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An Adaptive High Reasoning Educational Interpretable Evaluation Model for Children's Literature Based on an Intelligent Library System

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ABSTRACT

A key point in designing learning environments to implement children's literature programs is the intelligent adaptation to the highest quality content to serve users' peculiarities better. The concept of adaptation refers to the implementation of settings in a digital learning environment based on the diversity of students' characteristics and needs, adopting a highly reasoning educational design, based on which the system adapts the form and content of children's literature lessons. To implement the adaptation in a modern learning environment, this work proposes the design of a High Reasoning Intelligent Library System that provides personalized support for children's literature at an individual or group level, taking into account their unique characteristics, their evolution during their studies, but also to provide them with the possibility of involvement in the educational process. The proposed approach is a mathematical model expressed in mathematical equations and explanations. Mathematical models make it easier and cheaper to consider more system states than would likely be possible with actual experimental models. The proposed method uses intuitive disambiguation and fuzzy indexes to integrate the educational material based on its optimal adaptation in each case.

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Introduction

Adaptability in learning environments aims at the level of content (Content Level Adaptivity) or links (Link Level Adaptivity), and it concerns the dynamic creation of educational material based on the learner model (Urdaneta-Ponte, Mendez-Zorrilla, and Oleagordia-Ruiz 2021). Accordingly, Link Level Adaptivity assumes static content and changes the appearance and/or meaning of links in course contents (which appear

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to the learner in the form of hyperspace) by depicting specific types of relationships.

The forms of adaptation concern:

(1) Adaptivity. The system adapts to the particular characteristics of the learner in a system-controlled manner. It is defined as System Driven Adaptation.
(2) Adaptability. The system supports interventions by the learner, even offering him control of the learning process (Learner-controlled). It is defined as User Driven Adaptation.

The adaptability aims to support the learner during his study, allowing the system to dynamically adapt to his particular characteristics and evolution while increasing the functionality of the hypermedia by combining it with free navigation and personalization. In addition, adaptability, which is a common operational goal of intelligent systems, focuses on the following (Maghsudi et al. 2021):

(1) in the creation of work groups of trainees,
(2) in the process of selecting educational content,
(3) in the presentation of the educational content,
(4) to support problem-solving,
(5) in support of knowledge field navigation.

The dimension of adaptability, respectively, aims to share control between the system and learner by providing the learner with possibilities:

(1) control of specific elements/functions of the system, such as its adaptability, e.g., selection of adaptation technologies, enable-disable adaptability,
(2) intervention and participation in the system's educational decisions, such as selecting the appropriate material for the level of knowledge of the trainee.

The levels of adaptability adopted in terms of the intervention possibilities provided to the learner vary from choosing a learning objective/module or participating in the educational decisions of the system to completely disabling the adaptability.

In the area of intelligent learning systems, various adaptation technologies have been implemented that support personalized learning/teaching, either by shaping the content of the learner-system interaction itself or by supporting the learner during his study by acting as a consultant. Technologies that have been adopted are (Andaloussi, Capus, and Berrada 2017; Cha and Ahn 2014):

