox(data['price'])
     print('                  = {}'.format(param))
     diagnostic_plots(data, 'price_boxcox')
```

```
                = -1.8519809069200015
```


Probability Plot
Ordered Values
Theoretical quantiles