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REQUIREMENTS AND THEIR IMPLEMENTATION FOR THE INTELLIGENT SYSTEM OF DECISION-MAKING IDENTIFICATION AND CLASSIFICATION OF CULTURAL VALUES

Мартиненко А.А., Приходченко С.Д., Гуліна І.Г., Мороз Д.М. Вимоги та їх реалізація для інтелектуальної системи прийняття рішень ідентифікації та класифікації об'єктів культурних цінностей. В статті розглядається проблема розробки та аналізу вимог та шляхи їх реалізації для інтелектуальної системи підтримки прийняття рішень ідентифікації та класифікації об'єктів культурних цінностей. В роботі аналізуються як загальні стандарти розробки програмного забезпечення, так і спеціалізовані стандарти, що стосуються саме інтелектуальних систем, також враховано сучасні методології та практичні інструкції. В роботі визначаються та аналізуються такі вимоги до системи як: швидкість обробки великих обсягів даних, точність ідентифікації, інтеграція з іншими інформаційними системами та базами даних, захист даних та інформаційна безпека, масштабування, адаптація до нових типів даних і моделей поведінки об'єктів, інтерфейс користувача, обробка та аналіз різних типів даних, кросплатформність і прогнозування на основі наявних даних для підтримки прийняття рішень. Також в статті визначається складність та комплексність підходу вирішення поставленої задачі, визначені перспективи та шляхи подальшого дослідження даної предметної області.
Ключові слова: інтелектуальна система підтримки прийняття рішень, розробка та аналіз вимог, стандарт, методологія, інструкція, об'єкти культурних цінностей.

Martynenko A., Prykhodchenko S., Hulina I., Moroz D. Requirements and their implementation for an intelligent decision-making system for the identification and classification of objects of cultural value. The article considers the problem of development and analysis of requirements and ways of their implementation for an intelligent decision support system for identification and classification of objects of cultural value. The work analyzes both general standards of software development and specialized standards relating to intelligent systems, modern methodologies and practical instructions are also taken into account. The work defines and analyzes such system requirements as: speed of processing large volumes of data, accuracy of identification, integration with other information systems and databases, data protection and information security, scaling, adaptation to new types of data and object behavior models, interface user, processing and analysis of various types of data, cross-platform and forecasting based on available data to support decision-making. The article also defines the complexity and complexity of the approach to solving the given task, the prospects and ways of further research of this subject area are determined.
Keywords: intelligent decision support system, development and analysis of requirements, standard, methodology, instruction, objects of cultural values.

Introduction. An intelligent decision support system that can identify and classify objects of cultural value according to various criteria can be useful for analysis, training and evaluation, as well as for detecting fakes or similarities between different objects. To develop such a system, it is necessary to use models and methods that can process various information, extract various characteristics and attributes, compare and classify them using modern algorithms of machine learning and artificial intelligence. But in addition to mathematical models and methods of processing and analyzing the received data, one of the important components of the design and development of such a system is the development and analysis of requirements for it.

Analysis of research and publications. In works [1 – 6], the authors conducted a study of the relevance and prospects for the development and use of an intelligent decision-making support system for the identification of objects of cultural value. It should be noted that considerable attention is paid to the development of schemes and conceptual models of the decision support system and models and methods of identification and classification and methods of identification and classification of objects of cultural value. As a result of the analysis of the subject area, the authors came to the conclusion that the developers of such systems face an unresolved scientific and practical task of developing and analyzing the requirements for an intellectual decision-making support system for the identification of objects of cultural value.

Setting the problem. When developing and analyzing requirements for their further implementation in the design and development of intelligent systems, it is important to take into account

both general software development standards [7 – 10] and specialized standards relating specifically to intelligent systems [11 – 16] The following methodologies should also be taken into account and practical guidelines such as BABOK (Business Analysis Body of Knowledge - a standard describing best practices of business analysis that can be applied to gathering and analyzing requirements for intelligent systems) and Agile Methodologies (Scrum, Kanban - flexible software development methodologies that can be adapted for projects with intelligent systems, ensuring the adaptability of requirements under conditions of uncertainty).

The requirements for modern information and analytical systems for the identification of objects of cultural value are quite high due to the complexity and variety of tasks that these systems must perform. Thus, the authors of this work, based on the analysis of the state of the issue, determine the following requirements for this system:

– The system should provide fast processing of large volumes of data for prompt decision-making. This is especially important in real time, for example, in security systems or for object identification based on video surveillance.

– High accuracy of identification is critically important. The system should have a minimum number of recognition errors to avoid false positives or incorrect identifications.

– The information and analytical system should be easily integrated with other information systems and databases to provide comprehensive analysis and data exchange.

