Vasyl LYTVYN, Natalya SHAKHOVSKA, Volodymyr PASICHNYK[1], Dmytro DOSYN[2]

Lviv Polytechnic National University (1), Karpenko Physico-Mechanical Institute of NASU (2)

Searching the relevant precedents based on adaptive ontology

Abstract. *This document reviews the functioning of the intellectual agents based on adaptive ontology, which are using precedents. Also was made the software activity of such agents.*

Streszczenie. *W artykule dokonano przeglądu funkcjonowania inteligentnych agentów w oparciu o ontologie adaptacyjne przy precedensów. Matematycznych wsparcia tych środków.*

Keywords: intelligent agent, ontology, precedent.
Słowa kluczowe: inteligentnego agenta, ontologia, precedens.

Energy System is a set of power plants, electrical and heating systems and other energy facilities. However, since the system is dynamic and its elements have evolved at different rates, it complicates the collection and processing of information on elements of such a system. For example, the power stations use by various software, data from some of the sensors arrive with delay, searching for information in grouped data with power stations and accounting is relevant.

Intelligent agents (IA), based on precedents is widely using for the solving less formalized problems. Output, based on precedents, is a method of creating IA decision-makers about the current problem in the way of searching analogies, which are stored in the precedent's base [1]. This analogue is called relevant precedent. From the mathematical side it means that among the elements of the set of precedents $\Pr = \{\Pr_1, \Pr_2, ..., \Pr_N\}$ relevant to $\Pr_k$ is a precedent for which the distance d to the current situation S is the smallest: $\Pr_k = \arg\min_i d(\Pr_i, S)$.

Precedents may be problems on power station. The problem of finding the relevant precedents can be considered like a classification problem, where classes are precedents. Then the problem is in the attribution the current situation to some class.

In this space is defined the point corresponding to the current problem, and in the frames of this metric is detecting the nearest point to it among the points, which represent the precedents. To each attribute is prescribed weight, considering its relative value. Completely the degree of proximity precedent by all parameters can be calculated by using of generalized formula, which looks like:

$$\sum_k w_k \cdot sim(x_{ki}, x_{kj}),\ \sum_k w_k = 1,$$

where w_k – weight of k-feature, sim – function of similarity (metric), x_{ki} and x_{kj} – meaning of the feature x_k for the current problem i of the precedent – j. After the calculating the degrees of proximity, all precedents are ranking. The current situation is referring to the precedent with the highest rank. Selecting a metric is the central point from which will greatly depend on searching for the relevant precedents. To develop an approach for assessing the relevance of precedents based on ontologies. Build the metric for making such as estimates. Formally, an ontology consists of terms, organized in taxonomy, their definitions and attributes, and related axioms and inference rules. Therefore, under the ontology model O understand the triple looks like: $O = \langle C, R, F \rangle$,where C – concept, R – relation between concepts, F – interpretation concepts and relations (axioms). Axioms are making semantic restrictions for the system of the concepts and relations.

In order to be able to build metric of the ontologies, we proposed to extend this model by introducing two scalar variables – weight the importance of concepts and relations. Coefficient of importance of the concept (connection) – a numerical measure which characterizes the importance of certain concept (connection) in a particular subject area and dynamically changes according to certain rules in service systems. So: $O = \langle C, R, F, W, L \rangle$, where W – the importance of the concepts C, L – the importance of the relations R. Let us construct the metric for searching relevant precedents based on the adaptive ontologies. Let the set of precedents $\Pr = \{\Pr_1, \Pr_2, ..., \Pr_N\}$ describes the attributes $X = x_1, x_2, ..., x_M$. D_i – domain of the attribute x_i, w_{i_j} – coefficient of the importance of the attribute x_{i_j} of precedent $\Pr_j$. The value of the attribute xi will be denoted $z_i = z(x_i)$. So $\Pr_i \leftrightarrow X_i = \{x_{i_1} = z_{i_1}, x_{i_2} = z_{i_2}, ..., x_{i_k} = z_{i_k}\}$, where $z_{i_j} \in D_{i_j}$. Let us denote I_i – the set of index properties of the precedent $\Pr_i$. Then the distance between the precedent $\Pr_i$ and current situation S will be determined like: $d_i = \sum_{i_j \in I_i} \varphi(z_{i_j}, z_{i_j}^S)$, where z_{i_j} the value of the attribute x_{i_j} of the precedent $\Pr_i$, $z_{i_j}^S$ the value of the attribute x_{i_j} of the current situation S, $\overline{I}_i \subset I_i$ – the subset of the important index properties of the precedent $\Pr_i$, $\overline{I}_i = \overline{I}_{i1} \cup \overline{I}_{i2} \cup ... \cup \overline{I}_{iN_i}$, N_i – the number of the attributes (properties), what need to be considered for making decision about $\Pr_i$:

$$\overline{I}_{i1} = \left\{ i_{y1} \middle| i_{y1} = \arg\max_{i_j \in I_i} w_{i_j} \right\}, \overline{I}_{i2} = \left\{ i_{s2} \middle| i_{y2} = \arg\max_{i_j \in I_i / I_{i1}} w_{i_j} \right\}, \ldots$$

Let us consider the function $\varphi(\xi, \eta)$. Obviously, that ξ – may be a range, $\xi \subseteq D$, where D – universal set; numeric value or not numeric value. Depending on this $\varphi(\xi, \eta)$ is defined by its own way, such as:

$$\varphi(\xi, \eta) = \begin{cases} 1 - \mu_\xi(\eta),\ \xi - \text{fuzzy set}, \\ \lambda \cdot |\xi - \eta|,\ \xi, \eta - \text{numeric value}, \\ 1 - \mu(\xi, \eta),\ \xi, \eta - \text{not numeric value}, \end{cases}$$

where $\mu_\xi(\eta)$ – coefficient of confidence that η belongs to a fuzzy subset ξ; λ – numeric value, which depends on the SA, that product $\lambda \cdot |\xi - \eta| \in [0,1]$; $\mu(\xi, \eta) \in [0,1]$ – fuzzy set of the similar values ξ and η.

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The correspondence address is:
e-mail: vasyl17.lytvyn@gmail.com, natalya233@gmail.com