Wine Reviews

1.引包

```
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np
import seaborn as sns
```

2.读入数据

```
data_ori = pd.read_csv("archive/winemag-data_first150k.csv", index_col=0)
data_ori
```

	country	description	designation	points	price	province	region_1	region_2	variety	winery
0	US	This tremendous 100% varietal wine hails from ...	Martha's Vineyard	96	235.0	California	Napa Valley	Napa	Cabernet Sauvignon	Heitz
1	Spain	Ripe aromas of fig, blackberry and cassis are ...	Carodorum Selección Especial Reserva	96	110.0	Northern Spain	Toro	NaN	Tinta de Toro	Bodega Carmen Rodríguez
2	US	Mac Watson honors the memory of a wine once ma...	Special Selected Late Harvest	96	90.0	California	Knights Valley	Sonoma	Sauvignon Blanc	Macauley
3	US	This spent 20 months in 30% new French oak, an...	Reserve	96	65.0	Oregon	Willamette Valley	Willamette Valley	Pinot Noir	Ponzi
4	France	This is the top wine from La Bégude, named aft...	La Brûlade	95	66.0	Provence	Bandol	NaN	Provence red blend	Domaine de la Bégude
...	...	...	...	...	...	...	...	...	...	...
150925	Italy	Many people feel Fiano represents southern Ita...	NaN	91	20.0	Southern Italy	Fiano di Avellino	NaN	White Blend	Feudi di San Gregorio
150926	France	Offers an intriguing nose with ginger, lime an...	Cuvée Prestige	91	27.0	Champagne	Champagne	NaN	Champagne Blend	H.Germain
150927	Italy	This classic example comes from a cru vineyard...	Terre di Dora	91	20.0	Southern Italy	Fiano di Avellino	NaN	White Blend	Terredora
150928	France	A perfect salmon shade, with scents of peaches...	Grand Brut Rosé	90	52.0	Champagne	Champagne	NaN	Champagne Blend	Gosset
150929	Italy	More Pinot Grigios should taste like this. A r...	NaN	90	15.0	Northeastern Italy	Alto Adige	NaN	Pinot Grigio	Alois Lageder

150930 rows × 10 columns

由数据示例可以发现，region_2包含了大量空值，更具体的地点与本次数据分析无关，故删去该属性 同时，description也无需在本次数据分析中使用，故也删去该属性

```
# 删去region_2 和 description
data = data_ori.drop(['region_2','description'], axis=1)
data
```

	country	designation	points	price	province	region_1	variety	winery
0	US	Martha's Vineyard	96	235.0	California	Napa Valley	Cabernet Sauvignon	Heitz
1	Spain	Carodorum Selección Especial Reserva	96	110.0	Northern Spain	Toro	Tinta de Toro	Bodega Carmen Rodríguez
2	US	Special Selected Late Harvest	96	90.0	California	Knights Valley	Sauvignon Blanc	Macauley
3	US	Reserve	96	65.0	Oregon	Willamette Valley	Pinot Noir	Ponzi
4	France	La Brûlade	95	66.0	Provence	Bandol	Provence red blend	Domaine de la Bégude
...	...	...	...	...	...	...	...	...
150925	Italy	NaN	91	20.0	Southern Italy	Fiano di Avellino	White Blend	Feudi di San Gregorio
150926	France	Cuvée Prestige	91	27.0	Champagne	Champagne	Champagne Blend	H.Germain
150927	Italy	Terre di Dora	91	20.0	Southern Italy	Fiano di Avellino	White Blend	Terredora
150928	France	Grand Brut Rosé	90	52.0	Champagne	Champagne	Champagne Blend	Gosset
150929	Italy	NaN	90	15.0	Northeastern Italy	Alto Adige	Pinot Grigio	Alois Lageder

150930 rows × 8 columns

3.数据摘要

3.1 数据总览

```
data_src.describe()
```

	points	price

count	150930.000000	137235.000000
mean	87.888418	33.131482
std	3.222392	36.322536
min	80.000000	4.000000
25%	86.000000	16.000000
50%	88.000000	24.000000
75%	90.000000	40.000000
max	100.000000	2300.000000

3.2 数据频数

3.2.1数值展示数据频数

```
# 每个属性中，每个数值的频次信息
for column_name in data:
    print("--------------分割线--------------")
    print("%s的总描述:\n"%(column_name),data[column_name].describe())
    print("%s的每个值的频次:\n"%(column_name),data[column_name].value_counts())
```

```
--------------分割线--------------
country的总描述:
 count     150925
unique        48
top           US
freq       62397
Name: country, dtype: object
country的每个值的频次:
 US                        62397
Italy                     23478
France                    21098
Spain                      8268
Chile                      5816
Argentina                  5631
Portugal                   5322
Australia                  4957
New Zealand                3320
Austria                    3057
Germany                    2452
South Africa               2258
Greece                      884
Israel                      630
Hungary                     231
Canada                      196
Romania                     139
Slovenia                     94
Uruguay                      92
Croatia                      89
Bulgaria                     77
Moldova                      71
Mexico                       63
Turkey                       52
Georgia                      43
Lebanon                      37
Cyprus                       31
Brazil                       25
Macedonia                    16
Serbia                       14
```

```
Morocco                      12
Luxembourg                    9
England                       9
Lithuania                     8
India                         8
Czech Republic                6
Ukraine                       5
Switzerland                   4
South Korea                   4
Bosnia and Herzegovina        4
Slovakia                      3
Egypt                         3
China                         3
Tunisia                       2
Montenegro                    2
Albania                       2
Japan                         2
US-France                     1
Name: country, dtype: int64
-------------分割线-------------
designation的总描述:
 count      105195
unique      30621
top       Reserve
freq         2752
Name: designation, dtype: object
designation的每个值的频次:
 Reserve                 2752
Reserva                 1810
Estate                  1571
Barrel sample           1326
Riserva                  754
                        ...
Portal da Calçada          1
Barone Neri del Nero       1
Bucellas                   1
Pingus                     1
Grazia                     1
Name: designation, Length: 30621, dtype: int64
-------------分割线-------------
points的总描述:
 count    150930.000000
mean         87.888418
std           3.222392
min          80.000000
25%          86.000000
50%          88.000000
75%          90.000000
max         100.000000
Name: points, dtype: float64
points的每个值的频次:
 87     20747
88     17871
90     15973
86     15573
89     12921
85     12411
84     10708
91     10536
92      9241
83      6048
93      6017
82      4041
94      3462
95      1716
81      1502
80       898
96       695
97       365
98       131
99        50
100       24
Name: points, dtype: int64
-------------分割线-------------
```

```
price的总描述:
 count    137235.000000
mean         33.131482
std          36.322536
min           4.000000
25%          16.000000
50%          24.000000
75%          40.000000
max        2300.000000
Name: price, dtype: float64
price的每个值的频次:
 20.0     7860
15.0     7056
18.0     5988
25.0     5955
30.0     5449
         ...
740.0       1
545.0       1
351.0       1
698.0       1
588.0       1
Name: price, Length: 357, dtype: int64
-------------分割线-------------
province的总描述:
 count         150925
unique           455
top       California
freq           44508
Name: province, dtype: object
province的每个值的频次:
 California                  44508
Washington                   9750
Tuscany                      7281
Bordeaux                     6111
Northern Spain               4892
                            ...
Ella Valley                     1
Ticino                          1
Viile Carasului                 1
Pafos                           1
Central Otago-Marlborough       1
Name: province, Length: 455, dtype: int64
-------------分割线-------------
region_1的总描述:
 count          125870
unique           1236
top       Napa Valley
freq             6209
Name: region_1, dtype: object
region_1的每个值的频次:
 Napa Valley                 6209
Columbia Valley (WA)        4975
Mendoza                     3586
Russian River Valley        3571
California                  3462
                            ...
Santa Clara County             1
Listrac                        1
Vin de Pays de Hauterive       1
Jujuy                          1
Napa Valley-Paso Robles        1
Name: region_1, Length: 1236, dtype: int64
-------------分割线-------------
variety的总描述:
 count         150930
unique           632
top       Chardonnay
freq           14482
Name: variety, dtype: object
variety的每个值的频次:
 Chardonnay                  14482
Pinot Noir                  14291
Cabernet Sauvignon          12800
```

```
Red Blend                   10062
Bordeaux-style Red Blend     7347
                            ...
Muscat Hamburg                 1
Baga-Touriga Nacional          1
Moristel                       1
Syrah-Carignan                 1
Kinali Yapincak                1
Name: variety, Length: 632, dtype: int64
-------------分割线-------------
winery的总描述:
 count              150930
unique              14810
top       Williams Selyem
freq                  374
Name: winery, dtype: object
winery的每个值的频次:
 Williams Selyem          374
Testarossa               274
DFJ Vinhos               258
Chateau Ste. Michelle    225
Columbia Crest           217
                        ...
Domaine Jean Chartron      1
Terras de Lantaño          1
Reynolds                   1
Château Laroze             1
Monte delle Vigne          1
Name: winery, Length: 14810, dtype: int64
```

3.2.2数据频数可视化

分析一下每个数据的数据类型

```
for column_name in data:
    print("%s的数据类型是"%(column_name),type(data[column_name][0]))
```

```
country的数据类型是 <class 'str'>
designation的数据类型是 <class 'str'>
points的数据类型是 <class 'numpy.int64'>
price的数据类型是 <class 'numpy.float64'>
province的数据类型是 <class 'str'>
region_1的数据类型是 <class 'str'>
variety的数据类型是 <class 'str'>
winery的数据类型是 <class 'str'>
```

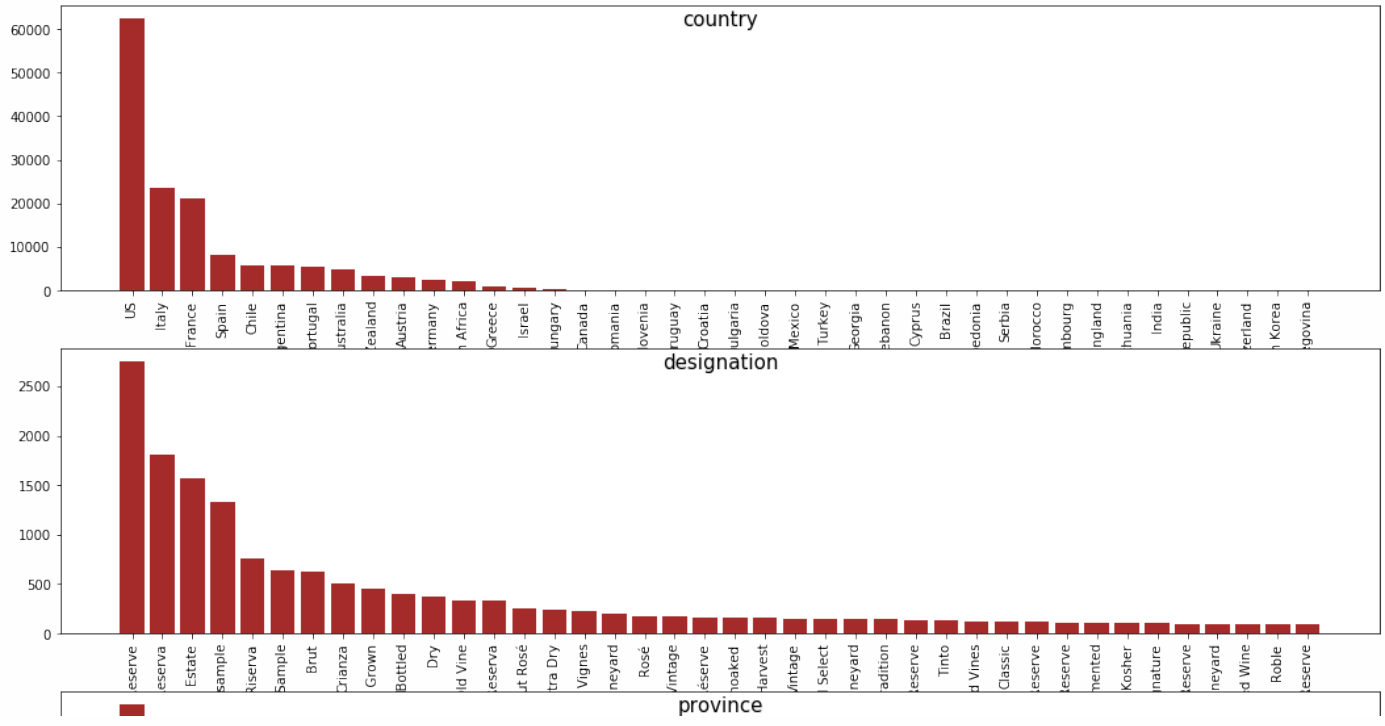
可以发现，数据主要是由:
数值型数据：**1、points的int；2、price的float64**
标称型数据：**1、country、designation、province、region_1、variety、winery的str类型**
以上组成

