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# MODERN TRENDS, CHALLENGES, AND PROSPECTS OF APPLYING ARTIFICIAL INTELLIGENCE IN APPLIED SCIENCES

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**Annotatsiya**

Maqola amaliy fanlar sohasida sun'iy intellekt (SI) texnologiyalarini qo'llashning zamonaviy tendensiyalari, mavjud muammolari va rivojlanish istiqbollarini tahlil qilishga bag'ishlangan. Shuningdek, SI evolyutsiyasi va mashinali o'rganishning nazariy asoslari ko'rib chiqiladi, shu tariqa SI modellarining "qora quti" muammosi, etik to'siqlar va avtonom ilmiy laboratoriyalar yaratish imkoniyatlari tadqiq etiladi. Tadqiqot natijasida amaliy fanlarda SI samaradorligini oshirish bo'yicha xulosalar shakllantirilgan.

**Kalit so'zlar**

Sun'iy intellekt, mashinali o'rganish, amaliy fanlar, raqamli transformatsiya, algoritmik tarafkashlik, tushuntiriladigan SI (XAI), avtonom tadqiqotlar.

**Abstract**

The article is devoted to the analysis of modern trends, existing problems and development prospects of the use of artificial intelligence (AI) technologies in the field of applied sciences. The theoretical foundations of the evolution of AI and machine learning are also considered, thus exploring the problem of the "black box" of AI models, ethical barriers and the possibilities of creating autonomous scientific laboratories. As a result of the research, conclusions are drawn on increasing the effectiveness of AI in applied sciences.

**Keywords**

Artificial Intelligence, Machine Learning, Applied Sciences, Digital Transformation, Algorithmic Bias, Explainable AI (XAI), Autonomous Research.

**Аннотация**

Статья посвящена анализу современных тенденций, проблем и перспектив применения технологий искусственного интеллекта (ИИ) в области прикладных наук. А также рассматриваются эволюция ИИ и теоретические основы машинного обучения, исследуются проблема «черного ящика» моделей ИИ, этические барьеры и возможности создания автономных научных лабораторий. По результатам исследования сформулированы выводы по повышению эффективности интеграции ИИ в прикладные исследования.

**Ключевые слова**

Искусственный интеллект, машинное обучение, прикладные науки, цифровая трансформация, алгоритмическая предвзятость, объяснимый ИИ (XAI), автономные исследования.

The journey of Artificial Intelligence (AI) from a conceptual framework in the 1950s to a cornerstone of modern applied sciences is marked by significant paradigm shifts. Initially, AI relied on symbolic logic and expert systems—rigid rule-based structures that struggled with real-world complexity. However, the emergence of Big Data and the exponential increase in computational power (Moore's Law) transitioned the field into the era of Connectionism and Neural Networks.

In the current landscape, AI is no longer a standalone discipline but an integrative layer across applied sciences. Modern AI systems are characterized by their ability to handle non-linear relationships and high-dimensional data, making them indispensable in fields where traditional mathematical models fall short. The current state of AI is dominated by "Narrow AI," which excels at specific tasks such as image recognition, natural language processing, and predictive analytics.

The most significant trend in contemporary applied research is the shift from "rule-based" algorithms to "learning-based" systems.

Machine Learning (ML): ML algorithms, such as Random Forests and Support Vector Machines, are being used to automate the classification of scientific data. In materials science, for instance, ML models can predict the properties of new alloys by learning from thousands of previous experiments, reducing the need for costly physical trials.

Deep Learning (DL): Utilizing multi-layered neural networks, DL has revolutionized fields that deal with unstructured data. Convolutional Neural Networks (CNNs) have become the gold standard for analyzing medical imagery (X-rays, MRIs), while Recurrent Neural Networks (RNNs) and Transformers are

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used to model sequential data, such as seismic activity or weather patterns over time.

Generative AI: A rising trend is the use of Generative Adversarial Networks (GANs) to create synthetic datasets. This is particularly useful in applied sciences where real-world data is scarce or sensitive (e.g., rare disease data in medicine).

The practical application of AI is transforming the "hard" sciences through specific, high-impact integrations:

-*Engineering and Manufacturing*: AI is the backbone of "Industry 4.0." Through Predictive Maintenance, AI analyzes sensor data from machinery to predict failures before they occur, optimizing the lifecycle of industrial equipment. In structural engineering, AI optimizes designs for weight and strength through generative design processes.

