Deep learning combined to NLP-based approach for constraint acquisition problems

Sara SAHBAOUI[1] and Imade BENELALLAM[2]

SI2M Laboratory, National Institute of Statistics and Applied Economics, Irfane Instituts, Rabat, Morocco.
[1] s.sahbaoui@gmail.com
[2] imade.benelallam@ieee.org

Abstract

Nowadays, the extent of the constraint programming paradigm as a friendly user platform remains limited. This level of restriction is due to the necessary mathematical modelling and programming knowledge to address many different types of NP-complete decision problems, such as planning, scheduling, and resource optimization problems.

Constraint acquisition algorithms [1][3][5], passive or active learners, are based on version space learning. The user provides solutions and non-solutions of his problem, and the learning algorithm builds the target constraint network, defining the set of variables, domains and constraints. The user needs to know beforehand solutions and non-solutions of his problem for passive learning and must classify correctly the given solutions for active learning. In addition to that, the constraint acquisition algorithms need to ask the user too many questions, which can be simple or more complex queries, to build an accurate target constraint network. The membership queries asked can be complete or partial assignments of the set of variables, and the user must classify them as solutions or non-solutions of his problem.

For this reason, we aim to combine natural language processing, through a conversational agent, with constraint acquisition, in order to make constraint programming paradigm accessible to a larger number of potential users. The aim of this work is to build an intelligent constraint acquisition system (figure 1), allowing a novice user to express a problem he wishes to solve in natural language. The system models the problem stated as a constraint network, solves it and offers possible solutions to the user through a solver.

This system would be based on an intelligent conversational agent, who allows, through an automatic learning process and interactive learning, to analyse and process the problem asked by the user and define the variables, domains and constraints of the problem. Once the target constraint network is formalized, it is provided to the solver to solve it.
A deep automatic learning algorithm [2][6] is used to identify the elements of the formal representation of constraint network. It is important that the interactions

(questions / answers) with the user are optimized, and that the solver provides the user the best possible solutions.

To correctly formalize the problem, two requirements must be executed correctly: (a) Parsing the users question in natural language, (b) Correctly mapping the elements to the corresponding formal representation.

The first task is processed through natural language processing approaches. Recently, Deep Learning algorithms have made impressive improvements in NLP tasks [7] such as part of speech tagging, parsing and machine translation, with neural networks based on dense vector representations. Convolutional neural networks, recurrent neural networks and recursive neural networks are deep learning models, which applied to natural language processing, have good performance and results for the related tasks.
The approach we are adopting is to build a training database, through a variety of examples of users problems expressed in natural language, classified by domain, and train the neural model to correctly generate the parsing tree [8].

The mapping to the elements of the formal representation would be processed through a classification algorithm, which is a neural network model as well.
The formal representation of the problem is a constraint network, which is built from the elements identified from the user's utterance: The variables, domains and constraints. Once the consistency of the network verified, it is solved by the constraint solver.
The solutions provided to the user must be in an understandable format, not only assignments of variables, since assignments are in some cases not understood by the user.

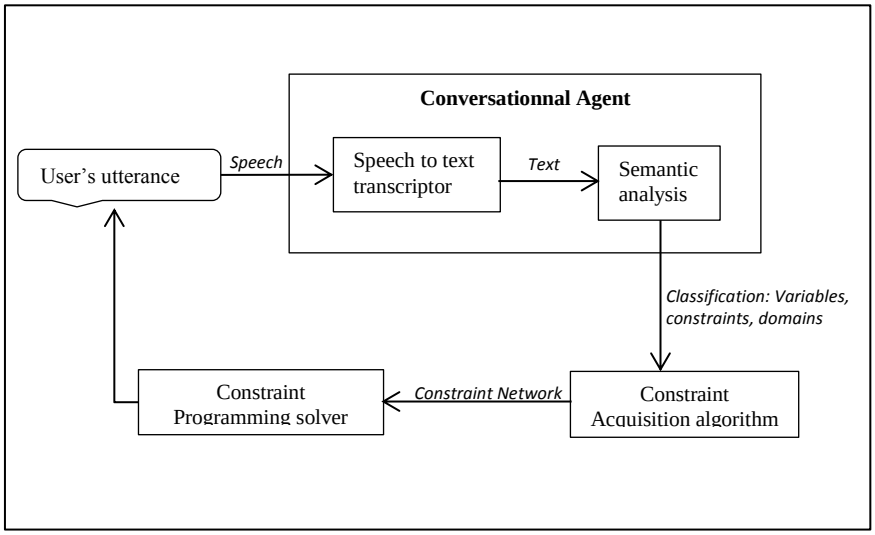

Fig.1: Targeted Acquisition system architecture

Keywords :
Constraint Acquisition, Constraint programming, Deep Learning, Constraint Solvers

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