

ANNOTATION OF SCIENTIFIC WORKS
for participation in the contest for the academic position of “professor”
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A total of 30 scientific papers and one textbook have been selected for participation in the competition. Of these, 25 are indexed in SCOPUS and/or Web of Science databases. Seven (7) of the publications are in scientific journals with an impact factor (IF), while twelve (12) have SJR.

The summarized works have not been submitted for obtaining the educational and scientific degree "Doctor" or for applying for the academic positions of "Assistant Professor" and "Associate Professor". All of them have been published after attaining the academic position of "Associate Professor".

1. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva** & M. Milev. *AI-Powered Approaches for Hypersurface Reconstruction in Multidimensional Spaces*. Mathematics, 2024, vol. 12(20), 3285. <https://doi.org/10.3390/math12203285> **Web of Science (Q1, IF=2.3), SCOPUS (SJR=0.475)**

The article presents a study on the use of neural networks for the approximation and reconstruction of surfaces. The main goal is to develop a method for interpolating missing parts of surfaces, which has applications in archaeology, anthropology, medical diagnostics, geographic information systems, and more. Various approximation methods are examined, including Bézier curves, the k-nearest neighbors method, Principal Component Analysis, Markov Random Fields, and Conditional Random Fields. Although these methods provide good results, neural networks outperform traditional techniques in reconstructing complex geometric shapes.

A new approach is proposed, in which instead of using a single neural network with three outputs, three separate neural networks are employed, each approximating one coordinate function of the surface points. Tests have been conducted on various types of surfaces, and the influence of the neural network architecture, the number of layers and neurons, as well as the training algorithms used, has been analyzed. The experimental results demonstrate that this method improves accuracy and reduces reconstruction errors.

2. Borisova, M., **S. Hadzhikoleva** & E. Hadzhikolev. *ChatGPT as a tool for creating educational games for school education in computer technology*, International Conference on Virtual Learning, ISSN 2971-9291, ISSN-L 1844-8933, vol. 19, pp. 323-333, 2024. <https://doi.org/10.58503/icvl-v19y202427> **SCOPUS**

The possibilities of using the ChatGPT chatbot for creating educational games and implementing them in schools for teaching computer modeling and information technologies have been explored. This discipline develops logical thinking, problem-solving skills, and digital competencies. However, students often face difficulties in grasping abstract concepts such as algorithms, data structures, and programming language syntax.

The article proposes a methodology for game development that details the main activities, including defining the game's objectives, designing the game scenario, developing the content, adding adaptability and personalization, testing and improving the game, evaluating its effectiveness, and refining it. Specific requirements for formulating prompts for ChatGPT are outlined. Examples of creating three different types of games are presented, suitable for both reinforcing knowledge and skills and for students' self-directed learning. The main risks and limitations associated with the use of artificial intelligence in education are also highlighted.

3. **Hadzhikoleva, S.**, T. Rachovski, I. Ivanov, E. Hadzhikolev & G. Dimitrov. *Automated Test Creation Using Large Language Models: A Practical Application*. Applied Sciences, 2024, vol. 14(19), 9125. <https://doi.org/10.3390/app14199125> **Web of Science (Q1, IF=2.5), SCOPUS (SJR=0.508)**

This article presents the development of a software application for the automated generation and assessment of tests, with a primary focus on utilizing large language models with artificial intelligence. Emphasis is placed on the ability of educators to specify particular requirements when creating test questions, such as Bloom's taxonomy level, question difficulty, style, and the inclusion of feedback. Teachers can provide additional guidelines, such as avoiding misleading answer choices, generating questions that require critical thinking, incorporating real-world examples, including interdisciplinary questions, and ensuring concise and precise wording. Moreover, the system supports training specific skills, such as computational skills, problem-solving, data interpretation, research abilities, and more.

The application is developed on the Google Firebase cloud platform and utilizes the ChatGPT API for generating test questions. The article describes its architecture, main roles, functionalities, and development details. Experiments and screenshots illustrating key functionalities are presented.

The presented application for generating test questions using the ChatGPT API has multiple advantages compared to the direct use of the ChatGPT chatbot. It provides the ability to store, edit, and manage test questions, easy test configuration, reusability of created test questions and tests, and automated checking and evaluation of tests.

4. Georgiev, V., **S. Hadzhikoleva**, E. Hadzhikolev, *Impact of Global Country Indicators on Life Expectancy*, Computer Science and Interdisciplinary Research Journal, vol. 1(1), 2024. <https://doi.org/10.70862/CSIR.2024.0101-04>

The study of factors influencing life expectancy is essential for improving public health in a country, planning the needs for healthcare and social services, pension insurance, and more.

