Exploratory_data_for_GitHub_Dataset

2024 年 3 月 26 日

1 Exploratory data analysis and data preprocessing for GitHub Dataset

1.1 一、数据摘要

[1]:

```
# 首先导入相关包，观察数据结构
import pandas as pd
import numpy  as np

target_data = pd.read_csv('./github_dataset.csv')
target_data.head()
```

[1]:

```
                repositories  stars_count  forks_count  issues_count  \
0         octocat/Hello-World            0            0           612
1  EddieHubCommunity/support          271          150           536
2             ethereum/aleth            0            0           313
3      localstack/localstack            0            0           290
4        education/classroom            0          589           202

   pull_requests  contributors language
0            316             2      NaN
1              6            71      NaN
2             27           154      C++
3             30           434   Python
4             22            67     Ruby
```

[2]:

```
# 单独提出数据的属性列便于观察
target_data_columns = target_data.columns
target_data_columns
```

[2]:

```
Index(['repositories', 'stars_count', 'forks_count', 'issues_count',
       'pull_requests', 'contributors', 'language'],
      dtype='object')
```

可以看到数据集已被成功加载，其属性列名称分别代表：
repositories（仓库名称）,stars_count（星标数）,
forks_count（分支数）, issues_count（问题数）,
pull_requests（拉取请求数）, contributors（贡献者数）,
以及 language（编程语言）, 从初步观察来看，language 列存在缺失值。

### 1. 标称属性，给出每个可能取值的频数

可以看到，标称属性只有 repositories 和 language 这两个，下面统计这两个标称属性的每个可能取值的频数

[3]:

```
# 数据摘要：标称属性频数统计
nominal_columns = ['repositories', 'language']
for column in nominal_columns:
    print(f'Frequency of {column}:')
    print(target_data[column].value_counts(dropna=False))
    print('\n')
```

```
Frequency of repositories:
kameshsampath/ansible-role-rosa-demos         2
aloisdeniel/bluff                             2
antoniaandreou/github-slideshow               2
jgthms/bulma-start                            2
artkirienko/hlds-docker-dproto                2
                                             ..
WhiteHouse/CIOmanagement                      1
0xCaso/defillama-telegram-bot                 1
ethereum/blake2b-py                           1
openfoodfacts/folksonomy_mobile_experiment    1
gamemann/All_PropHealth                       1
Name: repositories, Length: 972, dtype: int64


Frequency of language:
JavaScript          253
```

```
Python              155
NaN                 145
HTML                 72
Java                 44
CSS                  37
TypeScript           37
Dart                 36
Jupyter Notebook     29
C++                  29
Ruby                 28
C                    26
Shell                25
PHP                  16
Go                   15
Swift                10
Rust                 10
C#                    8
Objective-C           8
Kotlin                7
Makefile              6
Jinja                 5
SCSS                  4
AutoHotkey            3
Dockerfile            3
CoffeeScript          3
Perl                  3
Solidity              3
Vim Script            2
Pawn                  2
Assembly              2
PowerShell            2
Hack                  2
CodeQL                2
Vue                   2
Elixir                2
Gherkin               1
QMake                 1
```

```
CMake                1
Oz                   1
Cuda                 1
QML                  1
ActionScript         1
Roff                 1
HCL                  1
R                    1
PureBasic            1
Smarty               1
Less                 1
Svelte               1
Haskell              1
SourcePawn           1
Name: language, dtype: int64
```

1.1.1 2. 数值属性，给出 5 数概括及缺失值的个数

除去上面两个标称属性外
对剩下的 stars_count、forks_count、issues_count、pull_requests、contributors
这五个数值属性进行五数概括，并计算缺失值的个数。

[4]:
```python
# 数值属性五数概括及缺失值个数
numerical_columns = ['stars_count', 'forks_count', 'issues_count', 'pull_requests', 'contributors']
print("Numerical columns summaries:")
for column in numerical_columns:
    print(f'{column}:')
    print(target_data[column].describe())   # 统计数值属性五数概括（最小值、三位四分位数、最大值）
    print(f'Missing values: {target_data[column].isnull().sum()}') # 统计数值属性缺失值个数
    print('\n')
```

```
Numerical columns summaries:
stars_count:
```

```
count    1052.000000
mean       81.976236
std       170.403116
min         0.000000
25%         1.000000
50%        12.000000
75%        65.250000
max       995.000000
Name: stars_count, dtype: float64
Missing values: 0


forks_count:
count    1052.000000
mean       53.884981
std       127.699729
min         0.000000
25%         1.000000
50%         6.000000
75%        38.250000
max       973.000000
Name: forks_count, dtype: float64
Missing values: 0


issues_count:
count    1052.000000
mean        8.656844
std        32.445154
min         1.000000
25%         1.000000
50%         2.000000
75%         6.000000
max       612.000000
Name: issues_count, dtype: float64
Missing values: 0
```

```
pull_requests:
count    1052.000000
mean        4.374525
std        27.913732
min         0.000000
25%         0.000000
50%         0.000000
75%         2.000000
max       567.000000
Name: pull_requests, dtype: float64
Missing values: 0
```

```
contributors:
count    1052.000000
mean        8.364068
std        37.511807
min         0.000000
25%         0.000000
50%         2.000000
75%         4.000000
max       658.000000
Name: contributors, dtype: float64
Missing values: 0
```

经过上面的简要分析即可得知：
* 标称属性1. repositories列有多个仓库名称，其中部分仓库名称出现频率超过1次，说明数据集中可能包含重复条目。2. language列展示了不同的编程语言及其出现的频次，总计共145条记录的编程语言信息缺失。* 数值属性1. stars_count：最小值0，第一四分位数1，中位数12，第三四分位数65.25，最大值995，无缺失值。2. forks_count：最小值0，第一四分位数1，中位数6，第三四分位数38.25，最大值973，无缺失值。3. issues_count：最小值1，第一四分位数1，中位数2，第三四分位数6，最大值612，无缺失值。4. pull_requests：最小值0，第一四分位数0，中位数0，第三四分位数2，最大值567，无缺失值。5. contributors：最小值0，第一四分位数0，中位数2，第三四分位数4，最大值658，无缺失值。

