

Abductive Reasoning with Minimal Sensing in a Home Environment

1 - Context and funding

The thesis is equally funded by **ANR** (*Agence Nationale de la Recherche*) and **elm.leblanc**, one of the leading home automation system vendors. One of the main technical challenges in modern home automation is to use Artificial Intelligence (AI) to minimize the energy consumption of technical systems without loss of comfort. For instance, the production of hot water can be optimized by dynamically adapting the temperature of water and the time of use of the boiler based on activities monitored in the home. The general objective of the thesis is to monitor human activities without ubiquitous sensing capabilities.

2 - Research project

The domain of research of the thesis is **knowledge representation and reasoning**, a subfield of AI. Its objective is to evaluate abductive reasoning methods over sensor measurements performed in a home environment. Abductive reasoning in this context consists in finding logically sound hypotheses (e.g. 'the dishwasher is on') that explain observed sensor measurements ('electric consumption has risen in the last two hours') according to a model of human activity in a home.

The baseline assumption of the thesis is that only **minimal sensing is available in the home**, as is the case in most homes today: smart meters provide aggregated values (every hour/day) but no information is available per room. Abductive reasoning is expected to help optimize home automation systems without relying on some ubiquitous sensing apparatus (which raises environmental, technical and privacy-preservation questions).

Several abduction mechanisms will be evaluated, including **Abductive Logic Programming** (for an exhaustive exploration of hypothesis space) and **neural-symbolic integration methods** (for a probabilistic exploration of hypothesis space).

3 - Team supervision and PhD registration

The position is located at **Mines Saint-Étienne**, with regular contact with R&D teams of elm.leblanc (Drancy) as well as researchers at IMT Nord Europe (Lille-Douai). The PhD student will be part of LIMOS (*Laboratoire d'informatique, de modélisation et d'optimisation des systèmes*), a research institution based in Saint-Étienne and Clermont-Ferrand. The thesis is supervised by Antoine Zimmermann (supervisor) and Victor Charpenay (co-supervisor), both associate professors at Mines Saint-Étienne.

4 - Candidate profile

Holder of a **Master's degree in computer science or data science**. Prior knowledge in AI is expected, especially in **computational logics**, **logic programming** and/or **Semantic Web technologies**. Basic understanding of statistical inference methods and linear programming is also considered important. Technical skills required for the thesis include: multi-paradigm programming (Java, Lisp, R, Prolog, ...), data modeling (UML, OWL, E/R, BPMN, ...), Linux system administration (Bash, SSH, Docker, ...).

5 - How to apply

Send a **résumé**, a **cover letter** and a **transcript** of last two years to:

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