MODELED INTELLIGENCE: MODERN INTELLIGENT SYSTEMS BASED ON MACHINE LEARNING AND THEIR APPLICATION AREAS

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Abstract This article examines the essence of modeled intelligence (MI) and machine learning (ML) technologies, their operational principles, and their application areas in modern intelligent systems. It analyzes the advantages, limitations, practical examples, and future development prospects of MI-based systems. The article also provides a scientific and theoretical analysis of the principles of applying MI and ML technologies in the field of education, their benefits, practical achievements, and existing challenges. Furthermore, it highlights the impact of MI-based systems on the educational process, their contribution to the individual development of learners, and the prospects for their future advancement

Keywords Modeled intelligence, machine learning, intelligent systems, digital education, automated assessment, adaptive learning, and virtual tutors.

Аннотация. В статье рассматривается сущность технологий моделированного интеллекта (МИ) и машинного обучения (МО), принципы их работы и области применения в современных интеллектуальных системах. Анализируются преимущества, ограничения, практические примеры и перспективы развития систем на основе МИ. Также дан научно-теоретический анализ принципов применения технологий МИ и МО в сфере образования, их преимуществ, практических достижений и существующих проблем. Кроме того, рассматривается влияние систем на основе МИ на образовательный процесс, их вклад в индивидуальное развитие обучающихся и перспективы их дальнейшего развития.

Ключевые слова: моделированный интеллект, машинное обучение, интеллектуальные системы, цифровое образование, автоматизированная оценка, адаптивное обучение и виртуальные репетиторы.

Annotatsiya: Mazkur maqolada modellashtirilgan intellekt (MI) va mashinali o'qitish (MO) texnologiyalarining mazmuni, ularning ishlash tamoyillari hamda zamonaviy aqlli tizimlarda qo'llanilish sohalari yoritilgan. Modellashtirilgan Intelekt tizimlarining afzalliklari, cheklovlari, amaliy misollar va kelajakdagi rivojlanish istiqbollari tahlil qilinadi. Ushbu maqolada ta'lim sohasida

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modellashtirilgan intellekt (MI) va mashinali o‘qitish (MO) texnologiyalarining qo‘llanilish tamoyillari, afzalliklari, amaliy yutuqlari hamda mavjud muammolar ilmiy-nazariy jihatdan tahlil qilingan. Modellashtirilgan Intellekt asosidagi tizimlarning ta’lim jarayoniga ta’siri, o‘quvchilarning individual rivojlanishiga qo‘shgan hissasi va kelajakdagi rivojlanish istiqbollari yoritiladi

Kalit so‘zlar: Modellashtirilgan intellekt, mashinali o‘qitish, aqlli tizimlar, raqamli ta’lim, avtomatlashtirilgan baholash, adaptiv ta’lim, virtual tutor

1. Introduction

Modeled intelligence is becoming one of the most essential components of today’s modern digital world its essence lies in the fact that systems independently learn from human generated data expand their knowledge base and generalize existing experiences to perform new tasks at the core of such systems are methods known as machine learning machine learning enables computers to process data expand their understanding and provide increasingly accurate results in decision making as modeled intelligence continues to evolve many aspects of human thinking are being transferred into artificial environments and its fields of application are rapidly expanding and continuously developing..

At the foundation of modern smart systems lies the process of collecting organizing and extracting meaningful conclusions from data information comes from various sources including social networks industrial sensors medical indicators economic statistics and many other digital traces from different fields in the past such data was not collected due to insufficient processing methods but now it serves as the most important resource for modeled intelligence systems the more data available the better these systems learn and the more reliable their conclusions become the main advantage of machine learning is its ability to discover subtle hidden correlations within large datasets that human intelligence cannot detect.Modeled intelligence holds a special significance in the industrial sector where monitoring every stage of production requires significant time and effort from humans smart systems greatly enhance automation in these processes for example data collected through various sensors along production lines is analyzed by machine learning algorithms allowing predictions about the likelihood and timing of possible equipment failures this approach reduces maintenance costs increases production efficiency and decreases the number of accidents in industry modeled intelligence strengthens competition and simultaneously improves human safety these systems assist people in hazardous environments such as high temperature workshops or areas with high explosion risk where processes can be controlled through robots.

