Alzheimer_Disease_and_Healthy_Aging_Data_In_US

2023 年 3 月 25 日

0.1 数据集 Alzheimer Disease and Healthy Aging Data In US

0.1.1 此数据集包含一个 csv 文件：

- Alzheimer Disease and Healthy Aging Data In US.csv 包含 29 列和 214462 行美国的阿尔茨海默病和健康老龄化数据

[1]:

```
# 导入必要的包
import matplotlib.pyplot as plt
import statsmodels.api as sm
import numpy as np
import pandas as pd
import math
from scipy import stats
from collections import Counter
from math import isnan
%matplotlib inline
```

0.1.2 1. 数据集展示

[2]:

```
# 载入数据
f_data="dataset/Alzheimer Disease and Healthy Aging Data In US/Alzheimer␣
 ↪Disease and Healthy Aging Data In US.csv"
data = pd.read_csv(f_data, index_col=False, low_memory=False)
data.head()# 默认展示前五行数据
```

[2]:

```
   YearStart  YearEnd LocationAbbr LocationDesc Datasource           Class  \
0       2020     2020           HI       Hawaii      BRFSS  Overall Health
1       2017     2017           ID        Idaho      BRFSS   Mental Health
2       2017     2017           ID        Idaho      BRFSS  Overall Health
```

```
3       2018     2018           ID        Idaho      BRFSS  Overall Health
4       2020     2020           IN      Indiana      BRFSS   Mental Health

                                             Topic  \
0                      Arthritis among older adults
1                  Lifetime diagnosis of depression
2                      Arthritis among older adults
3  Physically unhealthy days (mean number of days)
4                  Lifetime diagnosis of depression

                                            Question Data_Value_Unit  \
0  Percentage of older adults ever told they have…               %
1  Percentage of older adults with a lifetime dia…               %
2  Percentage of older adults ever told they have…               %
3  Physically unhealthy days (mean number of days…          Number
4  Percentage of older adults with a lifetime dia…               %

  DataValueTypeID  … Stratification2                       Geolocation  \
0           PRCTG  …             NaN  POINT (-157.8577494 21.30485044)
1           PRCTG  …             NaN    POINT (-114.36373 43.68263001)
2           PRCTG  …             NaN    POINT (-114.36373 43.68263001)
3            MEAN  …             NaN    POINT (-114.36373 43.68263001)
4           PRCTG  …            Male  POINT (-86.14996019 39.76691045)

   ClassID TopicID QuestionID  LocationID StratificationCategoryID1  \
0      C01   TOC11        Q43          15                       AGE
1      C05   TMC03        Q27          16                       AGE
2      C01   TOC11        Q43          16                       AGE
3      C01   TOC01        Q08          16                       AGE
4      C05   TMC03        Q27          18                       AGE

  StratificationID1 StratificationCategoryID2 StratificationID2
0              5064                   OVERALL           OVERALL
1              5064                   OVERALL           OVERALL
2              5064                   OVERALL           OVERALL
3              5064                   OVERALL           OVERALL
```

```
4       AGE_OVERALL                   GENDER              MALE

[5 rows x 29 columns]
```

[3]:

```
data.dtypes # 每列数据的数据类型
```

[3]:

```
YearStart                       int64
YearEnd                         int64
LocationAbbr                   object
LocationDesc                   object
Datasource                     object
Class                          object
Topic                          object
Question                       object
Data_Value_Unit                object
DataValueTypeID                object
Data_Value_Type                object
Data_Value                    float64
Data_Value_Alt                float64
Low_Confidence_Limit           object
High_Confidence_Limit          object
Sample_Size                   float64
StratificationCategory1        object
Stratification1                object
StratificationCategory2        object
Stratification2                object
Geolocation                    object
ClassID                        object
TopicID                        object
QuestionID                     object
LocationID                      int64
StratificationCategoryID1      object
StratificationID1              object
StratificationCategoryID2      object
StratificationID2              object
dtype: object
```

[4]:

```
# 数据集的含义
# 列名------------------------含义
# YearStart                   数据收集开始的年份（标称）
# YearEnd                     数据收集结束的年份（标称）
# LocationAbbr                数据收集位置的缩写（标称）
# LocationDesc                数据收集位置的全名（标称）
# Datasource                  数据来源（标称）
# Class                       数据的类（标称）
# Topic                       数据的主题（标称）
# Question                    与数据相关的问题（标称）
# Data_Value_Unit             数据值测量的单位（标称）
# DataValueTypeID             数据值类型 ID（标称）
# Data_Value_Type             数据值的类型（例如平均值、百分比）（标称）
# Data_Value                  实际数据值（数值）
# Data_Value_Alt              一个替代数据值（数值）
# Low_Confidence_Limit        数据值置信区间的下限（数值）
# High_Confidence_Limit       数据值置信区间的上限（数值）
# Sample_Size                 用于收集数据的样本的大小
# StratificationCategory1     用于分层的第一个类别（例如年龄组）（标称）
# Stratification1             使用的特定分层（例如 18-24 岁）（标称）
# StratificationCategory2     用于分层的第二类（标称）
# Stratification2             用于第二类的具体分层（标称）
# Geolocation                 收集数据的位置的经纬度（数值）
# ClassID                     数据类的 ID（标称）
# TopicID                     数据主题的 ID（标称）
# QuestionID                  与数据相关的问题的 ID（标称）
# LocationID                  收集数据的位置的 ID（标称）
# StratificationCategoryID1   用于分层的第一个类别的 ID（标称）
# StratificationID1           用于第一类的特定分层的 ID（标称）
# StratificationCategoryID2   用于分层的第二个类别的 ID（标称）
# StratificationID2           用于第二类的特定分成的 ID（标称）
```

[5]:

```
# 将混合数据转换为数值数据
data["Low_Confidence_Limit"] = pd.
 ↪to_numeric(data["Low_Confidence_Limit"],errors='coerce')
```

```
data["High_Confidence_Limit"] = pd.
 ↪to_numeric(data["High_Confidence_Limit"],errors='coerce')
data.dtypes # 每列数据的数据类型
```

[5]:

```
YearStart                      int64
YearEnd                        int64
LocationAbbr                  object
LocationDesc                  object
Datasource                    object
Class                         object
Topic                         object
Question                      object
Data_Value_Unit               object
DataValueTypeID               object
Data_Value_Type               object
Data_Value                   float64
Data_Value_Alt               float64
Low_Confidence_Limit         float64
High_Confidence_Limit        float64
Sample_Size                  float64
StratificationCategory1       object
Stratification1               object
StratificationCategory2       object
Stratification2               object
Geolocation                   object
ClassID                       object
TopicID                       object
QuestionID                    object
LocationID                     int64
StratificationCategoryID1     object
StratificationID1             object
StratificationCategoryID2     object
StratificationID2             object
dtype: object
```

[6]:

```
data.shape # 数据集的大小
```

```
[6]: (214462, 29)
```

```
[7]: data.isnull().sum()
```

```
[7]: YearStart                         0
     YearEnd                           0
     LocationAbbr                      0
     LocationDesc                      0
     Datasource                        0
     Class                             0
     Topic                             0
     Question                          0
     Data_Value_Unit                   0
     DataValueTypeID                   0
     Data_Value_Type                   0
     Data_Value                    69833
     Data_Value_Alt                69833
     Low_Confidence_Limit          70009
     High_Confidence_Limit         70009
     Sample_Size                  214462
     StratificationCategory1           0
     Stratification1                   0
     StratificationCategory2       27669
     Stratification2               27669
     Geolocation                   23049
     ClassID                           0
     TopicID                           0
     QuestionID                        0
     LocationID                        0
     StratificationCategoryID1         0
     StratificationID1                 0
     StratificationCategoryID2         0
     StratificationID2                 0
     dtype: int64
```

注意到 Sample_Size 属性全部缺失，可能无法获取等原因。因对后续数据分析和处理无用，现将其删除。

[8]:

```
data.drop(labels = ['Sample_Size'],axis=1,level=None,inplace=True)
data.shape
```

[8]:

```
(214462, 28)
```

0.1.3 2. 数据分析

2.1 数据摘要和可视化　由数据集展示可知该数据集中将大量不同的问题对应的数据集中在一起，不同问题的数据之间应当分别分析。
接下来首先展示 **Class**，**Topic**，**Question** 等属性的频数和直方图，对整个数据集有一个大致的了解。
然后选取某一个问题对该问题对应的数据进行分析和处理。

[9]:

```
#(1)Class,  ClassID
data["Class"].value_counts()
```

[9]:

```
Overall Health                         71694
Screenings and Vaccines                46867
Nutrition/Physical Activity/Obesity    24851
Cognitive Decline                      19180
Caregiving                             18671
Mental Health                          16600
Smoking and Alcohol Use                16599
Name: Class, dtype: int64
```

[10]:

```
#(2)Topic, TopicID
data["Topic"].value_counts()
```

[10]:

```
Obesity
8300
Influenza vaccine within past year
8300
Physically unhealthy days (mean number of days)
8300
Frequent mental distress
8300
Current smoking
8300
```

```
Lifetime diagnosis of depression
8300
No leisure-time physical activity within past month
8300
Self-rated health (fair to poor health)
8299
Self-rated health (good to excellent health)
8299
Binge drinking within past 30 days
8299
Ever had pneumococcal vaccine
8268
Recent activity limitations in past month
8233
Disability status, including sensory or mobility limitations
6917
Arthritis among older adults
5511
Fair or poor health among older adults with arthritis
5447
Subjective cognitive decline or memory loss among older adults
5088
Diabetes screening within past 3 years
4808
Talked with health care professional about subjective cognitive decline or
memory loss                   4700
Need assistance with day-to-day activities because of subjective cognitive
decline or memory loss         4696
Functional difficulties associated with subjective cognitive decline or memory
loss among older adults    4696
Fall with injury within last year
4173
Colorectal cancer screening
4173
Oral health:  tooth retention
4172
```

```
Prevalence of sufficient sleep
4171
Eating 3 or more vegetables daily
4127
High blood pressure ever
4127
Cholesterol checked in past 5 years
4127
Eating 2 or more fruits daily
4124
Taking medication for high blood pressure
4108
Severe joint pain among older adults with arthritis
4064
Provide care for a friend or family member in past month
3848
Expect to provide care for someone in the next two years
3797
Provide care for someone with cognitive impairment within the past month
3682
Duration of caregiving among older adults
3681
Intensity of caregiving among older adults
3663
Up-to-date with recommended vaccines and screenings - Women
3280
Up-to-date with recommended vaccines and screenings - Men
3271
Mammogram within past 2 years
3271
Pap test within past 3 years
3242
Name: Topic, dtype: int64
```

[11]:

```
#(3)Question,  QuestionID
data["Question"].value_counts()
```

```
[11]: Percentage of older adults who are currently obese, with a body mass index (BMI)
      of 30 or more
      8300
      Percentage of older adults who reported influenza vaccine within the past year
      8300
      Physically unhealthy days (mean number of days in past month)
      8300
      Percentage of older adults who are experiencing frequent mental distress
      8300
      Percentage of older adults who have smoked at least 100 cigarettes in their
      entire life and still smoke every day or some days
      8300
      Percentage of older adults with a lifetime diagnosis of depression
      8300
      Percentage of older adults who have not had any leisure time physical activity
      in the past month
      8300
      Percentage of older adults who self-reported that their health is "fair" or
      "poor"
      8299
      Percentage of older adults who self-reported that their health is "good", "very
      good", or "excellent"
      8299
      Percentage of older adults who reported binge drinking within the past 30 days
      8299
      Percentage of at risk adults (have diabetes, asthma, cardiovascular disease or
      currently smoke) who ever had a pneumococcal vaccine
      8268
      Mean number of days with activity limitations in the past month
      8233
      Percentage of older adults who report having a disability (includes limitations
      related to sensory or mobility impairments or a physical, mental, or emotional
      condition)    6917
      Percentage of older adults ever told they have arthritis
      5511
      Fair or poor health among older adults with doctor-diagnosed arthritis
```

5447

Percentage of older adults who reported subjective cognitive decline or memory loss that is happening more often or is getting worse in the preceding 12 months

5088

Percentage of older adults without diabetes who reported a blood sugar or diabetes test within 3 years

4808

Percentage of older adults with subjective cognitive decline or memory loss who reported talking with a health care professional about it

4700

Percentage of older adults who reported that as a result of subjective cognitive decline or memory loss that they need assistance with day-to-day activities

4696

Percentage of older adults who reported subjective cognitive decline or memory loss that interferes with their ability to engage in social activities or household chores   4696

Percentage of older adults who have fallen and sustained an injury within last year

4173

Percentage of older adults who had either a home blood stool test within the past year or a sigmoidoscopy or colonoscopy within the past 10 years

4173

Percentage of older adults who report having lost 5 or fewer teeth due to decay or gum disease

4172

Percentage of older adults getting sufficient sleep (>6 hours)

4171

Percentage of older adults who are eating 3 or more vegetables daily

4127

Percentage of older adults who have ever been told by a health professional that they have high blood pressure

4127

Percentage of older adults who had a cholesterol screening within the past 5 years