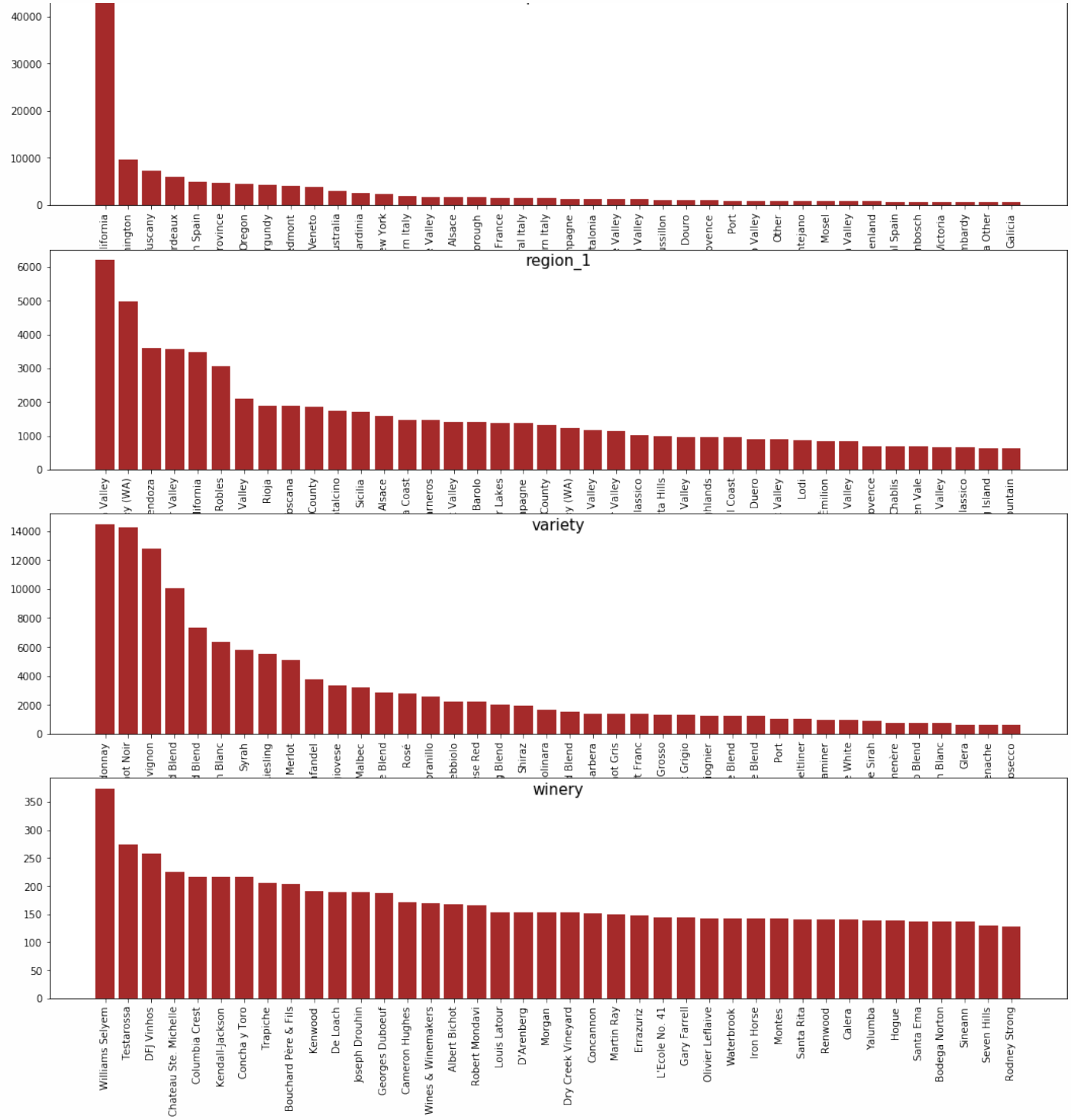
```
# 此处得到提示：string dtypes不被允许，使用'object'替代
# 标称型数据
nom_features = list(data.select_dtypes(include="object"))
# 数值型数据
num_features = list(data.select_dtypes(include=["int","float"]))

# 查看结果
print("nom_features是：",nom_features)
print("num_features是：",num_features)
```

```
nom_features是：  ['country', 'designation', 'province', 'region_1', 'variety', 'winery']
num_features是：  ['points', 'price']
```

3.2.1 标称型数据频数可视化

```
# 标称型数据频数
def NomFeaFreqs(data,data_contrast=None):
    plt.figure(figsize=(18,28))
    i = 1
    # 获取属性中各数值的频次
    def getFreqList(data,nom_feature_name):

        # dict将Series数据类型转化为dict数据类型
        freqs = dict(data[nom_feature_name].value_counts())

        # 如果数量过多，只保留频次数最高的max40个
        max = 40
        if len(freqs) > max:
            freqs = [list(freqs.keys())[:max],list(freqs.values())[:max]]
        else:
            freqs = [freqs.keys(),freqs.values()]
        return freqs

    # 绘图
    for nom_feature_name in nom_features:
        if data_contrast is None:
            freqs = getFreqList(data,nom_feature_name)
            plt.subplot(6,1,i)
            i = i+1
            plt.bar(freqs[0],freqs[1],color='brown')
            plt.xticks(rotation=90)
            plt.title(nom_feature_name,y=0.9,fontdict={'weight':'normal','size': 15})
        else:
            freqs1 = getFreqList(data,nom_feature_name)
            freqs2 = getFreqList(data_contrast,nom_feature_name)

            plt.subplot(6,2,i)
            i = i+1
            plt.bar(freqs1[0],freqs1[1],color='brown')
            plt.xticks(rotation=90)
            plt.title(nom_feature_name,y=0.9,fontdict={'weight':'normal','size': 15})

            plt.subplot(6,2,i)
            i = i+1
            plt.bar(freqs2[0],freqs2[1],color='green')
            plt.xticks(rotation=90)
            plt.title(nom_feature_name,y=0.9,fontdict={'weight':'normal','size': 15})
NomFeaFreqs(data)
```

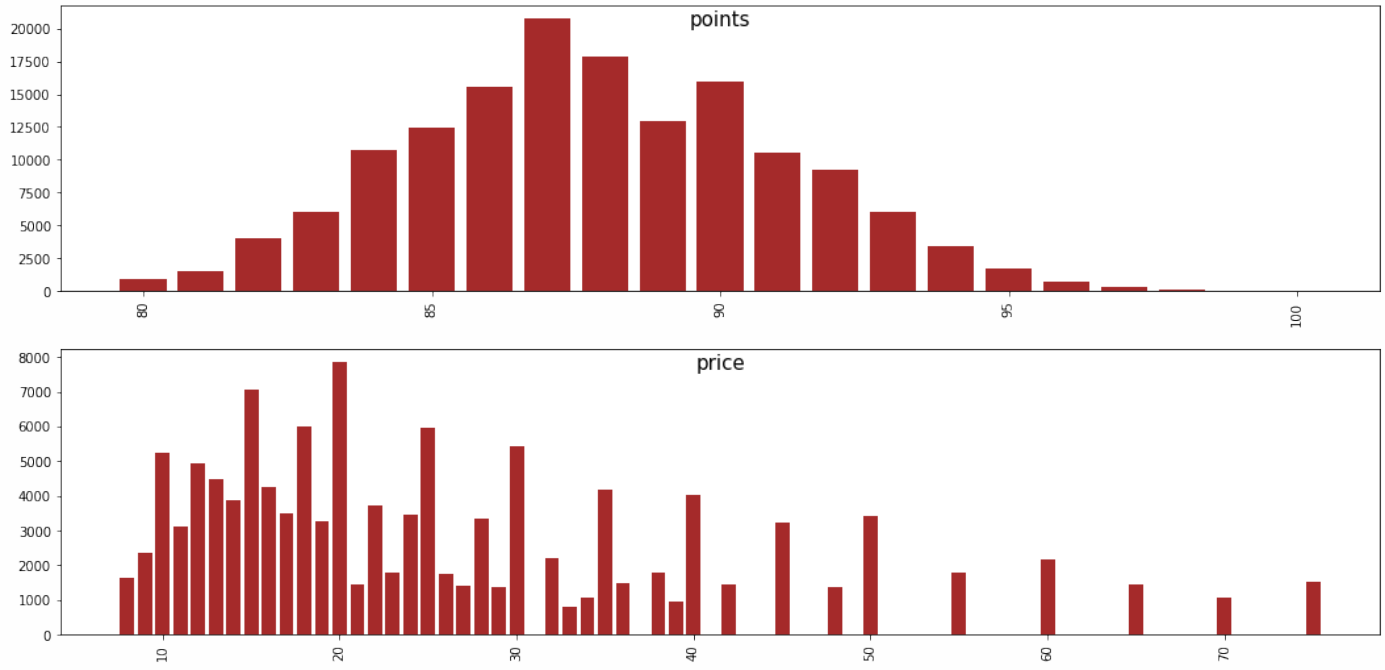




3.2.2 数值型数据频数可视化

```
# 数值型数据频数
def NumFeaFreqs(data,data_contrast=None):
    plt.figure(figsize=(18,28))
    i = 1
    # 获取属性中各数值的频次
    def getFreqList(data,num_feature_name):

        # dict将Series数据类型转化为dict数据类型
        freqs = dict(data[num_feature_name].value_counts())

        # 如果数量过多，只保留频次数最高的max40个
        max = 40
        if len(freqs) > max:
            freqs = [list(freqs.keys())[:max],list(freqs.values())[:max]]
        else:
            freqs = [freqs.keys(),freqs.values()]
```

```
        return freqs

    # 绘图
    for num_feature_name in num_features:
        if data_contrast is None:
            freqs = getFreqList(data,num_feature_name)
            plt.subplot(6,1,i)
            i = i+1
            plt.bar(freqs[0],freqs[1],color='brown')
            plt.xticks(rotation=90)
            plt.title(num_feature_name,y=0.9,fontdict={'weight':'normal','size': 15})
        else:
            freqs1 = getFreqList(data,num_fea_name)
            freqs2 = getFreqList(data_contrast,num_fea_name)

            plt.subplot(6,2,i)
            i = i+1
            plt.bar(freqs1[0],freqs1[1])
            plt.xticks(rotation=90)
            plt.title(num_fea_name,y=0.9,fontdict={'weight':'normal','size': 15})

            plt.subplot(6,2,i)
            i = i+1
            plt.bar(freqs2[0],freqs2[1],color='green')
            plt.xticks(rotation=90)
            plt.title(num_fea_name,y=0.9,fontdict={'weight':'normal','size': 15})
NumFeaFreqs(data)
```



3.3 五数分析、缺失值个数分析

因为五数分析仅涉及数值型数据，所以本部分分析仅针对数值型数据

3.3.1 五数分析

```
for num_fea_name in num_features:
    description = data[num_fea_name].describe()
    print("%s的五数分析如下：\n"%(num_fea_name),description)
```

```
points的五数分析如下：
 count    150930.000000
mean         87.888418
std           3.222392
```

```
min          80.000000
25%          86.000000
50%          88.000000
75%          90.000000
max         100.000000
Name: points, dtype: float64
price的五数分析如下:
 count    137235.000000
mean         33.131482
std          36.322536
min           4.000000
25%          16.000000
50%          24.000000
75%          40.000000
max        2300.000000
Name: price, dtype: float64
```

3.3.2 缺失值个数分析

```
for num_fea_name in num_features:
    null_num = data[num_fea_name].isnull().sum()
    print("%s中为null的数据数量有: %d"%(num_fea_name,null_num))
```

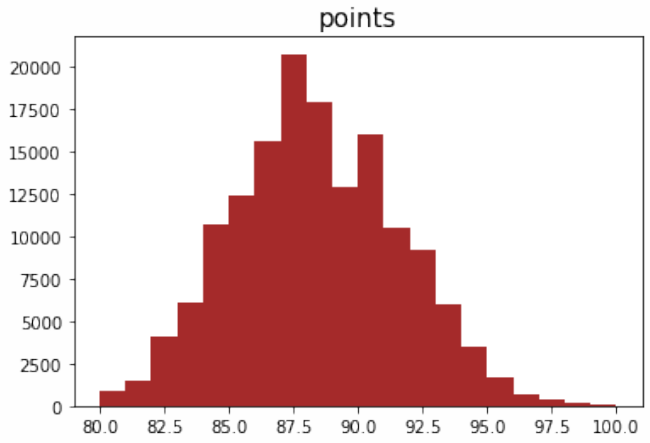
```
points中为null的数据数量有: 0
price中为null的数据数量有: 13695
```

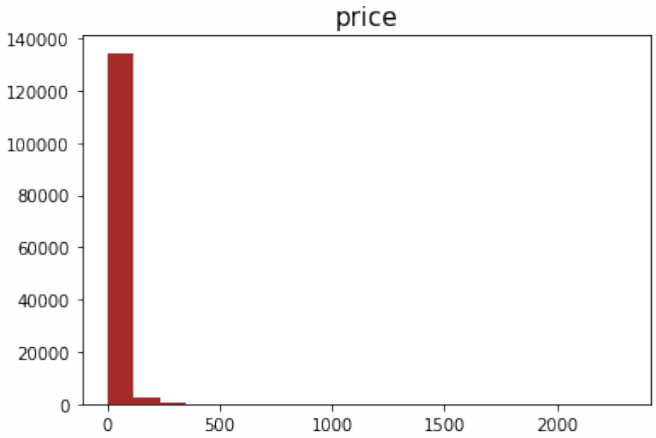
3.4 数据可视化

本部分数据可视化仅针对数值型数据：包含直方图、盒图、分布图

3.4.1 直方图

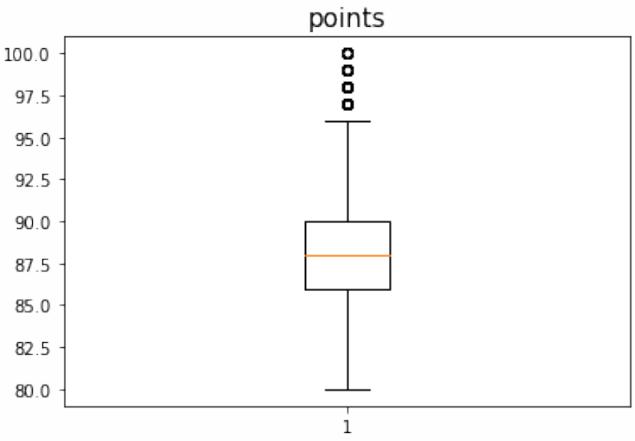
```
# 绘制数值型属性的直方图
def drawNumFeaHist(data,data_contrast=None):
    if data_contrast is None:
        for num_fea_name in num_features:
            plt.hist(list(data[num_fea_name].dropna(axis=0)),bins=20,color='brown')
            plt.title(num_fea_name,fontdict={'weight':'normal','size': 15})
            plt.show()
    else:
        plt.figure(figsize=(15,10))
        i = 1
        for num_fea_name in num_features:
            plt.subplot(2,2,i)
            i = i+1
            plt.hist(list(data[num_fea_name].dropna(axis=0)),bins=20,color='brown')
            plt.title(num_fea_name,fontdict={'weight':'normal','size': 15})

            plt.subplot(2,2,i)
            i = i+1
            plt.hist(list(data_contrast[num_fea_name].dropna(axis=0)),bins=20,color='green')
            plt.title(num_fea_name,fontdict={'weight':'normal','size': 15})
        pass
    pass
drawNumFeaHist(data)
```

