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Formal Languages Generation in Systems of Knowledge Representation Based on Stratified Graphs

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Abstract. The concept of stratified graph introduces some method of representation which can be embedded with an interpretation mechanism in order to obtain objects from some knowledge domain based on the considered symbolic graph-based representations. As it was defined in the literature, the inference process uses the paths of the stratified graphs, an order between the elementary arcs of a path and some results of universal algebras. The order is defined by considering a structured path instead of a regular path. In a previous paper the concept of system of knowledge representation was defined. It includes a stratified graph G, a partial algebra Y of objects, an injective mapping that embeds the nodes of G into objects of Y and a set of algorithms that takes pairs of objects from Y to get some other object of Y. In this paper the inference process defined for such a system of knowledge considers the interpretation of the symbolic elements of a stratified graph as formal language constructions. The concepts introduced in this paper can initiate a possible research line concerning the automatic generation mechanism for formal languages.

Key words: graph-based representation and reasoning, formal language generation, accepted structured paths.

1. Introduction

We can distinguish the following two research directions concerning the implications of graph-based theory into knowledge representation: conceptual graphs (Sowa, 1976), Sowa (1984) involve the usage of first-order logic into graph theory; labeled stratified graphs (Ţăndăreanu, 2000) and semantic schema (Ţăndăreanu, 2004a). The last two concepts were obtained by applying the methods of universal algebras to graph theory. For other details regarding graph theory and some of their applications, the reader is referred, for example, to Aho and Ullman (1955) Bang-Jensen and Gutin (2000), Berge (1967), Biggs (1993), Flaut and Ghionea (2008), Godsil and Royle (2001), Grossman (2002), Ore (1962), Pop and Negru (2002).

The conceptual graphs are formal knowledge representations provided with reasoning operations which are sound and complete with respect to deduction in first order logics (Sowa, 1984). The formalism takes the visual properties of the semantic nets and also the semantic aspects of these networks. Basically, a conceptual graph is a bipartite labeled oriented graph such that: each node is either a concept or a relation between two concepts; the arcs are not labeled; concepts have only arcs to relations and vice versa.

Same as conceptual graphs, the labeled stratified graphs are based on labeled graphs. Still, there are some important differences between these structures. The concept of the labeled stratified graph is entirely an algebraic one, and not logic as in the case of conceptual graph (conceptual graphs are usually considered as visual concepts for logic). The mathematical apparatus of labeled stratified graphs uses concepts from universal algebra: Peano algebra, partial algebras, morphism of partial algebras.

Up to this point various mechanisms were developed in order to define and generate formal languages such as: finite automata (Hopcroft *et al.*, 2000; Xavier, 2005), regular expressions (Hopcroft *et al.*, 2000), formal grammars (Hopcroft *et al.*, 2000), Lindenmayer systems (Prusinkiewicz and Lindenmayer, 1990), etc. A formal language consists of a non-empty set of words which are finite strings of letters, symbols, or tokens. The set from which these letters are taken is named the alphabet of the language, over which the language elements are constructed.

The method of knowledge representation based on stratified graphs was successfully applied in various domains such as: semantics of communications and image synthesis (Ţăndăreanu, 2004b), reconstruction of a graphical image by extracting the semantics of a linguistic spatial description given in a natural language (Ţăndăreanu and Ghindeanu, 2003, 2004), knowledge bases with output and their use to the scheduling problems (Ţăndăreanu, 2000).

In this paper we continue the research line initiated in Tudor (2011) concerning the use of the accepted structured paths to generate formal languages. In our approach we endowed the concept of System of Knowledge Representation based on Stratified Graphs (Dănciulescu, 2013) with formal language interpretation constructions. In this manner, we obtain a new system for Formal Language Generation as it will be detailed in what follows. Because the developed system is based on stratified graphs representations, we begin our study by presenting several definitions and properties from the Labeled Stratified Graphs theory.

