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Intelligent Technologies for Projective Thinking and Research Management in the Knowledge Representation System

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***Abstract*—It is proposed to address existing methodological issues in the educational process with the development of intellectual technologies and knowledge representation systems to improve the efficiency of higher education institutions. For this purpose, the structure of relational database is proposed, it will store the information about defended dissertations in the form of a set of attributes (heuristics), representing the mandatory qualification attributes of theses. An inference algorithm is proposed to process the information. This algorithm represents an artificial intelligence, its work is aimed at generating queries based on the applicant preferences. The result of the algorithm's work will be a set of choices, presented in ranked order. Given technologies will allow applicants to quickly become familiar with known scientific results and serve as a starting point for new research. The demand for co-researcher practice in solving the problem of updating the projective thinking methodology and managing the scientific research process has been justified. This article pays attention to the existing parallels between the concepts of technical and human sciences in the framework of their convergence. The concepts of being (economic good and economic utility) and the concepts of consciousness (humanitarian economic good and humanitarian economic utility) are used to form projective thinking. They form direct and inverse correspondences of technology and humanitarian practice in the techno-humanitarian mathematical space. It is proposed to place processed information from the language of context-free formal grammar dissertation abstracts in this space. The principle of data manipulation based on formal languages with context-free grammar allows to create new structures of subject areas in terms of applicants' preferences.**

It is believed that the success of applicants' work depends directly on the cognitive training of applicants, which needs to be practiced psychologically. This practice is based on deepening the objectivity and adequacy qualities of obtaining information on the basis of heuristic methods. It requires increased attention and development of intelligence. The paper studies the use of heuristic methods by applicants to find new research directions leads to several promising results. These results can be perceived as potential options in future research. This contributes to an increase in the level of retention of higher education professionals.

Keywords—intelligent technology; projective thinking and management; knowledge representation systems; convergence; subject area models; database management system; data model; heuristic methods.

I. INTRODUCTION

In the near future, only new research results will be able to compete with the results of the rapidly robotics industry developing in terms of employment. Therefore, it is natural to assume that the interest in academic degrees will increase every year. Consequently, the applicant institutes have to become more efficient, overcoming certain difficulties of methodological nature through implementation of intellectual technologies [1]. The following unresolved problems [2] can be noted in the current organization of the academic studies:

1. There is a lack of new more effective knowledge representation systems of applicants' specific domain of the research than universal classifiers like Universal Decimal Classification (UDC), Library-Bibliographic Classification (LBC), etc.

2. There are difficulties with the targeting of scientific research [3] due to the separation of technical and humanities disciplines in applied issues.

3. There is a lack of systematic analysis of the ways and results of using interdisciplinary approaches. These approaches include new possibilities related to projective thinking and applicants' activity management [4].

4. There is a lack of applicants' motivation to produce several fairly promising scientific results. This is a multiplier effect, implying several results promising for further research by other specialists [5].

The primary and the most important task for the applicant is to establish the correspondence between the sets of benefits (research objects) and the sets of utilities (research subjects). Benefits and utilities have the property to satisfy human needs and correlate with certain technical and natural science disciplines [6]. The phenomenon of

interdisciplinarity through the divergence of subject areas' knowledge leads to results at the intersection of several disciplines [7]. It raises the problem of studying and modelling the forward and backward projections of these disciplines in the mathematical space. For example, the projection is in the form of operations on sets. For this purpose, it is necessary to develop naming the concepts systems of the disciplines mutually-ambiguous with their semantics in a specially introduced mathematical space.

The central worldview issue of the present research is the establishment of dualism between technical and humanitarian disciplines (material and spiritual objects of knowledge). This is necessary for the organization of scientific research under the primacy of the spiritual, thinking, that leads to the study and use of reasonable goal-setting and appropriate motivation, which becomes a "material force" (V. Vernadsky). There are the parallels that always exist between the concepts of technical and humanity sciences in the framework of their convergences. Genesis is the economic benefits and material utility. Consciousness is the humanitarian economic benefits and humanitarian abstract values that form a projective thinking [8]. It provides a correspondence between the projection of economic benefits and humanitarian values. Projective thinking forms direct and inverse correspondences of technology and humanitarian practice in techno-humanitarian mathematical space [9].

Thus, it is demanded the essentially updated formation of projective thinking and management of process of scientific researches methodology [10]. The studies are based on intellectual technologies of representation of knowledge systems in the mathematical space, including management of a knowledge base systems in this methodology.

II. KNOWLEDGE RERPRESENTATION SYSTEM ORGANISATION

This task is proposed to be solved on the basis of the following principles.

1. The mathematical techno-humanitarian space is taken as a logically conceivable structure, which is the hosting environment for other structures or defended dissertations data (e.g. dissertation abstracts). This is necessary to familiarize applicants with known scientific results and to select a starting point for new research [11].

