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[IDAS M104 Projet en data analytics](#)

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[INFO M233 Natural Language Processing](#)

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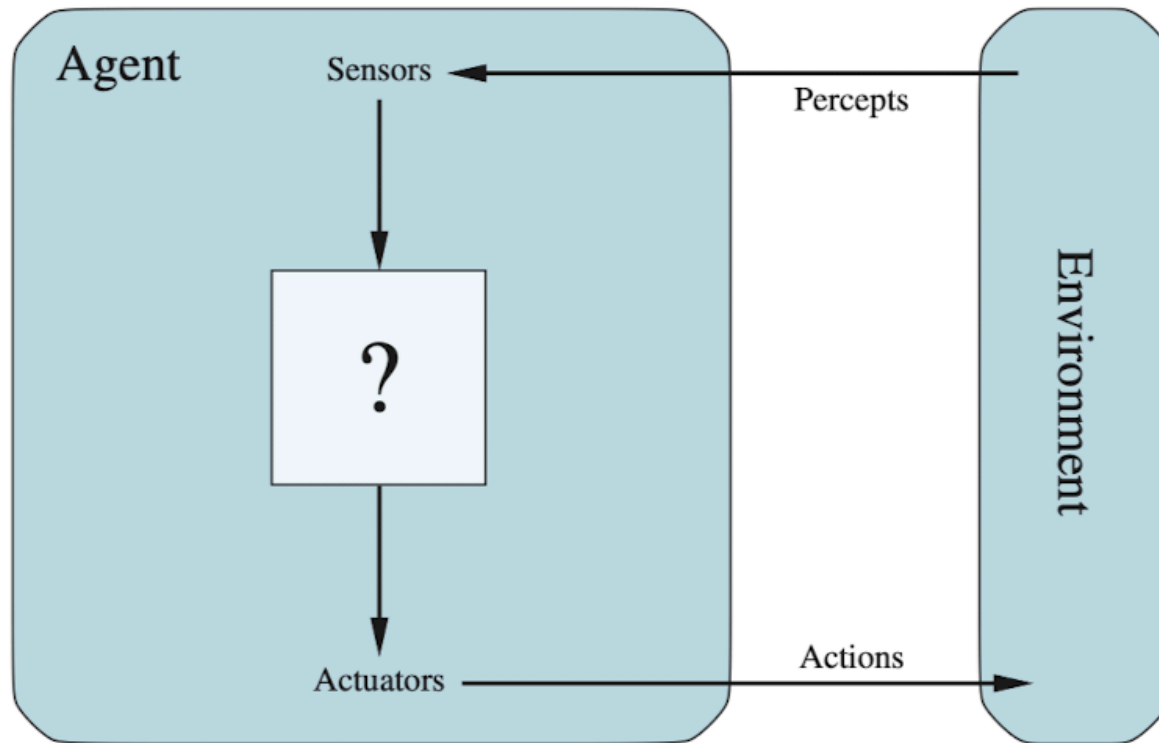
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Agents intelligents

