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DEVELOPMENT OF LOCK-FREE APPROACH FOR SHARED MEMORY ORGANISATION IN REAL-TIME MULTI-THREADING APPLICATIONS

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The development vector of modern central processing units, which increasingly involves using a more significant number of cores and prioritizing parallelism over the high power of a single computational unit, presents new challenges for the existing software design. This work investigates and addresses the problem of access to shared memory in multithreaded environments, such as operating systems, interactive distributed computing systems, and high-performance simulation systems. Thus, the object of study is a non-blocking approach to organizing access to memory and performing basic operations with it through non-blocking synchronization.

The research methods include developing an approach to organizing access to shared memory using the double-word compare-and-swap algorithm, followed by a theoretical and practical comparison of the resulting outcome with the standard blocking access algorithm to shared memory for different configurations of the number of threads and the number of simultaneous memory access attempts. Additionally, testing was conducted within the framework of an unnamed closed-source project by integrating the solution into it, followed by A/B testing.

The results showed that using non-blocking approaches is advisable, especially in comparison with locking approaches, which demonstrated a performance degradation relative to the standard allocation algorithm by more than 300 %, while non-blocking approaches provided an improvement of 40–90 %. It was also found that using hybrid approaches to the organization of shared memory systems at the software level can lead to more stable results and mitigate application performance degradation compared to classical approaches such as buddy algorithms or free lists.

Despite the results obtained, the author remains cautious about the idea of memory management and pool organization at the software level and does not recommend using specialized allocation algorithms without an urgent need to speed up memory allocation itself. The purpose of these structures is still not to improve software performance directly but to enhance and speed up access to the data stored in them.

Keywords: multi-threading, dynamic memory allocation, real-time systems, lock-free algorithms, game engine, high-performance computing.

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AN OVERVIEW OF CURRENT ISSUES IN AUTOMATIC TEXT SUMMARIZATION OF NATURAL LANGUAGE USING ARTIFICIAL INTELLIGENCE METHODS

pages 12–19

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The object of the research is the task of automatic abstracting of natural language texts. The importance of these tasks is determined by the existing problem of creating essays that would adequately reflect the content of the original text and highlight key information. This task requires the ability of models to deeply analyze the context of the text, which complicates the abstracting process.

Results are presented that demonstrate the effectiveness of using generative models based on neural networks, text semantic analysis methods, and deep learning for automatic creation of abstracts. The use of models showed a high level of adequacy and informativeness of abstracts. GPT (Generative Pre-trained Transformer) generates text that looks like it was written by a human, which makes it useful for automatic essay generation.

For example, the GPT model generates abbreviated summaries based on input text, while the BERT model is used for summarizing texts in many areas, including search engines and natural language processing. This allows for short but informative abstracts that retain the essential content of the original and provides the ability to produce high-quality abstracts that can be used for abstracting web pages, emails, social media, and other content. Compared to traditional abstracting methods, artificial intelligence provides such advantages as greater accuracy, informativeness and the ability to process large volumes of text more efficiently, which facilitates access to information and improves productivity in text processing.

Automatic abstracting of texts using artificial intelligence models allows to significantly reduce the time required for the analysis of large volumes of textual information. This is especially important in today's information environment, where the amount of available data is constantly growing. The use of these models promotes efficient use of resources and increases overall productivity in a variety of fields, including scientific research, education, business and media.

Keywords: automatic abstracting, natural language processing, artificial intelligence, generative models, neural networks, deep learning.

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DEVELOPING A NEURO-FLEXIBLE MECHANISM OF BANKRUPTCY RISK ESTIMATION BASED ON CONDITIONAL PARAMETERS