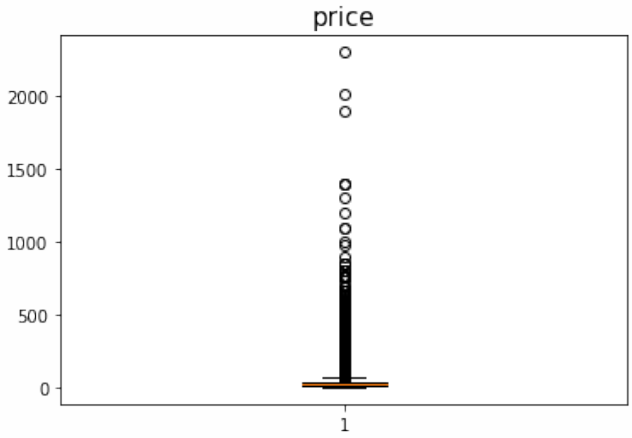




3.4.2 盒图

```
# 绘制数值型属性的盒图
def drawNumFeatBoxPlot(data,data_contrast=None):
    if data_contrast is None:
        for numfeatname in num_features:
            plt.boxplot(list(data[numfeatname].dropna(axis=0)))
            plt.title(numfeatname,fontdict={'weight':'normal','size': 15})
            plt.show()
    else:
        plt.figure(figsize=(15,10))
        i = 1

        for numfeatname in num_features:
            plt.subplot(2,2,i)
            i = i+1
            plt.boxplot(list(data[numfeatname].dropna(axis=0)))
            plt.title(numfeatname,fontdict={'weight':'normal','size': 15})

            plt.subplot(2,2,i)
            i = i+1
            plt.boxplot(list(data_contrast[numfeatname].dropna(axis=0)))
            plt.title(numfeatname,fontdict={'weight':'normal','size': 15})
        plt.show()
        pass
    pass

drawNumFeatBoxPlot(data_src)
```



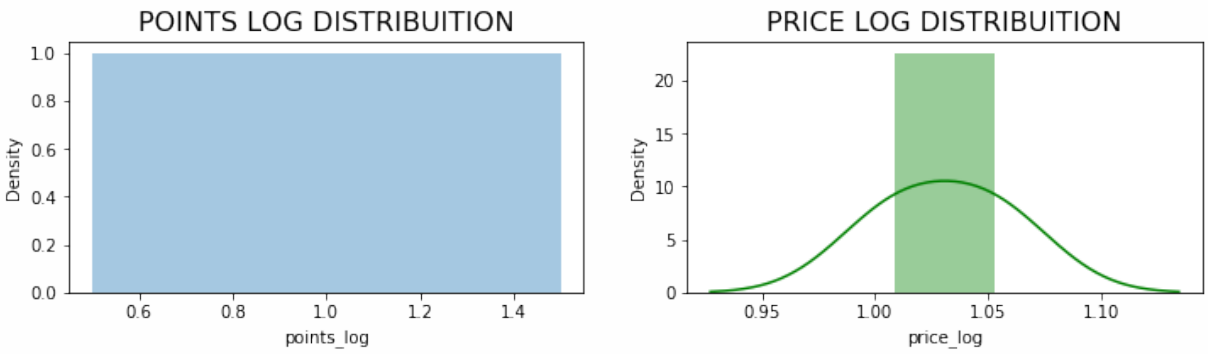


可以看到**points**主要集中在**80**到**96**分之间
价格主要集中在**1000**元以下

3.4.3 分布图

```
# 绘制正态分布图
def logDistribution(data):
    log_data = pd.DataFrame(['points_log','price_log'])
    log_data['points_log'] = np.log(data['points'] + 1)
    log_data['price_log'] = np.log(data['price'] + 1)
    plt.figure(figsize = (12,6))

    plt.subplot(221)
    g1 = sns.distplot(log_data['points_log'])
    g1.set_title("POINTS LOG DISTRIBUITION", fontsize=16)

    plt.subplot(222)
    g2 = sns.distplot(log_data['price_log'],color='green')
    g2.set_title('PRICE LOG DISTRIBUITION', fontsize=16)

    plt.show()
logDistribution(data)
```

```
/Users/guopeiqi/opt/anaconda3/envs/deeplearning/lib/python3.7/site-packages/seaborn/distributions.py:2619:
FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt
your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-
level function for histograms).
  warnings.warn(msg, FutureWarning)
/Users/guopeiqi/opt/anaconda3/envs/deeplearning/lib/python3.7/site-packages/seaborn/distributions.py:316:
UserWarning: Dataset has 0 variance; skipping density estimate. Pass `warn_singular=False` to disable this
warning.
  warnings.warn(msg, UserWarning)
/Users/guopeiqi/opt/anaconda3/envs/deeplearning/lib/python3.7/site-packages/seaborn/distributions.py:2619:
FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt
your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-
level function for histograms).
  warnings.warn(msg, FutureWarning)
```



4.缺失值处理

4.1 缺失值分析

```
# 数据中各属性的空值个数
data.isnull().sum()
```

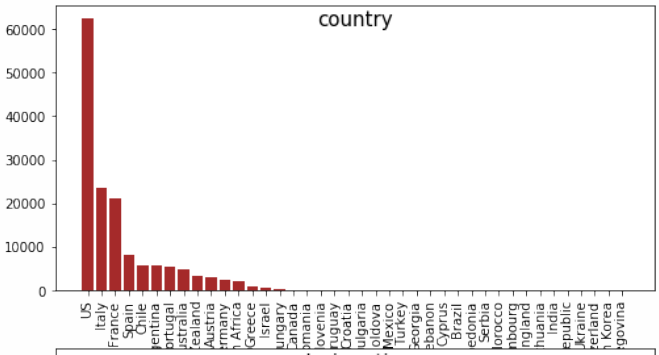
```
country            5
designation    45735
points             0
price          13695
province           5
region_1       25060
variety            0
winery             0
dtype: int64
```

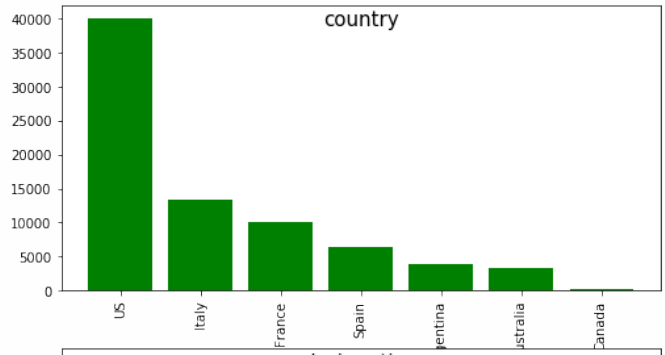
可以发现
country：有5个为空，不清楚产国
designation：45735个为空，不知道名称
prince：13695个为空，不知道价格
province：5个为空，不知道省份
region_1：25060，不知道具体区域

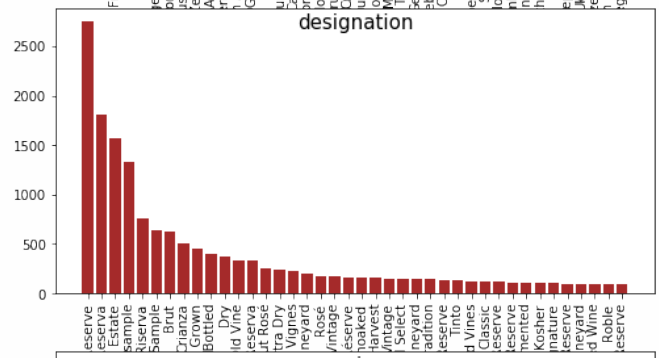
4.2 四种方法处理缺失值

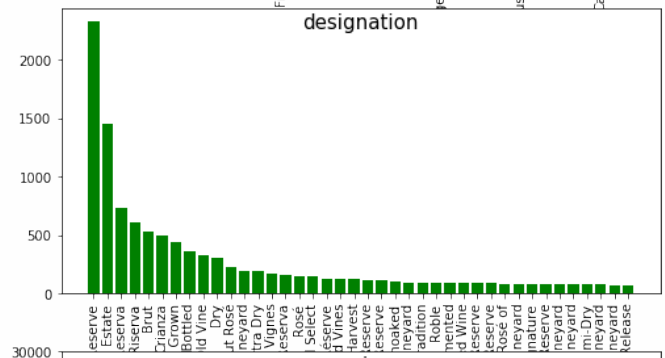
4.2.1 直接剔除缺失值

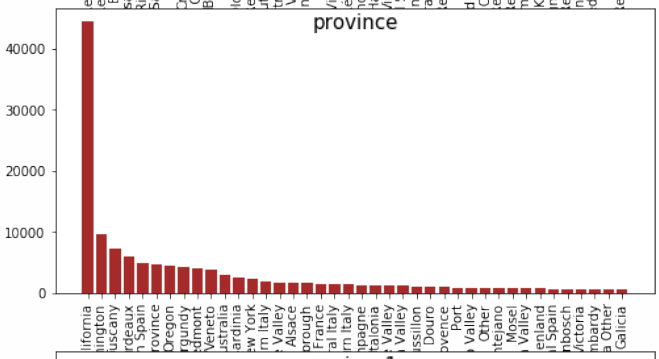
```
# 剔除缺失部分
data_dropnull = data.dropna(axis=0)

# 可视化数据
NomFeaFreqs(data,data_dropnull)
drawNumFeaHist(data,data_dropnull)
drawNumFeatBoxPlot(data,data_dropnull)
```

