```
from google.colab import drive
drive.mount('/content/drive',force_remount=True)

## Create a folder for the this HW and change to that dir
%cd drive/MyDrive/cse519_educational_ranking/Datasets/Final_Report_Datasets
```

```
     Mounted at /content/drive
     /content/drive/MyDrive/cse519_educational_ranking/Datasets/Final_Report_Datasets
```

```
!pip install -q kaggle
!pip install -q pandas
!pip install -q scikit-learn
!pip install -q numpy
!pip install -q Matplotlib
!pip install -q seaborn
!pip install -q ranky
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import ranky as rk
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import mean_squared_error
from sklearn.metrics import max_error
```

```
def merge_multiple_csv_files(file_paths, index_names, join_method):

    merged_df = pd.read_csv(file_paths[0])
    for i in range(1, len(file_paths)):
        merged_df = pd.merge(merged_df, pd.read_csv(file_paths[i]),
                             left_on=index_names[0], right_on=index_names[i], how=join_method)
    return merged_df
```

```
file_paths = ['openalex-concepts-data.csv', 'IPEDS_2021 - CSV_11152023-658.csv', '2021_RnDExpenditures_final_HERD.csv',
              'ncses_Doctorate_Recipients.csv', 'US-News-Rankings-Universities 2012.csv', 'arwu.csv',
              'compsci_arwu.csv', 'biosci_arwu.csv', 'qs.csv'
              ]
index_names = ['UNITID', 'unitid', 'UnitID', 'UnitID', 'IPEDS ID', 'UNITID',
                'UNITID', 'UNITID', 'UNITID'
               ]
```

```
merged_df = merge_multiple_csv_files(file_paths= file_paths, index_names = index_names, join_method = 'left')
```

```
print(merged_df.columns)
```

```
     Index(['Unnamed: 0_x', 'display_name', 'id', 'works_count', 'cited_by_count',
            'h_index', 'i10_index', 'city', 'region', '2yr_mean_citedness',
            ...
            'Total Score', 'Q1_y', 'CNCI_y', 'IC_y', 'TOP_y', 'AWARD_y', 'Bio_Rank',
            'Unnamed: 0', 'Institution', 'QS_Rank'],
           dtype='object', length=133)
```

```
columns_to_exclude = ['Unnamed: 0_x', 'unitid', 'Institution Name', 'UnitID_x', 'Name', 'UnitID_y', 'University Name', 'IPEDS ID
                   'DRVF2021.Research expenses as a percent of total core expenses (GASB)',
                   'DRVF2021.Research expenses as a percent of total core expenses (FASB)',
                   'DRVF2021.Research expenses as a percent of total core expenses (for-profit institutions)',
                   'DRVF2021.Salaries and wages for research as a percent of total expenses for research (GASB)',
                   'DRVF2021.Salaries and wages for research as a percent of total expenses for research (FASB)',
                   'DRVF2021.Salaries and wages for research as a percent of total expenses for research (for-profit institution
```

```
dropped_merged_df = merged_df.drop(columns=columns_to_exclude)
```

```
dropped_merged_df.replace(',','', regex=True, inplace=True)
dropped_merged_df.replace('-','0', regex=True, inplace=True)
columns_to_convert = ['R&D Expenditures by Detailed Funding Source',
       'R&D Expenditures by Broad Field and Fed and Nonfed Sources',
       'R&D Expenditures Passed Through to Subrecipients',
       'R&D Expenditures Received as a Subrecipient from Other Sources',
       '2021_Doctorate_Recipients']
for col in columns_to_convert:
  dropped_merged_df[col].fillna(0)
  dropped_merged_df[col] = dropped_merged_df[col].astype(str).astype(float)
```

```
dropped_merged_df["Total R&D Expenditure"] = dropped_merged_df[['R&D Expenditures by Detailed Funding Source',
      # 'R&D Expenditures by Broad Field and Fed and Nonfed Sources',
      'R&D Expenditures Passed Through to Subrecipients',
      'R&D Expenditures Received as a Subrecipient from Other Sources']].sum(axis=1)
```

```
dropped_merged_df = dropped_merged_df.drop(dropped_merged_df[dropped_merged_df['Total R&D Expenditure'] == 0].index)
```

```
# dropped_merged_df.to_csv('merged_data.csv')
```

```
dropped_merged_df = dropped_merged_df.drop(dropped_merged_df[dropped_merged_df['UNITID'] == 122436].index)
dropped_merged_df = dropped_merged_df.drop(dropped_merged_df[dropped_merged_df['UNITID'] == 228343].index)
dropped_merged_df = dropped_merged_df.drop(dropped_merged_df[dropped_merged_df['UNITID'] == 122612].index)
# print(dropped_merged_df[dropped_merged_df['display_name'] == 'University of California San Diego'])
```

