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1 Research Interests

My research interests are in artificial intelligence (AI) and its applications to natural language processing (NLP) and computer vision (CV), with a focus on the **manufacturing sector**. In particular, the research guides practitioners in selecting **architectural and functional elements** for SDSs. A **conceptual architecture** and **taxonomy** were developed (Colabianchi, 2023). The applications developed involve reflections on **slot filling**, **knowledge base (KB)**, and **Large Language Models (LLMs)**.

Past: a conceptual architecture and a taxonomy

SDSs represent an intuitive, and innovative solution that is still in the early adopter stage in manufacturing. The research underlined the absence of a reference standard for their logical operation and characteristics. This is also reflected in the literature, in which conflicting statements about the classification criteria and general architecture are often found ((Adamopoulou and Moussiades, 2020; McTear, 2020; Almansor and Hussain, 2020; Souvignier et al., 2000). Thus, from a theoretical point of view, the research composed an architecture that takes into account those developed so far, offering an articulated pathway between the different modules, with details on each step and terminological consistency. The architectural design includes modules from the beginning of the conversation to response generation and interface integration.

From a functional point of view, a taxonomy to support the selection of SDSs elements was developed. Taxonomies are widely recognized in the field of human-computer interaction. They serve a crucial role in enabling the formulation of design principles that can guide the development of future artifacts, such as SDSs. The research readapted the steps suggested by Nickerson et al. (2013). All the iterations integrated reference taxonomies, SDSs literature, and the cross-reading of manufacturing SDSs defining eighteen design dimensions and forty-two characteristics which can be divided into agent and agent-user interaction perspectives. In the first perspective, the taxonomy guides practitioners to ask themselves what objective they want to pursue (e.g., whether to develop a solution for training or to support the operator in complex operations) and how to achieve it (e.g., to include integrations with other tools, to give the chatbot a personification). In the second perspective, the taxonomy guides the choices regarding the type of interaction (e.g., by defining the duration of the conversation or the leader).

The taxonomy revealed important relationships between the dimensions of the design of SDSs for the manufacturing sector, providing interesting insights into their design. The case studies revealed that the rule-based approach is the most widely used, and this is credibly the next frontier that will be surpassed, thanks to the increasing adoption of LLMs (ChatGPT, BARD, etc.) (Li et al., 2022). On the other hand, it will be necessary to leverage generative AI systems toward a narrow knowledge domain, especially in goal-oriented contexts such as industrial applications. The evidence collected reveals a limited propensity for humanization of conversational agents, absence of empathy, and short-lived interaction, highlighting some additional features that current language models (LLMs) can overcome.

Present: real case applications

The research continued by testing the results in case studies, highlighting the importance of guiding the organization through the process. SDS applicability for the health and safety of workers was tested (Colabianchi et al., 2022). Next, a task-oriented

Proceedings of the 19th Annual Meeting of the Young Reseachers' Roundtable on Spoken Dialogue Systems, pages 12–14

SDS with a slot-filling approach for supporting employees in dealing with complex cybersecurity procedures and cyber threats. Specifically, the SDS was responsible for supporting operators in the attack phase by trying to recover after the attack and limiting the sense of shame felt by users who were victims of phishing attacks (Colabianchi et al., 2023). These applications had some limitations related to the KB and conversation adaptability to the user's profile. They also lacked interaction with external systems, which is increasingly required by industries.

Future: LLMs and multi-modal applications

The widespread adoption of LLMs represents a significant advancement that can overcome difficulties associated with rule-based and retrieval systems. My research focuses on the use of an SDS as an on-the-job training assistant for a complex assembly task. The solution uses LLM and OpenAI. The results so far are excellent in terms of accuracy of responses, memory, and adaptability of responses to different scenarios. Future work includes improving KB and better speech understanding. Research also investigates the integration of these systems with CV techniques (e.g., for defect identification in production) or integration with Virtual Reality (VR) solutions (e.g., for training production operators in high-risk operations).

2 Future of Spoken Dialog Research

I think the future of SDSs research is in extreme personalization. If we think of an SDS to support workers their different qualification has to be considered. A balance must be maintained between conciseness and ease of understanding. The way an experienced user and a novice approach the system can vary, as the novice lacks sufficient knowledge or experience. Additionally, other factors such as specific situations (like emergencies) may also play a role.

In the future also the use of LLMs and related privacy issues should be considered. The use of LLM and external players such as OpenAI frightens the industry. For an optimal KB, it is necessary to provide reports, data, and organizational values for greater customization. Such data sharing with an external player needs to be evaluated in terms of privacy and industry protection.

The third aspect is the evolution of SDSs. What do we expect in the future? How do we envision the integration of these systems with other senses such as sight? How to take into account the need for explainable and interpretable AI?

3 Suggestions for discussion

- *The evolution of SDSs: towards a multimodal approach*. Discussion on efficient integration of SDSs with images, videos, or augmented or virtual reality scenarios.
- *Building an optimal knowledge base*. How to work on an optimal KB that takes into account aspects such as:
    - the semantic meaning of words which might vary according to the application context;
    - the continuous update of procedures, reports, and data;
    - the ability to adapt to diction, and dialect, especially in contexts with low schooling personnel.
- *Privacy, industrial protection, and ethics in the era of LLMs and players such as OpenAI.* What conversational systems should and should not know. What are the limits of knowledge? Who is holding it? How to empower industries with deep knowledge of the model.

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Biographical Sketch

Silvia Colabianchi is a young research fellow at Sapienza University of Rome. She recently earned a PhD defending a thesis titled “Humans in cyber resilience: managerial and operational opportunities.” As part of her thesis, she has undertaken research on SDSs to support employees in managing cybersecurity. She is currently testing her architecture and taxonomy of elements for SDSs. Her research includes the use of a SDS to support operators in alienating and repetitive operations, preserving their creativity and critical thinking. She is currently a member of the task force for the development of Digital Intelligent Assistants for manufacturing established under the COALAH2020 project. Along with this, her future research includes the integration of SDSs with computer vision and virtual reality. In her free time, she enjoys playing padel, tennis, and going hiking in the mountains.