2. Labeled Stratified Graphs: Definitions and Basic Concepts

The concept of Labeled Stratified Graph was firstly introduced in Ţăndăreanu (2000). A labeled stratified graph (shortly, *LSG*) is constructed over a labeled graph and an algebraic structure defined by means of a Peano algebra, a finite set of binary relations and a morphism of partial algebras (Ţăndăreanu, 2004c).

By a *binary partial operation* on a non-empty set A we understand a partial mapping f from $A \times A$ to A. This implies that f is defined for the elements of some set noted with $dom(f)$ (Ţăndăreanu, 2000):

$$f : dom(f) \to A$$

where $dom(f) \subset A \times A$.

The pair (A, σ_A), where A is the support set and σ_A is a partial binary operation on A, is called a *partial σ-algebra* (Ţăndăreanu, 2000). If $dom(\sigma_A) = A \times A$ then the pair (A, σ_A) is called σ-algebra (Ţăndăreanu, 2000).

For a non-empty set S the collection of all subsets of $S \times S$ will be denoted with $2^{S\times S}$. If $\rho_1 \in 2^{S\times S}$ and $\rho_2 \in 2^{S\times S}$ are two binary relations on S then by $\rho_1 \circ \rho_2$ we understand the set of all pairs $(x, y) \in S \times S$ for which there is $z \in S$ such that $(x, z) \in \rho_1$ and $(z, y) \in \rho_2$.

For the mapping $prod_S : dom(prod_S) \to 2^{S\times S}$ such that $prod_S(\rho_1, \rho_2) = \rho_1 \circ \rho_2$ and $(\rho_1, \rho_2) \in dom(prod_S)$ if and only if $\rho_1 \circ \rho_2 \neq \emptyset$, the set $R(prod_S)$ denotes the set of **all restrictions** of the mapping $prod_S$ (Ţăndăreanu, 2000):

$$R(prod_S) = \{u \mid u \ll prod_S\}$$

where $u \ll prod_S$ means that $dom(u) \subseteq dom(prod_S)$ and $u(\rho_1, \rho_2) = prod_S(\rho_1, \rho_2)$ for $(\rho_1, \rho_2) \in dom(u)$. Moreover, if u is an element of $R(prod_S)$ then the pair $(2^{S\times S}, u)$ is a *partial algebra* (Ţăndăreanu, 2000). This is the structure used to define the concept of the *labeled stratified graph*.

In what follows, we take $u \in R(prod_S)$ and consider the closure $T = Cl_u(T_0)$ of T_0 in the algebra $(2^{S\times S}, u)$, where T_0 notes the set of binary relations in a labeled graph (Ţăndăreanu, 2004d).

A labeled graph is considered represented by the following tuple (Ţăndăreanu, 2000):

$$G_0 = (S_0, L_0, T_0, f_0)$$

where S_0 is a finite set of nodes, L_0 is a set of elements called labels, T_0 is a set of binary relations on S_0 and $f_0 : L_0 \to T_0$ is a surjective function.

For each nonempty set M there is a Peano σ-algebra over M. Indeed, for $B = \bigcup_{n>=0} B_n$, where:

$$B_0 = M,$$

$$B_{n+1} = B_n \cup \left\{\sigma_L(x_1, x_2) \,\middle|\, x_1, x_2 \in B_n\right\}$$

the pair (B, σ_L) is the Peano σ-algebra over M (Ţăndăreanu, 2004d).

We consider a collection of subsets of B, noted in what follows with $Initial(M)$. We have $L \in Initial(M)$ if:

- $M \subseteq L \subseteq B$;
- if $\sigma_L(u, v) \in L$, then $u \in L$, $v \in L$.

A *labeled stratified graph* over G_0 is a tuple (G_0, L, T, u, f) where (Ţăndăreanu, 2000):

- $L \in Initial(L_0)$;
- $(u \in R(prod_S)$ and $T = Cl_u(T_0)$;
- $f : (L, \sigma_L) \to (2^{S\times S}, u)$ is a morphism of partial algebras such that $f_0 \ll f$, $f(L) = T$ and if $(f(x), f(y)) \in dom(u)$ then $(x, y) \in dom(\sigma_L)$.

