Search Method Based on Figurative Indexation of Folksonomic Features of Graphic Files

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Abstract – **In this paper the search method based on usage of figurative indexation of folksonomic characteristics of graphical files is described. The method takes into account extralinguistic information, is based on using a model of figurative thinking of humans. The paper displays the creation of a method of searching image files based on their formal, including folksonomical clues.**

Keywords – **Search, method, figurative indexation, folksonomy, graphic files, Internet.**

1. Introduction

Exponential scale of growth of the Internet has made the issue of searching for information to be an important part among the most popular services of world wide web. Today, searching for a category of data that belongs to the "heavyweights" - graphical, audio and video files is especially important.

In recent years, folksonomical methods [1] have started to be applied to search for multimedia content, based on independent and voluntary description of particular media resources using verbal labels (tags). If we consider only the technical and technological aspects of folksonomical approach, it is worth to mention the following advantages:

- Low-cost way of implementation, which stems from motivational component – each media resource provider, that is also a user of the system, is interested in adequate reflection of his own media files.
- Intuitive visual representation of the overall results of folksonomy using the font size to represent the words in a tag cloud [2].
- Easy and quite effective method of search, based on intersection or union of elements of sets of tags (key words).

But advantages of folksonomy are the source of its drawbacks at the same time. The most significant limitation lies in direct dependence of the relevance of search results on the credibility of initial description of each resource based on a subset of tags, which is usually not checked in practice. Additionally, the verbal nature of tags leads to well-known issues in computational linguistics, such as polysemy of words, invariance of meaning of natural language constructs based on morphological and syntactic forms, etc. [3]. Since all these problems are not difficult for humans, it is necessary to develop a method of reliable search for image files in the repository of multimedia data, with support of folksonomy.

The idea of creating a method, which takes into account extralinguistic information, is based on using a model of figurative thinking of humans [4], which provides figurative indexing of natural linguistic information [5]. Imitation of the process of ontogenesis of formal system is achieved this way. The method is supposed to formalize the notion of the search space [6] and to build a vocabulary of linguistic images in its universe as a semantic network (ontology) of the set of tags. With this approach a subset of keywords to describe each resource can be automatically derived from its name, and associative links between linguistic syntagmatic type images are taken into account in the search results.

Thus, the research problem is to create a method of searching image files based on their formal, including folksonomical clues (hints), which provides figurative indexing and ontogenetical accumulation of information about the associative links between clues.

2. The ontogenetic system and linguistic images

Let us consider a system, which will be called ontogenetical from now on, in terms of formal characteristics of its functioning [6]. Suppose that S is able to recognize patterns of an infinite set $I = \{i_1, i_2, \dots, i_n, \dots\}$, similarly to how a human recognizes the gestalt. The ontogenetical system (OS) also accepts associative links between pairs of images as elements of the set $\omega \in \Omega$, where $\Omega \subseteq I \times I$ is an arbitrary set (space) of organized (associative) pairs. To determine figurative constructions (FC) we shall apply the concept F of sigma-algebra (σ-algebra) of subsets of Ω. Further we shall consider any subset a FC $\gamma \subseteq \Omega$, which has the property $\gamma \in F$. If, according to the properties of σ-algebra [7], of a set $A, B \in F$, then merger, intersection and odds of A and B in the theoretical-set sense also belong to F.

Assume that the system exchanges information with the external world as a black box exclusively as FC, to be used to distinguish the sequence of input events $X = \{x_1, x_2, ...\}$ and a set of figurative reactions of the system $Y = \{y_1, y_2, ...\}$, with $x_i \in F$, $y_i \in F$. Figure 1 shows the FC in the most general model of human mental activity: a set of stream images X is continuously sent from an external "black box" to the input, which signal about the current conditions of existence of the system, with the stream images Y providing viability under these conditions [8].