1.2 二、数据可视化

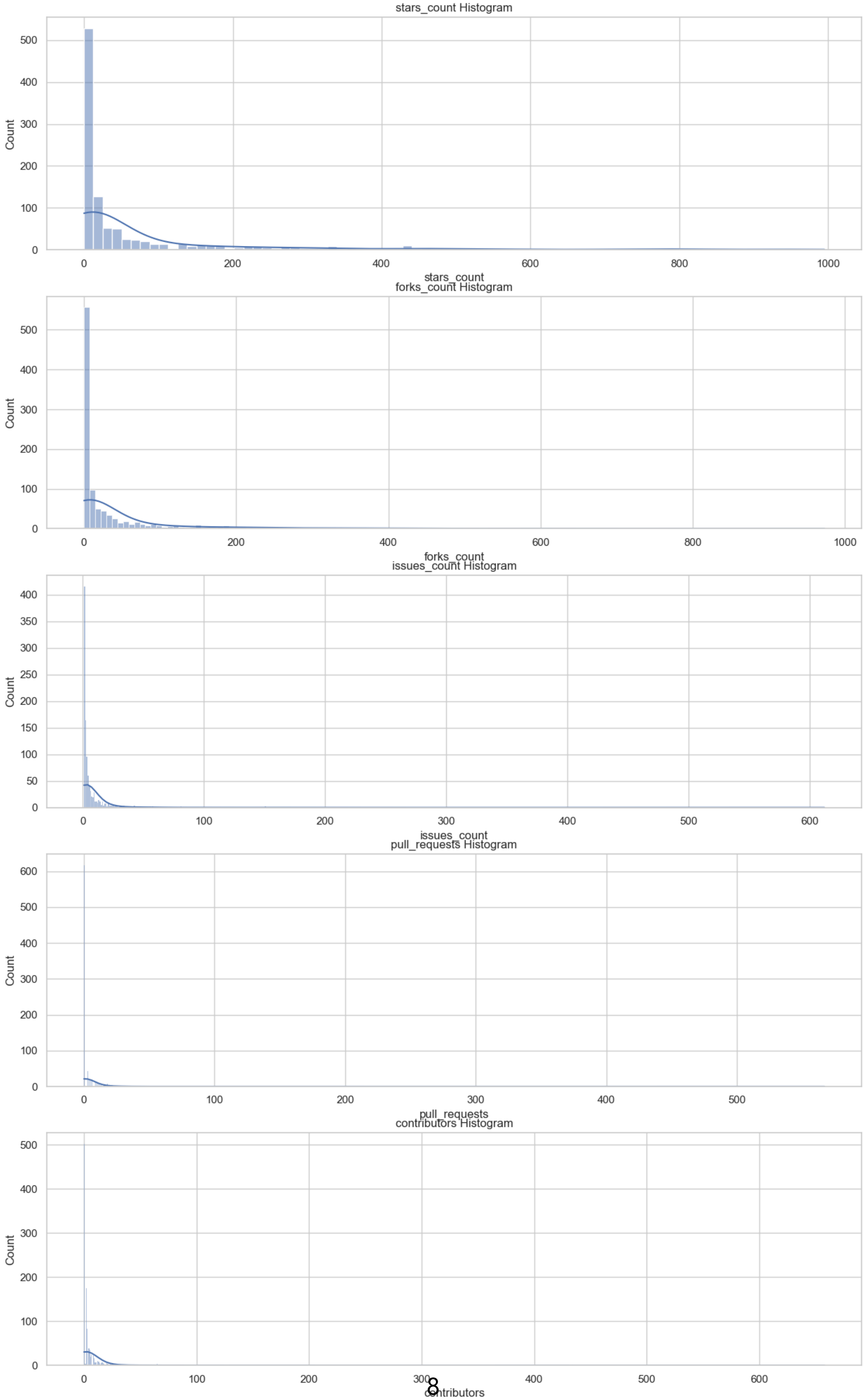
[5]:

```
# 先导入相关包文件用于后续可视化
import matplotlib.pyplot as plt
import seaborn as sns

# 设置图形风格
sns.set(style="whitegrid")
```

1.2.1 1. 使用直方图检查数据分布

[6]:

```
fig, axs = plt.subplots(5, 1, figsize=(15, 25))
# 绘制直方图
for i, column in enumerate(numerical_columns):
    sns.histplot(data=target_data, x=column, kde=True, ax=axs[i])
    axs[i].set_title(f'{column} Histogram')
```