(1) Curriculum Sequencing. According to this technology, the system undertakes the educational planning of the lessons for each learner, choosing their subject matter (Planning the Content) and/or the appropriate educational material (Planning the Delivery), taking into account their particular characteristics (cognitive level, preferences).
(2) Problem-Solving Support. The basic idea is to support learners in solving educational problems. In the first approach, he implements an intelligent analysis of the student's answers, aiming to identify their misconceptions. In the second, he supports him during the solution of a problem. At the same time, in the third, he suggests relevant examples from his recent experience (exercises solved by himself or models presented to him). Problem-solving support is an important instructional strategy that can help learners develop their problem-solving skills and achieve their learning goals. The specific approach used will depend on the context and the needs of the learners, but the goal is always to provide learners with the support and guidance they need to succeed. The system can provide hints, feedback, and suggestions to help learners overcome obstacles and reach a solution. Providing hints: The system can provide hints to help learners when they are stuck or struggling to make progress. These hints can range from general suggestions on how to approach the problem to more specific guidance on what to do next. The hints can be adaptive, meaning that the system can provide different hints based on the learner's level of understanding or progress in solving the problem. Offering feedback: The system can provide feedback on the learner's progress and performance as they work through the problem. The feedback can highlight areas where the learner is doing well, as well as areas where they need to improve. The feedback can be specific and actionable, providing the learner with guidance on how to correct their mistakes or improve their problem-solving skills. Providing suggestions: The system can provide suggestions on how to proceed when the learner is stuck or unsure of what to do next. The suggestions can include specific steps or strategies that the learner can use to move forward. The system can also provide examples of similar problems or solutions that the learner can use as a reference. Suggesting relevant examples: This approach involves providing learners with relevant examples from their recent experience or exercises that have been solved by others. Providing worked examples: The system can provide learners with worked examples that demonstrate how to solve similar problems step-by-step. The worked examples can show the learner how to apply problem-solving strategies or techniques to solve the problem. The learner can then use this knowledge to solve similar problems on their own. Offering relevant exercises: The system can provide learners with exercises that are similar to the problem they

are working on. These exercises can help the learner to practice their problem-solving skills and reinforce their understanding of the topic. The system can also provide feedback and guidance as the learner works through the exercises to help them improve their skills. Recommending resources: The system can recommend resources that the learner can use to deepen their understanding of the topic or problem. These resources can include textbooks, articles, videos, or other materials that provide additional information or examples. The system can also provide guidance on how to use these resources effectively to support their learning.

(3) Adaptive Presentation. According to this, the content of a page of educational material is adapted to the learner. The implementation of this technology includes:
   (a) the sub-conditional display or hiding text areas depending on the learner's cognitive level or preferences (Conditional text, Frame-based Technique).
   (b) the selective integration or not of areas of the text depending on the level, experience, etc. of the learner (Stretchtext).
   (c) the selective selection of educational material for the presentation of the concepts of a cognitive object in the form of self-contained representations (Explanation Variants).

(4) Adaptive Navigation Support. The system supports the learner in locating the most relevant path in hyperspace. The aim is to support the trainees in their navigation within the knowledge field of the design by appropriately adjusting the Visible Links. The most prevalent techniques are the following (Andaloussi, Capus, and Berrada 2017; Mulwa et al. 2010):
   (a) Direct Guidance. The system suggests to the learner the optimal path that leads him to achieve a specific cognitive goal. Direct guidance is a type of guidance that involves providing learners with a clear and explicit path to achieve a specific cognitive goal. In this type of guidance, the system suggests to the learner the optimal path that will lead them to achieve the desired learning outcome. The guidance can be in the form of step-by-step instructions, tutorials, or demonstrations. The key to providing the optimal path for direct guidance is to have a clear understanding of the learning goals and the prerequisite knowledge and skills, as well as to provide effective guidance and feedback throughout the learning process.
   (b) Adaptive Link Annotation. The system augments existing content links with information regarding their current status relative to the learner.

(c) Adaptive Link Hiding. Non-recommended links are visible but disabled and, therefore, unvisitable.

(5) Adaptive Collaboration Support. The system knowledge for the trainees is used to form working groups.

Today, the continuous increase of digital objects (files, images, sound, computer programs) available through the Web has caused classical libraries to change their form and give their place to the corresponding digital ones. Digital libraries are a new and growing field in computer science and take full advantage of the new possibilities provided by digital technology. Their development has led them from strict adherence to rigid library rules to standards that automated digital library organization systems can support (Demertzi and Demertzis 2020).

