

Week 5 Report

By Greenspace Group 3

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2024/JUN/04

Team Achievement

01. TA Predictors -
Supervised Machine Learning

02. TA Predictors -
Unsupervised Machine Learning

03. Therapist Match

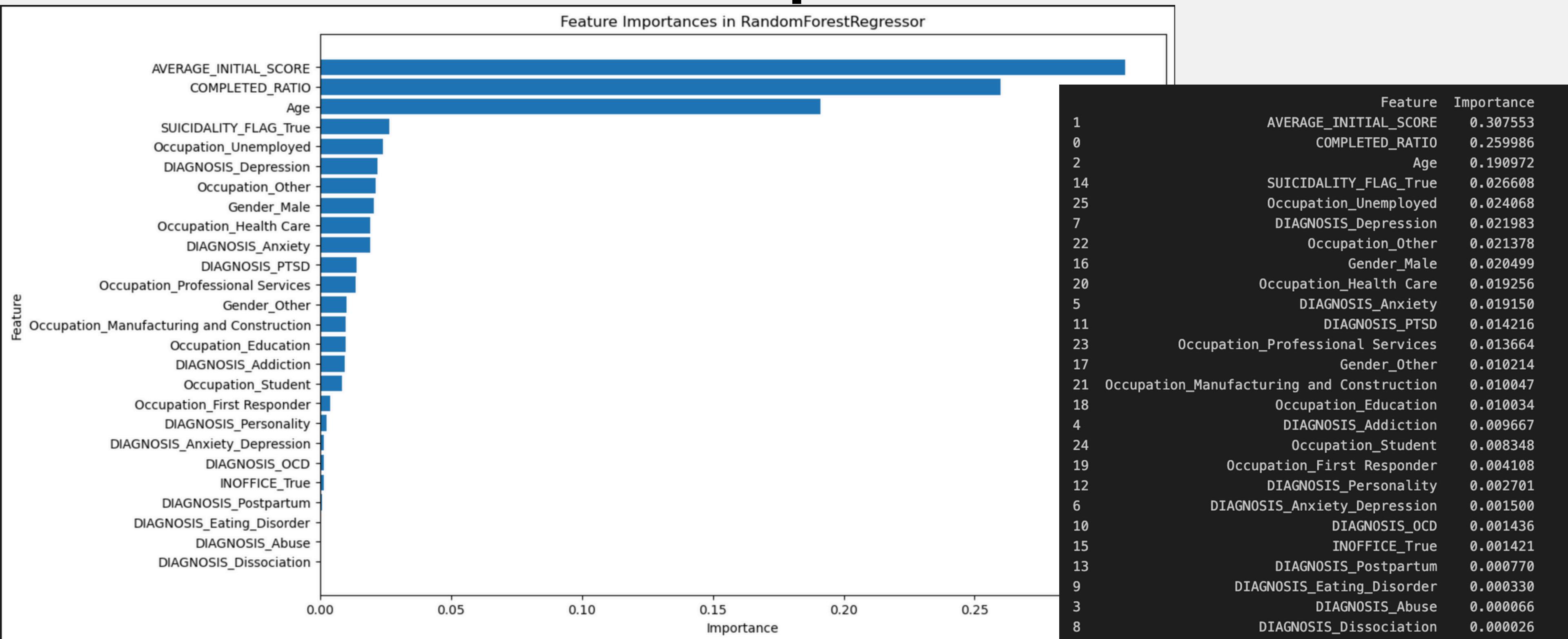
- For each therapist, calculate...
 - ratio of patients whose PHQ-9 assessment score showed severity level reduction
 - ratio of patients whose PHQ-9 assessment scores improved



Last week contribution- Bingshen

01. Utilized unsupervised learning models to uncover previously unrecognized patterns in our data.
02. Determined the feature importance of the supervised model, and re-run only with the feature importance.