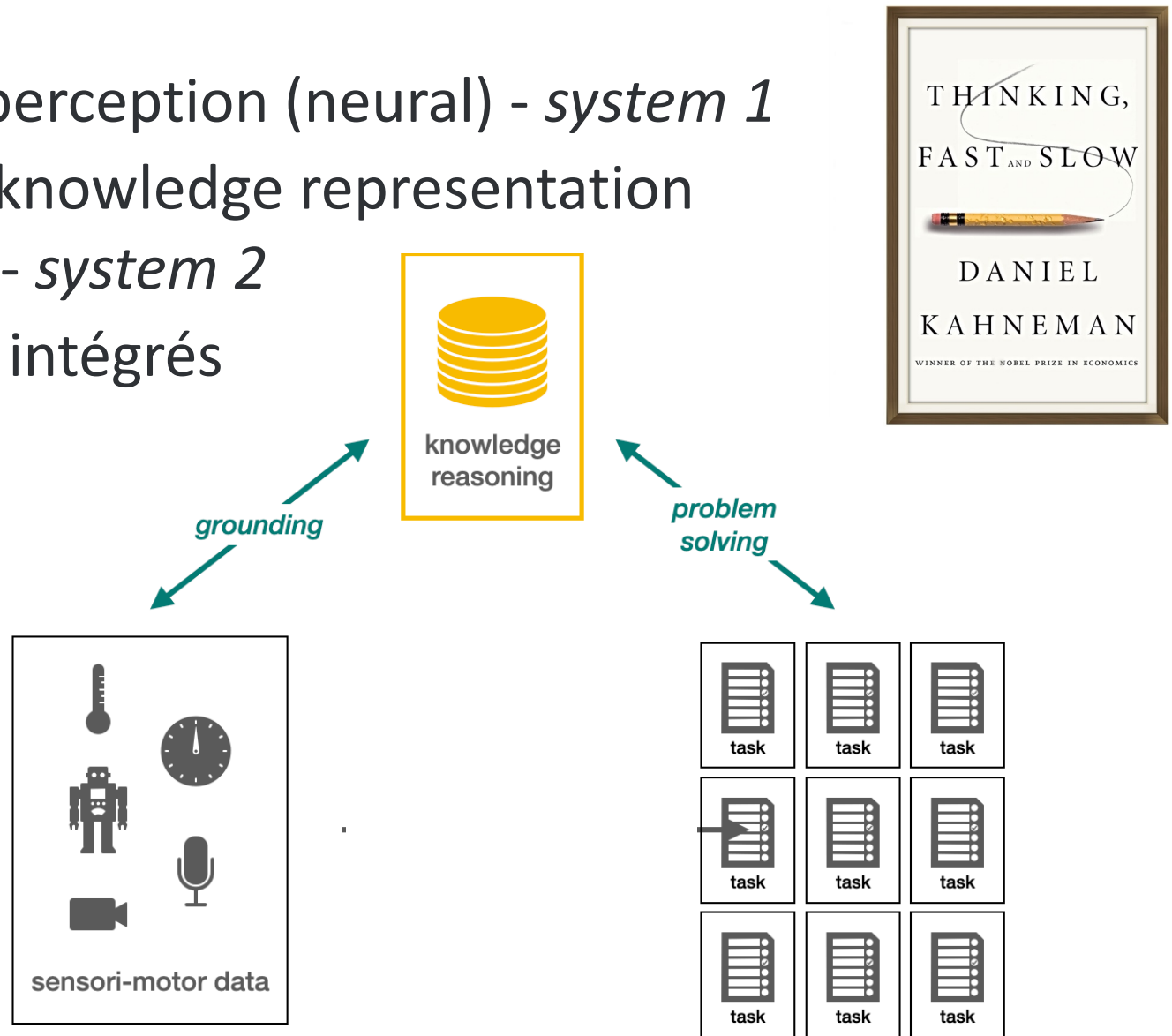


Perceive-reason-act-learn loop

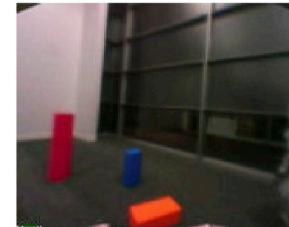
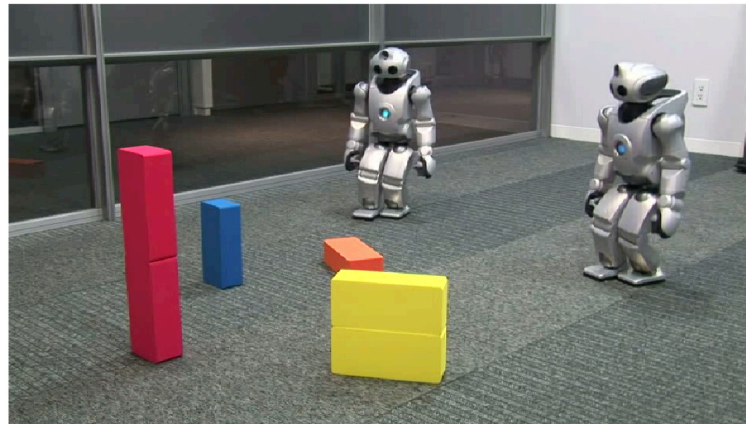
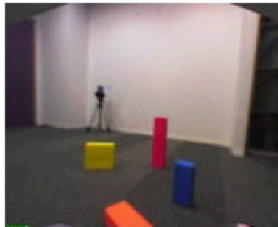
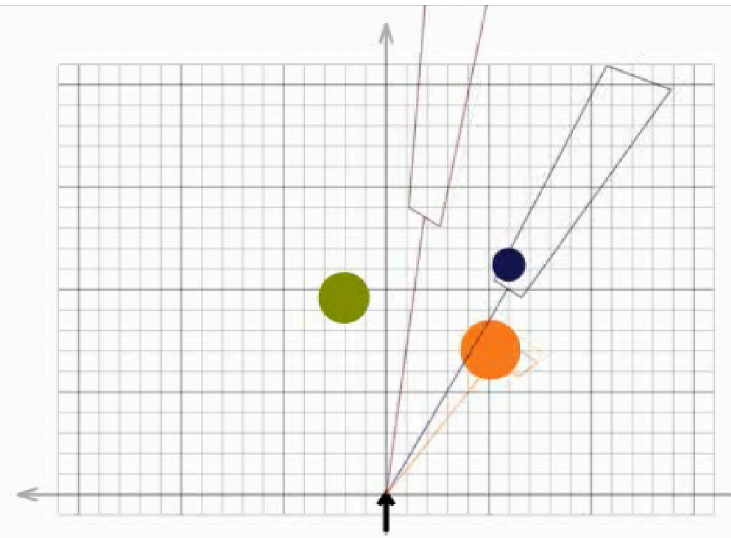
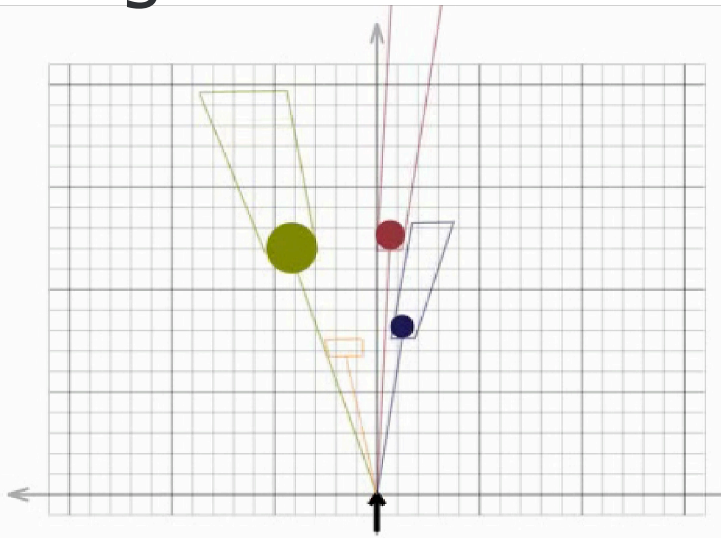
Russel, S. and Norvig, P. (2022). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson.

