MACHINE LEARNING AND NEW TECHNOLOGIES IN CLINICAL DATA ANALYSIS OPPORTUNITIES AND CHALLENGES

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Annotatsiya: Ushbu maqolada klinik ma’lumotlarni tahlil qilishda mashinaviy o‘rganish (Machine Learning – ML) va zamonaviy texnologiyalarning o‘rni, imkoniyatlari hamda duch kelinayotgan muammolari tahlil qilinadi. Tibbiyot sohasida ML uslublari katta hajmdagi klinik axborotlardan foydali xulosalar chiqarish, tashxisni aniqlashtirish va davolash sifatini oshirish imkonini bermoqda. Shuningdek, maqolada ML algoritmlarining amaliy misollari, texnik cheklovlari, axborot xavfsizligi, etik masalalar hamda kelgusidagi rivojlanish yo‘nalishlari yoritilgan.

Kalit so‘zlar: Mashinaviy o‘rganish, klinik ma’lumotlar, sun’iy intellekt, tibbiyot texnologiyalari, axborot xavfsizligi, tahlil, algoritmlar

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Аннотация: В статье рассматривается роль машинного обучения (Machine Learning – ML) и современных технологий в анализе клинических данных. Применение ML в медицине позволяет извлекать ценные сведения из больших объемов медицинской информации, улучшать точность диагностики и эффективность лечения. В работе также обсуждаются примеры применения ML, технические ограничения, вопросы информационной безопасности, этические аспекты и перспективы дальнейшего развития.

Ключевые слова: Машинное обучение, клинические данные, искусственный интеллект, медицинские технологии, информационная безопасность, анализ, алгоритмы

Abstract: This article explores the role of machine learning (ML) and emerging technologies in the analysis of clinical data. In the healthcare field, ML techniques offer valuable insights from large volumes of medical information, improving diagnostic accuracy and treatment quality. The paper discusses practical implementations of ML, technical limitations, data security issues, ethical concerns, and potential future directions of development in clinical informatics.

Keywords: Machine learning, clinical data, artificial intelligence, medical technologies, data security, analysis, algorithms

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In modern medicine, the speed, accuracy and scientific basis of decision-making have become the criteria for the quality of the healthcare system. In clinical practice, the increasing number of patients, their complex conditions, the large volume of various symptoms and laboratory indicators limit the ability of a doctor to work with data for accurate diagnosis and treatment. In such a situation, the use of artificial intelligence (AI) and machine learning (Machine Learning – ML) algorithms is becoming inevitable. In addition, electronic complaint systems, medical records (EMR), diagnostic analysis technologies and AI systems integrated with them are recognized as real auxiliary tools in modern medicine. This article will analyze in detail such technologies, their capabilities, practical achievements and current limitations.

Main part

2. The role of machine learning algorithms in clinical practice: Machine learning is a branch of artificial intelligence that allows computer systems to learn and draw conclusions from data without prior explicit programming. In clinical medicine, ML algorithms are of great help in processing, analyzing and making informed decisions on complex data sets. The following are the main functions of machine learning in clinical practice:

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- ***Application in diagnostics;*** ML algorithms are used to detect diseases such as cancer, stroke, and COVID-19 through image analysis (X-ray, MRI). Example: Models based on Convolutional Neural Networks (CNN) have higher accuracy than human experts in detecting cancer (Rajpurkar et al., 2022).
- ***Symptom clustering and classification:*** ML identifies similarities between patients by grouping symptoms. This clustering simplifies patient analysis and paves the way for accurate diagnosis.
- ***Predictive models*;** ML algorithms allow for the prediction of heart attacks, diabetes, or other chronic diseases based on a patient's historical data.
- ***Individualization of drug selection and treatment;*** Algorithms generate an individual treatment plan based on the patient's genetic and clinical characteristics.