Modeled intelligence plays an even more crucial role in healthcare analytical approaches based on data show some of their most powerful results in this field

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medical indicators x ray images ultrasound scans laboratory results and many other types of data are analyzed using machine learning enabling early detection of diseases such systems act as supportive tools for physicians identifying even the smallest changes in captured images for example modeled intelligence can accurately detect heart diseases oncological changes or irregularities in brain activity it also plays a vital role in creating personalized treatment plans as each patient's body responds differently individualized care significantly improves outcomes additionally by combining medical data collected worldwide modeled intelligence supports real time monitoring of global public health conditions.The use of modeled intelligence in transportation is one of the most visible ways it simplifies daily life smart transport systems help reduce congestion regulate traffic flow and increase safety smart traffic lights adapt to real time traffic conditions reducing jams and ensuring smoother vehicle movement autonomous autopilot systems enable self driving vehicles by detecting road signs pedestrians and traffic conditions although these technologies are developing rapidly they are not yet fully autonomous however in the future widespread adoption of driverless vehicles is expected in transportation modeled intelligence introduces a new era of road safety by controlling speed predicting accidents and identifying driver fatigue. In agriculture modeled intelligence enhances planned crop monitoring fields are observed using drones and sensors soil moisture plant health pest risks and many other indicators are analyzed through machine learning farmers can determine how much water is needed in specific areas which regions show early signs of disease and the best timing for fertilization this increases productivity saves resources and maintains high crop quality modern agricultural machinery is also automated using modeled intelligence processes such as plowing planting and harvesting become more efficient it is also possible to forecast market prices of agricultural products allowing farmers to plan according to expected market fluctuations.

In education modeled intelligence enables personalized learning each student's knowledge level learning pace and challenging topics are analyzed and customized learning materials are provided this approach helps improve student performance automated assessment systems analyze test questions offer additional guidance on misunderstood topics and make lessons more interactive the evaluation of student knowledge on educational platforms becomes fairer more transparent and more consistent the increasing prevalence of distance education is also linked to the rise of modeled intelligence as these systems support teachers by monitoring the learning process organizing information and recommending educational resources.

In security systems the role of modeled intelligence is growing daily by analyzing images from surveillance cameras it identifies dangerous situations

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prevents crimes and assists in maintaining order it tracks human movement facial expressions and suspicious behavior in real time enabling security personnel to respond quickly modeled intelligence has also led to major changes in cybersecurity detecting unusual network activity identifying malware and protecting user data as cyber threats become more complex the need for modeled intelligence increases because no human can monitor such massive information streams alone.

In everyday life the use of modeled intelligence continues to simplify human activities smart home systems offer voice control automate household devices and provide personal assistants that help plan daily tasks and send reminders smartphone cameras also rely on modeled intelligence to improve image quality adjust lighting and perform facial recognition content recommendations on social networks are powered by modeled intelligence as well systems analyze user interests and preferences to provide tailored content encouraging longer user engagement..

In economics and finance modeled intelligence simplifies market analysis investment decision making and risk assessment in banking it evaluates customer credit history reducing errors in loan issuance detects fraudulent activity and ensures more reliable financial services financial markets are highly volatile making modeled intelligence an essential tool for predicting trends helping investors build optimal portfolios and regulating economic processes.In society modeled intelligence plays an important role in studying social processes it analyzes political activities public opinion and social behavior data from social networks including posts comments and reactions reveal important societal trends and help identify their direction this supports effective public administration and community engagement modeled intelligence also assesses public needs measures the efficiency of social programs and suggests new improvements.

In science and innovation modeled intelligence accelerates research processes scientists can analyze huge amounts of scientific data and generate new ideas more quickly in chemistry for example modeled intelligence compares the properties of existing compounds and predicts which combinations might produce new useful results it plays a growing role in physics biology astronomy and other fields by identifying patterns in millions of data points far faster than the human mind ever could.

With the advancement of modeled intelligence its ethical principles and safety have become critical issues systems based on inaccurate data or unfair decision making can significantly harm society therefore data accuracy fairness and reliability are essential in development it is important to ensure that these systems serve human interests and remain under control concerns have arisen about

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modeled intelligence replacing human labor but most researchers believe it will enhance human capability rather than replace it humans will continue performing essential tasks while smart systems accelerate and simplify their work..