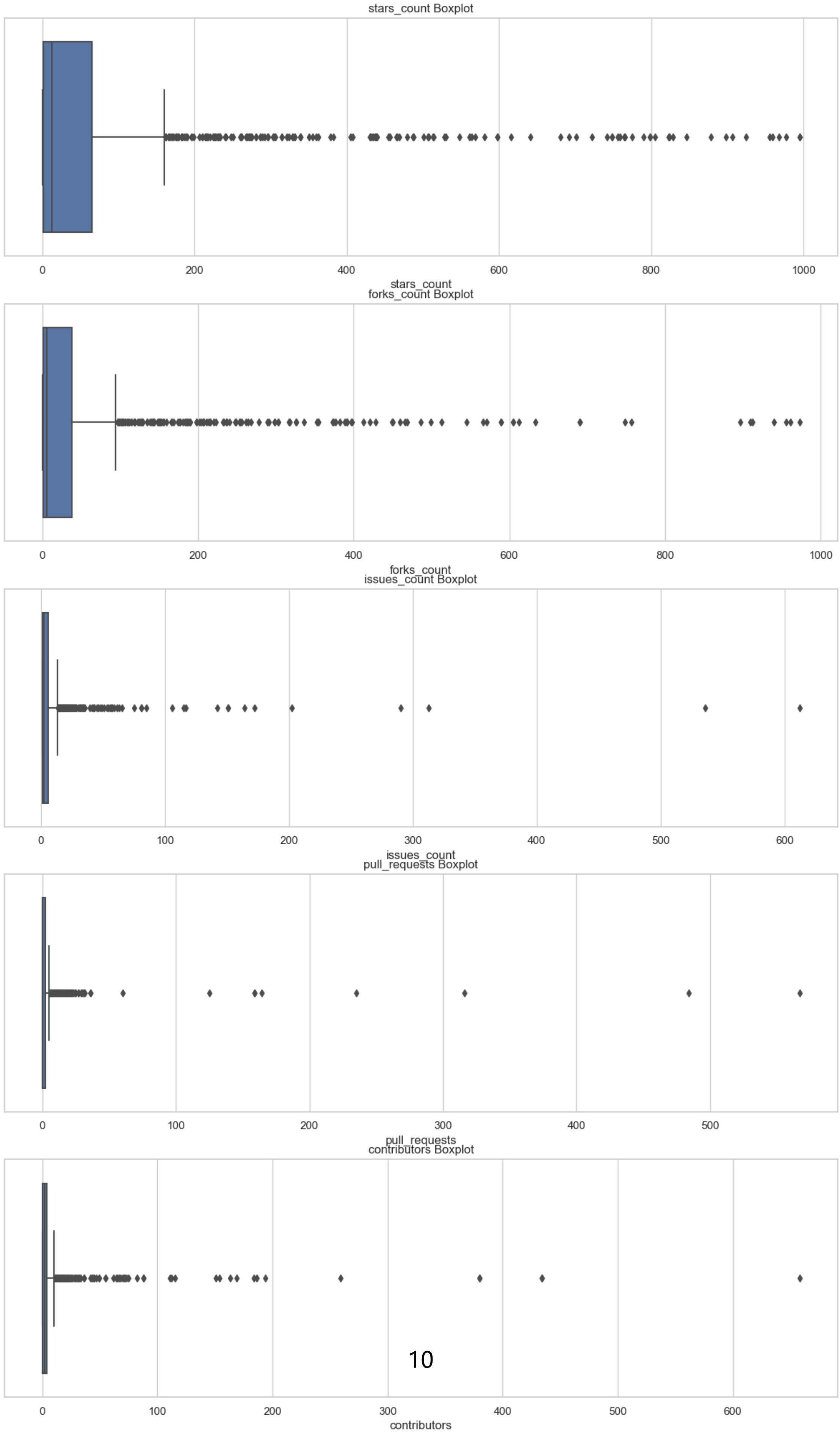

stars_count Histogram
Count
0
100
200
300
400
500
0
200
400
600
800
1000
stars_count
forks_count Histogram
Count
0
100
200
300
400
500
0
200
400
600
800
1000
forks_count
issues_count Histogram
Count
0
50
100
150
200
250
300
350
400
0
100
200
300
400
500
600
issues_count
pull_requests Histogram
Count
0
100
200
300
400
500
600
0
100
200
300
400
500
pull_requests
contributors Histogram
Count
0
100
200
300
400
500
0
100
200
300
400
500
600
contributors

可以观察到，多数属性呈现右偏分布，
意味着大多数仓库在星标数、分支数等指标上偏低，但存在少数高值的仓库。

1.2.2 2. 使用盒图检查数据离散点

[7]:

```
fig, axs = plt.subplots(5, 1, figsize=(15, 25))
# 绘制盒图
for i, column in enumerate(numerical_columns):
    sns.boxplot(x=target_data[column], ax=axs[i])
    axs[i].set_title(f'{column} Boxplot')
```


stars_count Boxplot
0
200
400
600
800
1000
stars_count
forks_count Boxplot
0
200
400
600
800
1000
forks_count
issues_count Boxplot
0
100
200
300
400
500
600
issues_count
pull_requests Boxplot
0
100
200
300
400
500
pull_requests
contributors Boxplot
0
100
200
300
400
500
600
contributors

可以观察到，几乎所有数值属性中都存在离散点，
尤其是在 stars_count、forks_count 和 contributors 这几个指标上，离散点较为明显，
这表明有些仓库在这些属性上远高于其他大多数仓库

2 三、缺失数据处理

2.0.1 1. 将缺失部分剔除

[8]:
```
# 1. 剔除含有缺失值的记录
target_data_dropped = target_data.dropna()
target_data_dropped
```

[8]:
```
                              repositories  stars_count  forks_count  \
2                           ethereum/aleth            0            0   
3                    localstack/localstack            0            0   
4                      education/classroom            0          589   
5                shobhit97/open-gpstracker            0            0   
6         donnemartin/system-design-primer            0            0   
…                                        …          …          …   
1047              Tyriar/canvas-astar.dart            2            1   
1048       ankitkumar70777/github-slideshow            0            0   
1049  aitikgupta/interactive_cpu_scheduler            0            5   
1050                gwmccubbin/voting_dapp           11            5   
1051                gamemann/All_PropHealth            4            3   

      issues_count  pull_requests  contributors    language
2              313             27           154         C++
3              290             30           434      Python
4              202             22            67        Ruby
5              172              0             3        Java
6              164            164           115      Python
…            …            …           …         …   
1047             1              0             0        Dart
1048             1              0             8        HTML
1049             1              1             7      Python
```

```
1050                1              0            0  JavaScript
1051                1              0            0  SourcePawn

[907 rows x 7 columns]
```

2.0.2 2. 用最高频率值来填补缺失值除

[9]:

```
# 2. 使用最高频率值来填补缺失值
mode_language = target_data['language'].mode()[0]  # 获取最高频率的语言
target_data_filled = target_data.fillna({'language': mode_language})

# 显示处理缺失值后的数据集大小变化
original_size = target_data.shape[0]
dropped_size = target_data_dropped.shape[0]
filled_size = target_data_filled.shape[0]
original_size, dropped_size, filled_size, mode_language
```

[9]:

```
(1052, 907, 1052, 'JavaScript')
```

- 原始数据集大小：1052 条记录
- 剔除含有缺失值的记录后：数据集减少到 907 条记录
- 使用最高频率值填补缺失值后：数据集仍然保持 1052 条记录，但所有缺失的 language 值都被填补为最高频率的语言’JavaScript’

[10]:

```
target_data_filled
```

[10]:

```
                                  repositories  stars_count  forks_count  \
0                           octocat/Hello-World            0            0
1                     EddieHubCommunity/support          271          150
2                                ethereum/aleth            0            0
3                         localstack/localstack            0            0
4                           education/classroom            0          589
…                                             …            …            …
1047                     Tyriar/canvas-astar.dart            2            1
1048         ankitkumar70777/github-slideshow            0            0
1049   aitikgupta/interactive_cpu_scheduler            0            5
```

```
1050                gwmccubbin/voting_dapp           11            5
1051               gamemann/All_PropHealth            4            3

      issues_count  pull_requests  contributors    language
0              612            316             2  JavaScript
1              536              6            71  JavaScript
2              313             27           154         C++
3              290             30           434      Python
4              202             22            67        Ruby
…            …            …           …         …
1047             1              0             0        Dart
1048             1              0             8        HTML
1049             1              1             7      Python
1050             1              0             0  JavaScript
1051             1              0             0  SourcePawn

[1052 rows x 7 columns]
```