Neuro-symbolic AI

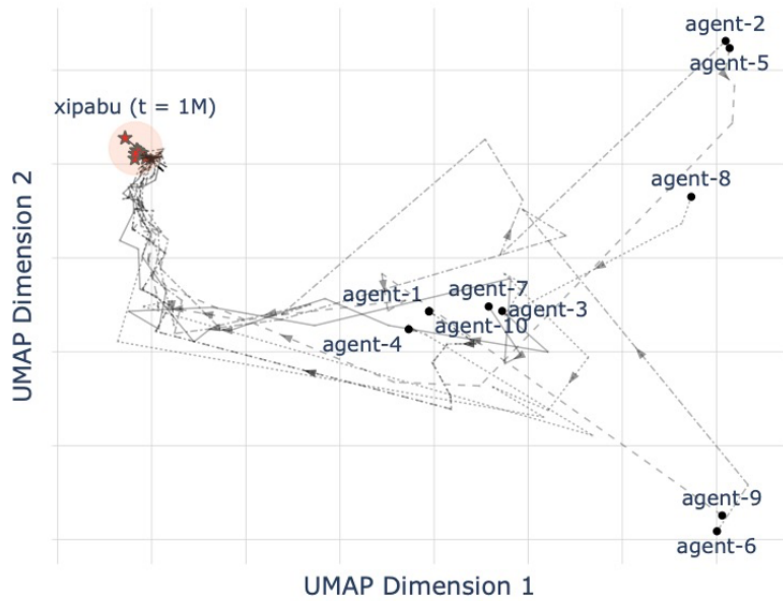
- ▶ Low-level perception (neural) - *system 1*
- ▶ High-level knowledge representation (symbolic) - *system 2*
- ▶ Fortement intégrés