In this spirit, the development of intelligent digital libraries is an exciting but volatile area of activity, which can be particularly effective in the effort to organize, provide and retrieve knowledge. In particular, it can be a springboard for implementing continuous adaptation to the requirements of modern learning environments. Trying to create conditions for further development and providing solutions, this work proposes the design of a High Reasoning Intelligent Library System that offers personalized support for children's literature at an individual or group level, taking into account their particular characteristics and their evolution during their study, at the same time providing them with the possibility of involvement in the educational process. The proposed method is a mathematical model composed of equations and explanatory statements. Mathematical models make it easier and less expensive to consider a greater number of system states than achievable with experimental models. Using intuitive disambiguation and fuzzy indexing, the suggested system integrates educational content depending on its optimal adaption in each scenario.

The following section of the paper provides some of the most significant methodologies from the literature review. Section 3 discusses the Proposed Adaptive Architecture, and section 4 summarizes the findings.

Literature Review

Andaloussi et al. (Andaloussi, Capus, and Berrada 2017) emphasized the significance of adaptive educational hypermedia systems since they offer individualized learning, which is regarded as the activation key for learners' motivation, hence enabling them to learn more effectively. In general, the multiple extant systems include three theories: learner, domain, and adaptability. However, how are these models constructed, and what obstacles do designers and developers face? In order to solve this issue, 50 adaptive instructional hypermedia systems were analyzed by comparing the three approaches.

They presented and discussed the findings. Additionally, limitations are emphasized, and some potential solutions are presented.

Urdaneta – Ponte et al. (Urdaneta-Ponte, Mendez-Zorrilla, and Oleagordia-Ruiz 2021) assessed recommendation systems that aid educational practices in order to acquire information regarding the type of education and subject areas addressed, the learning approach used, and the recommended elements, as well as to identify any research gaps in this area for future work. Numerous articles were included in a systematic review, and it was determined that the majority are geared toward recommending academic materials for formal education users, with the integrated effort, the content-based framework, and the hybrid approach being the most popular methods used in recommendation systems, with a recent trend toward machine learning. Finally, potential future study and development opportunities in this subject are discussed.

Herrera-Viedma et al. (Pérez et al. (2010, November). A New Application of a Fuzzy Linguistic Quality Evaluation System in Digital Libraries. In 2010 10th International Conference on Intelligent Systems Design and Applications (Pp. 639–644). IEEE.) presented a tool for assessing the effectiveness of digital libraries based on fuzzy language input. Users' impressions of the grade of digital services offered via digital library websites were used to define the assessment of digital library quality. The tool was user-centric since it evaluated the reliability of digital libraries based only on user evaluations. They adopted a fuzzy linguistic architecture to describe the users' perception and employed automated systems of fuzzy processing with words based on a few weighted aggregation operators to calculate global quality assessments of digital libraries.

Mulwa et al. (Mulwa et al. 2010) worked on Adaptive Educational Hypermedia Systems (AEHS) that include Learning Styles in their evaluation. Adaptive techniques to learning provide alternatives to the conventional "one-size-fits-all" approach and have pushed the creation of dynamic learning environments. They found that learning styles alongside other forms of adaptability give modest advantages in student motivation and information acquisition, but there was relatively few research in adaptive e-Learning that confined adaptability to learning style adaptability alone. Some research seemed to identify features of learners' performance, but modification had no appreciable effect on the performance of learners.

Iqbal et al. (Iqbal et al. 2021) examined the comparative effectiveness, theoretical and practical foundation, and educational implications of three program assessment approaches, as well as their strengths and shortcomings. The models were outcome-based evaluation, Kirkpatric, and CIPP. Among the studied methods, the CIPP model seems to be the most suitable for use in assessing educational programs since it is more extensive, adaptable, cost-effective, and implementable. The approach is applicable to many phases of educational programs. The research found that using the CIPP model to evaluate educational programs might provide realistic conclusions about the programs' overall development.