– Given the nature of the processed data, the system should have a high level of protection against unauthorized access. Protection of personal data and information security are priority requirements.

– The system must be able to scale to handle growing volumes of data without losing performance and efficiency.

– The system should be able to adapt to new types of data and object behavior models through mechanisms of machine learning and artificial intelligence.

– The user interface should be intuitive, with the possibility of quick access to the necessary information and analysis tools.

– The system should support processing and analysis of various types of data: text, numerical, graphic, video and audio files, etc.

– The system should be available on various platforms, including mobile devices, and provide remote access for users.

– An important requirement is the system's ability to make predictions based on available data to support decision-making.

These requirements are aimed at ensuring high efficiency, reliability and security of information and analytical systems for identifying objects in various fields, including security, transport, medicine, trade, etc.

The main material presentation and the obtained research results substantiation of development and ways of implementing requirements for the system.

Ensuring the speed of data processing in an intelligent decision-making system is an important task that requires the use of various technological approaches. To implement this requirement, the following steps are proposed:

– Parallel data processing:
  – Parallel computing (the use of multi-core processors and graphics processors (GPUs) allows data processing to be distributed between several cores, which significantly speeds up the processing of large volumes of data).
  – Distributed systems (the use of cluster computing, where data processing is distributed among several servers or even data centers, allows processing large amounts of data in parallel).
– Using indexes and caching:
  – Indexing (correct indexing of data in databases allows you to significantly speed up data search and filtering).
  – Caching (the application of caching allows you to store frequently used processing results in memory, reducing the need for repeated processing of the same data).
– Optimization of algorithms:
  – Selection of optimal algorithms (use of algorithms that are effective in terms of computational complexity allows to reduce data processing time. For example, using linear time sorting instead of quadratic).

  - Algorithmic optimization (improvement of existing algorithms, for example, by reducing the number of iterations or reducing the volume of processed data).
- Massively parallel processing (MPP):
  - Massively parallel processing (the use of a database or computing system that supports massively parallel processing allows processing large data sets simultaneously on many nodes).
- Use of modern database technologies:
  - In-memory databases (these databases keep data in RAM, which provides fast access and processing of data without the need to refer to disk drives).
  - NoSQL databases (for large volumes of non-relational data, NoSQL databases are used, which allow you to quickly store and retrieve data).
- Artificial intelligence and machine learning:
  - Machine learning (using machine learning models to pre-process and classify data can speed up decision-making).
  - Predicative algorithms (use of forecasting models for preliminary determination of the most likely solutions, which reduces the time for analyzing new data).
- Hardware accelerators:
  - FPGA and ASIC (use of specialized hardware accelerators, such as FPGA (Field Programmable Gate Array) or ASIC (Application-Specific Integrated Circuit), which are specially designed to perform certain computing tasks faster than universal processors).
  - Graphics processing units (GPUs) (application of GPUs for computations that are efficient for parallel tasks such as deep learning or big data analysis).
- Optimization of network delays:
  - Latency reduction (optimization of network protocols and equipment to reduce delays in data transmission).
  - Placing data closer to the user (using technologies such as Content Delivery Network (CDN) to store data closer to users, reducing access time).
- Application of cloud technologies:
  - Cloud computing (use of cloud services for dynamic scaling of computing resources according to system needs).

These methods and approaches can be combined depending on the specific requirements and tasks facing the intelligent decision-making system.

Ensuring accuracy and reliability in the intelligent decision support system for object identification is critical for the effective operation of the system. For this, it is suggested to use the following approaches:

- Using qualitative data:
  - Data collection and cleaning (ensuring high data quality by removing noise, duplication and other errors. This includes checking data for compliance with standards, eliminating gaps, and using data normalization and standardization methods).
  - Data relevance (constant updating of data to ensure its relevance, which is important for accurate identification of objects).
- Use of effective algorithms and models:
  - Machine learning algorithms (using advanced machine learning algorithms that provide high accuracy in object classification and identification, such as neural networks, decision trees, support vector algorithms (SVM), etc.).
  - Model testing and validation (conducting thorough testing of models on different data sets, including the use of cross-validation, to assess their accuracy and reliability).
  - Ensemble of methods (using a combination of several models (ensemble) to increase accuracy by reducing the risk of false identification of objects).
- Use of data verification methods:
  - Cross-validation (application of cross-validation methods to evaluate model performance on independent subsets of data).
  - Error analysis (regular analysis of the types of errors made by the system to identify and correct weaknesses in data processing models and processes).
- Optimization of model parameters:

  - Selection of hyperparameters (using methods of finding optimal hyperparameters of models, such as Grid Search or Random Search, to increase the accuracy and reliability of the system).
  - Regularization (application of regularization to avoid overfitting of models, which improves overall accuracy and reliability).
- Integration of additional data sources:
  - Multimodal analysis (using different types of data (text, images, video, audio) to improve the accuracy of object identification by combining disparate information).
  - Expansion of functionality (use of additional sensors, cameras, systems or other sources for data enrichment, which allows better distinguishing of objects).
- Development of sustainable models:
  - Adaptation to changes in the environment (development of models capable of adapting to new conditions, including changes in data or in the behavior of identifiable objects).
  - Protection against attacks (implementation of methods to protect against possible attacks on the system, such as attacks using forged data or attempts to manipulate results).
- System monitoring and updates:
  - Continuous monitoring (continuous monitoring of the performance of the system and its models, which allows timely detection and correction of failures or drops in accuracy).
  - Regular updating of models (updating models based on new data and feedback, which ensures their relevance and compliance with real conditions).
- Implementation of feedback system:
  - Error-based correction (having feedback mechanisms that allow users or other systems to report identification errors so that the system can learn from them and improve its accuracy).
  - Training on real data (using data from real cases of identification to refine models and increase their accuracy).
- Maintaining high security standards:
  - Data protection (ensuring confidentiality and integrity of data through the use of encryption, access control and other cyber security measures).
  - Audit and verification (regular auditing of the system and verification of its operation by independent experts to confirm compliance with high standards of accuracy and reliability).

Application of these approaches makes it possible to create a reliable and accurate intelligent decision support system for the identification and classification of cultural values, capable of effectively identifying objects in various conditions and fields of application.

Integration of the decision support system for object identification with other systems is an important aspect that ensures efficient data exchange, process synchronization and ease of use. The authors suggest using the following approaches to ensure integration:

- Using standardized APIs:
  - RESTful API (the use of RESTful API allows the system to easily interact with other systems through standardized HTTP protocols. This provides scalability and flexibility of integration).
  - GraphQL (the application of GraphQL for queries allows clients to receive only the necessary data, which optimizes the exchange of information).
  - gRPC (using gRPC (Google Remote Procedure Call) for fast and efficient data transfer between microservices or different systems, especially when low latency and high performance are required).
- Using middleware for integration:
  - Enterprise Service Bus (ESB) (use of ESB allows centralized management of data exchange between different systems, ensuring reliability and security of integration).
  - Cross-system platforms (the use of platforms such as Apache Kafka or RabbitMQ to exchange messages between systems provides asynchronous data exchange with high throughput).
- Use of standard data formats:
  - JSON and XML (the use of standard data exchange formats such as JSON or XML simplifies integration with different systems, regardless of their technological platform).
  - Protocol Buffers (the use of Protocol Buffers (Protobuf) for data serialization allows for compact and efficient data exchange between systems).
- Support for compatibility standards:

  - Compliance with industry standards (the integration of a decision support system with other systems can be facilitated by adhering to industry-specific standards (e.g. HL7 in medicine, OPC-UA in industry)).
  - Integration through API Gateway (using API Gateway to manage and simplify access to various APIs allows you to create a single-entry point interface for integration with other systems).
- Support of integration protocols:
  - SOAP (for more formal or secure integrations, particularly in large enterprise systems, the use of SOAP (Simple Object Access Protocol) can provide the required level of reliability and interoperability).
  - OData (using the OData protocol to provide standardized access to data via a REST API that allows for easy integration of different systems).
- Modularity and microservice architecture:
  - Microservices (the transition to a microservice architecture allows you to create independent system components that are easily integrated with each other and with other external systems through standardized APIs).
  - Modular design (the use of modular design allows the system to be easily integrated with other systems by adding or replacing individual modules without the need for significant changes).
- Integration through cloud services:
  - Cloud platforms (the use of cloud platforms such as AWS, Azure, Google Cloud provides easy integration through their API services and other data management tools).
  - iPaaS-type services (Integration Platform as a Service, iPaaS) allow you to easily connect different cloud and local systems, ensuring flexibility and scalability of integration).
- Ensuring integration security:
  - Authentication and authorization (using security standards such as OAuth2 or OpenID Connect for secure API access and data protection during integration).
  - Data encryption (ensuring data encryption during transmission between systems to protect confidential information).
- Integration testing:
  - Compatibility testing (conducting compatibility testing between systems to check the correctness of data exchange and interaction).
  - Monitoring and logging (the use of monitoring and logging tools to track the operation of integration processes, which allows you to quickly identify and eliminate problems.
- Using containerization:
  - Docker and Kubernetes (using container technologies to deploy integration components provides portability, scalability and simplifies software version management).

The use of these approaches ensures reliable, flexible and safe integration of the SPR for object identification with other systems, which increases the efficiency and accuracy of work in various environments and spheres of activity.