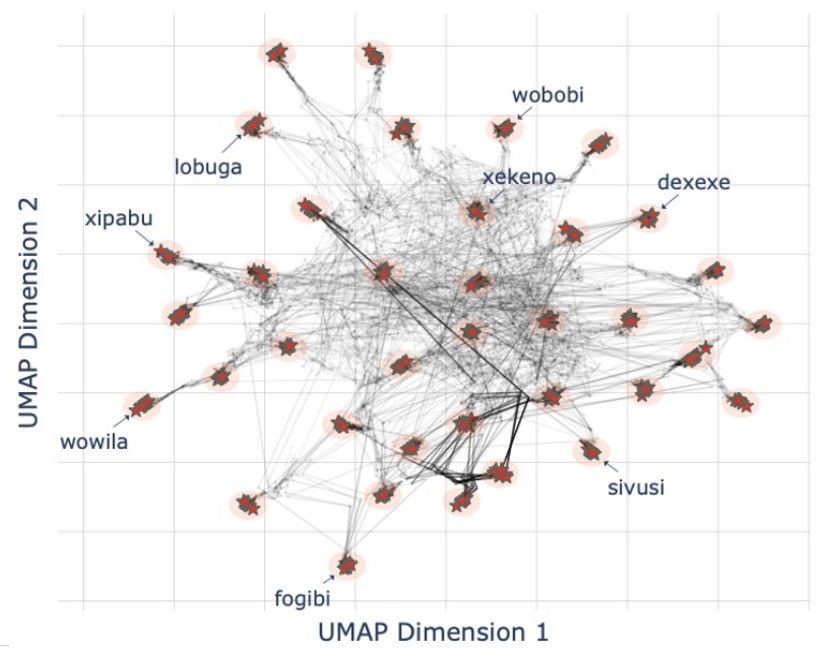
Emergent communication



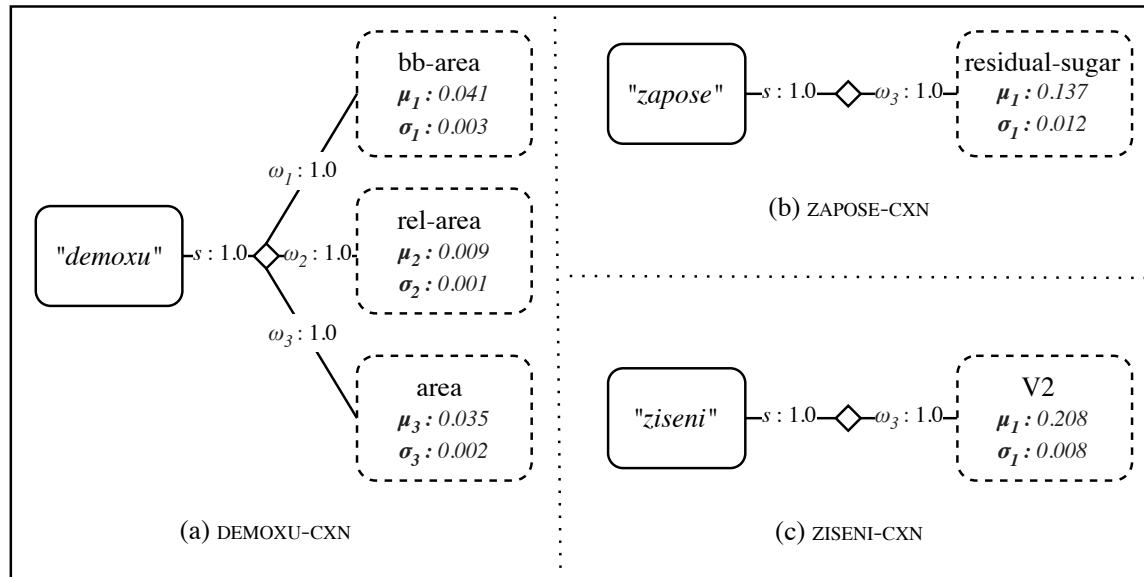
Botoko Ekila, J., Nevens, J., Verheyen, L., Beuls, K., and Van Eecke, P. (2024). Decentralised emergence of robust and adaptive linguistic conventions in populations