

Communicative Associative Logic of Cognitive Professional Robot with Imitative Thinking

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Abstract: There are two main approaches to hardware-software realization of imitative thinking of cognitive robots. On the basis of machine learning. Such cognitive robots are used in services industry, for the commercial and entertaining purposes. In article approach to creation of cognitive robots on the basis of modeling of communicative and associative logic of imitative thinking of the person is considered. Cognitive robots on the basis of modeling of communicative and associative logic of imitative thinking of the person are used as lecturers and consultants, also in professional activity when concepts and competences are strictly defined. The communicative and associative logic of thinking allows to create the symbolical conceiving robot capable to study, realize information requirements (tasks), to train subject areas, to communicate with the help of the speech, to read and write in various languages. The robot on the basis of symbolical language communicative logic solves a problem of the automated imitation of imitative thinking with associative and communicative symbolical language elements of knowledge. The main practical objectives of imitation of imitative thinking are drawing up the intrinsic focused dictionaries of the developed subject domains of knowledge and standard information requirements; drawing up standard procedures of realization of information requirements; formation of networks from communicative and associative symbolical language elements of knowledge of subject domains; expansion of a natural language to functional; creation of systems of speech and text communication in a natural language and recognitions of the speech of interlocutors.

Keywords: Imitative Thinking, Communicative and Associative Logic, Cognitive Professional Robot, Information Requirement

1. Introduction

Imitative thinking represents communicative and associative processes with words, phrases, offers and judgments. At the computer level imitative thinking is imitated by communicative and associative processes with symbolical language elements of knowledge. Imitation of imitative thinking at the computer level is carried out on the basis of symbolical language communicative logic and network communicative and associative representation of symbolical language elements of knowledge.

The information circle of the person represents the connected signs of environment of the first alarm level and the language intrinsic environment of the second alarm level. At the first alarm level information on a surrounding reality in the form of signs, signs of situational schemes and situational schemes is stored. At the second alarm level

symbolical elements of knowledge are stored in the intrinsic environment: words, phrases, offers, judgments.

The hardware-software information environment of the computer stores symbolical elements of knowledge in coded form with an intrinsic marking supplied with all signs of representatives of a reality and connected signs of situational schemes. To an element of knowledge from the hardware-software environment of the computer there corresponds the element of knowledge from the intrinsic circle of the person connected with the same signs and the scheme of the first alarm level. These elements of knowledge correspond to the same fragments of a reality. As the hardware-software environment works with sign elements of knowledge as language, it is necessary to supply still elements of knowledge of the hardware-software environment with syntactic structures and a language marking according to grammar and rules of a written language to use language practice of the person for

understanding of sense of written texts.

The hardware-software symbolical language environment which elements of knowledge have the marking described above and the semantic circle of the expert always correspond to the same surrounding reality or abstraction.

Therefore it is possible to imitate symbolical and language thinking of the person at the level of cogitative acts, keeping compliance between contents and language symbolical elements of knowledge, substituting surrounding or virtual (abstract) reality for the language symbolical description with functional the sintaktiky, selecting acts of thought process, keeping the relations between elements of knowledge and representatives realities and developing experience of understanding and transfer of sense.

The person joins semantic acts through the existential, cause and effect relations. Symbolical structures of elements of knowledge are built in memory of the person according to communicative communications of the first alarm level between the corresponding signs of representatives of a reality or abstraction. Symbolical elements of knowledge can be displayed one-to-one in the coded patterns of electric activity of memory of the robot.

At such robot semantic acts of the person are substituted for semantic synthesis of the corresponding coded patterns, keeping univocity of structures and communication language communications with the corresponding elements of knowledge, it is possible to carry out imitation of symbolical language thinking by means of the robot. The symbolical and language communicative logic of the person is the cornerstone of imitation of symbolical language thinking.

Imitation of symbolical language thinking is carried out on communicative and associative communications of elements of knowledge. Therefore it is important to have communicative communications at a stage of representation of knowledge. For this purpose it is necessary to specify subject domain of knowledge, a situation for judgments, the situational moment for offers. Situations connect the situational moments in the semantic focused representation of knowledge of subject domain. Representation of knowledge is essential for imitation of symbolical thinking as elements of knowledge and communicative and associative communications between them directly participate in cogitative acts. Elements of knowledge: words, phrases, offers, judgments are stored in memory of the person with communication and associative communications between them, the displaying communications between the corresponding representatives of a reality or abstraction.