4127

Percentage of older adults who are eating 2 or more fruits daily

```
4124
Percentage of older adults who have been told they have high blood pressure who
report currently taking medication for their high blood pressure
4108
Severe joint pain due to arthritis among older adults with doctor-diagnosed
arthritis
4064
Percentage of older adults who provided care for a friend or family member
within the past month
3848
Percentage of older adults currently not providing care who expect to provide
care for someone with health problems in the next two years
3797
Percentage of older adults who provided care for someone with dementia or other
cognitive impairment within the past month
3682
Percentage of older adults who provided care to a friend or family member for
six months or more
3681
Average of 20 or more hours of care per week provided to a friend or family
member
3663
Percentage of older adult women who are up to date with select clinical
preventive services
3280
Percentage of older adult men who are up to date with select clinical preventive
services
3271
Percentage of older adult women who have received a mammogram within the past 2
years
3271
Percentage of older adult women with an intact cervix who had a Pap test within
the past 3 years
3242
Name: Question, dtype: int64
```

[12]:
```
# 选取某一问题生成待处理的示例数据集
Question = 'Percentage of older adults who are currently obese, with a body␣
 ↪mass index (BMI) of 30 or more'
source_data = data.copy(deep=True)
data = data[data['Question'] == Question]
data.shape
```

[12]:
```
(8300, 28)
```

此时 **Class, Topic, Question, ClassID, TopicID, QuestionID** 等属性不再需要保留，展示后去除以便数据的后续处理

[13]:
```
# 保留属性如下:
['YearStart', 'YearEnd',
 'LocationAbbr', 'LocationDesc', 'Geolocation', 'LocationID',
 'Datasource',
 'Data_Value_Unit', 'DataValueTypeID', 'Data_Value_Type',
 'Data_Value', 'Data_Value_Alt', 'Low_Confidence_Limit',␣
 ↪'High_Confidence_Limit',
 'StratificationCategory1', 'Stratification1', 'StratificationCategoryID1',␣
 ↪'StratificationID1',
 'StratificationCategory2', 'Stratification2', 'StratificationCategoryID2',␣
 ↪'StratificationID2']

data.drop(labels = ['Class', 'Topic', 'Question', 'ClassID', 'TopicID',␣
 ↪'QuestionID'],axis=1,level=None,inplace=True)
data.shape
```

[13]:
```
(8300, 22)
```

[14]:
```
# 检查保留属性信息
data.dtypes
```

[14]:
```
YearStart                         int64
YearEnd                           int64
LocationAbbr                     object
LocationDesc                     object
Datasource                       object
```

```
Data_Value_Unit               object
DataValueTypeID               object
Data_Value_Type               object
Data_Value                   float64
Data_Value_Alt               float64
Low_Confidence_Limit         float64
High_Confidence_Limit        float64
StratificationCategory1       object
Stratification1               object
StratificationCategory2       object
Stratification2               object
Geolocation                   object
LocationID                     int64
StratificationCategoryID1     object
StratificationID1             object
StratificationCategoryID2     object
StratificationID2             object
dtype: object
```

[15]:

```
# 检查缺失值情况
data.isnull().sum()
```

[15]:

```
YearStart                       0
YearEnd                         0
LocationAbbr                    0
LocationDesc                    0
Datasource                      0
Data_Value_Unit                 0
DataValueTypeID                 0
Data_Value_Type                 0
Data_Value                   2411
Data_Value_Alt               2411
Low_Confidence_Limit         2411
High_Confidence_Limit        2411
StratificationCategory1         0
Stratification1                 0
StratificationCategory2      1044
```

```
Stratification2              1044
Geolocation                   720
LocationID                      0
StratificationCategoryID1       0
StratificationID1               0
StratificationCategoryID2       0
StratificationID2               0
dtype: int64
```

2.1.1 数据摘要　以 “Percentage of older adults who are currently obese, with a body mass index (BMI) of 30 or more” 为例进行数据分析和处理

- 标称属性，给出每个可能取值的频数
- 数值属性，给出 5 数概括及缺失值的个数

标称属性　由数据集展示可知该数据集标称属性共有 15 个，将其分为 9 组：

(1)LocationAbbr, LocationDesc,

(2)Datasource,

(3)Data_Value_Unit,

(4)DataValueTypeID, Data_Value_Type,

(5)StratificationCategory1, StratificationCategoryID1,

(6)Stratification1, StratificationID1,

(7)StratificationCategory2, StratificationCategoryID2,

(8)Stratification2, StratificationID2，

(9)Geolocation.

考虑到一些属性具有相关性，下面分组给出标称属性取值的频数

```
[16]: #(1)LocationAbbr, LocationDesc
      data["LocationDesc"].value_counts()
```

```
[16]: Alaska                                  144
      South                                   144
      Arizona                                 144
      Nevada                                  144
      New York                                144
      New Mexico                              144
      New Hampshire                           144
      North Carolina                          144
```

North Dakota	144
Oklahoma	144
Ohio	144
Oregon	144
Pennsylvania	144
Rhode Island	144
Minnesota	144
South Carolina	144
Tennessee	144
South Dakota	144
Texas	144
United States, DC & Territories	144
Utah	144
Vermont	144
West	144
Washington	144
Virginia	144
West Virginia	144
Mississippi	144
Missouri	144
Nebraska	144
Indiana	144
Alabama	144
Arkansas	144
Colorado	144
California	144
Connecticut	144
District of Columbia	144
Delaware	144
Florida	144
Hawaii	144
Georgia	144
Midwest	144
Illinois	144
Maine	144
Maryland	144

```
Massachusetts                      144
Michigan                           144
Northeast                          144
Kansas                             144
Wyoming                            144
Louisiana                          144
Kentucky                           144
Iowa                               143
Idaho                              143
Wisconsin                          143
Montana                            141
Guam                               126
New Jersey                         119
Puerto Rico                        117
Virgin Islands                      24
Name: LocationDesc, dtype: int64
```

[17]:

```
#(2)Datasource
data["Datasource"].value_counts()
```

[17]:

```
BRFSS    8300
Name: Datasource, dtype: int64
```

[18]:

```
#(3)Data_Value_Unit
data["Data_Value_Unit"].value_counts()
```

[18]:

```
%    8300
Name: Data_Value_Unit, dtype: int64
```

[19]:

```
#(4)DataValueTypeID,  Data_Value_Type
data["Data_Value_Type"].value_counts()
```

[19]:

```
Percentage    8300
Name: Data_Value_Type, dtype: int64
```

[20]:

```
#(5)StratificationCategory1,  StratificationCategoryID1
data["StratificationCategory1"].value_counts()
```

[20]:

```
Age Group    8300
Name: StratificationCategory1, dtype: int64
```

[21]:

```
#(6)Stratification1,  StratificationID1
data["Stratification1"].value_counts()
```

[21]:

```
Overall               2771
50-64 years           2768
65 years or older     2761
Name: Stratification1, dtype: int64
```

[22]:

```
#(7)StratificationCategory2,  StratificationCategoryID2
data["StratificationCategory2"].value_counts()
```

[22]:

```
Race/Ethnicity    5168
Gender            2088
Name: StratificationCategory2, dtype: int64
```

[23]:

```
#(8)Stratification2,  StratificationID2
data["Stratification2"].value_counts()
```

[23]:

```
Hispanic                    1044
Male                        1044
White, non-Hispanic         1044
Female                      1044
Asian/Pacific Islander      1035
Black, non-Hispanic         1035
Native Am/Alaskan Native    1010
Name: Stratification2, dtype: int64
```

[24]:

```
#(9)Geolocation
data["Geolocation"].value_counts()
```

[24]:

```
POINT (-147.722059 64.84507996)     144
POINT (-94.7942005 46.35564874)     144
POINT (-111.7638113 34.86597028)    144
POINT (-117.0718406 39.49324039)    144
POINT (-75.54397043 42.82700103)    144
POINT (-106.240581 34.52088095)     144
```

POINT (-71.50036092 43.65595011)	144
POINT (-79.15925046 35.46622098)	144
POINT (-100.118421 47.47531978)	144
POINT (-97.52107021 35.47203136)	144
POINT (-82.40426006 40.06021014)	144
POINT (-120.1550313 44.56744942)	144
POINT (-77.86070029 40.79373015)	144
POINT (-71.52247031 41.70828019)	144
POINT (-81.04537121 33.9988213)	144
POINT (-85.77449091 35.68094058)	144
POINT (-100.3735306 44.35313005)	144
POINT (-99.42677021 31.82724041)	144
POINT (-111.5871306 39.36070017)	144
POINT (-72.51764079 43.62538124)	144
POINT (-120.4700108 47.52227863)	144
POINT (-78.45789046 37.54268067)	144
POINT (-80.71264013 38.6655102)	144
POINT (-89.53803082 32.7455101)	144
POINT (-92.56630005 38.63579078)	144
POINT (-99.36572062 41.64104099)	144
POINT (-88.99771018 40.48501028)	144
POINT (-86.63186076 32.84057112)	144
POINT (-92.27449074 34.74865012)	144
POINT (-106.1336109 38.84384076)	144
POINT (-120.9999995 37.63864012)	144
POINT (-72.64984095 41.56266102)	144
POINT (-77.036871 38.907192)	144
POINT (-75.57774117 39.00883067)	144
POINT (-81.92896054 28.93204038)	144
POINT (-157.8577494 21.30485044)	144
POINT (-72.08269067 42.27687047)	144
POINT (-83.62758035 32.83968109)	144
POINT (-86.14996019 39.76691045)	144
POINT (-98.20078123 38.3477403)	144
POINT (-84.77497105 37.64597027)	144
POINT (-92.44568007 31.31266064)	144

```
POINT (-76.60926011 39.29058096)    144
POINT (-68.98503134 45.25422889)    144
POINT (-84.71439027 44.66131954)    144
POINT (-108.1098304 43.23554134)    144
POINT (-114.36373 43.68263001)      143
POINT (-93.81649056 42.46940091)    143
POINT (-89.81637074 44.39319117)    143
POINT (-109.4244206 47.06652897)    141
POINT (144.793731 13.444304)        126
POINT (-74.27369129 40.13057005)    119
POINT (-66.590149 18.220833)        117
POINT (-64.896335 18.335765)         24
Name: Geolocation, dtype: int64
```

数值属性 数值属性共有 7 个，分别为：YearStart,YearEnd,Data_Value,Data_Value_Alt,Low_Confidence_Limit ,High_Confidence_Limit,LocationID
下面给出每个属性的 5 数概括及缺失值的个数

[25]:
```
# 用 describe 函数对数值数据的 5 数进行概括
digital_data =␣
  ↪['YearStart','YearEnd','Data_Value','Data_Value_Alt','Low_Confidence_Limit','High_Confidenc
np.set_printoptions(suppress=True)
pd.set_option('display.float_format', lambda x:'%.4f'%x) # 小数点后面保留 4 位小
数
data[digital_data].describe()
```

[25]:
```
       YearStart   YearEnd  Data_Value  Data_Value_Alt  Low_Confidence_Limit  \
count  8300.0000 8300.0000   5889.0000       5889.0000             5889.0000
mean   2017.4917 2017.4917     33.7121         33.7121               29.1389
std       1.7079    1.7079      7.4038          7.4038                6.5922
min    2015.0000 2015.0000      3.7000          3.7000                2.1000
25%    2016.0000 2016.0000     29.2000         29.2000               25.5000
50%    2017.0000 2017.0000     33.3000         33.3000               29.4000
75%    2019.0000 2019.0000     38.0000         38.0000               33.4000
max    2020.0000 2020.0000     72.4000         72.4000               54.6000
```

```
       High_Confidence_Limit  LocationID
count              5889.0000   8300.0000
mean                 38.6961    653.5188
std                   9.6166   2280.1404
min                   6.5000      1.0000
25%                  32.3000     18.0000
50%                  37.2000     32.0000
75%                  43.6000     48.0000
max                  90.7000   9004.0000
```

```
[26]: # 给出数据缺失值情况
      data[digital_data].isnull().sum()
```

```
[26]: YearStart                   0
      YearEnd                     0
      Data_Value               2411
      Data_Value_Alt           2411
      Low_Confidence_Limit     2411
      High_Confidence_Limit    2411
      LocationID                  0
      dtype: int64
```

2.1.1 数据可视化

- 使用直方图、盒图等检查数据分布及离群点

标称属性

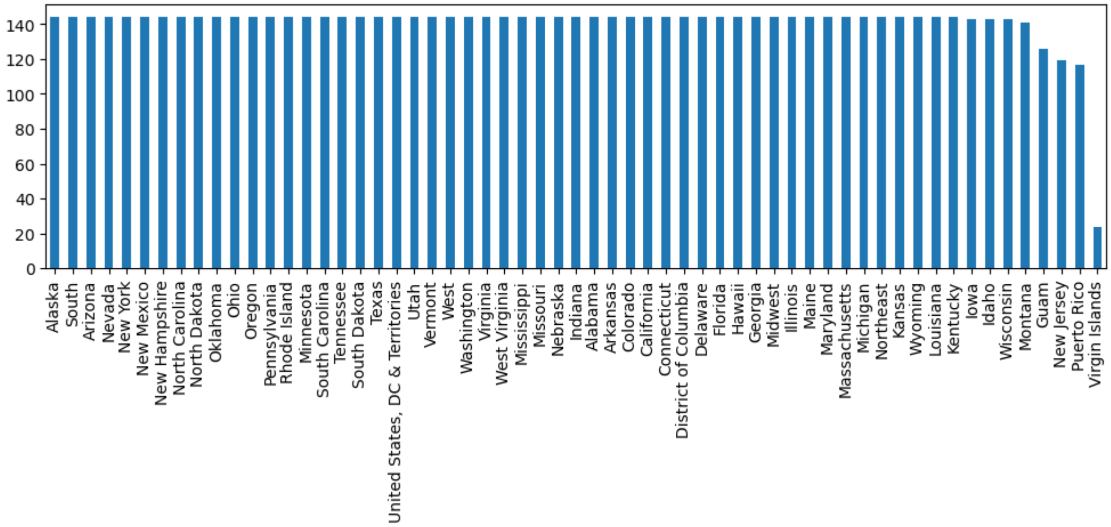
```
[27]: # 定义标称属性可视化函数
      def nom_attri_vis(attri):
          data[attri].value_counts().plot(kind="bar",figsize=(12,3))
```

