ISSN: 2682 - 9517
№ 4 (1), 2019
INTERNATIONAL SCIENTIFIC CONFERENCE
OCTOBER 10-11, 2019 – PLOVDIV, BULGARIA
"ARTIFICIAL INTELLIGENCE AND E-LEADERSHIP"
AIEL - 2019
INSTITUTE OF INFORMATICS AND INNOVATIVE TECHNOLOGIES

ПРИЛОЖЕНИЯ НА ИЗКУСТВЕНИЯ ИНТЕЛЕКТ В БИЗНЕСА

Желязко Терзийски, Емил Хаджиколев, Маргарита Терзийска

ARTIFICIAL INTELLIGENCE IN BUSINESS APPLICATIONS

Zhelyazko Terziyski, Emil Hadzhikolev, Margarita Terziyska

terziyski@engineer.com, hadjikolev@uni-plovdiv.bg, m.terziyska@uft-plovdiv.bg

Abstract. Artificial Intelligence (AI) is widely used to solve various problems in science, technology, business, education, medical diagnostics, etc. In recent years, there has been an increased use of artificial intelligence techniques in business. However, most business managers are still not sure exactly when and how to apply AI techniques to get the most out of it. Therefore, the aim of this paper is to present the basic AI techniques (neural networks, fuzzy logic), the main business problems they can solved and to identify the different business domain in which they are applicable.

Key Words: изкуствен интелект; невронни мрежи; размита логика; прогнозиране; маркетинг; финанси; artificial intelligence; neural networks; fuzzy logic; neuro-fuzzy systems; business forecasting; marketing; finance..

INTRODUCTION

Artificial intelligence (AI) is all around us. It is widely used to solve various problems in science, technology, business, education, medical diagnostics, etc. AI is a computer science of teaching machines which think like humans. AI techniques mainly include artificial neural networks (ANN), fuzzy logic (FL), genetic algorithms (GA), but also a various hybrid systems like neuro-fuzzy systems (NFS), neuro-genetic systems, etc., which are a combination between two or more AI techniques.

The simplest definition of an artificial neural network is given in [1]. According to it, the neural network is defined as "a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs". A neural network is formed from a large number of artificial neurons, organized in layers. Each neuron receives signals from the others (in the form of numbers), sums them up, as the sum goes through an activation function. In such a way, the activation of the neuron is determined, which is transmitted through the output connections to the other neurons. Each connection has a weight, which multiplied by the signal, determines its significance. The weights of the connections are analogous to the strength of synaptic impulses transmitted between biological neurons. A negative weight value corresponds to a suppressive impulse, and a positive value to an excitatory one. This idea is graphically represented on fig. 1.

ANN is a powerful technique for solving complex approximation and classification problems due to their high generalization capability, their ability to handle the incomplete data and to learn and tune their parameters depending on a particular dataset using a learning algorithm. ANN has fault tolerance, which means that the corruption of one or more units of ANN does not prevent it from generating output. The ANN have numerical strength that can perform more than one job at the same time, i.e. it has a parallel processing ability. Even though ANN techniques possess these capabilities, these have some limitations. The best-known disadvantage of neural networks is their "black box" nature and the other one is that ANN provide very little insight into what these models really do. Also, the ANN needs large amount of training data and this makes them computationally expensive structures.

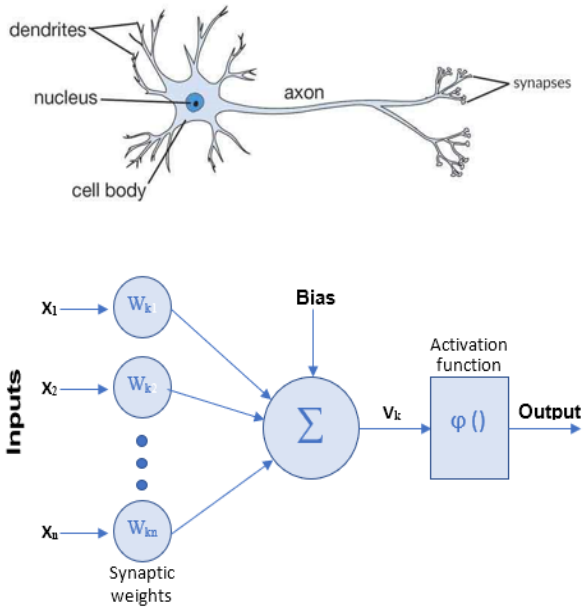

Fig. 1. Structure of biological and artificial neuron

Fuzzy logic is often used in our daily lives, even without paying attention to it. Classical logic implies that every sentence is either true or false. However, this standard creates a problem when describing ambiguous, inaccurate phenomena and formalizing intermediate situations. In such cases, it is convenient to use fuzzy logic. Fuzzy systems are structured numerical estimators. They start from highly formalized insights about the structure of categories found in the real world and then articulate the fuzzy IF-THEN rules as a kind of expert knowledge. Their inputs are represented as linguistic variables, which are derived from membership functions. The membership functions map input elements into a membership

