Workshop on the attribution of cognitive abilities to vehicles

Serge Thill
Interaction Lab
University of Skövde
54128 Skövde, Sweden
serge.thill@his.se

Azra Habibovic
Maria Nilsson
Viktoria Swedish ICT
Lindholmspiren 3A
41756 Göteborg, Sweden
azra.habibovic@viktoria.se
maria.nilsson@viktoria.se

Maria Riveiro
Skövde AI Lab
University of Skövde
54128 Skövde, Sweden
maria.riveiro@his.se

INTRODUCTION

Humans tend to modulate their behaviour based on beliefs about the agent they interact with [2], including cognitive abilities. This remains true when interacting with robots [16, 6] and, as some of our previous research has shown, interactive vehicles [11]. Present-day and future cars arguably offer skills and abilities that one would normally ascribe to intelligent agents, either contributing to the driving task in many ways (*e.g.* adaptive cruise control [7]; congestion assistance [15]), or even taking it over entirely. It can reasonably be expected that humans either are already treating cars as intelligent agents or will do so in the near future.

It is important, in this context, to highlight the distinction between perceived (or attributed) and actual intelligence: the vehicle may well be operating using sophisticated and complicated algorithms but if their effects (or even existence) are not perceivable by the driver, they may not contribute to the driver's beliefs about the vehicle's intelligence. On the other hand, the human tendency to project intentions and cognitive abilities on even simple shapes has long been known [4], which may influence expectations in vehicle behaviour: drivers, for instance, tend to expect near-perfect performance from automated systems [8]. A mismatch between expected and actual abilities – which can be lead to an inappropriate level of trust in the system [5, 10] – may lead to an inability of the drivers to accurately identify the limits of the automated system [3], with consequences for road safety.

Overall, it is therefore not just the actual abilities of the vehicle (and how to convey these to the driver) that matter; it is also the driver's *perception* of the vehicle as an artificial, possibly intelligent agent. It is this perception of a vehicle, along with the challenges and opportunities it offers for human-vehicle interaction and vehicle UX design, that we are interested in exploring in the present workshop.

GOAL AND TOPICS OF THE WORKSHOP

The goal of the workshop is to further the theoretical understanding of the ways in which the driver's perception (or attribution) of a vehicle's cognitive abilities (*e.g.* perceived intelligence), should be explicitly considered in vehicle UX design. The list of topics that will be discussed here therefore encompasses:

- **Characterisation of attributed abilities.** *E.g.*: what type of cognitive abilities do humans attribute to artificial agents? What are the contributing factors to such attributions?
- **Relationship between perceived and actual abilities.** *E.g.*: what relation (if any) exists between actual abilities and attributed abilities?
- **Relationship between perceived abilities and trust.** *E.g.*: how do perceived abilities affect trust, for instance in function of the degree to which they match with actual abilities?
- **Relationship between perceived abilities and UX.** *E.g.*: to what degree do user interface elements, or design decisions (rather than actual abilities), affect perceived abilities?
- **Metrics, methods, and tools for measuring perceived abilities.** *E.g.*: How do we effectively determine what abilities a driver attributes to a vehicle? How can these be measured and quantified?
- **Incorporating perceived abilities in the system design process.** *E.g.*: How should a system design process take into account the abilities that a driver might attribute to a system? Should it encourage attribution of particular abilities, while discouraging others?
- **Perception of non-safety critical systems (such as navigation assistants or systems to encourage eco-friendly driving behaviour).** *E.g.*: do non-safety critical systems influence the overall perception of the vehicle's ability, even though they are not necessary for the driving task?

These topics are naturally intertwined, and will be informed from a context larger than the automotive domain in the strictest sense, including work on human/machine interaction in other domains (such as cognitive robotics) with a clear relevance to the automotive domain.