Ueland et al. (Ueland, Hinds, and Floyd 2021) used Minnesota State's Equity 2030 top focus and efforts to incorporate a shared comprehension of data democratization to illustrate the implementation of Complex Adaptive Systems concept to higher education and to discuss how applying transition organization approaches from the CAS writings has the potential to result in long-lasting and viable structural change.

Based on the gap identified in the ways of implementing evaluation methods on kids training, this article adaptive high reasoning educational evaluation Method for children's literature based on an Intelligent Library System.

Proposed Adaptive Architecture

The proposed implementation is based on the fact that in modern digital libraries, the organization of their catalogs of content can work with common standards, so that search can "unify" all libraries and the "knowledge of the world" to offer the " more semantically relevant content. The Semantic Web (Bonacin et al. 2020) provides the possibility of developing various access solutions for many users while offering users better learning by making more efficient use of the learning resources available on the Web. With the popularization of the online environment, distance education distribution and implementation have become more accessible and faster because they make it possible to provide independence to the student, overcome space-time barriers, and offer freedom of choice.

Thus, based on semantic modeling, searching for a topic can return a semantic multimedia report with all related data (such as Web pages, databases, videos, scientific articles, etc.), including also comments and links for all upcoming related events happening near the user's area, as well as suggestions associated with their profile. In particular, Semantic Linked Open Data is based on the foundational technologies of the semantic web, with RDF providing a general graph-based data model to structure and connect the elements described. Several tools for creating RDF triples, or linked data, have been designed and are provided under open software licenses. Many of them aim to create an ontological representation of the relational database, while some aim at the semantic model of selected parts of the relational database. All these tools require the creation or configuration of some programming functions (Hou et al. 2019; Lomazova 2001).

One of the most well-known tools is D2RQ. With the D2RQ platform, a non-RDF-compliant database can be queried (searched) using the SPARQL query language. In addition, using the Jena API or the Sesame API, one can access the database information. At the same time, the database content can also be accessed as a model of semantically linked data. Finally, it is possible to perform SPARQL queries via the SPARQL protocol on the cross-linked data resulting from the database (Allemang and Hendler 2011a; Babovic and Milutinovic 2013).

Another critical tool is OpenLink Virtuoso, which also allows extracting the data of a relational database into RDF triplets and providing them as semantically linked data. It also, among other things, provides a cross-linked data server where SPARQL queries can be made. OpenLink Virtuoso has more features than D2QR, but both require a ready-made ontological representation of the base, usually represented by RDS or OWL (Allemang and Hendler 2011b).

On the other hand, there are also tools for the semantic display of a part of the relational database, such as triplify. Triplify is based on mapping HTTP-URI queries against the relational database. It tries to solve problems arising from the transfer of the data of a relational database into semantically interconnected data, such as the separation of data that is allowed to be published (public) and data that contains information that should not be published (private), the reuse of vocabularies available in the field of semantically linked data, but also the shortcomings that a database may have (e.g., foreign keys, constraints, etc.). triplify is based on the definition of the aspects of an application-specific database so that it retrieves the information through appropriate queries on the database and transforms it into RDF, JSON, and semantic linked data (Ibrahim et al. 2020; Zhu 2020).

Furthermore, the support of interactions in the virtual communities they support and the new virtual reality tools accessible through the library environments allow users-members of the community the free sharing of information and personalized support. Another significant development concerns the development of innovative applications and tools, which, using ontologies, allow the entire organization and extensive use of taxonomic and cataloging systems of modern librarianship, creating semantic "maps" of bibliographic material, which would enable direct and friendly content searching. Finally, the management of library systems is an essential field of applied innovation since a user can identify topics characterized by semantic content, compare them and register in whichever one he considers most appropriate for searching and carrying out his research. For the efficient integration and management of internet resources by libraries and the taxonomic and cataloging systems of modern librarianship, it is necessary to implement simple organizational structures and to present them in a way that is useful and understandable to library users, conventional or digital.