Understanding these factors enables the development and implementation of effective policies that enhance people's quality of life.

The article presents a study analyzing data from 195 countries, including 35 different characteristics – demographic, economic, healthcare, and educational – aiming to determine the factors influencing life expectancy. Various models were tested, including linear regression, Random Forest, Gradient Boosting, SVM, and artificial neural networks. During the model development process, different machine learning algorithms, feature combinations, and strategies for handling missing data were explored. The best-performing model was linear regression. The study found that reproductive characteristics, the number of people enrolled in higher education, and the number of general practitioners had the strongest correlation with life expectancy. A surprising discovery was that out-of-pocket healthcare expenses were not a leading factor in determining life expectancy. The models were evaluated using MSE, RMSE, MAE, and the coefficient of determination (R^2). The best models achieved an average error of 3.5%, equivalent to a 2.2-year deviation in life expectancy predictions.

5. Cheresharov, S., G. Dragomirov, G. Gustinov, **S. Hadzhikoleva**, K. Yotov. *Transforming Nursing Home Care: An Integrated Approach Using Sensors, AI, and Monitoring Technologies*. Computer Science and Interdisciplinary Research Journal, 2024 1(1). <https://doi.org/10.70862/CSIR.2024.0101-01>

The main challenges in elderly care include insufficient staff, the need for constant monitoring, and social isolation. This article presents an innovative system aimed at revolutionizing care in nursing homes. The proposed system integrates smart vital sign sensors, facial recognition cameras, and a radio-frequency call system, reducing the need for physical checks and improving communication between staff and residents. The inclusion of artificial intelligence for data analysis enables automatic detection of potential health issues and prediction of risk conditions.

The proposed model automates data collection and analysis processes, facilitates information exchange, and optimizes user interaction, significantly enhancing operational efficiency, quality of care, and user experience. The development and implementation of such integrated systems promise a transition toward more reliable, efficient, and easily manageable elderly care in nursing homes, setting a new standard in the digital healthcare environment.

6. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, M. Terziyska. *Comparative analysis in function approximation with neural networks and some basic polynomials*, Filomat 2024, vol. 38(32), pp. 11553–11582. <https://doi.org/10.2298/FIL2432553Y> **Web of science (Q2 IF=0,8) SCOPUS (SJR=0.353)**

The choice of an appropriate approximation method is a key step in solving a wide range of problems. It affects both the quality of the obtained solutions and the efficiency of the computational process. The article presents a study on different cases of approximation using a specific group of polynomials and artificial feedforward neural networks. A comparative analysis of the obtained results has been conducted.

The results show that polynomials outperform neural networks in small sample sizes, providing high interpolation accuracy and low computational complexity. However, as the data volume increases, neural networks demonstrate better generalization ability and lower prediction errors. Neural networks are more flexible and better adapted to complex relationships within the data. They offer superior long-term forecasting but require more computational resources and careful parameter tuning.

7. **Хаджиколева, С.,** М. Горгорова, Е. Хаджиколев, Г. Пашев. *Създаване на образователни игри с ChatGPT*. Сп. Образование и технологии, бр. 15, 2024, стр. 212-218, ISSN: 2535-1214. <https://doi.org/10.26883/2010.241.5981>

The study focuses on the possibilities of using generative artificial intelligence for creating educational games. Numerous experiments have been conducted with the ChatGPT chatbot, and it has been found that teachers can develop games with its assistance without requiring programming knowledge. The article describes the iterative process of game development, which includes the initial formulation of game requirements, testing, adding additional requirements related to functionality or design, improvements, debugging, and more. The basic requirements that need to be specified in the game creation prompt are detailed. The steps for generating HTML, CSS, and JavaScript code using ChatGPT are also outlined.

The article includes specific examples of interactive games, such as flashcards, quizzes, puzzles, matching games, and fill-in-the-blank exercises. These illustrate various ideas for using games in database learning. Creating educational games in this way offers many advantages – it allows for quick development of diverse interactive learning resources, it is accessible to any educator, and undoubtedly makes the learning process more enjoyable and engaging.

8. Горгорова, М., С. Гафтанджиева, **С. Хаджиколева**. *Използване на инструменти с изкуствен интелект в Moodle*, Втора национална научно-практическа конференция "Дигитална трансформация на образованието - проблеми и решения", 2024, ISSN 3033-0629, стр. 502-506, <https://www.conf-dte.bg/docs/2024/p-91.pdf>

The integration of artificial intelligence tools in Moodle and their application in the learning process is being studied. The following tools are presented: AI Text to Questions Generator, which automates the creation of test questions; AI Text to Image, which generates images for educational materials based on a given text and OpenAI Chat Block, which functions as a virtual assistant for students.

