The Virtual Assistant for Applicant in Choosing of the Specialty

Alibek Barlybayev, Dauren Kabenov, Altynbek Sharipbay

Department of Theoretical Computer Science, Eurasian National University, Astana, 010000, Kazakhstan
frank-ab@mail.ru

Abstract: This article's purpose is automation of answer formation to the user's request to the domain's knowledge base. The domain –the applicant chooses a specialty. Domain knowledge base is represented as a semantic network consisting of facts and rules of conclusion. It is required to construct two semantic networks. The first network is constructed by the expert, and the second is constructed by applicant, responding to questions, which are presented on the user interfaces. Thus function of intellectual system's problem solver is reduced to clarification of the question "is the semantic network of the applicant a part of the semantic network of the expert". If yes, then the answer is formed about the appropriate specialty for the applicant.
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1. Introduction

The semantic network is the weighted oriented graph, in which vertex weights are concepts, events, objects or entities, and weights of arcs - the relation between the vertices (Roussopoulos, 1976). Any fragment of network, such as one vertex, two vertices and arcs between them is called subnet (Quillian, 1968). The logical conclusion (decision search) on the semantic network consists in finding or designing a subnet meeting some conditions (Sowa, 2008).

Relations representing arcs in a semantic network can be various. Examples of these relations are shown in Table 1. Relation types are selected depending on the type of semantic network and solved task are shown in Table 2.

Table 1. The main types of the relations in semantic networks

Type	Description
A-kind-of	Specifies the hierarchical relations between classes
Is-a	Defines the value, describes specific object, concept
Are	It can be used instead of a-kind-of in the relations implying equality or equivalence
Has-part	Defines structural relations, describes parts or whole objects
Functional or predicative	Usually determined by verbs, reflects various actions or relations (learning, hold, etc.)
Quantitative	Display quantitative relations between the vertices (more, less, etc.)
Spatial	Display the spatial relations between the vertices (near, far, etc.)
Temporary	Describes temporal relations between the vertices (soon, long, now, etc.)
Attributive	Describe the properties of objects, concepts
Logical	Describes logical relations between the vertices (and, or, not)

Here verbs can be different cases, depending on the types of vertices and the type of orientation relation between them, for example: The subject - teacher, the subject - student. "The teacher teaches the student" or "the student learns from the teacher".

Here events are actions that occur in the real world, and are defined by type of action and roles which play objects in this action.

Let's notice that in a hierarchical network can divide a network into subnets and build relations not only between the vertices, but also between networks (different subnets exist in the network can be arranged in a tree subnets, vertices - the subnet, and arcs - the visibility).

Domain is an important part in semantic network's construction, which is defined as follows:

1. To define abstract objects and the concepts of domain for solving the problem. Making them as vertices.
2. Set properties for the selected vertices, having issued them as vertices connected with the original vertices by attributive relations.
3. Set the connection between these vertices using functional, spatial, quantitative, logical, temporal, attribute relations and relations like "a-kind-of" and "has-part".

4. Add concrete objects and concepts that describe the solved problems. Arrange them as vertices connected with the existing relations of the type “is-a”, “are”.

5. Check the correctness of the established relations (vertices and the attitude in proper construction form a sentence, such as “The engine is a part of the car”).

Table 2. Types of semantic networks.

Type	Description
By type of knowledge	
Extensional (terminal)	Describes the specific relations over specific values.
Intensional (non-terminal)	Describe names of concepts, events, objects and subjects, instead of their individual names or values, and the relations between them.
By type of restrictions on vertices and arcs	
Ordinary	Vertices of the network don't possess internal structure (terminal)
Hierarchical	Vertices of the network have an internal structure (non-terminal).
Dynamic (scripting)	Vertices of the network represents some actions or events
By amount of the types of relations	
Uniform	Have only one type of relations
Non-uniform	A mount of types of the relations more than two
By arity of relations	
Binary	All the relations in the network connect exactly two vertices
Multiple (n-ary, where n>2 – the amount of vertices)	The network has relations that connect more than two objects

2. Design of the virtual assistant with semantic network

Task 1. Construct network model of knowledge representation in the domain “the applicant chooses a specialty”. Performing the above steps 1-5, this domain can be defined as:

1. Key concepts of the domain – specialty, applicant. The applicant chooses for entering the specialty. Specialty is a part of the group of specialties. Group of specialties part of education levels. At a specialty choice the applicant uses characteristics having at present: education and position (job) in which he would like to work. We need to define which part of the labor sector is the position. Depending what education the applicant has at present, an important role is played the 4th subject handed over at entrance examinations (unified national testing). 4th subject is part of secondary education. The applicant’s higher education level and specialty is also an important part. Accordingly, the vertices are as follows: “Applicant”, “Specialty”, “Education”, “Labor sector”, “Position”, “4th subject”, “Education level”, “Education level and specialty” and “Group of specialties”.