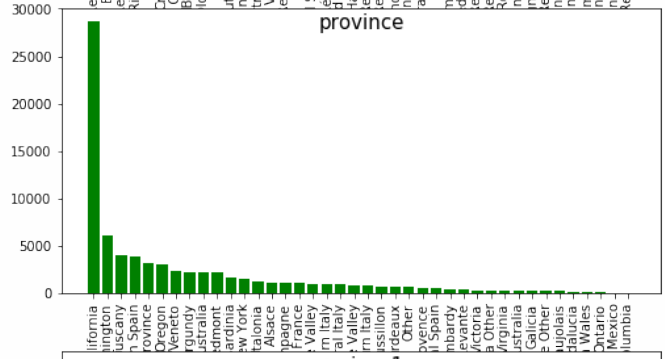


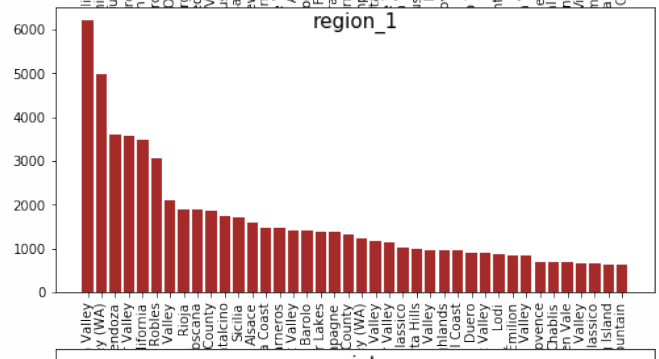


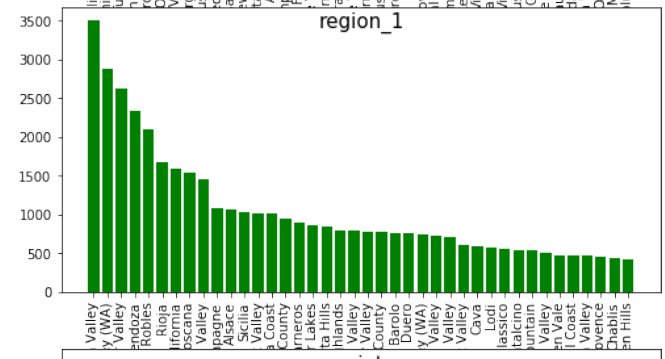


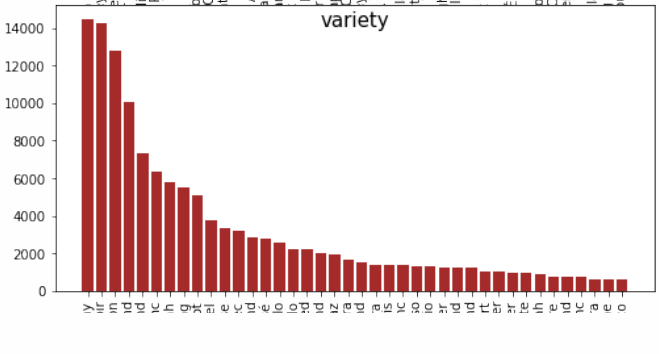


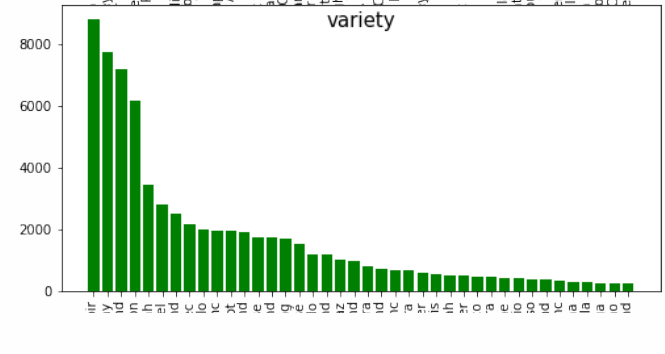


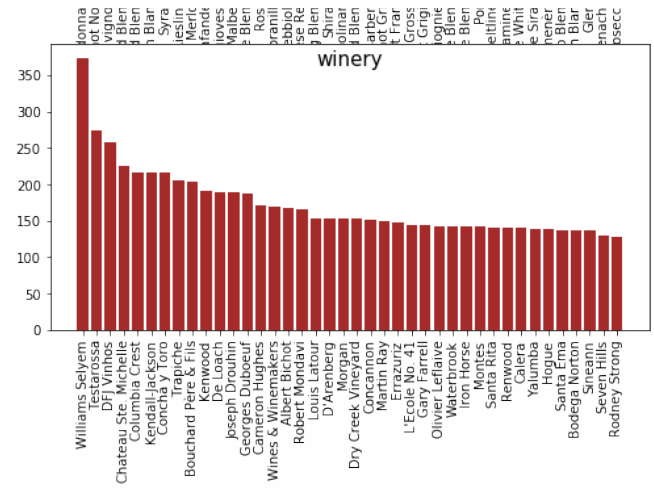


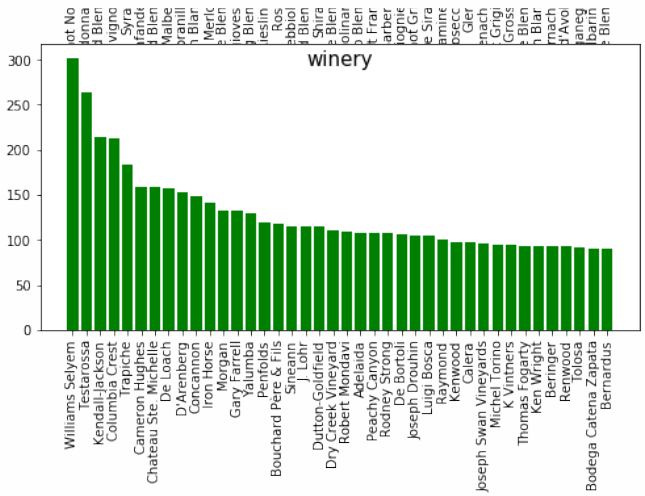


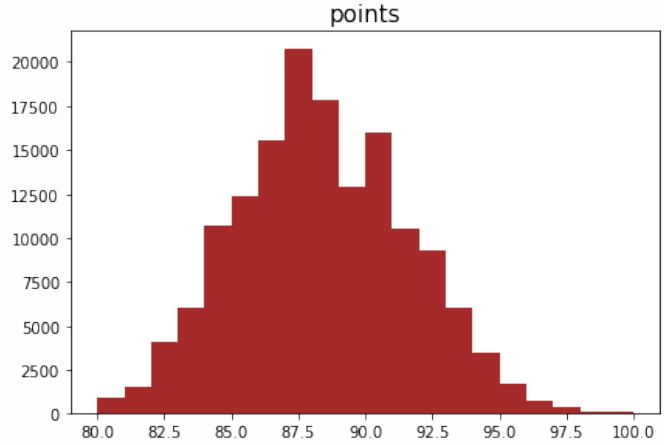


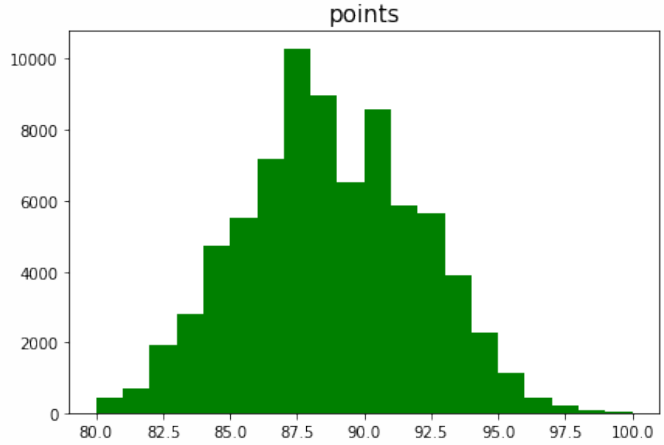


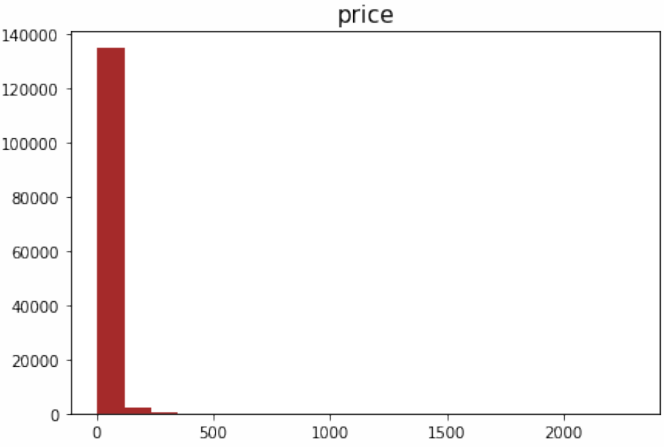


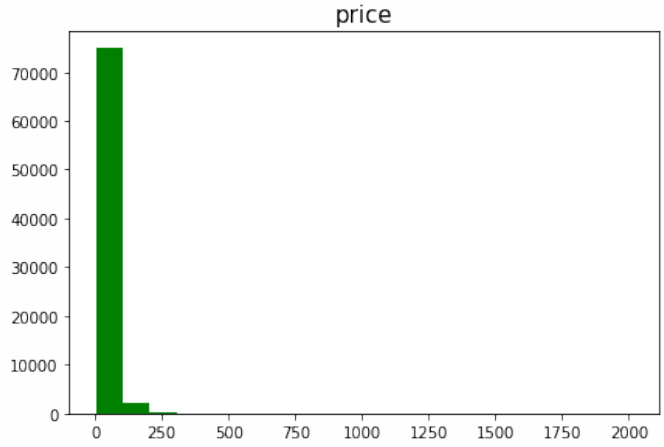

winery
Williams Selyem
Testarossa
DFJ Vinhos
Chateau Ste. Michelle
Columbia Crest
Kendall-Jackson
Concha y Toro
Trapiche
Bouchard Père & Fils
Kenwood
De Loach
Joseph Drouhin
Georges Duboeuf
Cameron Hughes
Wines & Winemakers
Albert Bichot
Robert Mondavi
Louis Latour
D'Arenberg
Morgan
Dry Creek Vineyard
Concannon
Martin Ray
Errazuriz
L'Ecole No. 41
Gary Farrell
Olivier Leflaive
Waterbrook
Iron Horse
Santa Rita
Renwood
Calera
Yalumba
Hogue
Santa Ema
Bodega Norton
Sineann
Seven Hills
Rodney Strong

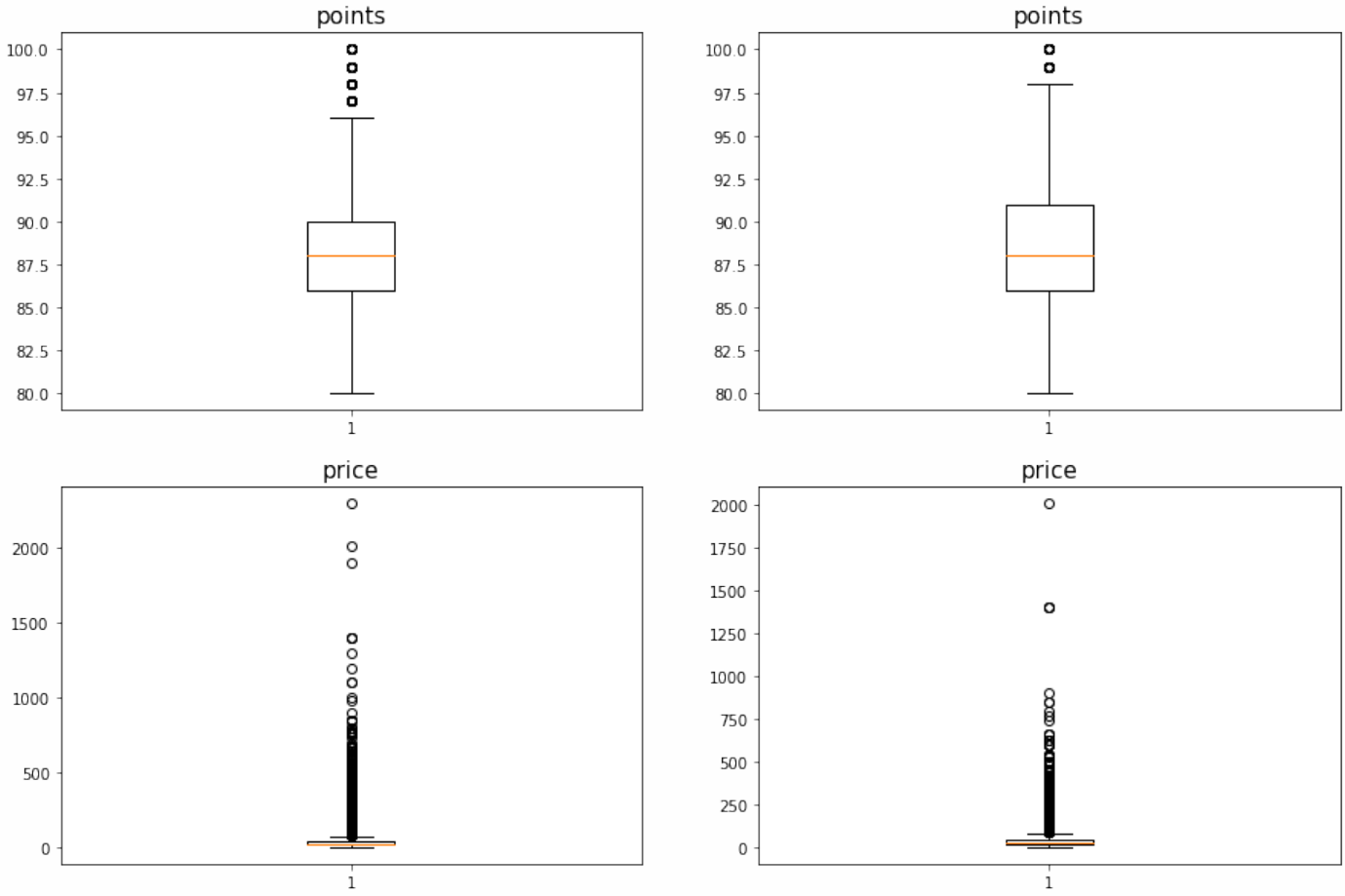

winery
Williams Selyem
Testarossa
Kendall-Jackson
Columbia Crest
Trapiche
Cameron Hughes
Chateau Ste. Michelle
De Loach
D'Arenberg
Concannon
Iron Horse
Morgan
Gary Farrell
Yalumba
Penfolds
Bouchard Père & Fils
Sineann
J. Lohr
Dutton-Goldfield
Dry Creek Vineyard
Robert Mondavi
Adelaida
Peachy Canyon
Rodney Strong
De Bortoli
Joseph Drouhin
Luigi Bosca
Raymond
Kenwood
Calera
Joseph Swan Vineyards
Michel Torino
K Vintners
Thomas Fogarty
Ken Wright
Beringer
Renwood
Tolosa
Bodega Catena Zapata
Bernardus