To evaluate the effectiveness of these tools, an experiment was conducted with students studying the "Databases" course. Within the study, students completed several tasks. With the help of the chatbot, they explored a new concept and applied it in practice. To assess the extent to which they had mastered the new ideas, they completed a short five-question test and answered a question about the advantages and disadvantages of the technology. The assigned tasks required students to demonstrate higher-order thinking skills. The study contributes to understanding the role of artificial intelligence in e-learning, highlighting certain risks and possible solutions.

9. Trankov, M., E. Hadzhikolev, **S. Hadzhikoleva**. *Machine learning algorithms in quality control of textile fiber manufacturing*. Journal of Theoretical and Applied Information Technology, 102(4), 2024, ISSN: 19928645. pp. 1673-1682. <https://www.jatit.org/volumes/Vol102No4/31Vol102No4.pdf> **SCOPUS (SJR=0,174)**

Predicting potential issues in the manufacturing process of textile fibers brings significant benefits. Detecting yarn quality defects at an early stage enables manufacturers to take preventive measures, thereby reducing the risk of defects and production waste.

The article presents a study on the application of machine learning methods in quality control for textile fiber production. The key challenges, objectives, and parameters related to yarn quality assessment are analyzed. The study utilizes four machine learning algorithms – Linear Regression, Logistic Regression, Decision Tree, and Random Forest – applied to production data related to various yarn characteristics. By analyzing data collected over a 20-day period, predictions are made for potential parameter deviations on the 21st day. The study highlights the potential of machine learning as a tool for automation and optimization of quality control in the textile industry.

10. Trankov, M., E. Hadzhikolev, **S. Hadzhikoleva**; *Model of a system for forecasting the production of textile fibers*. AIP Conference Proceedings, 24 January 2024; 2980 (1): 040001. <https://doi.org/10.1063/5.0184727> **SCOPUS (SJR=0.152)**

The manufacturing processes for creating textile fibers are highly complex. In general, the production of the final product – spools of thread – goes through multiple stages, different machines, and production workshops. Depending on the product type, various raw materials are used, different additional materials are added, and specific manufacturing activities are performed. Predicting the time required to complete an order is extremely important, as it allows for optimization of the production process. This prediction depends on numerous factors, including the type of product, planned production quantity, specifics of the manufacturing process, number of machines used and their setup time, availability of necessary raw materials in stock, free machines, and more.

The article presents the development of a software application for predicting the order fulfillment time for customer requests. Key factors for forecasting the production time of textile fibers have been identified. The system model and implementation details are presented. The work is illustrated with a specific example, and artificial intelligence algorithms have been used for prediction.

11. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, S. Cherescharov, *Finding the Optimal Topology of an Approximating Neural Network*. Mathematics, 2023, vol. 11(1):217, <https://doi.org/10.3390/math11010217> **Web of Science (Q1, IF=2.3), SCOPUS (SJR=2.475)**

The article presents a study on the topology of approximating artificial neural networks. The research focuses on neural networks with an equal number of neurons in each layer, trained using algorithms that utilize the Jacobian matrix. Common training methods used in practice

include Levenberg-Marquardt, Gauss-Newton, Bayesian Regularization, Scaled Conjugate Gradient, BFGS Quasi-Newton, and others. Based on the conditions embedded in the training procedures, a generalized formula has been derived to determine an upper bound on the number of hidden neurons in neural networks with multiple output neurons. Using this formula, an upper bound for the optimal number of hidden layers has also been found for the studied groups of neural networks. These formulas provide researchers with a useful tool for designing efficient neural networks with optimal topology.

The theoretical conclusions have been experimentally validated through modeling in MATLAB of multilayer neural networks approximating various target functions with one or more parameters. The results indicate that increasing the number of hidden layers beyond a certain threshold reduces efficiency, making the use of overly complex architectures unnecessary. For this reason, to achieve optimal results, it is advisable to use neural structures that adhere to the constraints on the number of hidden layers and neurons proposed by the derived formulas.

12. Terziyski, Z., M. Terziyska, I. Deseva, **S. Hadzhikoleva**, A. Krastanov, D. Mihaylova, E. Hadzhikolev, *PepLab Platform: Database and Software Tools for Analysis of Food-Derived Bioactive Peptides*, Applied Sciences. 2023, vol. 13(2):961, <https://doi.org/10.3390/app13020961>. **Web of Science (Q1, IF=2.5), SCOPUS (SJR=0.508)**

The article presents PepLab, an open web-based platform for the analysis of biologically active peptides derived from food sources. The platform includes a database of 2,764 peptide sequences, classified into 16 categories based on their biological activity and 7 categories based on their source of origin. PepLab supports peptide analysis, including retrieval of physicochemical properties of peptide sequences. Users can download data and results in a format suitable for further scientific research.