分别对上述 9 组标称属性绘制直方图
(1)LocationAbbr, LocationDesc,
(2)Datasource,
(3)Data_Value_Unit,
(4)DataValueTypeID, Data_Value_Type,
(5)StratificationCategory1, StratificationCategoryID1,
(6)Stratification1, StratificationID1,
(7)StratificationCategory2, StratificationCategoryID2,

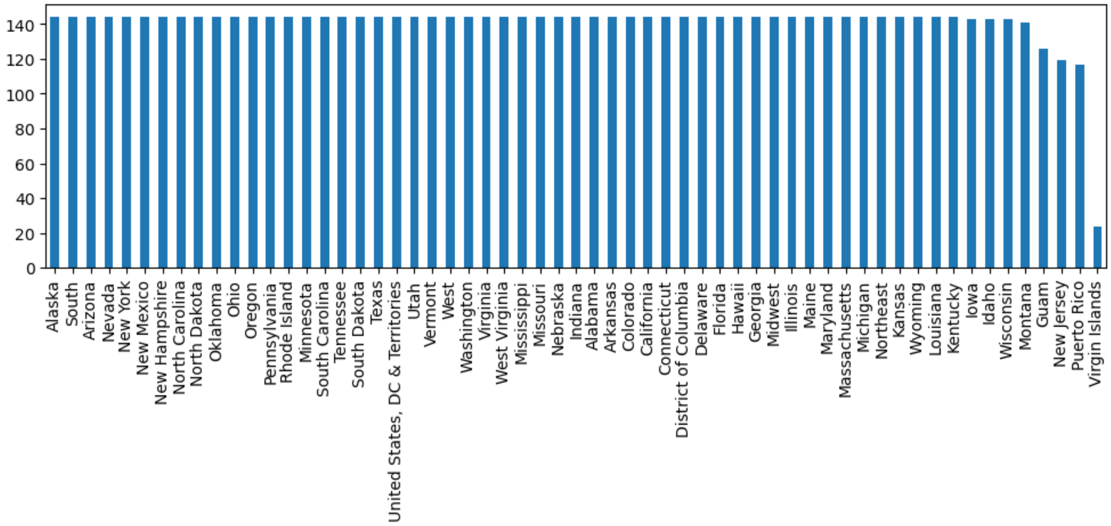
(8)Stratification2, StratificationID2，

(9)Geolocation.

[28]:
```
#(1)LocationAbbr， LocationDesc
attri = 'LocationDesc'
nom_attri_vis(attri)
```

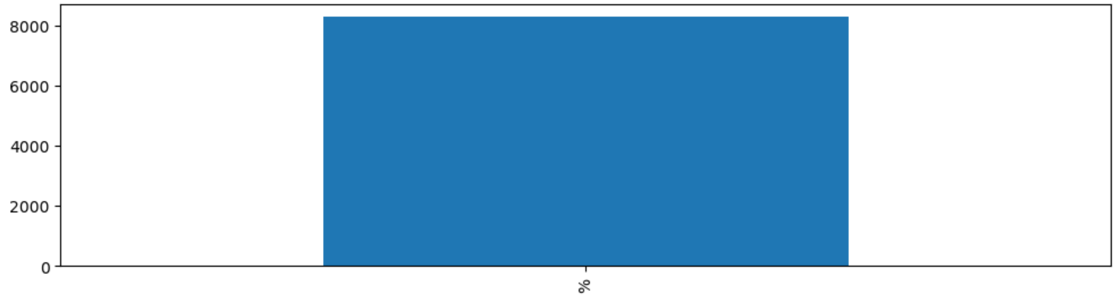


[29]:
```
#(2)Datasource
attri = 'LocationDesc'
nom_attri_vis(attri)
```



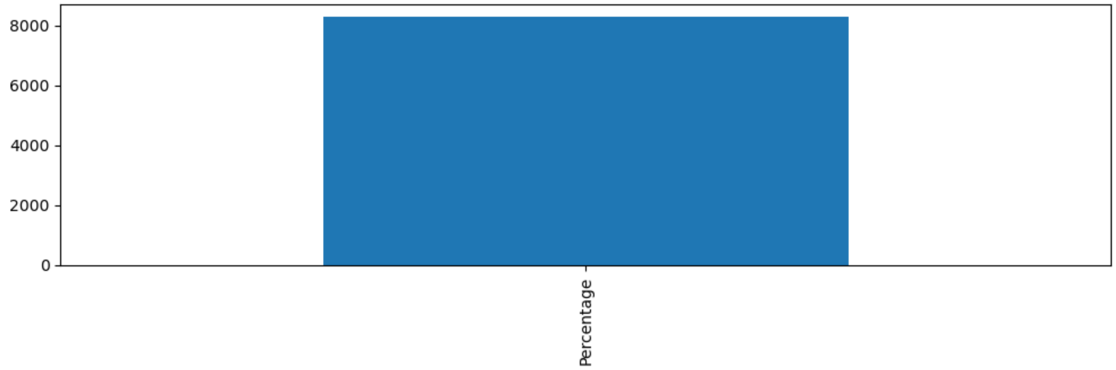
[30]:

```
#(3)Data_Value_Unit
attri = 'Data_Value_Unit'
nom_attri_vis(attri)
```



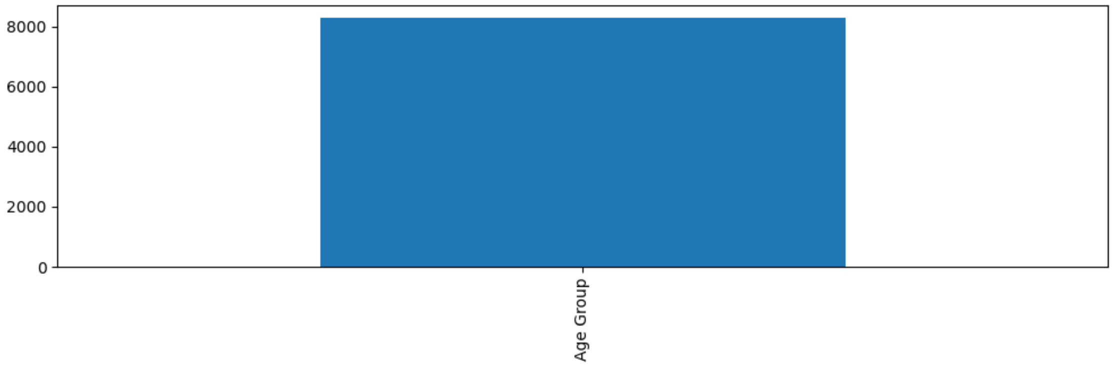
[31]:

```
#(4)DataValueTypeID,  Data_Value_Type
attri = 'Data_Value_Type'
nom_attri_vis(attri)
```

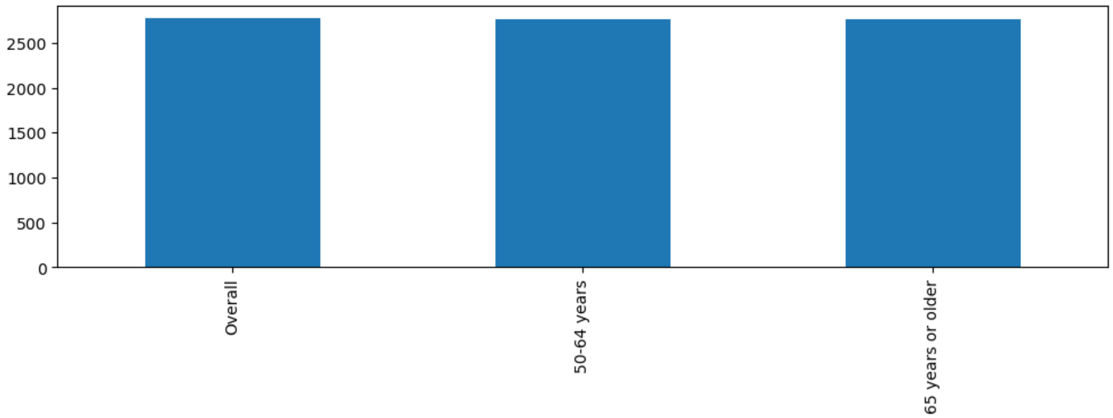


[32]:

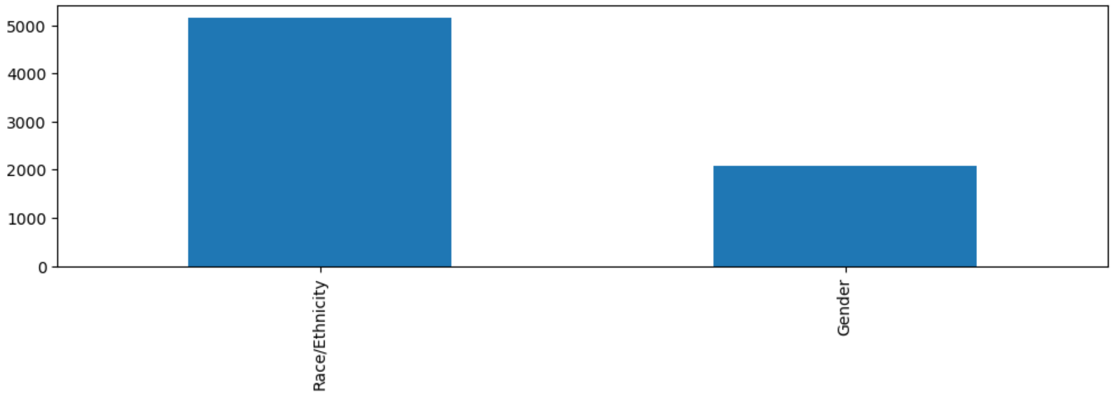
```
#(5)StratificationCategory1,  StratificationCategoryID1
attri = 'StratificationCategory1'
nom_attri_vis(attri)
```



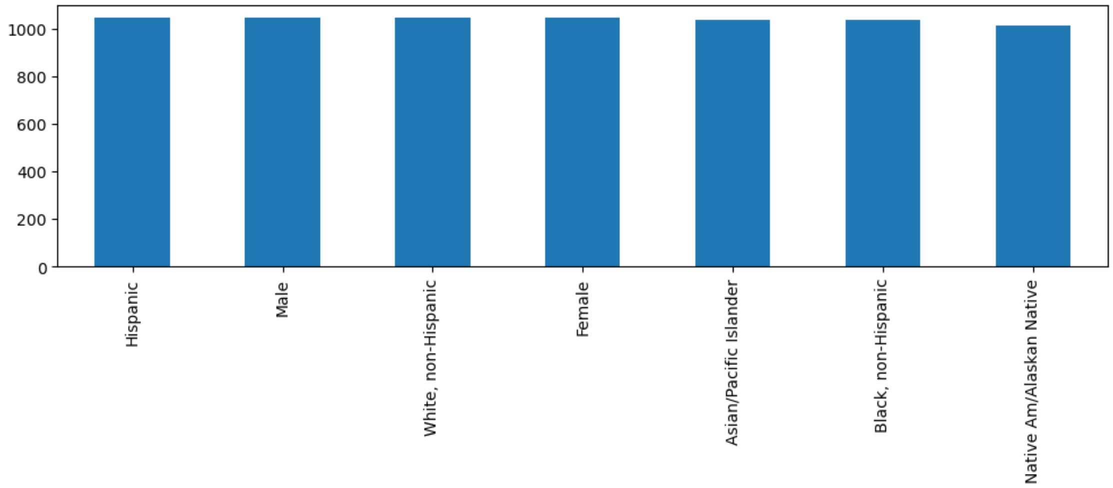
[33]:
```
#(6)Stratification1,  StratificationID1
attri = 'Stratification1'
nom_attri_vis(attri)
```