Borda

↳ 1 cell hidden

Metrics

```
metrics_df = dropped_merged_df.copy()
```

```
# metrics_df = metrics_df.dropna(subset=['Rankings_2022'])
metrics_df = metrics_df.dropna(subset=['ARWU Rank'])
```

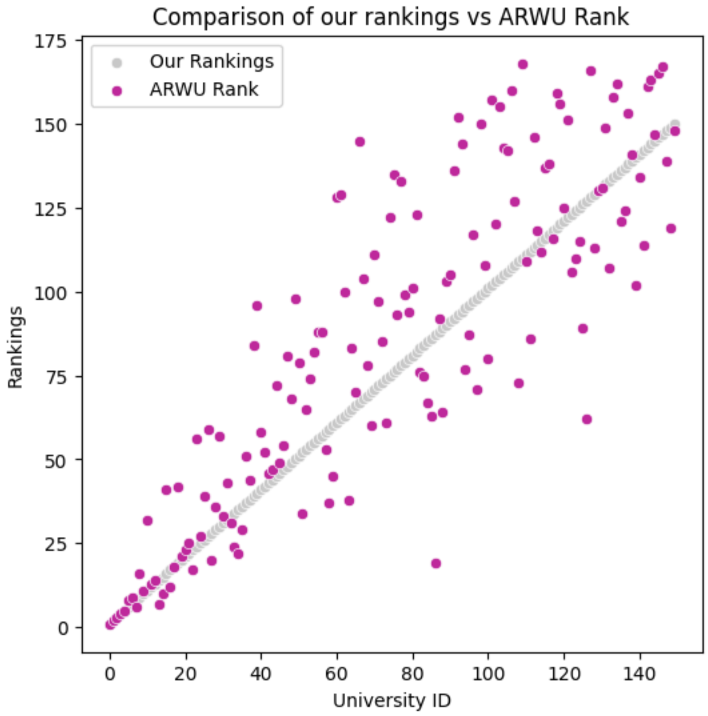
```
metrics_df['impact_index'] = metrics_df['h_index'] / np.power(metrics_df['works_count'], 0.4)
metrics_df['work_output_over_investment'] = np.power(metrics_df['works_count'], 2)/ np.power(metrics_df['Total R&D Expenditure']
metrics_df['work_quality'] = metrics_df['cited_by_count'] / metrics_df['works_count']
# metrics_df['alumni_quality'] = metrics_df['Award']/metrics_df['Alumni']
# metrics_df['graduate_over_enrollment'] = metrics_df['2021_Doctorate_Recipients']/metrics_df['EFIA2021_RV.Estimated full-time e
```

```
# metrics_df = metrics_df.sort_values(by='impact_index', ascending=False)

# metrics_df['impact_index_rankings'] = range(1, len(metrics_df) + 1)
```

```
# plt.figure(figsize=(10, 6))
# plt.scatter(metrics_df['impact_index_rankings'], metrics_df['Rankings_2022'])

# # Add labels and title
# plt.xlabel('Impact Index Rankings')
# plt.ylabel('Rankings_2022')
# plt.title('Rankings_2022 vs Impact Index Rankings')

# # Optional formatting
# plt.grid(True)
# plt.show()
```

```
rank_cols = [
    'impact_index',
    # 'Total R&D Expenditure',
    '2021_Doctorate_Recipients',
    'work_output_over_investment',
    'work_quality',
    # 'works_count'
]


df = metrics_df.copy()

ranked_df = rank_dataframe_borda(df, rank_cols, 'ARWU Rank')
eval_ranking(ranked_df, 'our_ranking', 'ARWU Rank')
plot_scatterplot(ranked_df, 'ARWU Rank')
```

```
    our_ranking                         display_name  borda_rank
0             1                   Harvard University    2.000000
1             2                  Stanford University    4.666667
2             3   Massachusetts Institute of Technology    5.000000
3             4      University of California Berkeley    5.333333
4             5                 Princeton University   10.000000
5             6                University of Chicago   10.666667
6             7                      Yale University   14.333333
7             8                  Columbia University   15.000000
8             9     University of California San Diego   16.000000
9            10   University of California Los Angeles   16.666667
10           11 University of California Santa Barbara   17.000000
11           12          University of Pennsylvania   17.333333
12           13            University of Washington   18.000000
13           14     California Institute of Technology   19.333333
14           15                  Cornell University   19.333333
15           16                   Boston University   21.666667
16           17            Johns Hopkins University   24.000000
17           18     Washington University in St. Louis   26.000000
18           19           Carnegie Mellon University   27.000000
19           20              Northwestern University   28.000000
Mean Absolute Error: 20.633333333333333
Max Error: 78.0
Spearman correlation coefficient: 0.8527746591182169
P-value: 1.3606441258375863e-43
```



```
top_20_df = ranked_df[['UNITID', 'display_name', 'our_ranking']].head(21)
```

```
top_20_df.to_csv('top_20_rankings.csv')
```