Ensuring security and privacy in an intelligent decision support system for the identification of objects of cultural value is critically important, especially when it comes to processing sensitive data. To achieve a high level of security and privacy, it is suggested to use the following approaches and measures:

- Data encryption:
  - Data at Rest encryption (using encryption algorithms to protect data stored in databases or file systems. For example, AES-256 is one of the standards for data encryption).
  - Encryption of data during transmission (Data in Transit) (ensuring protection of data during its transmission between systems or users over the network by using SSL/TLS protocols).
  - Encryption of data in memory (Data in Use) (ensure encryption of data even during its processing in memory to protect against attacks on RAM).
- Access control:
  - Authentication mechanisms (use of multi-level authentication (for example, two-factor authentication) to confirm the identity of users trying to access the system).
  - Authorization and roles (implementation of role-based access policies (Role-Based Access Control, RBAC), which allows restricting access to certain functions or data only to authorized users).

  - Access logging and monitoring (recording and monitoring of all attempts to access the system to detect and prevent unauthorized actions.
- Data protection and privacy:
  - Data anonymization (in case of personal data processing, use of anonymization or pseudonymization methods that allow to reduce the risk of identification of persons in case of data leakage).
  - Data minimization (collection and storage of only those data that are necessary for the performance of tasks to reduce the risks associated with the processing of redundant information).
  - Privacy policies (implementation and compliance with privacy policies that regulate the use and processing of personal data in the system).
- Protection against cyber-attacks:
  - Network protection (use of network screens (firewalls), intrusion detection and prevention systems (IDS/IPS), as well as protection against DDoS attacks to ensure system security against external threats).
  - Endpoint security (using anti-virus software, device access controls, and security policies to protect system end users).
  - Regular updating and patching (constant software updates to eliminate known vulnerabilities and prevent exploitation of these vulnerabilities by attackers).
- Identity and Access Management (IAM):
  - Centralized identity management (implementation of identity and access management systems that provide centralized management of user accounts and their access rights).
  - Single Sign-On (SSO) (using SSO technology to simplify access management and improve security by reducing the number of credentials that users need to enter).
- Monitoring and auditing:
  - Real-time security monitoring (using security monitoring systems such as SIEM (Security Information and Event Management) to detect and respond to suspicious activity in real-time).
  - Regular security audit (conducting regular security audits, which include analysis of logs, verification of security settings and assessment of compliance with the requirements of regulatory acts.
  - Pen-testing (conducting penetration testing (pen-testing) to detect vulnerabilities in the system before they can be used by attackers.
- Development security (DevSecOps):
  - Integration of security into the development cycle (implementation of DevSecOps practices that integrate security measures at all stages of development, from design to deployment and operation).
  - Code analysis (using tools for static and dynamic code analysis to identify vulnerabilities at the development stage).
  - Risk assessment (conducting regular risk assessments related to system security to determine and prioritize security measures).
- Security in cloud environments:
  - Data encryption in the cloud (use of data encryption tools stored and processed in cloud services to prevent unauthorized access).
  - Management of access to cloud resources (application of strict access management policies to cloud resources and services, including role-based access control and multi-factor authentication).
  - Verification of compliance with requirements (ensuring compliance with security policies of cloud providers and regulatory requirements for maintaining confidentiality and integrity of data).
- Incident management:
  - Incident Response Plan (development and implementation of a security incident response plan that includes clear procedures for incident detection, response, and recovery).
  - Incident response team (formation of a team of security specialists that is ready to promptly respond to threats and incidents, minimizing possible consequences).

Ensuring security and privacy in the system requires a comprehensive approach that includes technical, organizational and procedural measures. All these measures must be constantly updated and improved in response to new threats and challenges in the field of information security.

The scalability of the intelligent decision-making support system for the identification of objects of cultural value is suggested by the authors to be achieved with the help of several key approaches and technologies:

- Use of cloud computing:
  - Cloud infrastructure (cloud services such as AWS, Azure or Google Cloud allow you to scale computing power according to system needs. This allows you to process large amounts of data and use powerful machine learning models without the need for physical servers).
  - Distributed computing (distribution of computing tasks between several nodes in the cloud allows for parallel processing of data, which reduces execution time and increases system efficiency).
- Modular system architecture:
  - Microservices (dividing the system into separate services that are responsible for different tasks (for example, image processing, data analysis, decision-making), allows each component to be scaled independently. This provides flexibility and ease of deployment and maintenance).
  - Containerization (using Docker or Kubernetes to manage containers simplifies the deployment and maintenance of scalable applications).
- Optimization of machine learning algorithms:
  - Pre-training of models (using pre-trained models (for example, deep learning models for computer vision) allows you to reduce the load on the system and speed up the identification of objects).
  - Batch processing (instead of processing each request separately, the system can process requests in batches, which reduces waiting time and increases productivity).
- Application of hybrid approaches:
  - Local processing together with the cloud (to reduce delays and increase response speed, the system can perform initial data processing locally (on edge devices) and transfer the results to the cloud for further analysis).
- Optimizing data storage and transmission:
  - Deduplication and compression of data (reducing the amount of data transmitted between system components allows to reduce the load on the network and increase the efficiency of the system).
  - Caching of results (use of cache to store frequently used results allows to reduce the time for repeated processing of similar requests).
- Machine learning on the edge (Edge AI):
  - Use of machine learning models on edge devices for preprocessing and object identification. This reduces latency, which is important for systems that require real-time response.
- Intelligent routing and load balancing:
  - The use of intelligent algorithms to distribute tasks between different servers or system components ensures a uniform load and increases resistance to overloads.
- Automated scaling:
  - Configuring automatic scaling of resources in response to load changes. For example, adding new servers when the number of requests increases and reducing their number when the load decreases.

These approaches make it possible to ensure the effective scalability of the intelligent decision support system for object identification, which is important for its stable operation in conditions of growth in the volume of data and the number of requests.

The ability to learn and adapt is critical to ensuring its effectiveness in the face of change and new challenges. The authors propose to achieve this opportunity using the following approaches and technologies:

- Use of machine learning methods:
  - Models with the possibility of retraining (creating machine learning models that can be retrained on new data. This allows the system to adapt to new types of objects or identification conditions).
  - Method of learning with reinforcement (Reinforcement Learning) (this approach allows the system to learn based on feedback from the environment, adjusting its decisions to increase the accuracy of identification).

- Use of continuous learning algorithms (Continuous Learning):
  - Memory support (implementation of algorithms that allow you to store and use past experience to learn from new data, while not forgetting already acquired knowledge. This is important for maintaining the system's resistance to catastrophic forgetting).
  - Dynamic updating of models (ensuring the possibility of dynamic updating and improvement of machine learning models during their operation without the need for complete retraining).
- Use of hybrid models:
  - Combination of several learning methods (using a combination of different learning algorithms, such as Supervised Learning for structured data and Unsupervised Learning for discovering new patterns. This allows the system to effectively adapt to new types of data).
- Application of transfer learning (Transfer Learning):
  - Using pre-trained models (applying models that have already been trained on a large amount of data and adapting them to specific identification tasks. This significantly reduces the time and resources needed to train the system).
  - Adaptation to new domains (the transfer of knowledge from one area to another allows the system to quickly adapt to new conditions, in particular to changes in the environment or characteristics of objects).
- Using a feedback collection and analysis system:
  - Automatic data collection (implementation of automatic data collection mechanisms on system errors or uncertainties for further analysis and use of this data in the learning process).
  - Learning based on user feedback (the system can receive feedback from users on the correctness of identification, which allows it to adapt its models to real needs and conditions).
- Use of adaptive algorithms:
  - Adaptive neural networks (using neural network architectures that can dynamically change their structure depending on input data or changes in the environment).
  - Evolutionary algorithms (application of evolutionary learning methods, which allow the system to experiment with different configurations of models and choose the most effective ones for current conditions).
- Integration with other data sources:
  - Use of external data sources (connection to external databases or other sources of information to enrich training data and increase the accuracy of identification).
  - Online learning (Application of algorithms that can learn in real time on new incoming data).
- Automation of the process of processing new data:
  - Pipelines for automated learning (creating automated pipelines that can collect, clean and prepare data for training models without significant human intervention).
  - Automated ML-operations (MLOps) (using MLOps to automate the deployment, monitoring and updating of machine learning models, which allows you to quickly adapt the system to changing conditions).

These approaches make it possible to create a CSDP that is able to constantly learn, adapt to new conditions and increase its effectiveness over time.

Ease of use of the intelligent decision support system for the identification and classification of objects of cultural value is provided by a number of factors that contribute to increasing the efficiency of the user's interaction with the system and ensure the ease and speed of performing tasks. The main factors affecting the ease of use of the CSPR include:

- Intuitive user interface (UI):
  - Simplicity and logic (the interface should be simple and clear, with a logical structure and clear controls. This reduces the learning curve for new users and provides quick access to the main functions).
  - Data visualization (the use of graphical elements such as charts, graphs and charts helps users quickly evaluate identification results and make informed decisions).
- Personalization and customization:
  - Individual settings (allowing users to customize the interface and functionality of the system according to their needs, including language selection, design themes and notification settings).