3. Electronic complaint systems and data integration: In healthcare, electronic medical records (EMRs) and electronic complaint systems streamline the flow of clinical information between doctors and patients. These systems provide a strong foundation for rapid and accurate medical decision-making.

- ***The importance of an EMR system*;** A patient's symptoms, lab tests, diagnoses, and medications are stored in one place. ML and SI algorithms work on this large amount of data.
- ***Data integration*:** Data collected from clinical systems, laboratories, imaging tests, and even patient mobile apps are brought together in a single system. This integration enables multi-source analysis and real-time decision-making.
- ***Impact on clinical efficiency;*** With integrated systems, the diagnostic process is accelerated by 30–40%, human errors are reduced, and patient safety is increased.

4. New clinical analysis technologies and their effectiveness: Technologies are developing year by year and their role in clinical practice is expanding. The following is a summary of technologies that are widely used in clinics today:

- ***Mobile applications (Mobile Health – mHealth) ;*** AI-powered mobile apps like SkinVision, Ada, and MySugr provide users with a first-hand look at their health. They have features like symptom detection, reminders and risk assessment.
- ***Real-time analysis systems; Platforms like* Aidoc** or **Viz.ai** automatically analyze MRI or CT images and detect conditions such as stroke and bleeding within minutes.

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- ***Clinical Decision Support Systems (CDSS);*** These systems provide real-time recommendations to the physician regarding diagnosis, drug selection, dosing, or contraindications. IBM Watson for Oncology is the most popular of such systems.
- ***IoT technologies in diagnostics and monitoring;*** Sensors that measure heart rate, blood pressure, and blood sugar levels, and AI analyzes this data and provides real-time alerts.

5. Practical results and scientific approaches: Today, systems based on ML and AI have been tested in many clinics and their clinical effectiveness has been proven. Examples:

- ***Clinical study results;*** An AI model developed by Google Health was 11% more accurate than human radiologists in detecting lung cancer. A Harvard Medical School study showed that AI predicted heart disease with 80% accuracy.
- ***Scientific basis and statistical evidence;*** ML-based diagnostic systems have been described with high efficiency in numerous articles in medical journals in 2022–2024 (Esteva et al., Topol, Holzinger).
- ***Independent programs and scientific proposals;*** Innovative applications reduce physician workload, simplify patient communication, and help digitize the healthcare system.

There are many predictive algorithms for correctly identifying symptoms.

These algorithms support initial diagnosis based on medical condition-related indications, symptoms, and other information. Some algorithms help identify features associated with the symptoms of a product. For example, interesting highlights, surface disease, and other symptoms may be present.

It is important to use laboratory tests for relevant information. These tests help to determine the independence of treatment and the underlying cause, and are also useful for other diagnostic situations. This section begins with a brief introduction to symptom recognition and predictive algorithms in clinical situations. Examples of these algorithms and the role of laboratory tests are highlighted.

Conclusion

The increasing volume of medical information in modern clinical practice makes it difficult for doctors to make accurate, reliable and individualized decisions in real time. The introduction of machine learning (ML), artificial intelligence (AI) and new technologies as a solution to this problem has ushered in a new era in clinical decision-making processes. Analysis shows that ML algorithms have the potential to detect diseases early, cluster them based on

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symptoms, individualize treatment, optimize resources and reduce errors. In particular, the large amount of data collected through electronic complaint systems and EMRs serves as a rich source for ML. Real-time analysis systems, mobile applications and CDSS platforms created on the basis of this data not only accelerate clinical decisions, but also increase their accuracy. The full and successful implementation of AI technologies in clinical medicine depends not only on technical innovation, but also on cultural, legal and ethical changes in the entire healthcare system. In general, machine learning and new analytics technologies are opening up new possibilities in clinical practice. These technologies are expected to play a crucial role in improving the quality of healthcare, accelerating decision-making, ensuring patient safety, and simplifying the work of doctors. In the future, these technologies will form the basis of a new clinical model formed by the collaboration of humans and artificial intelligence.

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