



Greenspace Mental Health  
Team 3  
Therapeutic Alliance

Capstone Project Proposal

Kohsin Chen  
Bingshen Yang  
Zerui Zhang  
Zheng Zhang

# Introduction

## Background and Literature Review

Therapeutic alliance, defined as the collaborative and affective bond between a therapist and a patient, is a critical determinant in the success of psychological treatments. Extensive research has demonstrated that a strong therapeutic alliance significantly correlates with positive clinical outcomes across various psychotherapies. Ardito and Rabellino's study underscores the therapeutic alliance as a consistent predictor of successful treatment outcomes, emphasizing the importance of the relationship quality in influencing patient recovery trajectories [1]. Additionally, Martin et al. have explored various assessment methods for evaluating the quality of therapeutic alliances, identifying key factors such as empathy, agreement on therapy goals, and mutual collaboration as essential components of a robust therapeutic relationship [2].

Building on this foundation, recent advancements have incorporated machine learning and statistical algorithms to enhance treatment personalization. Schwartz et al. have developed models that integrate these technologies to recommend cognitive behavioral or psychodynamic therapies based on patient characteristics and predicted responses to treatment [3]. This approach provides insight that this method can also be applied to selecting suitable therapists for patients, thus optimizing treatment outcomes by tailoring therapy choices to individual profiles.

Furthermore, a randomized clinical trial by Constantino et al. tested the efficacy of matching patients to therapists based on the therapists' empirically derived strengths in treating specific mental health concerns [4]. The study revealed that such personalized matching significantly improves psychotherapy outcomes compared to traditional assignment methods. This evidence highlights the potential of data-driven approaches in refining therapist-patient matching processes to foster stronger therapeutic alliances and improve mental health care quality.

Greenspace Health has developed a comprehensive Measurement Based Care (MBC) platform tailored for mental health professionals, offering critical insights into patient outcomes and enhancing care decisions [5]. The platform's assessments component allows patients to complete mental health condition-related questionnaires throughout their treatment. Therefore, we aim to leverage the advanced capabilities of the Greenspace Health MBC platform to build predictive models that assess and enhance the therapeutic alliance.

## **Problem Overview**

The significance of a robust therapeutic alliance drives the need for intake workers and clinical supervisors to have detailed insights into the factors that enhance this relationship, thereby facilitating the assignment of the most suitable therapist at the onset of treatment. Establishing and maintaining a robust therapeutic alliance can be challenging due to the myriad factors influencing its development. These factors can be intrinsic to the patient, such as their psychological state and personal history, or inherent to the therapist, such as their interpersonal skills and therapeutic style, or a combination of both, influencing their interpersonal dynamics. Utilizing predictive analytics and tailored interventions, such as machine learning models and data-driven algorithms, supports the maintenance of the therapeutic alliance and ensures that each patient receives the most effective care tailored to their specific needs.

## **Motivation and Purpose**

The primary motivation for this project is to enhance the effectiveness of mental health treatment by identifying the predictors of a strong Therapeutic Alliance. This project seeks to answer critical questions such as what factors contribute to a robust Therapeutic Alliance.

## **Aims and Objectives**

### **Research Questions**

The objective of our project is to investigate the relationship between therapists and patients. What needs to happen for the Therapeutic Alliance score between a patient and therapist to be high? We aim to explore and model the relationship between Therapeutic Alliance scores and factors related to both the patient and the therapist. This involves identifying and understanding the dynamics and characteristics that foster a strong therapeutic alliance, which is crucial for effective treatment outcomes.

### **Methods and Tools**

We will conduct thorough Exploratory Data Analysis to understand the underlying business logic and to identify patterns and anomalies in the data, focusing on variables that are potentially linked to high Therapeutic Alliance scores. The insights gained from EDA will be pivotal in hypothesizing the factors that could enhance the therapist-patient relationship. We will write SQL queries to handle data

preparation tasks involving the extraction and transformation of data from Snowflake. Python will be the primary programming language in analytical process for its extensive libraries dedicated to data analysis and machine learning.