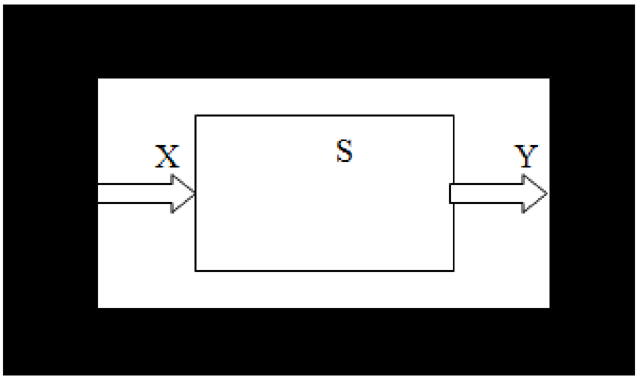

Figure 1. The scheme of ontogenetic model

Pattern recognition by humans occurs through a set of certain signs, as a result of cognitive activity and related processes of reflection in the consciousness of objects and phenomena of objective reality [4]. So, the image is a steady imprint in the human brain (neural model) of a fragment of reality (external stimulus). Formal features of images may have different nature depending on the sense organs through which they have been perceived by a human. Introspective analysis shows that the most bright images combine elements of all 5 available components: visual, sound, smell, touch and taste [4]. Actually the process of recognition absolutely doesn't require the entire set of features, it is sometimes enough to use quite a few elements of a set of potential features, but only one of them is crucial for image recognition, for example, characteristic odor. But the fact of understanding of the recognized image (animate and inanimate objects, phenomena, events, etc.) denotes a transition to a higher degree of formalization, as there is a language equivalent of the image in the form of verbal features.

It is clear that to search image files from ontogenetic model, the considered formal features of images can only be of 2 types: graphical, that is the result of analyzing images, and verbal, from the folksonomic descriptions of this image. Due to the complexity of construction of formal models of distinguishing of visual images from a pixel image [9], the main attention will be focused on folksonomical signs. Thereby in the offered method of search the most difficult part of picture processing is assigned to a human expert, who recognizes the images in it and describes them using verbal tags or file name. However it is necessary to admit that the suggested approach requires to control the relevance of initial folksonomical data, which is not always possible to provide in real conditions of maintaining large graphical repositories.

To analyze the folksonomical data we will introduce the notion of linguistic image (LI), which is different from others by the most unique symbolic feature. It is proposed to choose the root word as this sign , with the concept LI not solving the problem of polysemy of words of the language, but the core features significantly reduce the search space. Thus, we assume that LI is a set of one root words that characterize the image, based on morphemic classification [10]. This concept is more general then synset [11] of the famous WordNet, vocabulary entries or lexeme [12], in the form which concepts in the ontology are laid. The proposed approach provides morphemic classification and cluster principle of organization of LI dictionary.

Further we will formalize the notion of folksonomical data using a subset of LI, available for human perception, which will be presented using four key content concepts:

$$I' = < N; O; M; Q' >, \quad (1)$$

where N – notion, O – object, M – method, Q' – quality.

In its turn, detailing the basic concepts leads to the appearance of such concepts:

$$N = < ON; QN; MN >, \quad (2)$$

where ON – notion of an object, QN – notion of quality, MN – notion of a method;

$$Q' = < OQ,\ MQ >, \quad (3)$$

where OQ – quality of an object, MQ – quality of a method;

$$M = < Ev; C >, \quad (4)$$

where Ev – event (process), C – condition;

$$MQ = < H; T; L >, \quad (5)$$

where H – circumstance (the answer to the question how?), T – circumstance of time (the answer to the question when?), L – circumstance of place (answer to the question where?).

Interrelation between considered basic concepts of LI (1)–(5) in a form of a tree graph are shown in figure 2.

Appearance of of such of basic concepts of (components of LI) is explained by consideration of significant, those that always have defined meaning, parts of speech [13]. 5 meaningful concepts of LI which have resistant reflections in such parts of the language as an adjective, noun, verb and circumstance are indicated with gray color on the graph on figure 2. The concept of an image (N) is added to the selected five conceptual components to demonstrate the unity as visual-subject (syntagmatic) and abstract (paradigmatic) attributes of linguistic images.