Today's world is reaching a point where life without modeled intelligence is nearly unimaginable its role extends beyond technical and economic processes and appears in every aspect of human life its main function is to create convenience simplify processes and open the door to new opportunities as modeled intelligence continues to evolve the future is expected to become even more automated efficient and safe. Now we will examine modeled intelligence specifically in the field of education In the field of education modeled intelligence and machine learning technologies are an important tool for optimizing modern pedagogical processes and individualizing the learning process These technologies help determine students knowledge levels identify which topics they master quickly and effectively and which ones require additional exercises At the same time they enable the creation of customized learning programs Virtual tutors developed with modeled intelligence provide interactive support to students they answer students questions explain topics and create additional exercises for difficult subjects Virtual tutors monitor students activity assess their knowledge levels and personalize the learning process At the same time automated assessment systems check students work analyze results and reduce teachers workload This reduces subjectivity in the assessment process and increases the reliability of results. Adaptive learning systems determine the difficulty level for students and provide additional exercises tailored to their individual needs In this way the learning process is adapted to the characteristics of each student and the effectiveness of education is significantly increased

Modeled intelligence allows monitoring the learning process students activity the speed of completing assignments and the level of knowledge acquisition Based on this data teachers make pedagogical decisions optimize the curriculum and provide the necessary educational resources At the same time ML technologies create opportunities to identify and stimulate students motivation They develop learning modules that engage students and make their learning process more active Modeled intelligence and machine learning algorithms take into account students individual characteristics determine which topics they master quickly and which require more practice Thus the learning process becomes more effective and purposeful. Another important application of artificial intelligence and machine learning is automated assessment systems These systems check students tests essays and written work analyze results and reduce human involvement At the same time they provide real time feedback to students This helps reinforce knowledge and quickly correct mistakes during the learning process

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Virtual tutors provide interactive support to students they identify which topics are easily mastered and which require additional exercises In language learning ML technologies recognize speech analyze pronunciation detect grammatical errors and create interactive exercises This method improves foreign language learning efficiency and strengthens students independent learning skills.

Modeled intelligence and machine learning technologies allow monitoring the learning process students activity the speed of completing tasks and the level of knowledge acquisition Based on this data teachers optimize the learning process and develop individual development strategies At the same time modeled intelligence helps identify students mistakes in the learning process and guide them through their studies Adaptive learning systems create learning programs tailored to students individual needs Thus the learning process becomes effective and personalized for each student. ML technologies allow monitoring and analyzing each stage of students learning process identifying which topics they master quickly and which they struggle with Based on this data virtual tutors create individual additional exercises This strengthens students knowledge and makes the learning process more effective In addition ML technologies analyze motivation in the learning process track students interests and activity and help teachers make pedagogical decisions.

Artificial intelligence and machine learning applications in education encourage students individual development increase learning effectiveness reduce teacher workload and ensure objectivity in the assessment process At the same time virtual tutors and adaptive learning systems make students learning process more interactive and engaging ML technologies are an important tool for determining students knowledge levels and creating customized learning programs

An example of the practical application of ML technologies in education is online course platforms These platforms analyze students learning levels and create customized exercises for them This makes the learning process more effective and increases students knowledge levels Virtual tutors explain complex topics in a simple and understandable way Automated testing systems quickly and objectively assess students work reducing teachers workload and improving assessment quality.

ML technologies stimulate active student participation in the learning process Their knowledge level can be monitored in real time This allows teachers to optimize the learning process and develop individual learning strategies In addition modeled intelligence identifies learning difficulties students encounter and provides individual solutions Thus the learning process becomes personalized and effective.

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Modeled intelligence and machine learning technologies allow introducing new pedagogical methods into the learning process This makes the acquisition of knowledge interactive and engaging Through virtual tutors students reinforce the topics they are studying and complete individual exercises Adaptive learning systems create exercises tailored to each students needs Thus the learning process becomes effective and personalized for every student.

