An ontology for automatic generation of computer-based cognitive exercises

Silvana Quaglini[a], Silvia Panzarasa[b], Giorgio Leonardi[a,c], Mario Stefanelli[a]

[a] *Dipartimento di Informatica e Sistemistica, Università di Pavia, Italy*
[b] *Consorzio di Bioingegneria, Pavia, Italy*
[c] *Dipartimento di Informatica, Università del Piemonte Orientale, Italy*

Abstract and Objective

Cognitive rehabilitation may take advantage of computer-based approaches which, compared to the traditional paper-based ones, allow the management of a big amount of stimuli. These stimuli may be reused and recombined to create new exercises, whose difficulty level should be adapted to the patient's performance. This work proposes an ontological organization of the stimuli, to support the automatic generation of new exercises, tailored on the patient's preferences and skills. The ontology has been integrated into an existing cognitive rehabilitation tool [1], to test the new functionalities made possible by this approach.

Keywords:

Ontology, Cognitive rehabilitation, Exercise adaptation.

Introduction

Cognitive rehabilitation is designed to reduce and/or compensate the impact of cognitive dysfunction in patients suffering from brain damage. An improvement in this direction sees the use of computer applications, which offer the management of a big amount of stimuli and introduce multimedia features which allow the patient to focus more on the exercises. The organization of these stimuli in an ontological knowledge base, permits the rehabilitation software to automatically generate ever new exercises, by properly recombining the classified stimuli and using the ontological relations between them. Furthermore, a system to classify the patient's performance may help in generating exercises tailored on the patient's skills. The integration of the ontology of stimuli in a system such as the one described in [1] permits to achieve the goals described.

Methods

An ontology is composed by classes, attributes and relations. In our ontology, each class represent a stimulus, to be used in the exercises. The stimuli are grouped in taxonomies, which define the semantic categories (food, animals, dresses, etc.). Attributes can be associated to the classes, to bind stimuli to the corresponding images and/or sounds (e.g. the picture and the whistle of a train). The relations between the classes define the semantic links between the corresponding stimuli. For example, the relation "lives in" is defined between the classes "man" and "house". The same relation can link the classes "bird" and "nest", and the classes "fox" and "hole". A system using this knowledge base can automatically build a new exercise showing, for example, a "man" to the patient and asking him where the "man" "lives in". The system chooses three possible answers: a "house" as a correct answer ("man" → "lives in" → "house") and two incorrect answers ("nest" and "hole"). It is straightforward for the system to check the correctness of the patient's answer, by verifying that, in this situation, only the stimuli "man" and "house" are linked by the "lives in" relationship. This example demonstrates that the ontology of stimuli allows the system to automatically generate ever new exercises, and to verify the correctness of the answers, without human intervention. Images and sounds can also be used to obtain multimedia exercises.

Results

The ontology, implemented with Protegè, has been integrated in [1] using a dedicated tool. The preliminary tests show encouraging results, as half of the patients declare to prefer using the computer, rather than traditional paper-based exercises.

Conclusion

Tele-medicine and tele-homecare may represent an appropriate approach for moving care delivery and rehabilitation from hospitals to the patients' home. This work illustrates that an ontology-based approach permits the automatic generation of exercises for the rehabilitation of patients. Therefore, it may be considered as a means to create tele-homecare services.

References

[1] Quaglini S, Panzarasa S, Giorgiani T, Zucchella C, Bartolo M, Sinforiani E, Sandrini G: Ontology-Based Personalization and Modulation of Computerized Cognitive Exercises. AIME 2009: 240-244