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Towards a Personalized Business Services Recommendation System Dedicated to Preventing Frailty in Elderly People

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Abstract. Frailty is a clinical syndrome associated with ageing that characterizes an intermediate state between robust health and loss of autonomy. To preserve the abilities of older adults and prevent dependency, it is important to identify and evaluate their frailty. This approach is part of a dependency prevention strategy, based on a thorough understanding of their medical, social, and living environment. This understanding is usually acquired through significant data collection using standardized evaluation surveys. The obtained data is then analyzed to provide personalized recommendations for the beneficiaries' lifestyles. Our article presents the concept of frailty and a personalized recommendation system aimed at helping citizens prevent frailty. This system uses an innovative self-assessment approach designed for older adults, without necessarily involving healthcare professionals.

Keywords: Recommendation systems · Elderly · Frailty · Recommendation algorithm · Personalized recommendations

1 Introduction

As the global population ages, preserving physical, cognitive, and psycho-social abilities is essential for healthy aging. Age-related declines in these abilities can lead to frailty, a syndrome characterized by a decline in physiological systems, a decrease in functional reserves, and vulnerability to stress [4]. Unlike disability, frailty can often be reversed or minimized with personalized interventions [16] aimed at preserving abilities.

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Managing frailty involves a three-step process, including frailty screening and the definition of a personalized intervention plan, as well as follow-up to prevent or delay disability and dependence and improve the quality of life of elderly individuals [8]. Several European countries, including France, are developing innovative solutions for elderly individuals and their caregivers to improve their quality of life in the context of the Silver Economy [5]. Our work is aligned with this goal of promoting « Successful Ageing » and behaviours that promote good health by creating a personalized service recommendation engine for the prevention of frailty.

In this article, we provide an overview of the medical context and issues related to population ageing that motivated our research. We also discuss the link between frailty and intrinsic capacities. In the third section, we present our innovative recommendation platform, « Senselife », which is based on a thorough analysis of user profiles and provides personalized recommendations for services to meet their specific needs. Finally, we conclude the article by summarizing our results and discussing future perspectives for practical applications to improve the quality of life of elderly individuals.

2 Context

In order to comprehend the driving forces behind our research and the obstacles to be surmounted in advancing a recommendation engine, it is necessary to acquire a foundational understanding of the medical knowledge surrounding the factors that contribute to loss of autonomy in older adults, as well as how this can be addressed in an ongoing process of care.

2.1 Frailty and Intrinsic Capacities

The syndrome of frailty is characterized by a decline in physiological reserve capacities that impact adaptation mechanisms to stress. Psychological, social, economic, and behavioural factors, as well as comorbidities, influence its clinical manifestation. It is linked to increased mortality risk, disability, falls, hospitalization, and institutionalization [12]. Consequently, early interventions to prevent the progression of frailty and disability are crucial. Frailty evaluation allows older adults to be classified into three categories: robust, pre-frail, and frail.

Prevalence of frailty and pre-frailty in EU countries is around 15% and 50%, respectively, among those aged 65 and older based on the study [13].

The concept of intrinsic capacities (IC) was introduced by the World Health Organization (WHO) to enable a more comprehensive and suitable evaluation of the ageing population. IC refers to the sum of all physical and mental abilities an individual can use throughout their life and includes five domains that summarize their capacities [1].

Understanding the relationship between IC and frailty is crucial. Indeed, frailty is a state of vulnerability that can occur in elderly people due to a decrease

in intrinsic capacities. Thus, intrinsic capacities are the basic capacities that an elderly person needs to function independently.

Detecting and evaluating frailty is challenging due to the variety of available measurement tools. A review by [6] identified 29 different measures, ranging from simple screening instruments to complex ones. Meanwhile, the assessment of intrinsic capacities (IC) in older adults is a growing field. A proposed scoring system by [9] assesses IC in older adults and highlights the complementarity between measuring frailty and IC. Conducting a comprehensive evaluation of both frailty and IC is crucial for enhancing the quality of life and well-being of older adults.

2.2 Frailty Personalized Intervention Plans Implementation Challenges

To manage frailty in older adults, a personalized intervention plan involving collaboration between multiple stakeholders is necessary (up to 13 actors can be included) [2, 15]. However, its implementation can be complex and resource-intensive, limiting accessibility to a significant number of older adults.

Creating a personalized intervention plan for frailty in older adults requires a comprehensive evaluation of the individual's situation, including measures of intrinsic capacity and frailty. Identifying available services and personal information, such as preferences and history, also play a crucial role in developing an effective plan.

To develop an accurate and dynamic personalized intervention plan, a decision support system capable of recommending services taking into account their medical, social, and environmental profile would be useful. To this end, we will present our recommendation platform, called **Senselife**, in detail in the following section. It will enable an interactive, precise, and personalized response to the specific needs of each older adult, based on their frailty situation and personal preferences.