2. Research Methodology

Educational modeling is closely connected with the development of technology and engineering becoming one of the most important components in shaping modern learning processes as technology advances the way teaching is organized learning activities are planned educational materials are created and student knowledge is assessed is changing fundamentally modeling supported by technological tools allows the creation of a complete representation of the learning process it enables real educational situations to be reconstructed in a digital environment and makes it possible to analyze how students understand and master the material technology and engineering progress have elevated educational modeling to a new stage because modern computers digital systems and intelligent platforms allow complex processes to be studied in a simple and clear way.The possibilities of modeling have expanded greatly with the development of technical tools computer programs specialized simulators digital laboratories and virtual learning environments used in education are all based on technological achievements with such technologies students can study physical processes mechanical movements electrical circuits chemical reactions and mathematical models in a clear and understandable form for example electrical circuits that previously required physical tools can now be built safely in virtual modeling environments where every element and its interaction are accurately demonstrated this helps students understand and master complex concepts more easily technical modeling expands the practical thinking skills of students because they can understand the internal mechanics of devices even without interacting with real hardware. Technology based modeling has become a key tool for individualizing learning automated systems analyze each student’s learning behavior and identify where they experience difficulties giving teachers real time data through technical tools data processing technologies artificial intelligence algorithms and analytical systems used in digital learning platforms make modeling more precise technology based models monitor each learner individually offering personalized learning materials and exercises this leads to improved learning quality and enables continuous monitoring of the educational process through advanced technical capabilities.

Modeling in its most general form

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$$M = f(X, P, T)$$

Where:

M – model

X – input data

P – parameters

T – time or process stage

Evaluating learning effectiveness using machine learning

$$\hat{Y} = w_1x_1 + w_2x_2 + \ldots + w_nx_n + b$$

$\hat{Y}$ – predicted outcome

$x_1 \ldots x_n$ – indicators describing learner activity

$w_1 \ldots w_n$ – weights

b – bias term of the model

Used in evaluating the effectiveness of teaching technologies

$$E = (K_1C_1 + K_2C_2 + \ldots + K_nC_n) / N$$

Applied in robotics automation and technical education

$$\dot{X} = AX + BU$$

$$Y = CX + DU$$

X – system state

U – control signal

A B C D – system matrices.

Technical modeling is especially important in vocational and technical education since these fields require more practical skills technical simulators virtual stands and intelligent learning programs model the process of working with real equipment in a safe environment in fields such as industrial robotics automation mechatronics energy engineering and other technical areas modeling is used to teach practical experience efficiently and safely for example controlling a robotic manipulator in a virtual environment or simulating an industrial control system on a computer prepares students for real production tasks while meeting modern technical safety requirements students can make mistakes and learn from them without risking damage to real equipment.The development of technology has also connected educational modeling with scientific research modern software allows students to model scientific processes including biological cell growth chemical reaction sequences mechanical system behavior under force and changes in atmospheric physics such scientific simulations help integrate theory and practice students not only hear the theory but also observe and model it through technological tools deepening their scientific reasoning and expanding their analytical ability.

Furthermore modeling plays a crucial role in preparing learners for future professions artificial intelligence virtual reality robotics automated control

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cybersecurity and data analysis all rely heavily on modeling therefore students who begin learning these models today will become strong highly demanded specialists in the future in this way technology based educational modeling becomes an essential part of modern learning helping the next generation to grow into knowledgeable skilled and innovative thinkers ready to build the technological world of tomorrow

3.Computational experiment.

General mathematical formulas used in educational modeling

Learning curve model

L(t)=Lmax(1−e−kt)L(t) = L_{max} \left(1 - e^{-kt}\right)L(t)=Lmax(1−e−kt)

This model describes how a learner gradually improves over time and approaches a maximum learning level.

Error reduction model

E(t)=E0e−ktE(t) = E_0 e^{-kt}E(t)=E0e−kt

This expresses how mistakes decrease as practice increases.

Learning efficiency model

η=BT\eta = \frac{B}{T}η=TB

B is the amount of learned knowledge T is the time spent and the ratio expresses learning efficiency.

Formulas used in technical process modeling

Input output model of a technical system

Y=f(X)Y = f(X)Y=f(X)

This describes how an educational or technical system processes input and produces output.

Digital filter model

y[n]=∑akx[n−k]+∑bky[n−k]y[n] = \sum a_k x[n-k] + \sum b_k y[n-k]y[n]=∑akx[n−k]+∑bky[n−k]

Used when analyzing learning data as a digital signal.

