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PRINCIPLES OF CREATING REAL-TIME ANALYTICAL SYSTEMS BASED ON ARTIFICIAL INTELLIGENCE

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Abstract

The rapid development of digital technologies has led to a dramatic growth in the volume of data generated across different sectors. Modern information systems must process and analyze these data streams quickly in order to support effective decision-making. This article examines the principles of developing real-time analytical systems based on artificial intelligence technologies. The research analyzes the role of machine learning algorithms and neural network models in processing large data streams, detecting hidden patterns, and generating predictive insights. Particular attention is paid to system architecture, scalability, data processing speed, and reliability. The study demonstrates that integrating artificial intelligence with real-time data processing platforms significantly improves analytical capabilities and enables more accurate forecasting of complex processes.

Keywords: *artificial intelligence, real-time analytics, big data, machine learning, neural networks, predictive analysis, data processing systems*

Аннотация

Стремительное развитие цифровых технологий обусловило значительный рост объёма данных, формируемых в различных отраслях экономики и социальной сферы. В этих условиях современные информационные системы должны обеспечивать оперативную обработку и анализ непрерывных потоков данных для принятия обоснованных управленческих решений. В статье рассматриваются теоретические и практические аспекты разработки аналитических систем реального времени на основе технологий искусственного интеллекта. Исследуется роль алгоритмов машинного обучения и нейросетевых моделей в обработке больших данных, выявлении скрытых закономерностей и формировании прогнозных оценок. Особое внимание уделено вопросам архитектуры систем, масштабируемости, скорости обработки информации и надёжности функционирования. Установлено, что интеграция методов искусственного интеллекта с платформами обработки данных в реальном времени существенно повышает эффективность аналитики и обеспечивает более точное прогнозирование сложных процессов.

Ключевые слова: *искусственный интеллект, аналитика в реальном времени, большие данные, машинное обучение, нейронные сети, прогнозирование, системы обработки данных*

Introduction

The modern digital environment produces enormous volumes of data every second. Information is generated by industrial systems, financial transactions, mobile devices, sensors, social networks, and many other digital platforms. The ability to collect, process, and analyze these data streams has become a key factor in improving the efficiency of modern organizations and technological systems.

Traditional data analysis methods are often unable to cope with the speed, scale, and diversity of modern data streams. As a result, new approaches based on artificial intelligence technologies have been developed. Artificial intelligence provides powerful computational methods capable of analyzing complex datasets, detecting hidden relationships, and generating predictive insights.

Real-time analytics refers to the ability of a system to process and analyze data immediately after it is generated. This capability is extremely important in areas such as transportation management, financial monitoring, industrial automation, healthcare systems, and cybersecurity. In such domains, even a small delay in data processing may lead to inefficient decisions or operational risks.

The integration of artificial intelligence into real-time analytical systems enables automated decision-making and predictive modeling. Machine learning algorithms can learn from historical data and adapt to new information continuously. As a result, modern analytical platforms are capable of not only analyzing current data but also forecasting future events.

Main Part

Real-time analytical systems typically consist of several interconnected components including data sources, data streaming platforms, analytical modules, machine learning models, and visualization interfaces. These components work together to ensure continuous data collection, processing, and analysis.

As shown in Figure 1, a typical architecture of an artificial intelligence-based real-time analytics system includes several key components. The system begins with data sources such as sensors, databases, and online services. The collected data are transmitted through streaming technologies and processed by analytical modules. Machine learning algorithms are then applied to analyze the incoming data streams and generate predictive insights, which can be visualized through dashboards or used in various applications.

