Chapter VI

Language Evolution and Robotics:
Issues on Symbol Grounding and Language Acquisition

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Abstract

This chapter focuses on recent studies on the origins and evolution of language which have used multiple robot systems as their primary platform. After presenting some theoretical background regarding language evolution and the symbol grounding problem, the chapter discusses a number of themes within evolutionary linguistics that have been subject of robotic studies this far. These themes include categorisation, the formation of vocabularies, the evolution of grammar and the emergence of meaningful communication. Following this review, future avenues for research are discussed. The objective of the chapter is to present why robotics is a fruitful approach to study language origins and evolution, identify the main topics, report the major achievements and problems and provide a roadmap to future studies. The chapter concludes that robotics is, indeed, a very promising methodology to study language evolution and that, although many insights have been gained, we are still closer to the starting point than to the endpoint.
Introduction

One of the key aspects that distinguishes humans from other species is that humans use a complex communication system that is — among other things — symbolic, learned, compositional and recursive, whereas all other species’ communication systems typically lack these properties. It is often thought that this unique human feature is the key to understanding the nature (and nurture!) of human cognition. In order to understand the foundations of this distinction between humans and other species, scientists study the origins and evolution of language.

Traditionally, the origins and evolution of language has been studied by biologists, anthropologists, psychologists, palaeontologists, philosophers and linguists — although the Linguistic Society of Paris had strangely enough banned any studies on this issue between 1866 and 1974, because too many theories were proposed that were hard to verify at the time. With the recent advancements in computational resources, an increasing number of simulations studying various aspects of language origins and evolution have emerged (see, e.g., Briscoe, 2002; Cangelosi & Parisi, 2002; Kirby, 2002; Steels, 1997, for overviews).

Mostly, these computational studies incorporate a multi-agent system that can learn, or evolve, a communication system of varying complexity that allows the system to communicate about a predefined set of meanings. However, as human communication is about the real world, understanding the underlying principles of language requires an understanding of the mechanisms with which a language’s meanings are rooted in reality. Models based on predefined meanings therefore face what is often referred to as the symbol grounding problem (Harnad, 1990). A few studies have tried to tackle this problem using robotic models of language origins and evolution, most notably Marocco, Cangelosi, and Nolfi (2003), Steels, Kaplan, McIntyre, and van Looveren (2002), Steels and Vogt (1997), and Vogt (2000a).

In this chapter, I will present an overview of robotic (and other related) studies on the evolution of language. The aim is to present why robotics is a fruitful approach to study language origins and evolution, identify the main topics, report the major achievements and problems and provide a roadmap to future studies. Although I will cover most robotic studies on the evolution of language, the overview is not exhaustive and will, for instance, not cover studies on language learning robots, such as Oates, Eyler-Walker, and Cohen (2000), Roy (2000), Steels and Kaplan (2000), and Sugita and Tani (2005), since these deal with human-robot interaction rather than with multi-robot communication.

In the next section, I will provide some theoretical background on language evolution, discuss an alternative view on the symbol grounding problem and present some foundations toward studying language evolution using robots. Then I will present an overview of topics that have been studied in language evolution robotics. These topics will be illustrated with case studies and a critical review of the approaches taken. Following this, an outlook to future endeavours is presented, after which the chapter concludes.
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