of autonomous agents grounded in continuous worlds. In *Proceedings of the 23rd International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS)*, pages 2168–2170.



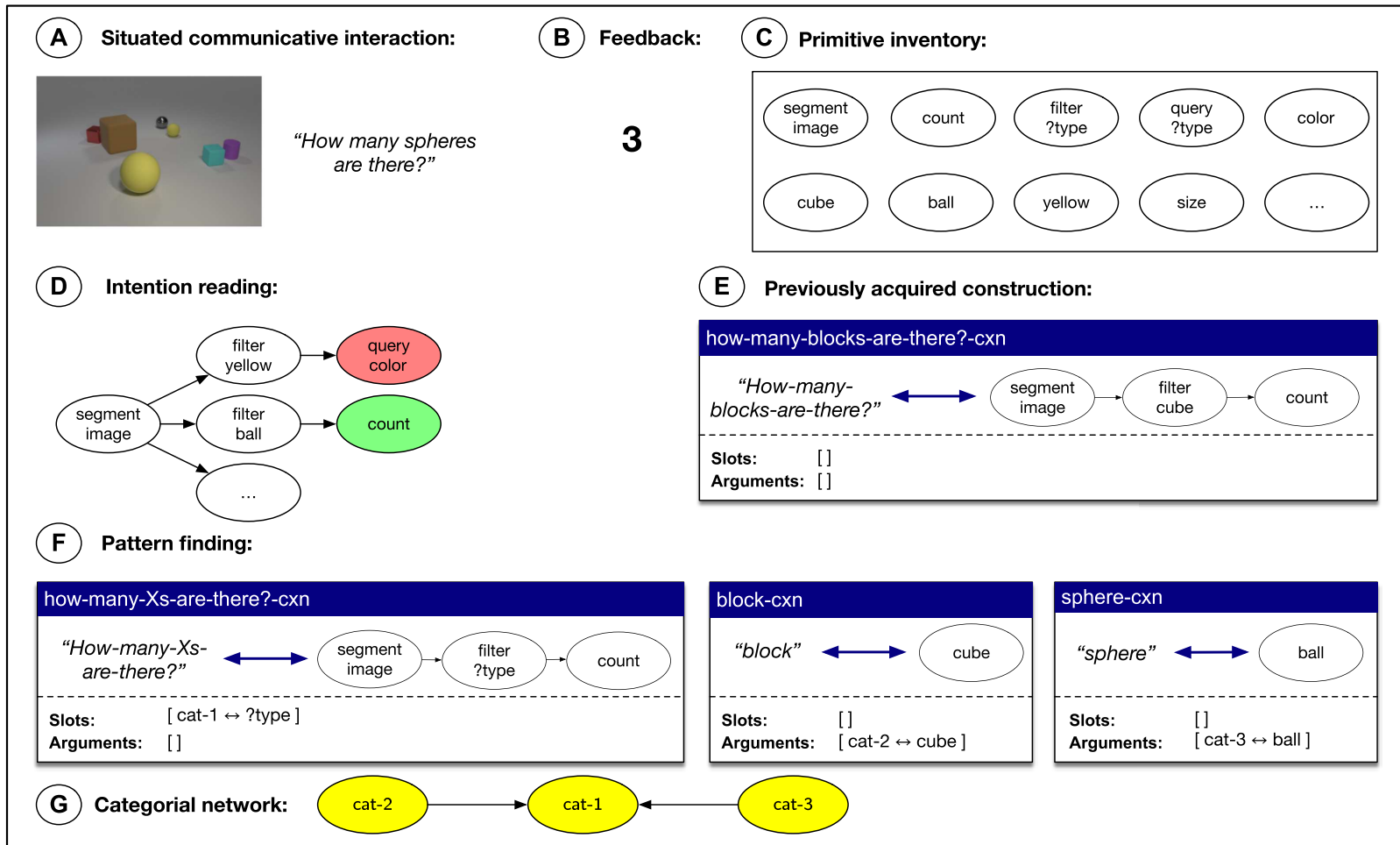
Trajectories of a single word "xipabu" 10 agents