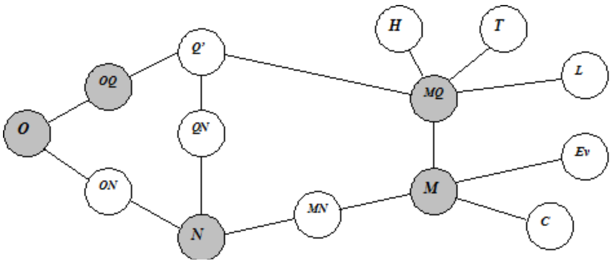

Figure 2. Graf tree of relationships of basic concepts of LI

Formally, the event is part of the set FC $Ev \in \gamma$ with certain restrictions on the number of images (7±2) and connectivity, which will be discussed later. While the verbal activity event has a syntagma as its analogue [4], which is usually describing an event in the form of a simple narrative sentence. We formalize interrelation between the concepts event – syntagma–sentence on the basis of introduction of the concepts of a structure of linguistic images (SLI) and natural language structures (NLC). Under the notion of SLI, we mean a subset LI$\gamma \subset \gamma'$, which includes only linguistic images. Then we consider an element of the set $Sy \in \gamma'$ a syntagma. NLC –it is a subset of SLI, elements of which are taken from the word, considering morphological and syntactic rules of of certain natural language.

Table 3. shows the results of formal combination of imaginative concepts with components of SLI and NLC.

Table 3. Interrelation of formal concepts of figurative analysis of NLC

F – σ-algebra of subsets from $\Omega \subseteq I \times I$				Lexical relations
↕				↕
FC: $\gamma \in F$	↔	SVI: $\gamma' \subset \gamma$	↔	NLC
↕		↕		↕
Event: $Ev \subset \gamma$ ($x_i \in X$, $y_i \in Y$)	↔	Syntagma: $Sy \subset \gamma'$	↔	Sentence
↕		↕		↕
Associative pair: $\omega \in \Omega$	↔	Meaning connections: $\omega' \in I' \times I'$	↔	Word combination
↕		↕		↕
Image: $I = \{i_1, i_2, ..., i_n, ...\}$	↔	VI: $I' \subset I$, $I' = \langle N; O; M; Q' \rangle$	↔	Word

The suggested approach revealed a relationship between significant conceptual notions of ontogenetic system and constructs of lexical processor through the new definitions of LI, meaning connections, syntagma and SLI. To formalize the lexical constructs, marked by the color, NLC–sentence–word combination–wordmorphological, syntactic and semantic relations considering priority bases shaped ontogenetic model should be applied.

3. Fuzzy relation of meaning

Let's construct the space for processing folksonomic data on the basis of binary fuzzy relation

$$Q = \{< i_l, i_j >, \mu_Q(< i_l, i_j >)\}, \qquad (6)$$

Where $\mu_Q(< i_l, i_j >)$ is a membership function of the fuzzy relation, defined as the reflection $\mu_Q : I \times I \rightarrow [0,1]$.

We'll apply binary fuzzy relation (6) as ontogenetic characteristic of a set Ω, while its membership function can be considered a natural numerical measure of meaning. In accordance with [14], the value $\mu_Q(< i_l, i_j >) = 1$ will be called a unit of size of Saw (Syntagmatic association weight). Besides, the word Saw (the second form of irregular verb to See) can be interpreted as «seen» and, this way, points to a figurative way of the emergence of meaning in the cognitive system. With this approach the meaning of an element (l, j) of a matrixi A_Q or the k-arc $e_k = < v_l, v_j >$of the graph G depends on the statistical occurrence of relation for cortege $< i_l, i_j >$ during the observation time L of incoming FC. So, in general, we define membership function (baseline) of the fuzzy relation sense for the pairs of images, as

$$\mu_Q(< i_l, i_j >) = f(k_{lj}, t_L), \quad (7)$$

where k_{lj} is the number of recorded by ontogenetical system connections between l- and j- images for the moment of time t_L. Additionally relation of meaning must consider the following important properties of IS, as an emotional state, needs (motives) and reflexes or other useful for OS operation results of external teaching.

According to the tasks of figurative indexing we will detail the membership function, which generates a binary fuzzy relation of meaning (6) in the following four serial levels, built on the basic one (7):

1. The level of probabilistic forecasting – in order to ration the membership function in the

interval [0,1]. It is provided the calculation of statistical evaluation λ (mathematical expectation): if $k_{\Sigma} = \sum_{l=1}^{n}\sum_{j=1}^{n} k_{lj}$, and m – the number of non-zero elements of the matrix A_Q, then $\lambda = k_{\Sigma}/m$ – in this case we will apply the known sigmoid function

$$\mu_Q(< i_l, i_j >) = f(k_{lj}, t_L) = 1/(1 + e^{-k_{lj}+\lambda}). \quad (8)$$

As a result of normalization there appears a characteristic property of the membership function obtained by using the ontogenetic method – the average value $\overline{\mu_Q} = \frac{1}{m}\sum_{j=1}^{m}\mu_{Qj} = 0{,}5$.