points


points


price

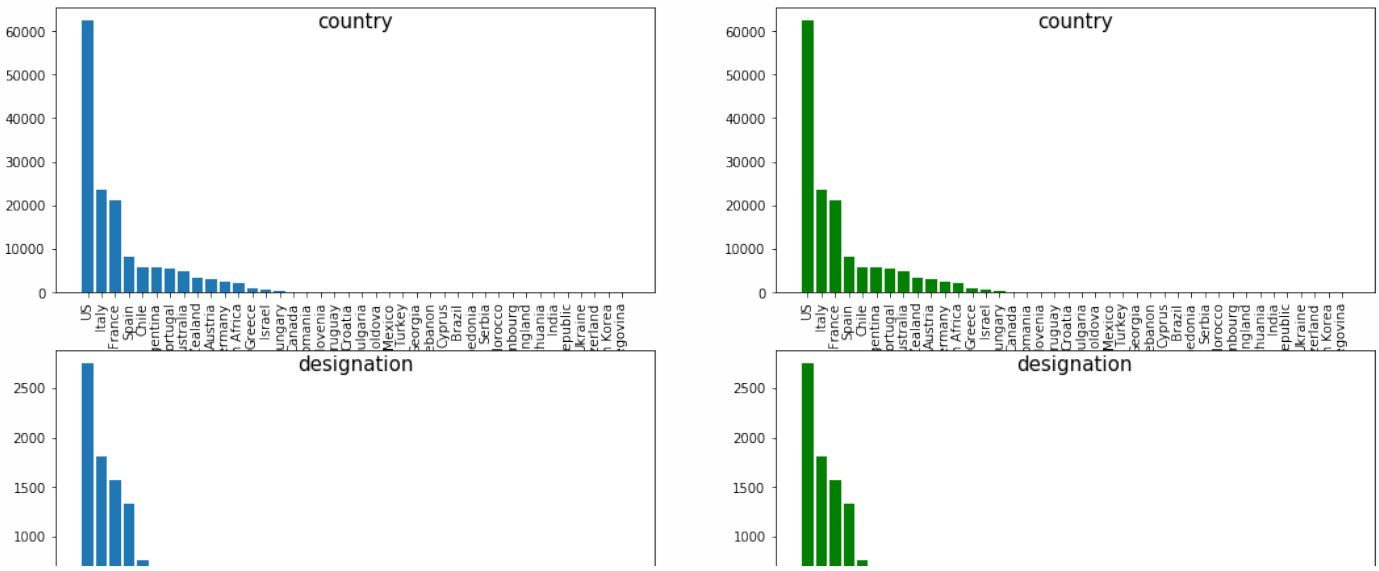

price

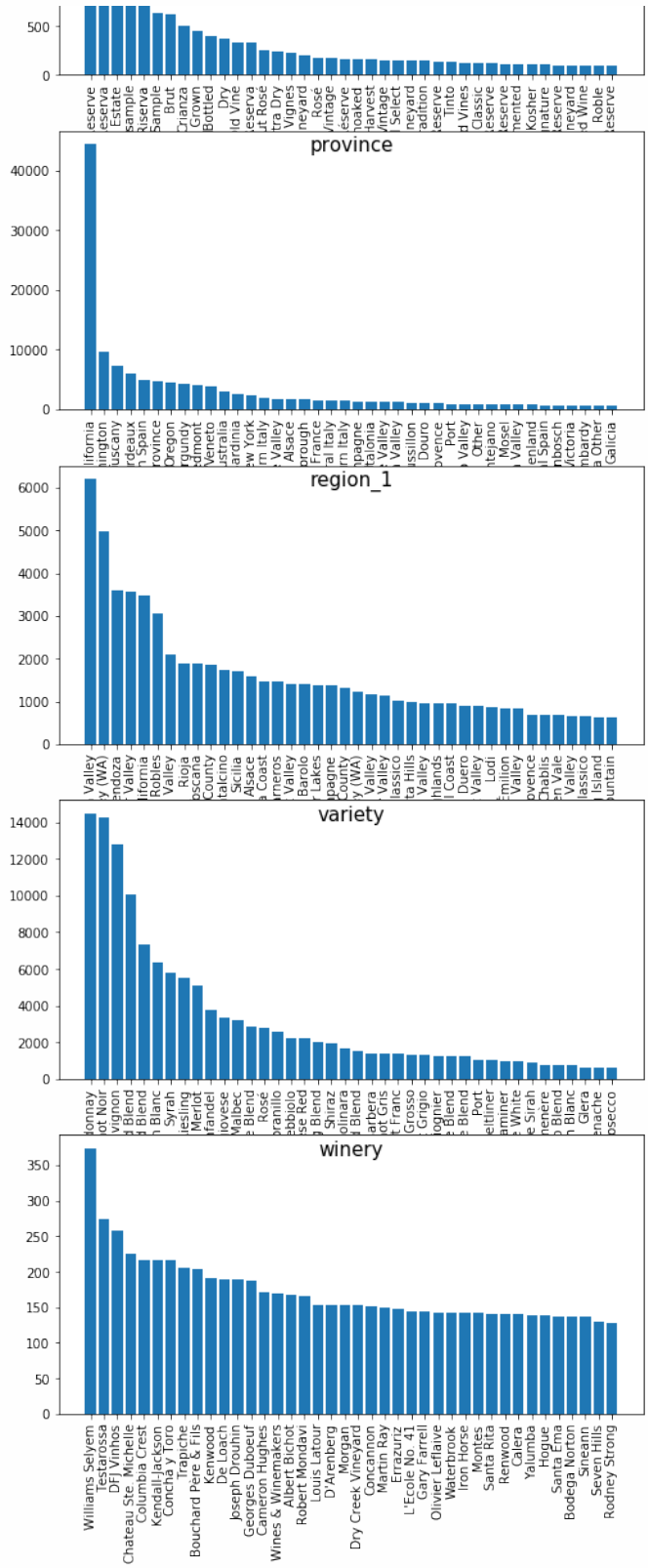


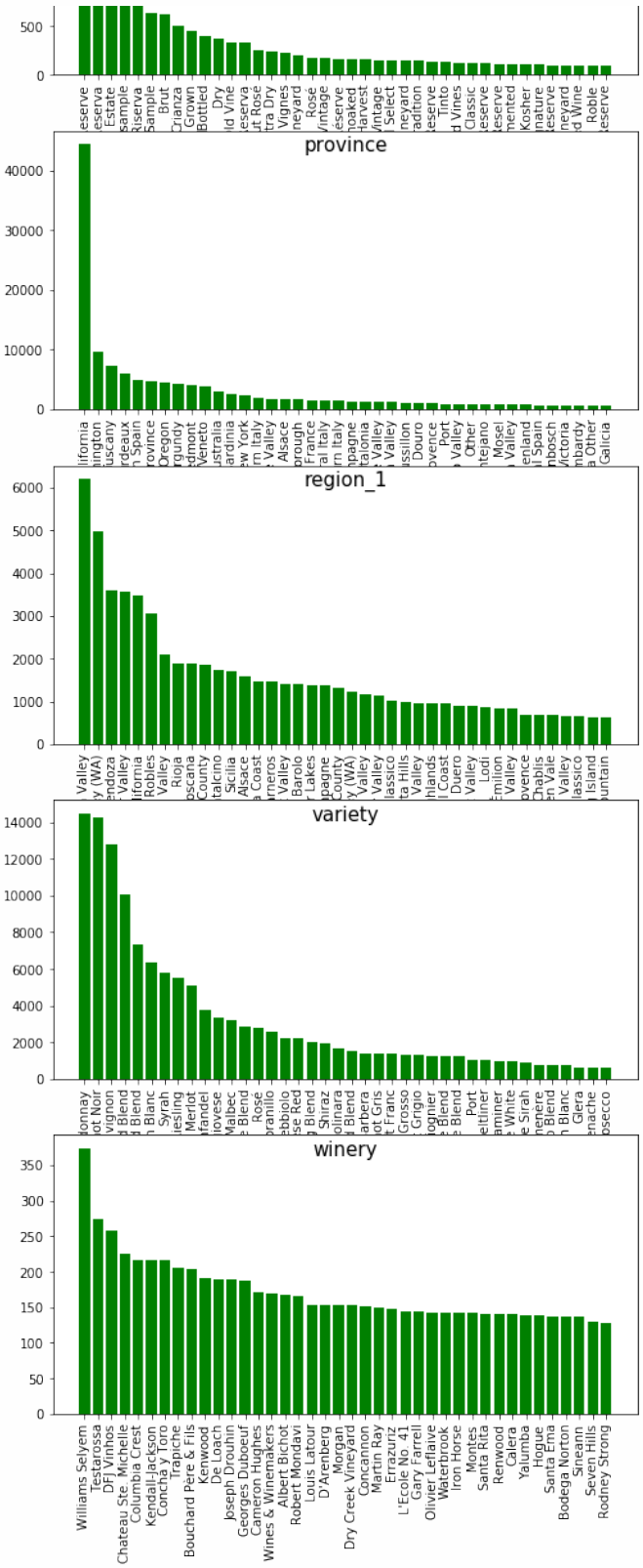
如果直接剔除缺失部分后：
country：仅保留下剩下7个具有完善数据的国家
从**price**和**points**：对于价格很低或很高的酒、品质低或很高的酒，信息收集均不完善。

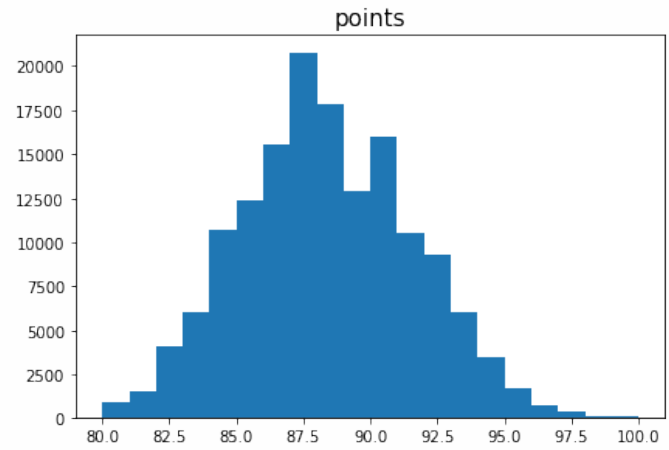
4.2.2 最高频率值填补缺失值

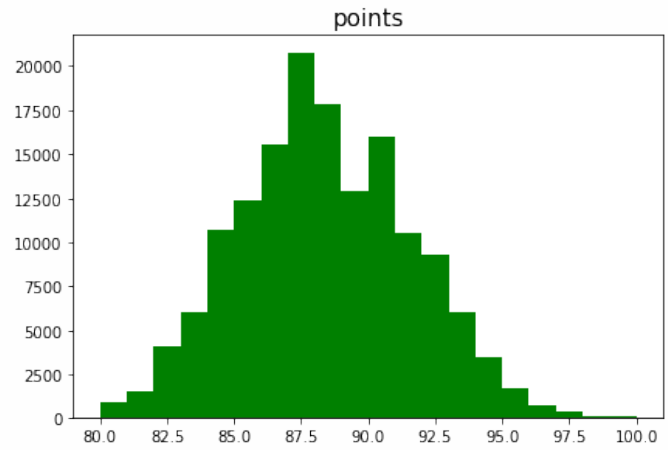
```
data_mode = data_src.copy()
data_mode = data_mode.fillna(data_mode.mode()) #使用众数
# 可视化数据
NomFeaFreqs(data,data_mode)
drawNumFeaHist(data,data_mode)
drawNumFeatBoxPlot(data,data_mode)
```

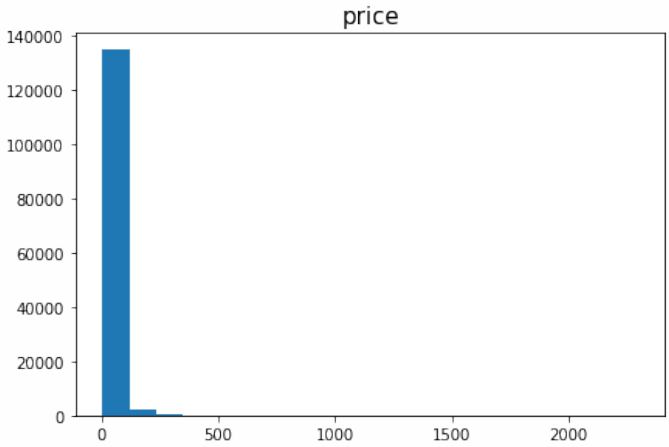


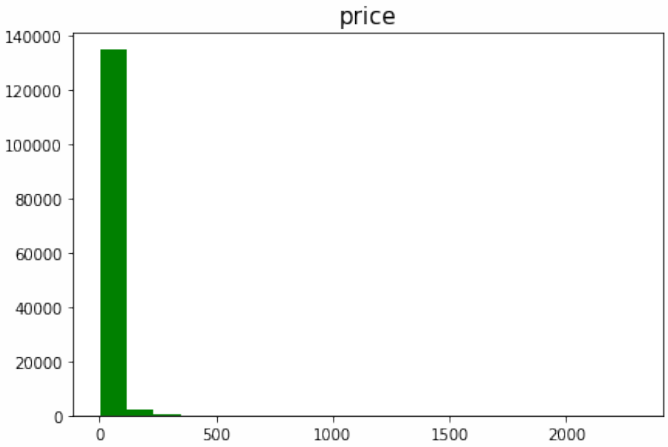

province
region_1
variety
winery

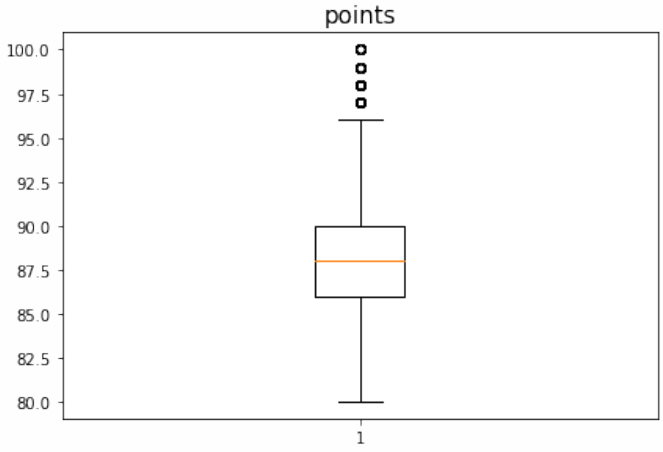

province
region_1
variety
winery

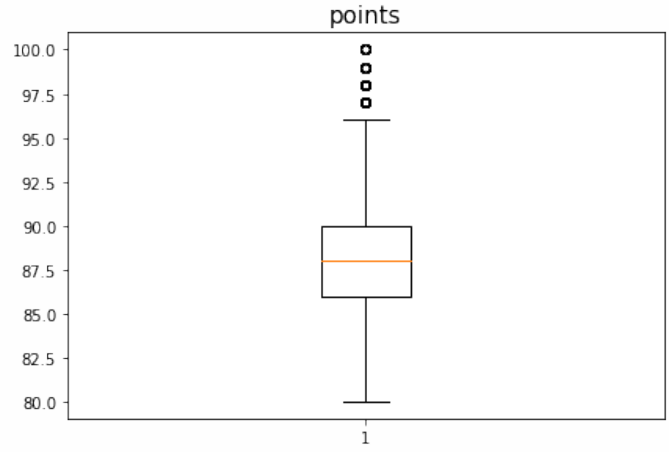

points
20000
17500
15000
12500
10000
7500
5000
2500
0
80.0
82.5
85.0
87.5
90.0
92.5
95.0
97.5
100.0

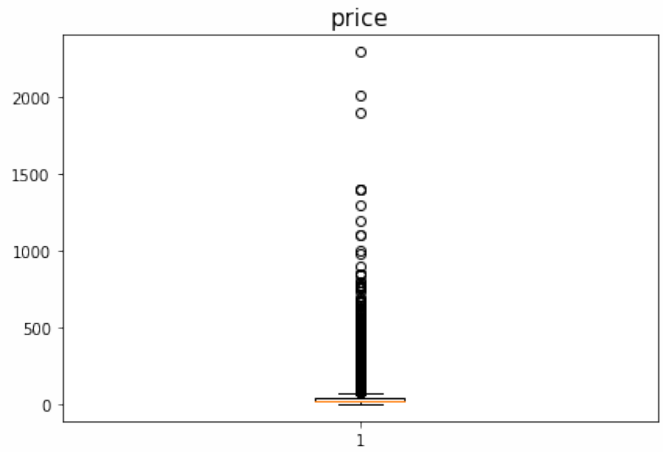

points
20000
17500
15000
12500
10000
7500
5000
2500
0
80.0
82.5
85.0
87.5
90.0
92.5
95.0
97.5
100.0

