

Nordic AI Meet 2026

P2: AI in Health, Medicine, Care & Human Well-being

3. An Explainable Knowledge-Based AI Framework Using Nested Fuzzy Inference for Healthy Living in Older Adults.

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Abstract: Background: Artificial intelligence (AI) is increasingly being adopted across healthcare; however, its use in clinical decision support remains constrained by limited transparency, dependence on large training datasets, and the "black-box" nature of many learning algorithms. Simultaneously, wearable sensors and smart monitoring devices are generating large volumes of heterogeneous health data that are difficult for clinicians and end users to interpret. Consequently, there is a growing need for explainable AI systems capable of transforming multimodal sensor data into meaningful, clinically interpretable knowledge.

Objective: Develop the conceptual architecture of ALIVE, a multimodal, knowledge-based AI platform designed to support older adults with complex health conditions in maintaining an active, safe, and independent lifestyle at home.

Method: Following a system development methodology, the conceptual architecture was designed by integrating wearable activity monitoring, environmental sleep sensing, user profiles, and personalized goals into a unified digital platform. Development steps: definition, implementation, integration, verification, validation and deployment. The platform is implemented in two phases: 1. Self-assisted mode, where users review the translated health summaries before choosing an intervention; 2. Autonomous mode, where the fuzzy inference engine generates interventions directly. Development is ongoing, with ethical approval for phase 1.

Results: The proposed architecture establishes an explainable decision-support framework that combines clinical knowledge with fuzzy reasoning to manage uncertainty inherent in real-world physiological data while maintaining transparency throughout the decision-making process. A knowledge translation mechanism converts heterogeneous sensor-derived biomarkers into understandable health summaries and personalized lifestyle interventions. The processing pipeline performs preprocessing, fusion, and biomarker interpretation for the summaries; subsequently, the information is analysed using a nested fuzzy inference system incorporating expert-defined clinical rules to generate personalized lifestyle recommendations. Lessons learned include integration of clinical feedback, translation of terminology, and interdisciplinary challenge resolution. During the definition step, system explainability and transparency had to be defined in a manner that aligns clinical and technical requirements.

Conclusion: The work illustrates how knowledge-based AI design can enable trustworthy, explainable, and personalized digital lifestyle platforms for older adults. By integrating multimodal sensing with clinically interpretable knowledge translation, the architecture provides a scalable foundation for future telecare systems that prioritize transparency, clinical acceptance, and healthy ageing.