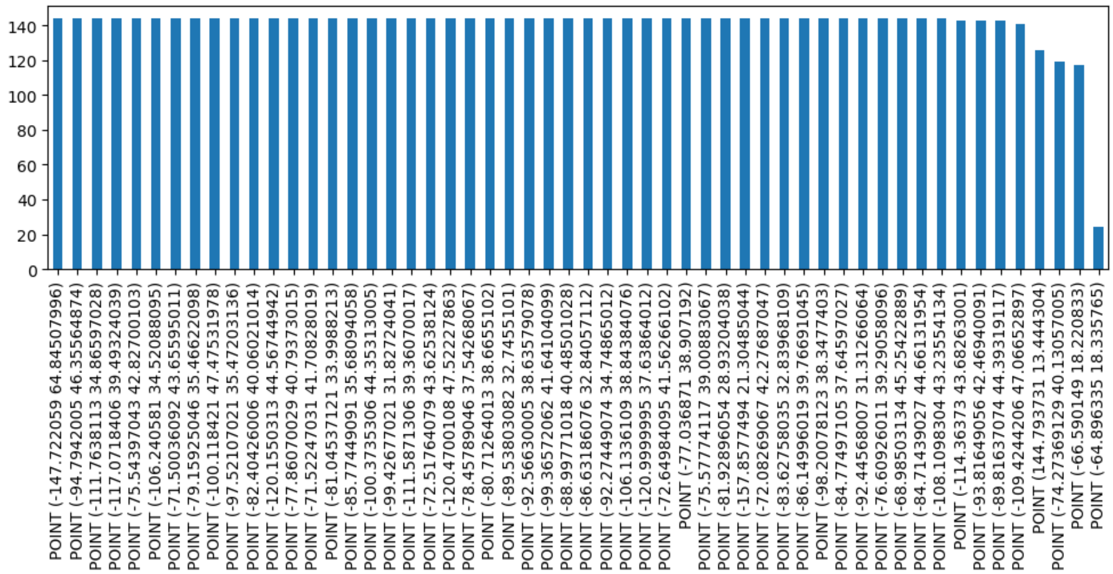
[34]:
```
#(7)StratificationCategory2,  StratificationCategoryID2
attri = 'StratificationCategory2'
nom_attri_vis(attri)
```



[35]:
```
#(8)Stratification2,  StratificationID2
attri = 'Stratification2'
nom_attri_vis(attri)
```



[36]:
```
#(9)Geolocation
attri = 'Geolocation'
nom_attri_vis(attri)
```



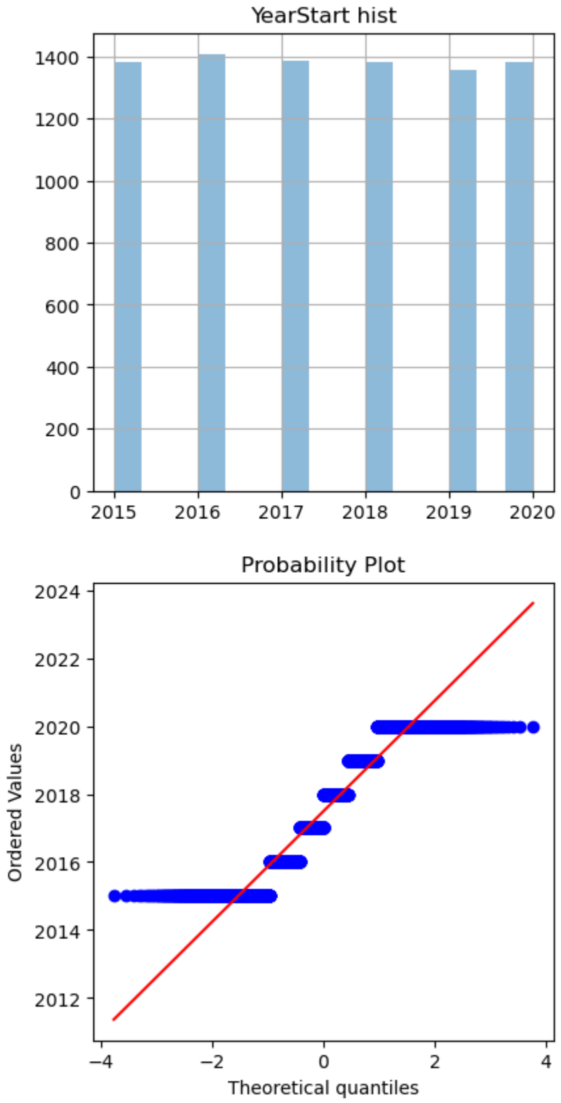
数值属性

[37]:
```
# 定义数值属性可视化函数
def num_attri_vis(attri):
    # coding=utf-8
    plt.figure(figsize = (10,10))
    # 直方图
    plt.subplot(2,2,1)
    title = attri + " hist"
    plt.title(title)
    data[attri].hist(alpha=0.5,bins=15) #alpha 透明度, bins 竖条数

    # 盒图
    plt.subplot(2,2,2)
    title = attri + " box"
    plt.title(title)
    p = data.boxplot([attri],return_type='dict')

    #q-q 图
    plt.subplot(2,2,3)
    stats.probplot(data[attri],dist="norm",plot=plt)
    plt.show()

    # 检查离群点
    print("离群点如下: \n",p['fliers'][0].get_ydata())
```

分别对上述 7 个数值属性绘制直方图、盒图和 q-q 图，并检查离群点 YearStart,YearEnd,Data_Value,Data_Value_Alt,Low_Confidence_Limit ,High_Confidence_Limit,LocationID

