INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 04 (2025)

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING TECHNOLOGIES IN FORMING ONLINE EDUCATION SYSTEMS

Bekmukhammedov Bunyodbek Nurmukhammad ugli
PhD Student, Kokand State University
bekmuhammedovb@gmail.com

Abstract: This article presents a methodology for creating a system to form individual learning paths in online education based on artificial intelligence (AI) and machine learning (ML) technologies, the proposed model considers the learner's cognitive level, learning style, ability, and learning intensity, enabling personalized education, the stages of data collection, analysis, recommendation systems, and learning process monitoring are detailed, the system aims to improve the quality of education and enhance learning outcomes.
Key words: Artificial intelligence, machine learning, individual learning path, personalized learning, educational technologies, learning analytics, recommendation system, knowledge level, digital footprints, big data in education.

Anotatsiya: Mazkur maqolada sun'iy intellekt va mashinaviy o'qitish texnologiyalaridan foydalangan holda individual o'quv yo'nalishini shakllantirish tizimini yaratish metodologiyasi taqdim etiladi, taklif etilgan yondashuv o'quvchining bilim darajasi, o'rganish uslubi, qobiliyati va intensivligini hisobga olgan holda shaxsiylashtirilgan ta'limni yo'lga qo'yishga qaratilgan, yaratilgan model asosida ma'lumotlarni yig'ish, tahlil qilish, tavsiya tizimlari va monitoring qilish bosqichlari amalga oshiriladi, tizim ta'lim sifatini oshirish, o'quvchilarning faolligini kuchaytirish va natijalarni yaxshilash imkonini beradi.
Kalit so'zlar: Sun'iy intellekt, mashinaviy o'qitish, individual o'quv yo'nalishi, shaxsiylashtirilgan ta'lim, ta'lim texnologiyalari, o'quv analitikasi, tavsiya tizimi, bilim darajasi, raqamli izlar, katta hajmdagi ta'lim ma'lumotlari.

Аннотация: В статье представлена методология создания системы формирования индивидуальной траектории онлайн-обучения на основе технологий искусственного интеллекта и машинного обучения, предлагаемая модель учитывает уровень знаний, стиль обучения, способности и интенсивность ученика, что позволяет внедрить персонализированное обучение, раскрываются этапы сбора и анализа данных, использования рекомендательных систем и мониторинга учебного процесса, система способствует повышению качества образования и улучшению учебных результатов.
Ключевые слова: искусственный интеллект, машинное обучение, индивидуальная траектория обучения, персонализированное обучение, образовательные технологии, учебная аналитика, рекомендательная система, уровень знаний, цифровые следы, большие данные в образовании.

The modern education system is undergoing a fundamental transformation through the use of artificial intelligence (AI) and machine learning (ML) technologies. In particular, these technologies have made it possible to deliver personalized educational content tailored to learners' knowledge levels, learning styles, and individual needs in the development of personalized learning pathways.

This article outlines a methodology for creating a system to shape individualized online learning pathways based on AI and ML. It presents the main stages, algorithms, and practical applications of the proposed system.

INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 04 (2025)

With the help of AI-powered tools, educators can gain deeper insights into their students' strengths and weaknesses and design personalized learning plans that support each learner's academic success. As a result, early identification of learning gaps plays a vital role in building a solid foundation for future development. AI serves as a powerful tool for detecting these gaps and delivering targeted support.

AI-based platforms collect and analyze data on student interaction with educational materials, time spent on tasks, test results, and overall learning performance, helping to better understand the needs and engagement levels of each learner. For instance, if the AI system identifies that a student is struggling with a specific assignment (including tests and exercises), it can recommend additional learning resources. Simultaneously, the system may offer self-assessment quizzes based on the material already covered by the student.

Analyses show that in forming individualized learning pathways (ILPs), AI and ML technologies make use of large volumes of educational data—commonly referred to as Big Data in Education.

Big Data is radically transforming the educational environment by providing valuable insights into students' behaviors, learning styles, and academic achievements. Through the analysis of Big Data, it is now possible to develop personalized learning plans tailored to the individual needs of each student, improve communication between teachers and students, and enhance overall student engagement (Figure 1).

