Ph.D. in Information Technology
Thesis Defense

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Sala Seminari Nicola Schiavoni, Ed.20

Pietro CROVARI – XXXV Cycle

MULTIMODAL CONVERSATIONAL INTERFACES: DESIGN, MODELLING, APPLICATIONS

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Abstract:

A conversational agent is a software that mimics human conversation. They are becoming increasingly successful and adopted in a wide range of domains, such as education, user assistance, mental health, and home automation.
In recent years, the interaction with conversational agents has been blended with other interaction modalities to increase the system's capabilities, creating new multimodal paradigms for interaction. However, this integration is still limited from a methodological perspective despite being broadly exploited.
This Ph.D. research investigates the design, modeling, and development of multimodal conversational agents. This work starts exploring this domain from the design of GeCoAgent and DSBot, two conversational agents to support the data science process. GeCoAgent is a multimodal conversational platform to enable biologists and clinicians to define data analysis pipelines on genomic data through dialogue. The platform automatically translates it into code, executes it, and returns the user the results. GeCoAgent's design process also led to modeling the bioinformatics tertiary analysis process in the form of an ontology that can be used as a reference to elicit the requirements for interactive applications.
DSBot evolves this concept by providing a tool that translates users' research questions, expressed in natural language, into executable pipelines. The system exploits autoML methodologies to select the best algorithm and optimize the parameter selection automatically. Users are involved in the process through the conversation when decisions related to the meaning of the data must be taken. In addition, we release one of the two modules of DSBot as an open-source framework for multimodal conversational troubleshooting.
Having assessed the potentialities of multimodal conversational interfaces, we realize that their design is a largely unexplored field. For this reason, we survey the literature to elicit a set of principles to follow during the design process, and we formalize a conceptual frame- work to describe the possible degrees of integration of conversational agents and other interfaces.
Then, we complement the finding in the literature by analyzing the impact of multimodality on the conversational experience from a linguistic perspective. We observe users' linguistic performances in a comparative study with more than 120 participants to assess how the introduction of graphical elements affects the conversational experience.
We use these findings to ground the formulation of a conceptual model to support the design process of multimodal conversational interfaces. The model exploits hierarchical schemes, inspired by BPMN formalism, to model conversational interaction and separate the task's

description from how it is reified on the various modalities.
In the last part of the thesis, we describe Albot Einstein, a case study of a multimodal pedagogical conversational agent to teach pH to children. In addition, to validate the descriptive capabilities of the model, we test the platform's efficacy in a comparative study with 28 children, obtaining results comparable to the ones achieved through a ''traditional" interactive web application.
We design and develop a graphical authoring tool that enables that transform expressed in a notation derived from one of the model into an instance of the application backend. An empirical evaluation with 15 developers shows how such an interface can support developing multimodal conversational interfaces.
Finally, we discuss how the work presented can be framed in a single framework that covers a multimodal conversational agent's whole design and implementation process.

PhD Committee

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