EUROPEAN SCIENCE FOUNDATION

Research Networking Programmes

Short Visit Grant ☒ or Exchange Visit Grant ☐

(please tick the relevant box)

Scientific Report

The scientific report (WORD or PDF file – maximum of eight A4 pages) should be submitted online within one month of the event. It will be published on the ESF website.

Proposal Title: Co-authoring a chapter on "Computational and algorithmic modeling of the mental lexicon" for the NetWordS volume

Application Reference N°: 7286

1) Purpose of the visit

Initially, visit was planned as work on the chapter for the NetWordS volume "Word Knowledge and Word Usage: A Cross-disciplinary Guide to the Mental Lexicon", an editorial project to be published by the De Gruyter Mouton Publishers. The chapter entitled "Computational and algorithmic modeling of the mental lexicon" is envisaged to describe the respective contributions that computational and algorithmic models of the mental lexicon can offer for a deeper understanding of how words are organized and how they function in the brain. Crucially, authors of the chapter are developing two such models, which are proven to be successful explanatory frameworks for a wide range of language processing phenomena.

The first model is developed in Pisa, at the Institute for Computational Linguistics, representing a specific, carefully developed system that belongs to a class of Temporal Self-Organizing Map models (TSOM: Koutnik, 2007; Pirrelli et al., 2011; Ferro et al. 2011; Marzi et al. 2012; Pirrelli et al., 2015 etc.). The second model is developed by the Tübingen's Quantitative Linguistics group, at the Eberhard Karls University, and it is based on the famous Rescorla-Wagner learning rule (Rescorla & Wagner, 1972; Ramscar & Yarlett, 2007), and is labeled the Naive Discrimination Learning model (NDL: Baayen et al., 2011; Milin et al., 2015 etc.). Both models provide an empirical basis for analyzing wide range of language-related hypotheses, from lexical acquisition and processing, to bi-/multi-linguism. Although two models are grounded on distinctive principles, they also show important formal similarities.

2) Description of the work carried out during the visit

During the work with the Computational Linguistics group from Pisa (Prof. Vito Pirrelli, Dr. Claudia Marzi, Dr. Marcello Ferro), at the Institute for Computational Linguistics, we have concentrated on establishing full formal (i.e., mathematical) analysis of similarities and differences of the two models. We carefully considered how to provide a realistic test-case example for the models, which could serve many colleagues to get familiarized with the principles of computational/algorithmic modeling within the broad field of word processing.

In few days we managed to build a detailed list of highlights for the chapter, to define formal similarities of the two models, and to specify procedures for intersecting two models onto the same research question. We have discussed in greatest detail how to provide a historical overview of the subfield of computational/algorithmic modeling, and we harmonized many methodological and terminological points.

Furthermore, we applied a state-of-the-art statistical procedures, where we have analyzed empirical results from modeling experiments using Pisa's TSOM system, the same we did with comparable results of the Tübingen's NDL. We used a range of techniques for describing distributional properties of the learning outcomes from the TSOM. This led as to apply Generalized Additive Mixed Modeling (GAMM), which revealed many aspects of how TSOM learns about the words in Italian and German.

3) Description of the main results obtained

The joint work targeted an overall assessment and comparisons of how two computational/algorithmic models acquire specific knowledge about the words. For that, we tested several additive mixed models, which revealed striking results of how such, in essence simple computational systems, make use of different linguistic information and, consequently, achieve flexibility (plasticity or adaptability) and respective success. As showed previously, incremental learning under different training conditions (see, for example, Marzi et al., 2012; Pirrelli et al., 2015), revealed different importance of particular bits of linguistic information, across languages such as German and

Italian. These results have been compared with recent developments in the NDL model (see Milin et al., 2015). What should lead to exciting chapter of the NetWordS volume are formal similarities of the two models and compatible outcomes, since, currently, two models are addressing quite different empirical questions: while Pisa's TSOM achieves great success in modeling the earliest phases of processing, Tübingen's NDL skips these steps (remaining mainly agnostic and engaging principles of parsimony and naïveness) and focuses on later processes.

4) Future collaboration with host institution (if applicable)

The joint work started at the meeting in Pisa is going to continue in the coming future. At least three specific goals can be foreseen:

(a) work on integration of the two systems to cover both the earliest and later word processing, respectively, by the TSOM and NDL;

(b) advanced statistical modeling of various output measures provided by the systems, using the range of language atributes (i.e., independent variables, predictors), and focusing also on cross-language comparative description;

(c) comparative testing of the TSOM and NDL agains the results of various behavioral experiments.

5)* Projected publications / articles resulting or to result from the grant *(ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)

In a med-term perspective, a joint publication will be submitted to an A-Journal in the field of computational or quantitative linguistics. In the short-term, as planned, the integrated learning perspective will be published as chapter in the NetWordS volume.

6) Other comments (if any)

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