To quantify and predict the impact of various factors on Therapeutic Alliance scores, we will employ regression models. These models will allow us to understand the strength and nature of the relationships between independent variables (such as patient demographics, therapist characteristics, and initial assessment scores) and the dependent variable, which is the Therapeutic Alliance score. Additionally, we will utilize advanced machine learning algorithms, including ensemble methods like Random Forest, and Neural Networks, to handle complex nonlinear relationships and interactions between variables. These techniques are particularly useful in scenarios where traditional linear models may not adequately capture the dynamics of the data.

This project is inherently multi-faceted and open-ended. We will adopt an iterative process where initial findings from our exploratory data analysis and predictive modeling guide further rounds of data examination, feature identification, and model enhancement. This iterative cycle will enable us to continuously refine our models and approaches based on real-time feedback and evolving insights from the data. By embracing this adaptable and progressive methodology, we aim to progressively fine-tune our analytical tools and techniques, aligning them closely with the project's objectives to enhance the matching of patients with therapists, thereby improving the effectiveness of patient care for clients at Greenspace Health.

## Dataset

### Dataset Description

The dataset comprises 15 tables designed to capture the aspects of therapeutic interactions, including generalized information about psychological assessments, patient responses and evaluation made by therapists. Each table contains 260 thousand up to 20 millions rows.

### Purpose of Variables in Analyzing Therapeutic Alliance:

Attribute	Description
THERAPIST_ID	Identifier for each therapist
THERAPEUTIC_ALLIANCE_SCORE	This score quantifies the strength of the therapeutic relationship between a therapist and their patient

PATIENT_ID	Identifier for each patient
PATIENT_TYPE	Binary variable indicates whether the patient is Adult or Child
INOFFICE	Binary variable indicates whether the patient's sessions are conducted in person (as opposed to remotely)
CREATED	The date when the question was created for a patient
DISPLAY_NAME (ASSESSMENTS)	The name of the assessment administered to the patient
SCORE	The raw score obtained from a patient's assessment
SCORE_NORMALI ZED	Standardized version of the raw score
SUICIDALITY_FLA G	Boolean value indicates whether the patient has suicidal tendencies
QUESTION_TITLE	The title of the question asked in the assessment
RESPONSES	The actual responses provided by patients to the assessment questions
DISPLAY_NAME (TAGS)	The custom labels assigned to patients by their therapists

By using these variables, the analysis can be structured to not only profile patients based on their assessment responses and therapist interactions, but also to link their common characters with therapeutic outcomes. This approach enables the identification of which therapists are particularly effective in managing specific types of psychological issues, leading to better patient-therapist pairings and improving therapeutic alliance.

### **Data Preparation**

To conduct an analysis of the predictors of therapeutic alliance, a series of specific data preparation steps will be undertaken. Firstly, relevant columns pertaining directly to patient treatment, assessment responses, and therapist attributes will be selected from each data table. These may include identifiers such as Patient ID (PATIENT\_ID) and Therapist ID (THERAPIST\_ID). Next, these selected columns will be merged into a single table to facilitate cross-referencing and insight generation, streamlining the analysis process.

Following this, non-informative records will be filtered out, specifically those with zero or null values for the Therapeutic Alliance Score, as they do not contribute

useful information regarding the quality of the therapeutic relationship. Besides that, assessment questions will be categorized into groups (for example anxiety, depression, mood disorders) to provide insight into the issues addressed during therapy and their correlation with changes in therapeutic alliance.

Furthermore, character profiles will be developed for patients based on their responses to initial or intake assessments. These profiles may include demographic information, initial conditions, and significant responses indicative of the severity or type of their conditions.

