Research on Component-Based Intelligence Analysis Model (Postprint)

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Abstract

[Purpose/Significance] In response to the challenges confronting intelligence analysis in the era of big data, this study proposes the introduction of component theory into the field of intelligence analysis to construct an intelligence analysis model, thereby providing novel theoretical foundations and methodological guidance for intelligence analysis research and practice.

[Method/Process] Initially, based on the current research status of intelligence analysis models and the characteristics of component technology, the fundamental concepts of component-based intelligence analysis models are elaborated. Subsequently, intelligence components are proposed, their connotations and atomicity principles are explicated, and their development framework and application process are specified. Finally, the prospective application value is examined from four dimensions: automation, standardization, intelligence, and open-source, while the advantages and challenges of component-based intelligence analysis models are summarized.

[Results/Conclusion] The component-based intelligence analysis model can furnish valuable references for improving intelligence analysis work and demonstrates substantial potential for application and development in the future.

Full Text

Research on a Component-Based Intelligence Analysis Model

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Abstract:
[**Purpose/Significance**] In response to the challenges facing intelligence analysis in the era of big data, this paper proposes introducing component theory

into the field of intelligence analysis to construct an intelligence analysis model, aiming to provide new theoretical foundations and methodological guidance for intelligence analysis research and practice. [**Method/Process**] First, based on the current research status of intelligence analysis models and the characteristics of component technology, we explain the fundamental concept of the component-based intelligence analysis model. We then propose the notion of intelligence components, explain their connotation and atomicity principles, clarify their development framework and application process, and finally prospect their application value from four aspects: automation, standardization, intelligence, and open source. [**Result/Conclusion**] The component-based intelligence analysis model can provide reference value for improving intelligence analysis work and has significant potential for application and development in the future.

Keywords: intelligence analysis; component; intelligence analysis model; intelligence task; big data; macro-intelligence perspective
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1 Introduction

Intelligence analysis in the big data era is an intelligent activity that, according to user needs across different disciplines and fields, employs modern technologies to collect, filter, evaluate, and analyze information to produce intelligence products that support decision-making services [1]. Under the 5V characteristics of big data, the massive volume of information, diversity of sources, rapid generation, low value density, and concerns about information accuracy pose certain challenges to intelligence analysis work [2]: First, under the guidance of the macro-intelligence perspective, intelligence analysis serves not only science, technology, and security fields but is also widely applied in social, economic, and cultural domains. People's demand for intelligence analysis continues to grow, with an increasing number of non-professionals needing to utilize intelligence analysis results to aid their decision-making, yet these needs cannot be quickly and adequately met. Second, the collection, processing, and analysis of massive multi-source data consume substantial time and heavily depend on human knowledge and analytical capabilities. Therefore, improving the degree of automation in intelligence analysis is key to reducing time costs. Finally, although people have begun using technical means to assist intelligence analysis work, they have not yet standardized the coordination and full utilization of human and computer advantages. How to improve automation while balancing the irreplaceable role of human intelligence in intelligence analysis remains a critical issue.

The rapid development of software component technology has revolutionized software production methods. The renowned component scholar C. Szyperski [3] defines software components as semantically complete and syntactically correct software units with certain structures and functions that provide specific services through external interfaces while hiding implementation details during software reuse. Unlike traditional software development approaches, software reuse no longer involves extensive repetitive work from scratch but instead assembles target systems using pre-designed and constructed reusable components [4]. Software components resemble "standard parts" on industrial assembly lines, offering characteristics such as reduced development costs, time savings, and reusability. They make structural reuse of numerous applications with similar architectures possible, significantly improving software reuse efficiency. Therefore, software component technology plays a vital role in software development, reuse, and integration.

Currently, researchers primarily apply component technology to software and information system development, with few component-based initiatives specifically targeting intelligence analysis. Consequently, addressing the challenges and practical needs of intelligence analysis in the big data era and leveraging the advantages of component technology, this paper proposes a component-based intelligence analysis model to enhance the automation and standardization of intelligence analysis processes, reduce analysis time, improve efficiency and quality, and lower costs and risks.

