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THE TASK OF FORMING ELECTRONIC FILES IN THE ELECTRONIC DOCUMENT FLOW SYSTEM

In connection with the transition of organizations and enterprises of the country from paper to electronic document management and the adoption of regulatory requirements for electronic document management systems and archival storage, the task of creating electronic files becomes relevant. The paper proposes an approach to solving the problem of generating electronic files, which is characterized by sufficient generality and simplicity in the creation of algorithmic and (or) software. The task of forming electronic files is solved by implementing a sequence of operations for binary (paired) comparison of the metadata of an electronic document within the existing (ordered in some way) feature space. Within the framework of the proposed approach, it is possible to obtain in an explicit form the conditions for the belonging of an electronic document to the corresponding electronic file. Fulfillment (non-fulfillment) of these conditions is equivalent to the truth (falsehood) of some very specific predicate, and the structure of this predicate makes it possible to implement the mentioned sequence of comparison operations. In practice, the approach allows you to effectively solve the problem of automated distribution of an electronic document in electronic cases, when some of the details of the electronic document are known.
Key words: management documentation support, electronic document, details of an electronic file, metadata, electronic document management system, nomenclature of files, formation of an electronic file, theory of predicates, binary comparison.

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Электрондық құжат айналымы жүйесінде электрондық істерді қалыптастыру мәселесі

Еліміздің ұйымдары мен кәсіпорындарының қағаз құжат айналымынан электрондық құжат айналымына көшуіне және электрондық құжат айналымы мен архивтік сақтау жүйелеріне қойылатын нормативтік талаптардың қабылдануына байланысты электрондық істерді қалыптастыру мәселесі өзекті бола бастады. Жұмыста электрондық істерді қалыптастырудың алгоритмдік және (немесе) бағдарламалық қамтамасыз етудің жеткілікті дәрежеде жалпылығымен және қарапайымдылығымен сипатталатын тәсілі ұсынылған. Электрондық істерді қалыптастыру электрондық құжаттар метадеректерінің (қандай да бір жолмен реттелген) белгілер кеңістігінде екілік (жұптық) салыстыру операциялары тізбегін жүзеге асыру арқылы шешіледі. ?сынылған тәсілдің шеңберінде электрондық құжаттың қандай электрондық іске тиесілігі шарттарын айқын түрде анықтауға болады. Бұл шарттарды орындау (орындамау) қандай да бір нақты предикаттың ақиқаттығына (жалғандығына) тең және бұл предикаттың құрылымы жоғарыда аталған салыстыру операцияларының тізбегін жүзеге асыруға мүмкіндік береді. Тәжірибеде бұл тәсіл электрондық құжат деректемелерінің белгілі бір бөлігі анықталған жағдайда, электрондық құжаттарды автоматтандырылған түрде электрондық істерге тарату мәселесін тиімді түрде шешеді.

Түйін сөздер: басқаруды құжаттамамен қамтамасыз ету, электрондық құжат, электрондық іс реквизиттері, метадеректер, электрондық құжат айналымы жүйесі, істер номенклатурасы, электрондық істерді қалыптастыру, предикаттар теориясы, бинарлық салыстыру.

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Задача формирования электронных дел в системе электронного документооборота

В связи с переходом организаций и предприятий страны от бумажного к электронному документообороту и принятием нормативных требований к системам электронного документооборота и архивного хранения становится актуальной задача формирования электронных дел. В работе предложен подход к решению задачи формирования электронных дел, отличающийся достаточной общностью и простотой при создании алгоритмического и (или) программного обеспечения. Задача формирования электронных дел решается путем реализации последовательности операций бинарного (парного) сравнения метаданных электронного документа в рамках имеющегося (упорядоченного некоторым образом) пространства признаков. В рамках предложенного подхода удается получить в явном виде условия принадлежности электронного документа к соответствующему электронному делу. Выполнение (невыполнение) этих условий эквивалентно истинности (ложности) некоторого вполне конкретного предиката, а структура этого предиката и позволяет реализовать упомянутую последовательность операций сравнения. На практике подход позволяет эффективно решать задачу автоматизированного распределения электронного документа по электронным делам, когда часть реквизитов электронного документа заведомо известна.

