Automation: Danger or Opportunity? Designing and Assessing Automation for Interactive Systems

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Abstract
This course takes a practical approach to introduce the principles, methods and tools in task modeling and how this technique can support identification of automation opportunities, dangers and limitations. A technical interactive hands-on exercise of how to "do it right", such as: How to go from task analysis to task models? How to identify tasks that are good candidate for automation (through analysis and simulation)? How to identify reliability and usability dangers added by automation? How to design usable automation at system, application and interaction levels? And more...

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Introduction
While early approaches in automation were focusing on allocating basic functions to the best player (e.g. Fitts' approach Machine Are Better At – Men Are Better At) [1], this courses focuses on operators' tasks and their analysis in order to identify tasks that are good candidate for automation. Current push in automation is towards fully autonomous systems (such as google cars) raising critical issues such as: how to ensure dependability of fully autonomous systems, how to make it possible to users to foresee future states of the automation, how to disengage automation or how to address legal issues raised by safety concerns (both for users and the environment) …. When higher automation levels are considered, users' activity gets closer to supervision which is a different interaction paradigm. This course takes a practical approach to introduce attendees to the principles, methods and tools for the design and the assessment of automation.

Contribution and benefit

This course intends to provide newcomers with a background in task modeling. It provides an overview on how the recent advances in task description techniques can be exploited to design and assess interactive systems.

Beyond this classical use of task models, they can be fruitfully exploited for identifying tasks (or sub tasks) that are good candidate for automation. Indeed, tasks models (when integrating enough details such as cognitive activities, knowledge required for the performance of the tasks, quantity of information to be stored in user's short term memory, …) can be analyzing to assess the complexity of the tasks but also to compute the average performance of the users. To this end, this course provides attendees with a pragmatic toolset, including techniques, guidelines and the HAMSTERS task modeling tool that can be directly applied in practice.

The tool will be distributed to attendees together with several examples going from toy examples to industrial projects. That tool can be used to describe how tasks are impacted when functions are migrated towards automation [13] and how such migration increases the overall performance of the couple (user, interactive system).

Objectives

On completion of this tutorial, attendees will:

- Know the theories and principle underlying automation designs in interactive systems,
- Be familiar with multiples policies for automations,
- Be knowledgeable about current use of automation in command and control systems such as aircraft cockpits, Air traffic control workstation and autonomous vehicles,
- Be aware of hazards related to the introduction of automation,
- Be knowledgeable about design principles for usable, reliable are performant automations,
- Know the benefits of using task modeling techniques to design, structure and assess user interfaces,
- Be able to describe users' activities in a systematic and structured way,
- Have experience in analyzing an interactive systems focusing on the tasks users have to perform with it.

Description and content

This is a one-unit course composed of three parts:

Part 1: the basic principles of automation and the various levels of automations [11]. Beyond that, this part will describe

- What task models are good for (recording the output of task analysis, performance evaluation of users, tasks complexity assessment[4] …)
- Basic principles of task models (hierarchical view on human activities, abstraction and refinement, temporal ordering, objects, information and knowledge … [3])
- How to reason on tasks descriptions for identifying functions that can be allocated to automation [2].

Part 2: practical issues and case studies

- Automation design (identification of users' activities that could be good candidates for task migration towards automation, authority

sharing, impact of automation degradation on tasks performance) [9],[10]
- Presentation of case studies from the safety critical domains such as interactive cockpits of large aircrafts, air traffic control workstation, space systems (such as the International Space Station). Closer to CHI concerns, this part will also present cases of automation within interaction techniques (such as mouse acceleration, animations [12], …).
- The fallacy that automation reduces human errors [8].

Part 3: interactive hands-on exercise
- How to identify tasks that are good candidates for automation?
- How to design transparent (and thus usable interactions),
- How automation can be related to presentation techniques and not only computational means,
- How to address conflicts between automation and keeping the human in the loop [14].

Lecture with slides, demonstrations and practical exercises. The course is approximately 60% tutorial and 40% activities on case studies and examples using the HAMSTERS graphical editor and simulator.

Agenda
This course is intended to be taught in one part made up of 3 subparts going from conceptual to very practical. It includes interactive hands-on exercises, case studies and HAMSTERS tool practice.

Audience and Prerequisite
This course is open to researchers, practitioners, educators and students of all experience levels. No specific skills or knowledge are required beyond a background in User Centered Design.

Resources
Each attendee of the course will receive a USB key containing HAMSTERS graphical editor and simulator, a set of examples, the course notes (including slides and a 30-page textual documentation) and a video demonstrating the use of the HAMSTERS tool. The examples provided to participants will highlight how to represent user tasks that are migrated towards automation, how such migration improves performance and how failures or degradation of the automation part might entirely jeopardize overall system performance.

Course background
A course on task analysis and task modelling exploiting HAMSTERS notation and tool has been taught at CHI 2015 [5] and CHI 2016 [6]. The proposed course is based on the material presented in those course but focusses on user tasks allocation and migration of tasks towards automation and has been given at the ICRAT 2014 conference [7]. This content has been taught in different places and countries such as the Master on HCI at the University of Toulouse (in French).

Instructors' background
The instructors have applied task modeling techniques to several industrial projects such as the design of collaborative environments to manage collision risks between satellite and space.

Philippe Palanque is Professor in Computer Science at University of Toulouse 3. He has been teaching HCI and task engineering classes for 20 years and is head of the Interactive Critical Systems group in Toulouse France.

Since the late 80s he has been working on the development and application of formal description techniques for interactive system. He has worked on research projects at the Centre National d'Études Spatiales (CNES) for more than 10 years and on software architectures and user interface modeling for interactive cockpits in large civil aircraft (funded by Airbus). He was also involved in the research network HALA! (Higher Automation Levels in Aviation) funded by SESAR program which targets at building the future European air traffic management system. The main driver of Philippe's research over the last 20 years has been to address in an even way Usability, Safety and Dependability in order to build trustable safety critical interactive systems. As for conferences he was co-chair of CHI 2014 and full paper co-chair of INTERACT 2015.

Célia Martinie is Assistant Professor in Computer Science at University of Toulouse 3. She has been working on task modeling techniques for the design and development of interactive systems since the beginning of her PhD in 2009. Prior to that, she worked in the mobile industry (Motorola) during 8 years, and has contributed to the design and development of user interfaces for mobile devices. She is the principal investigator of the projects related to the design and development of the HAMSTERS notation and tools.

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