2 Related Research

2.1 Intelligence Analysis Models

The purpose of intelligence analysis is to reduce ambiguity and uncertainty in decision-makers' processes, overcome intuitive reasoning biases and methodological inertia, minimize decision-making errors, and ensure result objectivity, traceability, and completeness [5]. A. Capiola et al. [6] define intelligence analysis more narrowly as research, analysis, judgment, and prediction based on all-source intelligence information according to tasks and requirements. Broadly defined, intelligence analysis refers to the entire process of collecting relevant data and materials according to specific intelligence analysis needs, processing and scientifically analyzing them to obtain conclusions with decision-support value. This study examines the intelligence analysis process from a broad perspective. For instance, the information collection phase also includes preliminary analysis such as selecting reliable information sources and verifying document authenticity—essential steps for subsequent multi-source information validation, reasoning, and decision-making [7].

In the big data era, intelligence analysis demands stronger contextual and target specificity, broader data sources, and larger data volumes, requiring integration and innovation in intelligence analysis methods and promoting conceptual renewal. A. R. Neigel et al. [8] note that automated or even semi-automated intelligence analysis systems can assist intelligence analysts in task operations and influence their decision-making paradigms. M. L. Ashwell [9] argues that increasingly automated data mining and analysis can reveal data patterns and correlations, yet the most important component of intelligence analysis digital transformation is people, with connectivity and innovation being key to enabling interaction between people and data/technology.

In the intelligence analysis field, scholars have conducted extensive research on processes and methods, constructing conceptual models and domain-specific application models from various perspectives, yielding rich research outcomes.

At the conceptual model level, J. J. Borek [10] divides the intelligence analysis process into three stages: transforming requirements into questions, transforming data into information, and transforming information into intelligence. L. K. Johnson [11] divides the "intelligence cycle" into five stages: planning and direction, collection, processing, analysis and production, and dissemination—a summary of traditional military intelligence analysis steps. Li Yan et al. [12], from a human-computer interaction perspective, divide intelligence analysis into two stages: primary analysis and multi-source analysis, corresponding to information-seeking loops and sense-making loops respectively. Zhang Jianian et al. [13] compare the intelligence analysis process with big data analysis processes, summarize similarities and differences, and propose an integration model, identifying three paths for intelligence analysis in big data environments: (1) traditional intelligence analysis based on intelligence needs; (2) achieving intelligence analysis through big data analysis processes; and (3) integrating intelligence analysis with big data analysis, where analysts first conduct "small data" analysis based on specific tasks and objectives while incorporating data mining results from big data analysis systems to improve intelligence product quality.

At the domain-specific application model level, intelligence analysis model construction has gradually extended from the initial scientific and technical information field to patent analysis, crime analysis, enterprise competitive intelligence analysis, and other domains. Zhang Xiaolin [14] proposed a patent technology intelligence analysis model, dividing it into micro, meso, and macro levels, employing specific analysis indicators and methods for patent technology intelligence analysis priorities at each level, and summarizing patterns for conducting patent technology intelligence research. Zeng Qinghua et al. [15] proposed constructing a counter-terrorism intelligence analysis system based on the meta-synthesis method, including three constituent elements: knowledge systems, personnel systems, and machine systems, emphasizing human-centered, human-computer integrated counter-terrorism intelligence analysis. Xu Min et al. [16] noted that intelligence analysis models are gradually developing toward computationalization, intelligence, all-source integration, and patternization. These studies demonstrate that scholars currently consider multi-source data, thinking integration, and technical support as important focal points driving intelligence analysis research development, outlining new research and development directions for intelligence analysis models.

2.2 Component Technology

The term "component" in China can be traced back to the first treatise on civil architecture, *Yingzao Fashi* [17], which documented components and their assembly techniques in detail. The mortise-and-tenon structure, a crystallization of ancient craftsmen's wisdom, provides important inspiration and reference for component development and related problem-solving. From the term's composition, "component" contains two elements: "com-" indicating assembly capability, and "-ponent" meaning self-contained with specific functions. Therefore, software components are reusable units with certain functions and structures that can be combined to develop new software or services. Broadly speaking, components have several basic attributes [18]: (1) **Encapsulation**, emphasizing separation from the environment with hidden internal details; (2) **Transparency**, requiring clear interface specifications where interface parameters and constraints serve as the basis for component invocation; (3) **Generality**, being applicable within a domain rather than serving only one specific need; and (4) **Independence**, with each component being an independently configurable unit—an essential foundation for subsequent maintenance and upgrades.