## Deliverables and Schedule/Timeline

The project will kick off on April 29th and include a mid-project presentation on May 27th, culminating in a final presentation on June 25th. We will adopt a weekly sprint model, launching a new sprint each Sunday beginning May 5. Our communication plan includes weekly check-ins with Mr. Nicholas Kwan every Thursday via Zoom, and meetings with team members every Wednesday and Saturday.

The final deliverable for enhancing the Therapeutic Alliance includes a predictive model report, a therapist recommendation system, and a guide of actionable insights for therapists. The predictive model report outlines significant factors that influence the relationship between a patient and their therapist, utilizing statistical analysis and machine learning to identify key predictors. Building on this, the recommendation system matches patients with therapists who are likely to form a strong therapeutic alliance with them, considering factors such as therapist specialties and communication styles. Also, the actionable insights guide compiles effective strategies from successful therapy interactions, offering therapists concrete suggestions on how to improve their therapeutic relationships. These strategies might include adjustments in therapy techniques or enhancements in communication, aimed at fostering a stronger connection between the therapist and patient. This set of tools is designed to optimize therapeutic outcomes by ensuring a good match and providing ongoing support for therapy professionals.

Below is a concise outline of the weekly objectives for the project:

### Sprint 1: Exploring

Task	Category	Assign to	Due by
Dataset exploring	Exploring	Bingshen, Zheng, Kohsin, Zerui	2024-05-12
Dataset loading	Exploring	Bingshen, Zheng, Kohsin, Zerui	2024-05-12

### Sprint 2: Setting up the model

Task	Category	Assign to	Due by
Model Type Discussion	Planning	Bingshen, Zheng, Kohsin, Zerui	2024-05-15
Dataset cleaning	Cleaning	Kohsin, Zerui	2024-05-23
Model Setup and Initialization	Implementation	Bingshen, Zheng	2024-05-26
Model Fine Tuning i	Optimization	Zheng, Kohsin	2024-05-26
Mid-point presentation	Presentation	Bingshen, Zheng, Kohsin, Zerui	2024-05-28

### Sprint 3: Analyze the result

Task	Category	Assign to	Due by
Model Comparison	Evaluation	Bingshen, Zheng, Kohsin, Zerui	2024-05-31
Key Features identification	Analysis	Bingshen, Zheng	2024-06-03
Key Features Verification	Validation	Kohsin, Zerui	2024-06-03
Model Prediction Accuracy Test	Testing	Bingshen, Zheng, Kohsin, Zerui	2024-06-09

### Sprint 4: Final report and presentation

Task	Category	Assign to	Due by
Model Fine Tuning ii	Optimization	Bingshen, Zerui	2024-06-12
Confirm the factors	Validation	Zheng, Kohsin	2024-06-15

Final report	Documentation	Bingshen, Zheng, Kohsin, Zerui	2024-06-27
Final presentation	Presentation	Bingshen, Zheng, Kohsin, Zerui	2024-06-27

## References

1. Ardito, R. B., & Rabellino, D. (2011). Therapeutic alliance and outcome of psychotherapy: historical excursus, measurements, and prospects for research. *Frontiers in Psychology*, 2, 270.
2. Martin, D. J., Garske, J. P., & Davis, M. K. (2000). Relation of the therapeutic alliance with outcome and other variables: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, 68(3), 438.
3. Schwartz, B., Cohen, Z. D., Rubel, J. A., Zimmermann, D., Wittmann, W. W., & Lutz, W. (2021). Personalized treatment selection in routine care: Integrating machine learning and statistical algorithms to recommend cognitive behavioral or psychodynamic therapy. *Psychotherapy Research*, 31(1), 33-51.
4. Constantino, M. J., Boswell, J. F., Coyne, A. E., Swales, T. P., & Kraus, D. R. (2021). Effect of matching therapists to patients vs assignment as usual on adult psychotherapy outcomes: A randomized clinical trial. *JAMA Psychiatry*, 78(9), 960-969.
5. Greenspace Health. (n.d.). Home. Retrieved May 4, 2024, from <https://greenspacehealth.com/en-ca/>