In particular, for the modeling of knowledge and its optimal utilization by the modern Intelligent Library System, the proposed system proposes the semantic interoperability of websites that contain educational material, such as, e.g., websites of schools/universities and libraries, based on the technologies offered by the semantic web. The semantic interconnection of library standards, applications, and data, as a first and primary action, is based on the following (Demertzi and Demertzis 2020; Thiombiano et al. 2020; Xue and Lu 2020):

(1) preparation of appropriate Ontologies that can clearly describe the subject matter of the sciences and the specialized concepts they deal with.
(2) preparation of similar Semantic Dictionaries, which can describe the learning concepts and needs of each educational level,

The widespread use of metadata, which is structured and coded data that describes characteristics of information entities to identify, discover, evaluate, and manage the entities described, concerns processes that are not dealt with in the study in question.

Finding the learner's profile and then the personalized design of the children's literature program, demonstrating how the semantic web can help in more effective information retrieval and customized education, is implemented based on the TAP Infrastructure. TAP is intended as an infrastructure for semantic web applications. It provides a set of simple mechanisms for websites to publish data to the semantic web and for applications to consume that data through a minimalistic query interface called GetData.

Several query languages have been developed for the resource description framework, such as RDF (Resource Description Framework) (belongs to the W3C-World Wide World Consortium framework). RDF and other languages provide very expressive mechanisms and are intended to make it easy to formulate complex queries. However, specific expression mechanisms make it easy to construct queries that require processing many computing resources. Consequently, since no significant website provides an SQL interface to the relational database, no one expects huge websites to use query languages as an external interface to their data. What is needed is a more lightweight interface that is easier to support and, more importantly, has a predictable behavior. This predictable behavior is essential not only for the provider but also for the customer of the services. Such a lightweight query system can be complementary to more complete query languages and does not preclude specific sites from aggregating data from multiple locations and providing richer query interfaces to those aggregations. GetData is intended to be a simple query interface to network-accessible data and not a full-fledged or expressive query language like SQL. Its purpose is to enable machines to query data on remote servers while also allowing access to the values of one or more properties of a resource from a graph.

Each quarriable graph has a single URL resource location associated with it. Each GetData query is a message that specifies two arguments, the resource whose properties are being accessed and the properties being accessed themselves. The response returned to a GetData query is also a graph containing the resources (whose properties are being queried), along with the arcs specified by the query and their corresponding source targets. Application programming interfaces hide the messages and XML encoding from the developer. So, as far as this particular application is concerned, the interface looks like this (De, Zhou, and Moessner 2017; Ibrahim et al. 2020):

GetData(<resource>, <property>), =><value>
For example, some questions of semantic content are:
GetData(<Qin Lu>, lectureplace), =><Hong Kong Polytechnic University>
GetData(<Hong Kong>, university), =><Hong Kong Polytechnic University>
GetData(<Qin Lu>, book), =><Routledge Handbook of Chinese Applied Linguistics, Routledge Pub>

< Qin Lu >and< Hong Kong> are references to the resources corresponding to that particular teacher and that particular city. Typically, references to these resources are made via the Uniform Resource Identifier URI which could be the following:

https://research.polyu.edu.hk/qinlu.html
https://research.polyu.edu.hk/
https://research.polyu.edu.hk/publications/computers-and-chinese-writing-systems

Each of the above GetData type queries is a message corresponding to the chart with the data.

In addition to the GetData core interface, two other interfaces provided by TAP help explore graphs. The first of these is the search interface which takes a string and returns all resources, and the second is the reflection interface, which is like the one used in object-oriented programming languages and returns a list of arcs from and to the nodes. This is useful for exploring a graph within the vicinity of a node without knowing what might be around it. In this way, the system's users have access to structured information, which can be simulated as a global common database, and to a set of inference rules to automatically produce conclusions and optimally choose the most relevant information, which forms the personalized education profile.

