Communication Orchestration with a Cognitive Architecture

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Introduction: The field of Neurotechnology involves the integration of brain science and computational technologies. In one of its facets, computational techniques are used to help in the diagnose and treatment of brain diseases [1]. A completely different facet uses brain science findings in order to foster the development of computational algorithms to simulate cognitive functions, as e.g. language. These algorithms are particularly useful within the field of cognitive architectures and can be used to control virtual or physical robots to assist or replace humans in several activities [2].
In this work we present a neuroscience inspired cognitive architecture that orchestrates virtual robots communication in order to create a semantic infrastructure to nominate environment objects. This infrastructure evolves gradually, without relying on pre-established rules.

Materials and Methods: We developed a cognitive architecture which was used to orchestrate and to simulate dialogs among robots from communities of different sizes (10, 50, and 100 virtual robots). In order to validate the system performance, the notion of language games was employed. A language game is a mechanism proposed by the philosopher Ludwig Wittgenstein to explain how words obtain meaning during established activities between a speaker and a listener [3]. This mechanism is a way of verifying if the robots are reaching linguistic consensus about the names of 4 objects.
In the proposed language game, the players are virtual robots and a mediator who grants them the permission to dialog. Several dialogs may be established in parallel. Nevertheless, the mediator allows two robots to dialog only if none of them is already talking.
In our experiment, the mediator maintains a list of playing robots and their current state. If a robot A (speaker) wants to talk to robot B (listener), the mediator checks if robot B is available. If not, robot A can not talk to robot B at the moment, and it can try another one. In the case both robots are available to talk, the mediator sends a positive feedback and the dialog is started. During the dialog, the speaker robot picks up an object, creates a name for it and utters it to the listener robot. If the name is already known by the listener, it indicates the corresponding object according to its own dictionary of names. Otherwise, the listener answers that it does not know that name. The game is only succesfull if the listener indicates the object which the speaker has picked up.
When the dialog is finished, the mediator updates the status of the robots. Then, the robots are once more available to start another dialog. There is a linguistic consensus among the robots in the community when all of them have the same dictionary of names.

Discussion and Results: The results indicate that the proposed cognitive architecture was specially interesting since many dialogs were established in parallel, apart from the size of the community. Moreover, the robots learned from their failing dialogs and their internal dictionaries converge towards a common language. Furthermore, the architecture does not depend on predefined linguistic terms and semantic rules, differently from traditional architectures in literature [4].

Conclusion: Our cognitive architecture is able to adequately simulate some aspects of language use among artificial agents. Since it does not depend on external synchronizing mechanisms and the linguistic consensus emerges evolutionarily, its performance is biologically plausible.

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