SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Artificial Intelligence Lab
has the honor to invite you to the public defence of the PhD thesis of

Zakaria Lemhaouri

to obtain the degree of Doctor of Sciences

Joint PhD with CY Cergy Paris Université

Title of the PhD thesis:

Computational modelling of language learning in robots: the development of meaning potentials in social and emotional contexts

Supervisors:

Prof. dr. Ann Nowé (VUB)

Prof. dr. Lola Cañamero (CYU)

Co-supervisor:

Dr. Laura Cohen (CYU)

The defence will take place on

Tuesday, December 16, 2025 at 2 p.m. in Amphi E3, CY Cergy Paris Université - Site De Saint-Martin, France.

The defence can be followed through a live stream at this link.

Members of the jury

Prof. dr. Angelo Cangelosi (University of Manchester, chair)
Dr. Paul Van Eecke (VUB)
Dr. Sofiane Boucenna (CYU)
DR. Alessandra Sciutti (Instituto Italiano di Tecnologia, IT)
Dr. John Lones (University of Hertfordshire, UK)

Curriculum vitae

Zakaria LEMHAOURI is a joint PhD candidate at the Cergy–Paris university (CY) and the Vrije Universiteit Brussel (VUB), his PhD is part of the EUTOPIA PhD co–tutelle program. He received his master's degree in AI for Robotics from the Sorbonne University in Paris. He is currently a member of the ETIS Lab (Equipe Traitement de l'Information et Systèmes) in Cergy and the VUB Artificial Intelligence Lab in Brussels. The topic of his PhD research is the development of a computational model of language learning in robots. The PhD is conducted under the supervision of Prof. L.Cañamero (CYU), and Prof. A. Nowé (VUB) and Dr. MCF L. Cohen (CYU).

Abstract of the PhD research

Recent advances in natural language processing—especially large-scale transformer models—have dramatically improved language generation and understanding. These systems, however, are not designed to explain how infants acquire language: they learn from massive static datasets, do not exhibit infant-like developmental trajectories, and overlook the cognitive, social, and psychological precursors that shape language learning.

We propose a cognitive model for a robot's early language acquisition, inspired by how human babies learn language. The robot's learning process relies on sensorimotor development, social interactions with a caregiver, and real time learning, making it an active learner. This modular architecture includes three components: a motivational module, a perception module, and a communication/action module. The robot employs two associative learning methods to form meaningful symbols and acquire words with functional meaning: first, through trial and error to learn the correct word for each situation, and second, by using a neural network to ground each word in the goal it achieves, as well as in proprioceptive and exteroceptive signals. This yields a dual word-referent association.

We implemented this architecture in a humanoid robot to study the development of its communicative skills. We aimed to follow major milestones in language learning, such as babbling, lexical development (learning nouns and verbs), syntax and early grammar development. The results indicate that the robot successfully acquired motivation-grounded language.

Developmentally plausible models, such as the one we present here, can be valuable tools for investigating questions related to cognitive and psychological development in humans. We conducted several experiments to study how extralinguistic factors like motivation, sensory-motor development, caregiver responsiveness and social interaction influence the emergence and shaping of language. The results show that these factors, which are often overlooked by most language models, promote more efficient and faster language learning, a richer vocabulary, better retention of acquired words, and improved categorization learning.