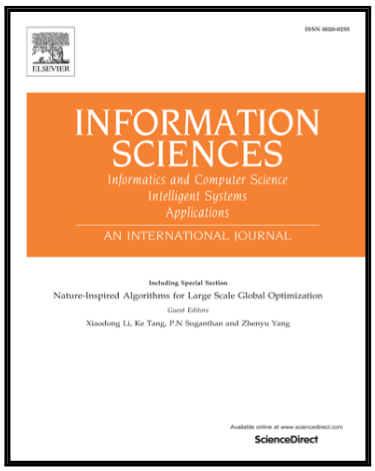

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Henrique F. de Arruda, Filipi N. Silva, Luciano da F. Costa, Diego R. Amancio

PII: S0020-0255(17)30929-5
DOI: 10.1016/j.ins.2017.08.091
Reference: INS 13096

To appear in: *Information Sciences*

Received date: 24 March 2017
Revised date: 27 August 2017
Accepted date: 31 August 2017

Please cite this article as: Henrique F. de Arruda, Filipi N. Silva, Luciano da F. Costa, Diego R. Amancio, Knowledge Acquisition: A Complex Networks Approach, *Information Sciences* (2017), doi: 10.1016/j.ins.2017.08.091

Knowledge Acquisition: A Complex Networks Approach

Henrique F. de Arruda[a], Filipi N. Silva[b], Luciano da F. Costa[b], Diego R. Amancio[a]

[a]*Institute of Mathematics and Computer Science, University of São Paulo, PO Box 668, 13560-970, São Carlos, SP, Brazil.*
[b]*São Carlos Institute of Physics, University of São Paulo, PO Box 369, 13560-970, São Carlos, SP, Brazil*

Abstract

Complex networks have been found to provide a good representation of knowledge. In this context, the discovery process can be modeled in terms of a dynamic process such as agents moving in a knowledge space. Recent studies proposed more realistic dynamics which can be influenced by the visibility of the agents, or by their memory. However, rather than dealing with these two concepts separately, in this study we propose a multi-agent random walk model for knowledge acquisition that integrates both these aspects. More specifically, we employed the true self avoiding walk modified to incorporate a type of stochastic flight. Such flights depend on fields of visibility emanating from the various agents, in an attempt to model the influence between researchers. The proposed framework has been illustrated considering a set of network models and two real-world networks, one generated from Wikipedia (articles from biology and mathematics) and another from the Web of Science comprising only the area of complex networks. The results were analyzed globally and by regions. In the global analysis, we found that most of the dynamics parameters do not affect significantly the discovery process. Yet, the local analysis revealed a substantial difference in performance, depending on the local topology. In particular, dynamics taking place at the core of the networks tended to enhance knowledge acquisition. The choice of the parameters controlling the dynamics were found to have little impact on the performance for the considered knowledge networks, even at the local scale.

Keywords: complex networks, knowledge acquisition, network search, network dynamics

1. Introduction

Understanding how science works and evolves has become an important subject of study over the last few years. Science itself can be seen as a complex system, approachable through concepts from many disciplines such as physics, statistics, linguistics, and information science. Knowledge, as acquired by humans, can be understood as being a subset of the knowledge underlyng nature as a whole. Moreover, human knowledge is constantly evolving and growing. This evolution has been studied by computational means (e.g. [18]). In particular, scientometry emerged as a new research area aimed at studying how science develops. Among such studies are those related to the modeling of the discovery process [26], which are, in general, based on investigations of the structure and dynamics of a knowledge space. Such dynamics usually involves researchers acquiring and exchanging information. Furthermore, the discovery process must take into account how knowledge is itself organized [39].

Understanding how knowledge acquisition takes place, and how its efficiency can be influenced by several elements, can contribute to improve the learning processes itself. A related study was conducted by Silva *et al* [41], and it was shown that discoveries in mathematics, in particular theorems, are more likely to take place at the borders of the respective knowledge network. Collective problem solving was studied elsewhere [20]. In order to understand the knowledge acquisition dynamics, some key elements need to be considered: (i) how researchers choose their research topics; (ii) the way they spread results; (iii) how fast

Email address: diego.raphael@gmail.com (Diego R. Amancio)