- *Biomedicine and Healthcare*: AI has shortened the drug discovery process from years to months. Algorithms can simulate how billions of chemical compounds interact with biological targets. Furthermore, Personalized Medicine uses AI to tailor treatments based on an individual's genetic makeup and lifestyle data.

-*Environmental and Earth Sciences*: AI is critical in addressing climate change. Machine learning models analyze satellite telemetry to track deforestation, predict flash floods, and optimize the distribution of energy in smart grids. By processing complex atmospheric data, AI provides more accurate long-term climate projections than traditional meteorological models.

While AI offers transformative potential, its integration into applied sciences is hindered by several critical challenges. The foremost issue is Data Quality and Availability. AI models, particularly deep learning networks, require massive datasets to function accurately. In many scientific fields, data is often fragmented, unstandardized, or proprietary, leading to the "data silo" problem.

Furthermore, Algorithmic Bias remains a significant ethical concern. If the training data contains historical biases, the AI will inevitably perpetuate and amplify them. In medical applications, for instance, an algorithm trained on a specific demographic may provide less accurate diagnoses for other ethnic groups. Additionally, Data Privacy is paramount; as AI processes sensitive patient records or confidential industrial designs, ensuring robust encryption and compliance with international regulations (like GDPR) becomes a complex technical necessity.

In the applied sciences — where safety and precision are non-negotiable — the "Black Box" nature of advanced AI models presents a major barrier. Unlike traditional mathematical models where every variable is traceable, deep neural networks often reach conclusions through millions of hidden parameters that are nearly impossible for humans to interpret.

This lack of Explainable AI (XAI) creates a "trust gap." For example:

• In Aerospace Engineering, a design suggested by AI cannot be fully trusted unless engineers understand the underlying physics of why that design is structurally sound.

• In Clinical Healthcare, a doctor may hesitate to prescribe a treatment recommended by an AI if the logic behind the suggestion is opaque. Developing models that offer both high performance and interpretability is currently one of the most active areas of research.

The future of AI in applied sciences is moving beyond mere data analysis toward Autonomous Discovery. We are entering the era of "Self-Driving Laboratories," where AI systems are integrated with robotic hardware to conduct physical experiments, analyze results, and refine hypotheses without human intervention. This could accelerate the discovery of new materials or drugs by a factor of a thousand.

Key future directions include:

• Physics-Informed Neural Networks (PINNs): Integrating fundamental laws of physics directly into AI architectures to ensure that predictions remain scientifically valid.

• Human-AI Collaboration: Moving away from AI as a replacement for scientists toward a "Centaur" model, where AI handles computational complexity while humans provide strategic intuition and ethical oversight.

• Sustainability: AI will play a decisive role in achieving the UN Sustainable Development Goals by optimizing carbon capture technologies and managing global resource distribution in real-time.

**Table -1. Comparison Table of AI Techniques in Different Applied Sciences**

| Scientific Field | AI Technique Used | Primary Application |
|---|---|---|
| **Biomedicine** | Deep Learning (CNN) | Medical Image Analysis |
| **Material Science** | Generative Models (GAN) | Discovery of new compounds |
| **Civil Engineering** | Predictive Analytics | Structural Health Monitoring |
| **Climate Science** | Recurrent Neural Networks | Weather forecasting & modeling |

This table-1 provides a structured comparative analysis of various Artificial Intelligence methodologies across key scientific disciplines. The table illustrates how specific algorithms are tailored to meet the unique requirements of fields such