Trajectories of all word with score > 0, 10 agents

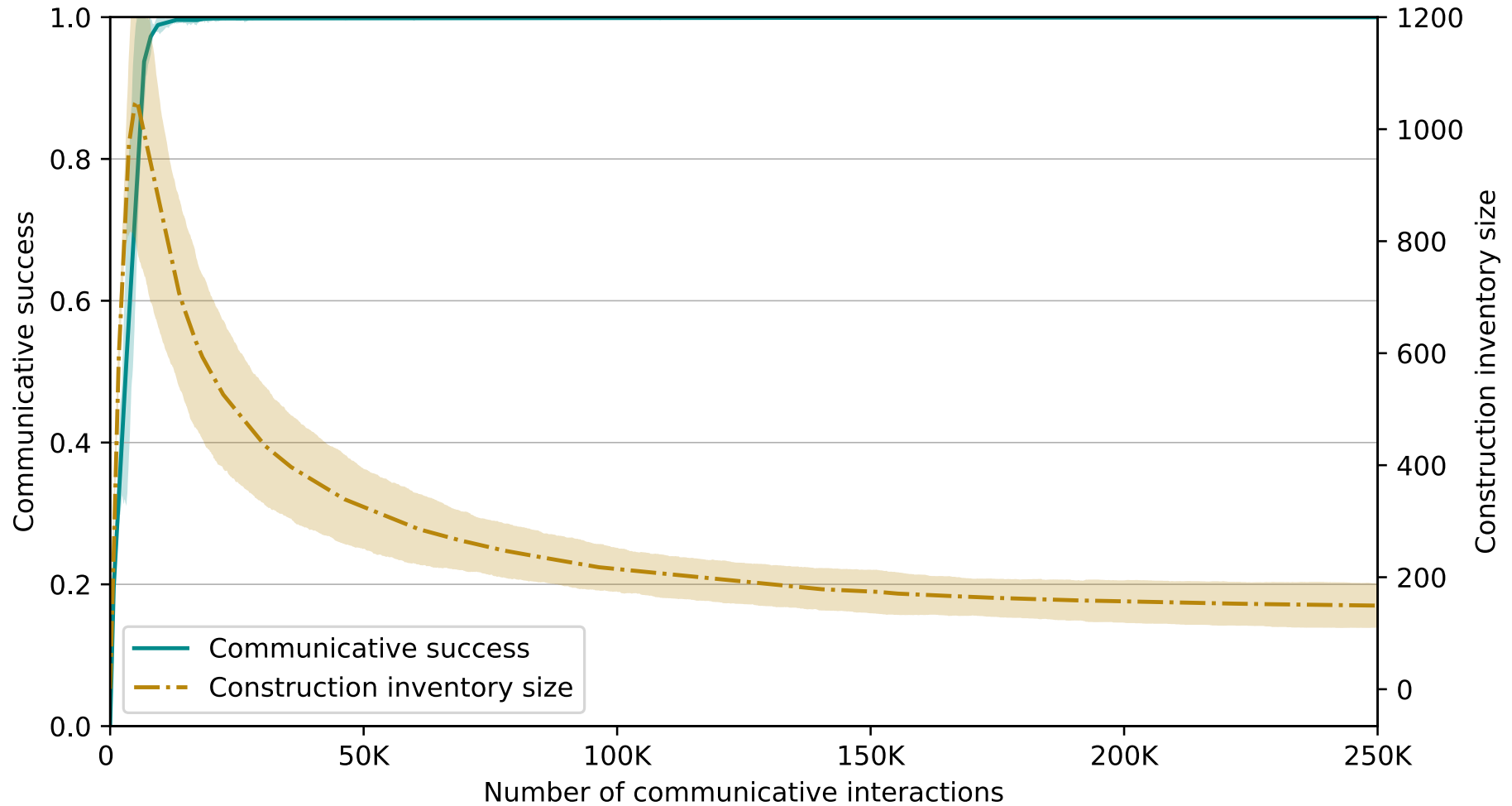


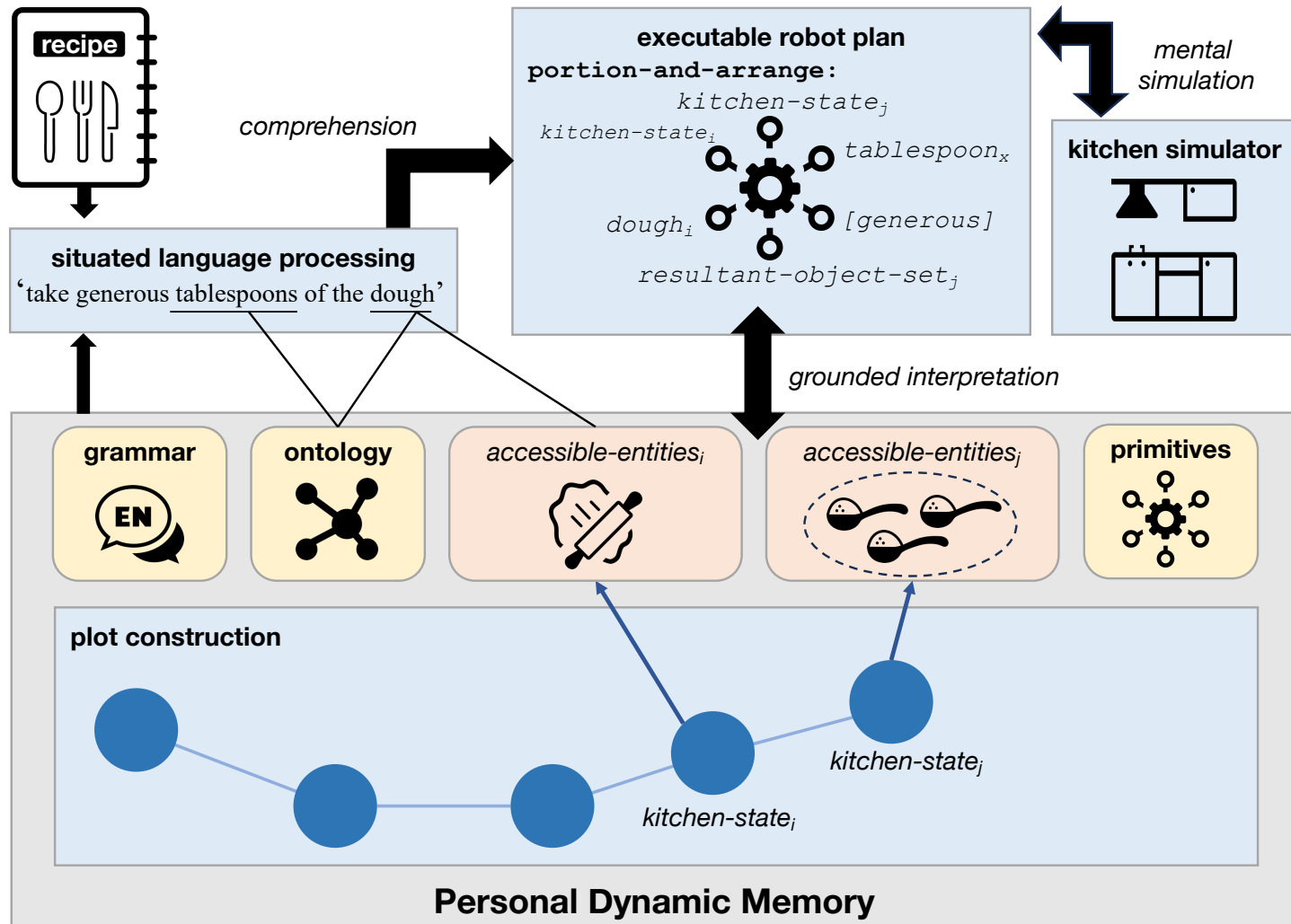
Situation-based reasoning



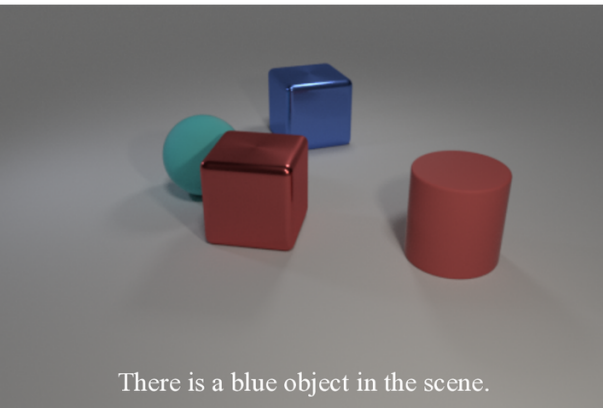
Beuls, K. and Van Eecke, P. (2024). Humans learn language from situated communicative interactions. What about machines? *Computational Linguistics*, 50(4):1277–1311.

Evolutionary dynamics





van Trijp, R., Beuls, K., and Van Eecke, P. (2024). The proof is in the almond cookies. In Steels, L. and Porzel, R., editors, Narrative-based Understanding of Everyday Activities: A Cookbook, pages 59–77. Venice International University, Venice.



Q₁: If there is an object left of it, what size is it?