3. Accepted Structured Paths

Let us consider a labeled graph $G_0 = (S_0, L_0, T_0, f_0)$. By $STR(G_0)$ we will note *the set of structured paths* of the labeled graph G_0, this concept being defined in Dănciulescu (2013) as the smallest set satisfying the following conditions:

- for every $a \in L_0$ and $(x, y) \in f_0(a)$ we have $([x, y], a) \in STR(G_0)$;
- if $([x_1, \dots, x_k], u), ([x_k, \dots, x_n], v) \in STR(G_0)$ then $([x_1, \dots, x_k, \dots, x_n], [u, v]) \in STR(G_0)$.

We consider:

$$STR_2(G_0) = \{w \mid \exists(\alpha, w) \in STR(G_0)\}.$$

In fact, $STR_2(G_0)$ represents the projection of the set $STR(G_0)$ on the second axis, more precisely, $STR_2(G_0) = pr_2(STR(G_0))$. We consider the mapping $h : STR_2(G_0) \to B$ such that (Dănciulescu, 2013):

$$h(a) = a, \quad \text{for } a \in L_0,$$
$$h([u, v]) = \sigma_L(h(u), h(v))$$

where B is defined as above. If we take $G = (G_0, L, T, u, f)$ a labeled stratified graph over the label graph G_0, then by $ASP(G)$ we note the set of all *accepted structured paths* over G (Dănciulescu, 2013):

$$([x_1, \dots, x_n], c) \in ASP(G) \text{ if and only if } ([x_1, \dots, x_n], c) \in STR(G) \text{ and } h(c) \in L.$$

Moreover, $\forall d = ([x_1, \dots, x_n], \sigma_L(u, v)) \in ASP(G)$, there is one and only one $k \in \{1, \dots, n\}$ such that: $([x_1, \dots, x_k], u), ([x_k, \dots, x_n], v) \in ASP(G)$.

In other words, this property states that every accepted structured path can be broken in other two accepted structured paths.

4. System of Knowledge Representation Based on Labeled Stratified Graph for Formal Language Generation

As it is considered in literature, a formal language is a set of words which are represented by finite strings of letters, symbols or tokens. The set of all the letters or symbols upon which the words are made of is called *the alphabet* of the formal language. Usually, a formal language is defined by means of some formation rules or a *formal grammar*.

An interpretation for a labeled stratified graph provides a representation in a domain of knowledge (Pop and Negru, 2003). In the presented approach, we take the domain of knowledge to be a particular formal language. In what follows we will note by V the alphabet of the generated formal language.

Therefore, let us consider the labeled stratified graph $G = (G_0, L, T, u, f)$ over a labeled graph $G_0 = (S_0, L_0, T_0, f_0)$. We defined the interpretation of G as a tuple:

$$I = \big(V^*, ob, D, Y\big)$$

such that:

- V^* is the set of all strings constructed over the characters of V; in this formalism V^* represents the knowledge domain of I;
- $ob : S \to V^*$ a bijective function that maps the symbols of S into the strings of V^*;
- $D = (V^*, \bullet)$ is a partial algebra over V^*. In what follows we will consider the operation o as a partial operation defined in the following manner:

  for every natural number m we take $w^{m+1} = w^m \bullet w$;

- the set of algorithms $Y = \{Alg_u\}_{u \in L}$ generate the elements of the interpretation domain V^*, $Alg_u : V^* \times V^* \to V^*$, $u \in L$.