Plots

```
other_rankings_df = metrics_df[["UNITID", "ARWU Rank", 'QS_Rank']]
```

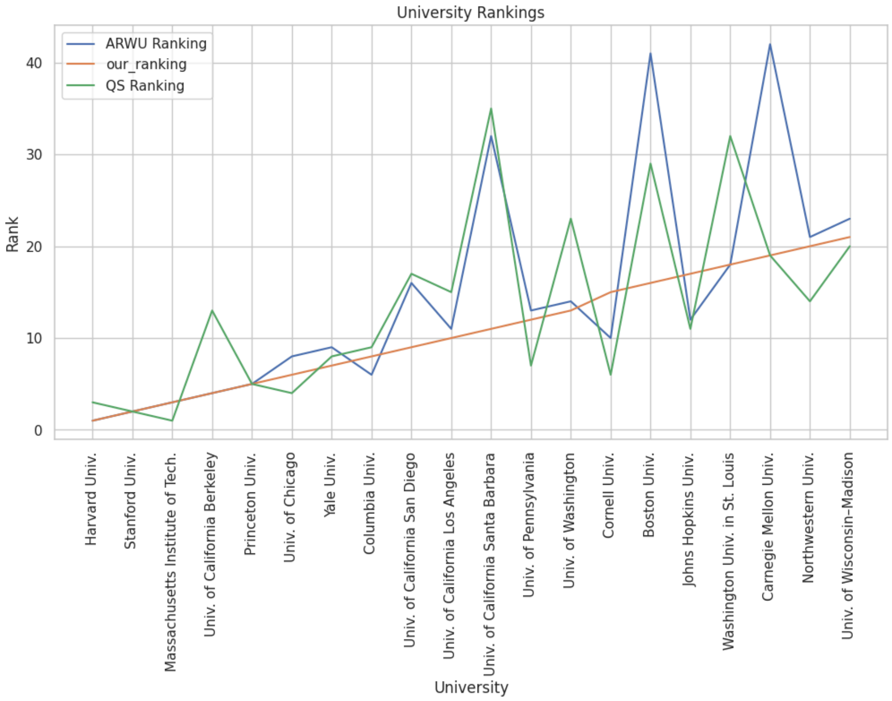
```
plot_df = pd.merge(top_20_df, other_rankings_df, on="UNITID", how="left")
```

```
plot_df = plot_df.dropna()
```

```
print(plot_df)
```

```
    UNITID                            display_name  our_ranking  ARWU Rank  \
0   166027                      Harvard University            1        1.0   
1   243744                     Stanford University            2        2.0   
2   166683   Massachusetts Institute of Technology            3        3.0   
3   110635       University of California Berkeley            4        4.0   
4   186131                    Princeton University            5        5.0   
5   144050                   University of Chicago            6        8.0   
6   130794                         Yale University            7        9.0   
7   190150                     Columbia University            8        6.0   
8   110680      University of California San Diego            9       16.0   
9   110662    University of California Los Angeles           10       11.0   
10  110705  University of California Santa Barbara           11       32.0   
11  215062              University of Pennsylvania           12       13.0   
12  236948                University of Washington           13       14.0   
14  190415                      Cornell University           15       10.0   
15  164988                       Boston University           16       41.0   
16  162928                Johns Hopkins University           17       12.0   
17  179867      Washington University in St. Louis           18       18.0   
18  211440              Carnegie Mellon University           19       42.0   
19  147767                 Northwestern University           20       21.0   
20  240444          University of Wisconsin–Madison           21       23.0   

    QS_Rank  
0       3.0  
1       2.0  
2       1.0  
3      13.0  
4       5.0  
5       4.0  
6       8.0  
7       9.0  
8      17.0  
9      15.0  
10     35.0  
11      7.0  
12     23.0  
14      6.0  
15     29.0  
16     11.0  
17     32.0  
18     19.0  
19     14.0  
20     20.0  
```

```
def shorten_univ_name(s):
    s = s.replace('University', 'Univ.')
    s = s.replace('Technology', 'Tech.')
    # s = s.replace('The', '')
    return s

plot_df['short_display_name'] = plot_df['display_name'].apply(shorten_univ_name)


sns.set(style="whitegrid")

# Create a multi-line chart
plt.figure(figsize=(12, 6))

sns.lineplot(x='short_display_name', y='ARWU Rank', data=plot_df, label='ARWU Ranking')
sns.lineplot(x='short_display_name', y='our_ranking', data=plot_df, label='our_ranking')
sns.lineplot(x='short_display_name', y='QS_Rank', data=plot_df, label='QS Ranking')


# Set labels and title
# plt.xlabel('University')
plt.ylabel('Rank')
plt.title('University Rankings')
plt.xticks(rotation=90)  # Rotate x-axis labels for better readability

# Display the legend
plt.legend()

# Show the plot
plt.show()
```