2. These objects have certain properties and attributes. For example, education may be a secondary or higher, the education level can be a bachelor, master or doctoral studies of PhD. So we will add vertices “Secondary education”, “Higher education”, “Bachelor”, “Master” and “Doctoral studies of PhD”.

3. Let's define relations and their types for existing vertices, using Table 2. The resulting graph (Figure 1).

4. Let's add knowledge about specific facts of solved problem. Suppose there are two applicants: “Mark” and “Alex”, the first has only secondary education, and the second has higher education. Mark at the Uniform National Testing chose physics as the 4th subject. Alex has graduated Bachelor of Economics. There are two groups of specialties “Social Sciences, Economics and Business” and “Natural Sciences”. The first group of specialties has specialties as “Management” and “Accounting and Auditing”, in the second has only the “Computer science”. Each group of specialties has a whole set of education levels: Bachelor's, Master's, doctoral studies of PhD. Mark wants to work in future as a programmer. And Alex wants to be top manager. Based on this, we will add relevant vertex to the graph and connect their functional relations and relations such as “for example or is-a”. It's worth noting that the relations “for example” and “is-a” equivalent. The resulting graph (Figure 2).

5. Let's carry out check of the established connection. For example, we will take vertex “Specialty” and we will pass on the established connection. We receive the following information: the specialty is a part of group of specialty, management, accounting and audit, computer science can be examples of specialty.

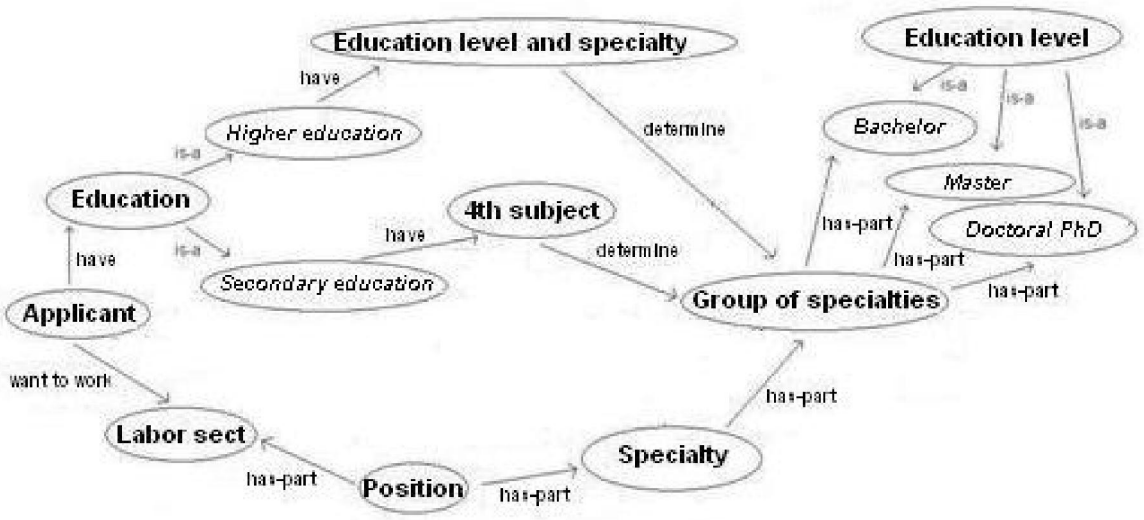

Figure 1. The intensional (non-terminal) semantic network of domain "The applicant chooses a specialty"