Feature Importance



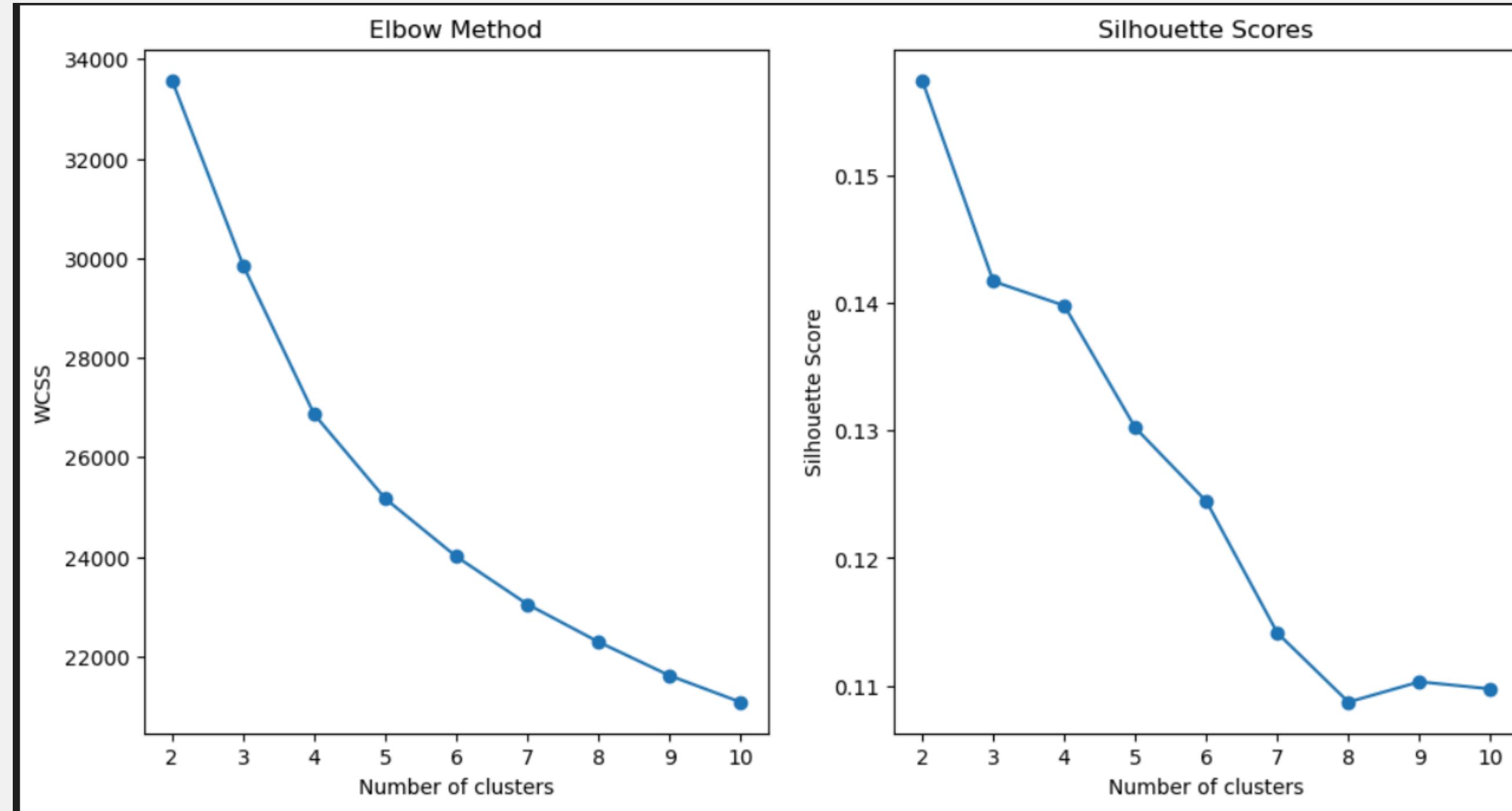
With Three Importance Features Only

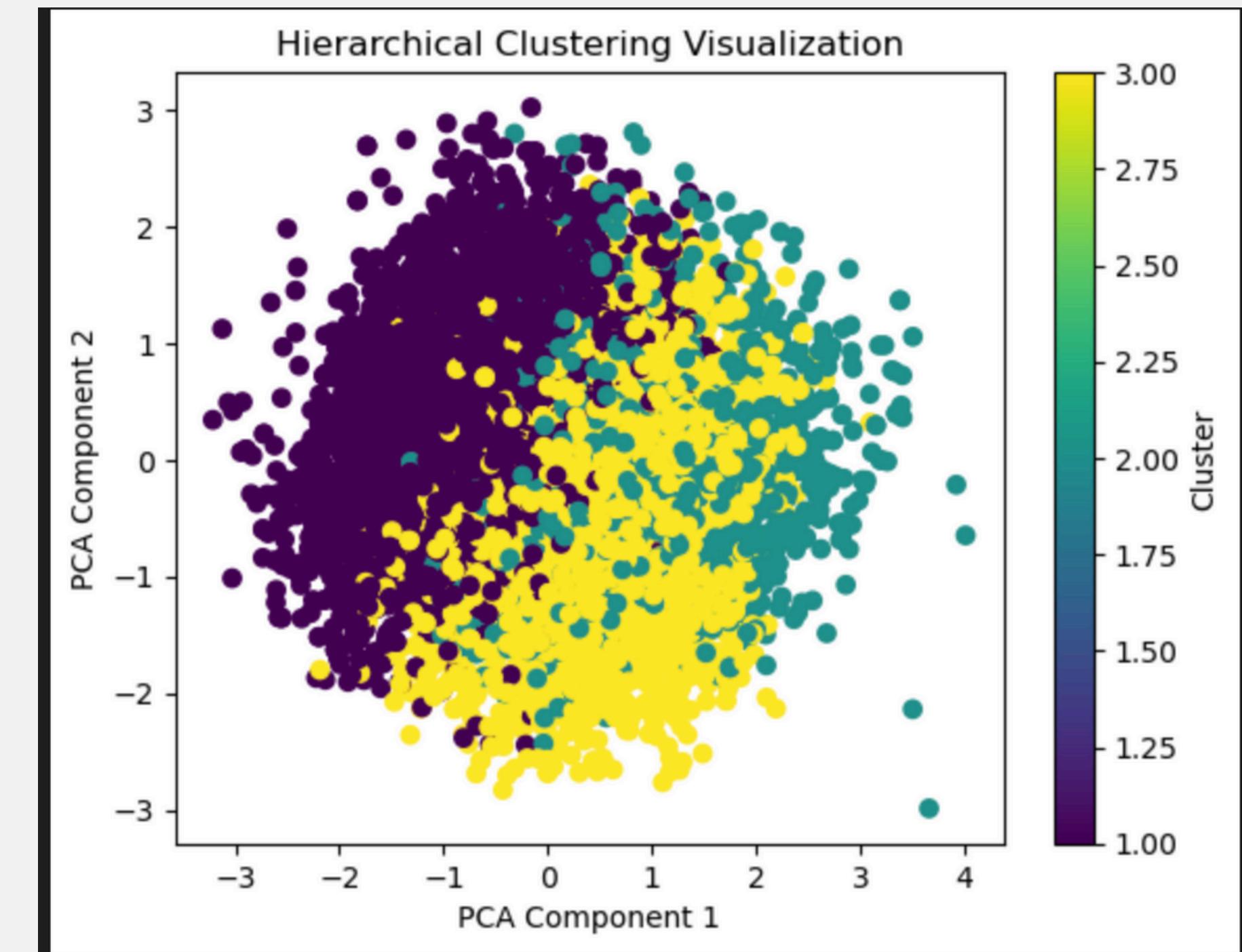
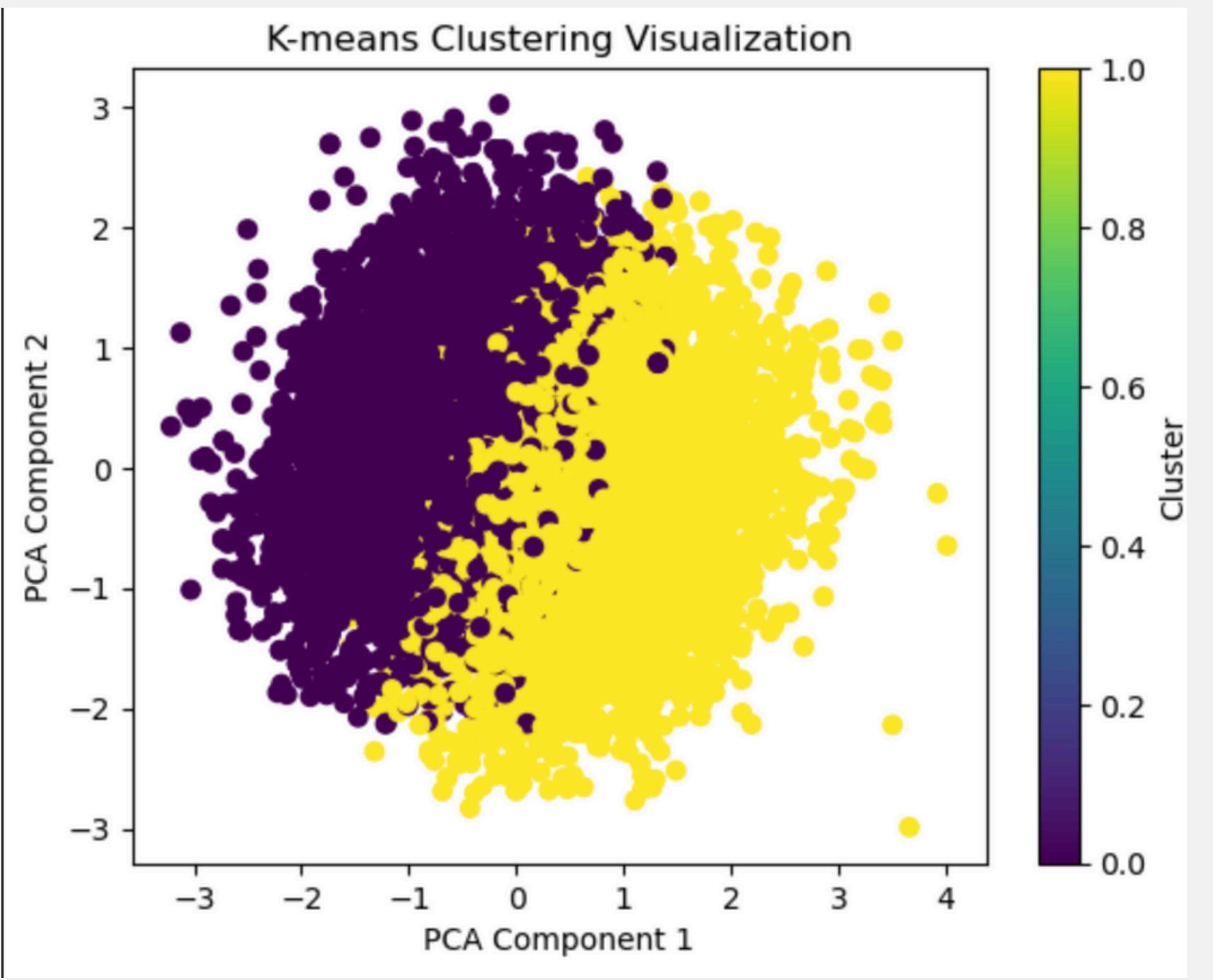
```
y = data['THERAPEUTIC_ALLIANCE_SCORE']
X = data[['COMPLETED_RATIO', 'AVERAGE_INITIAL_SCORE', 'Age']]
```

```
Mean Squared Error (MSE): 207.55776539834065
R^2 Score: 0.2679095085522517
Adjusted R^2 Score: 0.2674992972197259
```

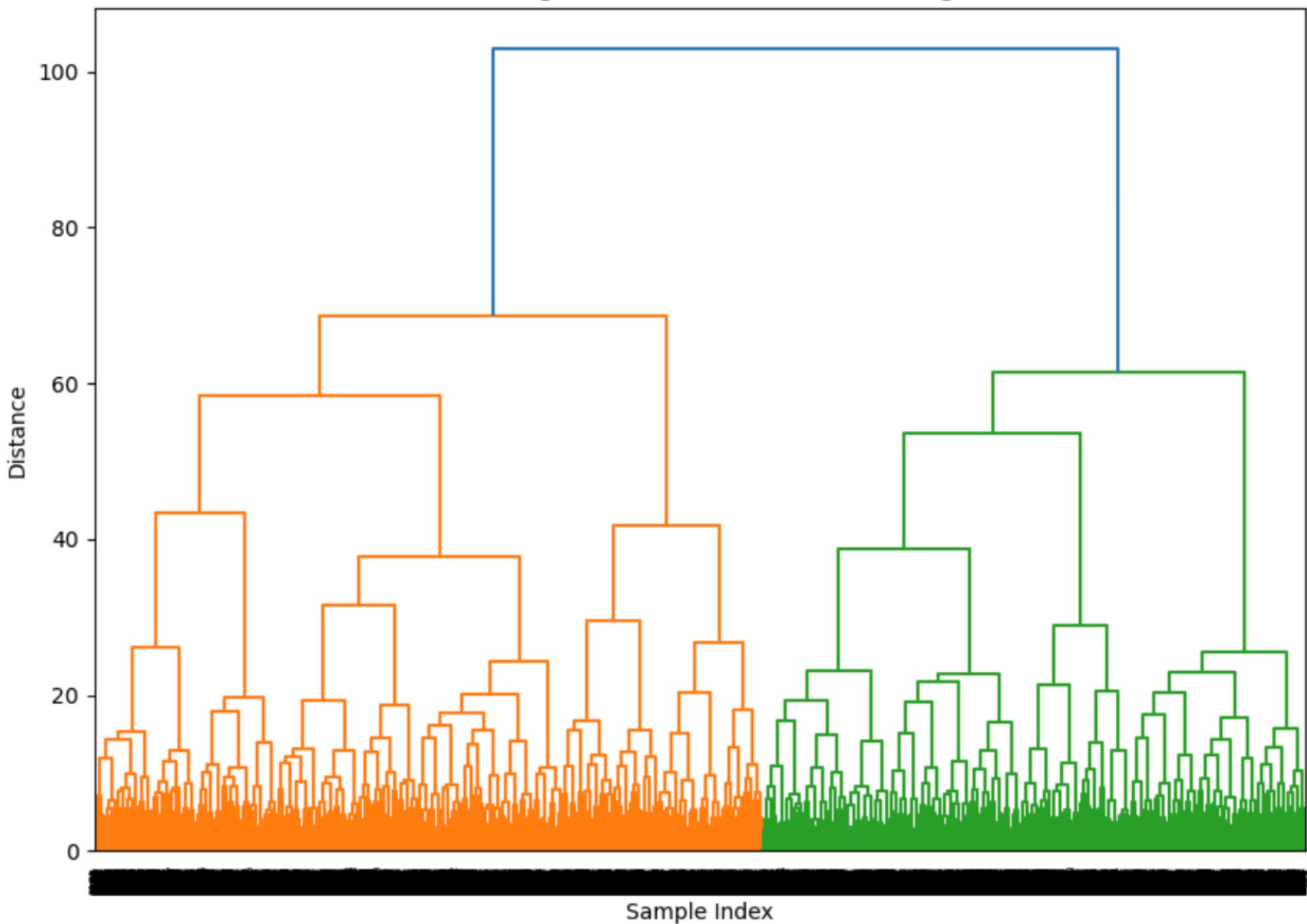
TA predictors unsupervised

ML





Dendrogram for Hierarchical Clustering



Silhouette Score: 0.0923264618978151

Cluster distribution:

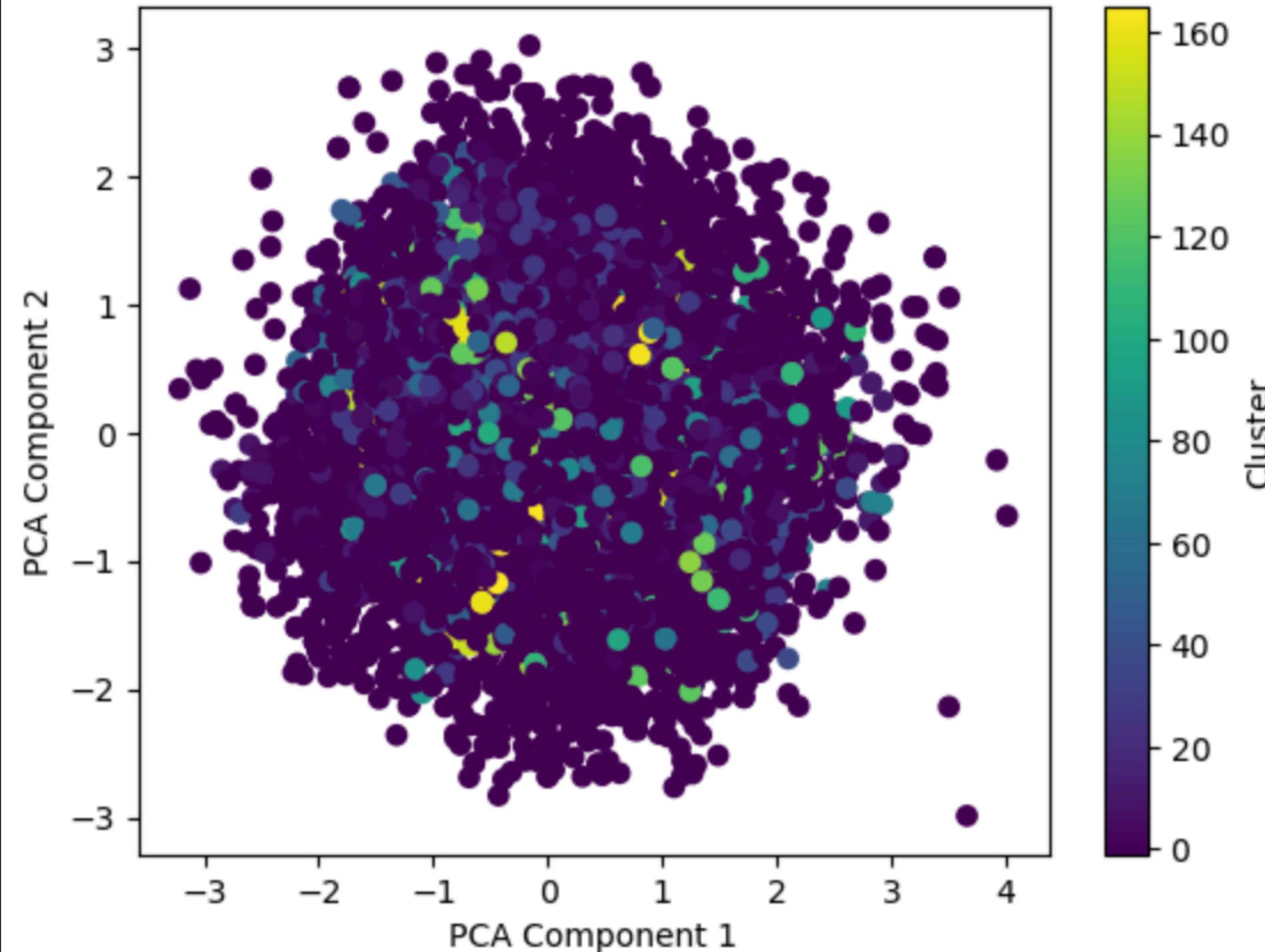
{1: 3717, 2: 1372, 3: 3204}

Silhouette Score: -0.2874889650044524

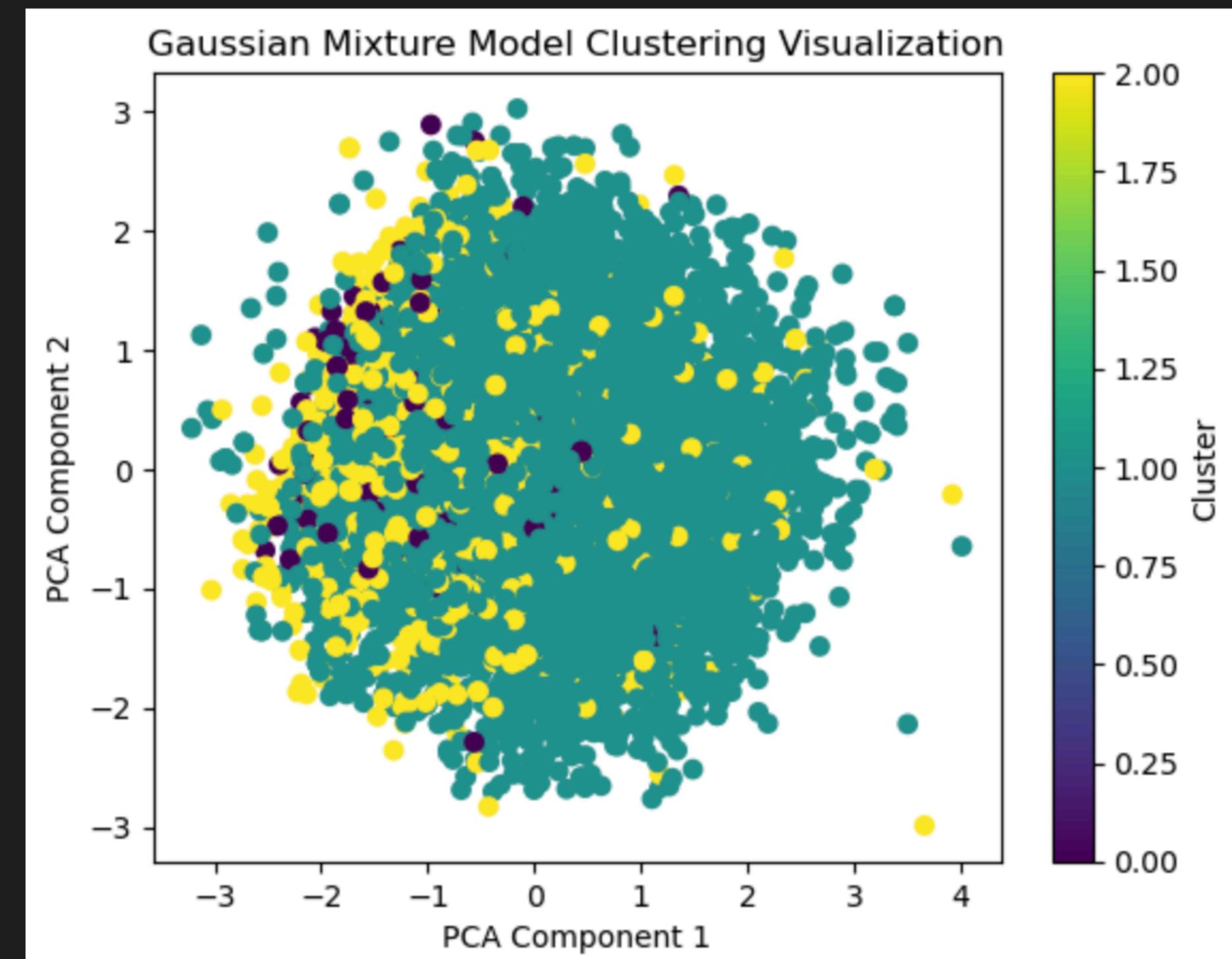
Cluster distribution:

{-1: 4682, 0: 203, 1: 189, 2: 479, 3: 142, 4: 131, 5: 102, 6: 381, 7: 68, 8: 59, 9: 13, 10:

DBSCAN Clustering Visualization



```
Silhouette Score: 0.04295661629127454
Cluster distribution:
{0: 219, 1: 6818, 2: 1256}
[[-1.89649278  0.77242401]
 [ 0.23536225  0.79651345]
 [-0.16726123  0.15395942]
 ...
 [-0.75101159  0.26095932]
 [-1.51537997 -0.74473996]
 [ 0.53656885 -0.14908672]]
```



Last week contribution- Kohsin

01. Performed a t-test to determine if there are any different features between the high therapeutic alliance score group and the low therapeutic alliance score group.
02. Built unsupervised models - PCA and kmeans clustering
03. SQL query to extract new data for other team members to analyze

High TA vs Low TA

```
from scipy.stats import ttest_ind

# Define high score and low score groups
high_score = df[df['THERAPEUTIC_ALLIANCE_SCORE'] > df['THERAPEUTIC_ALLIANCE_SCORE'].mean()]
low_score = df[df['THERAPEUTIC_ALLIANCE_SCORE'] <= df['THERAPEUTIC_ALLIANCE_SCORE'].mean()]

# Perform t-tests
for column in X.columns:
    t_stat, p_value = ttest_ind(high_score[column], low_score[column])
    print(f"{column}: p-value = {p_value}")

p_values = {}
for column in df.columns:
    if column != 'THERAPEUTIC_ALLIANCE_SCORE':
        t_stat, p_value = ttest_ind(high_score[column], low_score[column])
        p_values[column] = p_value

# Select features with p-value < 0.05
significant_features_stat_tests = [feature for feature, p_value in p_values.items() if p_value < 0.05]
print("Significant features from statistical tests:", significant_features_stat_tests)

COMPLETED_RATIO: p-value = 2.7621387442505534e-25
Gender_Male: p-value = 6.593959151458162e-10
DIAGNOSIS_PTS: p-value = 1.7875455541365882e-06
Occupation_Unemployed: p-value = 2.1942212849703487e-05
Age: p-value = 0.00025623511359601796
SUICIDALITY_FLAG_True: p-value = 0.00032204099057011384
Gender_Other: p-value = 0.0007475619604149788
Occupation_Health Care: p-value = 0.0011150652428821694
DIAGNOSIS_Anxiety_Depression: p-value = 0.0042590074226893
Occupation_First Responder: p-value = 0.01098109338516018
Occupation_Student: p-value = 0.012928391347566633
Occupation_Education: p-value = 0.02297643214914339
DIAGNOSIS_Addiction: p-value = 0.02745008694247103
DIAGNOSIS_Eating_Disorder: p-value = 0.031505281390338834
AVERAGE_INITIAL_SCORE: p-value = 0.045809733598244855
INOFFICE_True: p-value = 0.05706557716675558
DIAGNOSIS_Postpartum: p-value = 0.08520561632282861
DIAGNOSIS_Personality: p-value = 0.10230049105299306
Occupation_Other: p-value = 0.2589672246084003
DIAGNOSIS_Abuse: p-value = 0.31597966568504715
DIAGNOSIS_Dissociation: p-value = 0.31870627927876216
Occupation_Professional Services: p-value = 0.36684429207163627
DIAGNOSIS_Depression: p-value = 0.6147511294702661
DIAGNOSIS_Anxiety: p-value = 0.6859545531649707
DIAGNOSIS_OCD: p-value = 0.7431124373328641
Occupation_Manufacturing and Construction: p-value = 0.8325403654018448
```

Principal component analysis (PCA)