Ключевые слова: документационное обеспечение управления, электронный документ, реквизиты электронного дела, метаданные, система электронного документооборота, номенклатура дел, формирование электронного дела, теория предикатов, бинарное сравнение.

1 Introduction

The increasing pace of transition of the organization and enterprise of the country from paper to electronic document management causes a rapid increase in the volume of electronic documents (ED), which must be accepted for archival storage and used for public administration purposes. The directive documents [1, 2] define the requirements for systems of documentary support for management, electronic document management (EDMS) and archival storage of ED in the Republic of Kazakhstan.

In accordance with regulatory documents and historical tradition, the unit of archival storage of documents on paper is an archival file, which contains a finite number of archival documents, combined by subject matter, taking into account the importance and timing of their archival storage. In the case of electronic document management, this means that EDs must also be distributed among the relevant electronic files (formation of electronic files), which are subject to subsequent transfer to departmental and then state storage [3, 4]. Thus, the task of forming electronic files is to distribute a huge array of EDs executed over a calendar period (year) in electronic files, which will be stored, first, in the information system of the departmental archive of the organization, and then, possibly, in the information system of the state archive.

Currently, the interaction of the EDMS and the systems of temporary and long-term archival storage of ED in state bodies is carried out according to a "simplified"scheme, due

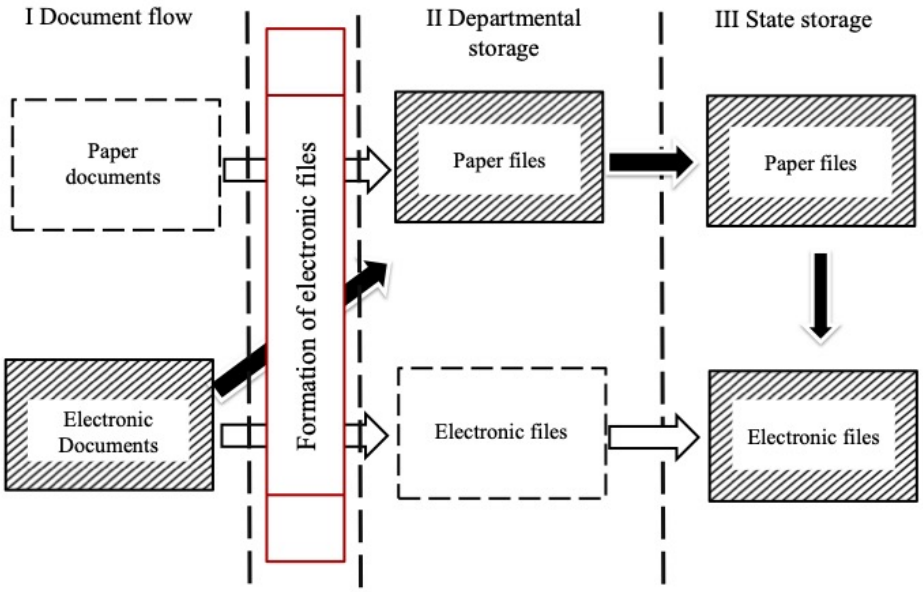

Figure 1: The current state of the formation of cases from traditional documents and electronic documents.

to the unresolved tasks of automating the processes of forming electronic files. In practice, it is performed manually, after making paper copies from the completed ED and in the future operating only with documents on paper. This nullifies the huge efforts to automate the organization's workflow, since at the output of the EDMS we are again dealing with paper documents that are manually distributed among cases according to its nomenclature of files.

Therefore, the automation of the now widely used routine manual actions of clerks and archivists for the distribution of completed documents on paper cases is an urgent task due to the lack of a unified scientific and methodological approach, the lack of effective algorithmic and software development, as well as the presence of a huge array of ED that has accumulated in the EDMS servers of the organization and requiring accelerated transfer to archival storage.