pages 20–23

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The object of the study is the estimation of the risk of enterprise bankruptcy. The work is aimed at developing a new model for estimating the risk of enterprise bankruptcy. Estimating the risk of bankruptcy is critical to assessing a company's financial health. It serves as a key indicator that enables management teams to proactively mitigate potential risks and develop strategies to strengthen the company's financial position over time. It is possible to enhance our prior bankruptcy prediction model by eliminating the Neural Arithmetic Logic Unit (NALU) block and refining the fuzzifier block to assess if the new architecture can effectively simulate approximate arithmetic for discovering complex financial ratios and relationships. The new model uses our bespoke «neuro-flexible» mechanism that incorporates a fuzzifier block as its initial layer, transforming each financial parameter into a fuzzy representation without any NALU blocks down the line. This approach allows the model to process undefined or missing inputs, enhancing its robustness in varied financial scenarios. The fuzzified values are then processed through linear layers with Mish activation, known for superior generalization performance. Key improvements include optimal categorization of raw numbers through embedding vectors and significant acceleration in learning speed. Experiments conducted using PyTorch on an Apple M1 processor demonstrated a substantial average prediction performance of 72 %, indicating the efficacy of the proposed enhancements in bankruptcy estimation. Bankruptcy risk is important for assessing a company's financial health. It helps management teams reduce risks and strengthen the company's finances. By predicting bankruptcy risk, companies can take steps to avoid financial problems and stay in business.

Keywords: statistical model, bankruptcy risk estimation, Neural Arithmetic Logic Unit, fuzzifier block, machine learning.

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ORCHESTRATION OF SERVICE-ORIENTED APPLICATIONS WITH REACTIVE PROGRAMMING TECHNIQUES

pages 24–29

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The object of research is the modular approach to application development using SOA, as well as the comparison of synchronous and asynchronous request processing methodologies using a reactive programming architecture. SOA allows applications to be divided into independent components, ensuring easy integration and scalability in distributed computing environments. With SOA, it is possible to create a network of loosely coupled services, providing users with the flexibility to develop applications tailored to specific needs.

One of the main issues is thread blocking and system instability under heavy loads when using synchronous methods. The study compares synchronous and asynchronous request processing methodologies using WebFlux, and examines key components of SOA, such as service discovery mechanisms and interaction models, particularly orchestration and choreography.

The results show that asynchronous approaches, using a non-blocking, event-driven architecture, reduce the number of active threads, increase system resilience, and improve performance. This is because the proposed non-blocking, event-driven approach has several features, including reducing thread blocking and enhancing system stability under heavy loads. Synchronous methods, while straightforward, have drawbacks such as thread blocking and system instability under excessive loads.

As a result, there is a high efficiency in processing a large number of requests in real-time. Compared to similar known approaches, this provides advantages such as increased system resilience and efficient resource utilization, making this approach particularly useful for scalable application architectures in distributed computing environments.

Keywords: service-oriented architecture (SOA), reactive programming, event loop, asynchronous requests.

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FORECASTING SOFTWARE DEVELOPMENT COSTS IN SCRUM ITERATIONS USING ORDINARY LEAST SQUARES METHOD

pages 30–33

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During scrum iterations, it is possible to apply cost forecasting for software testing and operation, if the data from previous iterations are known. Since the data for estimating the scope of work and the deadline within one sprint are accumulated during the project execution, it is possible to use such data to build a forecasting algorithm for the estimated parameters of the subsequent sprints.

The approach is based on refining the assessment provided by the development team and the scrum master in a specific metric. The main parameters for evaluation are the execution time and the amount of work performed. As a result of forecasting, it is possible

to obtain clarifications for the team's assessment regarding the scope of work for the next sprint. This estimate is based on planned and actual data from the previous sprints.

The article discusses the method of least squares and the proposed code for a machine learning model based on this method. An example and graphs for iterations in scrum and corresponding forecasting for the next sprints are presented.

The use of the least squares method allows creating a mathematical model that can be adapted to different project conditions, providing flexibility and accuracy in forecasting. For example, the study uses the real data from the previous sprints, which includes the team's resource assessment and actual expenditures. Based on these data, a model was built that demonstrates a high correlation between predicted and actual costs, confirming the effectiveness of using the least squares method.

So, the least squares method is an effective tool for forecasting software development costs in scrum iterations. This method allows development teams to better plan their resources and timelines, contributing to the overall efficiency of the project.

Keywords: cost forecasting, scrum, machine learning, least squares method, iterations, software development.