According to this interpretation system, the valuation mapping generated by I is defined as $val_I : ASP(G) \to Y$ such that:

$$val_I\big([x, y], u\big) = Alg_u\big(ob(x), ob(y)\big), \quad u \in L_0,$$
$$val_I\big([x_1, \dots, x_n], \sigma_L(u, v)\big)$$
$$= val_I\big([x_1, \dots, x_k], u\big) \bullet val_I\big([x_k, \dots, x_n], v\big), \quad \text{for } \sigma_L(u, v) \in L.$$

Remark 1. Because $D = (V^*, \bullet)$ is a partial algebra, results that $val_I([x_1, \dots, x_k], u) \bullet val_I([x_k, \dots, x_n], v) \in V^*$ if and only if $([x_1, \dots, x_k], u)$, $val_I([x_k, \dots, x_n], v \in V^*$ and $(([x_1, \dots, x_k], u), val_I([xk, \dots, xn], v)) \in dom(\bullet)$.

Remark 2. For each $(ob_1, ob_2) \in Y \times Y$, the string $Alg_u(ob_1, ob_2)$ for $u \in L$, is an element of V^*, therefore $\bigcup_{u \in L} Alg_u(ob_1, ob_2)$ represents the formal language over V constructed by means of the abstract notations of G.

Definition 1. We define a system of knowledge representation based on stratified graphs for formal language generation as follows:

$$SKR = \big(G, \big(V^*, \bullet\big), ob, Y\big).$$

The inference process IP_{SKR} generated by the system of knowledge representation SKR is:

$$IP_{SKR} : ASP(G) \to Y.$$

We obtain that the set Y includes all the words constructed over the alphabet V by means of the algorithms defined in the interpretation system I of the labeled stratified graph G.

Therefore $\forall d \in ASP(G)$ – an accepted structured path of the structure G, we have:

$$IP_{SKR}(d) = val_I(d).$$

Following the inference process given above the output elements of Y as defined follows:

$$\text{take } C_{(x,y)} = \big\{d \in ASP(G) \,\big|\, first(d) = x,\ last(d) = y\big\},$$

$$IP_{SKR} = \bigcup_{(x,y)\in S\times S} IP_{SKR}(C_{(x,y)});$$

$IP_{SKR} = \bigcup_{(x,y)\in S\times S}\{w \in Y \mid \exists d \in C_{(x,y)} : IP_{SKR}(d) = w\}$ where, for $d \in ASP(G)$, $d = ([x_1, \ldots, x_n], u)$: $first(d) = x_1$ and $last(d) = x_n$.

5. A Study Case

In order to exemplify our mechanism of formal language generation we will consider the following system of knowledge based on stratified graphs:

$$SKR = \big(G, \big(V^*, \bullet\big), ob, \{Alg_u\}_{u\in L}\big)$$

where the language alphabet is represented by the set $V = \{0, 1\}$ and the labeled stratified graph is given by the tuple $G = (G_0, L, T, u, f)$ for $G_0 = (S, L_0, T_0, f_0)$:

- $S = \{X_1, X_2, X_3\}$,
- $L_0 = \{a, b, c\}$,
- $T_0 = \{\rho_1, \rho_2, \rho_3\}$ where $\rho_1 = \{(X_1, X_2)\}$, $\rho_2 = \{(X_2, X_1)\}$ and $\rho_3 = \{(X_2, X_3)\}$,
- $f_0 : L_0 \to T_0$, $f_0(a) = \rho_1$, $f_0(b) = \rho_2$, $f_0(c) = \rho_3$.

If we take the following binary relations: $\rho_4 = \{(X_1, X_1)\}$, $\rho_5 = \{(X_2, X_2)\}$ and $\rho_6 = \{(X_1, X_3)\}$ then the mapping $u = prod_S$ is defined as follows:

$$\rho_1 \circ \rho_2 = \rho_4, \qquad \rho_2 \circ \rho_1 = \rho_5, \qquad \rho_1 \circ \rho_3 = \rho_6,$$

$$\rho_1 \circ \rho_5 = \rho_1, \qquad \rho_2 \circ \rho_4 = \rho_2, \qquad \rho_2 \circ \rho_6 = \rho_3,$$

$$\rho_4 \circ \phi = \phi, \quad \forall \phi \in \{\rho_1, \rho_6\},$$

$$\rho_5 \circ \phi = \phi, \quad \forall \phi \in \{\rho_2, \rho_3\}.$$

The structure of the considered labeled stratified graphs implies the following results:

- the set of labels L is infinite, $L = L_0 \cup \{\sigma_L(a, b), \sigma_L(b, a), \sigma_L(a, c), \sigma_L(a, \sigma_L(b, a)), \sigma_L(b, \sigma_L(a, b)), \sigma_L(b, \sigma_L(a, c)), \sigma_L(\sigma_L(a, b), a), \sigma_L(\sigma_L(b, a), b), \sigma_L(\sigma_L(b, a), c), \sigma_L(\sigma_L(a, b), \sigma_L(a, c)), \ldots\}$

  $$f(a) = \rho_1, \qquad f(b) = \rho_2, \qquad f(c) = \rho_3,$$

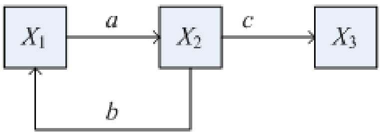

Fig. 1. The labeled graph G_0.

$$f\big(\sigma_L(a,b)\big) = \rho_4; \qquad \rho_1 \circ \rho_2 = \rho_4,$$
$$f\big(\sigma_L(b,a)\big) = \rho_5; \qquad \rho_2 \circ \rho_1 = \rho_5,$$
$$f\big(\sigma_L(a,c)\big) = \rho_6; \qquad \rho_1 \circ \rho_3 = \rho_6,$$
$$f\big(\sigma_L\big(a, \sigma_L(b,a)\big)\big) = \rho_1; \qquad \rho_1 \circ \rho_5 = \rho_1,$$
$$f\big(\sigma_L\big(b, \sigma_L(a,b)\big)\big) = \rho_2; \qquad \rho_2 \circ \rho_4 = \rho_2,$$
$$f\big(\sigma_L\big(b, \sigma_L(a,c)\big)\big) = \rho_3; \qquad \rho_2 \circ \rho_6 = \rho_3,$$
$$f\big(\sigma_L\big(\sigma_L(a,b), a\big)\big) = \rho_1; \qquad \rho_4 \circ \rho_1 = \rho_1,$$
$$f\big(\sigma_L\big(\sigma_L(a,b), \sigma_L(a,c)\big)\big) = \rho_6; \qquad \rho_4 \circ \rho_6 = \rho_6,$$
$$f\big(\sigma_L(\sigma_L(b,a), b)\big) = \rho_2; \qquad \rho_5 \circ \rho_2 = \rho_2,$$
$$f\big(\sigma_L\big(\sigma_L(b,a), c\big)\big) = \rho_3; \qquad \rho_5 \circ \rho_3 = \rho_3,$$
$$\ldots$$
$$f\big(\sigma_L(u,v)\big) = \rho_1, \quad \text{for } u \in f^{-1}(\rho_1) \text{ and } v \in f^{-1}(\rho_5),$$
$$f\big(\sigma_L(u,v)\big) = \rho_2, \quad \text{for } u \in f^{-1}(\rho_2) \text{ and } v \in f^{-1}(\rho_4),$$
$$f\big(\sigma_L(u,v)\big) = \rho_3, \quad \text{for } u \in f^{-1}(\rho_2) \text{ and } v \in f^{-1}(\rho_6),$$
$$f\big(\sigma_L(u,v)\big) = \rho_i, \quad \text{for } u \in f^{-1}(\rho_4) \text{ and } v \in f^{-1}(\rho_i) \text{ with } i \in \{1,6\},$$
$$f\big(\sigma_L(u,v)\big) = \rho_i, \quad \text{for } u \in f^{-1}(\rho_5) \text{ and } v \in f^{-1}(\rho_i) \text{ with } i \in \{2,3\}$$

– $T = Cl_u(T_0) = \{\rho_1, \rho_2, \rho_3, \rho_4, \rho_5, \rho_6\}$.