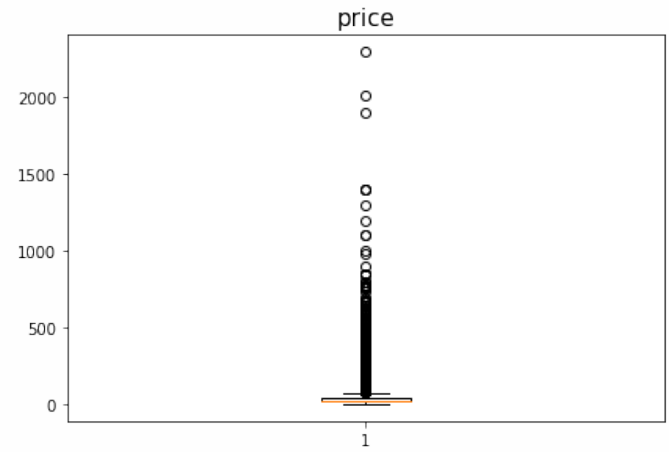

price
140000
120000
100000
80000
60000
40000
20000
0
0
500
1000
1500
2000


price
140000
120000
100000
80000
60000
40000
20000
0
0
500
1000
1500
2000


points
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
1

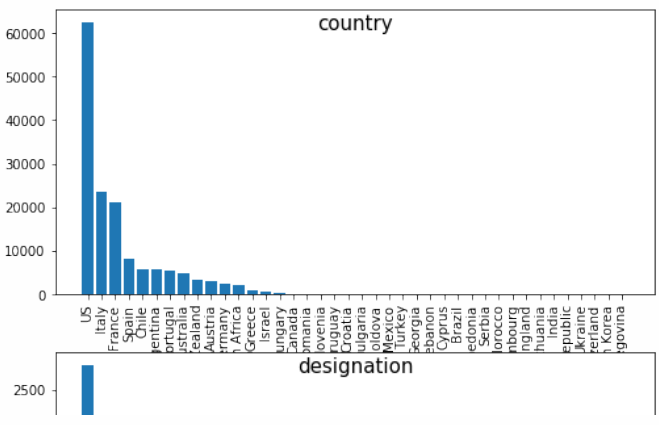

points
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
1

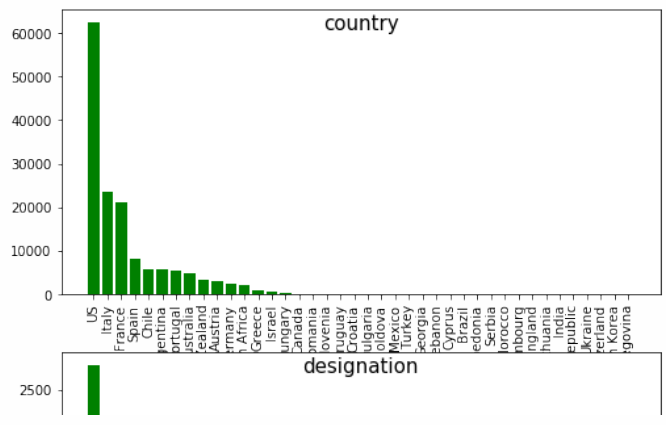

price
2000
1500
1000
500
0
1

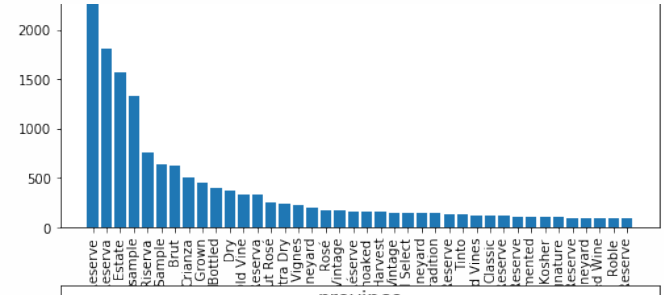

price
2000
1500
1000
500
0
1

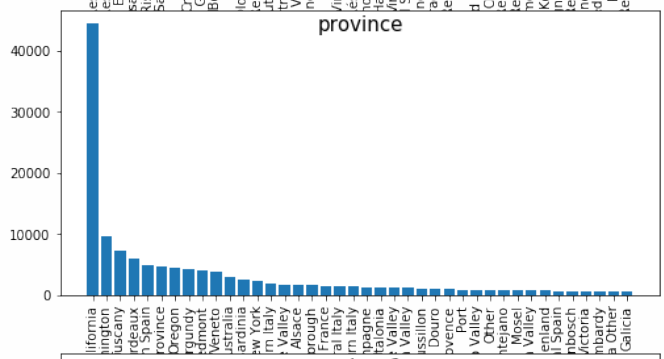
4.2.3 通过属性的相关关系来填补缺失值

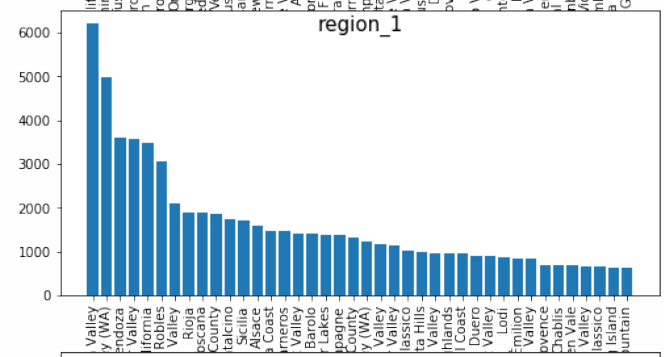
```
from sklearn import preprocessing
from sklearn.ensemble import RandomForestRegressor

# 通过属性的相关关系来填补缺失值
def fillna_rfr(data,predfeatname):
    # 用'NULL'(标称型属性)或-100(数值型属性)作为取值来填充非预测属性的缺失值
    data_filled = data.copy()
    for featname in data_filled.columns:
        if featname == predfeatname:
            continue
        if featname in num_features:
            data_filled[featname].fillna(-100,inplace=True)
        else:
            data_filled[featname].fillna('NULL',inplace=True)
        pass

    # 属性编码
    encx=preprocessing.OrdinalEncoder()
    encx.fit(data_filled.drop([predfeatname],axis=1))
    ency=preprocessing.OrdinalEncoder()
    ency.fit(data_filled[predfeatname].dropna(axis=0).values.reshape(-1,1))

    # 分割训练数据和预测数据
    data_train = data_filled[data_filled[predfeatname].notna()]
    data_pred = data_filled[data_filled[predfeatname].isna()]
    data_train_x = data_train.drop([predfeatname],axis=1)
    data_train_y = data_train[predfeatname]
    data_pred_x = data_pred.drop([predfeatname],axis=1)

    # 用RandomForestRegressor预测缺失值
    rfr = RandomForestRegressor(random_state=0, n_estimators=200, n_jobs=-1)
    rfr.fit(encx.transform(data_train_x),ency.transform(data_train_y.values.reshape(-1,1)).ravel())
    pred_y = rfr.predict(encx.transform(data_pred_x))
    data_pred_y = ency.inverse_transform(pred_y.reshape(-1,1))

    # 用预测的缺失值进行填充
    nanidxs = data_filled[data_filled.isna().values==True].index.values
    predidx = 0
    for idx in nanidxs:
        data.loc[idx,predfeatname] = data_pred_y[predidx][0]
        predidx = predidx+1
    pass

data_fill_rfr = data_src.copy()
fillna_rfr(data_fill_rfr,'price')
fillna_rfr(data_fill_rfr,'country')
fillna_rfr(data_fill_rfr,'designation')
fillna_rfr(data_fill_rfr,'province')
fillna_rfr(data_fill_rfr,'region_1')

# 可视化数据
NomFeaFreqs(data,data_fill_rfr)
drawNumFeaHist(data,data_fill_rfr)
drawNumFeatBoxPlot(data,data_fill_rfr)
```

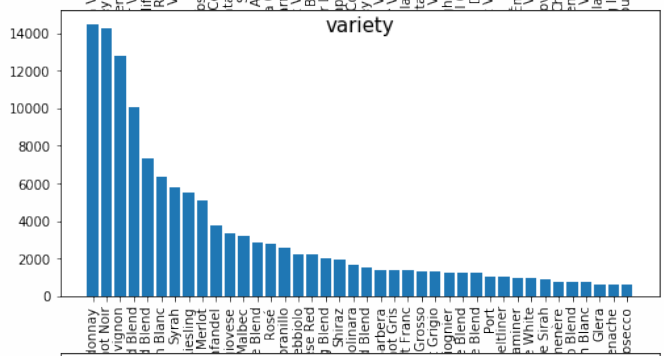


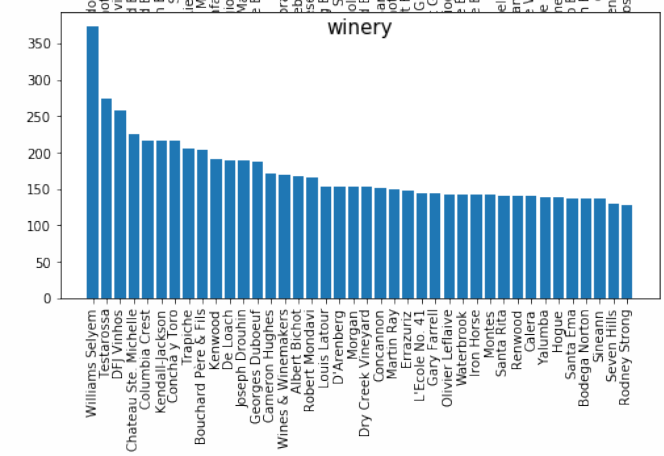


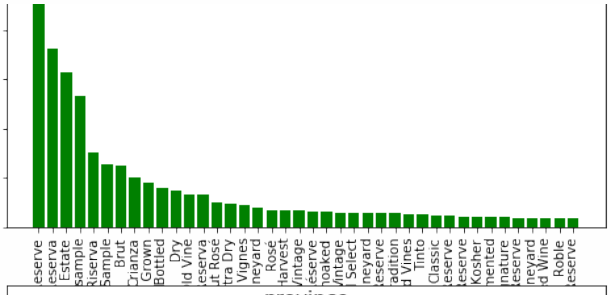


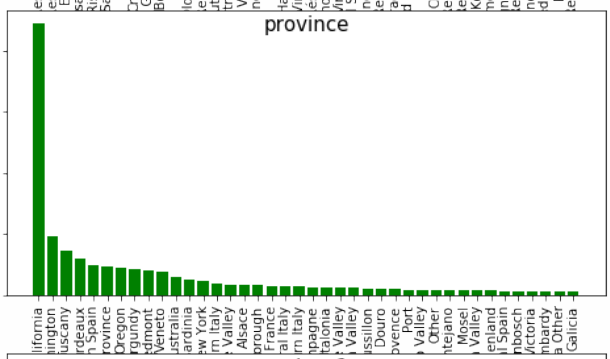

province

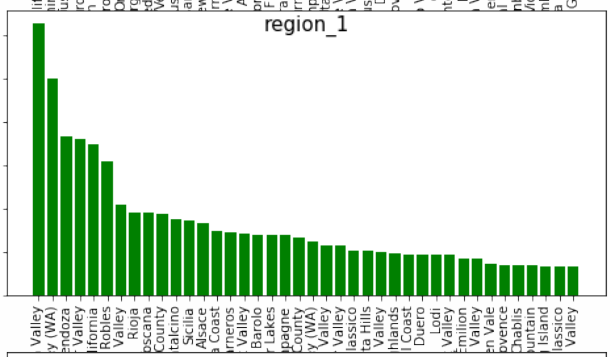

region_1

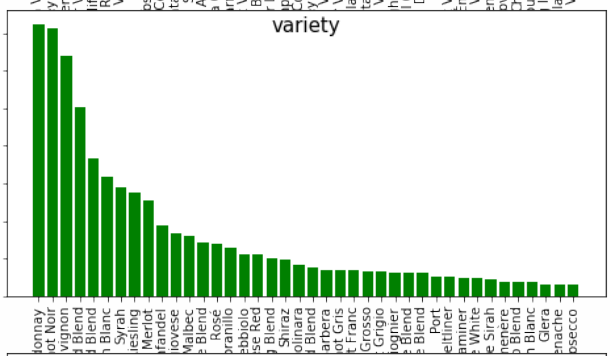

variety

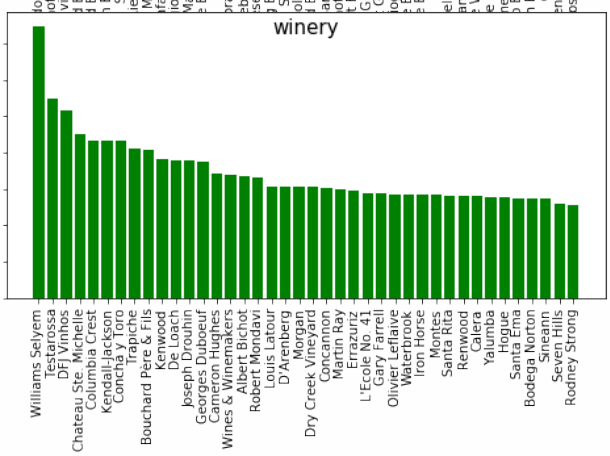

winery
Williams Selyem
Testarossa
DFJ Vinhos
Chateau Ste. Michelle
Columbia Crest
Kendall-Jackson
Concha y Toro
Trapiche
Bouchard Père & Fils
Kenwood
De Loach
Joseph Drouhin
Georges Duboeuf
Cameron Hughes
Wines & Winemakers
Albert Bichot
Robert Mondavi
Louis Latour
D'Arenberg
Morgan
Dry Creek Vineyard
Concannon
Martin Ray
Errazuriz
L'Ecole No. 41
Gary Farrell
Olivier Leflaive
Waterbrook
Iron Horse
Montes
Santa Rita
Renwood
Calera
Yalumba
Hogue
Santa Ema
Bodega Norton
Sineann
Seven Hills
Rodney Strong