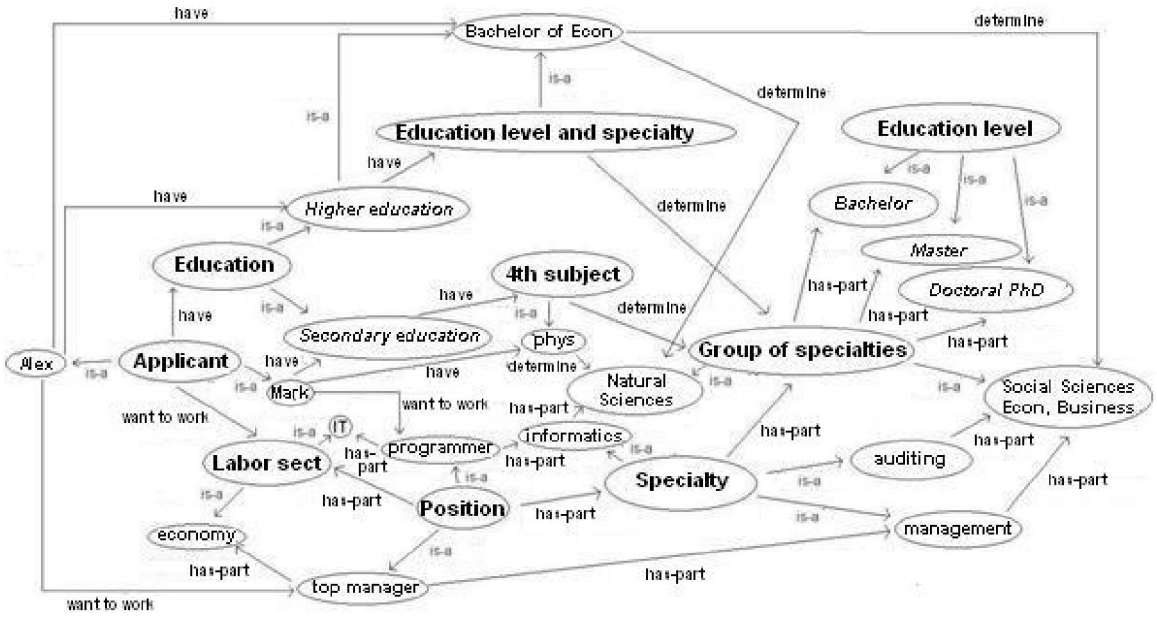

Figure 2. The extensional (terminal) semantic network of domain "The applicant chooses a specialty"

Task 2. What should applicant do to select the desired specialty. For solving this problem, we must use the rules of admission to higher education institutions in the Republic of Kazakhstan (Standard rules, 2012).

Following the rules, the applicant with secondary education can enroll in higher educational institutions on specialty of a bachelor degree, depending on the 4th subject that defines the field of study (group of specialties). And applicant with higher education can apply for all directions of specialties to the bachelor degree. For admission to the master's specialty must have undergraduate education in this field of study (group of specialty). For admission to the specialty of doctoral studies of PhD it is necessary to have a Masters degree in this field of study (group specialty).

Also, the applicant should define labor sector and a profession on which he will continue to work hard.

To choose the right specialty, considering above mentioned factors, the applicant fills in the profile-form. Applicant answers the questions:

1. The question "what is your education?" Possible answers: "secondary", "higher".

1.1 If "secondary", a question "which is your 4th subject?"

1.2 If "higher" is chosen, a question "what is your education level and your specialty?"

2. The question "what kind of labor sector do you want to choose in future" and "what is your position like?"

On the basis of answers the semantic network "profile-form" is constructed. Then obtained data are transferred to problem solver.

The problem solver – procedure which finds out, whether is the constructed "profile-form" network is a part of "the applicant chooses a specialty".

To get the answer to any question on this problem it is necessary to find the appropriate section of the network and using communications to get the result.

For example, the question "Having graduated BA in Economics, and desire to work as top manager, what specialty has to choose Alex?" From query clearly that it is necessary to find the following vertices: "Alex", "Specialty", "Higher education", "BA in economy" and "Top manager". The part of the semantic network, located between the vertices, contains the answer, namely, higher education, Bachelor of Economics provides an opportunity to enter to all bachelor and the master's degree of social sciences and economics and business. Accordingly, Alex eligible to apply for undergraduate specialties as computer science, accounting and auditing, management, as well as master's accounting and auditing, management. But the desired position is related with specialty management. More information in the model isn't presented, therefore we can conclude - Alex can apply for BA or MA degree in management.

Task 3. Description of the work "applicant's virtual assistant in choosing a specialty". Flowchart of the virtual assistant (Figure 3).

Applicants with a web interface of the virtual assistant builds the semantic network "profile-form". The constructed model is transferred to problem solver. Problem solver consists:

1. Database, the atomic block in which data, facts are stored.
2. Knowledge base, the block that contains the rules for processing data and facts.
3. Semantic network "the applicant chooses a specialty", is based on a database and knowledge base.

The problem solver compares the semantic networks "profile-form" and "the applicant chooses a specialty". If problem solver finds out that the constructed network "profile-form" is part of "the applicant chooses a specialty", then search of the decision in a semantic network is started.