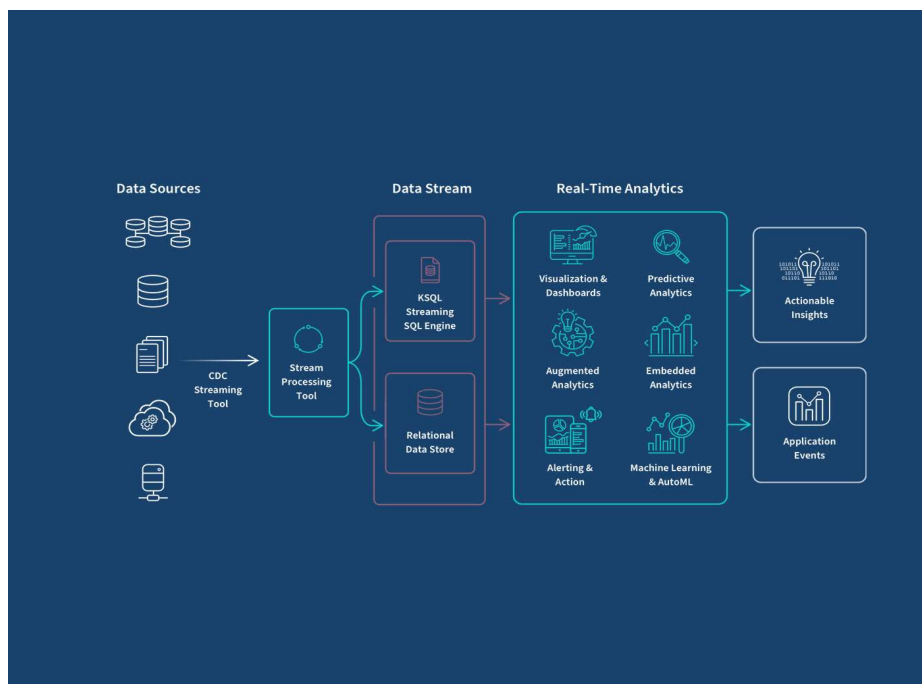


Figure 1. Architecture of an Artificial Intelligence-Based Real-Time Analytics System

One of the most important principles in developing real-time analytical systems is scalability. As data volumes grow continuously, the analytical infrastructure must be capable of expanding without reducing performance. Scalable systems distribute computational tasks across multiple processing nodes, ensuring efficient data processing even under heavy workloads.

Another important principle is low latency. Real-time analytics systems must provide analytical results with minimal delay. Technologies such as distributed computing frameworks and stream processing platforms are commonly used to achieve this objective.

Machine learning algorithms play a central role in real-time analytics. These algorithms allow systems to identify patterns within large datasets and generate predictive results. Neural networks, decision trees, and regression models are among the most commonly used techniques.

The workflow of real-time data analysis typically involves several stages including data collection, data preprocessing, feature extraction, model analysis, and prediction generation. This workflow is illustrated in Figure 2.