2. The level of consideration of emotional state – the ability to consider a binary model of emotions of IS due to index $\mu = \{\dots, -2, -1, 1, 2, \dots\}$ is introduced, then

$$\mu_Q(< i_l, i_j >) = f_2(k_{lj}, \lambda, \mu) = 1/(1 + e^{-\frac{-k_{lj}+\lambda}{|\mu|}}) \quad (9)$$

With $\mu = -1_{\vee}1$ emotions do not affect the meaning of the functioning of IS and the membership function (9) degenerates to the function (8). Increase of the index μ symmetrically smooths the sigmoid function f_2, what is shown on the figure 4.

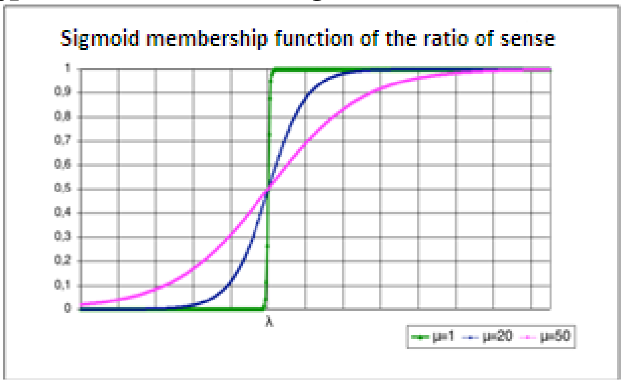

Figure 4. Influence of the μ index on the membership function (9) of meaning relation

3. The level of consideration of motivational component based on images - needs centers is suggested to consider to be a model of motive of infological system in the moment of time t_L achieving the image - needs center j', and calculate the dispersion and mean square deviation of observation results k_{lj} as $D = \frac{1}{m}\sum_{l=1}^{n}\sum_{j=1}^{n}(k_{lj} - \lambda)^2 \big| k_{lj} > 0$ and $\sigma = \sqrt{D}$.

Then, depending on the extent of approximation r of a pair of images $< i_l, i_j >$ to j', the function (9) can be shifted to the left along the abscissa decreasing mathematical expectation for this pair $\lambda_{lj} = \lambda - r \cdot \sigma$, where $r = \{0,1,2,3\}$, eventually we have:

$$\mu_Q(< i_l, i_j >) = f_3(k_{lj}, \lambda_{lj}, \sigma, \mu, i') = 1/(1 + e^{-\frac{-k_{lj}+\lambda_{lj}}{|\mu|}}) \quad (10)$$

The approach involves the application of a specific algorithm to determine the degree of approximation r of a pair $< i_l, i_j >$ to the need-image j', example:

a) if $j = j'$, then $r = 3$, else
b) if $\exists e_k \in E | e_k = < v_j, v_{j'} >$, then $r = 2$, else
c) if $\exists e_k \in E | e_k = < v_l, v_{j'} >$, then $r = 1$, else $r = 0$.

4. The level of consideration of reflexes and the results of external teaching – it is suggested to record the statistics of results of figurative reaction y_i' on the input FC x_i' with motivational goal i' as a change of emotional parameter $\Delta\mu$ in OS. Then, provided the previous experience of similar situations $< i', x_i' >$ for a specific subset of pairs $e_{lj} \in E'$, where $E' \subseteq y_i'$ increase or decrease of mathematical expectation is applied $\lambda_{lj} = \lambda \pm r \cdot \sigma$. Choice of $r = \{0,1,2,3\}$ depends entirely on the sign and value of $\Delta\mu$ and requires a separate algorithm, and the membership function will look like:

$$\mu_Q(< i_l, i_j >) = f_4(k_{lj}, \lambda_{lj}, \sigma, \mu, i', x', \Delta\mu) = \frac{1}{1 + e^{-\frac{-k_{lj}+\lambda_{lj}}{|\mu|}}} \quad (11)$$

It should be noted that, in contrast to (8) and (9), at higher levels of the membership function of meaning relation (10) and (11) as a result of local displacements of mathematical expectation property $\overline{\mu_Q} = 0{,}5$ disappears, what, according to the authors, says about the appropriate formal interpretation of the known facts about the psychology and physiology of conflicts between generally accepted (average) meaning and actions influenced by strong motives or individually acquired reflexes.