The platform offers prediction of undocumented and unexplored biological activities based on the analysis of amino acid sequences. This makes PepLab a valuable tool for researchers across various scientific fields.

13. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, St. Cheresharov, *A Method for Extrapolating Continuous Functions by Generating New Training Samples for Feedforward Artificial Neural Networks*. Axioms. 2023; 12(8):759. ISSN: 20751680, <https://doi.org/10.3390/axioms12080759>. **Web of Science (Q1, IF=1.9), SCOPUS**

Artificial neural networks are a powerful tool for approximating complex nonlinear dependencies, but traditional models exhibit significant error growth in long-term predictions. The aim of this study is to identify a method for improving the predictive capabilities of feedforward neural networks when forecasting values that lie outside the input-output range of the dataset. An iterative prediction algorithm is proposed, based on two key assumptions. The first is that predictions close to the statistical sample have significantly lower error compared to those further away from it. The second assumption is that the neural network can generate additional training data and use them for self-training to improve accuracy in predicting distant

values. The main hypothesis is that including predicted points as new training data leads to better extrapolation and a reduction in forecasting error.

The article presents the results of multiple experiments with various univariate and multivariate functions, comparing the predictions of neural networks before and after training with the proposed iterative algorithm. The results indicate that after undergoing the algorithm's stages, artificial neural networks significantly improve their interpolation accuracy for long-term forecasting, even for nonlinear and periodic functions, which are traditionally difficult to approximate.

14. Terziyski, Zh., M. Terziyska, **S. Hadzhikoleva**, I. Desseva, *A software tool for data mining of physicochemical properties of peptides*, BIO Web of Conferences, Volume 58, 03007, 2023, ISSN: 22731709, <https://doi.org/10.1051/bioconf/20235803007> eISSN: 2117-4458. **SCOPUS**

Biologically active peptides are of great interest to researchers in the field of bioinformatics due to their wide applications in medicine, the food industry, and the pharmaceutical industry. Studying their properties using traditional laboratory methods is expensive and time-consuming. However, the rapid advancement of technology in recent years has enabled the use of in silico methods.

The article presents a software tool that utilizes a data mining approach to identify the physicochemical properties of a specific peptide, including peptide length, atomic composition, molecular weight, aliphatic index, acid/base index, Boman index, isoelectric point, amino acid composition, and more. The application is designed to generate data to improve the accuracy of classification and prediction, as well as to assist in the design of new amino acid sequences. The tool's functionality is demonstrated with a specific example of amino acid sequence analysis.

15. Borisova, M., **S. Hadzhikoleva**, E. Hadzhikolev, M. Gorgorova, *Training of higher order thinking skills using ChatGPT*, International Conference on Virtual Learning, ISSN 2971-9291, ISSN-L 1844-8933, vol. 18, pp. 15-26, 2023. <https://doi.org/10.58503/icvl-v18y202301> **SCOPUS**

The article explores the use of ChatGPT for developing and assessing higher-order thinking skills based on Bloom's Taxonomy. The chatbot is examined and analyzed as a tool for generating educational resources that foster analysis, synthesis, and evaluation skills. In the presented experiment, ChatGPT was used to create tasks related to graph databases, formulating questions for analysis, synthesis of new knowledge, and evaluation of results. The study demonstrates that ChatGPT can effectively generate relevant questions that align with the cognitive levels of Bloom's Taxonomy.

Despite the advantages of ChatGPT, such as speed, accessibility, and flexibility, certain risks are highlighted, including the possibility of inaccuracies, lack of contextual awareness, and cultural or ethical challenges. The article concludes that ChatGPT can be a valuable tool in

education, but it should be used in combination with other methods and under expert supervision to ensure reliability and high-quality educational materials.

16. Borisova, M., **S. Hadzhikoleva**, E. Hadzhikolev, *Use of Artificial Intelligence technologies in studying the phenomenon of electric current in physics education*, International Conference on Virtual Learning, ISSN 2971-9291, ISSN-L 1844-8933, vol. 18, pp. 215-224, 2023. <https://doi.org/10.58503/icvl-v18y202318> **SCOPUS**

Achieving good results in physics and astronomy education requires demonstrating the physical laws and phenomena being studied to students. Modern technologies provide new opportunities to engage students through visualizations, experiments, and interactive tasks. This article explores applications suitable for physics education and shares practical experience from teaching the topic "Electric Current." The Tinkercad application was used for modeling electrical circuits and conducting experiments. A practical strategy is presented for using the ChatGPT AI chatbot to assist students in self-study and the development of educational assignments. The risks and limitations of using ChatGPT in the educational process are discussed, emphasizing the importance of critical thinking when interpreting its responses.

