Grounded Spatial Language Processing, Learning and Evolution

Michael Spranger
Sony Computer Science Laboratories Inc.
3-14-13 Higashi Gotanda
141-0022 Tokyo Email: michael.spranger@gmail.com

Abstract—This poster reports on an integrated research program on grounded spatial language processing, learning and evolution. We briefly discuss the research program and outline why we think it links A.I. with Cognitive Science in a fruitful way.

For a long time the scientific consensus was that much of spatial language is biologically determined. However, positions are shifting and an increasing community in Cognitive Science argues that language including spatial language is culturally determined [1, 2, 3]. The fact that spatial language is mostly a product of cultural negotiation raises interesting questions about its processing, learning and evolution. The languages of the world are very different. Yet humans are generally able to learn languages fast (especially in ontogeny) and adjust to different languages. Furthermore, humans actively shape and change language so as reflect changes in the ecosystem, as well as the cultural level.

This poster surveys recent research on locative spatial language that integrates various aspects of language to build a unified theory. The research aims can be summarized along well-established principles for scientific explanations defined in biology such as Tinbergen’s 4 principles [4]. For language in general and spatial language in particular, we need to answer the following questions.

1) What is the mechanism? This question targets the processing of spatial language and requires a mechanistic answer of how people conceptualise reality and how spatial grammar and lexicons function.

2) What is the function? Spatial language has a particular role in human communication in that it allows individuals to refer to specific objects using spatial relations. This question however goes deeper. We have to understand the particular role of spatial subsystems such as projective relations (front/back/left/right), and proximal relations (near/far) in association with other spatial systems such toponyms.

3) How is it acquired? To answer this question, we need to identify learning operators and the structure of learning situations.

4) How does it evolve? This question is primarily directed at language change. The spatial systems in use today are different from the once used by our ancestors. To understand these processes, we need to understand the mechanisms behind invention and alignment of language.

We explore these questions by building real-time artificial systems and testing our hypotheses in synthetic experiments. That is, we are interested in identifying concrete, implementable mechanisms that give rise to the phenomenon under investigation. For question 1 we built a large scale reconstruction of German locative spatial language including conceptualisation and linguistic processing. Question two is answered in experiments where agents are given parts of the reconstructed system to identify the exact function of spatial subsystems. Questions 3 and 4 are treated in experiments where agents start with little or no spatial language and have to acquire German locative language or evolve spatial language on their own.

Our approach is a whole systems approach spanning perception, semantics, syntax. It is inspired by Cognitive Science but at the same time tries to build actual systems that are more robust to noise, more adaptive and in the process more intelligent than traditional hand-crafted systems. Results of our research are applied in interactive systems such as personal digital assistants and consumer device interaction. We believe that linking empirical research with Artificial Intelligence in this way provides an excellent opportunity for progress beyond the state of the art.

REFERENCES