2.0.3 3. 通过属性的相关关系来填补缺失值

[11]:
```
target_data_coded = pd.get_dummies(target_data, columns=['language'], dummy_na=␣
 ↪True, drop_first= True)
target_data_coded
```

[11]:
```
                              repositories  stars_count  forks_count  \
0                      octocat/Hello-World            0            0
1                EddieHubCommunity/support          271          150
2                           ethereum/aleth            0            0
3                    localstack/localstack            0            0
4                      education/classroom            0          589
…                                    …          …          …
1047              Tyriar/canvas-astar.dart            2            1
1048      ankitkumar70777/github-slideshow            0            0
1049  aitikgupta/interactive_cpu_scheduler            0            5
1050                gwmccubbin/voting_dapp           11            5
1051               gamemann/All_PropHealth            4            3
```

```
      issues_count  pull_requests  contributors  language_Assembly  \
0              612            316             2                  0
1              536              6            71                  0
2              313             27           154                  0
3              290             30           434                  0
4              202             22            67                  0
…             …            …           …                …
1047             1              0             0                  0
1048             1              0             8                  0
1049             1              1             7                  0
1050             1              0             0                  0
1051             1              0             0                  0

      language_AutoHotkey  language_C  language_C#  …  language_Shell  \
0                       0           0            0  …               0
1                       0           0            0  …               0
2                       0           0            0  …               0
3                       0           0            0  …               0
4                       0           0            0  …               0
…                   …         …          …  …           …
1047                    0           0            0  …               0
1048                    0           0            0  …               0
1049                    0           0            0  …               0
1050                    0           0            0  …               0
1051                    0           0            0  …               0

      language_Smarty  language_Solidity  language_SourcePawn  \
0                   0                  0                    0
1                   0                  0                    0
2                   0                  0                    0
3                   0                  0                    0
4                   0                  0                    0
…                …                …                  …
1047                0                  0                    0
1048                0                  0                    0
1049                0                  0                    0
```

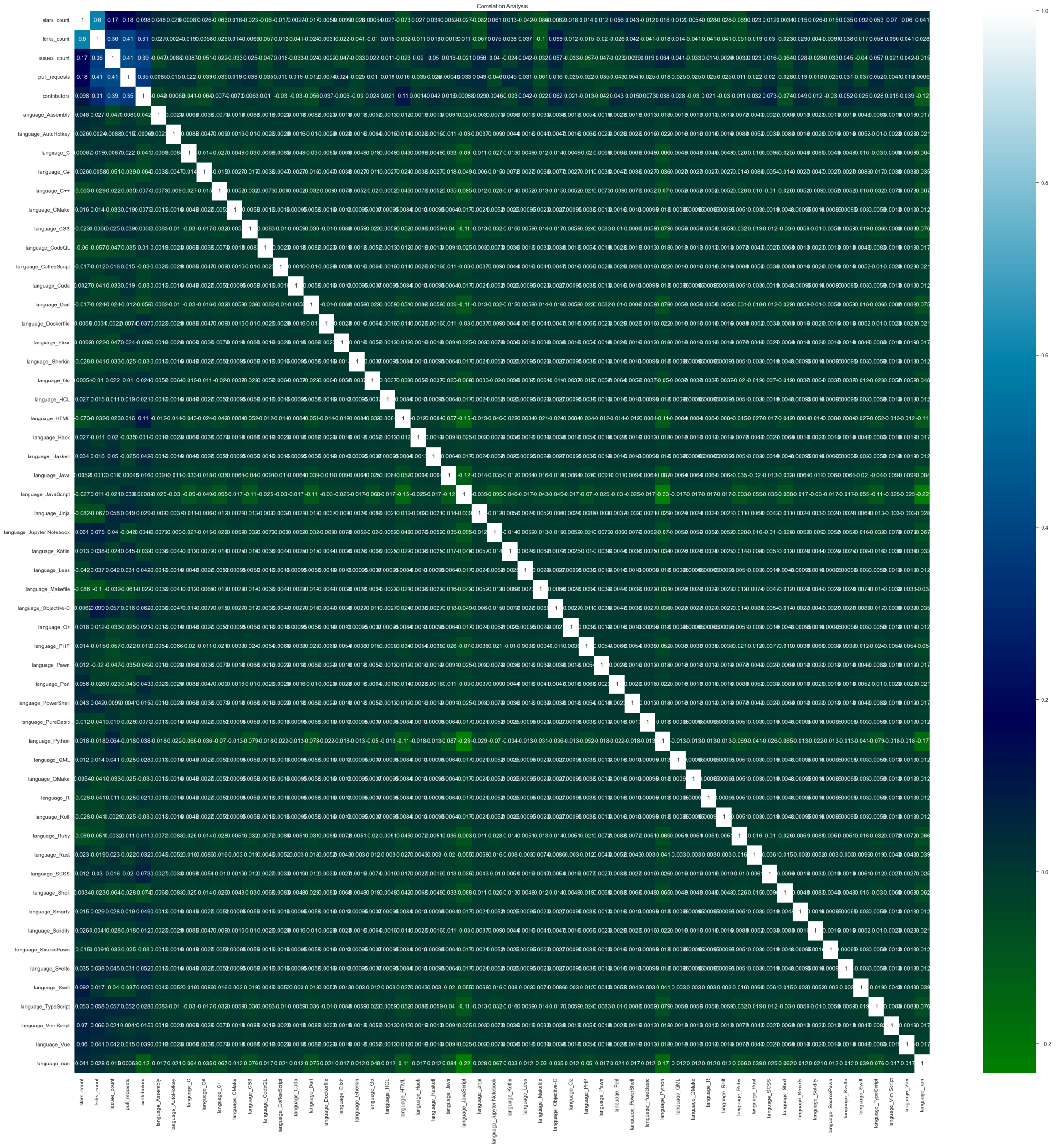
```
1050                0                  0                    0
1051                0                  0                    1

      language_Svelte  language_Swift  language_TypeScript  \
0                   0               0                    0
1                   0               0                    0
2                   0               0                    0
3                   0               0                    0
4                   0               0                    0
…               …             …                  …
1047                0               0                    0
1048                0               0                    0
1049                0               0                    0
1050                0               0                    0
1051                0               0                    0

      language_Vim Script  language_Vue  language_nan
0                       0             0             1
1                       0             0             1
2                       0             0             0
3                       0             0             0
4                       0             0             0
…                   …           …           …
1047                    0             0             0
1048                    0             0             0
1049                    0             0             0
1050                    0             0             0
1051                    0             0             0

[1052 rows x 57 columns]
```