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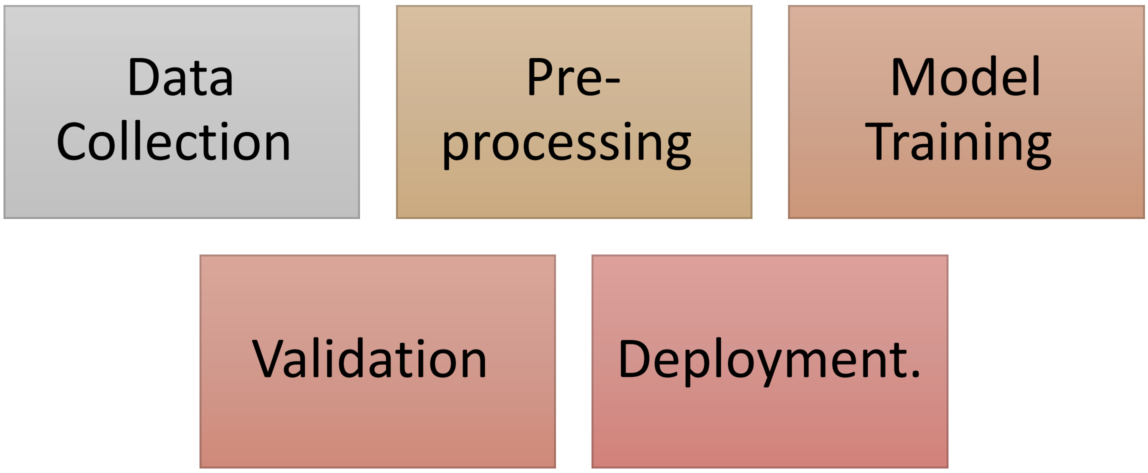
as biomedicine, engineering, and climate science. By categorizing these techniques, the reader can observe the versatility of AI, moving from image-centric analysis in healthcare to time-series forecasting in environmental studies.

**Table-2. Flowchart of AI-Driven Research Methodology**



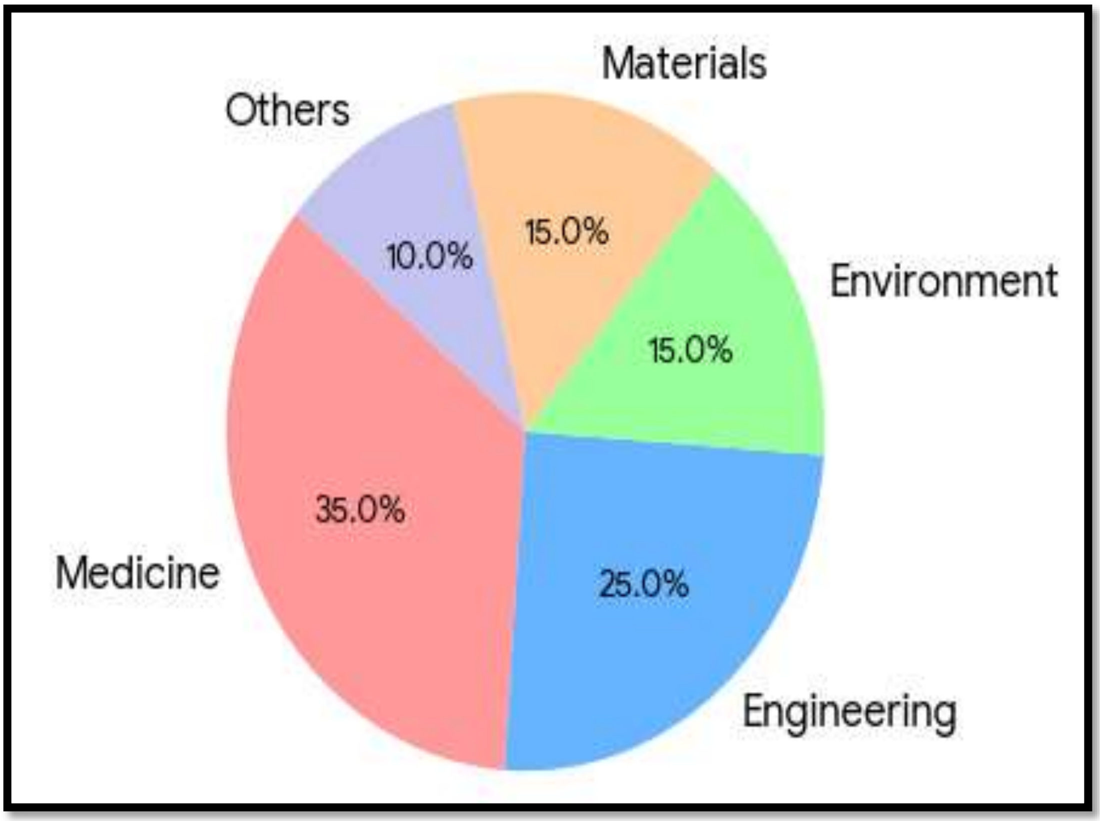

The flowchart presented in this table-2 outlines the systematic lifecycle of integrating AI into a standard scientific research project. It highlights the transition from raw data acquisition to the final deployment of predictive models. Special emphasis is placed on the iterative nature of "Model Training" and "Validation," which are crucial for ensuring the reliability of results in applied sciences. This table-2 is intended to provide a blueprint for researchers looking to implement AI-based frameworks in laboratory or industrial settings.