grade (or membership value) in the fuzzy set. Fuzzy linguistic descriptions of the system are represented by the fuzzy IF-THEN rules. From the fuzzy implication relation we can get the consequence (conclusion) of each rule. Usually the centroid of the response is used to generate the system output. However, fuzzy systems encounter different difficulties, such as how to determine the fuzzy logic rules and the membership functions.

As an extension of ordinary fuzzy sets (called Type-1) Zadeh [2] has been proposed the concept of Type-2 fuzzy sets. Subsequently, Mendel and Karnik developed a complete theory of Type-2 fuzzy logic systems (FLSs) [3-4]. Type-2 fuzzy systems are suitable to handle the data uncertainty. Unfortunately, Type-2 fuzzy sets are more difficult to use and understand than are Type-1 fuzzy sets. The schematic representation of an Interval Fuzzy Set with upper and lower membership functions and Footprint of Uncertainty (FOU) is given on Fig. 2.

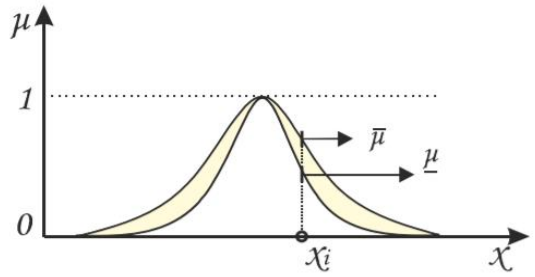

Fig. 2. Interval Type-2 Fuzzy Set with upper and lower membership functions and Footprint of Uncertainty (colored)

Another type fuzzy logic, which could successfully dealing with uncertainties, is the Intuitionistic one. The Intuitionistic fuzzy logic appear as an alternative of Type-2 fuzzy logic. Atanassov [20] defines an Intuitionistic Fuzzy Set (IFS) A in over a finite universal set E as an object with the following form:

$$A = \{(x, \mu_A(x), \nu_A(x)) \mid x \in X\} \quad (1)$$

where μA : X → [0,1] and νA : X → [0,1] are such that 0≤ μA + νA ≤1, μA(x) denote a degree of membership of x A, νA(x) denote a degree of non-membership of x A. For each intuitionistic fuzzy set in X, we call πA(x)=1-μA-νA the degree on non-determinancy (uncertainty) or hesitation of x A. This parameter expresses a hesitation degree of whether x belongs to A or not and it is obviously 0≤ πA ≤1 for each x ϵ X. The schematic representation of an Intuitionistic Fuzzy set is given on Fig. 3.

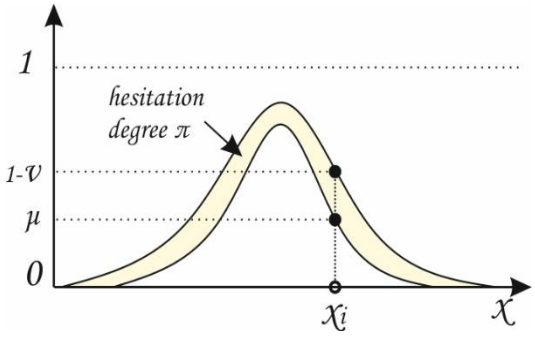

Fig. 3. Representation of an Intuitionistic Fuzzy set

The fusion of the fuzzy logic with the neural networks allows combining the learning and computational ability of neural networks with the human like IF-THEN thinking and reasoning of fuzzy system. This could be compared with the human brain [22] – the neural network concentrates on the structure of human brain, i.e., on the "hardware" whereas fuzzy logic system concentrates on the "software". Combining neural networks and fuzzy systems in one unified framework has become popular in the last few years.

In recent years, there has been an increased use of artificial intelligence techniques in business. Today, there are numerous applications of AI in the consumer and business spaces. In the business world, AI is enabling businesses to work smarter and faster, doing more with significantly less. Therefore, the aim of this paper is to present the basic AI techniques (neural networks, fuzzy logic), the main business problems they can solve and to identify the different business domain in which they are applicable.