Taking into account the set T of binary relations, we will consider in what follows the set $N = \{(X_1, X_2), (X_2, X_1), (X_2, X_3), (X_1, X_1), (X_2, X_2), (X_1, X_3)\}$. We define the function $ob :\to V^*$ in the following manner: $ob(X_1) = 0$, $ob(X_2) = 1$ and $ob(X_3) = 10$. We consider the set of algorithms $\{Alg_a\}_{a \in L_0}$ as follows:

– $Alg_a(ob(X_i), ob(X_j)) = ob(X_j)ob(X_i)$ – inversion of the two sequences $ob(X_j)$ and $ob(X_i)$;
– $Alg_b(ob(X_i), ob(X_j)) = ob(X_i)ob(X_j)$ – simple concatenation of the two sequences $ob(X_j)$ and $ob(X_i)$;
– $Alg_c(ob(X_i), ob(X_j)) = ob(X_j)ob(X_j)$ – concatenation and replacement of the first sequence with the second

REMARK 3. Because the set L is infinite, also the generated formal language by means of the considered interpretation I is infinite.

In what follows we will prove that the language generated by means of the labeled stratified graph G and the interpretation I is $\{(10)^m \mid m >= 1\}$. We have:

$$val_I([X_1, X_2], a) = Alg_a(ob(X_1), ob(X_2)) = 10,$$

$$val_I([X_2, X_1], b) = Alg_b(ob(X_2), ob(X_1)) = 10,$$

$$val_I([X_2, X_3], c) = Alg_c(ob(X_2), ob(X_3)) = 10 \bullet 10 = (10)^2,$$

$$val_I([X_1, X_2, X_1], \sigma_L(a, b)) = val_I([X_1, X_2], a) \bullet val_I([X_2, X_1], b)$$
$$= 10 \bullet 10 = (10)^2,$$

$$val_I([X2, X1, X2], \sigma_L(b, a)) = val_I([X2, X1], b) \bullet val_I([X_1, X_2], a)$$
$$= 10 \bullet 10 = (10)^2,$$

$$val_I([X1, X2, X3], \sigma_L(a, c)) = val_I([X1, X2], a) \bullet val_I([X_2, X_3], c)$$
$$= 10 \bullet (10)^2 = (10)^3,$$

$$val_I([X1, X2, X1, X2], \sigma_L(\sigma_L(a, b), a))$$
$$= val_I([X_1, X_2, X_1], \sigma_L(a, b)) \bullet val_I([X_1, X_2], a) = (10)^2 \bullet 10 = (10)^3,$$

$$val_I([X_2, X_1, X_2, X_1], \sigma_L(\sigma_L(b, a), b))$$
$$= val_I([X_2, X_1, X_2], \sigma_L(b, a)) \bullet val_I([X_2, X_1], b) = (10)^2 \bullet 10 = (10)^3,$$

$$val_I([X_2, X_1, X_2, X_3], \sigma_L(\sigma_L(b, a), c))$$
$$= val_I([X_2, X_1, X_2], \sigma_L(b, a)) \bullet val_I([X_2, X_3], c) = (10)^2 \bullet (10)^2 = (10)^4,$$

$$val_I([X_1, X_2, X_1, X_2, X_3], \sigma_L(\sigma_L(a, b), \sigma_L(a, c)))$$
$$= val_I([X_1, X_2, X_1], \sigma_L(a, b)) \bullet val_I([X_1, X_2, X_3], \sigma_L(a, c))$$
$$= (10)^2 \bullet (10)^3 = (10)^5,$$

$$\ldots$$

Using this interpretation, the generated language is made of $(10)^m$ sequences, $m > 0$ as it will be proved in the next proposition.