2 Methods

2.1 Statement of the problem of the formation of electronic files from ED

The process of forming electronic files from completed EDs consists in distributing a set of EDs between a set of electronic files in accordance with a finite set of common features (details) characteristic of all EDs included in one electronic file. In accordance with regulatory requirements, each case should include: case index, its name, start and end date, storage period in accordance with the List of typical archival documents with storage periods [5], article number of the departmental list of documents with their storage periods, name

structural subdivision to whose information field of activity the electronic file belongs, etc. "tuple which will unambiguously identify a specific electronic file, which will include this ED.

The scheme for recognition of ED attributes proposed in [6] (determining the values of tuple elements) begins with the definition of a set of knowledge areas (activity) in accordance with a given classifier, which include ED stored in the archive and newly arriving in the archive. The initial data are a list of standard documents with their storage periods, a nomenclature of cases for the current year, which corresponds to a certain set A of all electronic files in the archive A_{ij}, $1 \leq i \leq e$, $1 \leq j \leq j(i)$, where i - kind (number) of the classifier, $j(i)$ is the number of templates in the i-th classifier, e is a natural number corresponding to the number of classifiers, $e \geq 1$.

The set of electronic files A_{ij} combines all EDs compiled according to the template a_ij, related to the i-th classifier i (for example, "Foreign economic activity") and with the j-th type of electronic document template (for example, "Orders"), $1 \leq i \leq$, $1 \leq j \leq j(i)$, $e \geq 1$. Each case A_{ij} can belong to one of the knowledge areas (classifier) C_i from a certain set of knowledge areas C, which is represented as a union of classifiers of cases in each knowledge area, i.e. each field of knowledge has its own unique classifier: $C = \{C_1, C_2, \ldots, C_e\}$, $e \geq 1$, where each classifier $_i$ can be represented as a set (set) of EDs related to the i-th classifier with the j-th type of models (templates), $C_i = \{a_{i1}, a_{i2}, \ldots, a_{ij(i)}\}$, where $1 \leq i \leq e$, $1 \leq j \leq j(i)$.

To determine for each executed ED a specific electronic file, in [6–9] it is proposed to carry out the following sequence of actions. Initial data are set: nomenclature of files for the current year (set of cases A); criteria for attributing ED to a particular field of knowledge (classifier), as well as to a specific electronic file; requirements for the size of the electronic file (volume). Based on the initial data, a set of areas of knowledge is formed, according to the subject-matter and industry-specific features, and within the framework of the existing feature space, the executor distributes ED in electronic files.

Indeed, when the next ED is submitted for consideration, certain elements of its structure (metadata) are sequentially checked for compliance with one or another predetermined criteria (features) of referring to a specific electronic file, i.e. functions containing logical comparison operations and taking values 1 (true) or 0 (false) are executed, which in mathematical terminology are called "predicates". A predicate in programming is an expression that uses one or more values with a boolean result [10].

Based on the distribution results, appropriate marks are made in the ED accounting forms and details are formed, after which the ED is attached to the electronic file. However, in case of overflow of the memory allocated for a single electronic volume (file), they are automatically closed and the next volume of the file is formed. After the electronic file is closed, an automatic procedure for the formation and execution of its electronic inventory is performed.

We have proposed and substantiated the following approaches to solving the problem mentioned above:

- Transition from the language of predicate calculus to the function of distributing ED in electronic files and its advantage.

- Generalization of the ED distribution function for electronic files in the case of establishing more than 2 details.

- A new approach to solving the problem in the presence of an ED registration and control card.

3 Results

3.1 Mathematical model of function $F : D \to A$ distribution of ED in electronic files

The set of templates mentioned above, constituting the corresponding classifier, can be built as follows:

1. Denote by A the set of all electronic files in the departmental archive of the organization.
2. Denote by A_i the set of all electronic files from A related to C_i, that is, to the area of knowledge (classifier) with the number $1 \leq i \leq e$.

