

## Virtual Coaching Activities for Rehabilitation in Elderly

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Deliverable

### D4.7 Pattern recognition SW component, final release

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<b>Lead beneficiary:</b>	FZI
<b>Lead author:</b>	Jin Liu
<b>Co-author:</b>	Steffen Thoma
<b>Reviewers:</b>	Massimo Caprino (CCP), Sofoklis Kyriazakos (AU), Kai Gand (TUD), Hannes Schlieter (TUD)

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## Executive Summary

**D4.7** presents the final results for pattern recognition algorithms developed in WP4 for the knowledge layer, which is based on the first release of pattern recognition in **D4.6**. Since **D4.6** has been revised intermediately according to the reviewers, **D4.7** is based on the revised version of **D4.6**. **D4.7** focuses on the personalization of clinical pathways, where patterns found in the semantically integrated patient data (including relevant telemonitoring data from the patient's environment) are exploited to personalize the pathways for the patient's well-being and health development. Compared to **D4.6**, we added further pattern recognition features for time series data to **D4.7**, namely context-aware recommender and pattern recognition in telemonitoring app. The machine learning algorithms for pattern recognition are finally evaluated with other software components in the Knowledge Layer in **D4.8**.

In order to best present the developed algorithms, **D4.7** first thoroughly discloses possible personalization potentials with respect to the clinical pathways generated in the pathway modeller (see **D6.2**) and processed by the wrapper (see **D6.3**). In the Techlab phase, we have identified two personalisation points, namely activity recommendation within a pathway and frequency personalisation for game-related pathways. In the Livinglab and Pilot phases, these two personalisation points are not further developed, due to the lack of training facilities and requirements from clinicians. In the Livinglab phase, we identified further personalisation points in the realm of processing time series data and recommender systems, namely the personalisation of threshold values in the pathways and the recommendation of E-Learning videos. We included all four personalization points in this deliverable **D4.7**.

In the third part of this deliverable, we give an overview of the fundamental theories and frameworks of the machine learning algorithms applied in the Knowledge Layer for pattern recognition. In the first section, we explain the idea of our SAIL approach, which is realized with OpenAI Gym Environment with simulated data for activities recommendation in the Techlab phase. Following the SAIL approach, we introduce the contextual bandits algorithm for personalization and recommendation. The contextual bandits algorithm is implemented with Vowpal Wabbit tool, an open source framework from Microsoft Research. The general idea of the contextual bandits model and off-policy learning are explained briefly. The SAIL approach and contextual bandits algorithm are both based on reinforcement learning. Due to the fact that we have various health-related monitoring data, we explain typical pattern recognition algorithms and applications for these data from the time series perspective.

In the last part, we show use cases applying above mentioned algorithms in the Knowledge Layer for pattern recognition. Since data collection is critical for machine learning, we first show the collected and used data of the different phases, from the Techlab to the Pilot phase. For the SAIL approach, we show a use case with simulated data for recommending aerobic physical activities, which is developed in the Techlab phase. We have not further integrated the SAIL approach into the overall vCare system due to the encountered insufficient amount of training data. Therefore, we integrated contextual bandits as a machine learning approach that needs less training data. We further implemented the guarantee of safety in our recommendations. We show safety critical recommendations with personalization for the daily number of steps and safety uncritical recommendation case with E-Learning video

recommendation. Both cases are based on the contextual bandits algorithm. The contextual bandit algorithm is a simplified method of the original SAIL approach, which reduces the parameterization of action space and reduces the step in the Markov Decision Process to 1. This leads to the reduction of needed training data.

In the following Table, we list the changes of pattern recognition in **D4.7** compared to **D4.6**.

*Table 1: Pattern recognition components added to D4.7 in replacement of activities recommendation*

<b>Components added in D4.7</b>
Context aware recommendation <ul style="list-style-type: none"> <li>• Daily steps recommendation</li> <li>• E-Learning video recommendation</li> </ul>
Pattern recognition with Time Series Data <ul style="list-style-type: none"> <li>• Trend in weight/blood pressure data detection</li> <li>• Weight/Blood Pressure data prediction</li> </ul>

A demo can be accessed here: <https://wisecloud.wiwi.tu-dresden.de/s/8vdoeOhYGjQqM9h>