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SYSTEMS AND CONTROL PROCESSES

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DESIGN OF PROFESSIONAL COMPETENCIES OF AVIATION OPERATORS BY THE METHOD OF SITUATION-ORIENTED TRAINING IN A UNIFORM EDUCATIONAL ENVIRONMENT

pages 34–41

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Air traffic volumes will at least double by 2030, and with that in mind, thousands of new pilots and air traffic control officers (ATCO) will be needed. The object of research is the system of professional training of aviation operators. One of the problematic areas is the fact that, despite the similarity of both areas of training and professional competences, the training of these specialists is carried out completely separately. However, in the process of activity, they must work as a single team. The obtained results indicate that the vast majority of future control officers and pilots believe that training in the conditions of a single educational environment is necessarily required for a certain period. In order to increase the effectiveness of the interprofessional integration of such specialists and the system of their professional training, it is proposed to use the situation-oriented method in a single educational space for a certain period of time. The choice of this method is justified as follows. Virtually modeling, under the guiding influence of the instructor, the «student» solves the task in its own interpretation. Compared to similar known methods, simulation of the «real» working environment promotes the development of higher cognitive processes, such as analysis, risk management, consideration of possible alternatives and joint decision-making by the «ATCO-pilot» team. This approach makes it possible to transform theoretical knowledge into practical skills and operational skills in the most effective way, from the point of view of costs and benefits. An example of navigational guidance of an aircraft by the ATCO at the stage of descent and landing in conditions of loss of the signal of the global satellite positioning system is shown. This demonstrated the response of the training system to negative challenges in the state of the air navigation system within a relatively short period of time, as well as the formation of new competencies in the «ATCO-pilot» team.

Keywords: air traffic control officer, pilot, situation-oriented training, joint decision-making, unified educational environment, navigation aid.

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THE DEVELOPMENT OF A COMBINED SYSTEM OF FREQUENCY AUTOMATIC CONSTRUCTION OF RADIO MONITORING TOOLS WITH FIRST ASTATISM

pages 42–48

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At the present time, phase auto-adjustment systems are widely used, in which frequency stabilization and frequency tracking is achieved due to phasing of the reference (setting) and control voltages. Frequency auto-adjustment systems solve this problem as a result of direct measurement of the difference in frequencies of the reference and control voltages, and reduction of this difference. The scientific task solved in the research is to increase the dynamic characteristics of automatic tuning systems, to increase the dynamic accuracy and speed of frequency auto-tuning systems of radio monitoring devices with astatism. Therefore, the object of research is the system of automatic self-adjustment of military radio monitoring equipment. The subject of the research is the dynamic, root mean square errors of automatic self-tuning systems under different laws of change of the disturbing influence (input signal frequency deviation) and the speed of the systems. The methods of analysis and

synthesis, the theory of complex technical systems and the theory of radio receiving devices were chosen as the basic mathematical apparatus in the proposed research. The research proposed a combined system of frequency auto-adjustment of radio monitoring devices with astatism, as well as basic mathematical expressions that describe its operation. In the process of research the following tasks were solved:

- an analysis of the dynamic characteristics of a static system of frequency auto-adjustment with the principle of deviation control was performed;
- a functional scheme and a mathematical model of a combined frequency auto-adjustment system with first-order astatism and increased speed were developed.

One of the important advantages of the proposed mathematical model is the increased efficiency of frequency tuning depending on the type of signal compared to known frequency autotuning. This is accepted not only in the case of changes in the disturbing influence according to deterministic laws, but also in the case of random disturbing influence.

The direction of further research should be considered the increase in dynamic accuracy (reduction of dynamic, root mean square errors) and speed of frequency auto-adjustment systems.

Keywords: automatic autotuning systems, static frequency autotuning systems, first-order astatism.

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STUDY OF THE PRINCIPLE OF AUGMENTED COMPETENCY IN THE AUDIT OF IT PROJECTS IN THE ENVIRONMENT OF ARTIFICIAL INTELLIGENCE

pages 49–53

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The development of artificial intelligence (AI) is revolutionizing various industries, including IT project management. The object of research is the principle of augmented competence, which is a new approach that uses AI to strengthen and expand the capabilities of IT project teams. The essence of this principle lies in the complementary interaction of AI and the competence of project teams. Instead of replacing project managers, AI complements their competencies (knowledge, skills and experience). One of the hot spots is the application of AI in the process of automating routine tasks, analyzing large volumes of data and providing recommendations and predictions, freeing up time for team members to focus on more complex and creative tasks.

