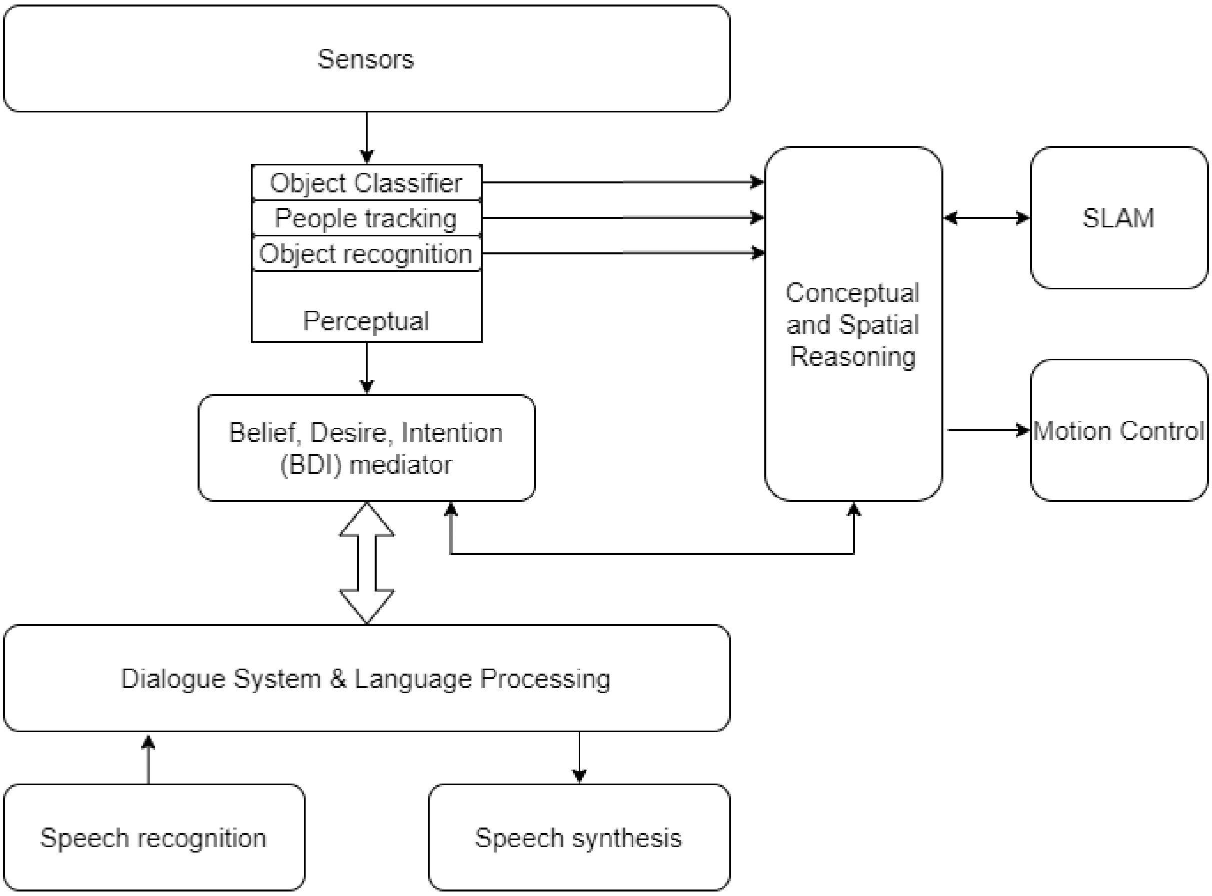
Learning language with robots

Group-2

Human-Robot Architecture



General Summary of HRI Architecture:

The figure above shows the *detailed components* of human-robot interaction (HRI), as shown in [1]. The robot interacts with his operator through verbal communication. The issue is to design a system that enables the robot to conduct a situated dialogue with the operator. *Speech recognition* is responsible for converting the operator's sound to text or formate that the robot can deal with. The *language processing* analyses the recognized user utterances and converts it into a suitable contextualized representation of meaning. In [1] and [2], this is mainly done via syntactic and semantics parsing analysis; this step's output depends on the system design. In [2], it is required to convert the user's utterances into robot commands. In [1], the output is in data structures representing semantic meaning: propositional content and intention. These structural descriptions are then evaluated to determine the intention, propositional content, and the truth value and then *mediated* between modalities.

The two papers discuss the interaction with autonomous robots. Usually, these types of robots gain information about the environment through sensors that enable them to *navigate*. In [1], the navigation design is based on the topological representation of a spatial organization that believed humans utilize. Three abstract layers of spatial representation, the final layer is a spatial ontological representation of the environment. Having this layer enables the robot to infer the environment; typically, a coffee machine is located in the kitchen. This multi-layer spatial representation is executed in *conceptual and spatial reasoning*.

In [2], the main task is Instruction-Based Learning; the robot is required to follow the navigate inside a city based on its operator's instructions. Sometimes the instructions miss the start point and/or the endpoint, and it is expected that the robot should execute them successfully. The robot has an innate knowledge consists of the primary sensory-motor procedures represented in symbolic formate and mapped to their respective robot command. In [1], the robot has an innate knowledge of the ontology representation of an office environment. The robot realms information from its operator and manipulate the symbols inside its system. In [2], the robot could learn that go to the post office is a series of primary procedures (from point-A turn left, turn right, go forward, etc.). It creates a symbol for these procedures and refers to it when needed in the future. In [1], the robot could learn that it is in the looby; the robot then names the respective symbol in its conceptual map as "lobby". This operation is also executed in *conceptual and spatial reasoning*.

Challenges and internal discussion

- The symbolic system tends to be deterministic and somehow rigid; for example, it is not always the case that you have a coffee machine in the kitchen, sometime it could be located in the meeting room. Handcraft all possible alternatives/designs in the innate knowledge base are time-consuming and expensive.
- The current symbolic learning design is limited to the quality or size of the innate knowledge base. A human can learn a new concept using existing knowledge.
- Safty design consideration, for example, in [1], the design considers that the robot should keep a socially appropriate distance to its operator.
- **Question:** In HRI, should the robot be a sensorimotor system? What about the interaction with robotic customer service through the phone? If we consider the tone and voice feature, will this system design fall within HRI, or is it regarded as a pure dialogue system?

References

1. Kruijff, G. J. M., Zender, H., Jensfelt, P., & Christensen, H. I. (2007). Situated dialogue and spatial organization: What, where, and why? International Journal of Advanced Robotic Systems, 4(1 SPEC. ISS.), 125–138. https://doi.org/10.5772/5701

2. Lauria, S., Bugmann, G., Kyriacou, T., & Klein, E. (2002). Mobile robot programming using natural language. Robotics and Autonomous Systems, 38(3–4), 171–181. https://doi.org/10.1016/S0921-8890(02)00166-5