Figure 1 – Use of Big Data in

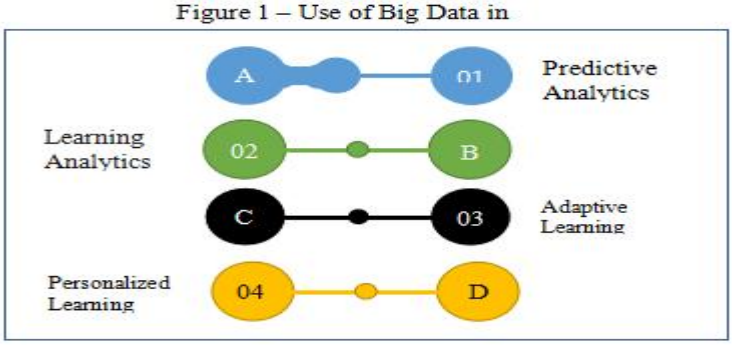


Figure 2. Block Diagram of the Algorithm for Forming a Personalized Learning Pathway Using Artificial Intelligence Mechanisms

The algorithm consists of the following stages:

Stage 1. Creating a Skills Matrix

To identify the learner's knowledge and form an educational profile, a skills matrix must first be created. For this, skills need to be described once by humans. This can be done by analyzing

employee resumes through textual analysis or having employees fill out simple forms to show skills in rows and their knowledge levels in columns. This data is then analyzed by a machine, resulting in an individual profile that reflects the learner's current level of knowledge and skills.

Stage 2. Collecting Educational Data (Aggregation)

Having data only about skills is insufficient. AI identifies, collects, and analyzes educational data from various sources within the organization. This can be easily done using xAPI (Experience API, previously known as Tin Can API), an open specification that describes the format for transferring statistical data between the educational activity provider (e.g., course, website, app) and a Learning Record Store (LRS). Through this API, detailed information about past and current learning experiences from systems like LMS, LXP, TMS, and HRIS can be gathered.

Stage 3. Using AI to Identify Patterns

After aggregating all the data, AI identifies trends and establishes patterns for each learner. This information provides valuable insights into students' acquisition levels and preferences in education for administrators or Learning and Development (L&D) teams. In the next step, this data will be used to recommend the most suitable educational content.

Stage 4. Creating Individual Learning Pathways (ILP) Based on AI Recommendations

By identifying educational trends, the system can offer students learning materials that match their learning styles and skill levels, considering the format and complexity. For instance, AI might indicate to an administrator that a specific employee prefers short video clips as their primary content format and shows interest in "Technical SEO" topics. Based on this information, the recommendation system will offer more videos on this topic instead of textual content. Students who receive relevant content in the preferred format are more likely to succeed in their learning courses.

Stage 5. Monitoring and Evaluating ILP for Adjustment

Learners begin their study using LMS or LXP systems. Each learner's progress is regularly measured and assessed. The AI mechanism adapts the course based on the learner's latest results. This process repeats continuously. By implementing AI technologies into their courses, organizations can gain a strategic advantage by identifying skill gaps in employees and providing timely retraining and upskilling.

Machine learning (ML) can be used in forming an individualized learning plan based on the following factors:

Learner's knowledge level;

Learning style;

Preferences;

Achievements in learning.

Some methods that can be applied include:

Clustering: This method is used to group students based on their learning profiles, and a separate learning plan can be developed for each group.

Recommendation systems: These systems suggest individual learning resources based on the learner's previous interactions and similarities to other students.

Reinforced learning: This method allows for real-time adjustment of the learning plan based on feedback received from the learner.

Prediction of mastery: ML models can predict how well a student will perform on a specific task or topic, enabling the adaptation of the learning plan to maximize success.

This work proposes a methodology based on a multi-algorithmic combined personalized model for recommending educational pathways for online education platforms. The model is designed based on four aspects of the learner:

Cognitive (knowledge) level,

Learning ability,
Learning style,
Learning intensity.

The associative rules algorithm is used to create the sequence of knowledge points and plan the learning sequence for students. The swarm intelligence algorithm ensures that each knowledge point is linked to highly adaptable personalized learning resources, allowing students to learn with a more targeted approach.

Experimental results show that research based on this model can provide real learning pathways for targeted users, enhance the accuracy of recommended resources, and improve the quality of education and students' learning outcomes. Figure 3 illustrates the architecture of the personalized learning pathway framework.

This work describes the application of education technology (EdTech) to create personalized learning pathways using artificial intelligence and machine learning technologies. Companies dealing with educational technologies use large volumes of educational data to create machine learning models, which allows them to leverage the benefits of various AI services available in Amazon Web Services (AWS) cloud.

Figure 3. Framework Architecture for Forming a Personalized Learning Pathway

As artificial intelligence (AI) and machine learning (ML) become more widespread and easier to use, EdTech companies and startups around the world are increasingly benefiting from these technologies, particularly in the area of personalizing educational content to meet the specific needs of students or teachers.