System stability condition

|λ|<1|\lambda| < 1|λ|<1

A model is stable if the absolute value of its eigenvalues is less than one

Artificial intelligence and machine learning formulas

Linear regression model

y=mx+by = mx + by=mx+b

Used to predict learning outcomes

Loss function.

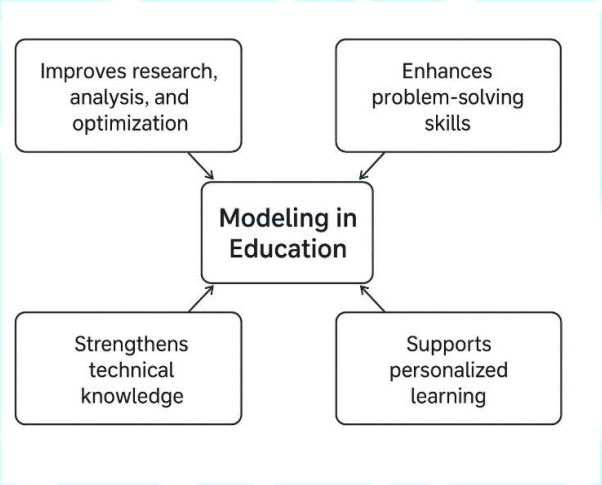
L=1N∑(yreal−ypred)2L = \frac{1}{N} \sum (y_{real} - y_{pred})^2L=N1∑(yreal−ypred)2

Measures how far model predictions are from real results

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Softmax model for classification

$$Pi=ezi∑ezkP_i = \frac{e^{z_i}}{\sum e^{z_k}}Pi=∑ezkezi$$



In education modeling supported by technology also makes the work of teachers easier technological tools automate the management of the learning process helping teachers plan lessons evaluate knowledge analyze test results and track the learning progress of each student technical analytical tools help improve teaching methods modern technologies simplify the explanation of complex topics and enable stronger interdisciplinary connections through modeling teachers can make the educational process more structured logical and effective. In the future technology and engineering will create even more advanced modeling opportunities in education through augmented reality and virtual reality students will be able to learn inside immersive environments they will virtually tour industrial facilities observe complex technical operations and experience simulations that feel like real life artificial intelligence will guide modeling in smarter ways offering highly personalized learning paths the continuous development of educational technologies will increase the complexity precision and scientific value of educational models making the learning process more innovative and effective.

In conclusion educational modeling supported by technology and engineering is a rapidly developing modern pedagogical process that deeply analyzes learning activities organizes teaching more effectively prepares learners with technical skills and equips them with the competencies required for future professions modeling enriched with technological tools makes education more innovative safe efficient and accessible enhancing both teaching quality and student learning outcomes. In the future the benefits of technology based and technics oriented educational modeling will be extremely broad and valuable not only for students but also for society and modern industries educational modeling allows learners to

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perform complex and risky experiments in a completely safe virtual environment helping them understand real world technical processes without facing any physical danger this approach also makes preparation for technical professions much easier because students develop practical skills in fields such as robotics automation mechatronics and energy engineering long before they encounter real industrial systems making them well prepared specialists for the future job market educational modeling also strengthens problem solving abilities because students learn to analyze technological systems understand processes logically and find independent solutions which are essential skills for tomorrow's engineering and technological careers.

Technological modeling also encourages innovation by allowing learners to test new technical ideas create prototypes of devices and design scientific models which helps develop a generation of creative engineers and inventors in the future learning through modeling will become even more effective with the support of artificial intelligence because intelligent systems will monitor each student's individual learning progress identify their difficulties and offer personalized study materials which will improve learning outcomes and help every learner unlock their full potential modeling also saves time and resources for schools and colleges because many technical laboratory processes can be performed virtually without the need for expensive physical equipment making education more efficient and economical.

Through modeling the gap between education and real industry becomes smaller because students gain early experience with industry 4 0 digital manufacturing smart systems robotics control and automated technologies this will allow them to adapt quickly when they join real technical workplaces modeling also enhances creativity as students can develop modify and test any technical idea strengthening their design and engineering abilities and raising their level of technical thinking.

3. Conclusion

Artificial intelligence models and machine-learning–based intelligent systems have become an integral part of modern technological development. Their capabilities demonstrate high efficiency in numerous fields, ranging from medicine and economics to education and transportation. In the future, these systems are expected to further enhance human activities through increasingly complex and adaptive models.

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