

# Processing and Visualization of Psychological Diagnostic Data

Bc. Andrea Chimenti

## Abstract

This project is part of an ongoing collaboration between Brno University of Technology and the Rehabilitation Center Kladruby. The aim of this collaboration is to develop a platform that would facilitate and unify the collection and evaluation of psychological diagnosis data, ultimately leading to a possibility of conducting research projects and developing new psychometric norms. In the first step a data model followed by an information system were developed, allowing clinicians to easily store and analyze results of psychometric tests. The system also implements a module for exporting anonymized data, allowing the center to proceed to the next step by sharing the dataset with researchers.

\*[xchime00@stud.fit.vutbr.cz](mailto:xchime00@stud.fit.vutbr.cz), Faculty of Information Technology, Brno University of Technology

## 1. Introduction

Clinical psychologists in medical facilities throughout the world conduct psychometric tests on patients to assess their medical condition. In order to give meaning to the measured (raw) results, clinicians use predefined psychometric norms to convert the raw score to weighted. A correctly defined norm is key to drawing correct conclusions about the medical condition of the patient and to delivering proper medical treatment. However, a significant part of these norms is either misleading, outdated or missing completely. The process of creating norms requires a substantial amount of data, which is often difficult to obtain. Furthermore, facilities often show reluctance to share their patients' data.

The problems mentioned above also occur at the Rehabilitation Center Kladruby<sup>1</sup>, one of the leading rehabilitation facilities in the treatment of spinal cord and brain injuries in the Czech Republic. Despite the substantial amount of data generated at the center, a standardized way of storing and analyzing it has yet to be implemented. Clinicians often rely on Excel sheets and manual calculations, which tend to make the work ineffective and tedious. Apart of leading to an increased risk of errors or data loss, a lot of information in the data remains hidden and impossible to unveil. Given the size of the population available

at the center, providing semi-open access to a set of anonymized data could potentially lead to further research projects and ultimately to the development of new norms.

The proposed solution comprises of two parts. First, a data model designed to properly store information about psychometric tests, its' norms, patients and examination results was implemented. Then second component exposes a user interface that allows the users to manipulate with the data in the system. Moreover, users have the ability to create graphical interpretations and comparisons of the patients' results. The system is currently in the phase of testing and the exact content of the analytical views is being discussed with representatives from the center.

## 2. Process

The whole process leading to an improvement of low-quality norms and an increase in the quality of healthcare consists of multiple steps. First of all it is important to establish a user friendly and flexible way of storing exam data. The tests differ in terms of subtests, tested cognitive functions, data types (e.g. numeric vs time) etc. The same can be said of norms, which can come in different formats, such as intervals, percentiles etc. After that, it is possible to start collecting the data, this step can be done either by uploading historical data, or by using the system

<sup>1</sup><https://www.rehabilitace.cz/>

for a given period of time. Two main goals were defined by the representatives of the Rehabilitation Center Kladruby. Both will be discussed in more detail in the following sections.

### 3. Goal N. 1

The analysis of the results of examinations of patients at Kladruby Rehabilitation Center is currently time-consuming and complicated. The center relies on outdated methods, such as manual inspection or Excel tables. Additionally, the way data is accessed and stored is unfavorable. General information about patients, the results of their tests, and the norms used to evaluate the results are all stored in different places. All of these factors contribute to an inefficient workflow and a decrease in the potential results of data analyses. Furthermore, comparing the results of a patient with his/her reference group is basically impossible.

The system provides an easy way to quickly compare the results with the selected norm as seen in [Figure 3](#) and [Figure 4](#). Since the norms are already stored in the system and the weighted score is calculated automatically, the users save time and the risk of a inducing a human error is mitigated.

Comparing a patient with the proper reference group is an important way effective way of creating an overall image of the condition. For example, the performance of the patient might appear as underwhelming in comparison with its age reference group ([Figure 6](#)), but favorable when compared to the diagnosis reference group ([Figure 5](#)). The system provide a complex set of filters to correctly select the reference group and automatically calculates both loose and strict percentiles.

[Figure 7](#) and [Figure 8](#) show the development of a patients performance in time. For showcase purposes the plots display Trail Making Test and its parts A and B. In part A the participant is to draw lines to connect circled numbers in a numerical sequence as rapidly in possible. In condition B the participant is to draw lines to connect circled numbers and letters in an alternating numeric and alphabetic sequence as rapidly as possible [\[1\]](#). The raw score is measured in seconds needed to complete the tasks.

### 4. Goal N. 2

For any psychological test to be acceptable for clinical use, it must be standardized and reliable. It is essential to have norms to meaningfully interpret the results obtained from the assessment of a single individual.

Without such points of comparison, it is impossible to determine the meaningfulness of the test results [\[2\]](#).

But as stated in section [1](#), norms of psychometric tests are often incomplete or imprecise, making room for errors in the process of examination evaluation. The amount of patients undergoing treatment at the Rehabilitation Center Kladruby represents a statistically significant population of subjects with various cognitive disabilities. The size of the dataset has the potential to be used as a base for defining new norms of neuropsychological tests. On top of that, the data can provide value for different research projects, which could be conducted on medical and psychological universities.

The system offers a way to easily export tabular data and aggregations that can be used for further analysis. Both `xls` and `csv` formats are available. An example of exported data is represented by [Table 1](#) and [Table 2](#).

### 5. Solution

The technical details of the solutions are shown in [Figure 2](#). The system is built on a three layer client-server architecture. The data tier is represented by a PostgreSQL database, its models are defined using SQLAlchemy on the application tier. The application tier, implemented in FastAPI, exposes a REST API with 77 endpoints that consist mostly of CRUD operations. Some of the endpoints are used for retrieving the aggregated data for plotting charts on the client side. The interface of the API is defined by Pydantic schemes, which provide a straightforward way of converting database models to JSON objects returned by the API.

The client tier is implemented in Typescript using the framework Vue.js and its UI library Vuetify, which follows the Material Design rules. The plots are rendered by the library Apache Echarts. The services were generated automatically from the OpenAPI specification using the tool `openapi-typescript-codegen`<sup>2</sup>.

### Acknowledgements

I would like to thank my supervisor Ing. Jiří Hynek Ph.D., who helped me with the technical part of the project. I also want to thank my advisors PhDr. Petra Fiřová Ph.D. and Mgr. Pavel Viktora, who introduced me to the problematic of testing in psychology and provided me with deep insights into the topic.

<sup>2</sup><https://github.com/ferdikoomen/openapi-typescript-codegen>

## References

- [1] Timothy A. Salthouse. What cognitive abilities are involved in trail-making performance? *Intelligence*, 39(4):222–232, 2011.
- [2] John Hunsley and Gina Giulio. Norms, norming, and clinical assessment. *Clinical Psychology: Science and Practice*, 8:378 – 382, 10 2001.