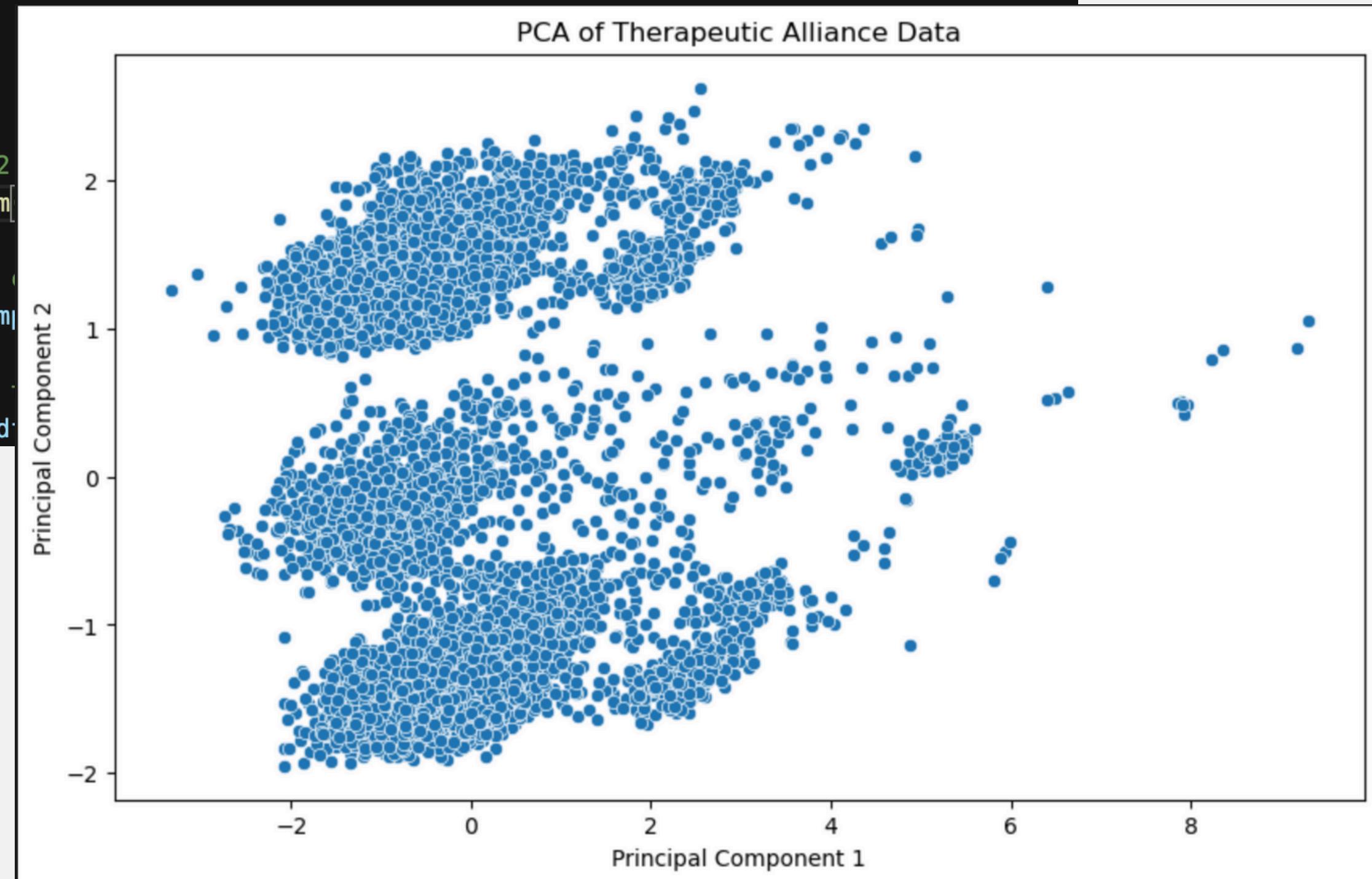
```
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
import seaborn as sns

# Apply PCA
pca = PCA(n_components=2) # Reduce to 2
principal_components = pca.fit_transform()

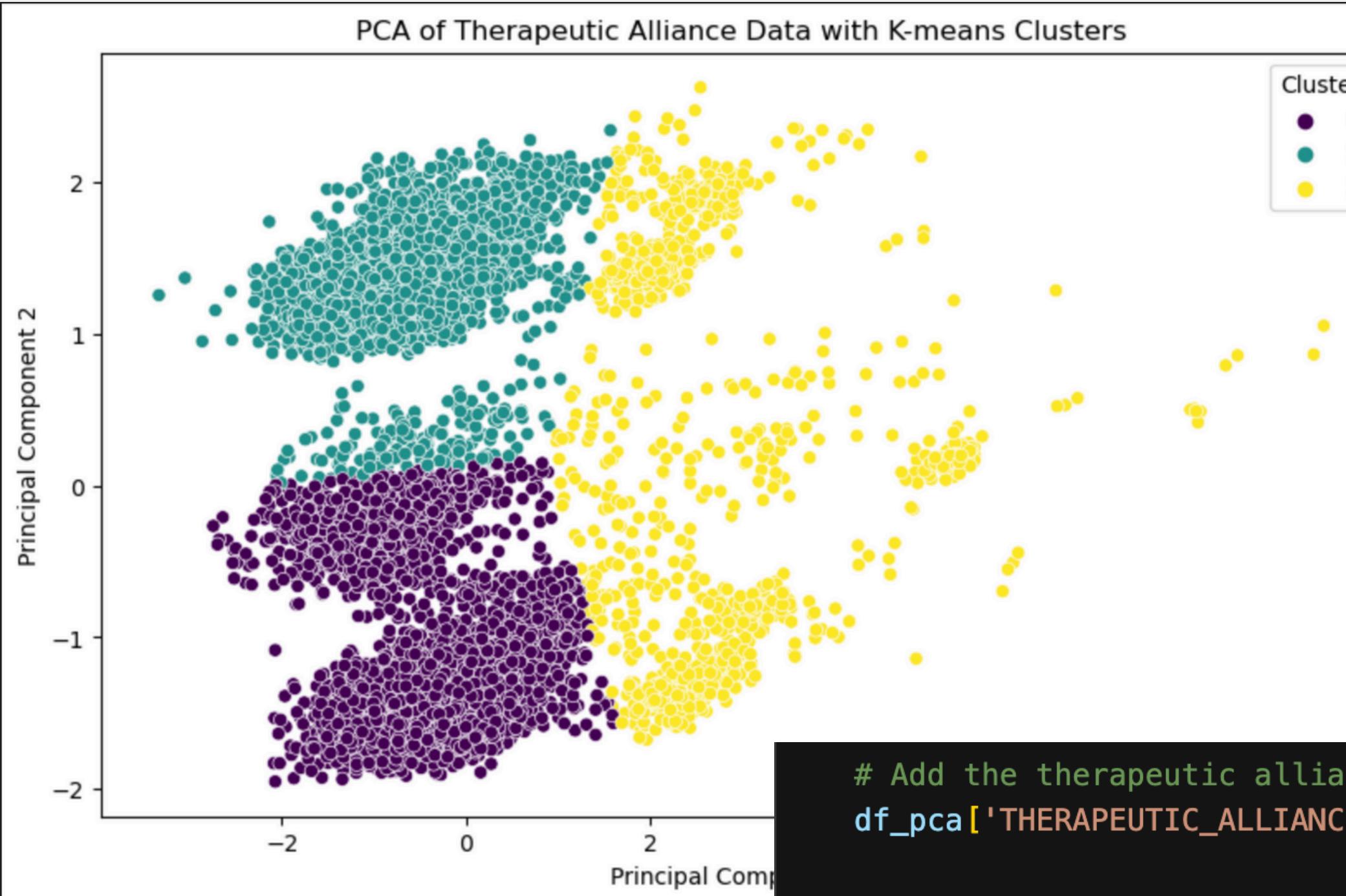
# Create a DataFrame with the principal components
df_pca = pd.DataFrame(data=principal_components)

# Add the therapeutic alliance score to the DataFrame
df_pca['THERAPEUTIC_ALLIANCE_SCORE'] = df['THERAPEUTIC_ALLIANCE_SCORE']
```

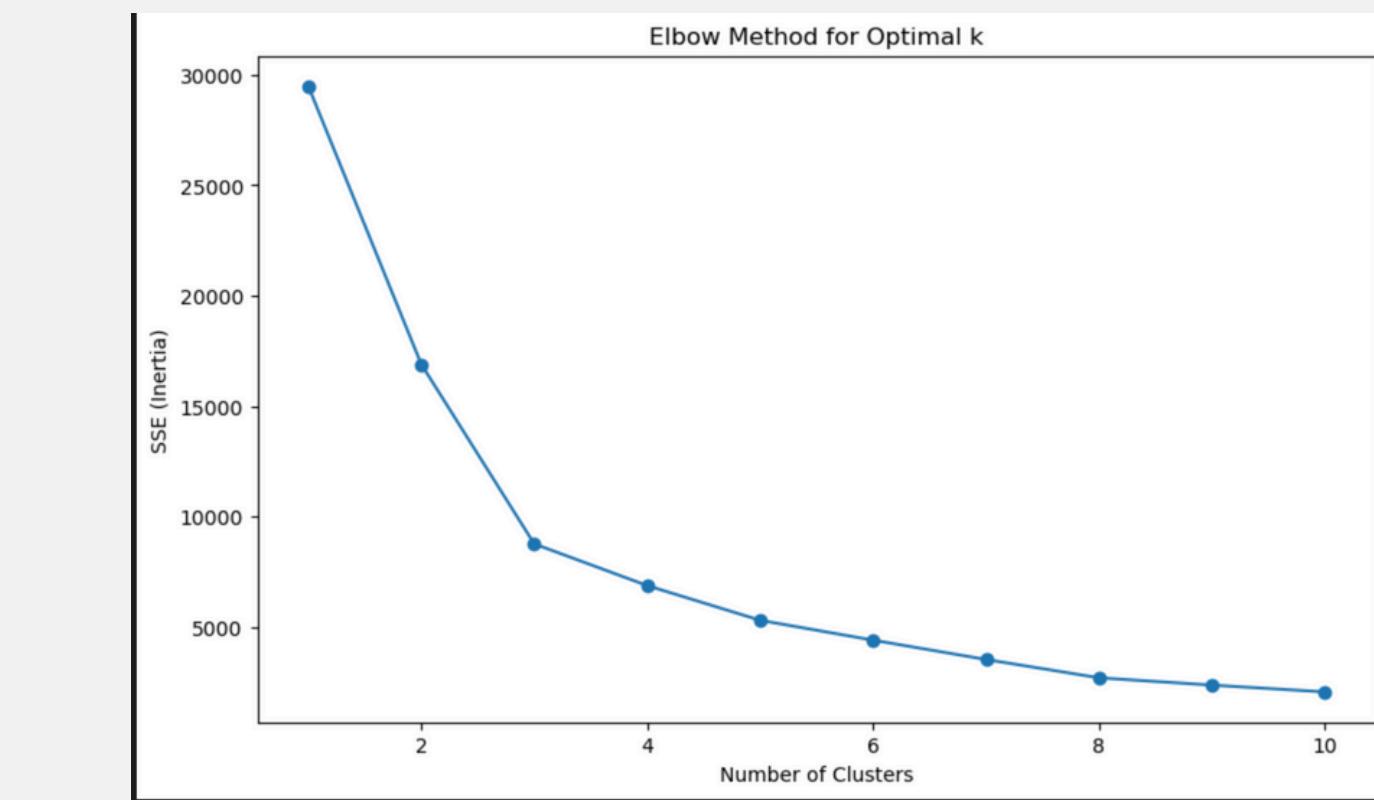
Explained Variance by Principal Components: 0.14



PCA of Therapeutic Alliance Data with K-means Clusters



K means clusters



```
# Add the therapeutic alliance score to the PCA DataFrame for comparison
df_pca['THERAPEUTIC_ALLIANCE_SCORE'] = df['THERAPEUTIC_ALLIANCE_SCORE']

# Analyze the distribution of therapeutic alliance scores within each cluster
cluster_analysis = df_pca.groupby('Cluster')['THERAPEUTIC_ALLIANCE_SCORE'].describe()
print(cluster_analysis)
```

✓ 0.0s

Cluster	count	mean	std	min	25%	50%	75%	max
0	974.0	81.494063	16.147854	0.0	72.658	85.0000	93.750	100.0
1	802.0	82.434246	16.262528	0.0	75.000	86.3585	95.310	100.0
2	285.0	83.088140	14.463216	1.0	75.000	85.9400	94.073	100.0