3 Senselife Platform

The goal of the Senselife platform is to address the challenge of managing frailty in older adults by utilizing self-evaluations to provide personalized recommendations tailored to their needs and preferences. The platform offers a variety of features such as the ability for users to express their living conditions and match supply and demand for services. Additionally, it provides a selection of services aimed at strengthening the functional abilities of older adults based on their intrinsic capacity. However, the platform needs to define and use knowledge to create tailored recommendations. This requires identifying key knowledge to characterize users and services, representing it, and integrating it with the software structure to improve recommendations. The scheme of the platform is illustrated in Fig. 1, which is composed of three main components: data collection,

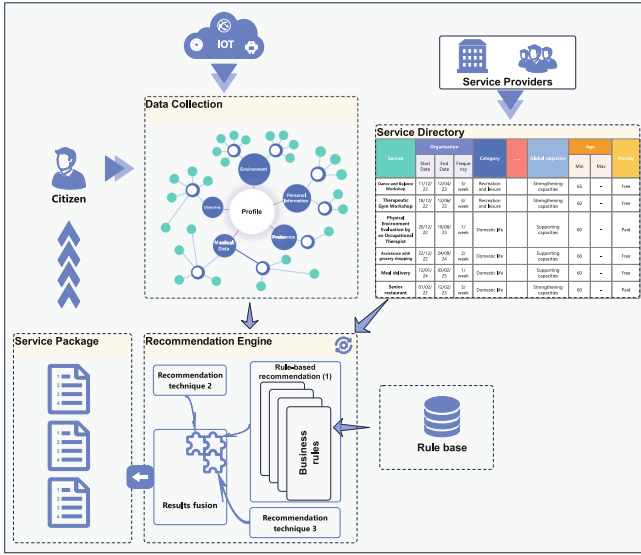


Fig. 1. Senselife Platform

recommendation generation, and services consumption. Citizen satisfaction and service utilization are used to adapt future recommendations.

The platform’s recommendations will heavily rely on the data it collects. The primary sources of this data will be the citizen’s self-evaluation survey responses and connected devices. The survey’s questions are chosen from different frailty surveys. They were selected based on whether the citizen can answer them alone (for example, ADL¹ questions) and whether they provide an understanding of the user’s condition. Additionally, service providers are responsible for defining their services on the platform, which is the second input for the recommendation engine.

The collected data will feed the recommendation engine, which will present the citizen with a list of services that meet their needs, factoring in their personal characteristics and preferences.

3.1 Citizen Profile

In the context of recommendation, user profiling is the process of collecting and analyzing information about users to understand their preferences, habits, and behaviors. It is a key element in improving the relevance and quality of recommendations [7]. To this end, we have developed a conceptual model of the user profile for our platform, which is the elderly citizen in our case. This

¹ ADL: Activities of Daily Living survey.
<https://www.alz.org/careplanning/downloads/katz-adl.pdf>.

model takes into account all relevant elements to characterize the citizen while remaining extensible. As shown in Fig. 2a, a citizen profile consists of 5 parts:

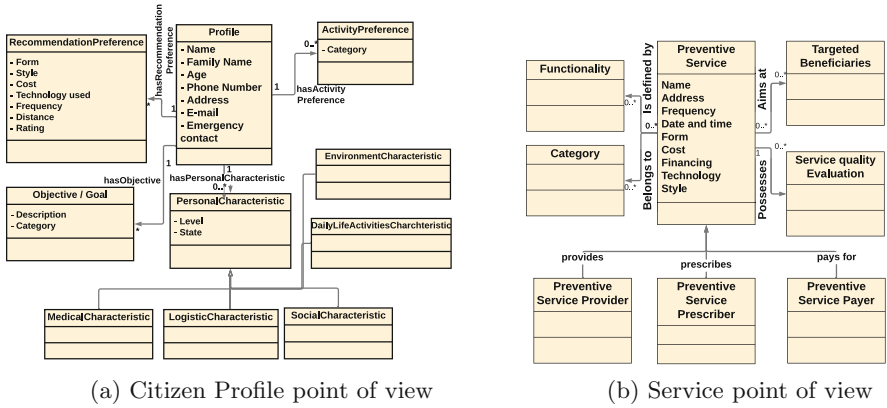


Fig. 2. Excerpt from the Senselife meta-model

- **Personal Information:** This section contains the citizen’s personal data, such as age, name, phone number, address, etc.
- **Goal:** This section describes the person’s overall goal. This information helps the recommendation engine to better understand the person’s motivations and establish a link with their intrinsic capacities. For example, the goal of “establishing new friendships” can be associated with the category “Social relationships” which is linked to psychological capacity.
- **Activity Preferences:** This section provides more details on the person’s activity preferences and their respective category.
- **Recommendation Preferences:** Helps the recommendation engine to filter the recommended services based on the person’s preferences, for example, by specifying a preference for well-rated services.
- **Personal Characteristics:** Are obtained from responses to the survey and can be classified into different categories of IC. For example, the characteristic “Vision problem” can be identified from the “Comprehensive Geriatric Assessment” survey [11] and is associated to the visual capacity [10].