Assuming that each case in A satisfies the conditions for belonging to one and only one area, it is clear that $A = A_1 \cup A_2 \cup \ldots \cup A_e$.

Let with a fixed number of the i-th classifier (nomenclature), $1 \leq i \leq e$, the archive has a set A_{ij} files, where $1 \leq j \leq j(i)$, where $j(i)$ - the number of files in the i-th classifier. Then obviously, $A_i = \{A_{i1}, A_{i2}, \ldots, A_{ij}(i)\}$, $1 \leq i \leq e$. Thus

$$A = \begin{pmatrix} A_{11} & A_{12} & \ldots & A_{1j(1)} \\ A_{21} & A_{22} & \ldots & A_{2j(2)} \\ \ldots & \ldots & \ldots & \ldots \\ A_{e1} & A_{e2} & \ldots & A_{ej(e)} \end{pmatrix}. \tag{1}$$

For every file $_{ij}$, $1 \leq i \leq e$, $1 \leq j \leq j(i)$, which combines all EDs related to the i-th type of the classifier (nomenclature) and the j-th number of the electronic file in the set $_i$, enter a unique template a_{ij} (distracting from the structure of the template, in order to analyze the methodology, it can be considered a_{ij} the name of the template). Then, by definition, the classifier $_i$ consists of a set of predefined templates a_{ij}, т.е. $C_i = \{a_{i1}, a_{i2}, \ldots, a_{ij(i)}\}, 1 \leq i \leq e, 1 \leq j \leq j(i)$.

It is assumed that there is a set D of all executed ED, which includes incoming documents d, each incoming document d is placed in a single case from A, and criteria for assigning d to a particular area are set C_i, as well as to a specific electronic case, matching pattern a_{ij}, $1 \leq i \leq e$, $1 \leq j \leq j(i)$.

Let's introduce the distribution function of ED in electronic files $F : D \to A$, $F(d) = A_{ij} \in A$ for some i and j (which must be determined).

The presence of appropriate criteria allows us to set predicates P and P_y:

$$P(C_i, d) = \begin{cases} 1, & \text{если } d \text{ satisfies the criterion for classifying ED as } C_i \\ 0, & \text{otherwise} \end{cases}$$

and

$$P_y(a_{ij}, C_i, d) = \begin{cases} 1, & \text{if } d \text{ matches pattern } a_{ij} \\ 0, & \text{otherwise} \end{cases}$$

In [6], it is proposed to determine the value of the function $F(d)$ through the value of an appropriately constructed predicate P_M based on the already introduced predicates P и P_y, that is, based on the following equivalence:

$$F(d) = A_{ij} \iff P_M(i,j,d) - \text{true}$$

(or, which is the same, $P_M(i,j,d) = 1$, if, as usual, we assume that the value is true – это 1, a false – this 0)

In view of the fact that the explicit expression for the predicate proposed in this work P_M incorrect both syntactically and semantically (in a number of subformula members it is necessary to replace the predicates P и P_y on their negations, there is also confusion in the indices), below we have made the appropriate corrections in the work and given a specific type of predicate P_M to calculate the function value $F(d)$ distribution of the document, which, in turn, can undoubtedly simplify the mathematical calculations for the formation of electronic files and the definition of their metadata. At the same time, we immediately pass from the language of predicate calculus to the corresponding interpretation, which allows, without loss of generality, to consider P_M the function of its parameters, which takes values only 0 or 1, and the logical operation "and"(conjunction) corresponds to the usual multiplication.

To do this, note that the function

$$F(d) = A_{ij} \iff \begin{cases} P(C_l,d) = 0, & 1 \le l \le i-1; P(C_i,d) = 1; \\ P_y(a_{im}, C_i, d) = 0, & 1 \le m \le j-1; \\ P_y(a_{ij}, C_i, d) = 1 \end{cases}$$

where $1 \le i \le e$, $1 \le j \le j(i)$.