17. Orozova, D., N. Angelova, **S. Hadzhikoleva**, E. Hadzhikolev, *Models for quality assurance in higher education area*, International Conference on Virtual Learning, ISSN 2971-9291, ISSN-L 1844-8933, vol. 18, pp. 133-146, 2023. <https://doi.org/10.58503/icvl-v18y202311> **SCOPUS**

The article examines issues related to quality assurance in higher education. The need for specialized software systems to fully automate business processes related to assessment and accreditation is justified. Two quality assurance models are proposed, based on the idea of automated information transfer between higher education institutions and accrediting bodies – one with stronger integration and one with weaker integration. The decentralized model offers greater integration capabilities between the university's quality management system and other internal institutional systems, allowing for greater control over data. The centralized model minimizes the need for administrative support from universities but limits integration possibilities with existing university systems. Additionally, the article proposes a formal generalized net model for data processing in self-assessment procedures in higher education institutions. It includes processes such as data collection, integration, processing, and the generation of self-assessment reports.

The use of software systems based on the proposed models offers numerous advantages, including: centralization of the assessment processes, facilitating administration and monitoring; a common platform for asynchronous teamwork among users with different roles and responsibilities; accessibility, allowing work at any time and from any location; improved communication and transparency; automated generation of documentation; optimization of time and material resources; reduced likelihood of errors and more. Another key advantage is the more objective and standardized evaluation of higher education institutions, which simplifies their international comparison.

18. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, S. Cheresarov, *Neuro-Cybernetic System for Forecasting Electricity Consumption in the Bulgarian National Power System*. Sustainability, 2022, vol. 14(17):11074, <https://doi.org/10.3390/su141711074>. **Web of Science (Q2 IF=3.9), SCOPUS (SJR=0.664)**

The synergy between mathematics and computer science has led to the development of a wide range of algorithms, approaches, methods, and tools for forecasting. On one hand, this provides the flexibility to choose a specific approach for solving a given problem. On the other hand, it complicates the process of identifying the most effective solution.

The article presents a comprehensive system for forecasting electricity consumption in Bulgaria's National Power System. The primary objective is automated forecasting, combining mathematical methods and artificial neural networks to enhance prediction accuracy. An automated process is introduced, selecting the most effective forecasting method for key socio-economic factors, such as GDP, energy intensity, income levels, population size, and electricity prices. The developed model employs neural networks, which predict electricity consumption with lower error compared to classical methods.

19. Yotov, K., **S. Hadzhikoleva**, E. Hadzhikolev, D. Orozova, *Forecasting Electricity Consumption in a National Power System*, 2022 22nd International Symposium on Electrical Apparatus and Technologies (SIELA), Bourgas, Bulgaria, 2022, pp. 1-4, <https://doi.org/10.1109/SIELA54794.2022.9845743>. **SCOPUS**

The article focuses on the task of forecasting electricity consumption, examining the socio-economic and demographic factors that influence energy demand. A comprehensive multi-factor forecasting model is proposed, based on predictive data for significant factors. These predictive data are obtained through an automated testing process, which evaluates various methods and selects the one with the lowest error. The developed model structures the process into six key stages, covering selection of relevant factors, development of forecasting models for each factor and final consumption prediction using a neural network.

The model was tested for forecasting electricity consumption in Bulgaria's National Power System. The key selected indicators include Gross Domestic Product (GDP), average annual income per capita, electricity prices for industry and households, energy intensity, and population size. For forecasting total energy consumption, industrial sector consumption, and household consumption, neural networks were developed based on historical and projected data for these factors. The achieved accuracy rates are 97.9% for total energy consumption, 98.6% for industrial sector consumption and 97.9% for household consumption. All experiments were conducted using publicly available data from Bulgaria's National Statistical Institute.

20. Hadzhikolev, E., **S. Hadzhikoleva**, H. Hristov, E. Yonchev, V. Tsvetkov, *Modeling of Pedagogical Patterns in an E-learning System*, International Journal of Emerging Technologies in Learning (IJET), 16(24), 2021, pp. 205–219, <https://doi.org/10.3991/ijet.v16i24.26775>. **Web of Science, SCOPUS (SJR=0.632)**

Pedagogical patterns describe teaching ideas that can be applied in various ways across different disciplines and for different types of learners. Their use in e-learning offers numerous benefits for both students and educators.