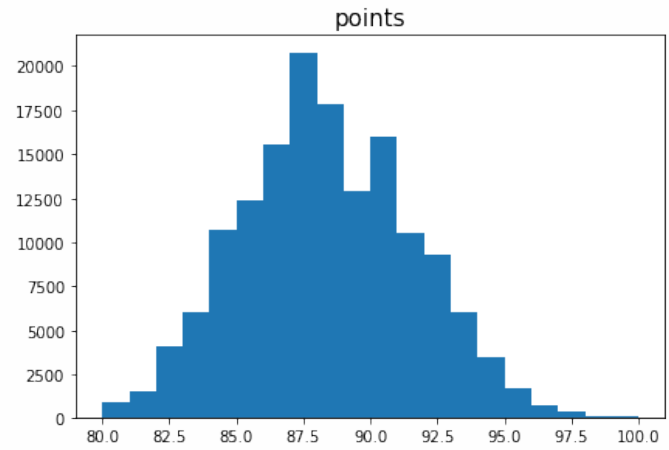


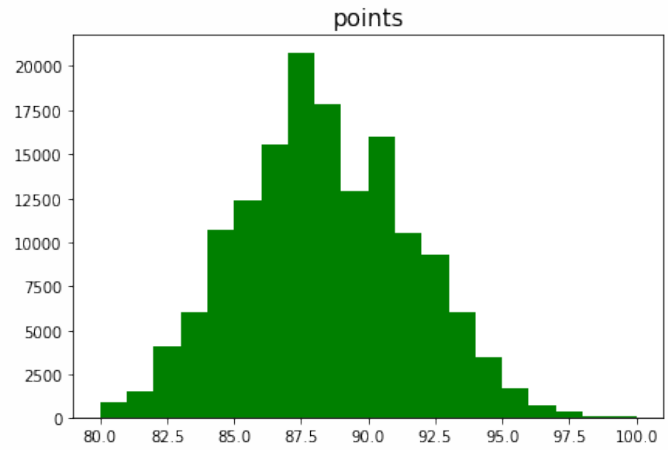

province

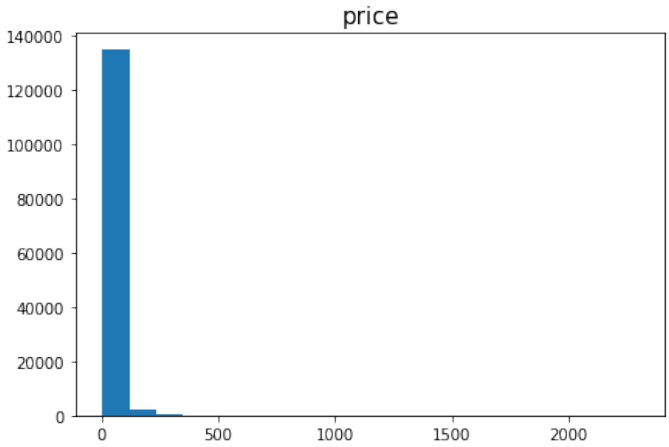

region_1

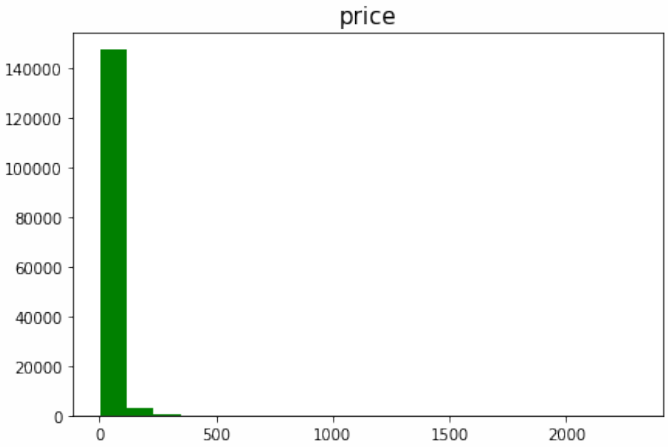

variety

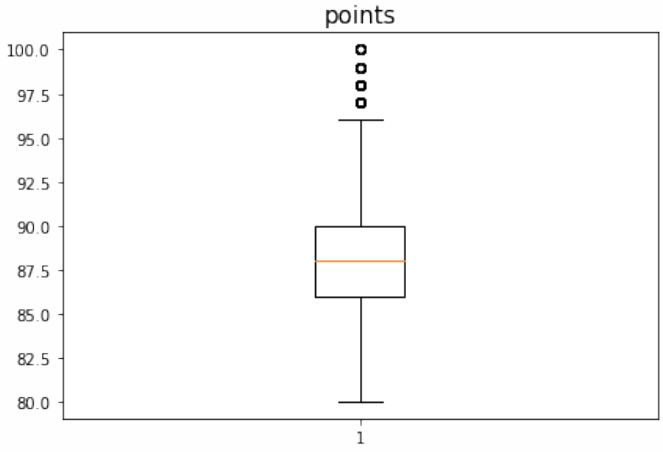

winery
Williams Selyem
Testarossa
DFJ Vinhos
Chateau Ste. Michelle
Columbia Crest
Kendall-Jackson
Concha y Toro
Trapiche
Bouchard Père & Fils
Kenwood
De Loach
Joseph Drouhin
Georges Duboeuf
Cameron Hughes
Wines & Winemakers
Albert Bichot
Robert Mondavi
Louis Latour
D'Arenberg
Morgan
Dry Creek Vineyard
Concannon
Martin Ray
Errazuriz
L'Ecole No. 41
Gary Farrell
Olivier Leflaive
Waterbrook
Iron Horse
Montes
Santa Rita
Renwood
Calera
Yalumba
Hogue
Santa Ema
Bodega Norton
Sineann
Seven Hills
Rodney Strong

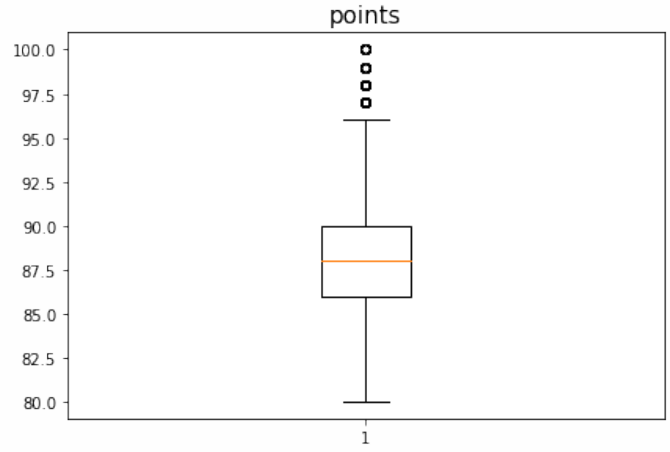


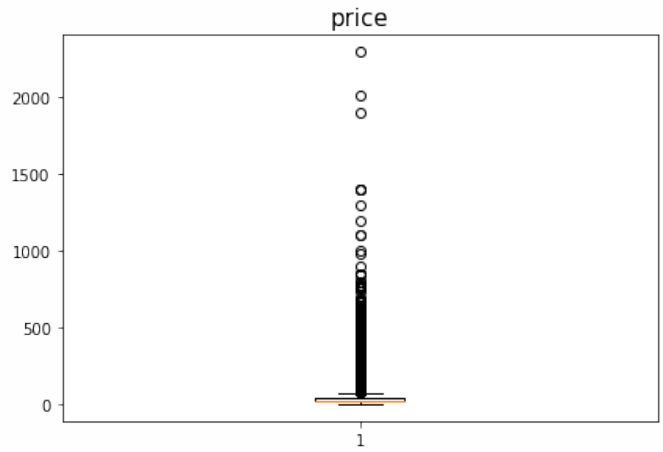


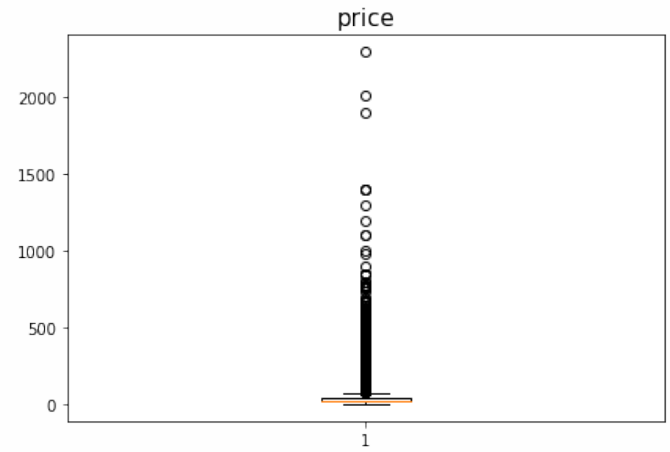








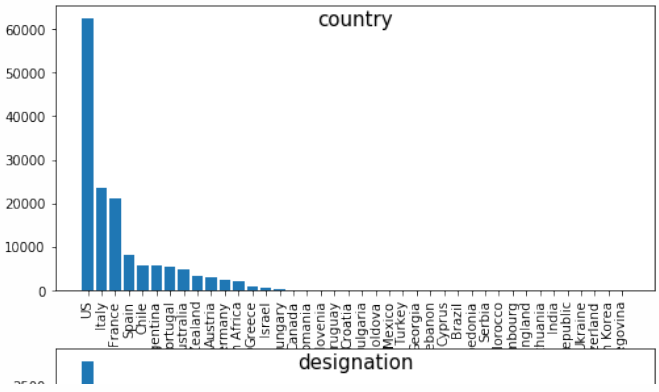


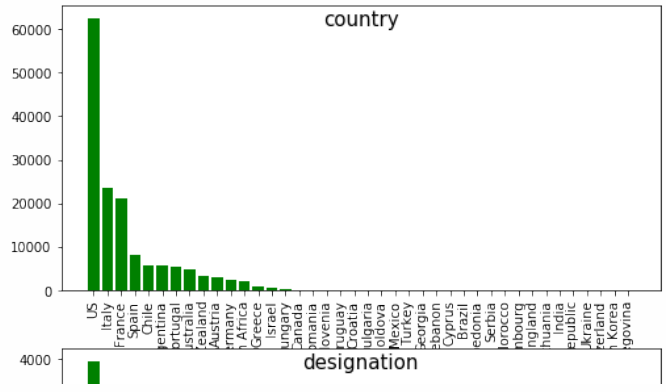


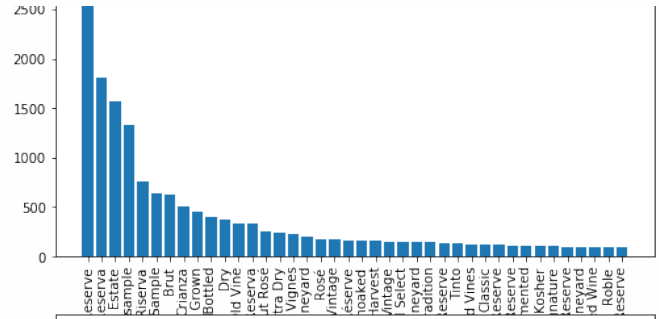
可以观察出数据分布未发生明显改变，说明该方法适用

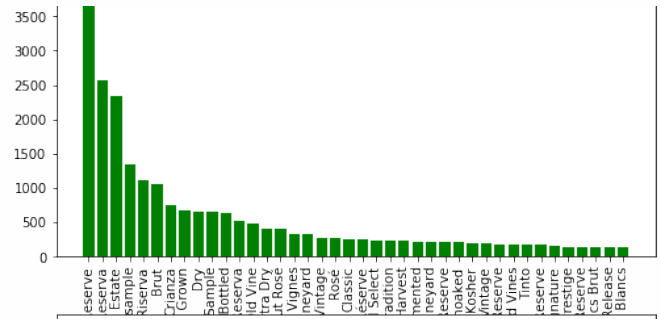
4.2.4 通过数据对象之间的相似性来填补缺失值

```
from sklearn.neighbors import KNeighborsClassifier

# 通过数据对象之间的相似性来填补缺失值
def fillna_knn(data,predfeatname):
    # 用'NULL'(标称型属性)或-100(数值型属性)作为取值来填充非预测属性的缺失值
    data_filled = data.copy()
    for featname in data_filled.columns:
        if featname == predfeatname:
            continue
        if featname in num_features:
            data_filled[featname].fillna(-100,inplace=True)
        else:
            data_filled[featname].fillna('NULL',inplace=True)
        pass

    # 属性编码
    encx=preprocessing.OrdinalEncoder()
    encx.fit(data_filled.drop([predfeatname],axis=1))
    ency=preprocessing.OrdinalEncoder()
    ency.fit(data_filled[predfeatname].dropna(axis=0).values.reshape(-1,1))

    # 分割训练数据和预测数据
    data_train = data_filled[data_filled[predfeatname].notna()]
    data_pred = data_filled[data_filled[predfeatname].isna()]
    data_train_x = data_train.drop([predfeatname],axis=1)
    data_train_y = data_train[predfeatname]
    data_pred_x = data_pred.drop([predfeatname],axis=1)

    # 用KNN预测缺失值
    knn = KNeighborsClassifier(algorithm='auto', leaf_size=26, metric='minkowski',
                               metric_params=None, n_jobs=1, n_neighbors=5, p=2,
                               weights='uniform')
    knn.fit(encx.transform(data_train_x),ency.transform(data_train_y.values.reshape(-1,1)).ravel())
    pred_y = knn.predict(encx.transform(data_pred_x))
    data_pred_y = ency.inverse_transform(pred_y.reshape(-1,1))

    # 用预测的缺失值进行填充
    nanidxs = data_filled[data_filled.isna().values==True].index.values
    predidx = 0
    for idx in nanidxs:
        data.loc[idx,predfeatname] = data_pred_y[predidx][0]
        predidx = predidx+1
    pass

data_fill_knn = data_src.copy()
fillna_knn(data_fill_knn,'price')
fillna_knn(data_fill_knn,'country')
fillna_knn(data_fill_knn,'designation')
fillna_knn(data_fill_knn,'province')
fillna_knn(data_fill_knn,'region_1')

# 可视化数据
NomFeaFreqs(data,data_fill_knn)
drawNumFeaHist(data,data_fill_knn)
drawNumFeatBoxPlot(data,data_fill_knn)
```

