

# Universal Object Interaction: Investigating edge intelligence techniques for real-time decision-making in UOI applications.

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## **Abstract**

*The article examines the edge intelligence techniques for real-time decision-making in Universal Object Interaction applications.*

**Keywords:** Universal Object Interaction, decision-making, artificial intelligence techniques.

## **Анотація**

*У статті досліджено методи периферійного інтелекту для прийняття рішень в режимі реального часу в додатках UOI.*

**Ключові слова:** універсальна взаємодія об'єктів, прийняття рішень, методи штучного інтелекту.

The primary objective of this research is to explore and analyse various edge intelligence techniques that can enable real-time decision-making in Universal Object Interaction (UOI) applications. To start with, an artificial intelligence (AI) is the powerful wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence.

The edge intelligence shows great potentials in a number of UOI applications, including smart homes, intelligent transportation systems, e-healthcare, wearable devices, etc. With this in mind the edge intelligence, the UOI will enable UOI devices to process data locally to reduce the data transmission over the UOI systems, which mitigates the workload from the current data centres to the edge and only necessary data needs to be exchanged or shared. Due to this can also reduce the risks posed by data on the UOI. The given issue discusses four key applications of edge intelligence-enabled UOI: smart meters, indoor navigation using UOI devices, smart healthcare, and intelligence wearable UOI solutions.

In addition, edge intelligence (EI) is edge computing with machine learning (ML) and advanced networking capabilities. This means that several information technology (IT) and operational technology (OT) industries are moving closer towards the edge of the network so that aspects such as real-time networks, security capabilities to ensure cybersecurity, self-learning solutions and personalized/customized connectivity can be combined. The summary results of investigating edge intelligence techniques for real-time decision-making in UOI applications are submitted below.

### Edge Analytics

Edge analytics is the process of analysing data and finding solutions at the edge, where data is collected via smart devices and UOI sensors. Moreover, there are benefits to an organization's workflow because it facilitates real-time decision-making. Consequently, not every company requires mission-critical analysis in real-time, but as AI and ML technologies evolve and become more applicable to the everyday consumer, organizations will be able to utilize collected data from the edge to modify and improve the customer experience for greater personalization and a customized, streamlined buyer journey.

### Edge Machine Learning

Edge machine learning (edge ML) is the process of running machine learning algorithms on computing devices at the periphery of a network to make decisions and predictions as close as possible to the originating source of data. It is also referred to as edge artificial intelligence. Unlike traditional machines, Edge ML devices will analyse and process incoming data at the source and determine what needs to be processed by more powerful algorithms in the Cloud, versus what can be processed locally. For instance, if you tell the Amazon Echo, "Alexa, let's play a game," or "Alexa, tell me a joke," the games and jokes

available are stored in and processed by the device's local hardware. This will not require sending data to the Cloud.

#### Edge-based Rule Engines

The main thing that an edge-based rules engine is a type of edge intelligence technology used in UOI applications for real-time decision-making. On top of that the rules engine runs on the edge device itself and can make instant decisions based on pre-defined rules and conditions. An edge-based rules engine requires the definition of rules to drive the decision-making process. Apart from that, rules can be created by developers or domain experts based on the specific needs of the UOI application. A rule usually consists of a condition and a corresponding action.

#### Distributed Decision-Making

Correspondingly distributed decision-making is a decision-making process where several people are involved to reach a single decision, for example, a problem-solving activity among a few persons when the problem is too complex for anyone alone to solve it. In distributed decision-making, edge devices work together to make decisions rather than relying on a centralized authority. Each device can contribute its own data, observations, or expertise to the decision-making process. The devices communicate with each other to exchange information and reach a consensus on the best decision.

#### Edge-based Deep Learning

Deep learning simulates the way neurons in the human brain strengthen and weaken connections to create an understanding of images. In deploying deep learning, neural networks are built from large image sets of similar objects. By modifying connections within and between these layers every time it is exposed to a new image, deep learning learns to identify anomalies and detect defects.

#### Edge Caching

Edge caching refers to the use of caching servers to store content closer to end users. For instance, if you visit a popular Web site and download some static content that gets cached, each subsequent user will get served that content directly from the caching server until it expires. To understand edge caching, it's essential to understand the global digital world and the technology that makes it work.

Needless to say, the choice of edge intelligence technology depends on the specific needs and constraints of your UOI application. Various applications may require combinations of these techniques or the use of specialized algorithms tailored to application-specific needs.

To put it briefly, the investigation of edge intelligence techniques for real-time decision-making in UOI applications has revealed several key findings and insights. Firstly, AI is a powerful branch of computer science that plays a crucial role in building intelligent machines capable of performing tasks that typically require human intelligence. The integration of edge intelligence in UOI applications, such as smart homes, intelligent transportation systems, e-healthcare, and wearable devices, shows great potential in improving their functionality and efficiency. Furthermore, edge analytics and edge machine learning are two important techniques in the field of edge intelligence. Edge analytics involves analysing data and finding solutions at the edge, where data is collected through smart devices and UOI sensors. This facilitates real-time decision-making, enabling organizations to improve the customer experience through personalization and streamlined buyer journeys. On the other hand, edge machine learning refers to running machine learning algorithms on computing devices at the periphery of a network, making decisions and predictions close to the source of data. It allows for local processing and reduces the reliance on cloud resources.

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