The article proposes a concept for an instance of a pedagogical pattern, encapsulating specific learning content, methodological guidelines for educators, and information necessary for managing the learning process within an e-learning system. A conceptual model has been developed, incorporating key aspects such as identity, adaptability, methodological guidance, knowledge management, and assessment. The learning content can have multiple "views", presenting knowledge in different formats, such as text files, presentations, audio or video content, and interactive materials. Logical categories of characteristics and activities form the "aspects" of the instance, including methodology, adaptability, assessment, and more. From a functional perspective, the pedagogical pattern appears differently for different user roles within the software system. For example, learners see only the learning content, educators see both the learning content and methodological guidance and course authors manage various characteristics related to modeling learning adaptability through the pattern. The set of activities available to different roles forms multiple "interfaces" of the pedagogical pattern.

21. **Hadzhikoleva, S.**, A. Uzunov, E. Hadzhikolev, S. Cheresarov, *Conceptual Model of a Quality Assurance System in Higher Education*, 2022 21st International Symposium INFOTEH-JAHORINA (INFOTEH), East Sarajevo, Bosnia and Herzegovina, 2022, pp. 1-6, <https://doi.org/10.1109/INFOTEH53737.2022.9751316>. **Web of Science, SCOPUS**

The article proposes a model of a software ecosystem for quality assurance in higher education. It is based on the successful experience of the authors in developing the quality assurance software application COMPASS. The application has been successfully used in multiple accreditation procedures at Plovdiv University. It comprehensively supports activities such as modeling organizational structures, designing evaluation methodologies, configuring assessment procedures, and conducting self-assessment in compliance with the regulatory framework of National Evaluation and Accreditation Agency.

The proposed model builds upon COMPASS by adding new components: a Service Registry, a Document Repository, and a Registry of Units and Users. These components aim to standardize the process of automated data extraction and quality analysis from existing university software systems while ensuring controlled access. The Service Registry is responsible for standardizing access to internal and external information systems. Such digital ecosystems can significantly optimize accreditation processes and quality management in higher education.

22. Hadzhikolev, E., **S. Hadzhikoleva**, D. Orozova, K. Yotov, *A Comprehensive Approach to Assessing Higher and Lower Order Thinking Skills*, Lecture Notes in Networks and Systems, vol 338. 2022. Springer, Cham, pp 164–177, Electronic ISSN: 2367-3389, Print ISSN: 2367-3370, https://doi.org/10.1007/978-3-030-95929-6_13. **Web of Science, SCOPUS (SJR=0.151)**

The article proposes an integrated approach for assessing students' knowledge and skills. A formal model of a multi-component assessment software process is presented, consisting of six main stages, ranging from meta-model creation and test configuration to result analysis. The model aims to generalize the assessment process while also allowing for high personalization in the grading methodology. A software system implementing this process would provide educators with a flexible platform for experimenting with various standard and custom test construction and evaluation models. The ability to analyze and assess the applied models enables the selection of the most optimal and objective assessment method.

The assessment concepts are illustrated with a model based on Bloom's Taxonomy, where cognitive skills are categorized into higher-order and lower-order thinking skills. The applied methodology integrates a hierarchical multi-component assessment approach, in which theory and practice scores are normalized and combined into a final grade.

23. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, *Linear Separability as a Condition for Solving Multiple Problems by a Single Threshold Neuron*. In: Pandian, A.P., Fernando, X., Haoxiang, W. (eds) *Computer Networks, Big Data and IoT. Lecture Notes on Data Engineering and Communications Technologies*, vol 117. Springer, Singapore, 2022, pp 575–592, Electronic ISSN: 2367-4520, Print ISSN: 2367-4512, https://doi.org/10.1007/978-981-19-0898-9_46. **SCOPUS (SJR=0.125)**

The article examines linear separability as a fundamental condition for solving various problems using a single threshold neuron. It analyzes the mathematical representation of linearly separable classes and their significance for object classification in multidimensional space. The study explores the possibility of solving multiple different tasks using the same threshold neuron, emphasizing the need for an additional input parameter that specifies the particular task. This concept is illustrated with a concrete example of a neuron simultaneously solving the Boolean functions "AND" and "OR". A conclusion is drawn regarding the existence of a neuron capable of solving an infinite number of tasks. A necessary condition for this is that the definition sets of the tasks must be linearly separable by a surface in the input space, and there must exist parallel classification boundaries for separability for each individual task.