The proposed architecture extensively uses Fuzzy Logic and Machine Learning methods to model the process of adapting children's literature recommendations through personalized practices, ideal for retrieving the appropriate material for each user. Technologies are used either (Al-Gunaid et al. 2017; Jang 1993; T Atanassov 2017):

(1) To identify the characteristics of the students and then their classification into specific groups (classes) and therefore, with Supervised Learning algorithms (Demertzis and Iliadis 2017),
(2) For clustering search results by content relevancy cluster and therefore with Unsupervised Learning algorithms.
(3) For the integration of the proposed material, the Fuzzy set theory is used, which is based on the extension of the concept of the characteristic function (characteristic function) of a classical set A for the reference set X, i.e. $I_A : x \in X \rightarrow I_A(x) \in \{0, 1\}$ in the membership function of a fuzzy set $\tilde{A}$,$\mu_{\tilde{A}} : x \in X \rightarrow \mu_A(x) \in [0, 1]$.

The architectural standardization of the proposed standard consists of the following essential structural elements:

(1) Front-end Model. In this model, all the actions and subsystems related to the user's interface with the system are included and performed, as the information subsystem that undertakes to interpret the knowledge about the standards of interpretation, the knowledge required for the content of the communication, and the knowledge about communication intent achieve two-way communication with Learner and Trainer levels.
(2) Student Model. In this model, all the cognitive and emotional states and actions concerning the learner and his development are included and carried out. The system detects its overall functions as the learner gradually works through the multidimensional learning processes and solves cognitive problems. It improves them by rearranging the training program and material, depending on progress and learning goals, and achieves two-way communication with the Supervisor and UI layers.
(3) Tutoring Model. This model includes all the functional choices regarding the teaching strategies and methods that can be followed, the educational actions, the solving of problems posed by the students, and the steps that the teacher must perform in an academic program to achieve two-way communication with the Supervisor and UI layers.
(4) Supervisor Model. In this model, all the steps required to prepare a course are included and performed. This model consists of concepts, rules, and learning strategies. It also provides the control box for the Trainee and Trainer models and achieves two-way communication with the Learner, Trainer, and Application Core layers.
(5) Core Model. All the actions from the above four models are included, coordinated, and controlled in this model. The interface and interconnection subsystem with the AI architectural layer is included. There is the artificial intelligence subsystem which, based on operational

processes and machine learning algorithms, handles the individual intelligent procedures required. These functions are carried out with the appropriate application, which must be developed in an integrated programming environment, with a programming language such as Python, and with the interface of the application in question with a database management system, in which all the information is registered achieves two-way communication with the Supervisor layer.

In this work, the material integration process is thoroughly presented, based on extensive use of Fuzzy Logic methods (Amelia, Abdullah, and Mulyadi 2019). In particular, to unify the material scattered in unified bases from the intuitionistic fuzzy field, we will return to the fuzzy field, constructing the fuzzy set corresponding to the modified intuitionistic fuzzy set A'_{opt}. For this purpose of deconstructing the intuitive fuzzy set, we use the Atanassov operator, which is described by the following equation (T Atanassov 2017):

$$if A \in \mathcal{JFS}(\mathcal{X}) \tag{1}$$

Different parameter values generate different fuzzy sets; therefore, different versions of the processed image are possible in the fuzzy field. Therefore, there is a need for a criterion that will allow us to choose the optimal parameter α_{opt}.