Labeling for convenience

$$Q(C_i,d) = 1 - P(C_i,d),$$
$$Q_y(a_{ij}, C_i, d) = 1 - P_y(a_{ij}, C_i, d)$$

(actually, it's a negation P и P_y respectively) and introducing the function

$$P_M(i,j,d) = \prod_{l=1}^{i-1} Q(C_l,d) \cdot P(C_i,d) \cdot \prod_{m=1}^{j-1} Q_y(a_{im}, C_i, d) \cdot P_y(a_{ij}, C_i, d),$$

defined on the set $= \{(i,j) | 1 \le i \le e, 1 \le j \le j(i)\}$, we see that this function takes the values 0 or 1 and only these values. Wherein

$$F(d) = A_{ij} \iff P_M(i,j,d) = 1.$$

The proposed model for finding the value of the distribution function $F : D \to A$ solves the original problem, however, compared to the original model, it is very simple and convenient for practical use in order to automate the procedure for generating electronic files (there is no need to use the apparatus of mathematical logic and graph theory).

If we denote

$$f = \max_{1 \le i \le e} j(i), N = e \cdot f,$$

then it is obvious that the number of operations of the ED selection algorithm has $O(N)$ time complexity,), that is, of polynomial complexity, and therefore, it is well implemented (in terms of speed).

Thus, by implementing a sequence of operations for binary (paired) comparison of the metadata of an electronic document within the existing feature space of features, we distribute each ED over a maximum of N electronic files.

3.2 Generalization of the distribution function model $F : D \to A$ in case of more than 2 details

Note that the technique considered in [5] makes it possible to match a specific ED with a specific number of an electronic file based on the results of recognizing two features: 1) the number of the classifier, 2) the type of the ED template. However, in practice, the solution of the desired task of distributing ED in electronic cases requires the establishment of a larger number of features, such as the details of the types of formalized models (templates), areas of knowledge (classifiers), articles of the List of standard documents with retention periods, retention periods, structural unit numbers, etc.

We noted above that the symbols a_{ij} serve as template names, where $1 \le i \le e, 1 \le j \le j(i)$. This allows you to determine whether the document belongs to the case number j in the knowledge area C_i, i.e. (due to the one-to-one correspondence a_{ij} and A_{ij}) to the file A_{ij}. In fact, for obtaining more detailed information or for the purpose of further ordering, these symbols alone, of course, are not enough. To be able to do this, we propose (in line with the arguments already given) to slightly improve the methodology.

For simplicity, we will assume that there is one more sign (props) of an electronic document and there is an appropriate criterion for classifying this document in some part of the electronic file A_{ij}. This means that we must "divide"the file A_{ij} subsection according to the attribute values. We enumerate (encode) all possible values (or absence) of this feature (props) by natural numbers from 1 to k. Then it is obvious that every file A_{ij} splits into k subdivisions (moreover, some of them may be empty, i.e., do not contain documents at all).

In accordance with the above, we will make some changes to our model, namely: Every file A_{ij} is a set of subfiles $A_{ij} = \{A_{ij1}, A_{ij2}, \ldots, A_{ijk}\}$, where A_{ijs} consists of documents d with attribute value code equal to s.

Let us designate the criterion for attributing an electronic document d to a specific attribute code r, i.e. set the predicate

$$S(r,d) = \begin{cases} 1, & \text{if attribute code in document } d \text{ is equal to } r, \\ 0, & \text{otherwise,} \end{cases}$$

where $1 \le r \le k$ an denote $T(r,d) = 1 - S(r,d)$.

$$R(i,j,p,d) = P_M(i,j,d) \cdot \prod_{q=1}^{p-1} T(q,d) \cdot S(p,d),$$

defined on the set $= \{(r,i,j) | 1 \le r \le k, 11 \le i \le e, 1 \le j \le j(i)\}$, we see that this function takes the value 0 or 1 and only these values.

