

## REVIEW

by Velislava Noreva Lyubenova, DSc

Professor at Institute of Robotics, Bulgarian Academy of Sciences (BAS)

of materials submitted for competition

for the academic position “Associate Professor” at Institute of Information and Communication

Technologies (IICT)- BAS

in speciality Informatics, professional direction 4.6. Informatics and computer sciences

In accordance with the order No. 180 / 19.07.2019 of the Director of IICT-BAS and the decision of the scientific jury I was selected as a reviewer of a competition for associate professor, announced in State Gazette No. 41 dated 21.05.2019 for the needs of the Department “Hierarchical Systems“. Documents for participation in the competition were submitted by Dr. Eng. Boryana Emilova Vachova, Chief Assistant at IICT-BAS.

### 1. Short biographical information

Chief Assistant Dr. Eng. Boryana Emilova Vachova graduated in 1992 in the Technical University, Sofia, Faculty of Automation, speciality in Systems and Control with the qualification of Electronics and Automation Engineer. In 2009 he received a PhD in specialty 02.21.10 "Application of the principles and methods of cybernetics in various fields of science" with a dissertation on "Extraction and evaluation of the reliability of knowledge for multifactorial technological processes". Since 1995 she has been working at the Institute of Computer and Communication Systems - BAS, having held the positions of Research Associate III until 2006 and Research Assistant II until 2010. From 2010 until now he is the Chief Assistant at the Institute of Information and Communication Technologies-BAS in the Department “Hierarchical Systems“.

### 2. General description of the presented materials

The materials presented by Dr. Boryana Vachova have been prepared in accordance with Act for the Development of the Academic Staff in the Republic of Bulgaria, Rules for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria, as well as with the specific requirements of the Regulations of BAS and IICT-BAS.

These include an application, a curriculum vitae for a European form, a copy of the diploma for a doctoral degree, a certificate of internship in the field, a list of scientific publications for participation in the competition, a list of citations, summaries of scientific publications for participation in the competition. Bulgarian and English, copies of scientific publications for participation in the competition, reference for meeting the minimum requirements of IICT, reference for original scientific and applied contributions, declaration that there is no proven plagiarism in the scientific works and other activities.

The reference to the minimum requirements of IICT for the academic position of Assistant Professor indicates that they have been met on all indicators with evidence presented. The points have been calculated according to the latest changes adopted by the Minutes of the 48th Session of the 7th General Assembly of the Bulgarian Academy of Sciences (20.05.2019) for the professional field 4.6 Computer Science and Computer Science.

To participate in the competition, Dr. Vachova submitted one monograph in Bulgarian and 15 scientific publications in English for the period 2005-2019. All publications are indexed in WoS and Scopus. Two publications are in the Journal of Intelligent & Fuzzy Systems and have an impact factor of 1.594 and 1.426, and 10 publications have an SJR. The publications were distributed by publishing houses as follows: 7 of them were published in IOS Press; 3 at Springer Nature Press; 3 in IEEE Press; 1 in the WSEAS Press and 1 publication was printed during the IADIS European Conference Mining in Rome, Italy. Of the publications presented in the competition, 3 are self-contained, including the monograph, 2 are co-authored with two authors, 6 with three authors and 5 with four authors.

Chief Assist. Dr. Eng. Boryana Vachova participates in the competition with 15 citations and 3 international scientific and educational projects under the Erasmus program.

### **3. General characteristics of the applicant's activities**

Chief Assist. Boryana Vachova, PhD, is an established specialist in the field of modeling complex systems based on knowledge. The research methodology in the presented publications is based on the methods of artificial intelligence and multi-valued logic.

During 2012, she participated in the development of an individual post-doctoral project on "Adaptive Methods for Complex Processes Characterized by Uncertainty, Non-Linearity and Non-Stationarity" sponsored by DAAD, Technical University of Dresden, Germany as well as in other international and national projects at the Institute. For the period 2011-2020 she is head of



the Erasmus and Erasmus+ projects between IICT-BAS and the Department of Calculation at the University of Portsmouth, UK . For the period 2012-2019 delivered lectures in teaching mobility and organized seminars at the IICT-BAS related to the visits of the Portsmouth lecturers. Under the Erasmus program, she has participated in 3 international scientific and educational projects, as well as in a number of summer schools in the UK, Italy, Germany, Bulgaria. During the period 1995-2010 she took parts in several international seminars organized by the Technical University, Munich, Germany, ETH Zurich, Switzerland, Imperial Collage London, Manchester, United Kingdom.

She has taught as a Chief Assistant in “Fundamentals of Informatics” for Bachelors at the Higher School of Telecommunications and Post, HSTP, for the academic year 2016/2017, and from 2015 until now has been a part-time lecturer in the discipline of Software Engineering for Masters in HSTP.

Dr. Eng. Vachova is fluent in English and has developed software, incl. bank software based on OS UNIX, Informix DB. She has also worked with the MATLAB optimization package on transport tasks.

#### **4. Scientific and applied scientific contributions**

Dr. Vachova's scientific and applied contributions are completely in line with professional direction 4.6. Informatics and computer science. These include important tasks for modeling and managing complex processes and their application. The solutions are based on modern methods and approaches developed based on knowledge.