AI IN BUSINESS PLANNING

Effective business planning is one of the most essential units of any business. A business plan deals with planning for different aspects of business. AI techniques has been used in business planning for decreasing information overload, real time and stressful decision problems, make easy up-to-date information, etc. Various AI techniques can be used in automating business planning decisions, especially highly uncertainty based decision problems. In [30] was proposed a RBF-based neuro-fuzzy system for scenario planning in project management in order to deal with uncertainties due to the external factors, shifting business objectives and poorly defined methods. Radial basis function was used for learning different situations in project management. An adaptive neuro-fuzzy inference system (ANFIS) for predicting the trustiness of business partners in a shared business relationship was presented in [11]. The system generate the monthly trust value between the two business partners, which could be low, medium or high. The authors determined the ANFIS model performance on the absolute percentage error. The error values suggest the efficiency of ANFIS for this forecasting problem.
NFS was used in the novel business planning applications like forecasting of intellectual capital of organization [12] and evaluate critical success factors to ERP implementation projects [13].

AI IN INFORMATION SYSTEMS

The information systems have become an important part of business for communication, inventory management, data management, management information system, customer relationship management and many other functions. AI are being used in this domain to decision problems like software cost estimation, information retrieval, software quality evaluation, etc. A ranked neuro fuzzy inference system (RNFIS) based on the combination of set of theoretic, vector space and knowledge-based systems was proposed in [27]. Each document in the list is in a zone, which has a relative importance as per its role in the query. Each of the zones had a fuzzy rule base associated with it. The parameters for this zone are derived from the vector space and the query expansion. The result of the fuzzy inference was the relevance level of each zone. To get the relevance of the whole document the relevance of different zones were combined using the ordered weighted average. In [14] authors used a NFS to predict the development cost of software. 22 software cost drivers are used as inputs to the neuro-fuzzy network. The cost drivers included 5 scale inputs and 17 effort multipliers which have an influence on the

development cost of the software. NFS generated the adjustment rating factors (ARF). The ARF and the numerical values obtained from ARF were passed to COCOMO model, which finished the cost estimation process. An ANFIS model to predict relationship between object-oriented metrics and software change proneness is presented [28]. In order to ascertain the model effectiveness area under the receiver operating characteristic technique was used. The researches also compared the performance of ANFIS with other techniques like bagging, logistic regression and decision trees. They concluded that ANFIS provided the best performance in comparison of other tested techniques applied to predict change susceptibility.

The complexity of aspect-oriented software was evaluated by an adaptive neuro-fuzzy inference system in [15]. The authors used three input parameters: complexity of attributes, nested components and operations. Three aspect-oriented languages namely CaesarJ, HyperJ and AspectJ were considered. The output estimates complexity of the component. The output of the system was divided into six complexity classes. The RMSE value calculated for the ANFIS-based system was 0.6309 which was better than simple fuzzy method.

AI IN FINANCE

The finance management is other important component of business for profitability of the business both in short-term and long-term periods. Artificial intelligence and machine learning have been widely used for banking, insurance investing, predicting a stock and FOREX markets, planning, coordinating activities, etc. Prediction of exchange rates could be categorized into fundamental and technical analysis methods. For prediction of exchange rates of the FOREX stock market in [25] is proposed a hybrid neuro-fuzzy system based on interval Type-2 fuzzy c-means clustering. The authors used a combination of back-resilient and back-propagation to obtain faster convergence. The performance of the model was analysed for the accuracy of the next day stock price prediction as well as the time for convergence. The performance of the model was compared with the c-means clustering-based type-1 NFS and functional fink artificial neural network NFS. The obtained results show the efficiency of the proposed modeling approach to handle FOREX stock market variations. To evaluate the effect of bad loans on technical efficiency of banks, a system which combines adaptive neuro fuzzy inference system and principal component analysis was presented [8]. In this model, the output of system was the efficiency modelled with respect to bad loans, cost and profit. ANFIS-based model for predicting the value of real estate was used in [9]. Many different scenarios were designed to proved that ANFIS is better than multiple regression analysis (MRA). The advantage of NFS was proved in all the test scenarios and indicated the potential of this technique in the area of real estate value estimation. A recurrent NFS for stock price time series forecasting was proposed in [10]. In this study researchers used the stock price current value and time series prediction for adjusting the NFS to obtain stock price prediction system with smallest forecasting error. The study shows that the ANFIS is much better than artificial neural network for stock price time series forecasting.

During the last years, in scientific literature are proposed various hybrid neuro fuzzy methodologies in the field of financy. However, the ANFIS is the most successful and widely used technique.

