

# Information Sharing for Care Coordination

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## Abstract

Teamwork and care coordination are of increasing importance to health care delivery and patient safety and health. My research aims at developing agents that are able to make intelligent information sharing decisions to support a diverse, evolving team of care providers in constructing and maintaining a shared plan that operates in uncertain environments.

## Introduction and Research Question

The health care literature argues compellingly that teamwork is of increasing importance to health care delivery, and improved care coordination is essential to improving patient safety and health. The lack of effective mechanisms to support health care providers in coordinating care is a major deficiency of current health care systems (Leape 2012). My thesis aims to develop agents that support the coordination of teams caring for children with complex conditions (Amir et al. 2013).

Care teams for children with complex conditions typically involve many providers (Figure 1) – a primary care provider, specialists, therapists, and non-medical care givers. The care team defines a high-level care plan that describes the main care goals, but there is no centralized planning mechanism that generates a complete plan for the team or that can ensure coordination. Caregivers see patients in different times and different context of care. They are unaware of their collaborators’ complete plans, yet their individual plans often interact. Communicating relevant information among team members is crucial for care to be coordinated and effective, but doing so is costly and often insufficient in practice.

My research on information sharing for care coordination aims to develop agents capable of assisting care providers in ensuring that their individual treatments plans mesh. Such agents would support caregivers with multiple responsibilities, and therefore limited time, by identifying from the large, heterogeneous body of information each has individually that portion most relevant to share, and determining those caregivers with whom it is important to share it.

Such agent capabilities are beyond the current state-of-the-art of AI information sharing techniques. BDI approaches to multi-agent planning, e.g. STEAM (Tambe

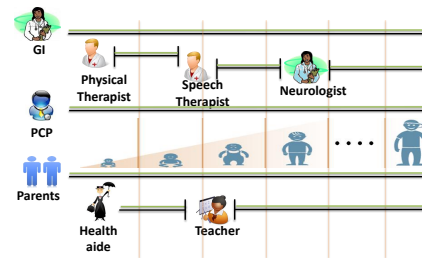


Figure 1: The care team for children with complex conditions.

1997), often base their communication mechanisms on theories of teamwork and collaboration (Grosz and Kraus 1996; Cohen and Levesque 1990; Sonenberg et al. 1992). These approaches, however, typically do not reason about uncertainty and utilities that are prevalent in the healthcare domain. Decision-theoretic approaches to multi-agent communication typically reason about communication within a POMDP framework (Goldman and Zilberstein 2003; Roth, Simmons, and Veloso 2006; Pynadath and Tambe 2002; Xuan, Lesser, and Zilberstein 2001; Spaan, Gordon, and Vlassis 2006). However, these approaches assume that all possible observations are known in advance and that the team has a joint policy. In contrast, in the healthcare domain new information that was unexpected at planning time is often observed. In addition, care providers only agree on high-level goals and team members individually plan ways to accomplish the tasks for which they are responsible. Therefore, it cannot be assumed that agents know the complete plans or policies of their teammates.

## Timeline

**Progress so far.** I have conducted interviews with care providers and parents of children with complex conditions and made observation studies in the complex primary care clinic at Stanford. Based on the information gathered from these interviews and observations, I have started working on both theoretical multi-agent systems challenges and implementing an application for the healthcare domain. On the application side, I started designing a prototype for “Goal-Keeper” (GK), a system that would support the care team of

children with complex conditions.

As a first step in the theoretical work, we formally defined the information sharing problem that arises in the healthcare domain as the “Single Agent in a Team Decision” (SATD) problem (Amir, Grosz, and Stern 2014). Informally, SATD can be described as follows: an individual collaborating in a multi-agent team obtains new information, unanticipated at planning time. This (single) agent has incomplete knowledge of others’ plans. It must decide whether to communicate this new information to its teammates, and if so, to whom, and at what time. SATD differs from previously studied multi-agent communications problems in that it does not assume complete knowledge of other agents’ plans or policies nor that all observations are knowable in advance. It assumes instead that agents have some knowledge of each other’s intentions and plans which can be used to reason about information sharing decisions.

To address this problem we proposed an integrated Belief-Desire-Intention (BDI) and decision-theoretic (DT) representation, “MDP-PRT”, that builds on the strengths of each approach. This approach integrates the Probabilistic Recipe Trees (PRT) representation of an agent’s beliefs about another agent’s plans (Kamar, Gal, and Grosz 2009) with a Markov Decision Process (MDP) to support a collaborating group in their execution of a plan. Results from empirical evaluation show that it outperforms the inform algorithm proposed by Kamar et al. (2009) and that it obtains results close to those obtained by this Dec-POMDP policy despite lacking a coordinated policy that considers all possible observations.

**Expected progress by the workshop.** I am currently working on an initial “Wizard of Oz” pilot study with two families of children with complex conditions and three of their care providers to simulate the use of GK. In this study, parents and their providers will form care plans for the child and parents will submit these status updates about the child’s condition to the system. The status updates will be reviewed by the participating care providers who will identify the information that is important to them and at the time they would have wanted the system to inform them. Similarly, parents will be presented with different summaries of the data and asked about their preferences. This study will help us to better understand the needs of care providers and patients’ families and will inform the design of GK and the information sharing algorithms.

Another question related to information sharing in the context of collaborative plans is how to convey changes in plans to team members. We hypothesize that the effectiveness of different methods for communicating changes in plans will depend not only on the extent of changes in the plan, but also on the extent to which the agent deploys context and information about an individual’s role in the plan in designing its communication. We are currently designing an initial study to explore this question in order to develop an intelligent interface that would be capable of familiarizing team members with the team plan as it evolves in an effective way. By July, I expect to have results from preliminary experiments.

**Future research directions.** Next year (Fall 2014-Spring

2015) I plan to integrate information sharing algorithms and plan elicitation mechanisms into GK and run small-scale experiments with larger groups of families and care providers. I will iterate between experimenting with new GK capabilities and refining the algorithms and representations based on these experiments. In my final year (Fall 2015-Spring 2016) I will focus on evaluating GK with larger scale experiments in the healthcare domain and writing my thesis.

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