Learning a Lightweight Ontology for Semantic Retrieval in Patient-Centered Information Systems

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ABSTRACT

The paper introduces a web-based eHealth platform currently being developed that will assist patients with certain chronic diseases. The ultimate aim is behavioral change. This is supported by online assessment and feedback which visualizes actual behavior in relation to target behavior. Disease-specific information is provided through an information portal that utilizes lightweight ontologies (associative networks) in combination with text mining. The paper argues that classical word-based information retrieval is often not sufficient for providing patients with relevant information, but that their information needs are better addressed by concept-based retrieval. The focus of the paper is on the semantic retrieval component and the learning of a lightweight ontology from text documents, which is achieved by using a biologically inspired neural network. The paper concludes with preliminary results of the evaluation of the proposed approach in comparison with traditional approaches.

Keywords: *Associative Network, Concept-Based Retrieval, Lightweight Ontology, Neural Network, Ontology Learning, Term Associations*

INTRODUCTION

A growing share of the burden of disease, i.e. the direct and indirect health costs, is accounted for by chronic conditions. At the same time, health authorities across Europe have come to realize the tremendous costs involved in chronic care. It is therefore not surprising that countries are shifting in health policy towards more self-management and patient-centered care. However, self-management of disease is a skill that cannot be taken for granted but has

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to be learned and most people need assistance for this task. Motivating people to change their behavior and lifestyle has emerged as the central challenge in this respect. Self-care tools and online interventions can provide useful assistance, especially because they enable the personalisation of monitoring and information access. Tailoring the information to the needs and requirements of the individual user has found to be an important prerequisite for the success of self-management initiatives (Kennedy et al., 2007). Concept-based retrieval is expected to address this shortcoming.

Before discussing this approach in detail, we give a brief overview of the SEMPER project which provides the framework for our work on concept-based retrieval. Subsequently, we outline the need for semantic retrieval and then describe how a lightweight ontology is learned using a biologically inspired neural network. We then evaluate our approach to learning association nets by comparing it with the classical cosine tf-idf co-occurrence measure. The conclusion outlines future work.

SEMPER: A SUPPORT SYSTEM FOR PATIENT SELF-CARE

The SEMPER (Project SEMPER, 2009) project develops an interactive, web-based platform that provides patients with ongoing assistance and encouragement for dealing with problems such as alcohol dependency and work-related disorders, especially those related to office work (e.g. stress, eye strain, repetitive strain injury). This will be realized through online assessment, disease-specific information, personalized monitoring and feedback as well as social and emotional support via virtual communities. The inclusion of new fields of application and/or target groups will be possible due to the open architecture of the platform.

The online components are not meant to replace consulting a doctor or other health professionals. Rather, we want to use the advantages of interactive technologies to lessen the burden of health professionals and complement face-to-face treatment. Figure 1 illustrates the main components of the SEMPER platform:

- *Motivation & monitoring support:* The online self-assessment questionnaire allows the user to specify the measures for changing behavior, such as daily exercise, or a certain maximum amount of alcohol intake per day (in the case of controlled drinking). This results in a personal action plan. Intended and actual behavior is then compared and the progress visualized.
- *Information portal:* The information portal provides health information and self-care training. This module focuses on increasing users' health literacy and improving their self-management skills. The patients can learn about symptoms, conditions, implications or consequences of their health conditions from a variety of information sources brought together on a single platform. They can learn about how their problems are related to their lifestyles and habits and how eventual behavioral changes can alleviate them. The information portal also allows access to relevant online communities which are included in the search. These represent a valuable social lifeline for those homebound due to illness, age or handicap, or those isolated in rural settings. Besides, in the case of alcohol-related problems, some may prefer the anonymous exchange online because of the social stigma attached to alcohol dependency. Besides, the knowledge to be found in online communities represents a resource into which health care professionals and researchers may be interested in tapping into so as to supplement their more structured research and to gain additional insights.
- *Maintenance & information cockpit:* This component allows adding or deleting contents in the information portal. Moreover, since the ontologies used to enable semantic search are automatically extended by the system (see further below) they need to