[38]:

```
#(1)YearStart
attri = 'YearStart'
num_attri_vis(attri)
```



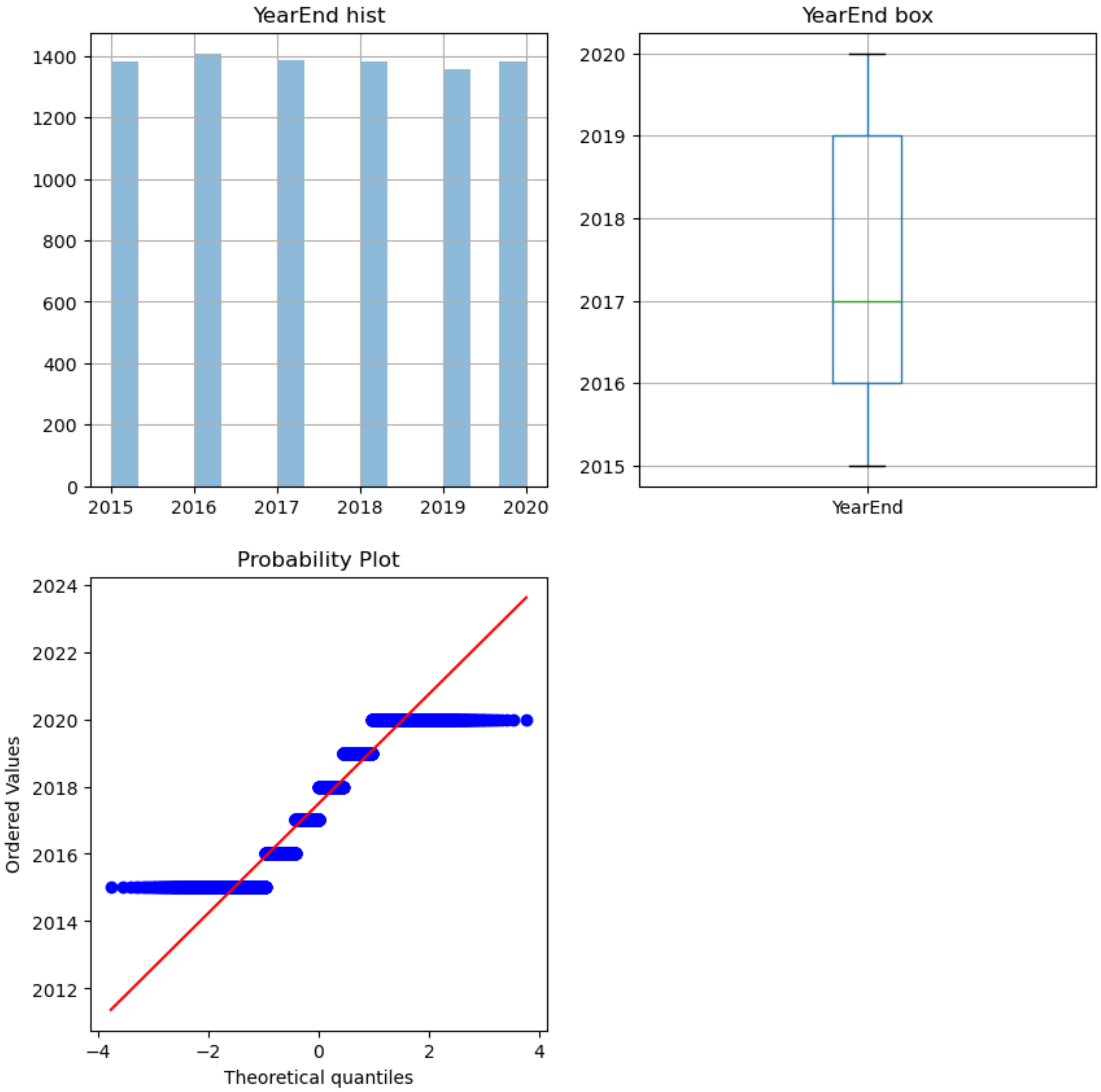
离群点如下：

```
 []
```

该属性大致符合均匀分布

[39]:

```
#(2)YearEnd
attri = 'YearEnd'
num_attri_vis(attri)
```



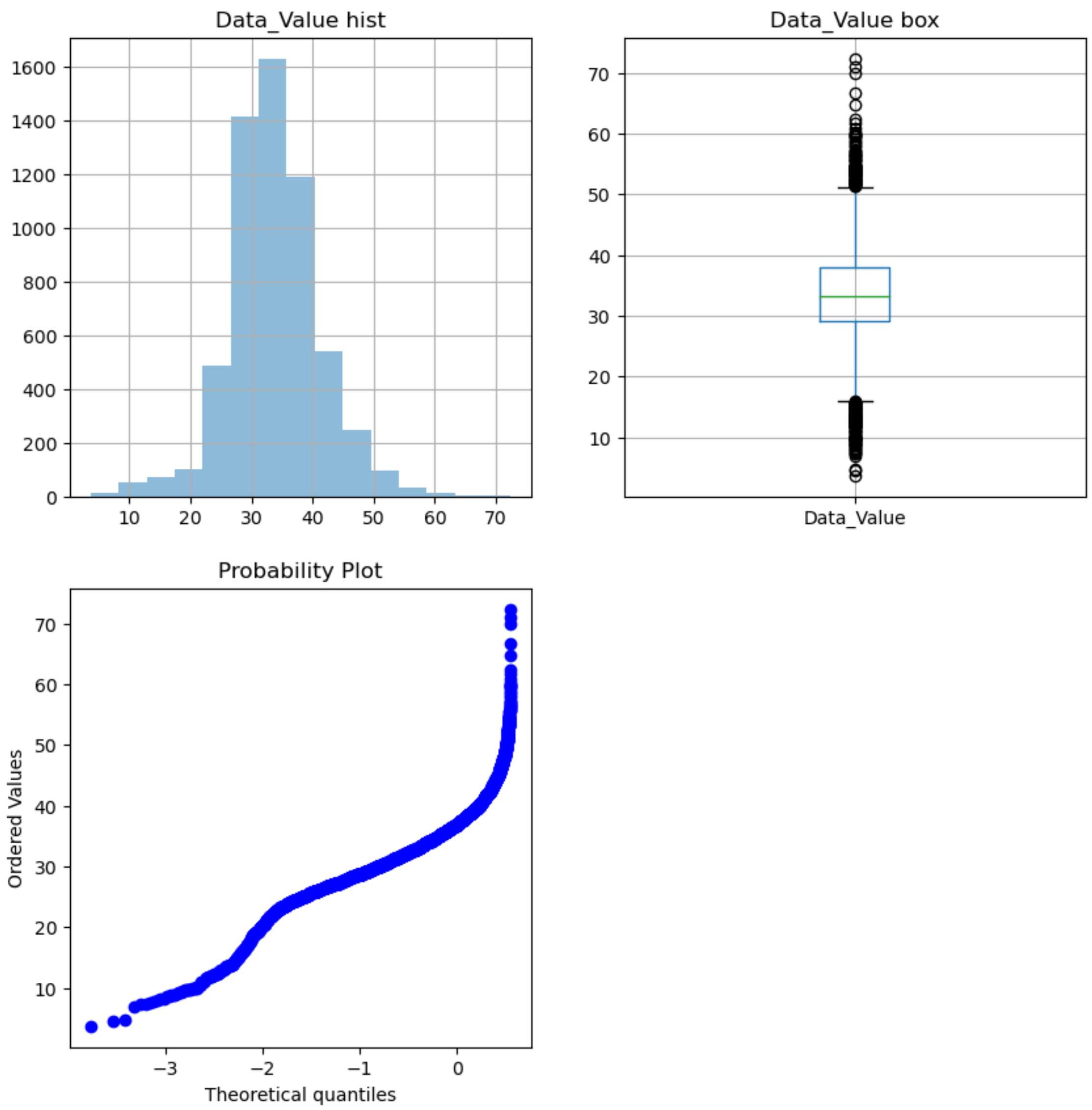
离群点如下:

```
[]
```

该属性大致符合均匀分布

[40]:

```
#(3)Data_Value
attri = 'Data_Value'
num_attri_vis(attri)
```

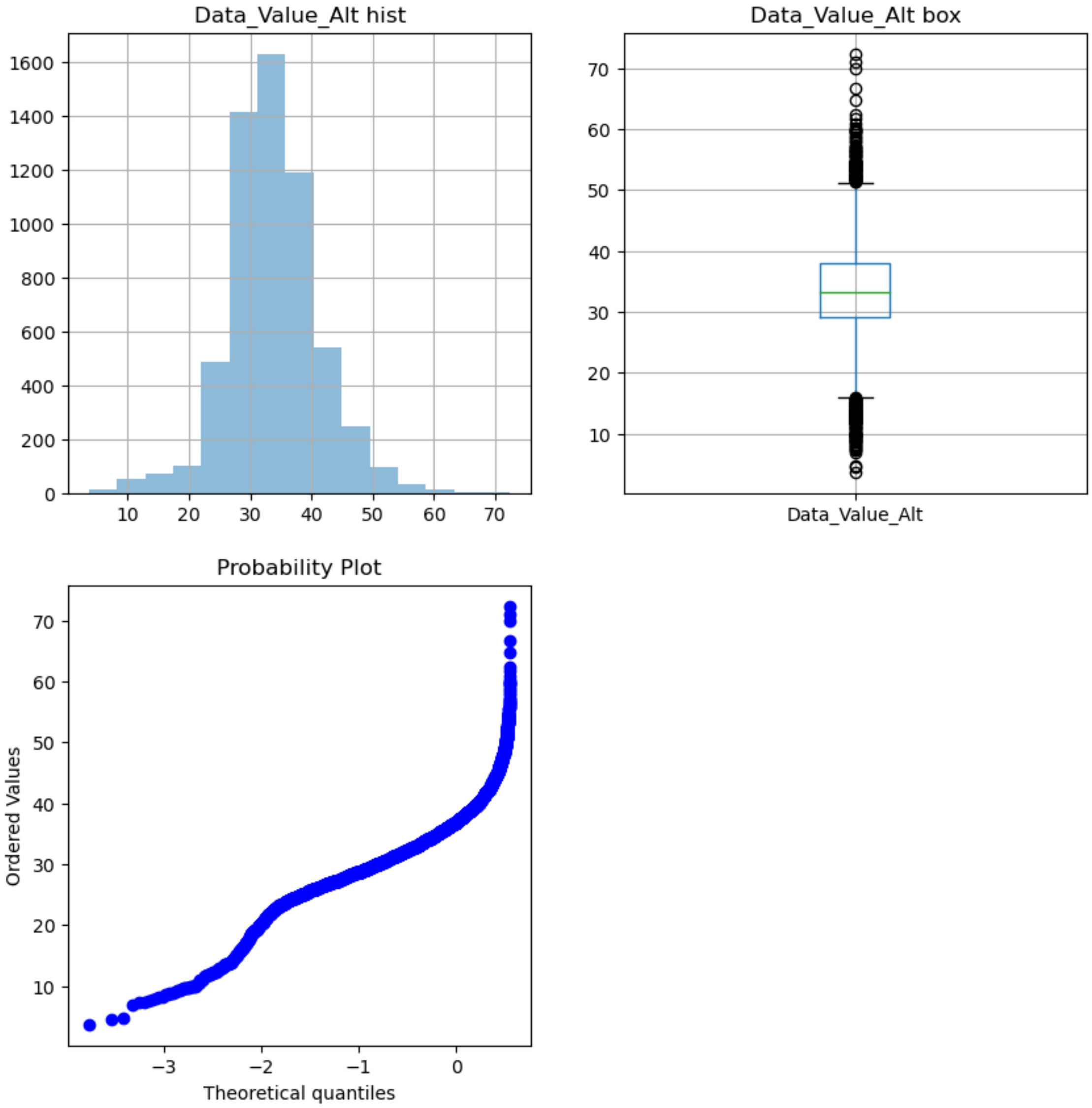


离群点如下：

```
[14.6 11.9 13.3 7.8 12.2 15.8 9.8 10.0 13.5 13.1 12.7 15.8 11.8 14.8 15.4
13.6 12.4 11.9 14.5 11.8 14.7 11.0 12.9 12.9 12.6 13.9 15.2 13.1 15.6
13.9 15.7 14.8 12.3 15.1 12.9 9.9 15.7 13.9 10.0 13.4 13.6 9.8 4.8 9.0
9.2 8.9 15.6 12.6 10.6 10.0 13.0 10.2 14.0 9.4 11.6 13.7 9.8 8.9 8.0 11.8
14.4 9.3 14.5 6.8 3.7 8.1 13.2 7.6 13.9 12.8 13.5 8.7 13.5 11.3 9.9 12.9
15.1 12.2 12.1 8.1 12.3 7.4 13.5 13.7 11.6 11.9 14.8 13.0 15.5 11.1 9.8
12.1 11.7 13.7 9.7 15.1 4.6 13.8 10.3 7.4 8.7 15.9 14.2 9.4 8.9 10.3 12.1
12.2 14.2 14.5 11.1 10.9 13.5 54.6 56.1 54.3 53.9 51.8 55.5 69.9 52.4
57.9 53.3 53.8 53.0 54.3 54.5 58.8 53.5 57.0 60.3 51.9 59.5 51.4 51.6
54.4 54.0 56.4 51.5 59.5 64.8 52.5 53.3 53.2 55.6 51.9 52.2 51.8 57.3
51.8 60.8 54.5 53.3 53.6 59.8 52.9 53.5 52.5 59.1 54.3 54.0 51.3 58.5
62.4 59.9 58.1 54.2 52.2 61.8 52.4 56.6 53.4 54.5 52.6 54.8 54.6 54.1
51.8 55.5 54.8 53.0 54.8 53.4 52.4 53.0 56.0 56.6 52.3 56.3 54.6 54.3
53.7 60.1 52.4 55.8 54.0 54.6 56.8 71.1 51.7 72.4 53.5 57.1 66.8]
```

该属性大致符合单峰分布

[41]:
```
#(4)Data_Value_Alt
attri = 'Data_Value_Alt'
num_attri_vis(attri)
```

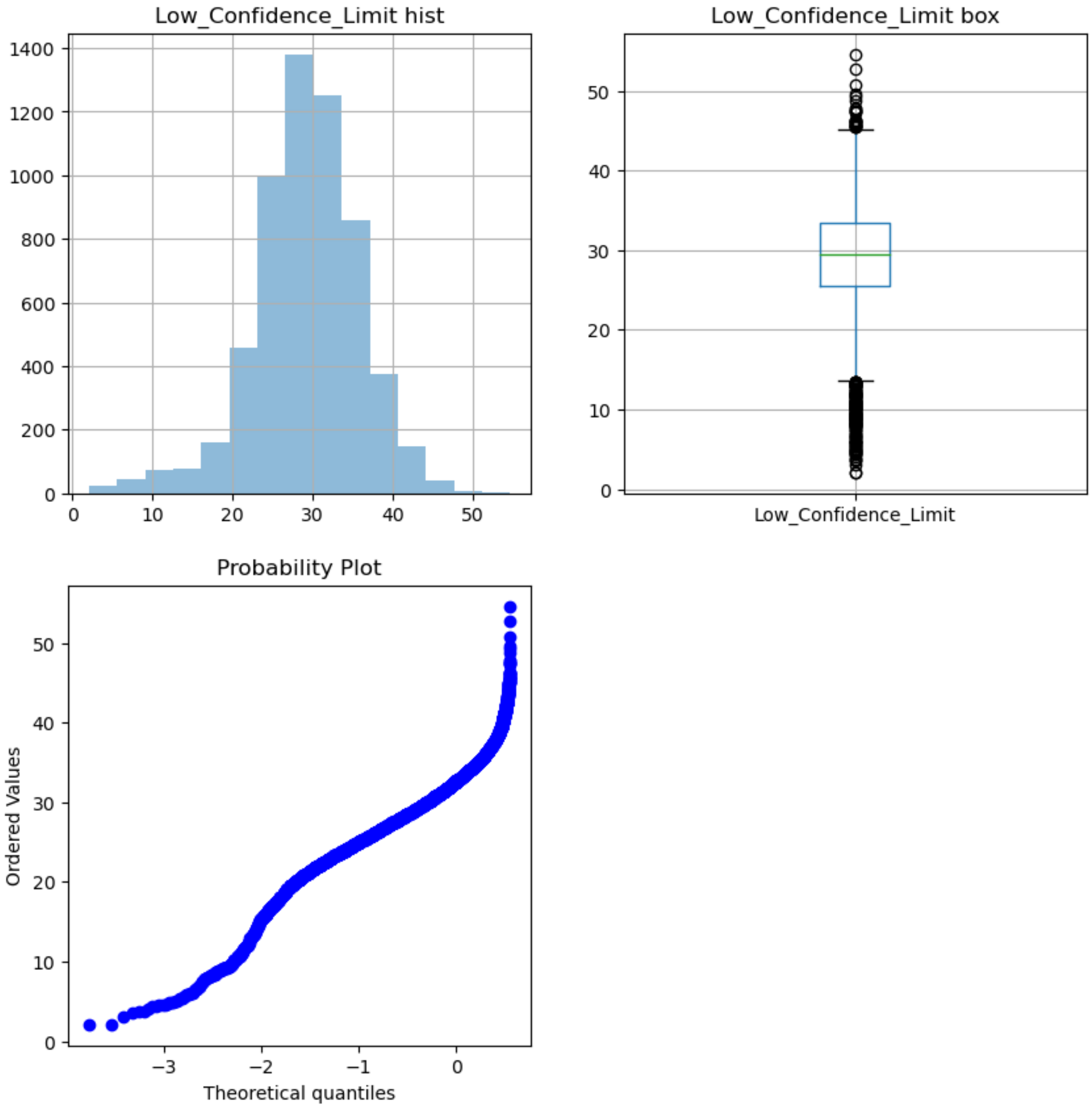


```
离群点如下:
[14.6 11.9 13.3 7.8 12.2 15.8 9.8 10.0 13.5 13.1 12.7 15.8 11.8 14.8 15.4
13.6 12.4 11.9 14.5 11.8 14.7 11.0 12.9 12.9 12.6 13.9 15.2 13.1 15.6
13.9 15.7 14.8 12.3 15.1 12.9 9.9 15.7 13.9 10.0 13.4 13.6 9.8 4.8 9.0
9.2 8.9 15.6 12.6 10.6 10.0 13.0 10.2 14.0 9.4 11.6 13.7 9.8 8.9 8.0 11.8
14.4 9.3 14.5 6.8 3.7 8.1 13.2 7.6 13.9 12.8 13.5 8.7 13.5 11.3 9.9 12.9
15.1 12.2 12.1 8.1 12.3 7.4 13.5 13.7 11.6 11.9 14.8 13.0 15.5 11.1 9.8
12.1 11.7 13.7 9.7 15.1 4.6 13.8 10.3 7.4 8.7 15.9 14.2 9.4 8.9 10.3 12.1
12.2 14.2 14.5 11.1 10.9 13.5 54.6 56.1 54.3 53.9 51.8 55.5 69.9 52.4
57.9 53.3 53.8 53.0 54.3 54.5 58.8 53.5 57.0 60.3 51.9 59.5 51.4 51.6
54.4 54.0 56.4 51.5 59.5 64.8 52.5 53.3 53.2 55.6 51.9 52.2 51.8 57.3
51.8 60.8 54.5 53.3 53.6 59.8 52.9 53.5 52.5 59.1 54.3 54.0 51.3 58.5
62.4 59.9 58.1 54.2 52.2 61.8 52.4 56.6 53.4 54.5 52.6 54.8 54.6 54.1
51.8 55.5 54.8 53.0 54.8 53.4 52.4 53.0 56.0 56.6 52.3 56.3 54.6 54.3
53.7 60.1 52.4 55.8 54.0 54.6 56.8 71.1 51.7 72.4 53.5 57.1 66.8]
```

该属性大致符合单峰分布

[42]:

```
#(5)Low_Confidence_Limit
attri = 'Low_Confidence_Limit'
num_attri_vis(attri)
```