Therapist Match

SQL query

Therapist vs PHQ-9 score

```
SELECT
    T.THERAPIST_ID,
    T.THERAPEUTIC_ALLIANCE_SCORE AS THERAPIST_THERAPEUTIC_ALLIANCE_SCORE,
    P.PATIENT_ID,
    P.PATIENT_TYPE,
    P.INOFFICE,
    P.THERAPEUTIC_ALLIANCE_SCORE AS PATIENT_THERAPEUTIC_ALLIANCE_SCORE,
    CAPS_ASSESSMENTS_ASSIGNED ASSESSMENT_ID,
    CAPS_ASSESSMENTS.CODE,
    RES.RESPONSE_SUBMITTED,
    RES.SCORE,
    RES.SCORE_NORMALIZED,
    RES.SUICIDALITY_FLAG,
    TP.PATIENT_COUNT
FROM CAPS_PATIENTS AS P
JOIN CAPS_PARTICIPANTS AS PAR ON P.PATIENT_ID = PAR.PATIENT_ID
JOIN CAPS_ASSESSMENTS_ASSIGNED ON PAR.PARTICIPANT_ID = CAPS_ASSESSMENTS_ASSIGNED.PARTICIPANT_ID
JOIN CAPS_ASSESSMENTS ON CAPS_ASSESSMENTS_ASSIGNED.ASSESSMENT_ID = CAPS_ASSESSMENTS.ASSESSMENT_ID
JOIN CAPS_RESPONSES AS RES ON RES.ASSESSMENT_ASSIGNED_ID = CAPS_ASSESSMENTS_ASSIGNED.ASSESSMENT_ASSIGNED_ID
JOIN CAPS_PATIENTS_ASSIGNED AS PA ON PA.PATIENT_ID = P.PATIENT_ID
JOIN CAPS_THERAPISTS AS T ON T.THERAPIST_ID = PA.PROVIDER_ID
JOIN CAPS_CLINICS ON P.owner_clinic_id = CAPS_CLINICS.clinic_id
JOIN PatientCount PC ON P.PATIENT_ID = PC.PATIENT_ID
JOIN TherapistPatientCount TP ON T.THERAPIST_ID = TP.THERAPIST_ID
WHERE RES.SCORE_NORMALIZED IS NOT NULL AND CAPS_ASSESSMENTS.CODE = 'PHQ-9' AND
T.THERAPEUTIC_ALLIANCE_SCORE IS NOT NULL
ORDER BY TP.PATIENT_COUNT ASC, T.THERAPIST_ID, P.PATIENT_ID, RES.ASSESSMENT_ASSIGNED_ID,
RES.RESPONSE_SUBMITTED ASC;
```

SQL query

Therapist vs TA score improvement

```
SELECT
    T.Therapist_ID,
    T.THERAPEUTIC_ALLIANCE_SCORE AS THERAPIST_THERAPEUTIC_ALLIANCE_SCORE,
    P.PATIENT_ID,
    P.PATIENT_TYPE,
    P.INOFFICE,
    P.THERAPEUTIC_ALLIANCE_SCORE AS PATIENT_THERAPEUTIC_ALLIANCE_SCORE,
    CAPS_ASSESSMENTS_ASSIGNED.ASSESSMENT_ID,
    CAPS_ASSESSMENTS.CODE,
    CAPS_ASSESSMENTS.SLUG,
    CAPS_ASSESSMENTS.ASSESSMENT_CATEGORY_ID,
    RES.RESPONSE_SUBMITTED,
    RES.SCORE,
    RES.SCORE_NORMALIZED,
    RES.SUICIDALITY_FLAG
FROM CAPS_PARTICIPANTS AS PAR
JOIN CAPS_PATIENTS AS P ON P.PATIENT_ID = PAR.PATIENT_ID
JOIN CAPS_ASSESSMENTS_ASSIGNED ON PAR.PARTICIPANT_ID = CAPS_ASSESSMENTS_ASSIGNED.PARTICIPANT_ID
JOIN CAPS_ASSESSMENTS ON CAPS_ASSESSMENTS_ASSIGNED.ASSESSMENT_ID = CAPS_ASSESSMENTS.ASSESSMENT_ID
JOIN CAPS_RESPONSES AS RES ON RES.ASSESSMENT_ASSIGNED_ID = CAPS_ASSESSMENTS_ASSIGNED.ASSESSMENT_ASSIGNED_ID
JOIN CAPS_PATIENTS_ASSIGNED AS PA ON PA.PATIENT_ID = P.PATIENT_ID
JOIN CAPS_THERAPISTS AS T ON T.THERAPIST_ID = PA.PROVIDER_ID
WHERE CAPS_ASSESSMENTS.ASSESSMENT_CATEGORY_ID = 1
AND RES.SCORE IS NOT NULL
AND (P.PATIENT_ID, CAPS_ASSESSMENTS.SLUG) IN (SELECT PATIENT_ID, SLUG FROM Patient_Assessment_Count)
ORDER BY T.Therapist_ID, P.PATIENT_ID, CAPS_ASSESSMENTS.SLUG, RES.RESPONSE_SUBMITTED;
```

Challenges

Some patients may link to several therapists, making the analysis more complicated.

THERAPIST_ID	PATIENT_ID	CODE	CREATED	SCORE	SCORE_NORMALIZED	SUICIDALITY_FLAG
1ed6933cf7b0ca8fcc84b5c71f925797	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-05-10T12:08:50.983Z	0.0	100.0	FALSE
1ed6933cf7b0ca8fcc84b5c71f925797	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-06-24T18:46:51.254Z	18.0	33.33	TRUE
1ed6933cf7b0ca8fcc84b5c71f925797	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
56e0e6feabb3a95b1bd28a4257b6db4b	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-05-10T12:08:50.983Z	0.0	100.0	FALSE
56e0e6feabb3a95b1bd28a4257b6db4b	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-06-24T18:46:51.254Z	18.0	33.33	TRUE
56e0e6feabb3a95b1bd28a4257b6db4b	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
76246a302ed99eda0724c4a51c4c4cd8	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-05-10T12:08:50.983Z	0.0	100.0	FALSE
76246a302ed99eda0724c4a51c4c4cd8	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-06-24T18:46:51.254Z	18.0	33.33	TRUE
76246a302ed99eda0724c4a51c4c4cd8	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
9136cd8892cfa4e6fd55e515a4f7298c	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-05-10T12:08:50.983Z	0.0	100.0	FALSE
9136cd8892cfa4e6fd55e515a4f7298c	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-06-24T18:46:51.254Z	18.0	33.33	TRUE
9136cd8892cfa4e6fd55e515a4f7298c	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
d01da87db14225fcacfb0903b5cb16b	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-05-10T12:08:50.983Z	0.0	100.0	FALSE
d01da87db14225fcacfb0903b5cb16b	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-06-24T18:46:51.254Z	18.0	33.33	TRUE
d01da87db14225fcacfb0903b5cb16b	5821cd89b20eeeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE

Last week contribution- Zheng

01. Calculated the number of patients successfully treated by each therapist in the largest clinic.
02. Determined the ratio of patients that improve for each therapist across all PHQ-9 assessments.
03. Explored the relationship between % and TA scores

Level the Score

PHQ-9 Score Guide

Grade	Range	Symptom Severity
0	0-4	Minimal or no depression symptoms
1	5-9	Mild depression symptoms
2	10-14	Moderate depression symptoms
3	15-19	Moderately severe depression symptoms
4	20-27	Severe depression symptoms

THERAPIST_ID	PATIENT_ID	initial_grade	final_grade
0a32dcbe450a554ee55614202b815b32	0e37120605461942982f38c843e91db3	2	3
	23d8d49fcf0d5ae9ead2d0575a5ff7f6	3	4
	29befc947cbb56328ab1ffce7326510c	3	1
	5c242bbc5bf5853aa4260226cc35e211	2	1
	84fc1c37e3f6fd7c23a9fd3352b2dbc5	3	2
...
c14ca06251416024988c1d2f5a657348	a5e52d4ba3db4a6c589c46ae2508b47e	4	4
	a5fe66849d2d93a51d87006d7cda7d7c	2	2
	e674dec7938f51d0eea0ce661263d618	4	3
	fb2dad63a3453c3ad4aead600b14d5ad	1	3
d01da87db14225fcacbf0903b5cb16b	5821cd89b20eeeaa859431c36bffdb1c7	0	1