 A₁: **Large**

Q₂: How about material?
 A₂: **Metal**

Q₃: What about shape?
 A₃: **Cube**

Q₄: And that of the above blue object?
 A₄: **Cube**

Q₅: How many objects does that metallic object have to its behind?
 A₅: **Two**

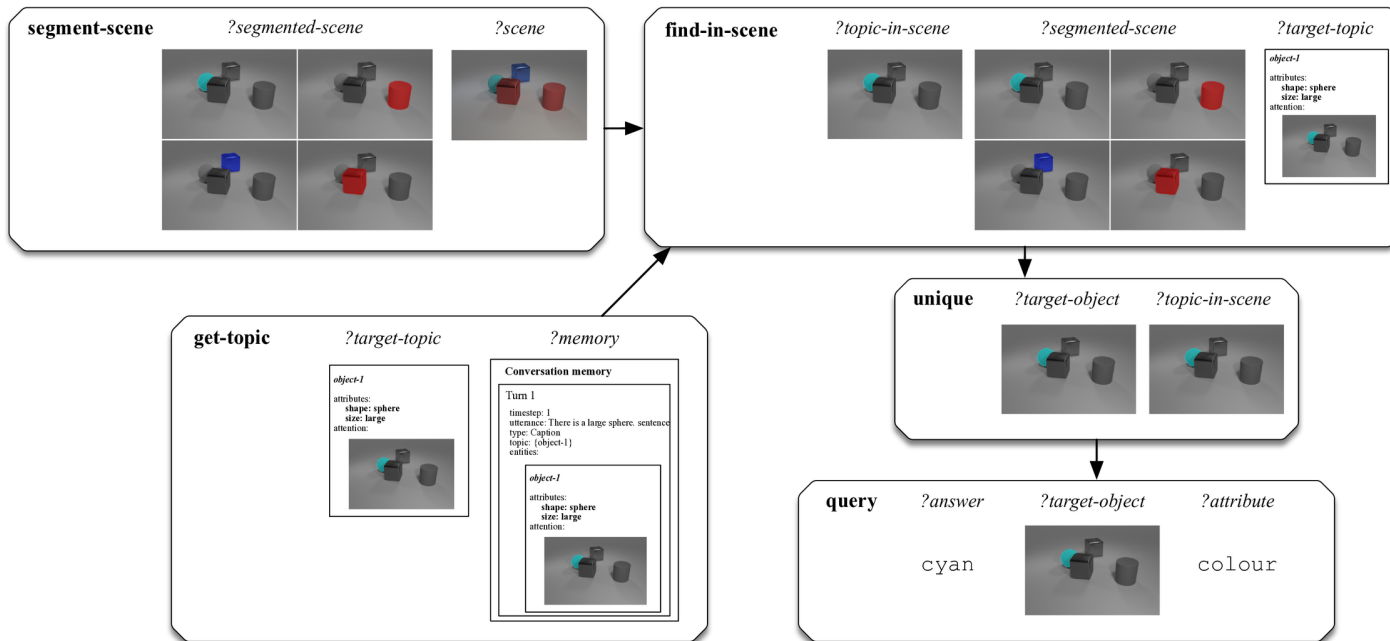
Q₆: What number of other objects share similar shape with the aforementioned big object?
 A₆: **One**

Q₇: If there is an object to the right of the earlier big object, what material is it?
 A₇: **Metal**

Q₈: Does it have objects to behind itself in the scene?
 A₈: **No**

Q₉: What color is the above large object?
 A₉: **Red**

Q₁₀: What number of other objects in the picture are of same shape with the previous blue object?
 A₁₀: **One**