  - Adaptive interface (the system should adapt to individual user habits, offering frequently used functions and quick access to necessary tools).
- Speed and efficiency of work:
  - Fast data processing (the system should provide a high speed of query processing and object identification, minimizing delays, which allows users to quickly get results).
  - Automation of routine tasks (implementing automation to perform repetitive or routine tasks, which reduces the burden on the user and allows you to focus on more complex aspects of decision-making).
- Quality of user interaction (UX):
  - Feedback in real time (the system should provide instant feedback on the user's actions, informing about the progress of tasks or possible errors).
  - Hints and training materials (the presence of integrated hints, training modules or guides that help users quickly learn the system and get answers to questions that arise).
- Integration with other systems:
  - Ease of integration (the system should be easily integrated with other tools and programs used by users, for example, with database management systems, analytical platforms or ERP systems).
  - Support for standard data formats (providing support for standard file and data formats to simplify the import and export of information).
- Reliability and security:
  - Data protection (the system must provide a high level of data security, including encryption, user authentication and access control, which is critical for protecting confidential information).
  - Resilience to errors (the system must be resistant to errors and failures, with mechanisms for automatic recovery and data saving, which guarantees uninterrupted operation even in the event of unforeseen situations).
- Multi-platform support:
  - Access from different devices (the system should be accessible from different types of devices, including computers, tablets and smartphones, ensuring ease of use at any time and from any place).
  - Responsive design (the system interface should automatically adapt to the screen size and features of the device on which it is used).
- Effective support and service:
  - Technical support (the presence of an effective technical support service that quickly responds to user requests and provides assistance in case of problems or questions).
  - Regular updates (implementation of regular software updates that include new features, bug fixes and usability improvements).
- Accessibility and inclusiveness:
  - Accessibility support (ensuring the ability to use the system by people with disabilities, including support for screen readers, voice control and other accessibility tools).
  - Localization (availability of the system in different languages, which makes it accessible to users from different regions and language groups).

These factors together provide high usability of the intelligent decision support system for the identification of objects of cultural value, which is key to its effective implementation and use.

The support of various types of data is realized due to several key technological and architectural solutions. This allows the system to efficiently process, analyze and integrate a variety of data such as text, numbers, images, videos, audio and other types of data. The main mechanisms providing such support include:

- Universal data architecture:
  - Modularity and flexibility (the system should have a modular architecture that allows you to add or change modules to work with different types of data without the need for significant changes in the entire system).
  - General data stores (using universal data stores that support storage of different data formats, for example, relational databases for structured data and NoSQL databases for unstructured or semi-structured data).
- Support of standard formats and protocols:

  - Support for different data formats (the system should support a wide range of file formats, including CSV, JSON, XML for structured data, as well as image (JPEG, PNG), video (MP4, AVI) and audio (MP3, WAV) formats).
  - Unified API interfaces (implementation of standard API interfaces for integration with other systems and data sources, which provides access to data in various formats.
- Use of various algorithms and models:
  - Algorithms for processing different types of data (the system should have a set of specialized algorithms for processing different types of data. For example, deep learning algorithms (CNN) for image processing, NLP models for working with text, and time series analysis algorithms for numerical data).
  - Universal machine learning models (use of models that can process several types of data at the same time (for example, multimodal models), which allows the system to identify objects based on different sources of information).
- Integration of ETL processes:
  - ETL (Extract, Transform, Load) (the implementation of ETL processes to extract, transform and load data into a format suitable for analysis. This allows you to adapt different types of data to the requirements of the system, regardless of their initial format).
  - Data conversion (the system should support the conversion of data from one format to another, including the merging of data from different sources and the conversion of non-standard formats into those suitable for analysis).
- Machine learning for different data:
  - Adaptive models (the use of machine learning models that can learn on different types of data and adapt to the specific requirements of each type. For example, the use of specialized neural network architectures for text processing (LSTM, Transformers) or images (Convolutional Networks)).
  - Analysis of multimodal data (the ability to simultaneously process and analyze data of different types, for example, text and images, which allows the system to make more informed decisions based on combined information).
- Extensibility and integration with other systems:
  - Plugins and extensions (using a system of plugins or extensions that allow you to easily add support for new data types or integrate new algorithms without having to rewrite the entire system).
  - Integration with external services (connection to external data processing services, such as services for image analysis or natural language processing, which allows you to use their capabilities to support new types of data).
- Caching and indexing:
  - Data caching (saving frequently used data in the cache for quick access, which improves system performance when working with large volumes of various data).
  - Indexing for quick search (use of indexing mechanisms for quick search and access to data of various types, which increases the efficiency of object identification).
- Implementation of Big Data approaches:
  - Processing large volumes of data (use of technologies such as Hadoop, Spark, which allow processing large volumes of various data (structured, semi-structured, unstructured) in parallel, which ensures the scalability of the system).
  - Distributed databases (using databases that allow storing and processing different types of data in a distributed environment).

