Influence of Human-AI Team Structuring on Shared Mental Models for Collaborative Decision Making

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Human collaboration with AI-based systems is premised on performance augmentation. As highly effective human teams develop and utilize a Shared Mental Model (SMM), this theory is being tested for humans and AI agents. This paper highlights some of the conditions under which SMMs in HAI teams have been studied, in the context of team structuring, and lays out a discussion for exploring them in more realistic and complex hierarchical teaming situations. We also highlight the factors affecting SMMs of different members in the team and identify challenges that must be overcome to study SMMs within decision hierarchies.

Status Quo: SMMs for HAI teams

Complementarity — Reduced human workload — Calibrated trust — Fulfill highly complex task objectives

- Humans **understand the world** by constructing working models of it in their minds, called **Mental Models**.
- Human teams are most effective when members of the team utilize a SMM i.e., **shared understanding of goals and actions** through **effective communication and dynamic understanding** of the task, team, and situation.
- Like human teams, it is hypothesized that **human-agent teams may also benefit from SMMs**.
  <u>Current research focuses on identifying the impact of humans and AI possessing mental models of each other and their shared tasks, and how this shared understanding impacts performance outcomes and workload experienced by human decision makers.</u>
- One study found that when multiple robots in a virtual collaborative task had a SMM, then there was maximum benefit from the collaboration.
- SMMs comprise of **Task** and **Team models**. It has been observed that when both the human and AI agent possess the similar task models and a mutual team model, there is maximum benefit in performance and human workload, when compared to teams with only a task model or a team model.
  <u>However, SMM studies have largely been conducted under the premise that humans and AI agents operate as peers!</u>

Factors affecting SMMs

Peer HAI Team		Hierarchical HAI Team	
Capabilities	**Challenges**	**Capabilities**	**Challenges**
Troubleshooting is easier	Risk of information overload	Tasks can be broken down and distributed	Decision making is slower
Decisions are made faster	Strategic and operational decisions are made by the human	Can leverage individual strengths	Difficult for higher level operators to keep track of each team member
Reduced communication requirements	Risk of greater individual workload	Reduced risk of information overload	Troubleshooting is difficult
Each agent works on common goals and information	Task decomposition is more challenging	Reduced workload experienced by individuals	Team efficiency depends heavily on timely and effective communication
Easier to establish mutual awareness	No task breakdown/simplification	Strategic and operational tasks are separated	Partial awareness in individuals may cause lack of contextual understanding

Needs and Challenges

Why study hierarchical teaming? What are the challenges?

- Studying SMMs for hierarchical HAI teams will help us **understand the conditions under which the SMM hypothesis holds.**
- With increasing AI integration, teams will organize themselves in more complex ways which would depend on the nature of the task and the context of operations.
- Studying SMMs for complex team structures will help understand **if AI integration** in everyday workplaces, and other critical environments such as the military or medicine, **is truly possible** and what are the **necessary prerequisites to achieve effective collaboration** with AI integrated systems.
- With **capabilities of AI agents that are quite different from their human counterparts**, the question of how SMMs be effectively established and maintained in a dynamically evolving environment remains challenging and hard to overcome.
- **Measurement techniques that quantify the mental models** of both the human and AI systems, **metrics** that capture mutual awareness, and the **dimensions across which mental models should be measured** vary as per the context, goals and the missions that the teams are engaged with.