**Table-3. Glossary of Terms**

| **ML** | **Machine Learning** |
|---|---|
| **DL** | Deep Learning |
| **XAI** | Explainable Artificial Intelligence |
| **NLP** | Natural Language Processing |
| **Big Data** | Extremely large data sets analyzed computationally. |

Table -3 due to the highly technical nature of the topics discussed in this article, this glossary provides concise definitions and full expansions for all acronyms and specialized terminology used throughout the article. Given that the fields of AI and applied sciences often overlap, defining terms like "Explainable AI (XAI)" and "Neural Networks" is essential for maintaining clarity and ensuring that the research is accessible to interdisciplinary readers. This section serves as a quick reference guide for the specialized vocabulary of the "Fourth Industrial Revolution".

**Picture-1. AI Application Trends in Applied Sciences**




Description pic. -1: This pie chart provides a statistical distribution of AI technology adoption across various sectors of the applied sciences as of the current research period.

- ✓ Medicine (35%): Leads the integration due to the heavy reliance on image recognition (radiology) and genomic sequencing.
- ✓ Engineering (25%): Focuses primarily on predictive maintenance, structural health monitoring, and generative design.
- ✓ Environmental Sciences (15%): Utilizes AI for climate modeling, biodiversity tracking, and renewable energy optimization.
- ✓ Material Science (15%): Employs generative models to discover new chemical compounds and alloys.
- ✓ Others (10%): Includes fields like forensic science, agriculture (precision farming), and specialized physics research.

Significance: The chart demonstrates the interdisciplinary nature of AI, showing its dominance in data-intensive fields like healthcare and its growing influence in sustainability-focused research.

**Conclusion.** The integration of Artificial Intelligence into applied sciences represents one of the most significant technological shifts of the 21st century. This research has explored the modern trends, challenges, and future prospects of this integration, leading to the following conclusions:

1. *Transformative Impact*: AI has evolved from a theoretical tool into a practical necessity. In fields like medicine, engineering, and environmental science, AI-driven models (ML, DL, and Generative AI) have demonstrated the ability to process complex data far beyond human capacity, leading to faster drug discovery and more efficient industrial designs.
2. *Addressing the "Black Box" Problem*: One of the primary barriers to widespread adoption is the lack of interpretability in deep learning models. For AI to be fully trusted in high-stakes environments like aerospace or surgery, the development of Explainable AI (XAI) is mandatory.
3. *Ethics and Data Integrity*: The success of AI is inherently tied to the quality of data. Issues such as algorithmic bias and data privacy remain critical challenges that require both technical solutions (e.g., synthetic data) and robust regulatory frameworks.
4. *The Era of Autonomous Science*: The future of applied sciences lies in the synergy between human intuition and autonomous AI systems. "Self-driving labs" and physics-informed neural networks will likely redefine the scientific method, shifting the human role from performing experiments to supervising AI-driven discovery processes.

In summary, while AI poses significant ethical and technical challenges, its potential to solve global problems — from climate change to incurable diseases — makes its continued development and integration the most vital frontier of modern science.

## REFERENCES:

1.World Economic Forum. The Future of Jobs Report 2025. – Geneva, 2025.

2.Official website of the President of the Republic of Uzbekistan. Strategy “Digital Uzbekistan – 2030”. – Tashkent, 2020.

3.Ministry of Information Technologies and Communications of the Republic of Uzbekistan. Concept for the Development of Artificial Intelligence. – T., 2025.

5. Joshi S, Bhattacharya S, Pathak P, Natraj NA, Saini J, Goswami S. Harnessing the potential of generative AI in digital marketing using the behavioral reasoning theory approach. Int J Inform Manage Data Insights. 2025;5(1):100317.

6. Pesapane F, Hauglid MK, Fumagalli M, Petersson L, Parkar AP, Cassano E, et al. The translation of in-house imaging AI research into a medical device ensuring ethical and regulatory integrity. Eur J Radiol. 2025;182:111852.

7.ZiyoNET. Collection of articles on artificial intelligence and its applications.

8.Academy of Sciences of the Republic of Uzbekistan. Development of modern information technologies. – Tashkent, 2026.

9.IT Park Uzbekistan. Development of innovations and startups in the IT sector. – Tashkent, 2025.