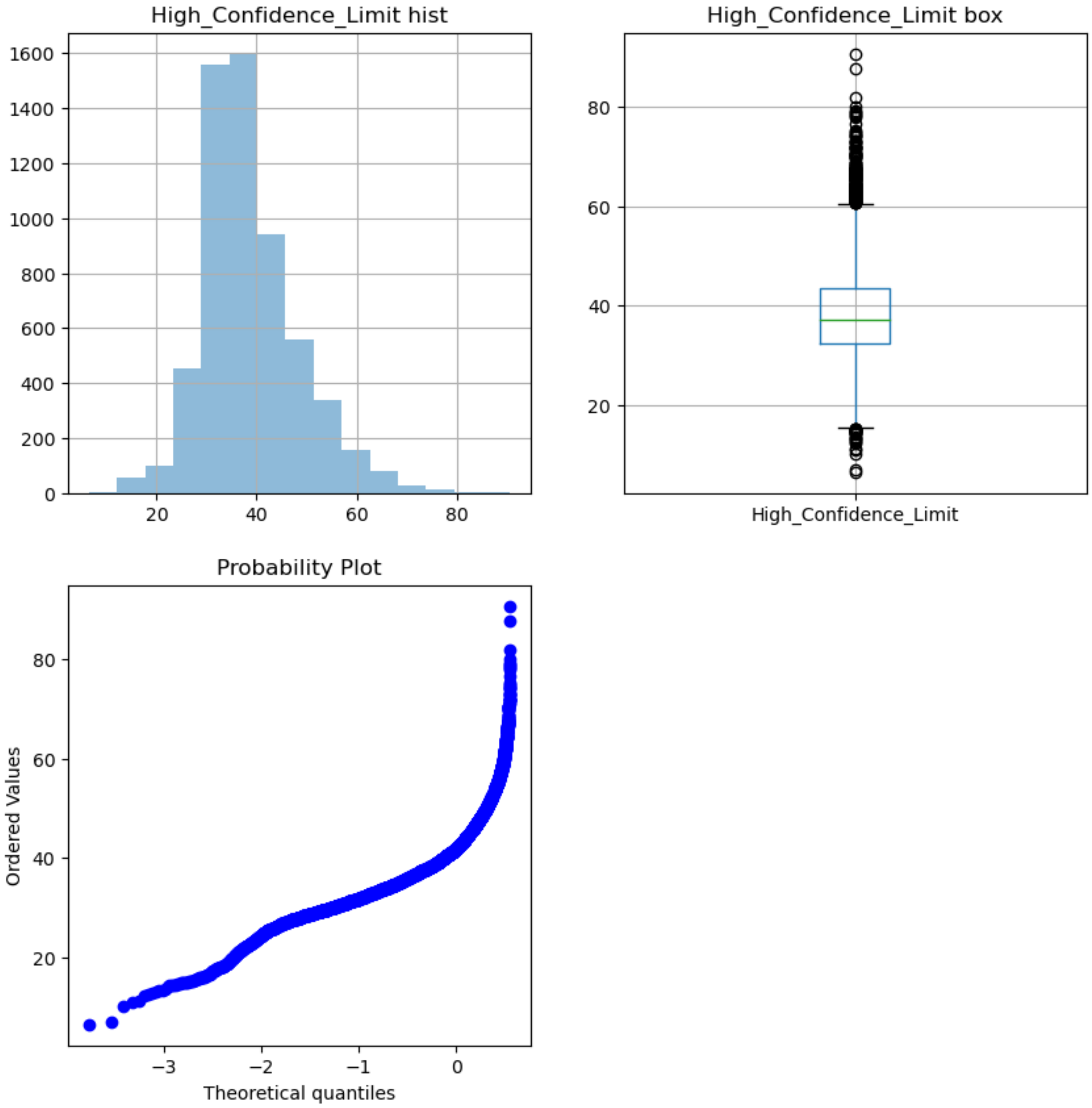


离群点如下：

```
[12.0 9.1 7.9 9.1 4.4 8.3 10.1 12.3 5.8 5.7 10.1 9.5 11.7 9.2 13.4 8.6
11.9 11.9 10.7 10.6 9.2 10.6 12.4 9.5 13.3 11.8 11.6 11.8 9.4 11.8 8.0
13.5 10.0 13.1 12.9 11.0 11.7 10.2 13.5 12.6 13.1 12.3 9.8 11.4 13.2 12.7
10.3 13.5 9.0 13.3 10.9 12.1 11.8 7.3 10.1 12.9 10.7 9.4 8.8 8.2 10.3
10.4 5.5 8.4 8.4 4.9 8.8 11.2 13.3 9.4 3.7 2.1 13.0 5.4 3.6 4.8 13.1 12.9
11.9 9.2 6.9 10.9 9.4 13.0 6.3 6.8 8.3 6.5 8.2 6.1 8.0 13.4 9.1 4.5 5.9
4.9 7.5 9.1 5.4 8.6 3.7 2.1 4.6 9.3 5.0 9.1 8.4 8.8 9.5 4.6 9.0 8.0 6.1
10.6 9.7 12.0 7.8 9.8 4.7 8.4 5.3 11.2 10.1 8.9 9.6 11.7 10.7 11.0 8.2
6.6 9.7 9.1 10.4 10.6 11.0 11.3 6.1 12.9 9.4 3.0 11.0 8.7 6.8 10.3 4.3
5.1 11.5 12.0 10.7 6.5 12.3 4.1 5.8 8.9 8.0 8.8 8.8 7.8 7.2 7.5 45.4 45.6
49.6 46.2 54.6 47.7 46.1 45.7 47.2 45.9 49.2 47.4 47.7 45.5 47.4 46.3
50.8 47.4 46.3 45.8 45.4 48.7 46.3 45.9 45.7 52.7]
```

该属性大致符合单峰分布

[43]:
```
#(6)High_Confidence_Limit
attri = 'High_Confidence_Limit'
num_attri_vis(attri)
```



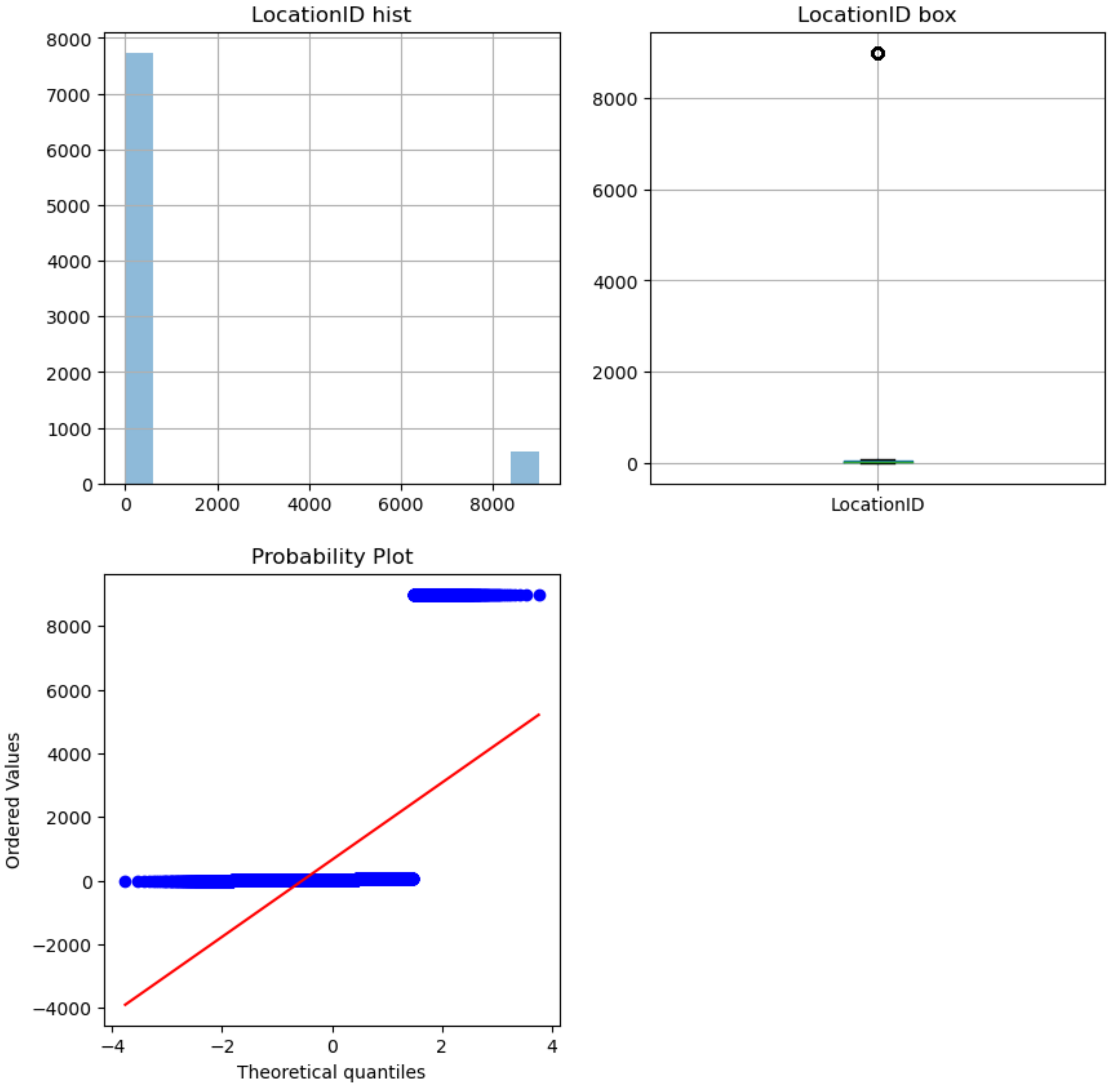
离群点如下：

```
[13.3 14.8 14.8 15.0 11.0 14.7 14.5 14.3 13.1 12.7 12.3 6.5 14.1 11.2 15.0
 13.6 10.2 15.1 14.6 14.8 14.4 15.1 14.9 15.3 7.0 15.2 12.5 14.3 13.3 64.2
 65.6 62.4 65.5 63.7 63.8 61.8 64.5 62.6 67.6 62.9 81.8 61.7 67.4 61.3
 62.6 66.7 62.9 68.6 67.3 65.5 74.3 74.6 70.4 67.7 61.6 69.9 65.4 70.6
 60.9 64.6 61.0 60.9 73.0 72.0 65.9 66.8 68.6 63.4 68.2 67.3 61.3 62.4
 66.5 62.6 63.5 66.8 71.8 61.6 60.6 63.0 65.6 61.1 65.6 66.6 60.9 77.8
 61.8 64.6 62.1 61.5 61.9 66.3 66.2 65.3 61.7 61.1 61.8 63.1 66.4 61.2
 67.0 71.2 62.8 79.3 71.7 63.2 64.0 65.8 64.7 65.4 65.4 63.4 75.2 61.1
 76.5 67.9 64.5 68.2 61.7 66.0 71.8 66.5 62.9 61.8 63.6 71.9 65.4 73.2
 78.7 64.2 78.2 60.9 64.2 73.1 71.9 70.0 60.9 80.0 64.6 69.8 62.7 60.6
 67.6 62.5 65.9 63.7 62.4 64.3 60.7 60.7 61.1 66.1 60.6 63.3 66.7 65.6
 63.9 65.5 61.4 68.0 61.8 64.4 74.0 62.0 75.0 65.7 65.3 62.6 70.1 61.3
 66.3 74.2 71.0 62.5 67.7 68.0 78.9 63.5 67.6 66.2 62.1 67.3 64.1 68.6
 70.4 62.3 68.9 61.3 63.9 73.0 69.6 64.9 67.1 72.7 87.8 70.4 90.7 67.2
 62.5 62.5 67.6 69.9 70.4 74.5 78.4]
```

该属性大致符合单峰分布

[44]:

```
#(7)LocationID
attri = 'LocationID'
num_attri_vis(attri)
```



离群点如下：

```
 [9001  9001  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002  9002
9002 9002 9002 9002 9002 9002 9002 9002 9002 9002 9002 9002 9002 9002
9002 9002 9002 9002 9002 9002 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001 9001
9001 9001 9001 9001 9001 9001 9001 9001 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
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9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003
9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9003 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004 9004
9004 9004]
```

该属性没有分布

2.2 数据缺失的处理　观察数据集中缺失数据，分析其缺失的原因。分别使用下列四种策略对缺失值进行处理:

- 将缺失部分剔除
- 用最高频率值来填补缺失值
- 通过属性的相关关系来填补缺失值
- 通过数据对象之间的相似性来填补缺失值

注意：在处理后完成，要对比新旧数据集的差异。

[45]:

```
# 检查数据缺失情况
data.isnull().sum()
```

[45]:

```
YearStart                        0
YearEnd                          0
LocationAbbr                     0
LocationDesc                     0
Datasource                       0
Data_Value_Unit                  0
DataValueTypeID                  0
Data_Value_Type                  0
Data_Value                    2411
Data_Value_Alt                2411
Low_Confidence_Limit          2411
High_Confidence_Limit         2411
StratificationCategory1          0
Stratification1                  0
StratificationCategory2       1044
Stratification2               1044
Geolocation                    720
LocationID                       0
StratificationCategoryID1        0
StratificationID1                0
StratificationCategoryID2        0
StratificationID2                0
dtype: int64
```

由输出可知，该数据集中以下属性存在缺失数据：

- Data_Value 实际数据值
- Data_Value_Alt 一个替代数据值

- Low_Confidence_Limit 数据值置信区间的下限
- High_Confidence_Limit 数据值置信区间的上限
- StratificationCategory2 用于分层的第二类
- Stratification2 用于第二类的具体分层
- Geolocation 收集数据的位置的经纬度

缺失原因可能是由于未完全记录、遗漏或无法获取

注意到 Data_Value, Data_Value_Alt, Low_Confidence_Limit 和 High_Confidence_Limit 四个属性缺失值数量相同
StratificationCategory2 与 Stratification2 属性缺失值数量相同
接下来检查是否在相同数据元组内缺失

[46]:

```
#(1) 检查 Data_Value, Data_Value_Alt, Low_Confidence_Limit, ␣
 ↪High_Confidence_Limit 是否同时缺失
flag = True
for index, row in data.iterrows():
    # 全空
    if np.isnan(row['Data_Value']) and np.isnan(row['Data_Value_Alt']) and np.
 ↪isnan(row['Low_Confidence_Limit']) and np.
 ↪isnan(row['High_Confidence_Limit']):
        continue
    # 全不空
    elif (not np.isnan(row['Data_Value'])) and (not np.
 ↪isnan(row['Data_Value_Alt'])) and (not np.
 ↪isnan(row['Low_Confidence_Limit'])) and (not np.
 ↪isnan(row['High_Confidence_Limit'])):
        continue
    else:
        flag = False
        break
flag
```