24. Йончев, Е., В. Цветков, **С. Хаджиколева**, *Формиране на компетентности за изграждане на електронни курсове с педагогически патерни*, Научни трудове на Съюза на учените в България – Пловдив, Серия Б – Естествени и хуманитарни науки, Том XXIII, 2022 г., ISSN 1311-9192 (Print), ISSN 2534-9376 (Online), стр. 98-103. https://usb-plovdiv.org/wp-content/uploads/2022/12/2022_natural_sciences_and_humanities_vol_XXIII.pdf

Pedagogical patterns are conceptual models that describe effective educational practices, which can be adapted and applied in various learning contexts. Their implementation in e-learning enhances learner engagement in the educational process and motivates them for more active learning. The article presents a study on creating educational content through the modeling of pedagogical patterns. An elective course was conducted at Plovdiv University "Paisii Hilendarski", aimed at providing students with knowledge about pedagogical patterns and their application in digital learning environments. During the course, students developed a two-day

online course in Moodle, where they were required to model a pedagogical pattern using various learning resources, interactive activities, and feedback tools. To explore students' opinions, two surveys were conducted – before and after the training. The results showed a significant increase in interest and satisfaction among participants. The findings contribute to the expansion of the methodological framework for using pedagogical patterns in digital education and provide guidelines for future improvements in e-learning.

25. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, *Model for Forecasting of Electricity Losses During Transmission and Distribution in an Electricity System*, International Journal of Engineering Trends and Technology, Volume 69 Issue 6, 93-98, 2021, ISSN: 2231 – 5381, <https://doi.org/10.14445/22315381/IJETT-V69I6P213>. **SCOPUS**

The study focuses on the task of forecasting electricity losses during transmission and distribution in Bulgaria's power system. Some losses can be predicted and assessed, while others are unpredictable, such as losses due to random failures, natural disasters, changes in maintenance schedules, unauthorized or illegal electricity consumption, and other factors. These unpredictable losses cannot be accurately forecasted using standard statistical methods or commonly known formulas. This challenge motivates the use of artificial neural networks, which can capture complex dependencies and nonlinearities in the data.

A neural network was developed and trained using electricity loss data for Bulgaria from 2000 to 2018, applying the Bayesian Regularization method. The results indicate that the model successfully predicts losses with an error of less than 2 thousand tons of oil equivalent (toe) for 2019 and forecasts a gradual decrease in losses to 120 thousand toe by 2024. This trend could be explained by improved energy efficiency in both the industrial sector and the power system. The proposed methodology can be applied to various energy systems for more precise planning and loss reduction.

26. Yotov, K., E. Hadzhikolev, **S. Hadzhikoleva**, *Influence of the price of electricity for the industry on the consumption in the economic sector in Bulgaria*, IOP Conference Series: Materials Science and Engineering, vol. 1031 (111), 2021, ISSN: 17578981, <https://doi.org/10.1088/1757-899X/1031/1/012084>. **SCOPUS**

The study examines the impact of electricity prices on consumption in Bulgaria's industrial sector. Numerous factors influence electricity consumption, including Gross Domestic Product (GDP), energy intensity, population size and income levels, expected temperatures, energy efficiency, fuel prices, and many others. Identifying, analyzing, and forecasting these factors, along with their underlying determinants, is an extremely complex and labor-intensive task. This complexity motivated experiments with artificial intelligence methods, which, in cases of multiple and intricate dependencies, provide more accurate predictions compared to traditional mathematical methods. Two neural networks were developed: Net_Ci, which forecasts future electricity prices and Net_Industry, which evaluates the relationship between electricity prices and industrial consumption. The training data for these networks were sourced from official records covering the period 2007–2018. Net_Ci was trained using the Levenberg-Marquardt algorithm, while Net_Industry was trained using Bayesian Regularization. The study confirms that an increase in electricity prices does not necessarily lead to a decrease in

consumption within the economy. The forecasts suggest a continued rise in both electricity prices and consumption.

27. Yotov, K., E. Hadzhikolev, **S. Hazdhikoleva**, *Determining the Number of Neurons in Artificial Neural Networks for Approximation, Trained with Algorithms Using the Jacobi Matrix*, Tem Journal, vol.9, No.4, 2020, ISSN: 2217-8309. <https://doi.org/10.18421/TEM94-02> Web of Science, SCOPUS (SJR=0.199)

The article presents a study aimed at supporting the search for an efficient neural network by determining constraints on the number of layers and the number of neurons within them. The subject of the research is approximating neural networks trained using algorithms that incorporate the Jacobian matrix in the error function. Formulas have been derived for upper bounds on the number of neurons, depending on the number of hidden layers, the number of parameters, and the training data. These formulas have been studied and experimentally validated. The conducted research confirms that searching for an efficient neural network with a number of hidden layers and neurons exceeding the limits defined by the formulas is meaningless.

The proposed formulas can be used for a preliminary evaluation of the topology of a neural network, helping to save time during modeling and enabling automated testing of neural networks with different configuration parameters. They are applicable to neural networks trained using methods such as Levenberg-Marquardt, Gauss-Newton, Bayesian Regularization, Scaled Conjugate Gradient, BFGS Quasi-Newton, and others that utilize the Jacobian matrix.