Along with the function F, we can introduce its "modernized" analogue, i.e. function $G : D \to A$, s.t. $G : d \to A_{ijs}$. Then

$$G(d) = A_{ijp} \iff R(i, j, p, d) = 1.$$

The generalization of the ED distribution function model to the case of several features is quite obvious. Thus, it is possible to continue expanding the ED distribution function for electronic files on a finite set of cases, according to the nomenclature of the organization's files, which will significantly simplify the solution of the initial problem of ED distribution and, accordingly, can serve as a mathematical tool for automating the formation of electronic files in the EDMS.

3.3 A new approach to automating the formation of electronic files in the EDMS.

The method proposed in [7] for automatically generating electronic files from ED obtained by scanning completed paper documents allows you to automatically set the number of an electronic file by sequentially recognizing (determining) a set of ED details in the form of a metadata tuple. Thus, the task of forming electronic files of the EDMS is reduced to determining the set of ED-in, the details of which will correspond to the values of the elements of the tuple describing the electronic file. This means that the intellectual activity of officials of a state governing body or a state institution to determine "their"electronic file for each executed ED is modeled and automated in the form of a sequence of procedures for recognizing the details (metadata) applied to the ED, determining the type of formalized ED, determining the structural unit (official) to whose zone of informational responsibility the ED belongs, the articles of the standard list of documents with retention periods to which the ED belongs, the definition of its storage period and, finally, the nomenclature of electronic files.

It should be noted that this technique [7] does not take into account the main feature of the functioning of modern EDMS, in which the origin of each ED (accounting, registration) is accompanied by the creation of its registration and control card (RCC), which contains a number of its important details. The presence of the RCM ED, which is filled in from the moment of registration of the ED, greatly facilitates the task of automating the formation of electronic files from the ED, since the RCM from the very beginning indicates the number of the responsible structural unit and the number of the electronic file to which this ED belongs, i.e. case index, type of document, etc. However, in practice, in many cases, the RCC, as a rule, cannot knowingly contain the article number from the List of standard documents with retention periods, the retention period, and some other ED details. In this case, to ensure the completeness of the data in the RCC, one can resort to the method proposed in [7] in order to establish the exact values of the missing details.

4 Discussion

The paper develops and simplifies the approach to automating the formation of electronic files in the EDMS, considered in [6]. For further development of the approach under consideration, it is necessary (by analogy with the technique proposed in [7]) to establish the optimal structure of templates a_{ij} (in terms of the names of the corresponding attributes) and specify

the attribute of the document d belonging to the knowledge area (classifier) $_i$, which is obviously equivalent to knowing explicit form of the predicates P_y and P.

5 Conclusion

The paper proposes a mathematical model for the problem of generating electronic files from ED, which boils down to sequential recognition and establishment of a complete set of details and registration data for each completed ED, i.e. "tuple which will unambiguously identify a specific electronic file, which will include this ED.

The proposed model for finding the value of the distribution function $F : D \to A$ solves the original problem, however, compared to the original model (from [6]), it is very simple and convenient for practical use in order to automate the procedure for generating electronic files, while there is no need to use the apparatus of mathematical logic and graph theory. If

$$f = \max_{1 \le i \le e} j(i), N = e \cdot f,$$

then the number of operations of the ED selection algorithm is $O(N)$, that is, polynomial complexity, and therefore, it is well implemented (in terms of speed).

Thus, by implementing a sequence of operations for binary (paired) comparison of the metadata of an electronic document within the existing feature space of features, we distribute each ED over a maximum of N electronic files.

The generalization of the ED distribution function model to the case of several features is quite obvious. Thus, it is possible to continue expanding the ED distribution function for electronic files on a finite set of files, according to the nomenclature of the organization's files, which will significantly simplify the solution of the initial problem of ED distribution and, accordingly, can serve as a mathematical tool for automating the formation of electronic files in the EDMS.

Known methods for the automated generation of electronic files from ED obtained by scanning completed paper archival documents are based on the sequential determination of details, when at the final stage the index of the file is determined, where the executed ED will be distributed. However, in modern EDMS, the index (file number and responsible structural unit) of the electronic file is known, but a number of important details may be missing. In this case, the application of the methodology we propose and its mathematical apparatus gives an adequate and efficient solution to the desired problem.

References

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