[12]:

```
plt.figure(figsize=(40, 40))
sns.heatmap(target_data_coded.corr(method='spearman'), cmap='ocean', annot=True)
plt.title('Correlation Analysis')
```

[12]:

```
Text(0.5, 1.0, 'Correlation Analysis')
```



[13]:
```
# 由上面的热力图不难看出 language 列与 stars_count 列的相干性最高
# 因此下面采用基于 stars_count 字段的平均值差异方法来填补缺失的 language 值
github_data_attr_corr = target_data
df1 = github_data_attr_corr.groupby('language').agg(avg = ('stars_count',␣
↪'mean'))
df1
```

```
[13]:                              avg
      language
      ActionScript            3.000000
      Assembly              426.000000
      AutoHotkey            118.333333
      C                     153.076923
      C#                     43.250000
      C++                    39.172414
      CMake                  30.000000
      CSS                    49.675676
      CodeQL                  0.000000
      CoffeeScript            7.333333
      Cuda                   14.000000
      Dart                   33.944444
      Dockerfile             61.666667
      Elixir                 36.000000
      Gherkin                 1.000000
      Go                    139.600000
      HCL                    65.000000
      HTML                   54.888889
      Hack                   59.500000
      Haskell               126.000000
      Java                   83.204545
      JavaScript             87.083004
      Jinja                   0.400000
      Jupyter Notebook      130.724138
      Kotlin                 26.714286
      Less                    0.000000
      Makefile                0.833333
      Objective-C           234.375000
      Oz                     37.000000
      PHP                    86.562500
      Pawn                   19.000000
      Perl                  294.000000
      PowerShell            127.500000
      PureBasic               5.000000
```

```
Python              73.038710
QML                 24.000000
QMake               16.000000
R                    1.000000
Roff                 1.000000
Ruby                25.071429
Rust                56.400000
SCSS               228.500000
Shell               28.600000
Smarty              28.000000
Solidity           113.333333
SourcePawn           4.000000
Svelte             133.000000
Swift              152.500000
TypeScript          70.837838
Vim Script         602.000000
Vue                424.500000
```

[14]:

```
from numpy import nan as NA
import warnings
warnings.filterwarnings(action='ignore')
for i in range(len(github_data_attr_corr)):
    if github_data_attr_corr['language'].iloc[i] is NA:
        rate = github_data_attr_corr['stars_count'].iloc[i]
        dist = []
        for j in range(len(df1)):
            dist.append(abs(df1.iloc[j]['avg']-rate))
        idx = dist.index(min(dist))
        github_data_attr_corr['language'].iloc[i] = df1.index[idx]
github_data_attr_corr['language'].value_counts()
```

[14]:

```
JavaScript            257
Python                155
HTML                   72
Java                   44
CSS                    42
Dart                   38
```

TypeScript	38
C	34
CodeQL	33
C++	33
Jupyter Notebook	29
Ruby	28
Shell	25
PHP	17
Go	17
Perl	14
ActionScript	12
Swift	10
Rust	10
C#	10
Kotlin	10
Vim Script	9
CoffeeScript	9
Pawn	8
Objective-C	8
Cuda	7
Gherkin	7
SCSS	7
Makefile	6
SourcePawn	6
AutoHotkey	5
QMake	5
Jinja	5
Assembly	4
PureBasic	4
Hack	4
QML	3
CMake	3
Dockerfile	3
HCL	3
Solidity	3
Elixir	2

```
Svelte                2
Smarty                2
Vue                   2
PowerShell            2
R                     1
Less                  1
Roff                  1
Haskell               1
Oz                    1
Name: language, dtype: int64
```

2.0.4 4. 通过数据对象之间的相似性来填补缺失值 (拟使用热卡填充法, i.e. Hot Deck Imputation)

[15]:

```python
# 这里采用归一化巨鹿来作为相似性度量
# 用这个相似性度量来找到最相似的数据对象

# 选择用于计算相似性的数值属性
attributes = ['stars_count', 'forks_count', 'issues_count', 'pull_requests', 'contributors']
def regularit(df):
    new_df = pd.DataFrame(index=df.index)
    for c in attributes:
        d = df[c]
        MAX = d.max()
        MIN = d.min()
        new_df[c] = (d - MIN) / (MAX - MIN)  # 归一化公式
    return new_df
```

[16]:

```python
github_data_sample_corr = target_data
normal_github_data = regularit(github_data_sample_corr)
normal_github_data
```

[16]:

```
      stars_count  forks_count  issues_count  pull_requests  contributors
0        0.000000     0.000000      1.000000       0.557319      0.003040
1        0.272362     0.154162      0.875614       0.010582      0.107903
2        0.000000     0.000000      0.510638       0.047619      0.234043
```

```
3       0.000000    0.000000     0.472995       0.052910      0.659574
4       0.000000    0.605344     0.328969       0.038801      0.101824
…            …          …            …             …             …
1047    0.002010    0.001028     0.000000       0.000000      0.000000
1048    0.000000    0.000000     0.000000       0.000000      0.012158
1049    0.000000    0.005139     0.000000       0.001764      0.010638
1050    0.011055    0.005139     0.000000       0.000000      0.000000
1051    0.004020    0.003083     0.000000       0.000000      0.000000

[1052 rows x 5 columns]
```

[17]:

```
normal_language = pd.concat([normal_github_data,␣
 ↪github_data_sample_corr['language']], axis=1)
normal_language
```

[17]:

```
      stars_count  forks_count  issues_count  pull_requests  contributors  \
0       0.000000    0.000000     1.000000       0.557319      0.003040
1       0.272362    0.154162     0.875614       0.010582      0.107903
2       0.000000    0.000000     0.510638       0.047619      0.234043
3       0.000000    0.000000     0.472995       0.052910      0.659574
4       0.000000    0.605344     0.328969       0.038801      0.101824
…            …          …            …             …             …
1047    0.002010    0.001028     0.000000       0.000000      0.000000
1048    0.000000    0.000000     0.000000       0.000000      0.012158
1049    0.000000    0.005139     0.000000       0.001764      0.010638
1050    0.011055    0.005139     0.000000       0.000000      0.000000
1051    0.004020    0.003083     0.000000       0.000000      0.000000

        language
0         CodeQL
1           Perl
2            C++
3         Python
4           Ruby
…           …
1047        Dart
1048        HTML
```

```
1049      Python
1050  JavaScript
1051  SourcePawn

[1052 rows x 6 columns]
```