[46]:

```
True
```

[47]:

```
#(1) 检查 StratificationCategory2, Stratification2 是否同时缺失
flag = True
for index, row in data.iterrows():
    # 全空
    if row['StratificationCategory2'] == "" and row['Stratification2'] == "":
        continue
    # 全不空
    elif row['StratificationCategory2'] != "" and row['Stratification2'] != "":
        continue
    else:
        flag = False
        break
#     print(row['StratificationCategory2'])
#     print(row['Stratification2'])
flag
```

[47]:
```
True
```

由上述结果可知：

Data_Value, Data_Value_Alt, Low_Confidence_Limit，High_Confidence_Limit 同时缺失

StratificationCategory2, Stratification2 同时缺失

[48]:
```
# 查看属性的相关关系
data.corr()
```

[48]:
```
                      YearStart  YearEnd  Data_Value  Data_Value_Alt  \
YearStart                1.0000   1.0000      0.1238          0.1238
YearEnd                  1.0000   1.0000      0.1238          0.1238
Data_Value               0.1238   0.1238      1.0000          1.0000
Data_Value_Alt           0.1238   0.1238      1.0000          1.0000
Low_Confidence_Limit     0.1148   0.1148      0.8725          0.8725
High_Confidence_Limit    0.1098   0.1098      0.9187          0.9187
LocationID               0.0013   0.0013     -0.0759         -0.0759

                      Low_Confidence_Limit  High_Confidence_Limit  LocationID
YearStart                           0.1148                 0.1098      0.0013
YearEnd                             0.1148                 0.1098      0.0013
Data_Value                          0.8725                 0.9187     -0.0759
Data_Value_Alt                      0.8725                 0.9187     -0.0759
Low_Confidence_Limit                1.0000                 0.6108     -0.0278
High_Confidence_Limit               0.6108                 1.0000     -0.0958
LocationID                         -0.0278                -0.0958      1.0000
```

注意到 **YearStart** 与 **YearEnd** **,** **Data_Value** 与 **Data_Value_Alt** 相关系数为 **1**，检查是否每个值都相同

[49]:

```python
# 检查 YearStart 与 YearEnd 是否每个值都相同
flag = True
for index, row in data.iterrows():
    # 相同
    if row['YearStart'] == row['YearEnd'] :
        continue
    else:
        flag = False
        break
#     print(row['StratificationCategory2'])
#     print(row['Stratification2'])
flag
```

[49]:

```
True
```

[50]:

```python
# 检查 Data_Value 与 Data_Value_Alt 是否每个值都相同
flag = True
for index, row in data.iterrows():
    # 相同
    if row['Data_Value'] == row['Data_Value_Alt'] :
        continue
    elif np.isnan(row['Data_Value']) and np.isnan(row['Data_Value_Alt']):
        continue
    else:
        print(row['Data_Value'])
        print(row['Data_Value_Alt'])
        flag = False
        break
#     print(row['StratificationCategory2'])
#     print(row['Stratification2'])
flag
```

[50]:

```
True
```

由上述结果可知，两组属性每组两个值都相同。因此，只需要对其同时处理即可。

方案一将缺失部分剔除 缺失数据中 **Data_Value, Data_Value_Alt, Low_Confidence_Limit, High_Confidence_Limit** 与其他属性没有直接关联，且同时缺失。 因此，可以尝试直接剔除方法 其他属性有明显的关联关系，这里不采用直接剔除方法

[51]:

```
new_data = data.copy(deep=True)
new_data = new_data.dropna(subset=['Data_Value'])
new_data.isnull().sum()
```

[51]:

```
YearStart                       0
YearEnd                         0
LocationAbbr                    0
LocationDesc                    0
Datasource                      0
Data_Value_Unit                 0
DataValueTypeID                 0
Data_Value_Type                 0
Data_Value                      0
Data_Value_Alt                  0
Low_Confidence_Limit            0
High_Confidence_Limit           0
StratificationCategory1         0
Stratification1                 0
StratificationCategory2      1044
Stratification2              1044
Geolocation                   709
LocationID                      0
StratificationCategoryID1       0
StratificationID1               0
StratificationCategoryID2       0
StratificationID2               0
dtype: int64
```

查看新数据集数据摘要

[52]:

```
#(1)LocationAbbr, LocationDesc
new_data["LocationDesc"].value_counts()
```

```
[52]: West                               144
      United States, DC & Territories    144
      Midwest                            142
      South                              141
      Northeast                          138
      Washington                         120
      Arizona                            119
      Oklahoma                           118
      New York                           118
      California                         117
      Kansas                             116
      Nebraska                           115
      Florida                            114
      Texas                              111
      Connecticut                        109
      New Mexico                         108
      Hawaii                             108
      North Carolina                     108
      Minnesota                          108
      Maryland                           108
      Colorado                           107
      Massachusetts                      106
      Illinois                           105
      Virginia                           104
      Indiana                            103
      Michigan                           102
      Delaware                           101
      Georgia                            101
      Ohio                                98
      South Carolina                      97
      Rhode Island                        97
      Pennsylvania                        97
      Nevada                              96
      Wisconsin                           94
      Montana                             93
      Alabama                             93
```

```
Missouri                             92
District of Columbia                 92
Louisiana                            92
Arkansas                             91
Utah                                 91
Kentucky                             90
Alaska                               90
Mississippi                          90
South Dakota                         90
Tennessee                            90
New Jersey                           89
Iowa                                 85
Guam                                 85
North Dakota                         85
Idaho                                83
Oregon                               82
Wyoming                              82
West Virginia                        79
Maine                                78
Vermont                              73
New Hampshire                        72
Puerto Rico                          72
Virgin Islands                       16
Name: LocationDesc, dtype: int64
```

[53]:

```
#(2)Stratification1,  StratificationID1
new_data["Stratification1"].value_counts()
```

[53]:

```
Overall                2089
50-64 years            1965
65 years or older      1835
Name: Stratification1, dtype: int64
```

[54]:

```
#(3)StratificationCategory2,  StratificationCategoryID2
new_data["StratificationCategory2"].value_counts()
```

```
[54]: Race/Ethnicity    2759
      Gender            2086
      Name: StratificationCategory2, dtype: int64
```

```
[55]: #(4)Stratification2,  StratificationID2
      new_data["Stratification2"].value_counts()
```

```
[55]: Male                         1043
      Female                       1043
      White, non-Hispanic          1017
      Black, non-Hispanic           712
      Hispanic                      595
      Native Am/Alaskan Native      295
      Asian/Pacific Islander        140
      Name: Stratification2, dtype: int64
```

```
[56]: #(5)Geolocation
      new_data["Geolocation"].value_counts()
```

```
[56]: POINT (-120.4700108 47.52227863)    120
      POINT (-111.7638113 34.86597028)    119
      POINT (-97.52107021 35.47203136)    118
      POINT (-75.54397043 42.82700103)    118
      POINT (-120.9999995 37.63864012)    117
      POINT (-98.20078123 38.3477403)     116
      POINT (-99.36572062 41.64104099)    115
      POINT (-81.92896054 28.93204038)    114
      POINT (-99.42677021 31.82724041)    111
      POINT (-72.64984095 41.56266102)    109
      POINT (-76.60926011 39.29058096)    108
      POINT (-79.15925046 35.46622098)    108
      POINT (-94.7942005 46.35564874)     108
      POINT (-106.240581 34.52088095)     108
      POINT (-157.8577494 21.30485044)    108
      POINT (-106.1336109 38.84384076)    107
      POINT (-72.08269067 42.27687047)    106
      POINT (-88.99771018 40.48501028)    105
      POINT (-78.45789046 37.54268067)    104
      POINT (-86.14996019 39.76691045)    103
      POINT (-84.71439027 44.66131954)    102
      POINT (-83.62758035 32.83968109)    101
      POINT (-75.57774117 39.00883067)    101
      POINT (-82.40426006 40.06021014)     98
      POINT (-77.86070029 40.79373015)     97
      POINT (-81.04537121 33.9988213)      97
      POINT (-71.52247031 41.70828019)     97
      POINT (-117.0718406 39.49324039)     96
      POINT (-89.81637074 44.39319117)     94
      POINT (-86.63186076 32.84057112)     93
      POINT (-109.4244206 47.06652897)     93
      POINT (-92.56630005 38.63579078)     92
      POINT (-92.44568007 31.31266064)     92
      POINT (-77.036871 38.907192)         92
      POINT (-111.5871306 39.36070017)     91
      POINT (-92.27449074 34.74865012)     91
      POINT (-100.3735306 44.35313005)     90
      POINT (-147.722059 64.84507996)      90
      POINT (-89.53803082 32.7455101)      90
      POINT (-84.77497105 37.64597027)     90
      POINT (-85.77449091 35.68094058)     90
      POINT (-74.27369129 40.13057005)     89
      POINT (-100.118421 47.47531978)      85
      POINT (144.793731 13.444304)         85
      POINT (-93.81649056 42.46940091)     85
      POINT (-114.36373 43.68263001)       83
      POINT (-108.1098304 43.23554134)     82
      POINT (-120.1550313 44.56744942)     82
      POINT (-80.71264013 38.6655102)      79
      POINT (-68.98503134 45.25422889)     78
      POINT (-72.51764079 43.62538124)     73
      POINT (-66.590149 18.220833)         72
      POINT (-71.50036092 43.65595011)     72
      POINT (-64.896335 18.335765)         16
      Name: Geolocation, dtype: int64
```

由于先前处理时五数概况及可视化默认剔除缺失值，这里只比较标称属性频数变化
对比新旧频数，可以看出缺失数据的分布较为平均，此时可以采用直接剔除缺失值的方法

方案二用最高频率值来填补缺失值　含缺失值属性如下：• Data_Value 实际数据值
- Data_Value_Alt 一个替代数据值
- Low_Confidence_Limit 数据值置信区间的下限
- High_Confidence_Limit 数据值置信区间的上限
- StratificationCategory2 用于分层的第二类
- Stratification2 用于第二类的具体分层
- Geolocation 收集数据的位置的经纬度

缺失数据中 **Data_Value, Data_Value_Alt, Low_Confidence_Limit, High_Confidence_Limit**
与其他属性没有直接关联，且同时缺失。 因此，可以尝试用最高频率值来填补缺失值
其他属性有明显的关联关系，这里不采用最高频率值来填补缺失值

```
[57]: # 用最高频率来填补 name,commit_count 缺失值
      attri = ['Data_Value', 'Data_Value_Alt', 'Low_Confidence_Limit',␣
       ↪'High_Confidence_Limit']
      new_data = data.copy(deep=True)

      for i in range(0,4):
          word_counts = Counter(new_data[attri[i]])
          top = word_counts.most_common()[0][0]
          if top != top:
              top = word_counts.most_common()[1][0]
          print("The most frequency value is:",top)
          new_data[attri[i]] = new_data[attri[i]].fillna(top)

      new_data.isnull().sum()
```

```
The most frequency value is: 32.2
The most frequency value is: 32.2
The most frequency value is: 30.8
The most frequency value is: 31.9
```

```
[57]: YearStart                   0
      YearEnd                     0
      LocationAbbr                0
```

```
LocationDesc                   0
Datasource                     0
Data_Value_Unit                0
DataValueTypeID                0
Data_Value_Type                0
Data_Value                     0
Data_Value_Alt                 0
Low_Confidence_Limit           0
High_Confidence_Limit          0
StratificationCategory1        0
Stratification1                0
StratificationCategory2     1044
Stratification2             1044
Geolocation                  720
LocationID                     0
StratificationCategoryID1      0
StratificationID1              0
StratificationCategoryID2      0
StratificationID2              0
dtype: int64
```

处理前后标称属性未发生变化，这里展示新旧数据集五数变化

```
[58]: # 原数据集五数
      digital_data =␣
       ↪['Data_Value','Data_Value_Alt','Low_Confidence_Limit','High_Confidence_Limit']
      data[digital_data].describe()
```

```
[58]:        Data_Value  Data_Value_Alt  Low_Confidence_Limit  High_Confidence_Limit
      count   5889.0000       5889.0000             5889.0000              5889.0000
      mean      33.7121         33.7121               29.1389                38.6961
      std        7.4038          7.4038                6.5922                 9.6166
      min        3.7000          3.7000                2.1000                 6.5000
      25%       29.2000         29.2000               25.5000                32.3000
      50%       33.3000         33.3000               29.4000                37.2000
      75%       38.0000         38.0000               33.4000                43.6000
      max       72.4000         72.4000               54.6000                90.7000
```

[59]:

```
# 新数据集五数
new_data[digital_data].describe()
```

[59]:

```
       Data_Value  Data_Value_Alt  Low_Confidence_Limit  High_Confidence_Limit
count   8300.0000       8300.0000             8300.0000              8300.0000
mean      33.2729         33.2729               29.6214                36.7219
std        6.2739          6.2739                5.6037                 8.6679
min        3.7000          3.7000                2.1000                 6.5000
25%       30.9000         30.9000               27.2000                31.9000
50%       32.2000         32.2000               30.8000                33.3000
75%       35.9000         35.9000               31.6000                40.4000
max       72.4000         72.4000               54.6000                90.7000
```