Componentization refers to system development methods featuring reconfigurable software architecture and reusable software components [19]. Components' ease of maintenance and reuse can reduce development costs [20], a concept applied to information system development [21-22]. Information system design and development reflect the correspondence between real-world problems and solutions, representing the refinement of knowledge embedded in solutions and their transformation into fixed patterns for handling similar problems. Information system development relies on developers' knowledge and understanding of problems and related affairs, converting this understanding into concrete descriptions that essentially map from high-level concepts and logic to low-level concepts and logic [23]. Information system development experts gradually realized that different system development processes involve substantial identical or similar work, with this redundant labor hindering efficiency improvements. Consequently, they proposed the concept of software reuse and introduced software components, domain engineering, software reengineering, and related technologies as software reuse support. As the mainstream technology for software reuse, software component technology first requires developing numerous components and storing them in component repositories, then integrating systems by invoking and assembling components to solve problems. Although component design and development require certain workloads, the system integration phase no longer starts from scratch, saving substantial development time.

3 Component-Based Intelligence Analysis Model

Growing intelligence analysis demands have yet to form standardized, efficient methods to reduce time costs, making it difficult to meet these needs within ideal timeframes. Understanding and applying intelligence analysis results 离不开人的智慧性思考 (cannot be separated from human intelligent thinking). Minimizing the difficulty of intermediate analysis processes, using technology to simulate human problem-solving workflows, clarifying human irreplaceability at critical stages, and fully leveraging both human and technological advantages hold important practical significance. Therefore, this paper introduces component thinking into the intelligence analysis field, proposing a component-based intelligence analysis model.

3.1 Basic Concept

In this paper, intelligence components are divided into computer components and manual operation components, jointly implementing intelligence analysis to shorten the knowledge distance between data and humans and improve knowledge transfer and discovery efficiency.

Humans possess genuine logical thinking abilities and are incomparable to computer technology in visual and imaginative thinking, associative memory, macro-coordination control, and resulting creativity. Computer technology essentially simulates, extends, and expands human capabilities, demonstrating obvious advantages in complex data computation and rigorous logical reasoning within short timeframes. Therefore, computer components and manual operation components each have their strengths, and human-computer integration should be achieved in the intelligence analysis process—leveraging computer components' rapid automated processing characteristics while employing manual operation components for tasks requiring dexterity, coordination, and creativity.

Currently, human-computer integration manifests in three primary ways [24]: (1) Basic use of computer software and hardware devices as auxiliary tools; (2) Information and data exchange through multimedia channels and computer user interfaces; and (3) Adjusting process planning strategies and optimizing complex engineering system designs under reasonable division of labor and complementary advantages, aiming for higher design efficiency and superior implementation effects. This paper's approach to optimizing intelligence analysis processes using computer and manual operation components focuses on the third method, with the following motivations and significance:

(1) The intelligence analysis process requires accuracy from information acquisition through processing and analysis to minimize error impacts on results. When computers lack certain functions or exhibit significant errors in handling specific problems, domain experts must complete these tasks. Some problems in intelligence analysis cannot or are difficult to achieve ideal results through current digital methods, requiring conversion of scientific methods into computer-understandable constraints or optimization objectives. For example, text recognition involving blurred, incomplete, or ancient character records, or image recognition where certain old photographs cannot be algorithmically identified and verified, necessitate manual processing.

(2) Intelligence analysts may have accumulated effective means or methods

for handling certain problem types through long-term practice. On this foundation, through appropriate human-computer interaction positively guiding design and implementation processes, more human-like solutions that better conform to design patterns can be achieved.

(3) To liberate intelligence analysts from cumbersome, low-level operational tasks, providing more time and energy to utilize accumulated experience and domain expertise while leveraging human processing advantages and innovative capabilities, complex problems must be decomposed and addressed using computers' capabilities in graphics, numerical computation, and symbolic operations to support experts' creative and decision-making roles at critical tasks.

