Proactive Intention Recognition for Home Ambient Intelligence

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Artificial Intelligence Techniques for Ambience Intelligence
Kuala Lumpur, July 18, 2010
Introduction

- Taking into account users’ preferences and needs is important for Ambient Intelligence systems to be more acceptable.
- Intention recognition enables to solve several issues, e.g. proactive support, security, emergency, in a timely manner.
- We explore a coherent combination of jointly logic programming based implemented systems:
  - **Evolution Prospection**: implements several kinds of well-studied preferences and useful constructs for decision making.
  - **Individual Intention Recognition**: performs in two stages, using Bayesian Networks and a Planner.
  - **Collective Intention Recognition**: for domains where multiple users are of concern.
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Evolution Prospection Agents - EPA

- Agents can prospectively look ahead into their hypothetical futures, in order to determine the best one to follow.

- EPA was implemented in ABDUAL, a XSB-Prolog abduction system, allows computing abductive solutions to given queries.

- Some constructs of EPA, to the extent of usage in this talk:
  - Active goals
  - Abducibles
  - Local preferences
Active Goal

At each cycle, the agent has a set of active goals to be satisfied

\[ \text{on\_observe}(AG) \leftarrow \text{Events} \]

“On observing Events trigger goal AG”

Combine with Intention Recognition: Motivation

- **Events**: dangerous intention detected  \( AG \): prevent it.
- **Events**: user intends to find sth.  \( AG \): help to locate it.
- **Events**: user intends to choose sth.  \( AG \): suggest him taking into account health conditions, preferences, agenda, etc.
Abducibles

- Each program has a set of abducibles, providing hypotheses for hypothetical solutions to a given query.
- An abducible can be hypothesized if it is expected and there is no counter-expectation.

Example

Three abducibles: \([\text{call\_police, warn\_persons, activate\_alarm}]\)

1. \(\text{on\_observe}(\text{solve\_intrusion}) \leftarrow \text{intrusion\_intention\_detected}\).
2. \(\text{solve\_intrusion} \leftarrow \text{call\_police}\).
   \(\text{solve\_intrusion} \leftarrow \text{warn\_persons}\).
   \(\text{solve\_intrusion} \leftarrow \text{activate\_alarm}\).
Local Preferences

- **A priori preferences:** prefs. over abducibles

\[ a \prec b \leftarrow \text{Precs} \quad \text{“Prefer abducible } a \text{ to abducible } b” \]

- **A posteriori preferences:** prefs. over abductive solutions

\[ A_i \ll A_j \leftarrow \text{holds \_given}(L_i, A_i), \text{ holds \_given}(L_j, A_j) \]

“\( A_i \) is preferred to \( A_j \) if \( L_i \) and \( L_j \) are true consequences of \( A_i \) and \( A_j \), respectively”

Example

3. \( \text{activate\_alarms} \prec \text{call\_police} \leftarrow \text{no\_weapon\_detected} \)

4. \( A_i \ll A_j \leftarrow \text{holds \_given}(\text{not\_annoy}, A_i), \text{ holds \_given}(\text{annoy}, A_j) \)
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Individual Intention Recognition

- **Intention recognition (IR):** process by which an agent becomes aware of the intention of others.

- **Mainstream of IR:** reducing to plan generation – generating conceivable plans achieving intentions and choosing ones matching observations.
  - Difficulty: finding the initial set of intentions.

- **Two-stage intention recognition system:**
  1. **Bayesian Networks:** computes likelihood of intentions conditional on current observations, then filter out the much less likely ones.
  2. **Planner or Plan Library:** generates conceivable plans for remaining intentions.
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Advantages of The Approach

• From likelihood of intentions, the recognizing agent can see which intentions are more likely and worth addressing first – especially important in case of quick decision making.