4. Space with a measure for the figurative indexation

Consider the possibilities of axiomatization space with scale based on the proposed fuzzy relation of figurative meaning Q. It is known that the the set function $m: P(X) \rightarrow R^+$, which satisfies the following three axioms [8], is called the scale:

1. $\forall A \subseteq X \Rightarrow m(A) \geq 0, m(\emptyset) = 0$.

2. $A \subseteq B \Rightarrow m(A) \leq m(B)$.
3. If $A, B \in P(X)$ and $A \cap B = \emptyset$, then $m(A \cup B) = m(A) + m(B)$,

where $P(X)$ is a set of all subsets X (σ-algebra), $R^+ = [0, \infty]$ is a set of positive real numbers.

With $R^+ = [0,1]$ these axioms define a probability measure, which is based on the basic concept of the event with the possibilities of experimental verification In the theory of fuzzy measures, instead of event the notion of subjective degree of confidence of a man in this event is used, which is also convenient to be limited by the interval $[0,1]$. Generalization of the notion of measure makes it possible to avoid the restrictive requirement of additivity, provided by well-known λ-fuzzySugeno measures to determine the extent of necessity, trust, credibility, possibility, etc. [15].

According to the concept of figurative meaning of OS and modeling of its cognitive activity figurative sense space cannot be limited by a measure on the interval $[0,1]$. Despite the fact that the teacher-expert puts a mark to a student using any system of knowledge assessment based on personal subjective level of confidence, but the object of comparison for him when determining the mark is his own knowledge. Thus, the results of cognitive activity have the property of unlimited or limited by physical corporeality of growth, and corresponding sense-parameter will be measured on $R^+ = [0, \infty]$.

We take the triple (Ω, F, Se), as the space for imaginative indexation of folksonomical data with fuzzy measure of sense $Se: F \rightarrow [0, \infty]$, where Se – fuzzy measure of sense that defined on the basis of the following axioms:

1. $\forall \gamma \subseteq \Omega \Rightarrow Se(\gamma) \geq, Se(\emptyset) = 0, Se(\Omega) \leq \infty$.
2. $\forall \omega \in \Omega \Rightarrow Se(\omega) \leq 1, Se(\omega) = \mu_Q(\omega)$.
3. If $\gamma_1, \gamma_2 \in F$and $\gamma_1 \subseteq \gamma_2$, then $Se(\gamma_1) \leq Se(\gamma_2)$ (monotony).
4. If $\gamma_i \in F$, where $\{\gamma_i, i = 1,2, \ldots\}$ is a monotonous sequence $\gamma_1 \supseteq \gamma_2 \ldots \supseteq \gamma_i \supseteq \cdots$, then $\lim_{i \to \infty} Se(\gamma_i) = Se(\lim_{i \to \infty} \gamma_i)$ (continuity).
5. If $\{\gamma_i\}_{i=1}^{\infty} \in F$ – countable family of sets of F, which pairwise do not intersect, namely $\gamma_i \cap \gamma_j = \emptyset, i \neq j$, then $Se(\bigcup_{i=1}^{\infty} \gamma_i) = \sum_{i=1}^{\infty} Se(\gamma_i)$ (σ–additivity).

The proposed measure Se is considered to be σ-finite, because there is a countable family of sets, which is measured $\{\gamma_i\}_{i=1}^{\infty} \in F$, with $Se(\gamma_i) < \infty, i \in N^+$ and $\Omega = \bigcup_{i=1}^{\infty} \gamma_i$, where N^+ – is a set of positive natural numbers. Usage of σ–finite measure Se leads to the fact that all the space of sense can be represented as a countable union of sets, which is measured on the basis of finite measure. On the basis of the axiom 5 we define the definition 1: if FC x and y intersect, then $Se(x \cup y) = Se(x) + Se(y) - Se(x \cap y)$.

We will show that the possibility of sense representation in a numeric form also allows us to consider the space of ordered pairs of images Ω as topological and quasimetric. The space of associative pairs Ω is topological, since the set F of its subsets is the topology on Ω, for which the conditions are satisfied [16]:

1) $\Omega \in F, \emptyset \in F$ – the set Ω and the empty set belong to F;
2) Association and intersection of a random family of sets belonging to F, belongs to F (according to the properties of σ–algebra).