3.2 Intelligence Components

Intelligence components are reusable units that implement corresponding functions for each decomposed task in the intelligence analysis process. Integrating intelligence components means systematically and normatively connecting intelligence analysis work. Currently, most intelligence analysis work cannot be completed independently by computers, with many critical stages requiring human brain intelligence involvement. After decomposition, each task in intelligence analysis work is completed by corresponding intelligence components—either computer components or manual operation components. For example, in intelligence analysis, information seeking includes information extraction, identification, association and merging, fusion and mining [12]. Information identification primarily examines information sources and channels, often requiring human judgment to distinguish truth from falsehood and filter out unreliable, misleading, or false information. Therefore, the information identification process contains many tedious repetitive tasks originally completed step-by-step by humans. According to the component-based intelligence analysis concept proposed in this paper, components can be designed following human rules for completing these tasks, specifying input-output patterns and related standards to reduce human input and save analysis time. In more complex scenarios where certain functions cannot be implemented through computer components, computer and manual operation components must cooperate to gradually complete the entire intelligence analysis process, achieving transformation from data to information, knowledge, and intelligence.

In the component-based intelligence analysis model, intelligence analysis thinking must be applied to 梳理 (sort out) problems, with each level requiring decomposition and solution by appropriate intelligence components. Intelligence component design must follow the principle of atomicity. In chemistry, an atom is the smallest particle that cannot be further divided, constituting the basic unit of general matter. From a granularity perspective, atomic components are the smallest components that cannot be constructed through reuse, including not only functional units that encapsulate basic data structures and related algorithms but also a basic human operation.

Intelligence component atomicity serves three purposes: First, to maximize the use of computer components for intelligence analysis tasks. After complex processes are decomposed into tasks, each task's complexity is significantly simplified, improving the feasibility of using computer components to implement corresponding functions and reducing human workload. Second, to maximize simplification of manual operation components. Manual operation components require selecting people who meet specific operational requirements, posing certain capability demands. For less specialized individuals, learning time is needed to master relevant skills. After atomicization, manual operation component complexity decreases, enabling ordinary people to perform operations according to requirements or master corresponding skills after short training periods. This minimizes dependence on high-level intelligence analysts while reducing skill requirements for problem-solving. Third, to improve intelligence component reusability. When decomposing different intelligence analysis problems, higher task refinement leads to greater overlap or similarity among required intelligence components, increasing the probability of using existing components to implement corresponding functions.

Within individual atomic components, specialized functions should be perfected as much as possible to ensure correct and precise operation. Different atomic components implement different functions, meaning assembled components can effectively integrate functions to solve more complex problems. Such large-granularity components with more complete functions after assembly also possess certain reuse value. It should be noted that in practical applications, computer component granularity requires comprehensive consideration of multiple factors, with interaction patterns, transmission independence, abstraction levels, and data representation forms all significantly impacting component granularity [19].

3.3 Development Framework

3.3.1 Intelligence Component Development Framework During intelligence component development, after transforming intelligence analysis requirements into tasks, they must be atomically decomposed to break complex problems into simple ones. Next, computer components should implement corresponding functions as much as possible, while leveraging humans' irreplaceable advantages in intelligence analysis to develop corresponding manual operation components. This development logic aims to improve intelligence analysis process automation, reduce dependence on high-level professional analysts, integrate human intelligent judgment and thinking during intelligence analysis, and quickly, orderly, and efficiently complete intelligence analysis workflows. Through feedback, iteration, and optimization, intelligence analysis result quality is enhanced.

Computer component development can reference software component development processes, which this paper will not elaborate on further. Manual operation component development aims to implement functions that are difficult or impossible to achieve ideal effects with computer components in intelligence analysis processes. Unlike computer components that inherently possess functions, manual operation component development actually involves function description. At the application level, qualified personnel must be quickly identified according to established standards to complete specific standardized operations. Manual operation components must combine computer component characteristics, establishing appropriate input-output standards and other specifications to achieve full collaboration with computer components and complete the entire intelligence analysis process to obtain results.