2. Context-free grammar languages for data manipulation are created to form a new subject area on a logical level. This is necessary to input and update the information in the techno-humanitarian space in accordance with the applicant's idea. In order to simplify the subject areas data formalizing task, their qualification attributes are listed. The list of qualification attributes includes possible options for supplementing the information right up to the symbols in the subject area models structures.

3. Formalization [12] allows such algebraic operations as union, intersection, complement over symbols' subsets. The subsets represent subject domains structural elements. Moreover, formalization enables to evaluate results of operations after variables transformation into the semantic form.

4. Formal description [13] and manipulation languages with type-2 context-free grammar [14] are used. This is due to the fact that inference rules within the set of subject area symbols as an alphabet of terminal symbols are characterized by meta-linguistic variables and mappings to describe their extensions [15].

The subject area structures are constructed according to a chosen standard scheme with the applicants' preferences in mind. This makes it easy to manipulate the subject areas in a sequence set by the applicant.

Consider the approximate of these structure compositions represented by vectors. Each component in vectors is an entity sets consisting of attributes (concepts) that form the subset access query and its content. The content for technical sciences includes date of the thesis defense, specialty code, object of research (benefits), subject of research (utility), relevance, research objective, scientific tasks, novelty and practical significance. The content for humanity sciences includes date of the thesis defense, specialty code, object of research (generalized values), subject of research (subject humanitarian utility), relevance, research objective, scientific tasks, novelty and practical significance. Technical science concepts are formed first and foremost, followed by humanities concepts [9].

An approximate structure of the database (Table I), where the information will be stored, is proposed based on the concepts outlined above.

TABLE I. AN APPROXIMATE STRUCTURE OF TABLE IN THE DATABASE

	Attribute 1	**Attribute 2**	**Attribute 3**	**…**	**Attribute N**
Entity 1	Concept 1.1	Concept 1.2	Concept 1.3	…	**Concept 1.N**
Entity 2	Concept 2.1	Concept 2.2	Concept 2.3	…	**Concept 2.N**
Entity 3	Concept 3.1	Concept 3.2	Concept 3.3	…	**Concept 3.N**
…	…	…	…	…	…
Entity N	Concept N.1	Concept N.2	Concept N.3	…	**Concept N.N**

The entity is the title and the attributes are the mandatory qualifying features of the dissertation. Concepts are the specific attribute values for a particular entity. The mathematical notation of the described elements is as follows:

<entity> :: concept 1 | concept 2 | concept 3 | ... | concept N

The syntactic forms of the concepts are translated into mathematical language in the form of special notations before performing algebraic operations. The concepts are converted back into a semantic form afterwards. This is necessary to detect new concepts that have emerged due to a change in their syntactic structure [16].

In order to obtain the required information, the applicant has to perform the following algorithm:

1. Describe the set of attributes that represent the selection criteria.

2. Rank attributes by importance.

3. Describe algebraic operations on these attributes (combination, intersection, addition, etc.).

The result of the algorithm execution will be a set of entities (dissertation abstracts). These entities should satisfy the generated query conditions.

The success of this procedure depends on the cognitive training of the applicants. The level of this preparation is influenced by psychological practices, which may include trainings for improving description and presentation data skills [17, 18]. It is also necessary to improve the level of concentration as the first stage of cognitive awareness and to increase intelligence. These recommendations are also useful in the final stage of applicants' research management in the knowledge representation system.

III. CONCLUSION

Heuristic methods are often used in the study of technologies for shaping projective thinking and managing the applicants' research under conditions of insufficient information. The proposed technologies will solve the problem of searching and processing a large amount of information. The problem is in analysis of existing studies on the selected topic. The presented database will store information about all studies in a structured form. The structure of the database will allow to highlight the key information in the studies. The querying algorithm will allow to optimize the process of research search according to the necessary criteria. There is certainly a demand for more information, but the way to obtain it is objectively hampered by the inaccessibility of future knowledge hidden behind the veil of time. Nobel Prize winner Herbert A. Simon succeeded in raising this curtain in some extent. The solution essence to this problem lies in the forced 'abandonment' of 'future' analysis by researchers in favour of solution preconditions and modelling future expectations based on the generation of an additional alternative solutions set. Such solutions have a poorly understood origin sometimes. Eventually, there is usually a satisfactory solution and a few worse, but perfectly acceptable solutions that give a chance for a multiplier effect through additional research on their reliability. The need for verification is related to the fact that people rely on a limited number of heuristics. They reduce the complex tasks of estimating probabilities and predicting values to simpler operations of judgement.

The proposed technologies will not only reduce the time for information search and processing, structure and systematize previously obtained results in accordance with the request of the applicant, but also find new promising areas of research by varying the parameters of the requests. The direction for further research will be the development of artificial intelligence, which will search for heuristics in all scientific databases, both domestic and foreign.

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