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Author: David Jesenko Marjan Mernik Borut Žalik Domen Mongus



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1 Two-level Evolutionary Algorithm for Discovering  
2 Relations Between Nodes' Features in a Complex  
3 Network

4 David Jesenko\*, Marjan Mernik, Borut Žalik, Domen Mongus  
5 *University of Maribor, Faculty of Electrical Engineering and Computer Science, Smetanova*  
6 *17, SI-2000 Maribor, Slovenia*

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7 **Abstract**

8 Complex network theory offers an efficient mathematical framework for mod-  
9 elling natural phenomena. However, these studies focus mainly on the topolog-  
10 ical characteristics of networks, while the actual reasons behind the networks'  
11 formation remain overlooked. This paper proposes a new approach to com-  
12 plex network analysis. By searching for the optimal functional definition of the  
13 network's edge set, it allows an examination of the influences of the physical  
14 properties of the nodes on the network's structure and behaviour (i.e. changes  
15 of the network's structure when the physical properties of nodes change). A two-  
16 level evolutionary algorithm is proposed for this purpose, whereby the search  
17 for a suitable function form is achieved at the first level, while the second level  
18 is used for optimal function fitting. In this way, not only the features with the  
19 largest influences are identified, but also the intensities of their influences are  
20 estimated. Synthetic networks are examined in order to show the superiority of  
21 the proposed approach over traditional machine learning algorithms, while the  
22 applicability of the proposed method is demonstrated on a real-world study of  
23 the behaviour of biological cells.

24 *Keywords:* complex networks, topology, function fitting, machine learning,  
25 evolutionary algorithms

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\*Corresponding author. Tel.: +386-2-220-7476; fax: +386-2-220-7272.  
Email address: david.jesenko@um.si (David Jesenko)  
URL: <http://gemma.feri.um.si> (David Jesenko)

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