

## Thesis

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# New methodology for disability assessment: analysis of WHO-Disability Assessment Schedule II with clustering based on rules

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**Abstract.** This thesis tries to give an answer to an open question about *functional disabilities (FD)*, constituting and application of Artificial Intelligence to medicine. In fact, there still is a lack of consensus on the concept of *FD* and many efforts are done at present to forward research on this field, even from the World Health Organization (WHO). On the other hand, in the context of Data Mining it is well known that some complex Knowledge Discovery (KDD) problems require combination of several techniques coming from different research areas to be properly solved.

In this work a hybrid KDD technique called *clustering based on rules (CIBR)* has been used to analyze a database referent to the assessment of *FD* by means of the WHO-DASII scale, which is a new assessment scale proposed by the WHO for validating functional disability degree. After analysis and interpretation of the results, a proposal of a new taxonomy of disabilities from a real functional point of view is presented as well as its relationship with the total score of the WHO-DASII scale.

Keywords: Knowledge Discovery, clustering based on rules, taxonomy, Functional Disabilities, assessment scale

## 1. Introduction

The concept of disability itself is not always precise and quantifiable. To improve agreement on it, the WHO developed a clinical test (WHO Disability Assessment Schedule, WHO-DASII). The purpose of this work is to extract knowledge about the performance of the WHO-DASII on the basis of a sample of neurological and psychiatric patients from the hospital S. Lucia (Rome, Italy). The work is focused to identify which are the typical answers to the WHO-DASII and which are the characteristics of the groups of patients who provide this types of answers. In fact, this raises a clustering problem, which has to be solved. However, it has been seen that classical clustering techniques cannot well recognize the structure of certain complex domains, so producing some non-sense classes.

*CIBR* [2] is an hybrid *AI and Statistics* technique which properly combines a clustering process with an inductive learning one in order to reach good performance in *KD* on this kind of domains. In this work it

has been used to analyze data and identify four different profiles for *FD*.

## 2. The WHO-DASII scale

The WHO-DASII (v.3.1a [3]) is a new scale, proposed by the WHO, containing 96 items that enables the assessment of disability levels according to the ICF classification. This interview measures self-reported difficulty of functioning in six major domains that are considered important in most cultures: Understanding and Communicating, Getting Around, Self Care, Getting Along with People, Life Activities and Participation in Society.

WHO-DASII total score goes from 0 (non-disable) to 100 (maximum disability).

## 3. The sample

The target sample includes 96 neurological patients in 18 to 80 years, recovering at the hospital between

October 1999 and February 2000. A control group has been enrolled. The sample contains 60.4% of males, 39.6% females. Average age, 56 years; 20 patients with spinal cord injury, 20 with Parkinson, 20 with stroke, 16 with depression and 20 control individuals. All patients were assessed by WHO-DASII at admission.

#### 4. The analysis

First of all the classical approach of testing association between the total WHO-DASII score, and the pathology of the patients was focussed. A clear separation between non-disable patients (mean score 6,08) and others (mean scores between 32,07 and 39,48) was found. However, it was expected that a 96 items scale could distinguish something more than differences between disable and non-disable. That's why a multivariate approach was used and answers of every patient to each item of the scale were considered. Data cleaning was performed and noisy items as well as redundant ones were identified and properly treated.

Then a first hierarchical clustering was done; 4 classes were obtained. However, interpretation of some of them was confusing, especially because answers to items about emotive problems overlapped on some. It was then seen that depressed patients appear scattered over several classes without apparent explanation.

Since patients with emotive problems constitutes a group with clear meaning from a clinical point of view, it was decided to use *CIBR* for biasing the clustering process with a Knowledge Base (KB) which properly express that *patients with emotive problems should not be randomly scattered along classes*. Indeed, the advantage of this technique is that background knowledge can be introduced in form of logic rules into the system and taken into account during the clustering. An important property of the method is that the *semantic restrictions* implied by the KB are satisfied by final clusters, and this guarantees interpretability of results.

#### 5. Results

By *CIBR*, four classes of *FD* were identified [1]. It has been seen that they are related with increasing degree of disability and the more characteristic items of every class have been also identified. Each class is identifying a different profile of *FD* and a new taxonomy of 4 groups of increasing disability was finally proposed:

**Low:** autonomous patients, no physical nor mental problems (includes all control patients and some ill patients which are non-disable).

**Intermediate I:** moderate disabilities in physics and mental, patients with perception of high disability but really showing lower level (on daily work or standing up to 30 minutes...).

**Intermediate II:** moderate physical disability related to autonomy (difficulties on toileting and dressing), non emotive problems.

**High:** extreme physical and mental disability.

#### 6. Conclusion

From our experience, WHO-DASII is itself confirmed as a valid tool, if interpreted under a multivariate approach (that is taking into account the individual items of the scale, besides the total score). To have a number of items, not always guarantees good results (wrong analysis, noise effect, redundant information, irrelevant items...).

None of the classic statistical methods allows that expert knowledge influences the data analysis. *CIBR* is a hybrid technique which sensibly improved results. Integration of clinical knowledge inside the analysis is fundamental to allow a proper interpretation.

Results of *CIBR* allowed proposal of a new taxonomy of disabilities, increasing the domain knowledge:

- Four profiles of increasing degree of disability were proposed. From the analysis it became possible to distinguish between intermediate degrees of disability which are qualitatively different.
- The taxonomy really face disabilities from a functional point of view; furthermore it was seen that the proposed profiles are not directly associated with underlying pathology; however they are associated to increasing mean values of the total WHO-DASII score, which is opening the door to a future proposal of a cut-off for the WHO-DASII.

There is actually in progress a clinical application study of the individual disability profiles.

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## References

- [1] R. Annicchiarico, K. Gibert, U. Cortés et al., Analysis of WHO-DASII disability assessment by clustering based on rules, in: *Proc. IAG03*, Barcelona, 2003 (in press)
- [2] K. Gibert, The use of symbolic information in automation of statistical treatment for ISD, *AI Communications* **9**(1) (1997), 36–37.
- [3] J. Rehm, T.B. Ustun, S. Saxena et al., On the development and psychometric testing of the who screening instrument to assess disablement in the general populations, *Journal of Methods in Psychiatric Research* **8**(2) (1990), 110–122.

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