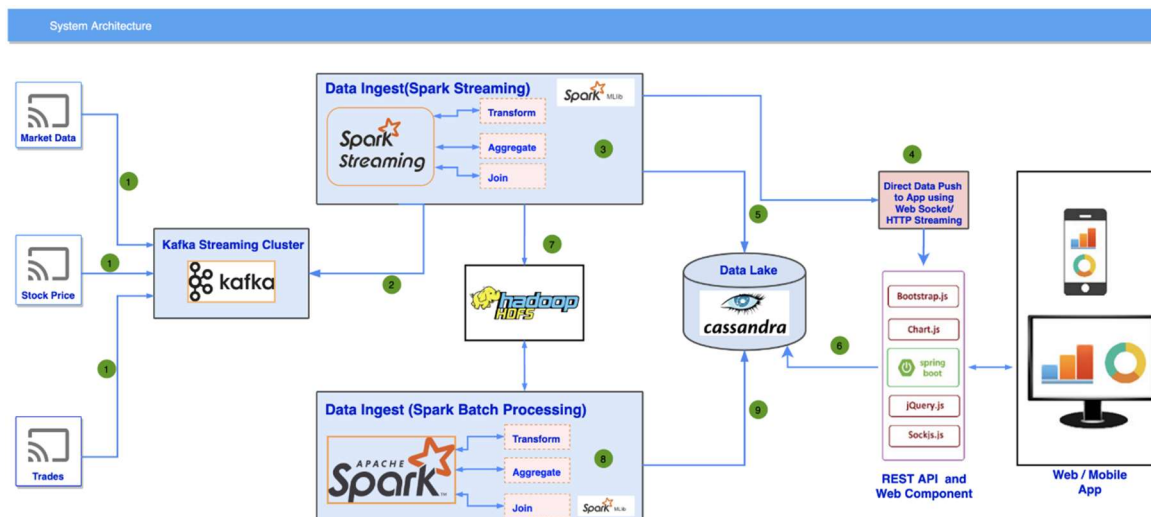


Figure 2. Workflow of Real-Time Data Processing and Analysis Using Artificial Intelligence

Data quality is another critical factor in analytical systems. Raw data streams often contain errors, missing values, or inconsistencies. Therefore, preprocessing and filtering mechanisms must be implemented to ensure the reliability of analytical results.

Key Benefits of Real-time AI Monitoring

The integration of AI for real-time monitoring transcends traditional surveillance by providing actionable intelligence. The primary advantages include:

- **Proactive vs. Reactive Management:** Traditional systems only alert operators after an incident has occurred. Real-time AI monitoring uses predictive analytics to identify early signs of potential issues—such as a sudden change in traffic density or a slight deviation in engine vibration—allowing for intervention before a failure or accident happens.
- **Enhanced Operational Efficiency:** By continuously analyzing data streams, AI can optimize resource allocation in real-time. In a transport context, this means dynamically rerouting vehicles to avoid congestion, thereby reducing fuel consumption and minimizing delivery delays.
- **Reduction of Human Error:** Monitoring high-velocity data is mentally exhausting for human operators, leading to overlooked anomalies. AI algorithms maintain a consistent level of precision, processing thousands of data points per second without fatigue, which significantly improves the reliability of safety-critical systems.
- **Predictive Maintenance and Cost Savings:** Real-time monitoring allows for "condition-based maintenance." Instead of replacing parts on a fixed schedule, AI predicts the actual remaining useful life of a component. This prevents costly "over-maintenance" and catastrophic "under-maintenance" (unexpected breakdowns).

– Improved Public Safety and Security: In intelligent transport systems, real-time AI can instantly detect unauthorized intrusions, suspicious behavior at stations, or dangerous driving patterns, enabling law enforcement or emergency services to respond within seconds.

A comparison of several widely used artificial intelligence algorithms applied in real-time analytical systems is presented in Table 1.

Table 1.
Comparison of Artificial Intelligence Algorithms Used in Real-Time Data Analysis

Algorithm	Application Area	Advantages	Limitations
Decision Trees	Classification and prediction	Easy to interpret and implement	May overfit complex data
Neural Networks	Pattern recognition and forecasting	High predictive accuracy	Requires large training datasets
Linear Regression	Trend analysis and forecasting	Simple and computationally efficient	Limited for nonlinear patterns
Support Vector Machines	Classification and anomaly detection	Effective in high-dimensional spaces	Computationally expensive

Discussion

The integration of artificial intelligence technologies into analytical systems has significantly improved the ability to process and interpret complex data streams. Machine learning algorithms provide adaptive capabilities that allow systems to learn from previous experiences and continuously improve analytical performance.

Real-time analytics is particularly important in intelligent transportation systems. By analyzing traffic data, sensor information, and environmental conditions, analytical platforms can predict congestion, optimize transport routes, and improve operational efficiency.

In industrial environments, real-time analytical systems are used for predictive maintenance. Machine learning models analyze equipment data to detect early signs of malfunction, allowing organizations to prevent failures and reduce maintenance costs.

Conclusion

The study demonstrates that artificial intelligence technologies play a crucial role in the development of real-time analytical systems. Machine learning algorithms enable efficient processing of large data streams, detection of hidden patterns, and generation of predictive insights.

The implementation of scalable architectures, high-speed data processing platforms, and advanced analytical models significantly improves the effectiveness of data analysis. As digital technologies continue to evolve, real-time analytics systems

will become increasingly important in supporting intelligent decision-making across various domains.

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