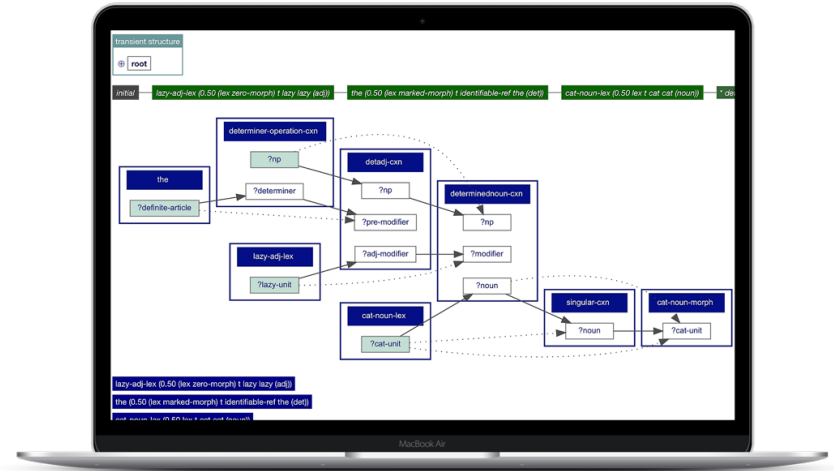
Verheyen, L., Botoko Ekila, J., Nevens, J., Van Eecke, P., & Beuls, K. (2025). Neuro-symbolic procedural semantics for explainable visual dialogue. *PLOS ONE*.

Babel

The all-in-one toolkit for multi-agent experiments on emergent communication

View on GitLab 

Get in touch 



<https://emergent-languages.org>

- » Experiment framework
- » Robot interface
- » Reasoning engine
- » Language engine



Sony CSL



PyFCG: Fluid Construction Grammar in Python

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Abstract

We present PyFCG, an open source software library that ports Fluid Construction Grammar (FCG) to the Python programming language. PyFCG enables its users to seamlessly integrate FCG functionality into Python programs, and to use FCG in combination with other libraries within Python's rich ecosystem. Apart from a general description of the library, this paper provides three walkthrough tutorials that demonstrate example usage of PyFCG in typical use cases of FCG: (i) formalising and testing construction grammar analyses, (ii) learning usage-based construction grammars from corpora, and (iii) implementing agent-based experiments on emergent communication.

of abstraction, thereby facilitating a uniform handling of both compositional and non-compositional linguistic phenomena.

FCG is primarily being used as the language representation, processing and learning component in agent-based models of linguistic communication. Such models simulate the emergence, evolution and acquisition of human languages in populations of artificial agents that take part in situated communicative interactions modelled after those that human language users continuously engage in (e.g. [van Trijp, 2016](#); [Beuls and Van Eecke, 2024](#)). Other common uses of FCG include the formalisation and computational operationalisation of construction grammar analyses (e.g. [Gerasymova, 2012](#); [Micelli, 2012](#)), and the corroboration of construction gram-

Sujets de mémoire

- ▶ PyFCG (multiple topics) - stage VUB AI Laboratory
 - ▶ Blockly interface
 - ▶ FFI vs HTTP benchmarking
 - ▶ Emergent communication experiments in Python
- ▶ Vector-symbolic architectures for advancing neuro-symbolic AI - stage VUB Digital Mathematics
- ▶ A tractable algorithm for merging nested feature structures (co-promoteur: Wim Vanhoof) - stage VUB AI Laboratory / Sony CSL Paris

Sujets de mémoire

- ▶ Belgian Anti-Phishing Shield (multiple topics) - stage Centre for Cyber Security Belgium (CCB)
- ▶ Improving LSFB Sign Recognition with Phonology (co-promoteurs B. Dumas + L. Meurant)
- ▶ Solving the MUHAI recipe execution benchmark with LLMs vs. qualitative simulation - stage UBremen (topic reserved)

Humans Learn Language from Situated Communicative Interactions. What about Machines?

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Humans acquire their native languages by taking part in communicative interactions with their caregivers. These interactions are meaningful, intentional, and situated in their everyday environment. The situated and communicative nature of the interactions is essential to the language acquisition process, as language learners depend on clues provided by the communicative environment to make sense of the utterances they perceive. As such, the linguistic knowledge they build up is rooted in linguistic forms, their meaning, and their communicative function. When it comes to machines, the situated, communicative, and interactional aspects of language learning are often passed over. This applies in particular to today's large language models (LLMs), where the input is predominantly text-based and where the distribution of character groups or words

Katrien Beuls, Paul Van Eecke; Humans Learn Language from Situated Communicative Interactions. What about Machines?. *Computational Linguistics* 2024; 50 (4): 1277–1311. doi: https://doi.org/10.1162/coli_a_00534

embodied AI
human-like AI
neuro-symbolic
artificial intelligence
computational linguistics
emergent communication
situated learning
natural language understanding
language emergence
self-organisation
evolutionary dynamics
evolutionary AI
multi-agent systems
language games

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