• Comparing to approaches using BNs solely, combining with a planer guides recognition process: which actions should be checked for whether they were or will be (maybe hiddenly) executed.
Example (Elder Intentions)

- An elder stays alone in his apartment.
- One day, the Burglary Alarm is ringing.
- IR system observes that he is looking for something.
- To assist him, it needs to figure out what he intends to find.
- Possible things are:
  - Alarm button \((\text{AlarmB})\);
  - Contact Device \((\text{ContDev})\);
  - Defensible Weapons \((\text{Weapon})\);
  - Light switch \((\text{Switch})\).
Bayesian Network for Intention Recognition
Collective Intention

- Collective intention of a group of agents is not a mere summation of individual intentions (Philosophy, AI)
  - It involves a sense of acting and willing something together.

- “Glue” amongst agents, e.g. mutual beliefs:
  - Agents have mutual expectations among each other.
  - Expectation actions should be observed, and reactions to any lack thereof.
Collective Intention Recognition Method

Searle’s Account of Collective Intention

With presuppositions of mutual awarenesses or beliefs:

a virtual plural agent has the collective intention.

Method

Collective IR is reduced to individual IR plus checking if there are actions reflecting mutual expectations amongst agents:

1. First step: From the observations infer the intentions as if these observations came from the plural agent; then

2. Second step: Figure out which of the recognized intentions is a genuine collective intention by checking if there are actions reflecting the mutual expectations between the agents.
Some Desired Features for Home AmI

- Proactively provide support for users
- Handling security situations (for Home AmI)
  - Security in terms of Burglary Alarm systems
  - Security in terms of health and well-being of residents
- Handling emergency
Proactively Providing Support

- **Aml key feature**: the systems should take initiative to help.
- In order to **proactively provide contextually appropriate help**, e.g. for elders, the assisting system needs to be able to
  1. Observe the elders’ actions
  2. **Recognize his/her intentions**, or their collective intention
  3. **Provide suggestions or help** for achieving the recognized intentions (EPA).

**Examples**

- `on_observe(suggest_a_drink) ← find_drink_intention_detected`.
- `on_observe(help_locate) ← find_TV_remote`
Security: Burglary Alarm System

• Burglary Alarm technology has been based on sensing and recognizing very last actions of an intrusion plan
  • e.g. “breaking the door”.

• It may be too late to provide appropriate protection.

• Need to anticipate possibility of intrusion from very first observed actions of potential intruders.

• Two-stage Intention Recognition:
  • From first observed actions BN computes likelihood of conceivable intentions.
  • If worrisome enough, the carer should be informed.
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**Two-stage Intention Recognition:**
- From first observed actions BN computes likelihood of conceivable intentions.
- If worrisome enough, the carer should be informed.
Security: Health and Well-being

- Aml systems need being able to prevent hazardous situations, which usually come from dangerous ideas or intentions:
  - e.g. take a bath when drunk; drink alcohol while not permitted; or even commit suicide.

- To this end, guessing their intentions from very first relevant behaviors is indispensable for taking timely actions.
Emergency Handling

• **Emergency situations**: recognizing intrusion intention; users’ dangerous intentions; detecting fire; etc.

• **Emergency handling with EPA**
  
  • An active goal for each emergency situation.
  
  • For each goal: a list of possible actions, represented by abducibles, are available to form solutions.
  
  • Take into account users’ preferences:
    
    • *a priori* prefs. for preferring amongst available actions;
    
    • *a posteriori* prefs. for comparing solutions taking into account their consequences and utility;

  • Expectation and counter expectations rules: encoding pros and cons of users towards available actions.
Summary

- We have described two systems: Evolution Prospection and Individual Intention Recognition.
- And shown how their combination are useful to tackle some issues of AmI in home environment
  - Providing proactive support.
  - Security and Emergency issues.
- We have presented a method for collective intention recognition.
Future Work

- Provide explanations for the suggestions the system provides.
- Develop an anytime, incremental intention recognition system for different issues of AmI.
Thank you!

QUESTIONS?