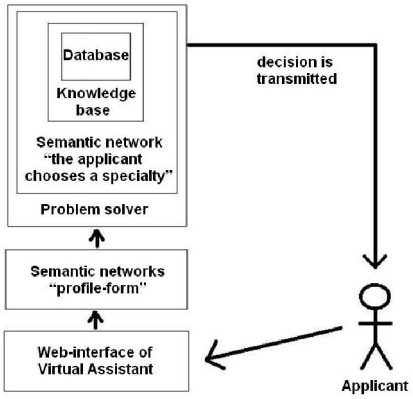

Figure 3. Flowchart of the virtual assistant

The solution would be intermediate vertices which are absent in semantic network "profile-form", but presented in the semantic network "the applicant chooses a specialty" (Figure 4).

The decision will be intermediate vertices which depend on the semantic network "profile-form", but thus exist in the semantic network "the applicant chooses a specialty".

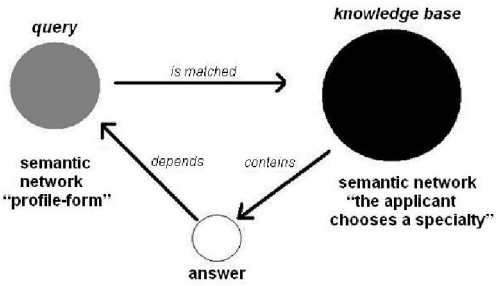

Figure 4. Visualization of search of the decision in a semantic network

Below the algorithm of a problem solver will be constructed which compares the semantic networks "profile-form" and "the applicant chooses a specialty".

Let's describe the following objects which will be used in the construction of the algorithm in Table 3.

This algorithm has been implemented in the Cache Object Script (Mumps) programming language with using of technology of post-relational DBMS Cache Intersystems.

The resulting program's processing time: 1.649 seconds, on the server Intel (R) Xeon (R) CPUX5660 2.80GHz, RAM: 1 GB, 64-bit system, the OS Windows Web Server 2008 R2 SP1.

In the future, the program will be tested specific users. Thus, the amount of simultaneous testing users will be at least 1000 people. Tests will be carried out during 1 year. It will help us to identify the server specifications necessary for industrial use.

According to the established characteristics it is required to obtain license agreements of the software from company Intersystems. At the expiration of one year from the beginning of the test and taking into account the changes and amendments the program will be commissioned into commercial operation.

Table 3. The description of the semantic network objects used in problem solver.

№	Sign	Description
1	->	The operator connected
2	∈	The operator contains
3	E	Education
4	HE	Higher education
5	GS	Group of specialty
6	LEaS	Level of education and specialty
7	LE	Level of education
8	AGS	List of groups of specialties of the applicant
9	LM	Labor sector
10	P	Position
11	ALM	Applicant's labor sector
12	AP	Applicant's position
13	S	Specialty
14	AS	The list of eligible specialties for applicants
15	FS	Fourth subject
16	AFS	Applicant's fourth subject

START OF THE ALGORITHM "problem solver"
Background:

1. The applicant's semantic network the profile-form which consists of objects (vertices): LEaS, ALM, AP, AFS;

2. The expert's semantic network the applicant chooses a specialty which consists of objects (vertices): E, HE, GS, LE, LM, P, S, FS;

The resulting data:

1. Yes: AS;

2. No: there are executing the command that displays the message "Sorry, but we do not have a suitable specialty for you", quit 0 command is executed, this is stop operation of the algorithm;

Method:

Comparison of applicant's semantic network with a semantic network of the expert
Check on available education
If higher education, Then AGS is formed depending on LEaS
Else, AGS is formed depending on AFS
AGS filtration depending on ALM and AP
AGS∈GS->S
If S->P=AP and P->LM=ALM, then AS=S
If they are identical or AS'="", Then YES
Else NO
END OF THE ALGORITM "problem solver"

3. Conclusion

Definitions of the semantic network are given. The applicant's virtual assistant operation in choosing specialty is designed. At designing methods of information searching in semantic networks were used. It was projected operation and structure of the problem solver in semantic networks. The algorithm of a problem solver is constructed which compares the expert's semantic network with the semantic network of the applicant. Program realization of this algorithm is written. The initial experimental observations of the algorithm is conducted. This problem can be expanded up to solve the problems of the improvement the efficiency of the education system according to regional labor resources.

Corresponding Author:
Mr. Alibek Barlybayev
Department of Theoretical Science
Eurasian national University
Astana, 010000, Kazakhstan
E-mail: frank-ab@mail.ru

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