'Success' # of Patient

01

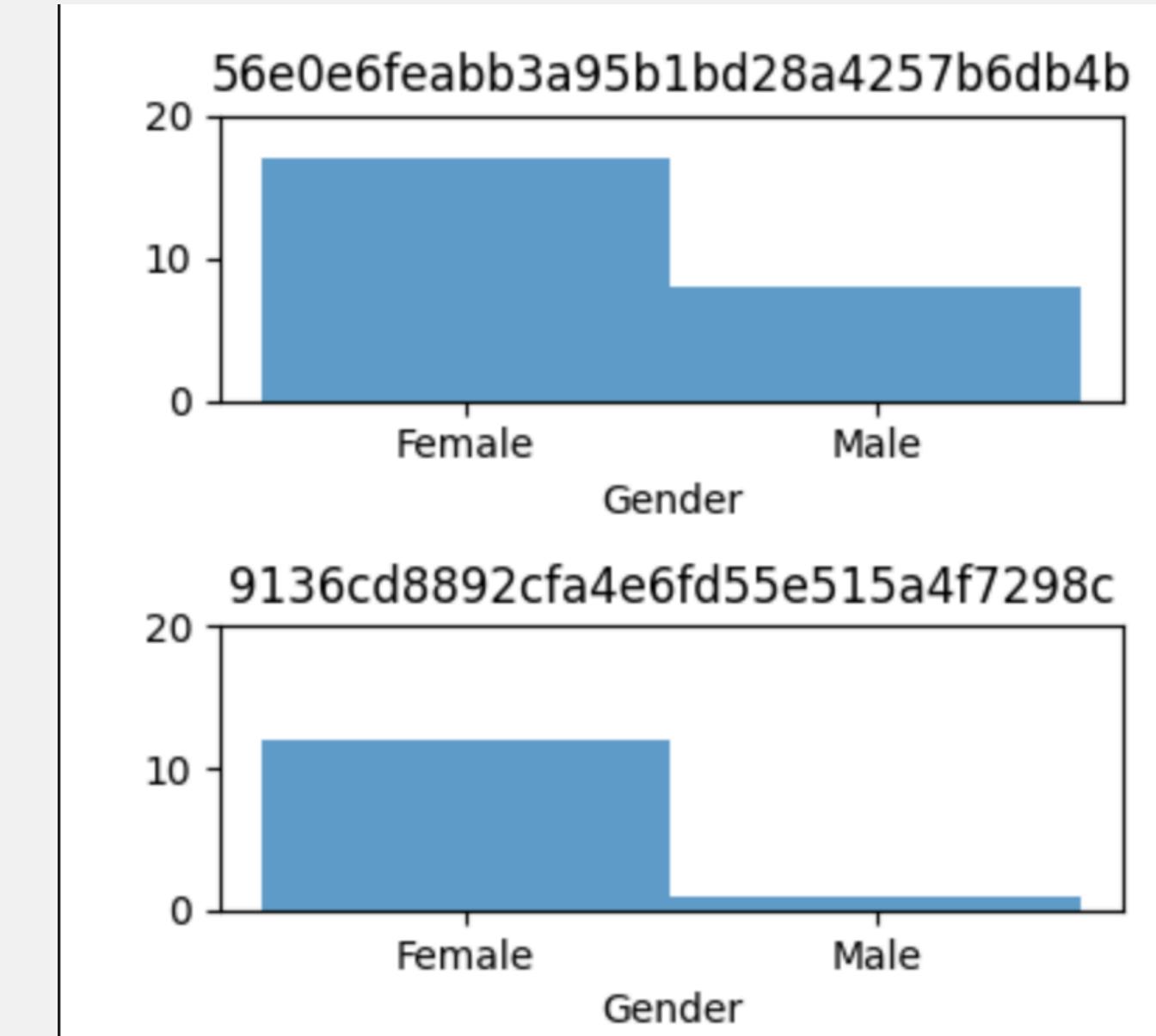
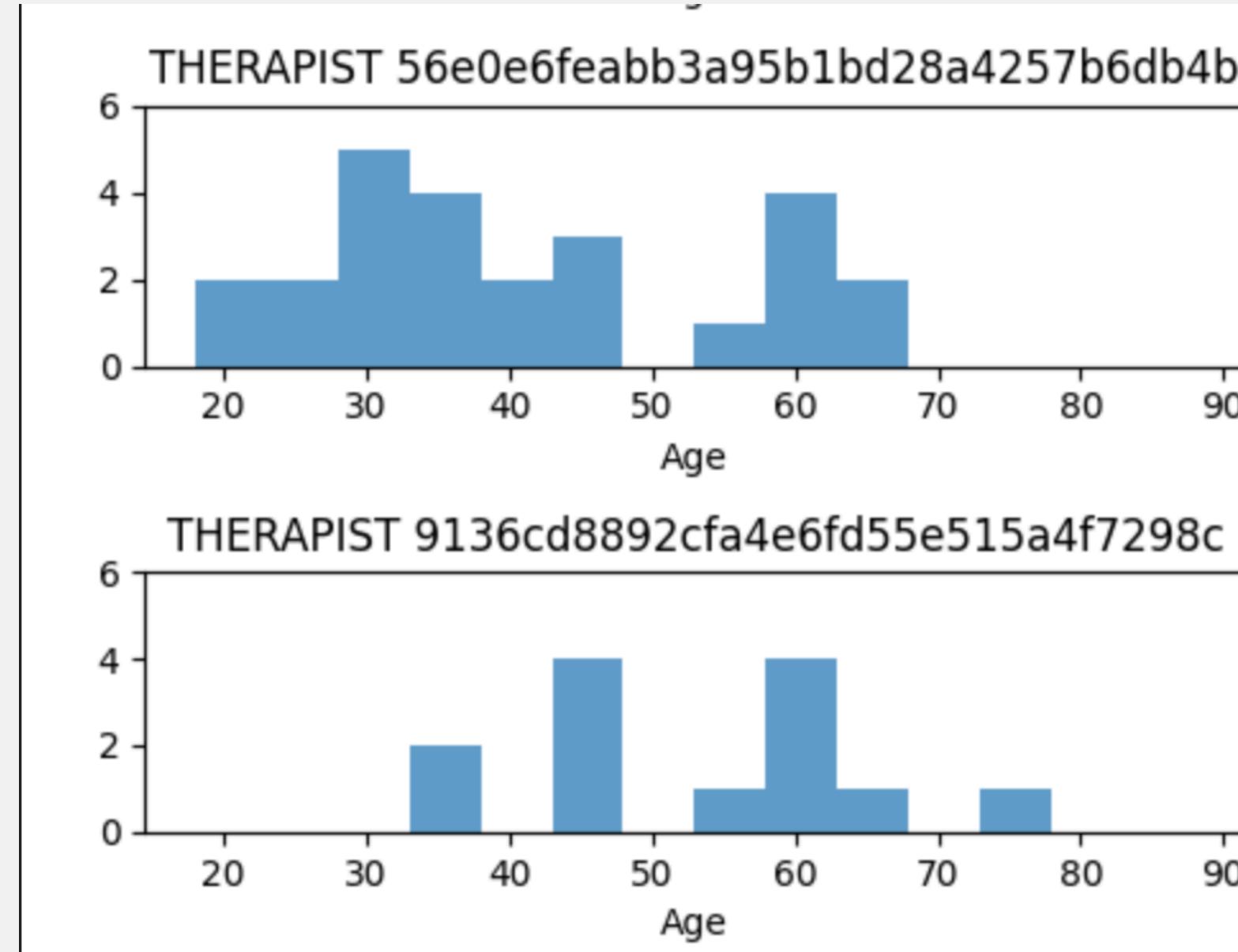
If the final level is lower than the initial level

02

If the initial level is moderate or higher, and final level is lower than mild

THERAPIST_ID	
0a32dcbe450a554ee55614202b815b32	4
1ed6933cf7b0ca8fcc84b5c71f925797	0
56e0e6feabb3a95b1bd28a4257b6db4b	25
76246a302ed99eda0724c4a51c4c4cd8	0
9136cd8892cfa4e6fd55e515a4f7298c	13
a6fde55faad5a3539f39f4cb349b89a8	8
c14ca06251416024988c1d2f5a657348	1
d01da87db14225fcacfb0903b5cb16b	0

THERAPIST_ID	
0a32dcbe450a554ee55614202b815b32	2
1ed6933cf7b0ca8fcc84b5c71f925797	0
56e0e6feabb3a95b1bd28a4257b6db4b	5
76246a302ed99eda0724c4a51c4c4cd8	0
9136cd8892cfa4e6fd55e515a4f7298c	6
a6fde55faad5a3539f39f4cb349b89a8	4
c14ca06251416024988c1d2f5a657348	0
d01da87db14225fcacfb0903b5cb16b	0



Problem:

1. Hard to tell the similar demographic of patients that improved
2. Comparison between numbers seems unfair

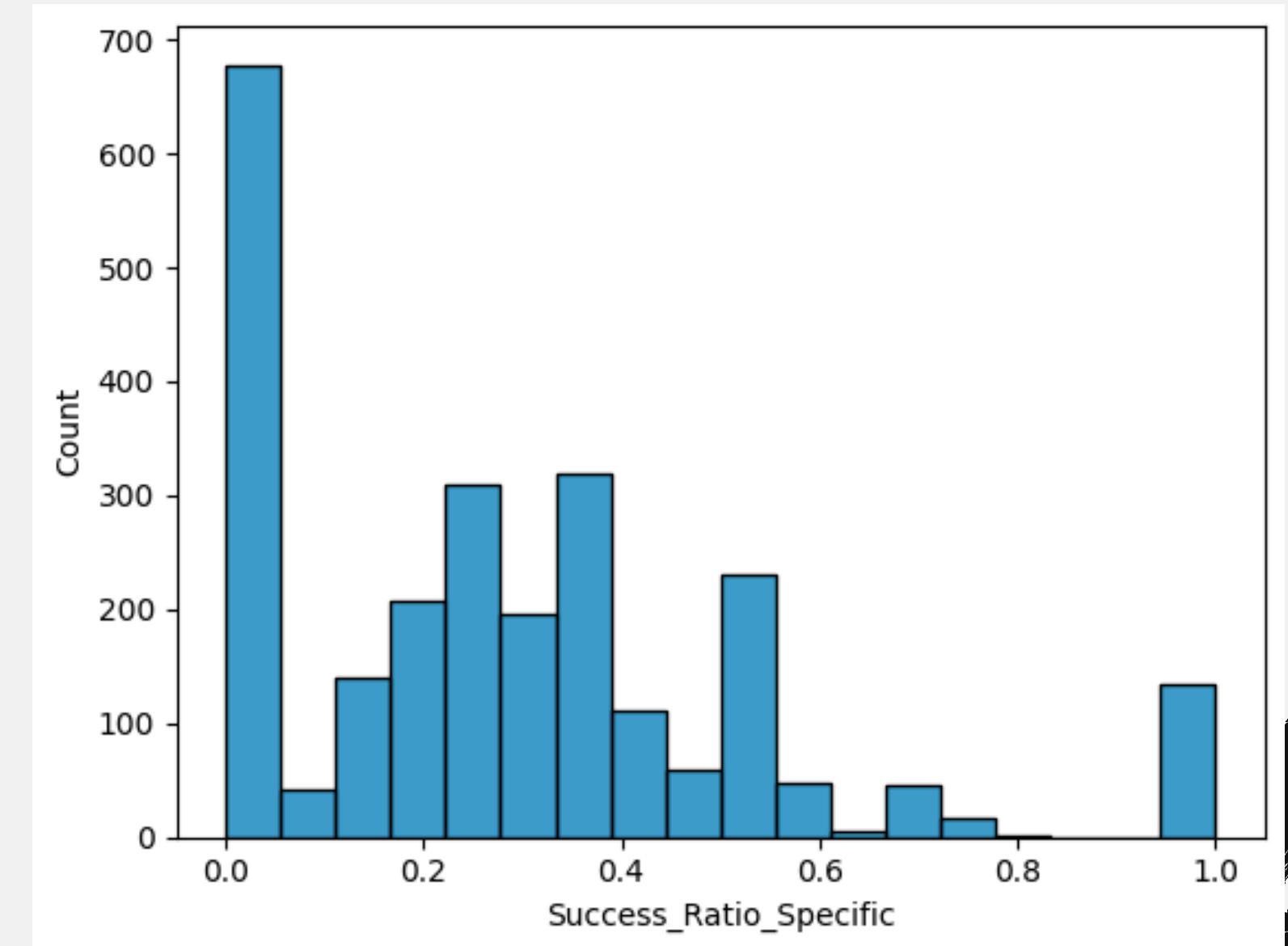
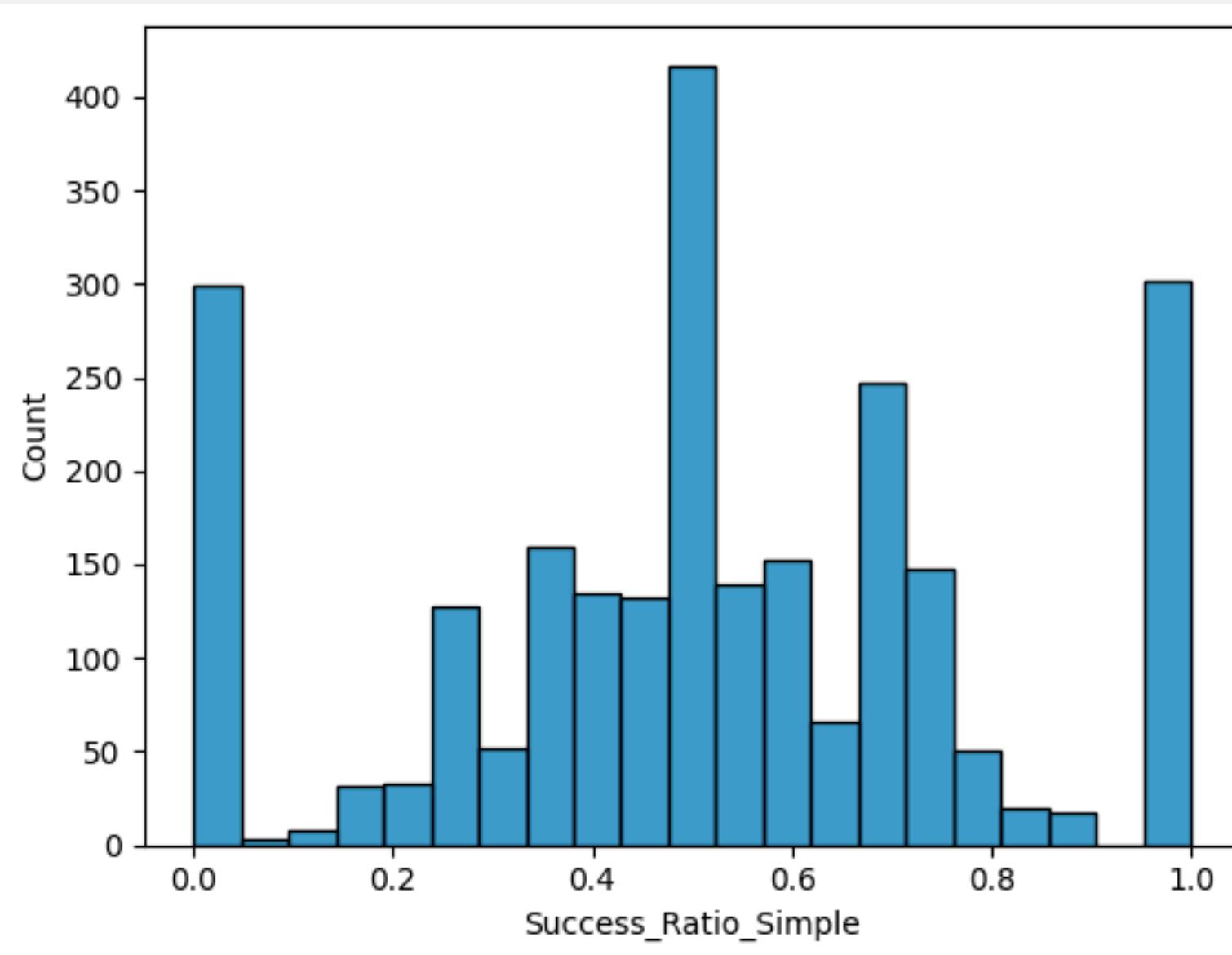
'Success' Ratio