The linear ambiguity index measures the inherent ambiguity of a fuzzy set. For a fuzzy set $\tilde{A}$, the linear fuzzy index is defined by the equation (Georgopoulos and Stylios 2017; Venkata Subba Reddy 2013):

$$\gamma_l(\tilde{A}) = \frac{1}{2|X|}\sum_{i=1}^{|X|} min\left\{\mu_{\tilde{A}}(x_i), \mu^c_{\tilde{A}}(x_i)\right\} \tag{2}$$

Replacing the min level with the product operator, we have the ambiguity index given by the equation:

$$\gamma(\tilde{A}) = \frac{1}{4|X|}\sum_{i=1}^{|X|} \mu_{\tilde{A}}(x_i)\mu^c_{\tilde{A}}(x_i) \tag{3}$$

The fuzzy index will be the optimization criterion to extract the optimal fuzzy set corresponding to the intuitionistic fuzzy set A'_{opt}. The fuzzy index is a measure of how well the intuitionistic fuzzy set A'_{opt} can be approximated by the optimal fuzzy set D_α. The above equation calculates the fuzzy index using a weighted average of the degree of membership and non-membership of A'_{opt} with respect to D_α, where the weights are given by the function $h^c_{\tilde{A}}$. So we have (Anezakis, Demertzis, and Iliadis 2018; Demertzis et al. 2018):

$$\gamma\left(\mathrm{D}_\alpha\left(A'_{\mathrm{opt}}\right)\right) = \frac{1}{4MN}\sum_{g=0}^{\mathrm{L}-1} h^{\mathrm{c}}_{\tilde{A}}(g)\mu_{\mathrm{D}_\alpha\left(A'_{opt}\right)}(g)\left(1-\mu_{\mathrm{D}_\alpha\left(A'_{opt}\right)}(g)\right) \tag{4}$$

By setting:

$$\frac{d\gamma\left(D_\alpha\left(A'_{\mathrm{opt}}\right)\right)}{d\alpha} = 0 \tag{5}$$

We have:

$$\alpha'_{\mathrm{opt}} = \frac{\sum_{g=0}^{\mathrm{L}-1} h^{\mathrm{c}}_{\tilde{A}}(\mathrm{g})\pi_{A'_{\mathrm{opt}}}(\mathrm{g})\left(1-2\mu_{A'_{\mathrm{opt}}}(\mathrm{g})\right)}{2\sum_{g=0}^{\mathrm{L}-1} h^{\mathrm{c}}_{\tilde{A}}(\mathrm{g})\pi^2_{A'_{\mathrm{opt}}}(\mathrm{g})} \tag{6}$$

In addition, because:

$$\frac{d^2\gamma\left(D_\alpha\left(A'_{opt}\right)\right)}{d\alpha^2} = -\frac{1}{2MN}\sum_{g=0}^{MN} h^{c}_{\tilde{A}}(g)\pi^2_{A'_{opt}}(g) \leq 0 \tag{7}$$

it is evident that the extremum of the equation is a total maximum. The equation shows that the second derivative of the fuzzy index with respect to α is always negative or zero, which means that the fuzzy index is a concave function of α. This property is important for the optimization of the fuzzy index because it guarantees that the optimal value of α, which maximizes the fuzzy index, can be found using standard optimization algorithms that rely on the gradient of the objective function. However, it does not ensure the value of the parameter α'_{opt} will lie in the interval [0; 1], because it may take its maximum value also outside the interval [0; 1]. Therefore, the optimal α_{opt} value to transfer from the intuitive fuzzy field to the fuzzy field is calculated based on the relation (Chen and Yeh 2000; Guo et al. 2021; Liwen and Wang 2016):

$$\alpha_{\mathrm{opt}} = \begin{cases} 0,\ if\,\alpha'_{\mathrm{opt}} < 0 \\ \alpha'_{\mathrm{opt}},\ if\,0 \leq \alpha'_{\mathrm{opt}} \leq 1 \\ 1,\ if\,\alpha'_{\mathrm{opt}} > 1 \end{cases} \tag{8}$$

Based on the above, we will prove the application of the intuitive fuzzy framework to achieve the integration optimization of the solution space for integrating educational materials. Specifically, let be an intuitive fuzzy set:

$$A = \left\{\langle x, \mu_A(x), \nu_A(x)\rangle \mid x \in X\right\} \tag{9}$$

where $\mu_A(x), \nu_A(x)$ are increasing/decreasing and decreasing/increasing functions of x. Then, the membership function of the fuzzy set $D_\alpha(A)$ preserves the monotonicity of the function $\mu_A(x)$.