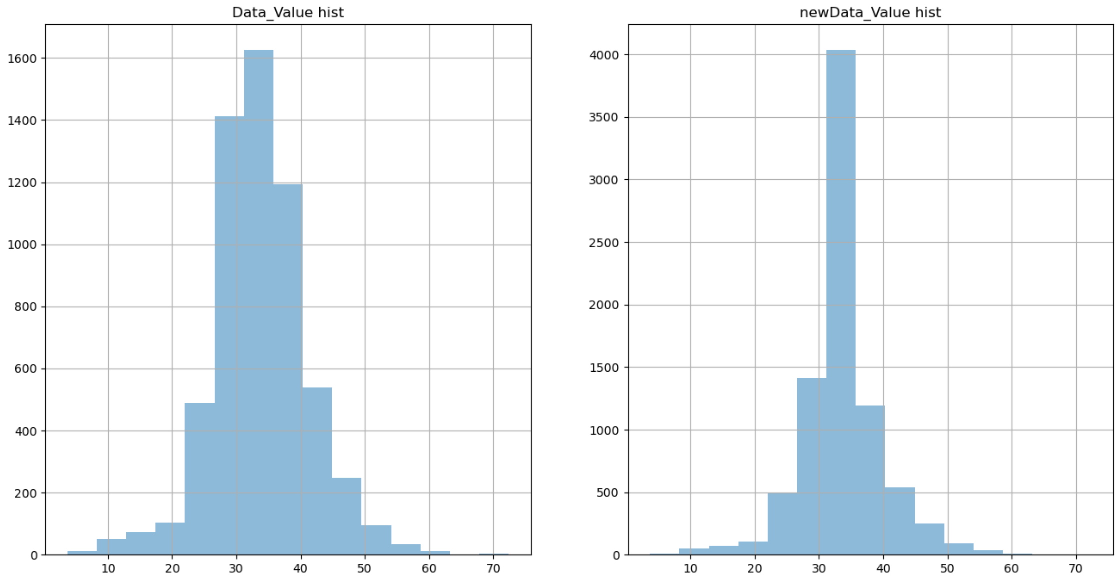
结合以上两表，可以看出用最高频率值替换后，平均值变化较小，五数变化幅度也不大。
接下来比较处理前后数据集相关属性的直方图变化

[60]:

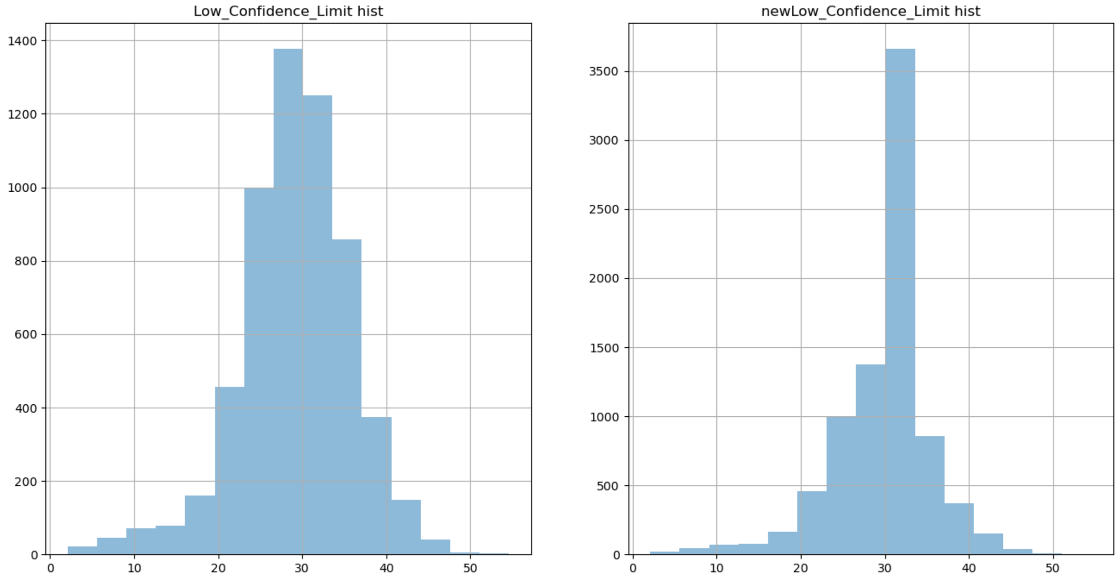
```
# 定义直方图比较函数
def hist_cmp(attri):
    # coding=utf-8
    plt.figure(figsize = (16,8))

    # 原数据
    plt.subplot(1,2,1)
    title = attri + " hist"
    plt.title(title)
    data[attri].hist(alpha=0.5,bins=15) #alpha 透明度, bins 竖条数

    # 新数据
    plt.subplot(1,2,2)
    title = "new" + attri + " hist"
    plt.title(title)
    new_data[attri].hist(alpha=0.5,bins=15) #alpha 透明度, bins 竖条数

    plt.show()
```

[61]:

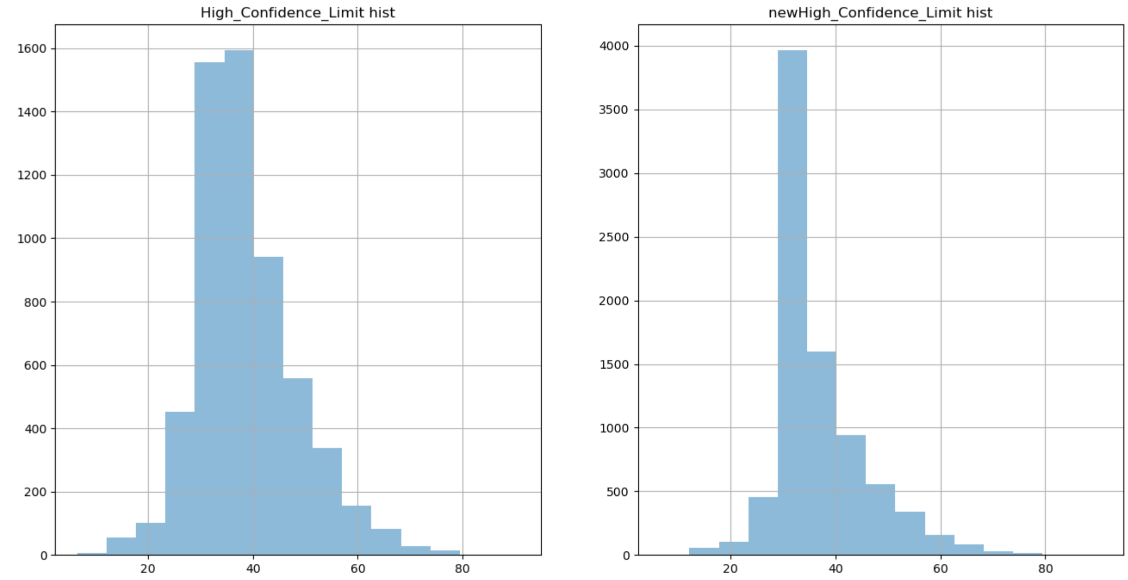
```
#(1)Data_Value
hist_cmp("Data_Value")
```



[62]:
```
#(2)Low_Confidence_Limit
hist_cmp("Low_Confidence_Limit")
```



[63]:
```
#(3)High_Confidence_Limit
hist_cmp("High_Confidence_Limit")
```



从三组对比可以看出，处理前后数据均为单峰分布，未发生太大改变。只是处理后峰值更高

方案三通过属性的相关关系来填补缺失值　由数据集属性可知：**StratificationCategory2** 与 **StratificationCategoryID2**，**Stratification2** 与 **StratificationID2**，**Geolocation** 与 **LocationID** 之间存在着属性间的相关关系。
因此，可以尝试通过属性的相关关系来填补缺失值

[64]:
```
# 寻找属性之间的对应关系
miss_attri = ['StratificationCategory2', 'Stratification2', 'Geolocation']
cor_attri = ['StratificationCategoryID2', 'StratificationID2', 'LocationID']
new_data = data.copy(deep=True)

for i in range(0,3):
    table = data.copy(deep=True)
    data.shape
    table = pd.DataFrame(new_data,columns=[miss_attri[i], cor_attri[i]])
    table.drop_duplicates(inplace=True)
    table.reset_index(inplace=True,drop=True)
    print(table)
#     for j in range(0,)
# new_data.isnull().sum()
```

```
  StratificationCategory2 StratificationCategoryID2
0          Race/Ethnicity                      RACE
1                  Gender                    GENDER
2                     NaN                   OVERALL
            Stratification2 StratificationID2
0                  Hispanic               HIS
1  Native Am/Alaskan Native               NAA
2                      Male              MALE
3       White, non-Hispanic               WHT
4                       NaN           OVERALL
5    Asian/Pacific Islander               ASN
6       Black, non-Hispanic               BLK
7                    Female            FEMALE
                         Geolocation  LocationID
0    POINT (-147.722059 64.84507996)           2
1   POINT (-111.7638113 34.86597028)           4
2   POINT (-86.63186076 32.84057112)           1
3   POINT (-92.27449074 34.74865012)           5
4   POINT (-106.1336109 38.84384076)           8
5   POINT (-120.9999995 37.63864012)           6
6   POINT (-72.64984095 41.56266102)           9
7       POINT (-77.036871 38.907192)          11
8   POINT (-75.57774117 39.00883067)          10
9   POINT (-81.92896054 28.93204038)          12
10      POINT (144.793731 13.444304)          66
11  POINT (-157.8577494 21.30485044)          15
12  POINT (-83.62758035 32.83968109)          13
13    POINT (-114.36373 43.68263001)          16
14  POINT (-88.99771018 40.48501028)          17
15  POINT (-86.14996019 39.76691045)          18
16   POINT (-98.20078123 38.3477403)          20
17  POINT (-93.81649056 42.46940091)          19
18  POINT (-84.77497105 37.64597027)          21
19  POINT (-92.44568007 31.31266064)          22
```

```
20  POINT (-76.60926011 39.29058096)          24
21  POINT (-68.98503134 45.25422889)          23
22                               NaN        9001
23  POINT (-84.71439027 44.66131954)          26
24  POINT (-72.08269067 42.27687047)          25
25                               NaN        9002
26  POINT (-99.36572062 41.64104099)          31
27   POINT (-94.7942005 46.35564874)          27
28   POINT (-89.53803082 32.7455101)          28
29  POINT (-92.56630005 38.63579078)          29
30  POINT (-109.4244206 47.06652897)          30
31  POINT (-117.0718406 39.49324039)          32
32  POINT (-74.27369129 40.13057005)          34
33  POINT (-75.54397043 42.82700103)          36
34   POINT (-106.240581 34.52088095)          35
35  POINT (-71.50036092 43.65595011)          33
36  POINT (-79.15925046 35.46622098)          37
37   POINT (-100.118421 47.47531978)          38
38  POINT (-97.52107021 35.47203136)          40
39  POINT (-82.40426006 40.06021014)          39
40  POINT (-120.1550313 44.56744942)          41
41  POINT (-77.86070029 40.79373015)          42
42      POINT (-66.590149 18.220833)          72
43                               NaN        9003
44  POINT (-71.52247031 41.70828019)          44
45   POINT (-81.04537121 33.9988213)          45
46  POINT (-85.77449091 35.68094058)          47
47  POINT (-100.3735306 44.35313005)          46
48  POINT (-99.42677021 31.82724041)          48
49                               NaN          59
50  POINT (-111.5871306 39.36070017)          49
51  POINT (-72.51764079 43.62538124)          50
52                               NaN        9004
53  POINT (-120.4700108 47.52227863)          53
54  POINT (-78.45789046 37.54268067)          51
55      POINT (-64.896335 18.335765)          78
56  POINT (-89.81637074 44.39319117)          55
```

```
57   POINT (-80.71264013 38.6655102)          54
58  POINT (-108.1098304 43.23554134)          56
```

由以上结果可知，存在一些故意设置为空的选项，可能是无法获取或出于隐私考虑。
暂不对其进行处理

方案四通过数据对象之间的相似性来填补缺失值

[65]:
```
# 查看数值数据之间的相似性
data.corr()
```

[65]:
```
                       YearStart  YearEnd  Data_Value  Data_Value_Alt  \
YearStart                 1.0000   1.0000      0.1238          0.1238
YearEnd                   1.0000   1.0000      0.1238          0.1238
Data_Value                0.1238   0.1238      1.0000          1.0000
Data_Value_Alt            0.1238   0.1238      1.0000          1.0000
Low_Confidence_Limit      0.1148   0.1148      0.8725          0.8725
High_Confidence_Limit     0.1098   0.1098      0.9187          0.9187
LocationID                0.0013   0.0013     -0.0759         -0.0759

                       Low_Confidence_Limit  High_Confidence_Limit  LocationID
YearStart                            0.1148                 0.1098      0.0013
YearEnd                              0.1148                 0.1098      0.0013
Data_Value                           0.8725                 0.9187     -0.0759
Data_Value_Alt                       0.8725                 0.9187     -0.0759
Low_Confidence_Limit                 1.0000                 0.6108     -0.0278
High_Confidence_Limit                0.6108                 1.0000     -0.0958
LocationID                          -0.0278                -0.0958      1.0000
```

存在缺失值的属性与其他未缺失属性相关性过低，无法通过数据对象间的相似性填补缺失值。