AI IN CLOUD MARKETING

The transition from enterprise software to Software as a service (SaaS) over the past decade has radically changed the business. The future of SaaS are ease of installation and upgrades, streamlined testing and minimizing large investments. Artificial Intelligence is an important part of the SaaS evolution [22]. Artificial intelligence essentially collects large ones amounts of data. AI and machine learning then distils the requested information into automatic processes that were previously carried out by people. The sustomer service artificial intelligence platforms such as chatbots, which automatically respond to customer questions and resolve them, ask customer service departments, are able to handle more questions between 30 - 40 percent [5, 24]. Thanks to the using of the artificial antelligence technology in customer service, employees will have more time to solve more important problems. Artificial intelligence makes customer personalization possible [6].

Consumers expect personal experiences that meet their unique needs. If they don't have that experience at that company, they will go to another company. Predictive analysis is perhaps the most essential of all Artificial Intelligence options. Machine Learning not only enables companies to identify and analyze what customers are doing now, but also what they will do in the future. The combination of historical data and predictive analysis, can discover models to determine what a consumer's next step is [7]. This predictive analysis helps better personalize marketing communication, to refine customer database and to further to customize the user's experience before making another decision in the buying cycle [17]. This active approach identifies customer's needs before they do it themselves.

AI AND BLOCKCHAIN

AI and blockchain concepts are spreading at a phenomenal rate. Both technologies play an important role in the Fourth Industrial Revolution (Industry 4.0) and have a significant impact on business. AI can help implement the blockchain technology. AI techniques can be used to optimize energy consumption, can improve the performance of hash function and in a such way to help solve privacy problems. Also, with AI techniques be predicted the likelihood of a node to fulfill certain mining task, to detect blockchain application layer intrusion issue, to form multi-agent system for generating virtual distributed ledger agent. In [18] the authors outlined several blockchain related implementation concerns and how AI techniques can help.

Recently, Bitcoin has attracted considerable attention in the fields of economics, cryptography, and computer science due to its inherent nature of combining encryption technology and monetary units. In [19] Bayesian neural networks is used to predict Bitcoin price time series. How to predict Bitcoin price using different Machine learning techniques is demonstrated in [30]. Deep Neural Networks are also used for Bitcoin price prediction. This is presented in [23].

CONCLUSIONS

The purpose of this article is to present various fields of activity in which artificial intelligence techniques have been successfully applied. Due to its limited volume, the article does not claim to have full scope of application. A sample of the publications available in the scientific databases is examined and the relevant inferences are made.

AI techniques are mainly used for prediction and for classification. AI techniques are mainly used for forecasting

and classification. In recent years, hybrid neural-fuzzy structures have been increasingly used in business applications. This is due to the limitations of the application of standalone AI techniques for different real-world problems. The limitations are generally attributed to the volume and vagueness of datasets, complexity of the real-world problems, lack of sufficient and uncertain or unclear information. Such problems can be successfully solved by including fuzzy logic, mainly Type-2 or Intuitionstic fuzzy logic.

ACKNOWLEDGMENTS

The work is funded by the SP19-FMI-012 project at the Research Fund of the Plovdiv University "Paisii Hilendarski".