[18]:

```
infos = []
for i in range(len(normal_language)):
    info = []
    star = normal_language['stars_count'].iloc[i]
    fork = normal_language['forks_count'].iloc[i]
    issue = normal_language['issues_count'].iloc[i]
    pull = normal_language['pull_requests'].iloc[i]
    contributor = normal_language['contributors'].iloc[i]
    info.append(star)
    info.append(fork)
    info.append(issue)
    info.append(pull)
    info.append(contributor)
    infos.append(info)
```

[19]:

```
for i in range(len(normal_language)):
    if normal_language['language'].iloc[i] is NA:
        dists = []
        for j in len(rates):
            dist = np.sqrt(np.sum(np.square(infos[i] - infos[j])))
            dists.append(dist)
        idx = dists.index(min(dists))
        github_data_sample_corr['language'].iloc[i] =␣
  ↪github_data_sample_corr['language'].iloc[idx]
github_data_sample_corr['language'].value_counts()
```

[19]:

```
JavaScript          257
Python              155
HTML                 72
Java                 44
CSS                  42
```

Dart	38
TypeScript	38
C	34
CodeQL	33
C++	33
Jupyter Notebook	29
Ruby	28
Shell	25
PHP	17
Go	17
Perl	14
ActionScript	12
Swift	10
Rust	10
C#	10
Kotlin	10
Vim Script	9
CoffeeScript	9
Pawn	8
Objective-C	8
Cuda	7
Gherkin	7
SCSS	7
Makefile	6
SourcePawn	6
AutoHotkey	5
QMake	5
Jinja	5
Assembly	4
PureBasic	4
Hack	4
QML	3
CMake	3
Dockerfile	3
HCL	3
Solidity	3

```
Elixir                2
Svelte                2
Smarty                2
Vue                   2
PowerShell            2
R                     1
Less                  1
Roff                  1
Haskell               1
Oz                    1
Name: language, dtype: int64
```

3 四、预处理前后数据集差异比较分析

3.0.1 1. 用最高频率值来填补缺失值除

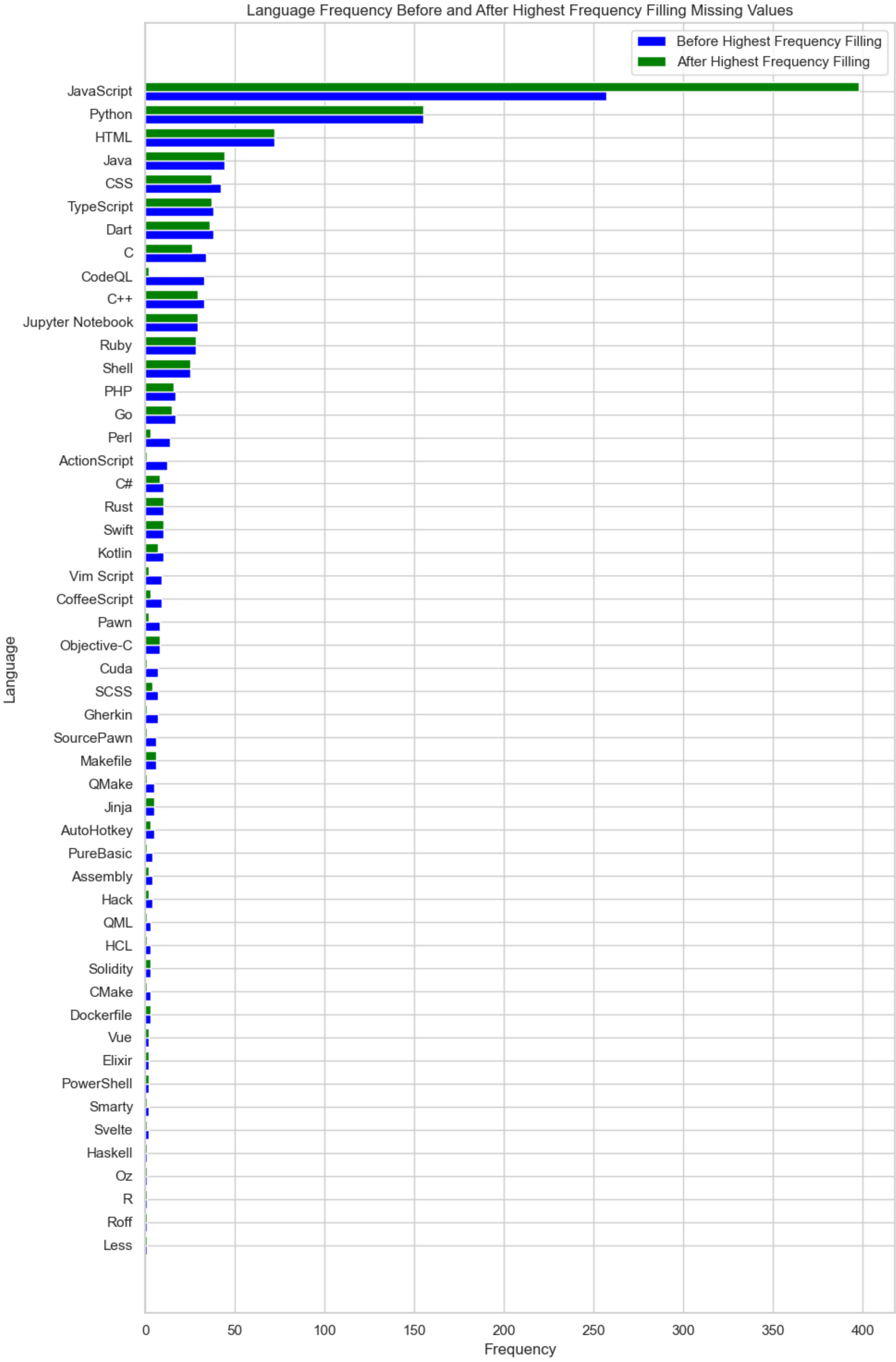
[22]:

```python
language_counts_before = target_data['language'].value_counts().sort_index()
language_counts_after = target_data_filled['language'].value_counts().sort_index()
```

