1 Introduction

1.1 Motivations

The social skills of modern robots are rather poor. Often, it is that lack that inhibits human-robot communication and cooperation. Humans being a social species, they require the use of implicit social cues in order to interact comfortably with an interlocutor. The primary goal of this thesis is to address this issue and create the formal foundations of a system able to help dependent people.

In order to enhance assistance to dependent people, we need to account for any deficiency they might have. An entire field of medicine and computer sciences is already dedicated to helping with the physical deficiencies. In our case we chose to address cognitive deficiencies. The main issue is that the patient is unable or unwilling to express their needs. That is a problem even with human caregivers as the information about their intents needs to be inferred from their past actions.

la transition est un peu rapide, et la mise en contexte aussi. Tu plonges directement dans le sujet et ses problématiques, en critiquant les BN et MDP, mais un lecteur extérieur ne sait même pas encore de quoi tu parles/à quoi tu t'intéresses/quelle est la problématique en IA. Il manque un paragraphe pour la mise en contexte de la reco d'intention dans l'IA, qui explique cela assez simplement. Ca ferait le lien entre ton 1.1 et les problématiques

1.2 Issues

on ne comprends pas ce qu'est external agent ici

The main issue addressed is the intent recognition problem using Artificial Intelligence (AI). The problem is simple to formulate: from observational data, we need to infer the goals and intent of an external agent. There are several ways to handle this issue. Most approaches use trivial machine learning techniques like Bayesian Networks (BN) or Markovian Decision Processes (MDP). The issue with these common approaches is that they require an extensive amount of training data and need to be trained on each patient. This makes the practicality of such system quite limited. To address this issue, some works proposed hybrid approaches using hand-made plan libraries or enforcing logical constraints on the probabilistic method.

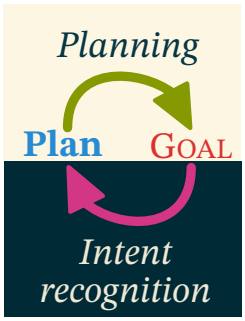
je comprends pas: tu critiques les approches hybrides ? où elles ont un intére^t ? développer

A work from Ramirez Ramırez and Geffner (2009), added an interesting method to solve those kinds of problems. Indeed, they noticed an interesting parallel of that problem with the field of automated planning. This analogy was made by using the Theory of mind Baker *et al.* (2011), which states that any agent will infer the intent of other agents using a projection of their own expectation on the observed behavior of the other agent.

quels problèmes ?

parallel between

citation nécessite ()



This made the use of planning techniques possible to infer intent without the need for extensive and well-crafted plan libraries. Now only the domain of the possible actions, their effects and prerequisites are needed to infer the logical intent of an agent.

The main issue of planning for that particular use is computation time and search space size. This prevents most planners to make any decision before the intent is already

realized and therefore being useless for assistance. This time constraint lead to the search of a real-time planner algorithm that is also expressive and flexible to accommodate for dynamic changes. c'est une problématique non évoqué encore avant: à rajouter !

1.3 Contributions

In order to achieve such a planner, the first step was to formalize what is exactly needed to express a domain. Hierarchical and lenient forms of plans to order gave the most expressivity and flexibility but at the cost of time performance. This is why, a new formalism of knowledge representation was needed in order to increase the speed of the search space exploration while restricting it using semantic inference rules.

While searching for a knowledge representation model, some prototypes were done using standard ontology tools but all proved to be too slow and inexpressive for that application. This made the design of a lighter but more flexible knowledge representation model, a requirement of the project.

Then the planning formalism has to be adapted to our general knowledge representation tool. Since automated planning has a very diverse ecosystem of approaches and paradigms, its standard, the Planning Domain Description Language (PDDL) need use of various extensions. However, No general formalism has been given for PDDL and some approaches often lacks proper extensions (hierarchical planning, plan representation, etc). This is why a new formalism is proposed and compared to the one used as standard of the planning community.

Then finally, a couple of planners were designed to attempt answering the speed and flexibility requirements of human intent recognition. The first one is a prototype that aims to evaluate the advantages of repairing plans to use several heuristics. The second is a more complete prototype derived from the first (without plan repairs), which also implements a Breadth-First Search (BFS) approach to hierarchical decomposition of composite actions. This allows the algorithm to provide intermediaries plan that, while incomplete, are an abstraction of the result plans. This allows for anytime probability computation using existing techniques of invert planning.

1.4 Plan

à compléter !