Find anomalies

```
our_ranking_df = ranked_df[["UNITID", "display_name", "our_ranking"]]
arwu_df = metrics_df[["UNITID", "ARWU Rank"]]
print(arwu_df.head())
print(our_ranking_df.head())
```

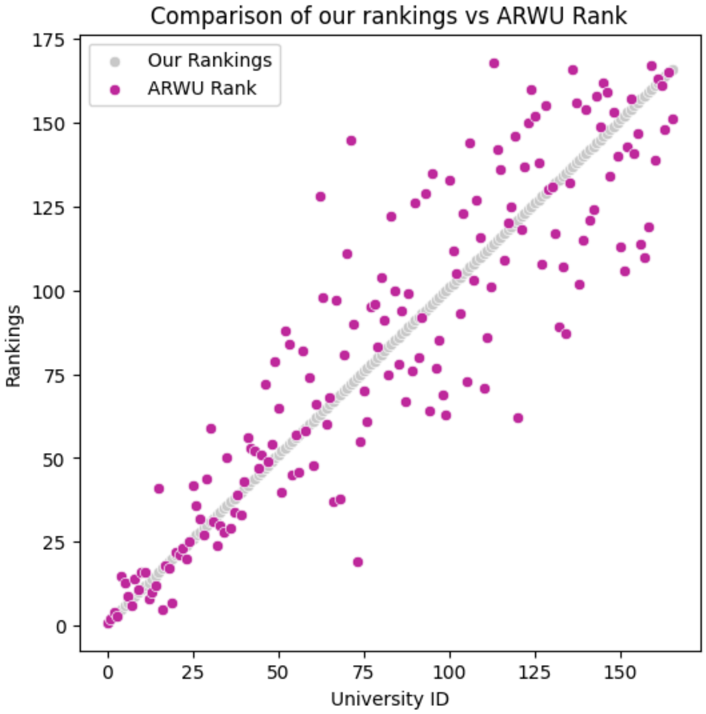
```
       UNITID  ARWU Rank
    0  223232      115.0
    1  153603      117.0
    2  182281      147.0
    4  186380       47.0
    8  182290      125.0
       UNITID                         display_name  our_ranking
    0  166027                   Harvard University            1
    1  122612  University of California San Francisco            2
    2  243744                  Stanford University            3
    3  166683   Massachusetts Institute of Technology            4
    4  110635       University of California Berkeley            5
```

```


df = pd.merge(our_ranking_df, arwu_df, on="UNITID")

# Calculate the absolute difference between 'our_ranking' and 'ARWU Rank'
df["absolute_difference"] = abs(df["our_ranking"] - df["ARWU Rank"])


# Filter rows where the absolute difference is more than 100
result_df = df[df["absolute_difference"] > 80][["UNITID", "display_name", "our_ranking", "ARWU Rank"]]

# # Print or use the result_df as needed
print(result_df)
```

```
         UNITID                    display_name  our_ranking  ARWU Rank
    18   183044       University of New Hampshire           19      126.0
    105  170976  University of Michigan-Ann Arbor          104       19.0
    144  232186           George Mason University          143       62.0
```