Manual operation components must adhere to the following principles in development:

(1) **Reusability**: In component-based intelligence analysis models, a component is not customized for just one intelligence analysis problem but shared across multiple problems. Manual operation components' actual completion objects remain physical people who, unlike assembly line workers performing identical tasks long-term, flexibly adjust operations according to component descriptions to complete specific tasks in different intelligence analysis processes.

(2) **Simplicity**: Standardized manual operation components should simplify complex problems as much as possible, reducing implementation difficulty so people can easily master operational rules through simple training while saving time for individual operations.

(3) **Understandability**: At the development level, manual operation components are also universal abstractions. To facilitate user adoption, corresponding descriptive documentation must be provided, recording names, operational rules, exception handling, and other relevant standards to guide, assist, and clarify during component use and maintenance.

(4) **Interoperability**: Manual operation components must interact and collaborate well with computer components to optimize intelligence analysis processes. Each component's output must serve as the next component's input to achieve progressive intelligence analysis work.

As intelligence components, manual operation components should also be specific, normative, and easy to implement. As shown in Figure 2 [Figure 2: see original paper], manual operation components must include:

(1) **Input-Output**: Manual operation components must collaborate with computer frameworks, requiring each step's data types and formats to be understandable by the next intelligence component to continue subsequent processing.

(2) **Operational Rules**: Since these operations cannot achieve ideal effects through computer components, they necessarily require human intelligent judgment and processing to reduce error interference and improve accuracy. Therefore, operational rules must be described in detail, enumerat-

ing guiding principles distilled from practice, including listing encountered situations and how to handle each.

(3) **Operation Time**: Recording approximate processing time for each operation component is an important efficiency indicator that enhances users' global awareness and assists with time planning.

(4) **Personnel Knowledge Level Requirements**: Component design should follow simple, understandable principles. Generally, ordinary people can master essentials for batch processing, while certain domain-specific operations require higher-knowledge experts. Therefore, involved knowledge domains and personnel knowledge level requirements must be specified.

(5) **Training Time**: Some operations require training for full mastery. This step combines event characteristics while ensuring overall process accuracy and facilitating managers' time planning.

(6) **Exception Handling**: Specific applications may encounter exceptional operations. Design phases should anticipate these situations and provide handling solutions.

3.3.2 Domain Components Real-world intelligence analysis often involves different domains such as law, history, and medicine. Intelligence analysts cannot be experts in all areas, making it difficult to produce professional analysis results when problems touch their knowledge blind spots. Moreover, comprehensive analysis combining multiple domains yields more thorough results than single-domain analysis. Integrating knowledge elements from different domains into intelligence analysis processes represents the trend of big data era intelligence analysis. Therefore, domain analysis and domain component design are essential when applying component technology to intelligence analysis.

Domain analysis actually involves refining knowledge required to solve domain-related problems. By consistently describing the common structures and characteristics of objects with similar functional coverage within a domain, conceptual domain models are extracted [26]. Conceptual structures must be further transformed into static logical structures, using classification methods to categorize domain knowledge hierarchically. Representing domain-acquired knowledge through domain models can provide more valuable information for intelligence component development and reuse. Domain analysis is the starting point for domain component design. As shown in Figure 3 [Figure 3: see original paper], the domain component design process requires participation from domain experts, domain analysts, and domain engineers, comprehensively considering user needs, expert suggestions, and future requirements to design domain components. Domain analysis results must be combined to determine domain component classification, standards, functional models, domain languages, and other content to develop components across various domains. Domain components must be stored in the intelligence component repository for selection when intelligence analysis problems involve those domains.

3.3.3 Intelligence Component Repository The intelligence component repository plays a crucial role in the entire model, serving as the foundation for intelligence component retrieval, assembly, maintenance, and management. A component repository is a system that organizes, collects, accesses, and manages components, forming component collections according to certain semantic and organizational structures [27], providing functions for component retrieval, querying, browsing, and expansion. For computer components, program code and specification documentation must be provided when storing in the repository to facilitate component generation, debugging, and assembly. For manual operation components, specification documentation must clarify input-output requirements, operational requirements, personnel knowledge level requirements, and other content to facilitate subsequent retrieval and selection of qualified personnel to implement manual operation component functions in actual problem-solving.