The possibility of automating tasks and providing new knowledge, which will significantly improve the efficiency and productivity of the team, has been obtained through the use of the principle of augmented competence. As a result, data-driven recommendations and predictions enable teams to make more informed and effective decisions. Access to new knowledge and insights stimulates innovation and leads to new ideas and solutions, helps identify and mitigate potential risks, which can lead to more successful projects. Applying this principle to IT project management audits will automate software testing with AI, which replaces testers so they can focus on more complex types of testing

such as exploratory testing, performs customer data analysis with AI, and enables companies to better understand your customers and their needs, which can lead to better marketing campaigns and products. It is important to note that this principle does not involve replacing project managers with AI. Instead, AI is used as a tool to empower human teams and help them achieve better results. As AI technologies continue to evolve, the principle of augmented competence is likely to play an even more important role in IT project management. AI can help teams overcome complex challenges, make better decisions, and succeed in a more dynamic and competitive environment.

Keywords: project audit, IT project management, artificial intelligence, augmented competence.

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MATHEMATICAL MODELING

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ANALYTICAL CONNECTION BETWEEN THE FRENET TRIHEDRON OF A DIRECT CURVE AND THE DARBOUX TRIHEDRON OF THE SAME CURVE ON THE SURFACE

pages 54–59

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Frenet and Darboux trihedrons are the objects of research.

At the current point of the direction curve of the Frenet trihedron, three mutually perpendicular unit orthogonal vectors can be uniquely constructed. The orthogonal vector of the tangent is directed along the tangent to the curve at the current point. The orthogonal vector of the main normal is located in the plane, which is formed by three points of the curve on different sides from the current one when they are maximally close to the current point. It is directed to the center of the curvature of the curve. The orthogonal vector of the binormal is perpendicular to the two previous orthogonal vectors and has a direction according to the rule of the right coordinate system. Thus, the movement of the Frenet trihedron along the base curve, as a solid body, is determined.

The Darboux trihedron is also a right-hand coordinate system that moves along the base curve lying on the surface. Its orthogonal vector of the tangent is directed identically to the Frenet trihedron, and other orthogonal vectors in pairs form a certain angle ε with the orthogonal vectors of the Frenet trihedron. This is because one of the orthogonal vectors of the Darboux trihedron is normal to the surface and forms a certain angle ε with the binormal. Accordingly, the third orthogonal vector of the Darboux trihedron forms an angle ε with the orthogonal vector of the normal of the Frenet trihedron. This orthogonal vector and orthogonal vector of the tangent form the tangent plane to the surface at the current point of the curve, and the corresponding orthogonal vectors of the tangent and the normal of the Frenet trihedron form the tangent plane of the curve at the same point. Thus, when the Frenet and Darboux trihedrons move along a curve with combined vertices,

there is a rotation around the common orthogonal vector point of the tangent at an angle ε between the osculating plane of the Frenet trihedron and the tangent plane to the surface of the Darboux trihedron. These trihedrons coincide in a separate case (for a flat curve) ($\varepsilon=0$).

The connection between Frenet and Darboux trihedrons – finding the expression for the angle ε , is considered in the article. The inverse problem – the determination of the movement of the Darboux trihedron at a given regularity of the change of the angle ε , is also considered. A partial case is considered and it is shown that for a flat base curve at $\varepsilon=\text{const}$, the set of positions of the orthogonal vector of normal forms a developable surface of the same angle of inclination of the generators. In addition, the inverse problem of finding the regularity of the change of the angle ε between the corresponding orthogonal vectors of the trihedrons allows constructing a ruled surface for the gravitational descent of the load, conventionally assumed to be a particle. At the same time, the balance of forces in the projections on the orthogonal vectors of the trihedron in the common normal plane of the trajectory is considered. This balance depends on the angle ε .

Keywords: orthogonal vector, direction cosines, Euler angles, surface osculating plane, tangent plane.

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