

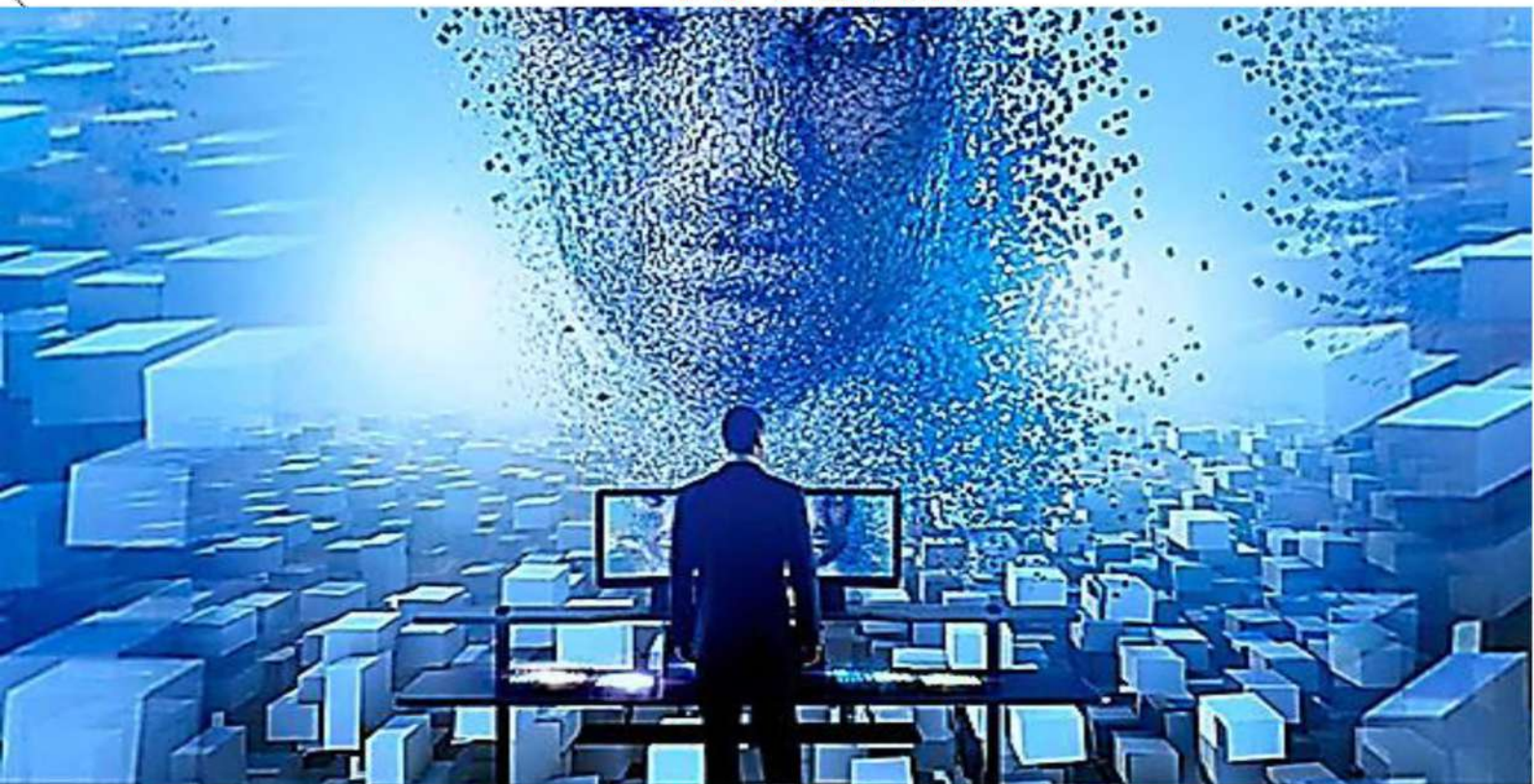


O'ZBEKISTON RESPUBLIKASI
MAKTABGACHA VA MAKTAB
TA'LIMI VAZIRLIGI



BUXORO VILOYATI PEDAGOGIK
MAHORAT MARKAZI

**“RAQAMLI TEXNOLOGIYALAR, SUN’IY INTELLEKT VA
PSIXIKA: XALQARO TAJRIBALAR VA RIVOJLANISH
ISTIQBOLLARI” MAVZUSIDA RESPUBLIKA ILMIY-AMALIY
KONFERENSIYASI
(OFFLAYN-ONLAYN) 2025-yil, 23-iyun
T O ‘ P L A M I**



Buxoro viloyati pedagogik mahorat markazi yillik rejasiga asosan
“Raqamli texnologiyalar, sun’iy intellekt va psixika: xalqaro tajribalar va rivojlanish istiqbollari” mavzusida Respublika ilmiy-amaliy konferensiyaga tayyorgarlik ko‘rish va uni yuqori saviyada o‘tkazilish bo‘yicha:

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Buxoro viloyati pedagogik mahorat markazi ilmiy-metodik kengashi 2025 yil 25-maydagi 3-sonli yig‘ilishi bayonnomasi qarori bilan foydalanishga tavsiya etilgan

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Matnlarda foydalanilgan misol, ko‘chirma va ma’lumotlar aniqligi uchun mualliflar javobgardirlar.

KIRISH SO‘ZI

METHODOLOGY FOR USING ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN THE FIELD OF SEARCH ENGINES

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Abstract. This paper explores the methodological foundations and implications of integrating artificial intelligence technologies into modern search engines. As information retrieval systems evolve from static, rule-based architectures to dynamic, intelligent platforms, AI has become essential in enabling context-aware, personalized, and semantically rich search experiences. The literature reveals significant advancements in machine learning, natural language processing, and deep learning, particularly through models such as BERT and GPT, which have redefined how user queries are interpreted and results delivered. However, these advancements also introduce new methodological challenges related to transparency, ethical personalization, data bias, multilingual access, and sustainable implementation. Through critical analysis, this study discusses the balance between performance and interpretability, the role of high-quality data, and the need for more inclusive and explainable AI-driven systems. The findings contribute to a more nuanced understanding of how AI should be methodologically integrated into search technologies to enhance both effectiveness and user trust.

Keywords: artificial intelligence, search engines, machine learning, natural language processing, deep learning, information retrieval, personalization, semantic search, transformer models, ethical AI.

Introduction. In the current digital age, the volume of information accessible through the internet has grown to such an extent that traditional search engine models are no longer sufficient to meet users’ demands for speed, precision, and contextual understanding. As users increasingly seek more natural and human-like interactions with digital platforms, the limitations of rule-based and keyword-dependent search technologies have become more apparent. In response to these challenges, the incorporation of artificial intelligence (AI) into search engine frameworks has emerged as a transformative solution, fundamentally reshaping how information is retrieved and interpreted.

Artificial intelligence, particularly in the forms of machine learning (ML), deep learning (DL), and natural language processing (NLP), provides a foundation for building search systems that not only analyze textual input but also grasp the context, intent, and semantic structure behind user queries. Unlike traditional models, which often treated words as isolated tokens, AI-enabled systems consider sentence structure, user history, and even behavioral patterns to generate more

relevant and adaptive responses. This capability has significantly enhanced the quality of search results, reduced the prevalence of irrelevant data, and improved overall user satisfaction.

One of the key milestones in this evolution has been the development and deployment of language models capable of understanding contextual relationships within language. For example, models like BERT (Bidirectional Encoder Representations from Transformers) and transformer-based architectures used in OpenAI’s GPT series have introduced unprecedented levels of comprehension into search engine algorithms. These systems are no longer just retrieving data—they are interpreting language in a way that mimics human cognition, leading to results that are more accurate, meaningful, and useful. Furthermore, AI technologies have enabled the personalization of search experiences. By analyzing previous interactions, location data, and user preferences, intelligent systems tailor search results to the specific needs and expectations of individual users. This level of customization was previously unattainable with traditional approaches and represents a significant leap forward in user-centric design. However, the integration of AI into search engine technology is not without its complexities. It requires a robust methodology that spans data collection, preprocessing, model selection, training and fine-tuning, evaluation, and continuous feedback loops. Moreover, it raises important ethical and technical considerations, such as data privacy, algorithmic bias, transparency, and the balance between relevance and manipulation. As such, the methodology behind using AI in this domain must be both technically rigorous and ethically responsible.

This paper seeks to delve deeply into the methodologies employed in the application of artificial intelligence to search engines. It examines not only the technical aspects—such as model architectures, training protocols, and performance metrics—but also the broader implications of these technologies on information access, digital literacy, and user autonomy. Through this exploration, the study aims to contribute a comprehensive perspective on the current state and future direction of AI-enhanced search engines, providing both theoretical insights and practical guidelines for researchers, developers, and decision-makers working at the intersection of artificial intelligence and information retrieval.

Literature Review. The intersection of artificial intelligence and search engine technology has been the subject of a growing body of research over the past two decades. Early works in this domain focused primarily on improving indexing mechanisms and keyword matching techniques to enhance the relevance of search results. However, as the limitations of these approaches became more evident, especially in handling ambiguous queries and understanding user intent, researchers began to explore the potential of AI-driven solutions.

One of the foundational studies in this field was Salton and McGill’s vector space model, which introduced a mathematical representation of textual content. While innovative for its time, this model lacked the capacity to understand semantics and contextual relationships. This gap spurred the adoption of machine learning techniques, where algorithms could be trained to recognize patterns in user behavior and content structure. The introduction of latent semantic indexing (LSI) and probabilistic models like Latent Dirichlet Allocation (LDA) further advanced the field by incorporating topic modeling and probabilistic reasoning.

With the rise of deep learning, the focus shifted toward neural network-based models. Research by Mikolov et al. on word2vec marked a significant milestone by enabling semantic representations of words in continuous vector spaces. This advancement laid the groundwork for subsequent innovations in natural language processing (NLP), such as recurrent neural networks (RNNs), long short-term memory (LSTM) networks, and eventually transformer architectures. These models moved beyond word-level understanding and began capturing sentence-level and even document-level semantics, thereby transforming the very foundations of search engine functionality.

The development of BERT by Google marked a paradigm shift in search engine AI. By leveraging bidirectional training and attention mechanisms, BERT enabled search systems to better understand the nuances of language, including word order, syntax, and semantic context. Numerous studies have since validated the effectiveness of BERT and similar transformer-based models in improving search relevance, particularly in long-tail queries and complex natural language questions. Beyond the technical advances, researchers have also investigated the implications of AI-driven personalization in search engines. Studies have highlighted both the benefits—such as improved user satisfaction and faster information access—and the risks, including filter bubbles and privacy concerns. As AI systems increasingly rely on user data to optimize search results, the ethical dimensions of data usage, transparency, and algorithmic bias have become prominent themes in academic literature.

Several recent surveys and meta-analyses have attempted to synthesize the evolving landscape. For instance, recent work by Liu et al. (2022) provides a comprehensive review of AI applications in web search, categorizing them into retrieval, ranking, and user modeling tasks. Meanwhile, Gupta and Singh (2023) emphasize the need for interdisciplinary approaches, combining insights from computer science, cognitive psychology, and human-computer interaction to build truly intelligent and ethical search systems. Despite the abundance of research, gaps remain in the literature regarding the standardization of methodologies for implementing AI in search engines. While there is consensus on the effectiveness of

deep learning models, there is still limited clarity on best practices for model selection, training data optimization, cross-lingual retrieval, and evaluation metrics. Additionally, most current studies focus on large-scale commercial search engines, leaving a relative dearth of research on AI integration in niche or domain-specific search systems.

Taken together, the reviewed literature underscores the transformative impact of artificial intelligence on search engine technologies while also highlighting the need for further methodological refinement. This study seeks to build on these foundations by proposing a structured and critical approach to the methodological aspects of AI deployment in search, contributing to a more coherent and ethically aware technological future.

Discussion. The integration of artificial intelligence into search engine technologies presents a multifaceted transformation that extends beyond technical upgrades; it redefines how users interact with digital information and how systems interpret and deliver knowledge. As explored in the literature, the application of AI—especially through machine learning and natural language processing—has allowed search engines to evolve from static information retrieval tools into adaptive, context-aware systems. However, this transformation is not without its challenges, trade-offs, and open questions that demand careful consideration.

One of the core issues in implementing AI in search engines is striking the right balance between accuracy and interpretability. While deep learning models such as BERT and GPT have shown remarkable improvements in understanding user queries and providing relevant results, their "black box" nature raises concerns about transparency and trust. Users and developers alike are often unaware of how specific decisions are made by these models, making it difficult to audit or explain results—especially when they lead to misinformation, biased outcomes, or overlooked content. This challenge has prompted ongoing discussions in the AI research community about the importance of explainable AI (XAI) and the development of models that can offer insight into their decision-making processes without sacrificing performance. Another significant topic of discussion is personalization. AI allows search engines to tailor results based on user behavior, preferences, and history. While this undoubtedly enhances user satisfaction and efficiency, it also introduces the risk of creating echo chambers or filter bubbles, where users are continually exposed to information that reinforces existing beliefs. This phenomenon limits exposure to diverse viewpoints and can inadvertently contribute to misinformation or social polarization. Therefore, an ethical methodology must consider not only how effectively an AI system can predict and personalize but also how it can encourage exploration and ensure a balanced flow of information. From a methodological standpoint, data remains the cornerstone of AI performance. High-

quality, diverse, and representative training datasets are essential to train models that generalize well across user groups and query types. However, in real-world applications, data is often noisy, biased, or limited to specific domains. The methodology for data curation, preprocessing, and augmentation thus plays a critical role in the success of AI-driven search systems. Moreover, as search engines expand globally, multilingual and cross-lingual capabilities become increasingly important. Yet, most AI models still perform disproportionately better in English and a few major languages, highlighting a critical gap in the inclusivity of AI technologies in search.

Performance evaluation is another area where methodological clarity is essential. Traditional metrics such as precision, recall, and F1-score are useful but may not fully capture the user experience in dynamic and context-sensitive environments. User-centric evaluation methods—such as satisfaction surveys, click-through rates, and dwell time analysis—provide more holistic insights but are harder to standardize. The ongoing methodological debate focuses on how to design evaluation frameworks that reflect both system performance and user interaction quality, ensuring that AI technologies serve human needs rather than just optimizing numerical benchmarks. Furthermore, computational efficiency and sustainability cannot be ignored. Training and deploying large-scale AI models require substantial computational resources, contributing to environmental concerns and operational costs. Efficient architectures, model compression techniques, and federated learning are being explored to address these issues, yet they require methodological innovation to ensure that performance is not compromised in the pursuit of efficiency.

In sum, the application of artificial intelligence in search engines is as much a methodological and philosophical endeavor as it is a technical one. It calls for a holistic approach—one that balances accuracy with fairness, personalization with openness, and innovation with responsibility. As AI continues to evolve, so too must the methodologies that guide its integration into systems that shape how billions of people access and interact with information daily.

Abstract. The integration of artificial intelligence technologies into search engines represents one of the most profound advancements in the field of information retrieval. As this paper has demonstrated, the shift from traditional keyword-based systems to intelligent, context-aware models has been made possible through significant progress in machine learning, natural language processing, and deep neural networks. These developments have not only improved the relevance and personalization of search results but have also redefined user expectations and engagement with digital content. However, the growing sophistication of AI models introduces new methodological responsibilities. It is no longer sufficient to focus

solely on improving accuracy or response time. Developers and researchers must also address questions of transparency, ethical personalization, data diversity, and sustainability. The discussion has shown that while transformer-based architectures like BERT and GPT have revolutionized semantic understanding in search, their opaque nature and resource-intensive deployment raise valid concerns about explainability and environmental cost.

In this evolving landscape, methodology plays a central role—not only in how AI systems are technically designed and trained, but also in how they align with human values, ensure equitable access to information, and foster trust in automated decision-making. A sound methodological framework must encompass rigorous data handling, inclusive model development, user-centric evaluation metrics, and ethical oversight. Only then can AI-driven search engines truly serve their purpose: empowering users with meaningful, unbiased, and efficient access to the world’s information. This study concludes that future research should continue to refine these methodologies, ensuring that innovation in AI remains grounded in both scientific rigor and social responsibility. As search engines increasingly become gateways to knowledge, the way we design and apply AI will fundamentally shape not only the digital experience, but also the flow of information in society at large.

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SUN'NIY INTELEKT ORQALI O'QUV MATERIALLARNI YARATISHDA PEDAGOGLARNI IJODIY QOBILIYATLARINI TAKOMINLASHTIRISH

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Annotatsiya. Ushbu maqolada sun'iy intellekt texnologiyalari yordamida o'quv materiallarini yaratishda pedagoglarning ijodiy qobiliyatlarini takomillashtirish masalasi o'rganilgan. Ta'lim jarayonida sun'iy intellekt vositalaridan foydalanish pedagoglarning yangi, interaktiv va shaxsiylashtirilgan ta'lim resurslarini yaratish imkoniyatlarini kengaytiradi. Shuningdek, maqolada pedagoglarning malakasini oshirish va sun'iy intellekt texnologiyalarini samarali qo'llash yo'llari haqida fikrlar bayon etilgan. Natijada, ta'lim sifati va o'quvchilarning bilim olish jarayoni yaxshilanishi ta'kidlangan.

Kalit so'zlar: sun'iy intellekt, ta'lim, o'quv materiallari, pedagoglar, ijodiy qobiliyat, ta'lim texnologiyalari, malaka oshirish, interaktiv o'quv resurslari.

Kirish. Zamonaviy ta'lim tizimida innovatsion texnologiyalarni joriy etish muhim ahamiyat kasb etmoqda. Ayniqsa, sun'iy intellekt (SI) texnologiyalari ta'lim sohasida katta imkoniyatlar yaratmoqda. Sun'iy intellekt yordamida o'quv jarayoni yanada shaxsiylashtirilgan, interaktiv va samarali bo'lishi mumkin. Bu esa o'quvchilarning o'rganish motivatsiyasini oshirish, bilimlarni chuqurroq va uzoq muddatli egallashga xizmat qiladi.

Shu bilan birga, pedagoglarning kasbiy faoliyatida ham sun'iy intellekt texnologiyalarining roli tobora ortib bormoqda. Pedagoglar endi faqat tayyor o'quv materiallarini taqdim etish bilan cheklanmay, balki sun'iy intellekt vositalari

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21.	<p>KICHIK MAKTAB YOSHIDAGI O‘QUVCHILARNI PSIXOLOGIK-PROFILAKTIK QO‘LLAB QUVVATLASH ISHLARDA MAKTAB VA OTA ONA HAMKORLIGI</p> <p>Abduraxmonova Mohinur Abdisodiq qizi Qarshi shahar 23-maktab amaliyotchi psixologi</p>	84
22.	<p>ANIQ VA TABIIY FANLARNI O‘QITISHDA SUN’IY INTELLEKT IMKONIYATLARI</p> <p>Abdurahimova Iqbolxon Qodirjonovna Namangan viloyati Pedagogik mahorat markazi</p>	87
23.	<p>BOSHLANG‘ICH TA’LIMDA RAQAMLI TEXNOLOGIYALARNI QOLLASHDA ELEKTRON DIDAKTIK MATERIALLARDAN FOYDALANISH</p> <p>Abduraximova Odinaxon Maxammatsolijonovna Andijon viloyati, Asaka tumani 12-umumta’lim maktabi Boshlang‘ich ta’lim fani o‘qituvchisi, Oltin Qalam sohibi</p>	92
24.	<p>BOSHLANG‘ICH TA’LIMI FANI O‘QITUVCHILARI RAQAMLI TA’LIMDA HAMKORLIK VA ALOQA VOSITALARIDAN SAMARALI FOYDALANISH</p> <p>Abduraximova Odinaxon Maxammatsolijonovna Andijon viloyati, Asaka tumani, 12-umumta’lim maktabi, Boshlang‘ich ta’lim fani o‘qituvchisi.</p>	97
25.	<p>INNOVATSIYA VA IJODKORLIK - INTELLEKTUAL SALOHIYAT RIVOJIDA MUHIM OMIL</p> <p>Abdullayeva Muxayyo Iskandarovna Buxoro viloyti pedagogik mahorat markazi “Ijtimoiy-iqtisodiy fanlar metodikasi” kafedrası, katta o‘qituvchi</p>	104
26.	<p>METHODOLOGY FOR USING ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN THE FIELD OF SEARCH ENGINES</p> <p>Ahmedova Shoirakhon Bilalkhanovna Associate Professor of the Department of Methodology of Exact and Natural Sciences, Andijan Regional Center for Pedagogical Skills</p>	108
27.	<p>SUN'NIY INTELEKT ORQALI O'QUV MATERIALLARNI YARATISHDA PEDAGOGLARNI IJODIY QOBILIYATLARINI TAKOMINLASHTIRISH</p> <p>Ahmedova Shoiraxon Bilalxanovna Andijon viloyati Pedagogik mahorat markazi Aniq va tabiiy fanlar metodikasi kafedrası dotsenti, p.f.f.d (PhD)</p>	114
28.	<p>ZAMONAVIY TA’LIMDA RAQAMLI RESURSLARNING AHAMIYATI</p> <p>Ahmedova Shoiraxon Bilalxanovna</p>	118

	Andijon viloyati Pedagogik mahorat markazi Aniq va tabiiy fanlar metodikasi kafedrası p.f.f.d., dotsent	
29.	ПРИМЕНЕНИЕ И ИЗУЧЕНИЕ ЦИФРОВЫХ ТЕХНОЛОГИЙ В ОНЛАЙН ПЛАТФОРМЕ ПРЕДМЕТА ФИЗИКИ Юлдашева Гуль-Рано Мамаджановна учительница физики, Андижанская область, город Андижан общеобразовательная школа №25	125
30.	“O‘ZBEKISTON TARIXI”NI O‘QITISHGA INNOVATSION YONDASHUVLARNING DOLZARB MASALALARI Haydarov Yuldash Hazratovich Buxoro viloyati pedagogik mahorat markazi “Ijtimoiy-iqtisodiy fanlar metodikasi”kafedrası dotsenti , tarix fanlari nomzodi haydarovyu@inbox.uz. tel: 98 274 55 85	128
31.	ZAMONAVIY PSIXOLOGIK TRENINGLAR SHAXS INTELLECTUAL RIVOJLANTIRISH MANBAI Maxmudova Dilafruz Mirzaevna Buxoro shahar 14 -maktab amaliyotchi psixologi	134
32.	SHAXSNING QOBILIYATLAR INDIVIDUAL-PSIXOLOGIK XUSUSIYATI SIFATIDA SUNIY INTELEKTNI RIVOJLANTIRISH ASOSI Tosheva Dildor To yirovna Romitan tuman 30-maktab amaliyotchi psixologi	140
33.	SUN’IY INTELECT VA PSIXIKA Ramazonova Dildora Subhonovna Peshko ‘ tumani 6-son umumiy o‘rta ta’lim maktabi amaliyotchi psixologi	147
34.	TA’LIM SAMARADORLIGI OSHIRISHDA INNOVATIV MODULLI O‘QITISH TEXNOLOGIYALARINING ROLI Ubaydulla Axrorovich Kosimov Buxoro viloyati pedagogik mahorat markazi (BPM) «Pedagogika va psixologiya, ta’lim texnologiyalari» kafedrası, psixologiya fanlari nomzodi(PhD), dotsent	152
35.	ZAMONAVIY TA’LIMDA SUN’IY INTELEKTNING ROLI Choriyeva Mahliyo Narzullayevna Jondor tuman 11-maktab amaliyotchi psixologi	156
36.	ALISHER NAVOIY VA OG‘AHY G‘AZALLARIDA KO‘NGIL TALQINI Shodiyeva Mahliyo G‘afforovna Buxoro viloyat PMM Tillarni o‘qitish metodikasi kafedrası o‘qituvchisi, +998906374139	164
37.	ZAMONAVIY PSIXOLOGIYADA SUN’IY INTELEKTNING QO‘LLANILISHI Kosimov Ubaydulla Axrorovich	167