AI-MAS Group

Computer Science & Engineering Department

Combining Knowledge and Data Driven Context Inference in Ambient Intelligence Applications

Coordinators **Nr. Students**

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1. Introduction

The domains of Ambient Intelligence (AmI) and Active and Assisted Living (AAL[1]) are seeing increasing interest and practical development at levels of both research and innovation.

In both domains, one of the often encountered problems is that of recognizing activities of daily living (ADL - e.g. sleeping, toileting, preparing food, eating, watching TV).
Recognizing and monitoring these activities is especially useful in extending the care for elderly people at their own home. It allows senior citizens to increase their autonomy and keep living in familiar surroundings, while also ensuring that family members and caregivers can remotely follow up on the daily well being and the activity habits of the senior person.

The AI-MAS laboratory has been active in recent years in projects which seek to develop platforms for health and home monitoring of senior (CAMI[2]), as well as general frameworks (CONSERT[3]) that enable context-aware processing of information in AmI and AAL applications .

The CONSERT Engine has been recently refactored [1] to work over a well-known Java-based complex-event processing engine: DROOLS Fusion[4].
The refactored engine was tested over two instances of the CASAS ADL Dataset[5], the task being to recognize ADLs such as cooking, cleaning, watching TV, refilling pill dispensers, based solely on binary sensor activations (e.g. motion sensors, item presence sensors) While for some instances the activities can be well identified using prior domain knowledge about how they w*ould be executed* [1], for others the degree of variability is too large among users to be pinned down using a knowledge-driven decomposition of sensor activations.

Therefore, the aim of this research proposal is to incorporate data-driven inference capabilities into the context inference process. The purpose is to develop online-learning based algorithms that can in time *learn* the pattern of sensor activations for individual activities and individual users. These must then be coupled with knowledge-driven

1 AAL: http://aal-europe.eu
2 CAMI project: http://camiproject.eu
3 CONSERT project: https://aimas.cs.pub.ro/consert
4 DROOLS: https://goo.gl/LarFtf
5 CASAS Dataset: http://casas.wsu.edu/datasets/

approaches that can, for example, precisely cue, when a shift in context has happened (e.g. by change of position from one room to another).

2. Objective

The main objective of this research proposal is to investigate and implement data-driven and online-learning based activity detection algorithms, that augment the knowledge-driven inference capabilities that already exist in the CONSERT Engine.

Specifically, tasks in the proposal consider the following:

- **Milestone 1**
  - Understanding of the CONSERT knowledge-driven information flow
  - Research, understanding and pre-processing of datasets for ADL detection, categorized by type of sensors used and whether sensor faults are present or not
  - Research into data-driven algorithms for activity recognition and combinations of knowledge-driven and data-driven approaches to ADL recognition using binary sensor streams or body-worn sensors. Focus should be given to issues dealing with activity interruption or interweaving of activities that trigger similar sensors.

- **Milestone 2**
  - Design of the methodology for training data-driven algorithms for ADL. How is the cold start problem handled?
  - Design the architecture and configuration options of the reasoning engine which specifies how each type of activity is detected.
  - Implementation of the augmented, data-driven + knowledge-driven approach into the existing CONSERT framework.

- **Milestone 3**
  - Testing of the combined platform on hand of various recorded AmI scenario datasets
  - Testing of the combined platform on hand of driving context scenarios, stemming from an application for assistance in autonomous driving. Prior research is expected to define what exactly constitutes relevant context for an autonomous driving solution.

3. Required and Learned Skills

Requirements:

- Comfortable programming in Java and Python
- Basic knowledge of Machine Learning is a plus
- Minimum 16h per week availability and a proactive mindset are appreciated
- Love for software architecture design is a plus

Skills learned:

- Experience working with sensor data streams
- Experience working with robotics frameworks
- Experience working with Machine Learning libraries and developing and testing data driven inference mechanisms for recognizing Activities of Daily Living (ADL)
- Experience in software architecture design and integration of new code into existing solutions
- Experience working in a research project
- Support and guidance for writing academic research papers

4. References

[1] Mihai Trăscău, Alexandru Sorici, Adina Magda Florea. Detecting Activities of Daily Living Using the CONSERT Engine. In Proceedings of the 9th International Symposium on Ambient Intelligence (ISAmI 2018). In print.