01

If the final level is lower than the initial level

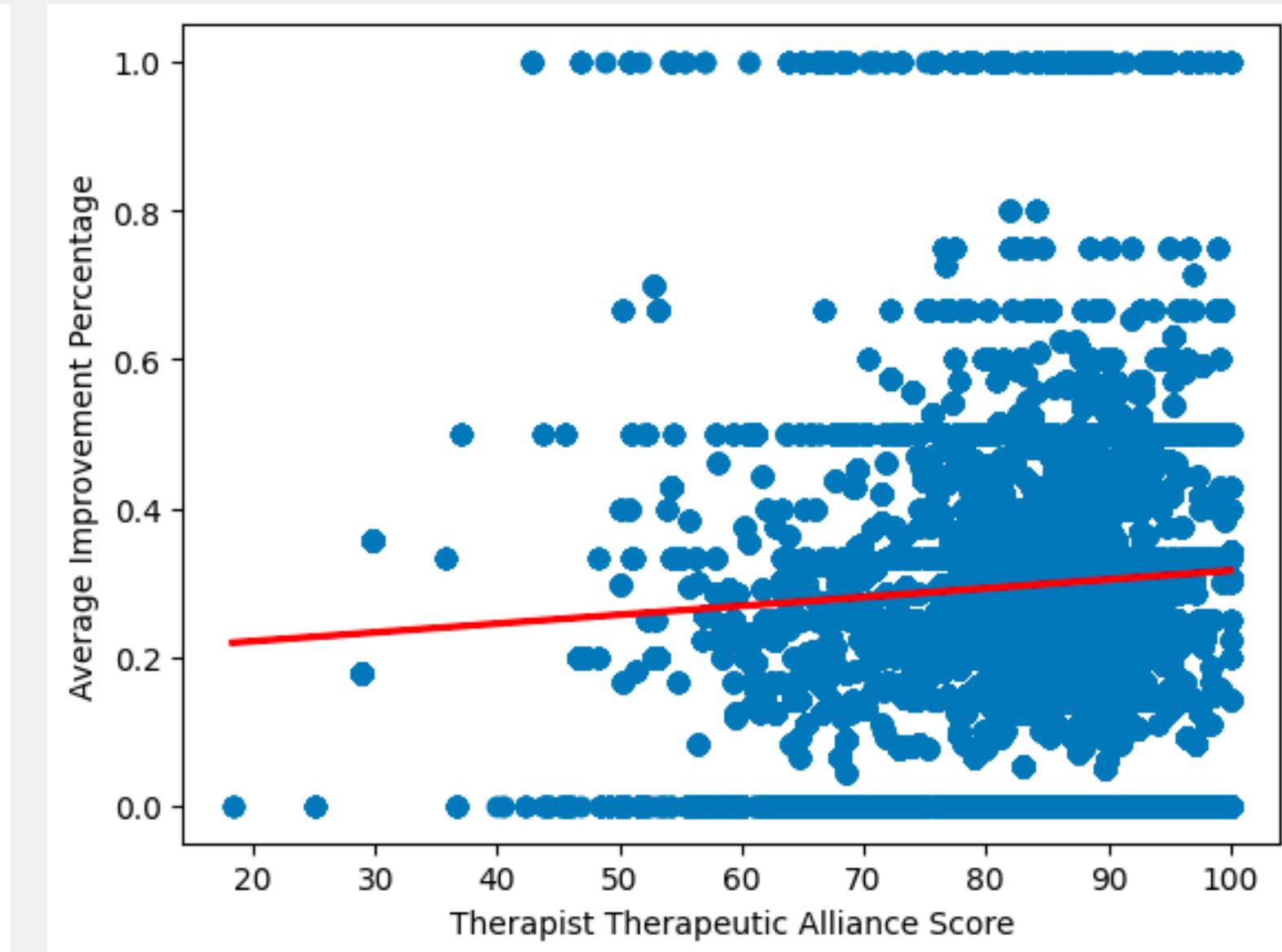
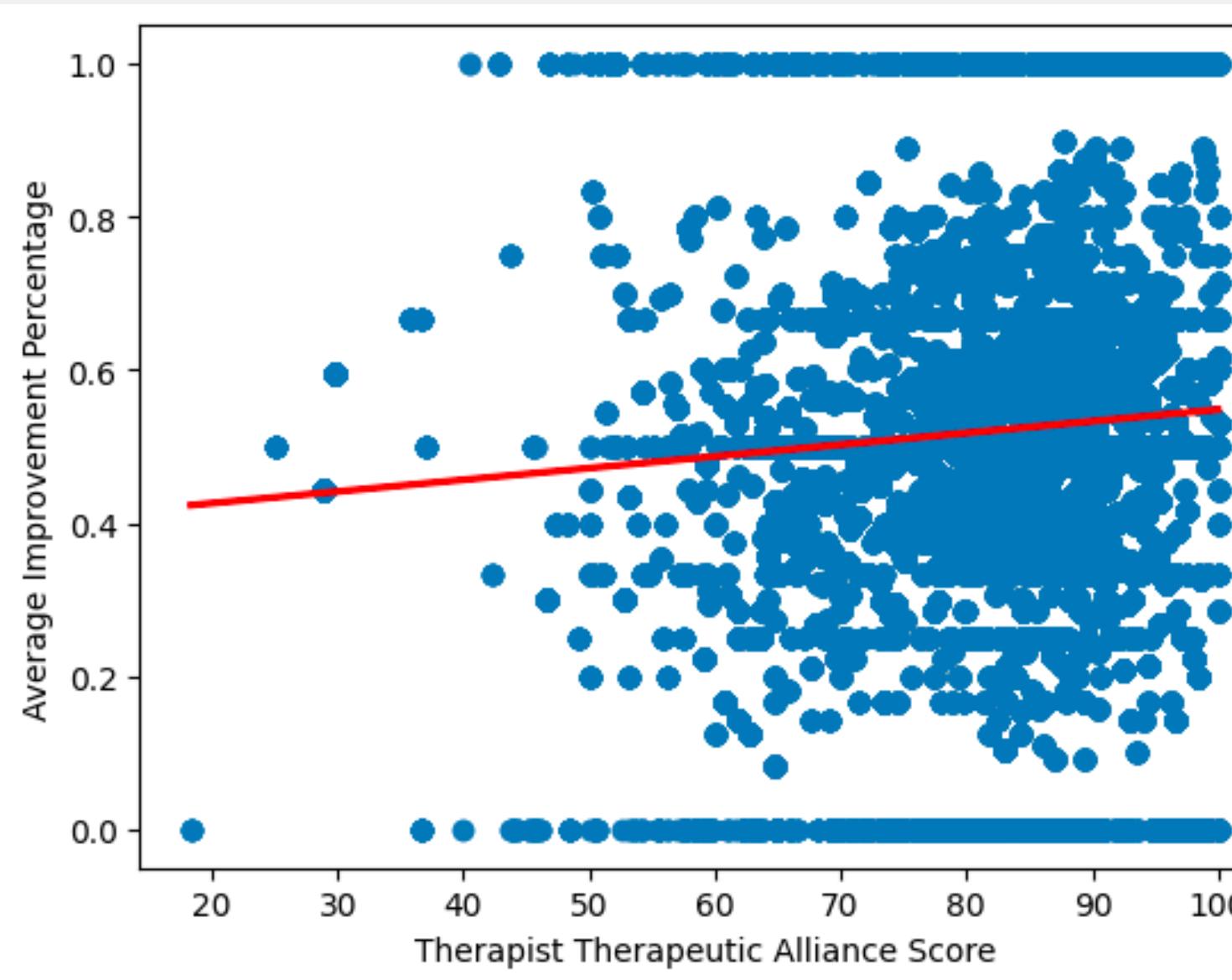
02

If the initial level is moderate or higher, and final level is lower than mild



Correlation

	THERAPIST_THERAPEUTIC_ALLIANCE_SCORE	Success_Ratio_Simple	Success_Ratio_Specific
THERAPIST_THERAPEUTIC_ALLIANCE_SCORE	1.000000	0.09680	0.089331
Success_Ratio_Simple	0.096800	1.00000	0.768310
Success_Ratio_Specific	0.089331	0.76831	1.000000



Last week contribution- Zerui

01. For all patients who did PHQ-9 assessment, extracted their first and last score and calculated the improved score.

Score Improvement

	THERAPIST_ID	PATIENT_ID	first_score	last_score	score_improvement
0	000c75d138b5b9a632654980cebc1069	057bf10203885e1bdd151366c3cd5208	22.22	29.63	7.41
1	000c75d138b5b9a632654980cebc1069	11b872665e658f052c7d0358e9de4e77	44.44	18.52	-25.92
2	000c75d138b5b9a632654980cebc1069	12318b5f0a3917409fc5b8806b4c9fa0	29.63	14.81	-14.82
3	000c75d138b5b9a632654980cebc1069	16b7f422b250e0829e52e56eaf0c8dc4	66.67	44.44	-22.23
4	000c75d138b5b9a632654980cebc1069	1753d67723cc97b932b67363a12336e0	33.33	44.44	11.11
...
63568	fff49949e8f30dce6667cd41bb07fe40	734e2e18fd8ce343d715cf7a9826ebe0	74.07	70.37	-3.70
63569	fff49949e8f30dce6667cd41bb07fe40	a6b9fbe8477dfc1fea3503acfd6fdc56	88.89	85.19	-3.70
63570	fff49949e8f30dce6667cd41bb07fe40	dd17878d39dfb8531dd26d982eb40ff2	55.56	85.19	29.63
63571	fff49949e8f30dce6667cd41bb07fe40	de9b572b7daf333a710c22210637ccb1	44.44	62.96	18.52
63572	fff49949e8f30dce6667cd41bb07fe40	e5db637c9916e4eb122809ef37c33e30	70.37	77.78	7.41

63573 rows × 7 columns

Last week contribution- Zerui

01. For all patients who did PHQ-9 assessment, extracted their first and last score and calculated the improved score.

02. For each therapist, calculated the average improved score of patients, and % of patients who have a(n) improved/no change/worsened score.