An example of this is the Lalia program located in Singapore, an interactive online learning platform designed to teach English to non-native speakers. It provides adaptive materials tailored to each learner's level of language proficiency. Using AI, Lalia personalizes the learning activity for each student, helping them to expand their vocabulary and grammar, as well as improve their communication skills at their own pace according to their needs.

Thus, AI and machine learning technologies are widely applied in systems for forming individualized learning pathways (ILPs). However, as a promising approach, a machine learning-based method stands out. To describe this approach, the UML activity diagram shown in Figure 4 is used.

INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 04 (2025)

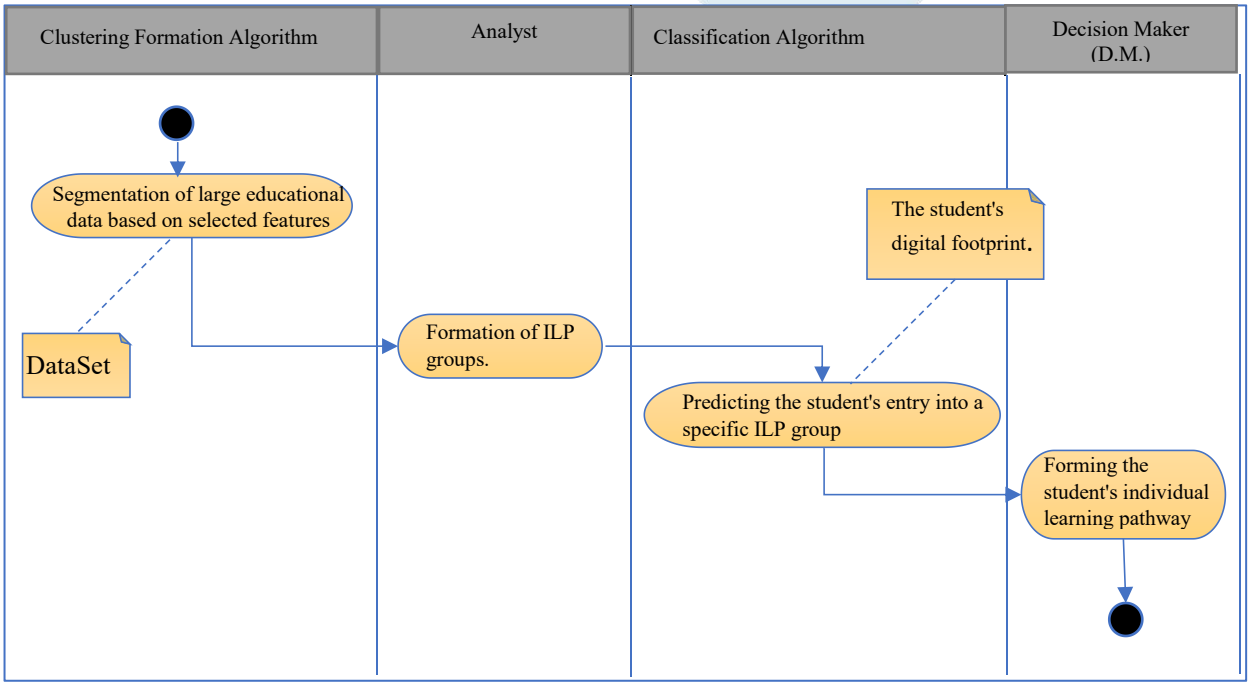


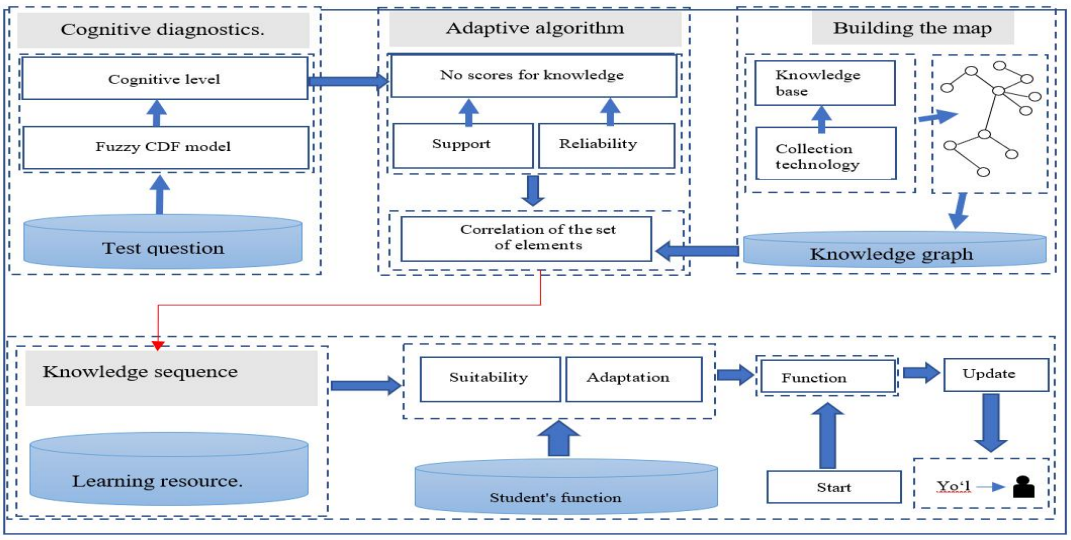
Figure 4. Activity Diagram of the System for Forming Individual Learning Pathways (ILP) Based on Machine Learning Technologies