Table 1. Workshop schedule

Time slot	Activity
0:00 - 0:10	Workshop organiser's introduction
0:10 - 0:40	Presentation: Attribution of cognitive abilities
0:40 - 1:10	Presentation: Understanding and communicating intentions
1:10 - 1:40	Presentation: Trust in autonomous technology
1:40 - 1:45	Group work organisation
1:45 - 2:00	Coffee break
2:00 - 3:15	Group work
3:15 - 4:00	Roundtable discussion and conclusion

SCHEDULE

Table 1 shows the schedule breakdown. We plan a four hour schedule, and for convenience, we count time as starting from 0:00 (and running until 4:00). The workshop is divided into two parts: introductory presentations on the workshop themes followed by group work involving all participants. The purpose of the group work is to identify gaps in the current research landscape and directions for future research. We conclude the workshop with a roundtable discussion, led by the workshop organisers.

Introductory presentations

The purpose of the introductory presentations is to set the scene for the group work, and to familiarise workshop participants with relevant research in areas beyond the automotive domain (*e.g.*, how humans interact with other intelligent agents (both artificial and natural), and what consequences this may have for the design of artificial agent.

Group work

Workshop participants are divided into three groups. Each group is given a theme based on the introductory presentations, and joined by one of the workshop organisers. Groups will explore application scenarios of human interaction with vehicles as artificial agents, and focus on the UX design consequences for their particular topic.

Roundtable discussions

The purpose of this roundtable discussion is to distill a unified take-home message from the group work and discussions of the workshop (see *"Intended outcomes"* below). It will discuss, in particular, the direction future research is heading, and identify the most important areas for current and near-future development.

INTENDED OUTCOMES

The workshop promotes understanding vehicles as artificial agents, and exploring the consequences that this has for UX design. This is a, to date, relatively unexplored topic [12, 11], and the present workshop is perhaps the first to be dedicated to this topic in particular. There is therefore a strong potential for fostering new research avenues and collaborations in the present workshop. The workshop organisers will write a freely accessible report synthesising the outcome of the roundtable discussion in particular. This report will be made available on the workshop website [1].

ORGANISER BIOGRAPHIES

Serge Thill is an associate professor of cognitive science at the University of Skövde, Sweden. He holds a Bachelor of Science (with Honours) in Cognitive Science from the University of Exeter, a Master in Informatics from the University of Edinburgh, and a PhD from the department of engineering at the University of Leicester. He joined the University of Skövde in 2008, first as a post-doc, then as a senior lecturer, and, since January 2014, in his current role.

Thill currently heads the Interaction Lab research group at the school of informatics. His main research interests are in natural and artificial cognition, in particular as manifested in the interaction between such agents. He sees intelligent, adaptive, or autonomous vehicles as a particular example of artificial agents.

He has co-authored the EU FP7 integrated project "DREAM" (www.dream2020.eu) on robot-enhanced therapy for children with autism spectrum disorder. He co-coordinates (with Tom Ziemke) the Swedish research initiative "AIR", on action and intention recognition between humans and automated technology (including automated vehicles, see [9]) in shared physical spaces and has been/is the PI for two projects (CARS and TIEB), funded nationally, that directly deal with the perceived intelligence of vehicles [11, 13, 14].

Azra Habibovic is senior researcher within Cooperative Systems at Viktoria Swedish ICT. She holds a PhD in Vehicle Safety Systems (2012) and a MSc in Electrical and Electronics Engineering (2006), both from Chalmers University of Technology, Sweden.

Azra's research focuses on the improvement of traffic safety by means of automation and connectivity. Before joining Viktoria, she has been working on methods for real-world data analysis, and specification of requirements for active safety systems addressing vulnerable road users.

At Viktoria, Azra is involved in both national and international research projects concerning e.g., system evaluation from user perspective, interface design for improved interaction between pedestrians and automated vehicles, and safety concepts and strategies based on wireless communication for road tunnels. Several of these projects are either directly or indirectly addressing the topic of the perceived intelligence of vehicles as a tool to improve traffic safety and energy-efficiency.

She is also the main author of a newsletter on automated vehicles that is published by Viktoria several times a week.

Maria Riveiro received her PhD in Computer Science from Örebro University, Sweden, 2011. The main research questions tackled were the analysis of traffic data using artificial intelligence methods, the detection of interesting events as well as the the use of interactive visualization for decision support. Dr. Riveiro is currently a Senior Lecturer at the University of Skövde and she is part of the Artificial Intelligence Lab. Riveiro has carried out several projects focusing on interaction aspects between driver and vehicle, see [5, 13, 14].

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