Proposition 1. *The language generated by the considered system of knowledge representation SKR is:*

$$IP_{SKR} = \bigcup_{d \in ASP(G)} IP_{SKR}(d) = \bigcup_{d \in ASP(G)} val_I(d),$$

$$IP_{SKR} = \left\{(10)^m\right\}_{m>0}.$$

Proof. We have: $IP_{SKP} = \bigcup_{(x,y)\in N} C(x, y)$. But $N = \{(X_1, X_2), (X_2, X_1), (X_2, X_3), (X_1, X_1), (X_2, X_2), (X_1, X_3)\}$, which implies: $IP_{SKP} = \{val_I(d) \mid d \in ASP(G), \mathit{first}(d) = X_1, \mathit{last}(d) = X_2\} \cup \{val_I(d) \mid d \in ASP(G), \mathit{first}(d) = X_2, \mathit{last}(d) = X_1\} \cup \{val_I(d) \mid d \in ASP(G), \mathit{first}(d) = X_2, \mathit{last}(d) = X_3\} \cup \{val_I(d) \mid d \in ASP(G), \mathit{first}(d) = X_1, \mathit{last}(d) = X_1\} \cup \{val_I(d) \mid d \in ASP(G), \mathit{first}(d) = X_2, \mathit{last}(d) = X_2\} \cup \{val_I(d) \mid d \in ASP(G), \mathit{first}(d) = X_1, \mathit{last}(d) = X_3\}$.

Results $IP_{SKR} = \{(10)^{2k+1}\}_{k>0} \cup \{(10)^{2k+1}\}_{k>0} \cup \{(10)^{2k}\}_{k>0} \cup \{(10)^{2k}\}_{k>0} \cup \{(10)^{2k}\}_{k>0} \cup \{(10)^{2k}\}_{k>0} = \{(10)^{2k+1}\}_{k>0} \cup \{(10)^{2k}\}_{k>0} = \{(10)^m\}_{m>0}$. □

6. Conclusions

In this paper we propose a new system for formal language generation by means of a system of knowledge based on labeled stratified graphs (LSGs). We exemplified that, using an interpretation system specially defined for stratified graphs representations, a particular formal language can be obtained by means of the resulted accepted structured paths. Based on labeled stratified graphs representations a new mechanism for natural language generations was developed (see Dănciulescu and Colhon, 2014). This generation mechanism pays attention to the syntactic agreements involved in natural language constructions. In a future study we intend to investigate the manner in which, by imposing a set of restrictions R on the computations in the inference process of such systems the generated formal language sequences would be affected. Also, we intend to study the formal languages families that can be obtained in this type of knowledge system: regular languages, context-sensitive languages, etc.

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Formalios kalbos generavimas žinių vaizdavimo sistemose, grįstose sluoksniniais grafais

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Pateikiant sluoksninius grafus, supažindinama su žinių vaizdavimo metodu, kuriam gali būti pridėtas interpretavimo mechanizmas, skirtas objektų išgavimui iš tam tikros žinių srities, atsižvelgiant į simbolinius grafais pagrįstus atvaizdavimus. Remiantis literatūra, išvedimo procese yra naudojami sluoksninių grafų keliai, tvarka tarp elementariųjų kelio lankų ir keli universaliųjų algebrų rezultatai. Tvarka yra apibrėžiama, pasirenkant struktūrizuotus kelius vietoj įprastų. Ankstesniame straipnyje buvo pristatyta žinių vaizdavimo sistema. Ją sudaro sluoksninis grafas G, dalinė objektų algebra Y, injekcinis surišimas, kuris susieja grafo G viršūnes su algebros Y objektais, ir algoritmų aibė, kurie naudoja objektų iš Y poras, kad išgautų kitus Y objektus. Šiame straipsnyje žinių sistemos išvedimo procese sluoksninių grafų simboliniai elementai interpretuojami kaip formalios kalbos konstrukcijos. Darbe pateikiamos idėjos, kurios gali būti panaudotos, vystant formalių kalbų automatinius generavimo mechanizmus.