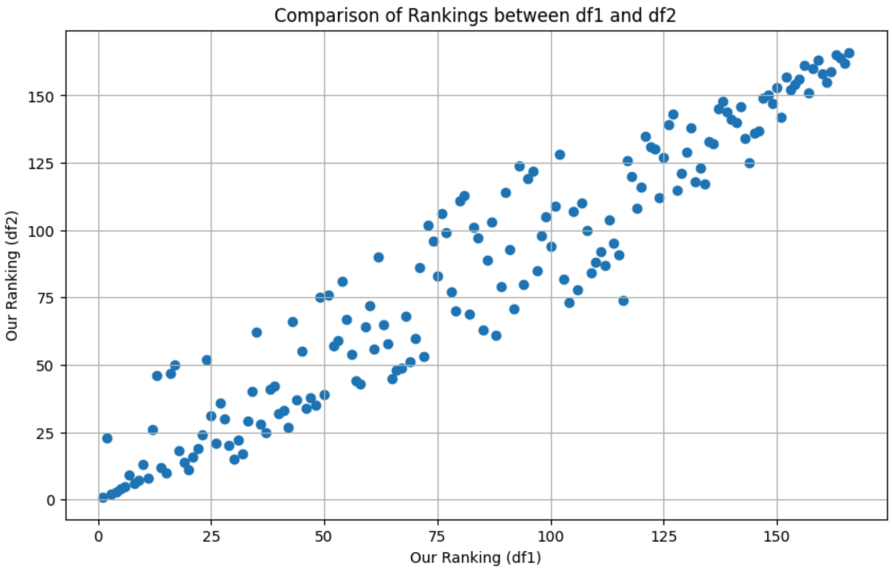
```
rank_cols = [
    # 'UNITID',
    'impact_index',
    'Total R&D Expenditure',
    '2021_Doctorate_Recipients',
    'work_output_over_investment',
    'work_quality'
]

# rank_cols = [
#     'impact_index',
#     'works_count'
# ]

df = metrics_df.copy()

ranked_df_1 = rank_dataframe_borda(df, rank_cols, 'ARWU Rank')
eval_ranking(ranked_df_1, 'our_ranking', 'ARWU Rank')
plot_scatterplot(ranked_df_1, 'ARWU Rank')
```

```
    our_ranking                          display_name  borda_rank
0             1                    Harvard University         2.5
1             2                   Stanford University         5.0
2             3      University of California Berkeley         8.0
3             4  Massachusetts Institute of Technology         8.0
4             5 University of California San Francisco        14.0
5             6            University of Pennsylvania        14.5
6             7                       Yale University        15.5
7             8                   Columbia University        16.0
8             9              University of Washington        16.0
9            10    University of California Los Angeles        17.0
10           11      University of California San Diego        17.5
11           12      University of California San Diego        17.5
12           13                 University of Chicago        18.0
13           14                    Cornell University        18.5
14           15              Johns Hopkins University        19.5
15           16                     Boston University        20.5
16           17                  Princeton University        23.5
17           18      Washington University in St. Louis        25.5
18           19                   New York University        27.0
19           20      California Institute of Technology        29.5
Mean Absolute Error: 16.16867469879518
Max Error: 73.0
Spearman correlation coefficient: 0.8964648336176241
P-value: 7.402282883482644e-60
```



```
# Combine DataFrames
ranked_merged_df = pd.merge(ranked_df, ranked_df_1, on='UNITID')

# Extract data for plot
x_data = ranked_merged_df['our_ranking_x']
y_data = ranked_merged_df['our_ranking_y']
hover_text = ranked_merged_df['UNITID']
```

```
# Create scatter plot
plt.figure(figsize=(10, 6))
plt.scatter(x_data, y_data)


# Use the list for annotation
# plt.annotate(hover_text_list, (x_data, y_data), textcoords="offset points", xytext=(0, 10), ha='center')

# Add labels and title
plt.xlabel('Our Ranking (df1)')
plt.ylabel('Our Ranking (df2)')
plt.title('Comparison of Rankings between df1 and df2')

# Show plot
plt.grid(True)
plt.show()
```