To prove the above hypothesis, from the equation:

$$\mathrm{D}_\alpha(A) = \left\{\langle x_i, \mu_A(x_i) + \alpha\pi_A(x_i), \nu_A(x_i) + (1-\alpha)\pi_A(x_i)\rangle \mid x_i \in X\right\} \quad (10)$$

Taking in consideration that:

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x) \quad (11)$$

the membership function of the set $D_\alpha(A)$ can be written as follows:

$$\mu_{\mathrm{D}_\alpha(A)}(x) = \alpha + (1-\alpha)\mu_A(x) - \alpha\nu_A(x) \quad (12)$$

The derivative of the above equation for x is:

$$\frac{\mathrm{d}\mu_{\mathrm{D}_\alpha(\mathrm{A})}(x)}{\mathrm{d}x} = (1-\alpha)\frac{\mathrm{d}\mu_{\mathrm{A}}(\mathrm{x})}{\mathrm{d}x} - \alpha\frac{\mathrm{d}\nu_{\mathrm{A}}(\mathrm{x})}{\mathrm{d}x} \quad (13)$$

Now suppose that the functions $\mu_A(x), \nu_A(x)$ are respectively increasing and decreasing functions of x. Then, since $\alpha \in [0, 1]$ and $\frac{\mathrm{d}\mu_{\mathrm{A}}(\mathrm{x})}{\mathrm{dx}} \geq 0$ (increasing function) and $\frac{\mathrm{d}\nu_A(x)}{dx} \leq 0$ (decreasing function), it follows that:

$$\frac{d\mu_{\mathrm{D}_\alpha(A)}(x)}{dx} \geq 0 \quad (14)$$

Therefore, the function $\mu_{\mathrm{D}_\alpha(A)}$ is an increasing function of x. Similarly, the same can be proved in the case where $\mu_A(x), \nu_A(x)$ are decreasing and increasing functions of x.

Finally, the optimal fuzzy set corresponds to the modified intuitionistic fuzzy set A'_{opt} is defined by the relation:

$$\tilde{A}'_{\mathrm{opt}} = \left\{\langle g, \mu_{\mathrm{D}_{\alpha_{opt}}(A'_{\mathrm{opt}})}(\mathrm{g})\rangle \mid \mathrm{g} \in \{0, \ldots, \mathrm{L}-1\}\right\} \quad (15)$$

This method of intuitive disambiguation allows the integration of the educational material based on its optimal adaptation in each case.

Conclusion

In this paper, we propose a High Reasoning Intelligent Interpretable Library System that provides individualized assistance for children's literature on an individual or group level, taking into consideration their unique characteristics, their academic development, and the opportunity for their participation in the learning process.

To implement the adaptation in a contemporary learning environment, this paper proposes the design of a High Reasoning Intelligent Library System that provides personalized support for children's literature on an individual or group level, taking into account their unique characteristics, their development during their studies, as well as giving them the opportunity to participate in the educational process. The proposed method is a mathematical model composed of mathematical equations and explanatory statements. Mathematical models make it easier and less expensive to consider a greater number of system states than would be achievable with actual experimental models. Using intuitive disambiguation and fuzzy indexing, the suggested system integrates educational content depending on its optimal adaption in each scenario.

However, the proposed method can also have limitations. It may not be suitable for all learners, especially those who prefer a more exploratory or self-directed learning approach. It can also limit creativity and critical thinking if learners are only taught a fixed set of procedures or methods. As such, it's important to use direct guidance judiciously and to balance it with other types of guidance, such as exploratory or scaffolding guidance, to provide learners with a more comprehensive and flexible learning experience.

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Data Availability Statement

The data used in this study are available from the author upon request.

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