I accept the applicant's proposed 3 scientific and 3 scientific contributions, presented in the following groups:

##### ***Scientific contributions***

They are related to the development of:

1. Network structure model for knowledge extraction from complex processes.
2. Method for modeling multifactor nonlinear stochastic objects.
3. Method combining genetic algorithms and a gradient method for faster targeting of local extremums.

##### ***Scientific-applied contributions***

They are related to the development of:

1. A method of extracting knowledge of non-stationary processes by combining data into packages using the apparatus of Multi-Valued Logical Probability Function (MLPF).
2. Logical method for knowledge extraction based on experimental data on complex technological flotation process from the mining industry.  
and with
3. Application of innovative fuzzy network theory with a rules base for different types of complex processes and objects.

#### *Network structure model for knowledge extraction from complex processes*

The proposed network structure includes three layers: an input layer with the number of elements in it, corresponding to the number of input measurable factors in the object; an intermediate layer with a number of elements corresponding to the number of dominant grouped sets in the experimental input packet; output layer with number of elements corresponding to the number of realized logical values of one of the outputs of the object. The links between the elements of the three layers are made by transfer constants. The network model allows to calculate the logical values and the probability of realization of the output under consideration.

As an example, a network model with three inputs and one output was developed. It is applied to a technological process and is considered in detail in a publication [4]. In publication [14], the model is compared to that of MLPF (multivariate logical probability functions) with changing base of rules.

#### *Method for modeling multifactor nonlinear stochastic objects*

These features characterize complex objects from different fields of application such as technological, energy, thermal, transport, etc. The developed method is based on the conversion of experimental data from control objects into a multi-valued logical function and the related with it procedures (relation, interpolation). It provides an opportunity to estimate the maximum interpolation error for each particular MLF and further extract reliable, significant, covered and grounded knowledge. The method and its related applications have been repeatedly verified through real experimental data and brought to the level of practical application. The results are presented and reported in publications [8], [14] and the monograph.

#### *A method combining genetic algorithms and a gradient method for faster targeting of local extremums*



The method developed reduces the number of experiments and changes the number of arguments in the fitness function. The method not only directly targets the extremum, but also purposefully changes the velocity of the state coordinates according to the extremum sought. The results are reflected in a publication [3].

*A method of extracting knowledge of non-stationary processes by combining data into packages using a system of production rules Multi-Valued Logical Probability Function (MLPF)*

The method is based on algorithms including logical and statistical procedures, as well as flexible arrays of experimental data (old ones are dropped and new ones are introduced). This data is packaged into groups and transformed into logical values of functions of multivalued logic. These functions have some degree of probability for any logical value that is evaluated in real time. In this way, a new construction of the type of multi-valued logical and probabilistic functions is introduced, which expresses two interrelated parts - logical and probabilistic, which change in real time. The method is considered in a publication [11] and implemented in a publication [14]. In [13], real copper ore flotation data is used to simulate the flotation process using the methods of innovative theory for managing rule-based networks.

*Logical method for knowledge extraction based on experimental data on technological process for copper ore flotation*

A method for extracting knowledge from real data on complex mining processes is presented. Based on the transformation of data from numerical to relative and then in logical values, more accurate and reliable knowledge of the object under study is obtained. The created bases of rules of multivalued logic are used for predicting, controlling and analyzing complex processes characterized by uncertainty. The method was considered with real data from a passive experiment for copper ore flotation obtained under laboratory conditions and was published in [10]. An example is also discussed in the monograph.

*Application of the innovative theory of fuzzy networks with a rule base for different types of complex processes and objects*

Simulation investigations in MATLAB environment with the Fuzzy Logic Toolbox are carried out for systems including single-rule and multi-rule bases as well as rule-based networks. Real

data on the flotation process and other processes were used. The results are summarized and presented in the publications: [1], [2], [5], [6], [7], [9], [12], [15].

#### **5. Reflection of candidate's scientific publications in literature (known citations)**

Dr. Vachova has documented a total of 15 citations to 15 publications. In three of the publications the author is on the first place. Cited in specialized publications with IF and SJR are 6, those cited in web of science - 3, and in specialized publications without IF and SJR are 6. These data indicate that d-r Vachova' results are used by specialists working in the field.

#### **6. Assessment of the applicant's personal contribution**

The candidate's personal contribution is indisputable. She has 3 publications, where is the only author, one of which is a monograph and 2 publications in international conferences proceedings. In two of the publications she is the first author, and in the other publications her participation is on par with the other co-authors.

#### **7. Critical notes**

I have no critical remarks on the material presented by Dr. Boryana Vachkova.

#### **8. Conclusion**

The materials fully comply with the requirements of Act for the Development of the Academic Staff in the Republic of Bulgaria, Rules for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria, as well as the specific requirements in the Regulations of BAS and IICT-BAS.

After getting acquainted with the competition materials, the comprehensive evaluation of the applicant's qualities, including the scientific and applied scientific contributions, I strongly recommend Ch. Assistant Dr. Boryana Emilova Vachova to be elected to the academic position of Assistant Professor at IICT-BAS in the field of Informatics, professional field 4.6. Computer science and computer science.

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Sofia

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