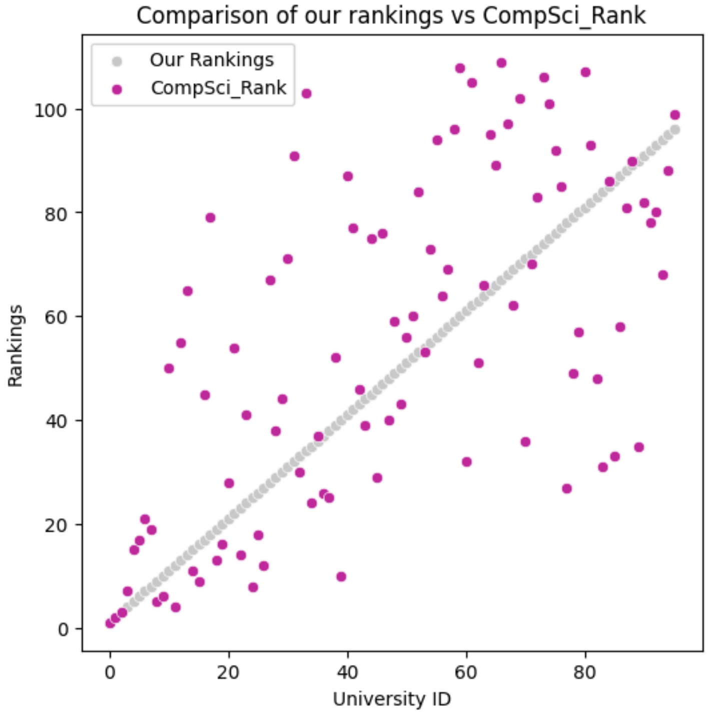
CS Rankings

```
cs_metrics_df = metrics_df.copy()
cs_metrics_df = cs_metrics_df.dropna(subset=['CompSci_Rank'])
cs_metrics_df = cs_metrics_df.dropna(subset=['concept-Computer science'])
```

```
cs_metrics_df['CS_impact_index'] = (cs_metrics_df['h_index']*metrics_df['concept-Computer science']) / np.power(cs_metrics_df['w
cs_metrics_df['CS_work'] = metrics_df['works_count']*metrics_df['concept-Computer science']
```

```
rank_cols = [
    # 'impact_index',
    'CS_impact_index',
    # 'Total R&D Expenditure',
    '2021_Doctorate_Recipients',
    'work_output_over_investment',
    'work_quality',
    'CS_work',
]


df = cs_metrics_df.copy()

ranked_df_1 = rank_dataframe_borda(df, rank_cols, 'CompSci_Rank')
eval_ranking(ranked_df_1, 'our_ranking', 'CompSci_Rank')
plot_scatterplot(ranked_df_1, 'CompSci_Rank')
```

```
    our_ranking                            display_name  borda_rank
0             1    Massachusetts Institute of Technology        5.25
1             2                      Stanford University        5.25
2             3         University of California Berkeley        5.25
3             4                     Princeton University       13.25
4             5                 University of Washington       15.25
5             6                      Columbia University       17.75
6             7   University of Illinois Urbana0Champaign       17.75
7             8        University of California San Diego       18.75
8             9                       Harvard University       19.25
9            10      University of California Los Angeles       20.00
10           11                    University of Chicago       20.00
11           12               Carnegie Mellon University       21.25
12           13        California Institute of Technology       21.75
13           14    University of California Santa Barbara       22.00
14           15         The University of Texas at Austin       22.75
15           16                       Cornell University       23.50
16           17             Pennsylvania State University       26.50
17           18                          Yale University       27.00
18           19          University of Michigan–Ann Arbor       28.75
19           20           University of Wisconsin–Madison       28.75
Mean Absolute Error: 20.239583333333332
Max Error: 69.0
Spearman correlation coefficient: 0.6339392295170917
P-value: 4.118749604228652e-12
```



Bio Rankigs

```
bio_metrics_df = metrics_df.copy()
bio_metrics_df = bio_metrics_df.dropna(subset=['Bio_Rank'])
bio_metrics_df = bio_metrics_df.dropna(subset=['concept-Biology'])
```

```
bio_metrics_df['Bio_impact_index'] = (bio_metrics_df['h_index']*bio_metrics_df['concept-Biology']) / np.power(bio_metrics_df['wor
bio_metrics_df['Bio_work'] = bio_metrics_df['works_count']*bio_metrics_df['concept-Biology']
```

```
rank_cols = [
    # 'impact_index',
    'Bio_impact_index',
    # # 'Total R&D Expenditure',
    '2021_Doctorate_Recipients',
    'work_output_over_investment',
    'work_quality',
    'Bio_work'
```