REFERENCES

1. Caudill, M. Neural Network Primer: Part I. - *AI Expert*, Feb., 1989.
2. Zadeh, L A. The Concept of A Linguistic Variable and Its Application to Approximate Reasoning. - *Information Sciences*, Vol. 8, pp. 199-249, 1975.
3. Liang Q., J. Mendel. Interval Type-2 Fuzzy Logic Systems: Theory and Design. - *IEEE Trans. On Fuzzy Systems*, Vol. 8(5), pp. 535-550, 2000.
4. Karnik, N., J. Mendel, and Q. Liang. Type-2 Fuzzy Logic Systems. - *IEEE Trans. On Fuzzy Systems*, Vol. 7(6), pp. 643-658, 1999.
5. Radziwill, Nicole M. and Morgan C. Benton. Evaluating Quality of Chatbots and Intelligent Conversational Agents. *ArXiv* abs/1704.04579 (2017): n. pag.
6. Cheung, Kwok-Wai, et al. Mining customer product ratings for personalized marketing. *Decision Support Systems* 35.2 (2003): 231-243.
7. Lee, Wei-Po, Chih-Hung Liu, and Cheng-Che Lu. Intelligent agent-based systems for personalized recommendations in Internet commerce. *Expert Systems with Applications* 22.4 (2002): 275-284.
8. Hajialiakbari, Firoozaeh, et al. Assessment of the effect on technical efficiency of bad loans in banking industry: a principal component analysis and neuro-fuzzy system. *Neural Computing and Applications* 23.1 (2013): 315-322.
9. Guan, Jian, et al. Analyzing massive data sets: an adaptive fuzzy neural approach for prediction, with a real estate illustration. *Journal of organizational computing and electronic commerce* 24.1 (2014): 94-112.
10. Mahmud, Mohammad Sultan, and Phayung Meesad. An innovative recurrent error-based neuro-fuzzy system with momentum for stock price prediction. *Soft Computing* 20.10 (2016): 4173-4191.
11. Azadeh, Ali, et al. Improved trust prediction in business environments by adaptive neuro fuzzy inference systems. *International Journal of Advanced Research in Engineering* Vol 1(1) Apr – Jun 20154 (2015): 24.
12. Ahmad, Fahad, et al. Forecasting of intellectual capital by measuring innovation using adaptive neuro-fuzzy inference system. *International Review of Applied Sciences* 2.1 (2015): 1-13.
13. Gupta, Rekha, and S. Kazim Naqvi. A framework for applying critical success factors to ERP implementation projects. *International Journal of Business Information Systems* 17.4 (2014): 469-490.
14. Kashyap, Divya, Ashish Tripathi, and A. Misra. Software development effort and cost estimation: neuro-fuzzy model. *J. of Computer Engineering* 2.4 (2012): 12-14.
15. Momeni, H. and Yavari, A. Complexity evaluation of aspect-oriented software with adaptive neuro-fuzzy inference system. *International Journal of Basic Sciences and Applied Research, Vol. 3, No. 1, pp.22–30*.
16. Rajab, Sharifa, and Vinod Sharma. Neuro-fuzzy approach in business applications: a decade survey. *International Journal of Business Information Systems* 26.4 (2017): 451-487.
17. Zhang, Yu, Jianguo Yao, and Haibing Guan. Intelligent cloud resource management with deep reinforcement learning. *IEEE Cloud Computing* 4.6 (2017): 60-69.
18. Marwala, Tshilidzi; Xing, Bo. Blockchain and artificial intelligence. *arXiv* preprint arXiv:1802.04451, 2018.
19. JANG, Huisu; LEE, Jaewook. An empirical study on modeling and prediction of bitcoin prices with bayesian neural networks based on blockchain information. *Ieee Access*, 2017, 6: 5427-5437.
20. Atanassov, Krassimir T. Intuitionistic fuzzy sets. Intuitionistic fuzzy sets. Physica, Heidelberg, 1999, 1-137.
21. Alavala, Ch. R. Fuzzy Logic and Neural Networks: Basic Concepts and Applications, New Age Int. Pvt. Ltd. Publishers, December 2008.
22. Nassim L.M., Ramdane M. Intelligent Business Process Based Cloud Services. In: Rocha A., Correia A., Costanzo S., Reis L. (eds) New Contributions in Information Systems and Technologies. Advances in Intelligent Systems and Computing, 2015, vol 354. Springer, Cham.
23. Appel, Michelle. Bitcoin price prediction using Deep Neural Networks. Thesis for the degree of Bachelor of Science in Artificial Intelligence, University of Amsterdam, June 2016.
24. Satu, Md Shahriare, and Md Hasnat Parvez. Review of integrated applications with aiml based chatbot. 2015 International Conference on Computer and Information Engineering (ICCIE). IEEE, 2015.
25. Fallahzadeh, Emad, and Mohammad Ali Montazeri. Forecasting foreign exchange rates using an IT2 FCM based IT2 neuro-fuzzy System. 2013 21st Iranian Conference on Electrical Engineering (ICEE). IEEE, 2013.
26. Khatibi, Vahid, Siamak Haji Yakhchali, and Abbas Keramati. "An RBF-based neuro-fuzzy system for scenario planning in project management." International conference on financial management and economics. Vol. 11. 2011.
27. Nawaz, Asif, and Aasia Khanum. Ranked neuro fuzzy inference system (RNFIS) for information retrieval. International Symposium on Neural Networks. Springer, Berlin, Heidelberg, 2011.
28. Peer, Akshit, and Ruchika Malhotra. Application of adaptive neuro-fuzzy inference system for predicting software change proneness. 2013 International Conference on Advances in Computing, Communications and Informatics (ICACCI). IEEE, 2013.
29. McNally, Sean, Jason Roche, and Simon Caton. Predicting the price of Bitcoin using Machine Learning. 2018 26th Euromicro International Conference on Parallel, Distributed and Network-based Processing (PDP). IEEE, 2018.
30. Khatibi, Vahid, Siamak Haji Yakhchali, and Abbas Keramati. An RBF-based neuro-fuzzy system for scenario planning in project management. International conference on financial management and economics. Vol. 11. 2011.