Although our platform can generate an estimated frailty score based on the data collected, it’s essential to acknowledge that this score may not be as accurate as those obtained by healthcare professionals. For example, the 6 questions of the ADL survey can help us to understand a specific aspect of the person and have a frailty score on a scale of 6. Other scores are also calculated which will give us more comprehension about the person. In summary, our primary goal is to gather information about the citizen to better understand their situation and develop personalized recommendations, rather than providing an exact frailty score.

3.2 Services

Service providers are responsible for creating services on the platform. We offer a service model that will assist providers in creating their services while enabling the recommendation engine to efficiently comprehend the input data. Figure 2b displays this model.

- **Service attributes:** General information about the service. This information is crucial for grouping available services. It can also be used to filter options and help elderly people make their choices.
- **Targeted Beneficiaries:** The group of citizens targeted by this service. It is important to note that some services may be limited to specific profiles.
- **Functionality:** There are various interventions, such as multimodal exercises, that contribute to multiple domains of IC. Therefore, when defining the service, the provider can specify the domains affected by this service.
- **Category:** Services can take various forms, whether as autonomous activities performed by the individual, products provided, or services provided by other individuals or organizations. This will allow for more effective identification of services that meet the specific needs of the elderly person.
- **Service quality evaluation:** Service quality is crucial for recommendations. Evaluations help assess quality, allowing beneficiaries to judge and future beneficiaries to gain insight.

3.3 Recommender Engine

The Senselife platform employs a recommendation engine that provides services for frailty prevention. With the help of algorithms, this recommendation engine suggests specific services to elderly individuals based on their personal information and circumstances. The engine evaluates the data provided by the elderly person and suggests the most relevant services using the knowledge bases and the rule base available. The knowledge base contains the different personal characteristics, needs, the service types and the relation between them. The rule base contains the rules that will be used to manipulate the data in the knowledge base. The validation of this rules are based on the expertise of the health-care professionals.

There are various recommendation techniques, such as collaborative filtering algorithms, content-based algorithms, and knowledge-based algorithms. The choice of algorithm depends on the specific requirements and objectives of the recommendation system [14]. Our recommendation engine uses a knowledge-based recommendation technique that enables increased personalization. This technique analyze information about users, items, or their relationships to suggest relevant items using a knowledge base. This approach infers the relationship between a user's needs and a possible recommendation, as explained in [3].

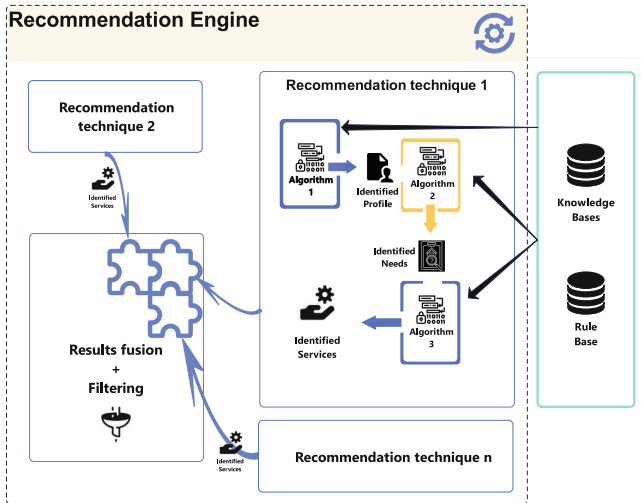


Fig. 3. Recommendation Engine overview

When we zoom-in on Fig. 1 in the recommendation engine section, we can see Fig. 3, which provides a schematic representation of the knowledge-based recommendation technique. Ultimately, the elderly person receives a filtered recommendation based on their preferences.

4 Conclusion and Perspectives

The article focuses on the vulnerability of elderly people and suggests personalized service recommendations for frailty prevention. The proposal is a recommendation platform that assesses the older person in a multidimensional way, taking into account both intrinsic abilities and measures of frailty.

This approach is crucial in understanding an individual's needs to determine the most suitable services. The platform uses a self-evaluation approach, which is user-friendly and accessible to everyone. The recommendation technique of the engine is presented (knowledge-based one), with an explanation of its different steps and the knowledge bases used.

The platform provides a holistic solution to ensure that elderly people receive the necessary support without relying solely on healthcare professionals. To achieve this goal, the approach requires attention to various aspects. We identify several research avenues for future work, including validating citizen and service profile models, verifying the effectiveness of the incremental approach, and considering the optimization and complexity aspects of the algorithms used by the recommendation engine.

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