These technologies and approaches ensure the system's ability to effectively work with various types of data, which is critical for the accuracy and versatility of object identification in various scenarios.

The mobility and accessibility of the intelligent decision support system is ensured by various methods and means that allow users to access the system from any place and on different devices, and also ensure the smooth operation of the system in different conditions. The main methods and means of implementing mobility and accessibility, according to the authors, may include:

- Cloud technologies:

  - Cloud services (SaaS) (the use of cloud services, such as Software as a Service (SaaS), allows users to access the CSPR via the Internet from any device that has a browser. This ensures flexibility and scalability of the system).
  - Data processing in the cloud (the use of cloud computing for data storage and processing, which allows access to large amounts of information from anywhere and at any time).
- Mobile applications:
  - Development of cross-platform mobile applications (creating mobile applications that work on different platforms, such as iOS and Android, provides access to the CSDP from mobile devices. Using frameworks such as React Native or Flutter allows you to create applications that work on several platforms at the same time).
  - Offline mode (implementation of the possibility of working in offline mode with further synchronization of data when connected to the Internet. This ensures the availability of the system even in places with limited Internet connection).
- Web technologies:
  - Responsive web design (using Responsive Design, which automatically adjusts the CSPR interface to different screen sizes and types of devices (smartphones, tablets, computers). This ensures ease of use on different devices).
  - Progressive Web Applications (PWA) (development of progressive web applications that work like regular websites, but have features characteristic of mobile applications (offline mode, push notifications). This allows for high availability and mobility of the system without the need to install separate applications).
- API usage and integration with other systems:
  - RESTful and GraphQL APIs (using RESTful or GraphQL APIs to provide access to CMS functions from different devices and platforms. This allows you to create custom client applications or integrate CMS with other systems, providing flexibility of access).
  - Integration with corporate systems (integration of the ERP system with other corporate systems, such as CRM or ERP, through API provides access to the necessary identification information of objects in various work environments).
- Mobile security:
  - Authentication and authorization (use of secure authentication and authorization methods, such as two-factor authentication (2FA) and OAuth, to protect access to the system from mobile devices).
  - Data encryption (ensuring that data is encrypted both on the device and during transmission to protect information from unauthorized access).
- Geolocation services:
  - Use of geolocation (the integration of geolocation functions in the DSS allows providing users with context-dependent information, which increases the accuracy of object identification and location-based decision-making).
  - Geo-fencing (the implementation of geo-fencing technology to activate certain functions or notifications when the user is in a defined geographical area, which improves the user experience).
- Cloud storage and synchronization:
  - Data synchronization (using cloud storage to store data and synchronize it between different devices in real time. This provides access to up-to-date information from any device).
  - Automatic backup (implementation of automatic data backup in the cloud to prevent information loss and ensure its availability in case of unforeseen situations).
- Support for voice and text interfaces:
  - Voice assistants (integration with voice assistants such as Google Assistant or Siri to provide voice access to the helpdesk, allowing users to perform hands-free tasks).
  - Chatbots and text interfaces (the use of chatbots or text interfaces to allow users to interact with the system through text queries, which is especially convenient in mobile applications).
- Caching and optimization:
  - Content caching (implementation of caching mechanisms to reduce loading time and provide quick access to frequently used data, which improves the performance of mobile applications).

- Traffic optimization (use of traffic optimization methods, such as data compression and asynchronous download, which ensures fast access to information even in conditions of a slow Internet connection).

Together, these methods and tools provide system mobility and availability, allowing users to work with the system at any time and from any location, while maintaining high efficiency and security.

The ability to predict and the ability of the system to make predictions based on available data to support decision-making in the identification of objects is ensured by the use of various methods, algorithms and technologies that allow analyzing data, identifying patterns and making predictions. According to the authors, the following tools allow you to implement these functions:

- Machine learning and artificial intelligence (AI) models:
  - Machine learning (ML) algorithms (using various machine learning algorithms, such as linear regression, decision trees, random forests, support vector machines (SVM), to predict the behavior of objects based on historical data).
  - Deep Learning (the use of neural networks, including recurrent neural networks (RNN), long-term short-term memory (LSTM) and convolutional neural networks (CNN), to predict complex patterns and behavior of objects based on large volumes of data).
- Time series analysis:
  - Time Series Analysis Techniques (using time series analysis techniques such as ARIMA, SARIMA, Prophet to predict future events based on historical time-varying data. This can be particularly useful for predicting trends and future behavior of objects) .
  - Seasonality and trends (detection of seasonal and trending components in data, which allows the system to take into account recurring patterns and make more accurate forecasts).
- Methods of statistical analysis:
  - Regression analysis (using regression analysis to identify relationships between different variables and make predictions based on these relationships. This allows you to make predictions based on correlations in the available data).
  - Bayesian approach (the use of a Bayesian approach to forecasting, which allows you to take into account previous knowledge and adapt to new data, improving the accuracy of forecasts).
- Processing of big data (Big Data):
  - Tools for working with big data (using technologies such as Hadoop, Apache Spark, to process and analyze large volumes of data, which allows for more accurate predictions based on a large amount of historical data).
  - Real-time (using streaming technologies such as Apache Kafka to process data in real-time and make predictions based on it in real-time).
- Computational intelligence and optimization:
  - Evolutionary algorithms (use of evolutionary algorithms and genetic algorithms to find optimal solutions and predict future states of objects based on simulation of natural selection processes).
  - Metaheuristics (use of metaheuristic methods (for example, the particle swarm method, tabu search) to optimize the forecasting process and improve the quality of forecasts).
- Neural network forecasting:
  - Generative-Competitive Networks (GANs) (using GANs to create models that can generate new data based on existing data, which allows predicting the behavior of objects in different scenarios).
  - Autoencoders (using autoencoders to discover latent representations of data and make predictions based on these representations).
- A rule-based decision support system:
  - Expert systems (the use of expert systems and knowledge bases, which allows making predictions based on defined rules that take into account the knowledge of experts in a certain field).
  - Logical rules and deductive forecasting (using logical rules to predict results based on available data, especially in cases where there are clearly defined rules for the behavior of objects).
- Integration with business intelligence (BI) systems:
  - BI tools (the use of business intelligence tools for data analysis and visualization, which allows you to make predictions based on trends and analytical conclusions obtained from the data).
  - Dashboards and reporting (creation of dashboards that provide users with forecasts in an easy-to-understand form that facilitates informed decision-making).

- Data analysis using artificial intelligence (AI):
  - Neural networks for forecasting (using specialized neural network architectures such as LSTM and GRU for time series analysis and forecasting based on complex non-linear dependencies in data).
  - Multimodal models (the use of multimodal models that can simultaneously take into account different types of data (text, images, numbers) to predict the behavior of objects based on complex information).
- Integration with external data sources:
  - Connection to external sources (integration with other data sources (for example, social networks, financial markets, weather services) to enrich data and improve the accuracy of forecasts).
  - API for external data (using the API to obtain relevant data in real time, which allows making more accurate predictions based on new information).

These methods and technologies provide the possibility of forecasting and the ability of an intelligent system to make forecasts based on available data, which allows to increase the efficiency and accuracy of the decision-making process in the tasks of object identification.

Conclusions and further development and research of the importance of determining and ways of implementing requirements for modern information and analytical systems for object identification:

1. The speed of data processing ensures promptness of decision-making, especially in situations that require a quick reaction. Use of high-performance computing technologies, parallel computing and optimization of data processing algorithms.

2. Accuracy and reliability guarantees the correctness and stability of the results, which is critical for decision-making. Applying accurate classification and identification algorithms, testing the system on different data sets, and introducing verification and validation mechanisms.

3. Integration with other systems provides interaction with other information systems, which allows the use of complex information. Use of standard APIs, data exchange protocols and support for compatibility with various platforms and technologies.

4. Security and privacy protects data from unauthorized access and ensures the confidentiality of information. Use of encryption, multi-level authentication, regular updates of security systems and data access control.

5. Scalability allows the system to adapt to the growth of data volumes and the number of users without losing performance. Use of cloud technologies, distributed databases and containerization for dynamic expansion of resources.

6. The ability to learn and adapt makes the system flexible, allowing it to improve over time and adapt to new challenges. Use of machine learning and self-updating mechanisms of models based on new data.

7. Ease of use increases the efficiency of user interaction with the system, making it accessible to a wide range of users. Development of an intuitive interface, adaptive design and support for various devices.

8. Support of various types of data allows processing of various data (text, image, video) for more complete and accurate identification of objects. Using multimodal models capable of analyzing different types of data and ensuring compatibility with different formats.

9. Mobility and accessibility ensures access to the system from any place and on different devices, which is important for prompt decision-making. Use of mobile applications, cloud services, responsive design and offline mode support.

10. Forecasting capabilities allow you to predict future events and the behavior of objects, which improves the quality of decision-making. Use of machine learning methods, time series analysis and integration with business intelligence systems to create predictive models.

Ensuring these requirements is critical for creating an effective, reliable and flexible information and analytical system capable of supporting decision-making in a rapidly changing environment and large volumes of data. Further development of the study by the authors is planned in the analysis of the relationship between the main requirements and their impact on each other and the system as a whole. It is also planned to develop and introduce their qualitative and quantitative characteristics for their further research.

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