Therapist Performance

THERAPIST_ID	Average Improvement	PATIENT_COUNT	Improved %	No Change %	Worsened %
000c75d138b5b9a632654980cebc1069	1.83	83	50.60	8.43	40.96
0019fe5c93771053e8d1d9014621abfe	2.63	138	44.93	8.70	46.38
0062eafcf651bfc36265b367e0c67244	-1.85	4	25.00	25.00	50.00
00a1f0cc02971313dd317eecc011aa01	15.18	40	67.50	7.50	25.00
00b2d11a030058db91509d35c65240ae	26.67	5	80.00	0.00	20.00
00b72fbf3a2cb71bbddacb682ba53b85	14.81	1	100.00	0.00	0.00
00b879aa8bccd627ae62f1e50bf8b040	33.33	2	100.00	0.00	0.00
00bd5d807b2ccc910dcdc2f01064b413	9.31	39	56.41	20.51	23.08
00cefbd66c6396c64432629951541184	25.93	1	100.00	0.00	0.00
00e6205fd30bce5ff975b4655a1972ab	-2.47	3	33.33	33.33	33.33
00f45ca7f9b564f61ea96fcf9aa1feb6	6.17	6	50.00	16.67	33.33

Challenges

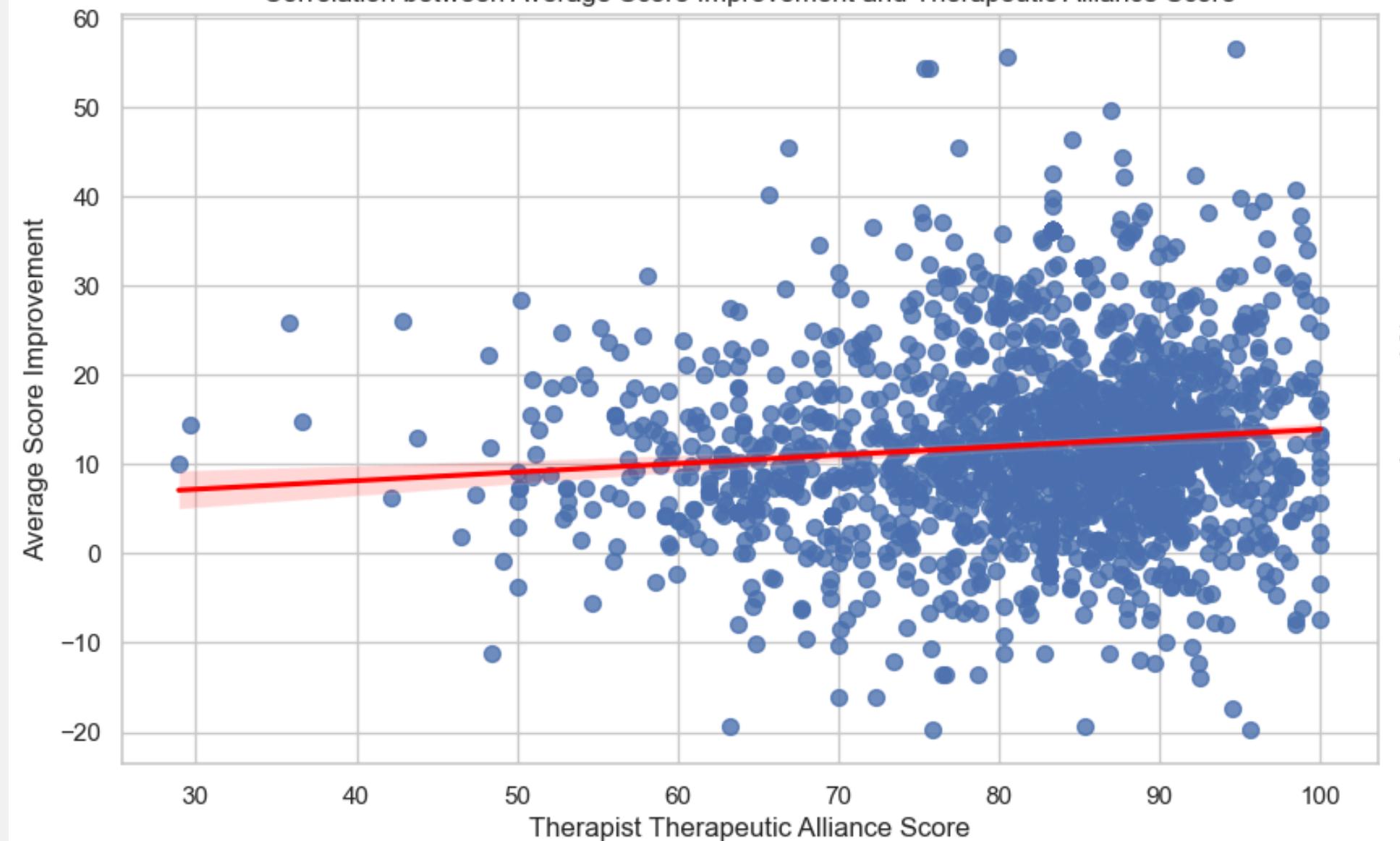
THERAPIST_ID	PATIENT_ID	CODE	CREATED	SCORE	SCORE_NORMALIZED	SUICIDALITY_FLAG
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1ed6933cf7b0ca8fcc84b5c71f925797	5821cd89b20eeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
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76246a302ed99eda0724c4a51c4c4cd8	5821cd89b20eeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
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9136cd8892cfa4e6fd55e515a4f7298c	5821cd89b20eeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE
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d01da87db14225fcacfb0903b5cb16b	5821cd89b20eeea859431c36bffdb1c7	PHQ-9	2021-06-24T18:46:51.254Z	18.0	33.33	TRUE
d01da87db14225fcacfb0903b5cb16b	5821cd89b20eeea859431c36bffdb1c7	PHQ-9	2021-07-16T17:47:52.590Z	5.0	81.48	FALSE

Last week contribution- Zerui

01. For all patients who did PHQ-9 assessment, extracted their first and last score and calculated the improved score.
02. For each therapist, calculated the average improved score of patients, and % of patients who have a(n) improved/no change/worsened score.
03. Calculated and visualized the correlation between therapist TA score and average improved score/improved %.

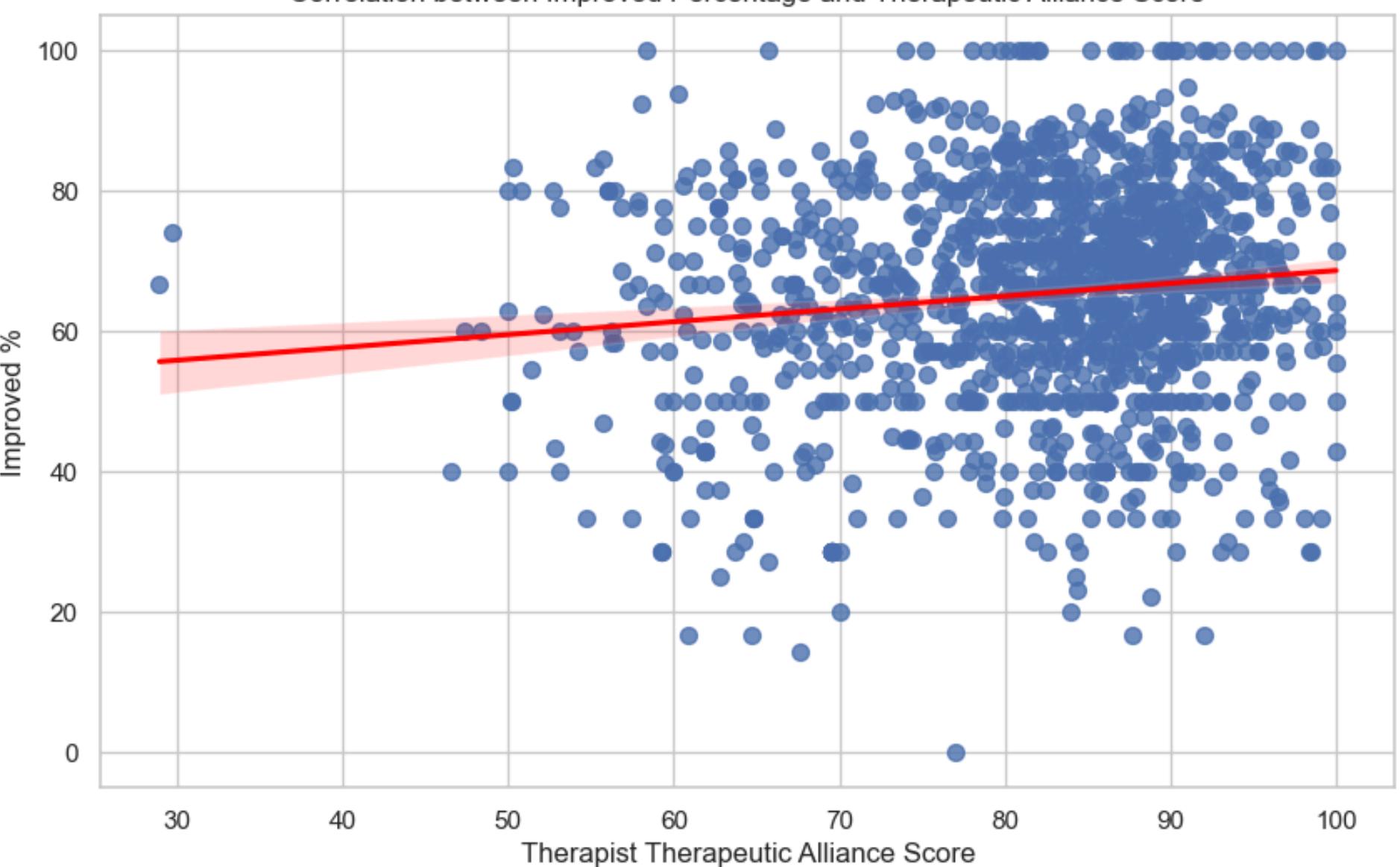
Correlations

Correlation between Average Score Improvement and Therapeutic Alliance Score



Corr: 0.099

Correlation between Improved Percentage and Therapeutic Alliance Score



Corr: 0.128

Match Logic

- high average TA
- high average TA of clients with similar characteristics
- low caseload
- improvement within 6 sessions with patients of similar characteristics
- success with 5 similar patients based on their clinical outcomes

Next Steps

01

BINGSHEN

Find which therapist helps with TA improvement the most.

02

KOHSIN

Try to identify caseloads for every therapist.

03

ZHENG

Determine the proportion of patients who show improvement under each therapist for different assessment.

04

ZERUI

Find the most frequently assigned assessments by each therapist to determine their specialty.

Thank you