The space of associative pairs Ω is a quasimetric space [16], since any two elements $\omega_i, \omega_j \in \Omega$ are associated with a non-negative number q such that $q(\omega_i, \omega_i) = 0$, and for any triple $\omega_1, \omega_2, \omega_3 \in \Omega$ we have the inequality of a triangle $q(\omega_1, \omega_3) \leq q(\omega_1, \omega_2) + q(\omega_2, \omega_3)$ provided that quasi-distance $q(\omega_i, \omega_j) = |Se(\omega_i) - Se(\omega_j)|$.

The space Ωcan not be considered a metric space, the condition that $q(\omega_i, \omega_j) = 0$ is not satisfied if and only if $\omega_i = \omega_j$.

Also, it is easy to show that the set FC of F is also a quasi–space with quasi–distance q.

5. Technology of implementation of a method of search

Let us consider the possibility of constructing the technology of search of folksonomical data in the quasi-metric and the topological space of pairs of VI $\omega \in \Omega$ та SLI $\gamma \in F$ [6]. We will consider only words denoting tags, category and name of an image file that corresponds to each image, to be the initial data for searching. If no other information for the image indexation of offolksonomical data is not used, then there is an intermediate task of creating a vocabulary of linguistic images and accumulation of primary syntagmatic relations between them according to (8).

We assume that dictionary of LI is built as a result of primary processing of folksonomic lexical material and each word corresponds to one of linguistic images. More simple case is the so-called "tags cloud" that characterizes each image. It can be considered with sufficient certainty that all the links of the type "each with each" to be links between LI in this case. A more difficult case is the definition of links between words in the name of a picture. It is clear that you can qualitatively solve this problem by applying a parser of the natural language, which describes the image, but this approach has some difficulties, especially for flexion languages.

As the name of an image, usually consists of a small number (2÷4) of meaningful words, that's why it is proposed to adopt such a limiting of a method of search - the links are fixed a) between adjacent words of the name and b) between every word of the name and the keyword of a category of a picture. Thus is a word is considered to be meaningful if it corresponds to the linguistic image from the dictionary, and in case b) taken into account if there is an expert confirmation of the keyword of a category. Thus, while determining the primary syntagmatic relations between linguistic images function words, pronouns and prepositions not taken into account. In view of these constraints, such technology of implementation of a method of finding graphics is offered [17]:

a. Get output data from multimedia repository as the relation $Pictures \subset Id_p \times Picture \times Category \times URL$, where the attributes are $Picture, Category \in (I|F)$.

b. By isolating meaningful words, sorting and avoidance of them duplicating the attributes $Picture$ and $Category$ create a relation $Words \subset Id_w \times Word \times Id_p \times Id_i$, where Id_p is an identification attribute of the relationship $Pictures$, a Id_i is an identification attribute of the relation for a linguistic images repository $Images$.

c. Create the relation $Images \subset Id_i \times Image \times Category \times Quality_0 \times Object \times Notion \times Method \times Quality_m$ by combining all identical words from the relation $Words$.

d. Combine the words from relation $Images$ by expert or programmatical way and determine the composition of the relation $Stems \subset Id_s \times Stem \times Quantity$, while filling the attribute Id_i for $Words$.

e. Create the relation $Construct \subset Id_c \times Id_t \times Id_{wl} \times Id_{w2} \times Id_p$ for fixing the relations in the names and $Twice \subset Id_t \times Id_{i1} \times Id_{i2} \times Weight$ for the accumulation of their power.

f. For each pair of adjacent words and a pair title word is a keyword of category of each cortege of $Pictures$ create a cortege in $Construct$ with reference to a new or existing cortege in $Twice$ for the corresponding pair of LI. Value of the attribute $Twice.Weight$equals the number of links from the relation $Construct$.

g. Decompose the verbal request into LI and select all the files, in the names of which they occur; organize the list by the sum of $Twice.Weight$ for pairs of LI.

After implementation of this method with PHP-MySQL technology a database of folksonomical data in 6 tables is created, an example of filling of which is shown in figure 5.

