

# Short Term Scientific Mission Report

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## Abstract

This report summarizes the outcome of the short term scientific mission (STSM) undertaken by Marija Slavkovik, a PhD candidate at the University of Luxembourg, to the Univesitá degli Studi di Torino (21st March to 28th March 2010). The host in the Univesitá degli Studi di Torino was Prof. Dr. Guido Boella.

## Visit Objective

The main objective of the visit was to develop a framework for group goal dynamics that allows for agents beliefs to be utilized when a group goal is chosen or revised.

The relations between individual goals and belief change have been studied by distinguishing various commitment and intention strategies. However, an analogous general framework to specify or analyze how group goals are related to the beliefs that the group members hold, or group informational attitudes in general, is still lacking. Existing theories of joint intentions and group decision making protocols focus on the formation of group intentions and the distribution of the such over the individual agents to fulfill the group goal. These theories do not consider the aggregation of individual goals and informational attitudes into account during the commitment and intention reconsideration. For example, it is often assumed either that all agents of the group have the same beliefs, or that the communication among agents is successful in persuading a receiver about the conveyed information. The situation when the agents have different beliefs and goals is not considered, and we focused on making the first steps towards filling in this gap by judgment aggregation for the task of group goal selection.

My PhD thesis focuses on developing judgment aggregation procedures for the use in multi-agent systems. Judgments are true or false valuations assigned to the elements of a set of formulas by agents. This set of formulas is called an agenda. Judgment aggregation is a field of social choice that studies how to aggregate sets of judgments rendered over the same agenda by a set of agents. Judgment aggregation enables for an argued (by reasons) decision to be

selected from a profile of argued decisions. This type of aggregation is well suited for the problem of selecting a group goal supported by group endorsed beliefs in such a manner that the group goal and beliefs are representing the individual goals and beliefs of the agents in the group. A judgment aggregation function is a mapping from profiles of individual judgments to collective judgment sets. The judgments (individual and collective respectively) are interrelated via a decision rule.

## Outcomes

We developed a model for group goal selection and change. Our model combines modal agent logic with judgment aggregation. There are three reasons why these two formal theories fit well together in a formal framework for goal change:

1. We can map the distinction between beliefs and goals in modal agent logic to the distinction between premises and conclusions in judgment aggregation.
2. Both of the theories are highly abstract theories that do not make many assumptions about the nature of goals or judgments.
3. Both of the theories use logic as their representation language, which makes it easier to combine modal action logic with judgment aggregation than with, for example, Arrows social choice theory.

We were able to extract three challenges that need to be handled in order to successfully combine modal agent logic with judgment aggregation for the purpose of modeling goal dynamics.

1. Properties relating goals with beliefs are expressed in the logic, whereas the properties relating individual to collective judgments are not.
2. Many properties in agent theory are not expressed in a logic either, for example the properties of belief dynamics expressed in theories of belief revision. In general, the properties of judgment aggregation and modal agent logic are of a different kind, and were initially developed for a different purpose.
3. While the modal agent logic had Kripke semantics, judgment aggregation utilizes functions which are not part of the representation language.

We outlined the following three main tasks ahead in merging agent logic and judgment aggregation for the purpose of combined revision of group goals and group epistemic attitudes :

1. Revision strategies. The commitment strategies define when to reconsider intentions, but they do not tell us how to change them. This is the first main challenge in our combination of modal agent logic and judgment aggregation.

2. Multiple goals. Judgment aggregation is developed to deal with a single conclusion. We need to consider what happens when a group is pursuing a goal and new information indicates that a higher priority goal previously dropped had become available.
3. Judgment aggregation procedure. For the adoption of the group goals and as part of the revision strategy, we need to decide which judgment aggregation procedure to use. The main quest is to find a judgment aggregation procedure which is deterministic.

We propose a general formal language that is able to represent both agents judgments (on goals and beliefs) and allow for reasoning about a change in information over time. We extend on the theory of commitment to a goal and make it applicable to a group setting. We propose four revision strategies that a group of agent can adopt to change its goals and beliefs in light of new information and de-committing. We propose a method for handling multiple goals by introducing a priority hierarchy among the goals.

## Conclusions and further work

We are preparing a submission for CLIMA (<http://centria.di.fct.unl.pt/events/climaXI/>) on the topic of using judgment aggregation for group goal selection and revision. For the time being we are focused on existing judgment aggregation procedures, however we are aware that the properties of the existing judgment procedures are not ideally matched for the problem of group goal dynamics.

Future collaboration will be focused on extracting the properties of judgment aggregation procedures that are desirable for the group goal change utilization and develop judgment aggregation procedures aimed specifically for the group goal change task.