[23]:

```python
# 合并前后填补数据，准备排序
combined_counts = pd.DataFrame({
    'Before Highest Frequency Filling': language_counts_before,
    'After Highest Frequency Filling': language_counts_after
})

# 按照填补前的频次进行降序排序
combined_counts_sorted = combined_counts.sort_values(by='Before Highest Frequency Filling', ascending=True)

# 绘制横向柱状图
plt.figure(figsize=(10, 15))
y_positions = range(len(combined_counts_sorted))
```

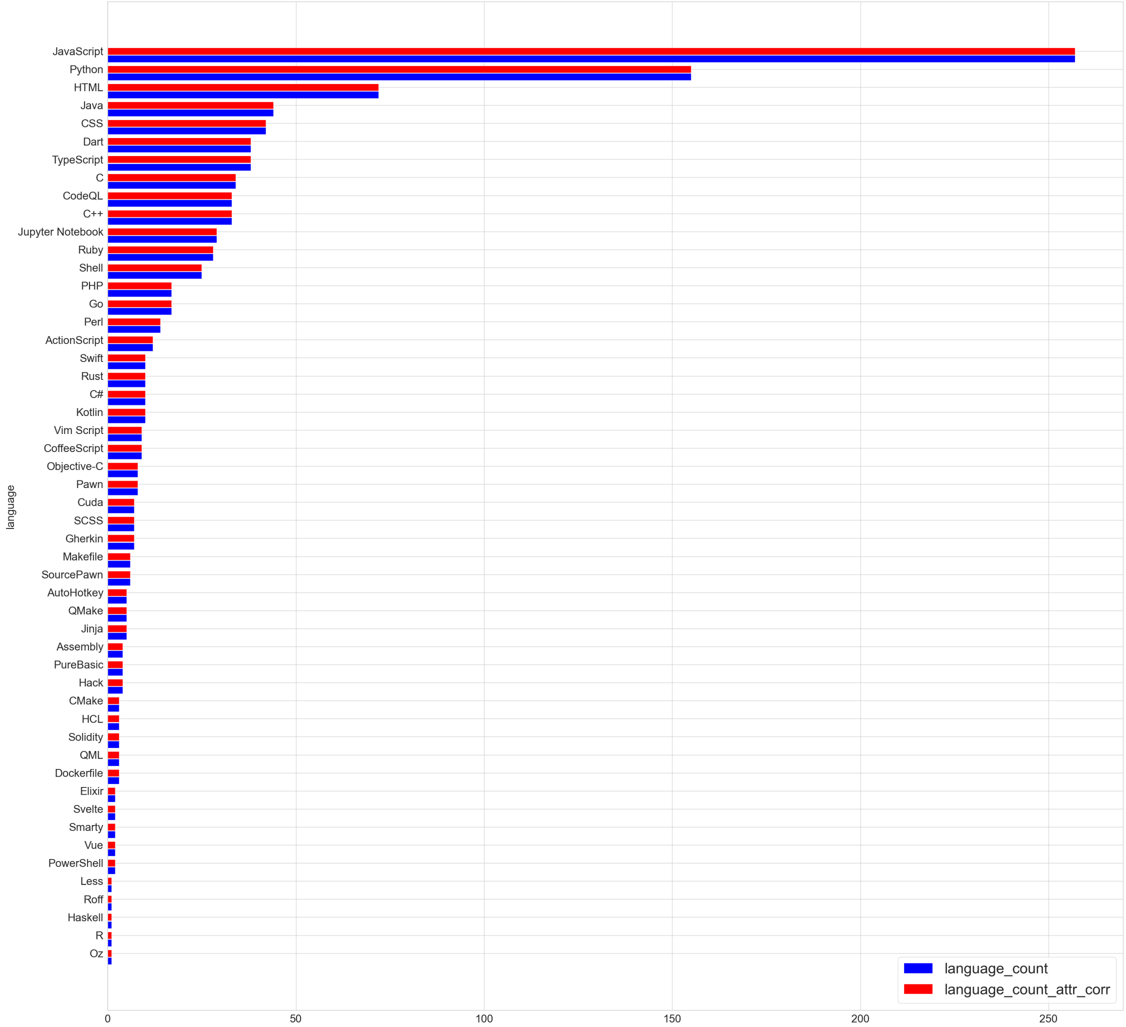
```
plt.barh(y_positions, combined_counts_sorted['Before Highest Frequency␣
 ↪Filling'], height=0.4, label='Before Highest Frequency Filling',␣
 ↪color='blue', align='center')
plt.barh([p + 0.4 for p in y_positions], combined_counts_sorted['After Highest␣
 ↪Frequency Filling'], height=0.4, label='After Highest Frequency Filling',␣
 ↪color='green', align='center')

plt.yticks([p + 0.2 for p in y_positions], combined_counts_sorted.index)
plt.xlabel('Frequency')
plt.ylabel('Language')
plt.legend()
plt.title('Language Frequency Before and After Highest Frequency Filling␣
 ↪Missing Values')
plt.tight_layout()
plt.show()

# 可以看出这种简单粗暴的缺失值填补方式，拟合效果并不是很好
```


Language Frequency Before and After Highest Frequency Filling Missing Values
Before Highest Frequency Filling
After Highest Frequency Filling
Language
JavaScript
Python
HTML
Java
CSS
TypeScript
Dart
C
CodeQL
C++
Jupyter Notebook
Ruby
Shell
PHP
Go
Perl
ActionScript
C#
Rust
Swift
Kotlin
Vim Script
CoffeeScript
Pawn
Objective-C
Cuda
SCSS
Gherkin
SourcePawn
Makefile
QMake
Jinja
AutoHotkey
PureBasic
Assembly
Hack
QML
HCL
Solidity
CMake
Dockerfile
Vue
Elixir
PowerShell
Smarty
Svelte
Haskell
Oz
R
Roff
Less
0
50
100
150
200
250
300
350
400
Frequency