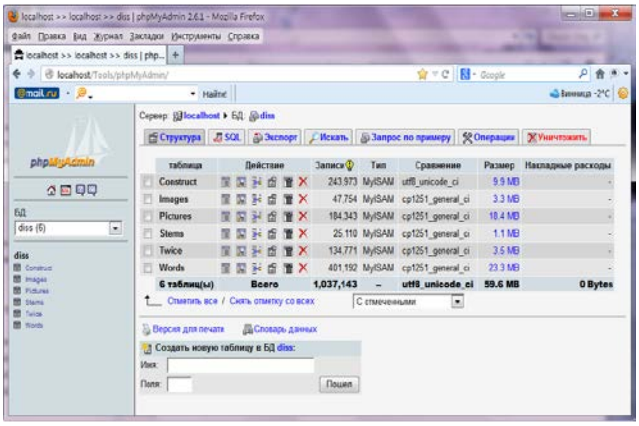

Figure 5. Base of folksonomical data for search

It is offered to put a 4-level classification of quality of a separate search result - excellent / good / satisfactory / unsatisfactory, as the basis of the assessment methodology of the relevance of search results that requires the use of expert methods. By revision of each detected image of a particular verbal request expert puts a quality grade for standard (built into the system) approach by mask of words and intellectual search through figurative indexation of folksonomic data in the space (Ω, F, Se). We get the analysis of the relevance by comparing the evaluations of quality for the two approaches in a graphical representation of three-dimensional diagrams for certain categories of verbal requests in order of presentation of search results.

6. Experimental research

The software experiment for testing of suggested method is carried out for graphical resources, freely available on the site (http://www.bankoboev.ru/). Operating constraints, defined in the plan of the experiment, are as follows:

1. Due to the commonly used in this repository laconism for description of image, pairs are adjacent words of titles.
2. Pronouns, prepositions and function words are not taken into account in the search.
3. The number of images with the corresponding description is limited by 47754 files from this site, belonging to 71 categories (Figure 5).
4. Informational technology generalizes the words in russian into linguistic images on the basis of standard features of the linguistic package NLTK Stemmers (http://nltk.org/api/nltk.stem.html#module-nltk.stem.snowball).

Initial evaluation of the relevance of search results $EvRe_i$ was carried out independently by 3 experts, using a 4-level scale: 3 – excellent, 2 –good 1 –satisfactorily, 0 –poor. The evaluation was obtained for 50 first results of 10 inquiries, half of which consisted of 3 meaningful words, the other half –of 4 ones. Further you can see the examples of comparison of the proposed and standard image searches for 4 requests with the worst / best results for 3 and 4 words, for example «Леснаярекаосенью». On the basis of the averaged for 3 experts evaluations of the relevance of search results for selected requests, additionally it was determined the binary evaluation $BiEv_j$ and the evaluation of accuracy $EvAc_i$ of each i-result using the formulas:

$$BiEv_i = \begin{cases} 1, EvRe_i > 1 \\ 0, EvRe_i \le 1 \end{cases},$$

$$EvAc_i = \frac{1}{i}\sum_{j=1}^{i} BiEv_j,$$

And also a total accuracy $Ev_{\Sigma} = \frac{1}{N}\sum_{i=1}^{N} EvAc_i$, where *N* is the overall number of marks.

Example of comparison of the obtained results in a graphical representation is depicted in figure 6.

Figure 6. Request – 3 words with the least improvement in accuracy of search

The results of the program experiment revealed that the improvement of accuracy lays between 5.9% and 11.7% for queries with 3 words and between 25.8% and 29.7% for queries with 4 words. Thereafter the completeness of search increases from 14.3% to 28.2% for queries with 3 words and from 17.4% to 95.5% for queries with 4 words. Thus, increasing of the number of significant terms in the query improves image search results in the accuracy and the completeness. Average improvement of accuracy for all results of search was 18.3%, and increase in completeness of search was 38.8%.

7. Conclusion

The paper considers the theoretical and technological peculiarities of the new method of search of image files in the repository of multimedia data. The method is based on figurative indexation of folksonomic attributes of corresponding images, provided by formalization of concepts of ontogenetic system, linguistic image and by construction of space with the measure on the basis of fuzzy relation of meaning. It is suggested to use the algorithm of technological implementation of approach in a system supporting folksonomy and methodology for assessing the relevance of search results. Experimental investigation of the suggested method in comparison with existing analogues confirmed the improvement of image search results in accuracy and completeness by taking into account the strength of the accumulated associative links between LI.

Further development of the suggested method of searching image files can include:

- Analysis of files content that is relevant to the search results in order to identify common graphical features for a LI or SLI;
- Combined use of folksonomic attributes of and linguistic images in algorithms of search.

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