This approach was selected for creating a system to form an individual learning pathway for the student.

Conclusion

As a result of the conducted work, the following conclusions were made:

Using a comprehensive approach in implementing the concept of personalized education based on artificial intelligence (AI) and machine learning (ML) yields the best results.



Large volumes of educational data are used in forming an individual learning pathway with AI and ML.

The object model of the personalized learning pathway formation system (PLPFS) is based on the "ML Model" class, which logically represents a machine learning model. This model is used to

predict the likelihood of the student's entry into a certain group of behaviors and to form their individual online learning pathway.

The research demonstrated high efficiency in forming individual learning pathways based on AI and ML technologies. The proposed methodology contributes to personalizing the educational process, deeply analyzing student needs, and creating content tailored to their knowledge levels. This not only improves the quality and efficiency of education but also enhances students' learning outcomes.

References

1. Якубов, Максадхан Султанниязович. "ТАЪЛИМ ТИЗИМИДА СТРУКТУРАЛАШГАН МАЪЛУМОТЛАР АЛМАШИНУВИНИНГ ЎЗИГА ХОС ҲУСУСИЯТЛАРИ." IQRO INDEXING 8.2 (2) (2024): 247-254.
2. Bekmuxammedov, Bunyodbek. "THE DEVELOPMENT STRATEGY AND IMPORTANCE OF ONLINE EDUCATION SYSTEM." DTAI–2024 1.DTAI (2024): 436-439.
3. Якубов, Максадхан Султанниязович. "ТАЪЛИМ ТИЗИМИДА ЭЛЕКТРОН ХУЖЖАТ АЙЛАНИШИНИ ТАШКИЛ ЭТИШ ТАМОЙИЛЛАРИ." PEDAGOGS 54.1 (2024): 113-118.
4. Yashnarovna, Mansurova Makhina, Bekmukhammedov Bunyodbek, and Jumaboev Behzod. "OPTIMIZING WORKFORCE DYNAMICS: A COMPARATIVE ANALYSIS OF REGIONAL." Open Access Repository 10.3 (2024): 1-7.
5. Якубов, Максадхан Султанниязович. "КАТТА МАСШТАБЛИ ТАЪЛИМ СОҲАСИ ЭЛЕКТРОН
6. ҲУЖЖАТ АЛМАШИНУВИНИНГ ТЕХНИК ВА ТАШКИЛИЙ ТАЪМИНОТИ." BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI 3.12 (2023): 163-170.
7. Якубов, Максадхан Султанниязович. "ТАЪЛИМ ТИЗИМИДА ЭЛЕКТРОН ХУЖЖАТ АЙЛАНИШИНИ ТАКОМИЛЛАШТИРИШ ОМИЛЛАРИ." BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI 3.11 (2023): 145-149.
8. Якубов, Максадхан Султанниязович. "КАТТА МАСШТАБЛИ ОБЪЕКТЛАР ЭЛЕКТРОН ҲУЖЖАТ АЙЛАНИШ ТИЗИМИНИ ТИЗИМЛИ ТАҲЛИЛИ: СИСТЕМНЫЙ АНАЛИЗ СИСТЕМЫ ЭЛЕКТРОННОГО ДОКУМЕНТООБОРОТА КРУПНЫХ ОБЪЕКТОВ." Молодой специалист 2.14 (2023): 43-55.
9. Якубов, Максадхан Султанниязович. "ТАЪЛИМ СОҲАСИДА ЭЛЕКТРОН ҲУЖЖАТ АЙЛАНИШ ТИЗИМИНИ ЖОРИЙ ЭТИШНИНГ ЎЗИГА ХОС ХУСУСИЯТЛАРИ: SPECIFIC CHARACTERISTICS OF THE IMPLEMENTATION OF THE ELECTRONIC DOCUMENT CIRCULATION SYSTEM IN THE FIELD OF EDUCATION." Молодой специалист 2.13 (2023): 45-53.