3.0.2 2. 通过属性的相关关系来填补缺失值

[24]:

```
# 观察缺失值填补前后, language 频次的柱状图, 结果表明该方法可以很好的平滑原始分布。
language_counts = pd.DataFrame(target_data['language'].value_counts()).
 ↪sort_values(by='language', ascending=True).rename(columns={'language':␣
 ↪'language_count'})
language_count_attr_corr = language_counts
language_count_attr_corr['language_count_attr_corr'] = [0] *␣
 ↪len(language_counts)

for level in list(language_counts.index):
    if level in list(github_data_attr_corr['language'].value_counts().index):
        language_count_attr_corr.loc[[level], ['language_count_attr_corr']] =␣
 ↪github_data_attr_corr['language'].value_counts().loc[[level]].values[0]

plt.figure(figsize=(40, 40))
plt.yticks(fontsize=24)
plt.xticks(fontsize=24)
plt.barh(list(range(len(language_count_attr_corr))),␣
 ↪tick_label=language_count_attr_corr.index,␣
 ↪width=language_count_attr_corr['language_count'], label='language_count',␣
 ↪height=0.4, color='blue')
plt.barh([d+0.42 for d in list(range(len(language_count_attr_corr)))],␣
 ↪tick_label=language_count_attr_corr.index,␣
 ↪width=language_count_attr_corr['language_count_attr_corr'],␣
 ↪label='language_count_attr_corr', height=0.4, color='red')
plt.ylabel('language', fontsize=24)
plt.xlabel('', fontsize=24)
# plt.title('Number of movies for each appropriation-level?', fontsize=32,␣
 ↪loc='center')
plt.legend(fontsize=32, loc='lower right')
plt.show()
```

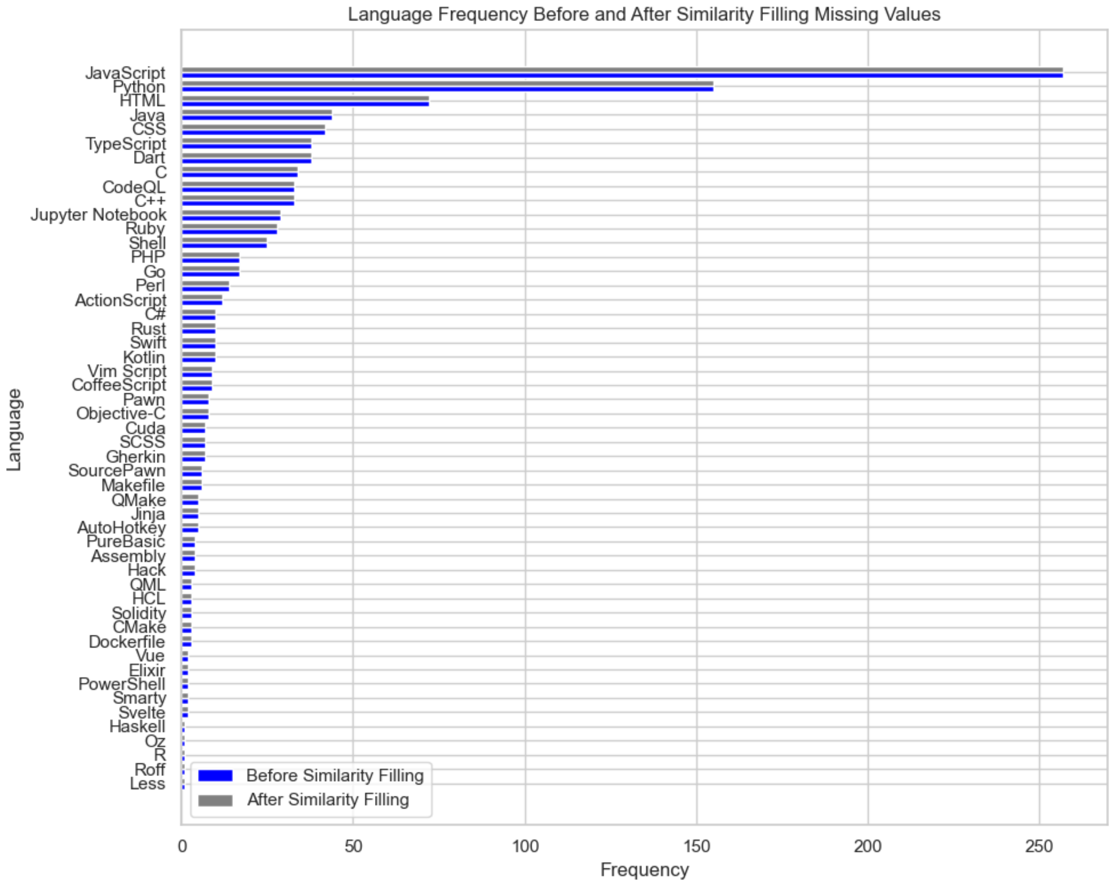


3.0.3 3. 通过数据对象之间的相似性来填补缺失值 (拟使用热卡填充法, i.e. Hot Deck Imputation)

[25]:

```
language_counts_before_simulation = language_counts_before
language_counts_after_simulation = github_data_sample_corr['language'].
  ↪value_counts()
# 将两个 Series 合并为 DataFrame 以便于排序和可视化
combined_counts_simulation = pd.DataFrame({
    'Before Similarity Filling': language_counts_before_simulation,
    'After Similarity Filling': language_counts_after_simulation
}).sort_values(by='Before Similarity Filling', ascending=True)
```

```python
# 绘制横向柱状图
plt.figure(figsize=(10, 8))
y_positions = range(len(combined_counts_simulation))

plt.barh(y_positions, combined_counts_simulation['Before Similarity Filling'], height=0.4, label='Before Similarity Filling', color='blue', align='center')
plt.barh([p + 0.4 for p in y_positions], combined_counts_simulation['After Similarity Filling'], height=0.4, label='After Similarity Filling', color='gray', align='center')

plt.yticks([p + 0.2 for p in y_positions], combined_counts_simulation.index)
plt.xlabel('Frequency')
plt.ylabel('Language')
plt.legend()
plt.title('Language Frequency Before and After Similarity Filling Missing Values')
plt.tight_layout()
plt.show()
# 这种去除缺失值的方式也比较平滑可以看出
```


Language Frequency Before and After Similarity Filling Missing Values
Language
JavaScript
Python
HTML
Java
CSS
TypeScript
Dart
C
CodeQL
C++
Jupyter Notebook
Ruby
Shell
PHP
Go
Perl
ActionScript
C#
Rust
Swift
Kotlin
Vim Script
CoffeeScript
Pawn
Objective-C
Cuda
SCSS
Gherkin
SourcePawn
Makefile
QMake
Jinja
AutoHotkey
PureBasic
Assembly
Hack
QML
HCL
Solidity
CMake
Dockerfile
Vue
Elixir
PowerShell
Smarty
Svelte
Haskell
Oz
R
Roff
Less
Before Similarity Filling
After Similarity Filling
0
50
100
150
200
250
Frequency

[ ]:

[ ]: