

An ontology-based recommender system to promote physical activity for pre-frail elderly

Mohammad Hossein Nassabi¹, Harm op den Akker^{1,2}, Miriam Vollenbroek^{1,2}

Telemedicine Group, University of Twente, The Netherlands¹

Telemedicine Group, Roessingh Research and Development, The Netherlands²

Abstract

The increasing ageing population and the prevalence of chronic diseases have introduced new challenges to healthcare systems motivating researchers to use telemonitoring solutions for providing care. In some solutions, a special focus has been given to promoting physical activity as it can decrease the risk of becoming frail and prevents further health complications. The focus of this research is to keep seniors physically active by designing and developing an intelligent system that recommends exercises tailored to an individual's health status, goals and preferences hence aiming for an adaptive personalized solution.

1 Introduction

The proportion of the older adults (65+) is increasing and is expected to double within the European Union in a period of 50 years. Frailty is a highly prevalent condition amongst the elderly population in which the older adult is at an increased risk of adverse future health outcomes such as developing dementia, falling, hospitalization or increased mortality¹.

This research is done in the context of PERSSILAA², an FP7 European project which aims to develop a new service model to screen for and prevent frailty focusing on the physical, nutritional and cognitive functioning. Such a holistic approach can yield active and healthy ageing for the elderly, facilitate independent living and potentially limit the burden on the healthcare systems.

¹ Definition from European Innovation Partnership on Active and Healthy Ageing (EIP on AHA)

² <http://www.perssilaa.eu>

2 Research plan

The focus of this research is to keep seniors physically active by recommending exercises tailored to their health status, user goals and preferences. The latter two items are found to be important for establishing a healthy lifestyle change. The recommender engine will be integrated in CoCo, a web-based platform that allows elderly to perform physical exercises assigned by healthcare professionals at the home setting (Tabak 2014). We plan to make use of ontologies because user data can arise from multiple resources. Semantic technologies and ontologies have been used previously to address the issue of heterogeneity in the healthcare domain (Orgun and Vu 2006).

The envisaged recommendation procedure has 3 main steps: (1) After mapping the physical health status of the elderly and each exercise's targets, an initial set of exercises is selected; (2) the exercises are adapted to the user according to the usage history and prior feedbacks (e.g., difficulty level, level of enjoyment); (3) the final set of exercises is selected based on aggregated health outcomes (of similar users) and consequently presented to the end-user.

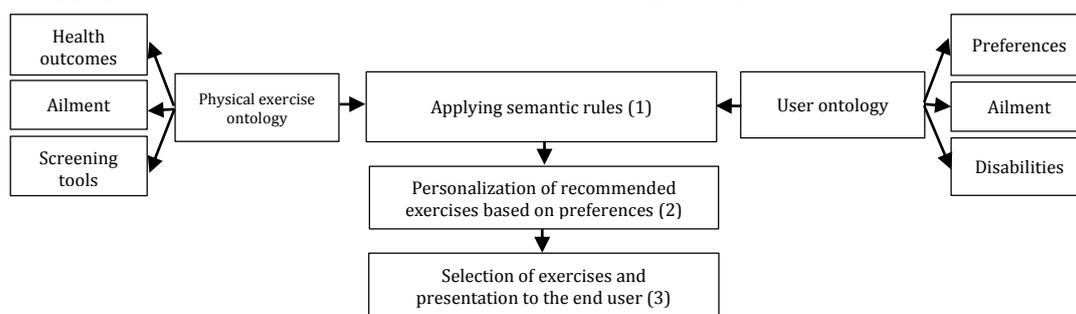


Figure 1: The three steps required to provide physical exercise recommendations.

To successfully realise the described procedure, the following questions must be adequately addressed:

1. *Which patient information and health outcomes are considered for the user model?*

The user model should contain an up-to-date status of the elderly at all times. The model contains demographics, co-morbidities and impairments. In addition user goals and preferences will be asked for and structured similar as in the GUMO ontology or will be derived from the interactions with the CoCo platform.

2. *How can we represent the knowledge of healthcare professionals?*

We will first create an ontology for physical exercises and define a set of rules to be executed against the ontology. The combination of the ontology and rules will form the knowledge base for recommending exercises. The knowledge base is created by (1) interviewing healthcare professionals – we have held some meetings with physiotherapists to have a better understanding of the concepts and processes involved in this domain, (2) retrospective analysis of logged data in the CoCo platform which has been extensively used in multiple trials and (3) consulting literature and online exercise repositories.

3. *Which psychological theory(s) will be used for providing recommendations to achieve adherence to physical exercises?*

When making recommendations, it should be made certain that the elderly is physically and mentally able to perform the exercise. Therefore, special attention should be paid to the elderly's self-efficacy i.e., the elderly's belief whether a certain exercise is in his/her control. In this research, we will look into those strategies that support the self-efficacy of the end-users for example the system will gradually increase the difficulty level of the exercises based on the feedback received after each exercise.

4. *Which technologies and algorithms are considered?*

User and exercise model ontologies will be defined in the Web Ontology Language (OWL) and the Semantic Web Rule Language (SWRL) will be used to enforce rules on the ontology. The JENA API will be used for interacting with the ontologies. In addition, algorithms such as the Weighted Directed Acyclic Graph (wDAG) can be used to compare the similarity between two ontologies. The SNOMED CT repository will be used to enable semantic matching of clinical terms (e.g., diseases). Lastly, a hybrid of both rule-based and collaborative filtering approaches is used for providing recommendations.

3 Conclusions

In this paper, we have proposed a roadmap towards a recommender system for physical exercises that considers both health conditions and preferences of the end-users. As for the validation, we plan to first evaluate the level of agreement between our recommender system and domain experts (e.g. physiotherapists) in a study where multiple patient cases are presented. In the second validation step, the system will be evaluated with 350 seniors residing in the Netherlands and Italy. We will specifically investigate the effectiveness of the conventional physical trainer with the one using recommender engine in terms of adherence to the exercises and gained health improvement.

4 References

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Contact information

Mohammad Hossein Nassabi: m.h.nassabi@utwente.nl

Telemedicine Group, University of Twente, P.O.Box 217, 7500 AE Enschede, The Netherlands