Project objectives and main hypotheses

It order to conduct the aforementioned experiments (language games), ALEAR uses mechanisms which include the necessary sensori-motor intelligence (for example for achieving joint attention), scripts for establishing the turn-taking interaction among agents, perceptual processes, processes that perform the conceptualisation of what to say and the expression of these conceptualisations in language (as speaker) and processes that perform the parsing of sentences and their interpretation in sensori-motor experience (as listener). They will further include strategies for diagnosing and repairing failures in communication by expanding or modifying conceptual and linguistic inventories, and strategies for consolidating and aligning these inventories based on feedback in the language game. Humanoid robots will thus evolve their own artificial languages adapted to the environ-ment and task settings with which they have to deal with.

Instead of focusing on only one aspect, such as object recognition or grammatical parsing, we hypothesise that the complete chain that links physical embodiment, perception, action, conceptualisation, language and pragmatics in comprehensive situated language games must be taken into account because there are crucial interdependencies which cannot be understood by studying each aspect in isolation. A whole systems approach is in some sense harder because all components have to be in place and work, but in the end it is necessary because it ensures that each component does the right thing (no more or less than is needed) and that the different components can mutually influence each other in a non-modular fashion, both for learning and for performance. For example, concept formation may influence language and may be influenced by language, acquisition of the affordances of objects may be stimulated and channelled by communicating about these objects with others, visual attention can be guided by communication, etc.

The project hypothesises that the intelligence of the artificial systems must be self-generated. Existing approaches are either based on designing or programming cognition and language by hand, which means that it relies entirely on the intelligence of the human programmer, or on acquiring concepts and language already developed by humans through statistical learning from human-generated data. Although this has yielded important results and applications, the project argues that this can never lead to adequate performance because conceptual and communication systems are complex adaptive systems undergoing constant change. So the project wants to understand how language and cognition can emerge autonomously by the interactions and cognitive operations of the agents themselves. We therefore do not try to mimic human conceptualisations or human languages but expect that the robots develop their own ways of conceptualising the world and their own artificial languages expressing these conceptualisations. We believe that it is only by synthesising the creative aspects of language and cognition that we will be able to build artificial agents that can participate actively in open-ended human interaction and dialogue in an unconstrained open real world environment.

The project hypothesises that a social, collective multi-agent viewpoint must be adopted instead of focusing on a single individual. This is based on the conviction that a single isolated individual can never arrive at complex cognitive capacity on his or her own. This is why feral children who develop in isolation from a human social group never acquire language, nor rich cognition. The multi-agent view makes it possible to study how artificial agents may (i) align the cognitive and language systems that they individually build up, (ii) build further on the competences of others so that they do not have to invent everything themselves, and (iii) motivate and stimulate each other in order to push the emergent languages and cognitive systems towards higher and higher levels of complexity.

The project hypothesises that an evolutionary or selectionist point of view must be adopted, not in the sense of genetic evolution but cultural evolution. This means that agents start from scratch, establish object identity and names through naming games, then move to perceptually grounded categories (like colours and shapes) co-evolving with terms to express them through guessing games, and then move to richer conceptualisations co-evolving with grammatical structures and more complex language games. The whole population hence gradually bootstraps and self-organises increasingly more complex languages and richer conceptual systems. Not only the developing conceptual repertoires, but also the perception and behaviours of the agents will be influenced by the emerging communication systems. The project will also investigate what happens when there is a flux in the population, with new agents entering or leaving. This puts additional pressures on the agents in the sense that the cognitive and linguistic systems they evolve must be resilient against cultural transmission and this can in turn be a cause of new structure.

alear

Artificial Language Evolution on Autonomous Robots

ALEAR

'Artificial Language Evolution on Autonomous Robots' is a tightly integrated focused project which aims at fundamental breakthroughs in understanding and synthesising the mechanisms achieving cognition and language. It engages in carefully controlled experiments in which autonomous humanoid robots self-organise rich conceptual frameworks and communication systems with similar features as those found in human languages. Language and cognition are seen as complex adaptive systems that are continuously shaped by the actions of their users.

The ALEAR approach

The project takes a 'whole systems' approach and tackles the complete chain from embodiment and sensorimotor action to conceptualisation and language. Concept formation and language invention and acquisition are embedded in situated interactions. The inventory of concepts, the strategies for grounding them in the world, and action co-evolve with the emergent artificial languages. Next to the required physical and cognitive capacities of each robotic agent, we also focus on the complex systems phenomena that appear when a group of such agents starts to interact in a distributed fashion.

The machinery required for these experiments will heavily push the state-of-the-art in all relevant technologies, particularly robotics, concept formation, computational linguistics, and A.I. We aim at rich sensors, actuators and robust, real-time performance of vision and motor control subsystems. We establish a sophisticated constraint-based conceptualisation of the world and effective parsing and production systems. Within ALEAR, we investigate how these systems can build up their competence autonomously and remain adaptive to cope with changing environments.

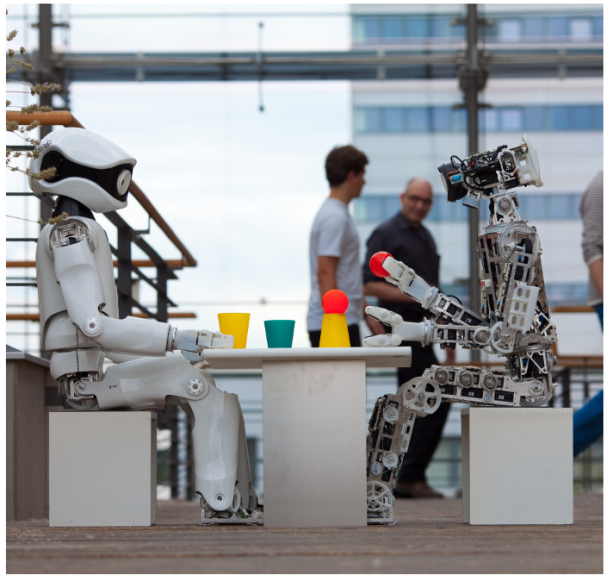
The project's orientation towards robotic experimentation is complemented by a search for an encompassing framework in which we seek to identify the principles underlying the evolution of human language-like cognition and to investigate in how far these principles are relevant to understand the most magnificent achievement of our own minds: language.

ALEAR divides the labour into several subfields: Embodiment, Behaviour, Perception, Conceptualization, and Language (Grammar). Next to these subfields, we collaborate on a platform for integrated experiments to ensure the "whole systems" philosophy of the project.

Project Partners

The ALEAR project is a tight cooperation of six research groups in Europe:

Humboldt-Universität zu Berlin, (Germany)
Sony Computer Science Laboratory Paris, (France)
Universität Osnabrück, (Germany)
Universitat Autonoma de Barcelona, (Spain)
Vrije Universiteit Brussel AI/COMO Lab. (Belgium)
University Alexandru Ioan Cuza of Iasi, (Romania)



Further information

The ALEAR project has a website which not only gives further information but also is continuously updated to include the latest news. Important results, like detailed reports, demonstrations or software frameworks can be downloaded from there, too.

http://www.alear.eu/

Project Funding and Support

The ALEAR project is part of the European Union's Seventh Framework programme (ICT FP7 Challenge 2: Cognitive Systems, Interaction, and Robotics).

SEVENTH FRAMEWORK PROGRAMME