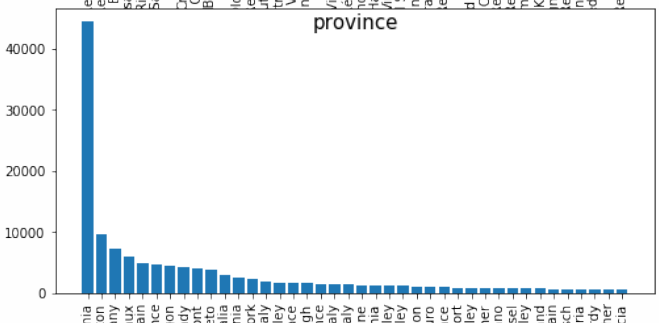




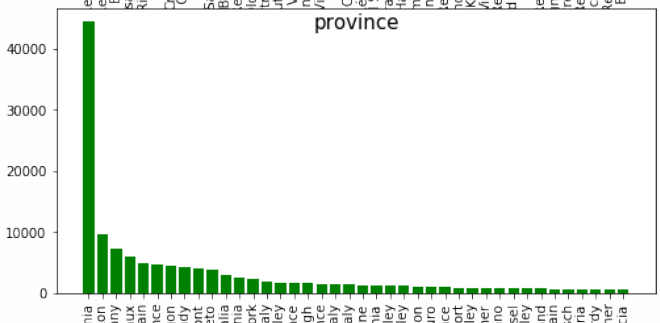




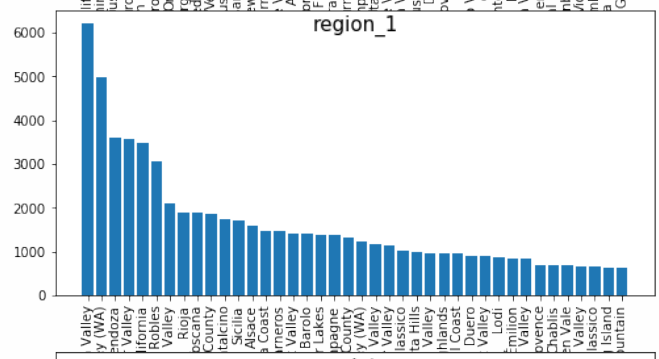
province



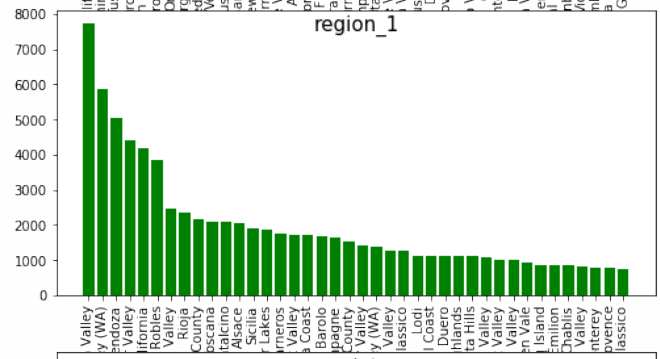
province



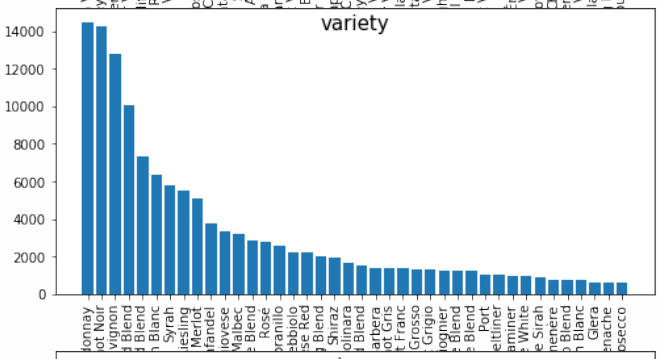
region_1



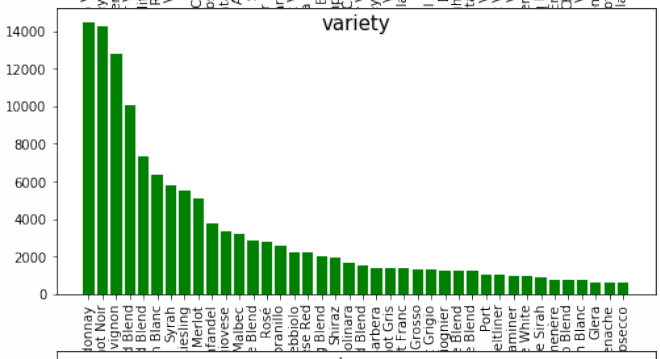
region_1



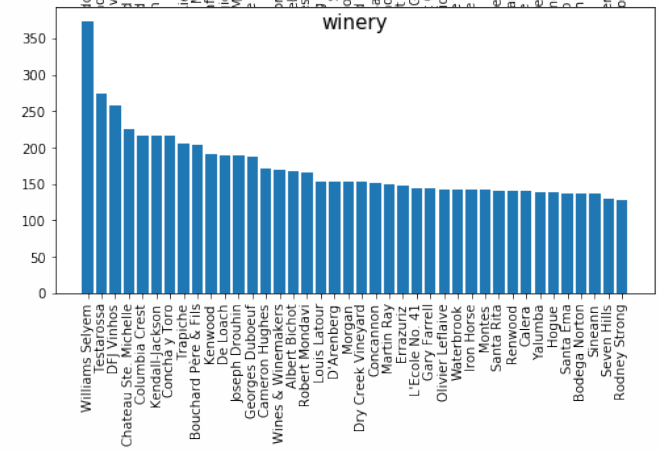
variety



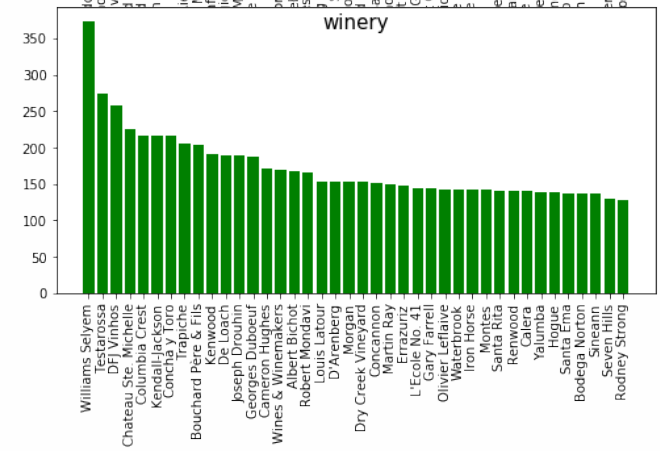
variety

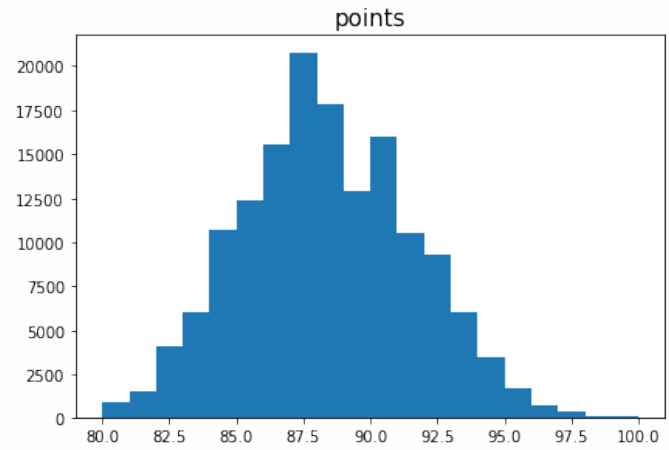


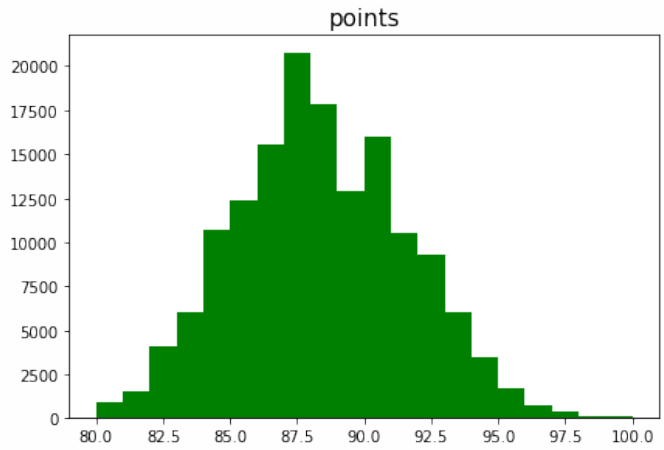
winery

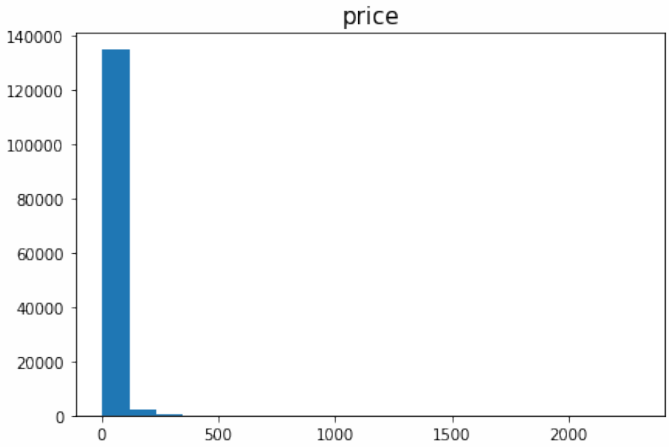


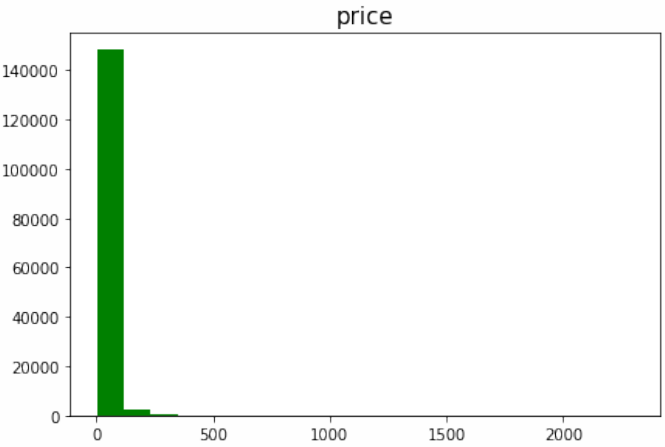
winery

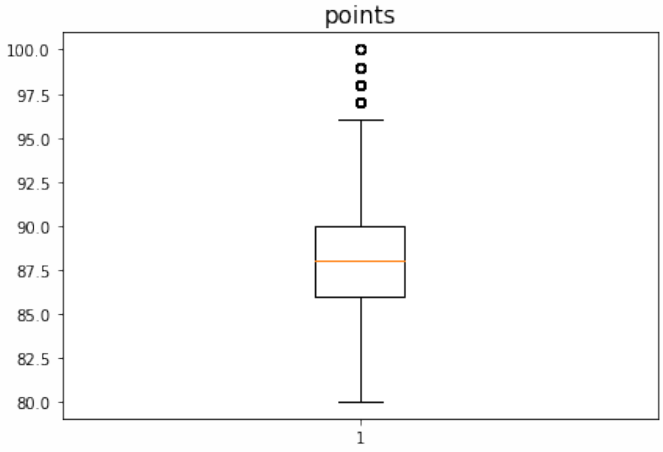


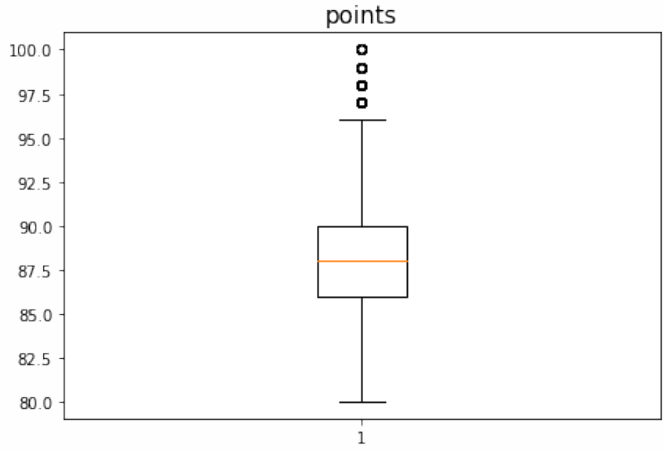


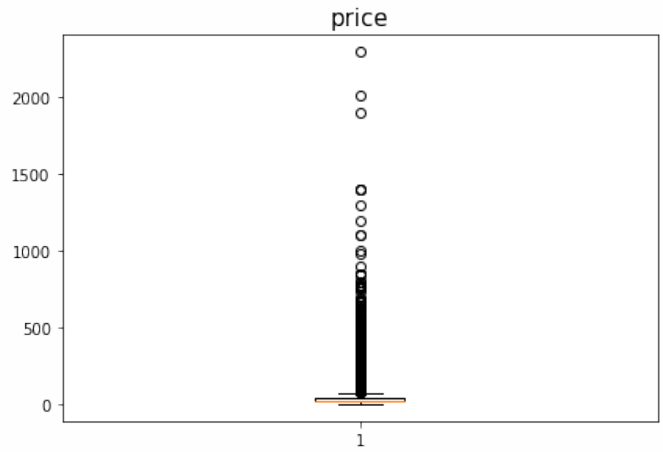


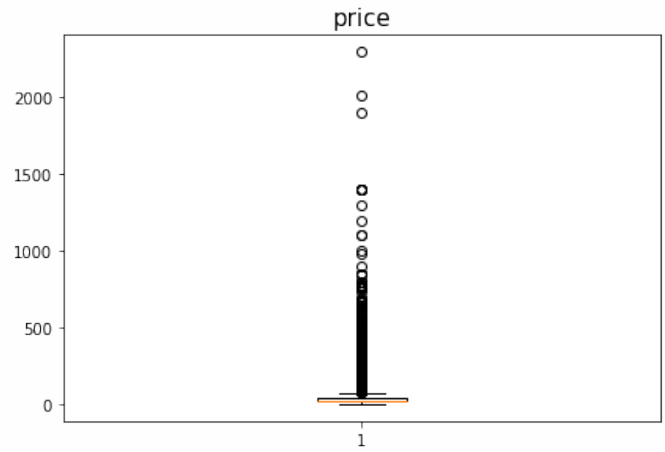












可以发现数据分布没有发生明显改变，该方法适用