When the component repository contains numerous components, developers must consider whether they can effectively classify, store, and retrieve intelligence components, which affects query efficiency and result comprehensibility. Therefore, a reliable intelligence component repository management system must be established. Designing efficient component classification and retrieval methods based on different domain characteristics and intelligence component features enables users to quickly find corresponding components according to needs, improving retrieval and usage efficiency. If users possess programming backgrounds, they can modify parameters of retrieved computer components according to target intelligence analysis needs and provide feedback to developers based on usage experiences as a basis for component maintenance. Therefore, the intelligence component repository management system is paramount for using components to implement intelligence analysis processes, requiring component developers to design relevant rules and conduct development and optimization in advance to avoid module reuse and code reuse issues. As intelligence component quantities increase, deeper classification and organization should be performed to enhance component reuse safety and rationality, achieving higher-level component repositories to support advanced intelligence analysis work.

3.4 Application Process

The development process of the component-based intelligence analysis model focuses on intelligence component design and implementation. During application, the problem-solving process must be decomposed according to intelligence analysis requirements to clarify which tasks can be implemented through computer components and which require manual operation components, establishing correspondences between intelligence analysis tasks and components. Relevant components are then selected from the repository for assembly, generating larger-granularity components to complete information collection, processing, and analysis functions.

Using emergency intelligence analysis with intelligence components as an example, Figure 4 [Figure 4: see original paper] illustrates the application process. After analyzing emergency intelligence requirements and transforming them into specific problems, problems are decomposed to clarify required component functions and types: (1) In big data environments, emergency incident information sources are diverse. Information collection components must comprehensively gather multi-source heterogeneous data, including e-government information, social media information, and IoT information. Web crawler components can be selected to acquire required items from specific URLs, questionnaire and interview components can collect critical information, and voice information collection and text recognition components can enable more forms of information collection. (2) Information processing components clean and process collected information, requiring domain professionals to establish event description models. Based on description model elements and rules, information indexing components, classification components, etc., process information into formats required for subsequent analysis. (3) Appropriate emergency intelligence analysis method components are selected from information analysis components to analyze information, such as emergency event association analysis components, situation analysis components, and risk assessment components. Users can employ multiple method components for comparative analysis to make results more comprehensive. Intelligence analysis method components may not always produce ideal results and require parameter adjustments based on actual conditions. These method components are also larger-granularity components integrated from atomic components with reuse value that can be classified and stored in the intelligence component repository. When users have partially identical work tasks, these integrated components can be directly invoked for analysis, eliminating small-granularity component assembly processes and further improving intelligence analysis efficiency. Finally, these components can be integrated and encapsulated into a standardized emergency intelligence analysis system that stably and quickly solves similar problems, enabling managers to make decisions and issue emergency management measures. Professionals can also evaluate and provide feedback on emergency intelligence analysis results to supplement and improve component functions, making them closer to human intelligence analysis thinking and enhancing result value.

In practical applications, if the component repository's functions are limited—meaning tasks cannot be implemented with existing components after decomposition—similar components can first be retrieved and adjusted. If this remains unachievable, professional developers must redevelop corresponding intelligence components. Under ideal conditions where the component repository contains sufficiently complete functions, selecting and assembling corresponding components after task decomposition can form an efficient, standardized, and stable target system.

4 Application Value Outlook

Based on Hall's three-dimensional structure thinking and lifecycle theory, we refine and construct the time, logic, and knowledge dimensions of component-based intelligence analysis work to systematically reflect involved elements, workflows, and organizational management activities. As shown in Figure 5 [Figure 5: see original paper], the time dimension includes information collection, processing, analysis, manual analysis, and evaluation feedback stages to describe the intelligence analysis work lifecycle; the logic dimension includes requirement analysis, task decomposition, component selection, component assembly, and effectiveness evaluation processes to describe work content and thinking procedures at each stage; the knowledge dimension represents the knowledge fusion structure of intelligence science-related theories and methodological techniques, specifically including intelligence science, information science, knowledge organization and management, systems science theory, computer science and technology, information resource management, and data analysis. Through Hall's model, we can systematically and comprehensively understand the theoretical foundations, specific processes, and application ideas of the component-based intelligence analysis model. This paper prospects future application value from four aspects:

4.1 Automation

Traditional intelligence analysis work primarily concentrated on professional analysts who combined technical means according to processes, potentially spending substantial time and money on meaningless, tedious repetitive work. Using the component-based intelligence analysis model, even non-professional users can complete intelligence analysis tasks through assembled component-generated systems to aid their decision-making. In practical applications, original intelligence analysis tasks can be maximally implemented through computer components, with manual operation component operations also simplified, improving overall efficiency, releasing significant human resources, and making the entire process more automated.

4.2 Standardization

Compared with traditional intelligence analysis's cumbersome steps, the model-guided intelligence analysis steps are more standardized and efficient. On one hand, using components to implement filtering, deduplication, cleaning, and conversion preprocessing can standardize and normalize disordered, scattered data while eliminating ambiguity and redundancy. On the other hand, compared with previous pressures on individuals or organizations conducting independent intelligence analysis tasks, more standardized component assembly methods shorten the time required to conduct intelligence analysis work. Component technology's advancement and comprehensiveness can effectively improve data and analysis result quality.

4.3 Intelligence

Traditional intelligence analysis mostly involves superficial, manual statistical processing and analysis of static, structured, integrated information without achieving automated, integrated mining analysis of information resources. The component-based intelligence analysis model can integrate knowledge from data science, computer science, and other fields, combining natural language processing, deep learning, and other intelligent technologies with knowledge organization and discovery methods from information management to gradually develop function-richer components adapted to needs, enhancing large-scale knowledge acquisition capabilities and intelligent processing levels, and innovating intelligence analysis methods through multi-dimensional research integrating various domain knowledge.

4.4 Open Source

As intelligence components continuously expand through practical application, increased component quantities mean richer achievable functions and the ability to complete more complex tasks. Future development can create open-source intelligence component repositories where people from different domains can publish their components to the repository with functional descriptions, interface specifications, and input-output descriptions. In practical applications, users can evaluate components based on their experiences, facilitating developers' adjustments and improvements based on feedback.

The component-based intelligence analysis model holds significant importance for improving intelligence analysis work, with main advantages including: (1) Shortening intelligence analysis time and improving efficiency. Generating intelligence analysis systems through components enables rapid batch processing of similar intelligence analysis problems, providing good support for entire processes. (2) Reducing intelligence analysis process costs. Traditional processes require analysts to conduct all work independently or cooperatively, typically involving complex mental labor and consuming substantial human, time, and financial resources. Component design and application minimize and simplify human resource demands. Compared with traditional system development from scratch, this approach significantly reduces coding personnel requirements. More flexible combinations of computer and manual operation components can solve different intelligence analysis problems and improve quality. (3) Effectively reducing intelligence analysis risks. Intelligence analysis systems generated through components exhibit higher stability and security because components undergo long-term testing and continuous adjustment and improvement through practice, enhancing system stability, reducing development risks, and demonstrating strong practicality. (4) Having broad development prospects. As intelligence component repositories continuously improve and practical experience accumulates, solving intelligence analysis problems through components can promote intelligence analysis work development.

Although component-based intelligence analysis offers numerous advantages, several issues require resolution. Component repository construction demands substantial time and effort from professionals across different domains. Computer components require continuous testing and optimization by developers after design and implementation. As component quantities increase, deeper classification and organization should be conducted to enhance component reuse safety and rationality, achieving higher-level component repositories to support advanced intelligence analysis work. Future research will further investigate intelligence component standardization and application issues based on this paper.

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Author Contributions

Wang Yajun: Drafted and revised the manuscript; Shi Jin: Proposed the research framework, reviewed and revised the manuscript; Li Ming: Reviewed and revised the manuscript; Liu Yizhuo: Reviewed and revised the manuscript.

Note: Figure translations are in progress. See original paper for figures.