28. **Hadzhikoleva, S.**, D. Orozova, E. Hadzhikolev, N. Andonov, *Model of a Centralized System for Quality Assurance in Higher Education*, Proceedings of 2020 IEEE 10th International Conference on Intelligent Systems, pp. 87 - 92. <https://doi.org/10.1109/IS48319.2020.9199951> SCOPUS

The challenges in conducting assessment and accreditation procedures in higher education are briefly outlined, and the need for the development and integration of an automated software system is justified. A model is proposed to centralize and optimize these processes. It is based on previous experience and best practices from the COMPASS software system, developed and used at Plovdiv University for quality assurance in education. The developed model is described using generalized network notation and formalizes two main processes, which take place separately in the accrediting institution and the accredited institution. It is aligned with the regulatory framework and practices of Bulgaria's National Evaluation and Accreditation Agency. The study highlights that centralized orchestration of quality assurance procedures through a software application will optimize time and human resources, reduce errors and inaccuracies, and ensure greater transparency.

29. E. Hadzhikolev, K. Yotov, M. Trankov, **S. Hadzhikoleva**, *Use of Neural Networks in Assessing Knowledge and Skills of University Students*, Proceedings of ICERI2019 Conference, 11th-13th November 2019, Seville, Spain, pp. 7474-7484, <https://doi.org/10.21125/iceri.2019.1787>. Web of Science

The article examines the issue of fair assessment of students' knowledge and skills. The limitations of traditional assessment methods are analyzed, as they can sometimes be influenced by subjective factors, including the expertise and prior experience of the teaching staff, the approaches used, and other variables. The study explores the possibilities of automated assessment of students' knowledge and skills using artificial neural networks, aiming to enhance objectivity and reliability. A methodology is proposed to reduce subjectivity and account for the correlation between theoretical and practical results. The developed automated assessment model is based on four indicators: theoretical and practical knowledge, as well as theoretical and practical skills. These indicators are inspired by Bloom's Taxonomy and assess different levels of higher- and lower-order thinking skills. Experimental results show that neural networks can predict final grades with high accuracy, surpassing traditional assessment methods. In addition to neural networks, other machine learning algorithms, such as Random Forest and K-Nearest Neighbors were tested, also demonstrating high efficiency. The proposed methodology is applicable across various academic disciplines and can contribute to the advancement of modern educational practices.

30. **Hadzhikoleva, S.**, Z. Raykova, E. Hadzhikolev, *A pedagogical framework to form scientific competencies in bachelor students by a specialized course*, International journal of scientific & technology research, vol. 8, issue 9, September 2019, ISSN 2277-8616, pp. 1088-1092, <https://www.scopus.com/record/display.uri?eid=2-s2.0-85073591446&origin=resultslist&sort=plf-f>. **SCOPUS**

The article proposes a pedagogical framework for developing scientific competencies in undergraduate students through a specialized academic course. The methodology was tested in an experimental course at Plovdiv University, which included a variety of practical tasks simulating real scientific work. Students progressed through several key stages, including conducting research, creating and editing scientific texts, peer reviewing, preparing and presenting reports, participating in discussions, and evaluating the presentations of their peers. The effectiveness of the course was assessed through a student survey, with results indicating that the applied teaching methods were beneficial for the development of critical thinking and analytical skills. The findings support the integration of scientific competencies into undergraduate education, emphasizing the importance of specialized courses in motivating students to engage in research activities. The proposed pedagogical framework can be adapted to various academic disciplines, and individual components can be integrated into traditional university courses to support students in developing their research potential.

31. Emil Hadzhikolev, **Stanka Hadzhikoleva**, Kostadin Yotov, Zhelyazko Terziyski, *Introduction to Databases*, University Publishing House "Paisii Hilendarski", 2023, 236 pages, ISBN 978-619-202-821-3.

The textbook aims to provide a comprehensive and systematic approach to the study of relational databases, integrating theoretical concepts with practical applications. The learning content is structured into two main sections, ensuring a smooth transition from fundamental knowledge to practical skills.

The first section, "Database Theory," consists of eleven chapters covering core concepts and key principles, including database structure and management, the relational model, the Entity-Relationship model, normalization, and the principles of transaction management.

The second section, "Practical Guide to Working with SQL", focuses on Transact-SQL and MySQL, providing numerous examples and hands-on exercises for working with databases.

Each section includes questions and self-study tasks that help reinforce the material and solidify learning. The textbook is intended for students specializing in the professional fields 1.3. "Methods of Teaching..." and 4.5. "Mathematics."

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February 12, 2025