Symbolical language thinking offers and judgments represents communicative and associative process of realization of information needs of the person. Information requirement is formed in subject domain and is implemented in her system of knowledge.

The person gathers experience of realization of information requirements by means of imitative thinking on the basis of cogitative experience of others, accumulating information requirements and their realization in memory. Then, combining the initial information requirements which

are in memory person builds new information requirements. The person realizes new information requirement the corresponding combination of realization of initial information requirements, components new. At the person imitative thinking thus develops.

If to store realization of information needs for a type of the coded patterns of elements of knowledge in hardware-software memory, then it is possible to automate process of realization of information requirements on communicative and associative logic with use of a functional natural language [1-2].

2. Technology of Realization of Communicative and Associative Logic

Logical unit of communicative and associative logic is the word. The text of information requirement is under construction in a functional natural language of elements of the intrinsic dictionary. The functional natural language contains means of the description of communicative and associative communications between elements of knowledge that allows to imitate imitative thinking at the symbolical language level by means of the robot. Communicative and associative language communications between elements of knowledge follow communications of objects, actions, qualities, properties, time, spaces, etc. which also designate elements of knowledge.

In language structural, functional and semantic attributes of elements of knowledge are coordinated. Use of words as a part of elements of knowledge of information requirement is set by communicative communications. In language there are grammatical rules of speciation of word forms for generation and expansion of families and generation of communities, communicative rules of formation of phrases, offers of judgments. At each rule the range of definition. For example, at the deductive rule of generalization a range of definition are deductive sets. Deductive rules allow to order the words of language on the generalized sets. The generalized set is presented by convergent sign. Private values of convergent sign are his specification. In language the accent in a word, in the offer, in judgment between offers is fixed sintaktiky. Shock words in the offer are highlighted in bold type. For example, Evgeniy was in China. Evgeniy was in China. Evgeniy was in China. Percussions of a syllable are highlighted in bold type. Communications according to contents of sentences have syntactic designations.

On the assembly ascending parse and the morphological analysis selects the offers of information requirement corresponding to acts of thinking and establish grammatical types and signs for each word according to the dictionary of semantic orientation, builds a tree of syntactic submission of words, defines communicative communication of words, phrases and offers. For the analysis the intrinsic dictionary, networks of phrases, offers, judgments, information families and communities are used.

Parse is carried out on a language syntactic marking of information requirement and its structural signs of situational

to a marking. By parse are defined, grammatical meanings of elements of knowledge, the words in offers, phrases in offers, offers in judgments, elementary judgments in compound judgments are selected, grammatical types of words, species groups of phrases by grammatical types of words of bases and additional, grammatical types of lexical meanings of information niches of offers, and specific communications of offers of elementary judgments come to light.

The morphological analysis is carried out on a language morphological marking and circuit signs of situational. In the course of the morphological analysis morphological values of elements of knowledge and signs of situational schemes of morphological values are defined.

Allocation of offers is carried out on syntactic structure in which to words signs and indexes of representatives, grammatical types and lexical meanings are attributed, to phrases semantic values. On the assembly ascending parse and the morphological analysis of texts of information requirement information niches of the offer are defined. The received text after the assembly analysis comes to the system of symbolical and language realization of information requirement – the system of imitation of thinking.

Entrance information of system is the information requirement and attributes received in the course of the syntactic and morphological analysis. According to information obtained as a result of the syntactic and morphological analysis of information requirement, the system of imitation of thinking carries out her semantic analysis.

At first the type of information requirement is distinguished. Information requirement can be interrogative or incentive. Then by the semantic analysis is defined whether there is a realization of information need for the knowledge base. If there is no her realization, then is defined whether information requirement is standard basic. If information requirement isn't standard basic, then in the course of the analysis is defined whether it consists of standard basic information requirements. If it doesn't consist of standard basic information requirements, then by the semantic analysis is defined whether there is a necessary and sufficient set of procedures of realization in base of abilities both a necessary and sufficient set of elements of knowledge in the knowledge base for her realization.

In case as a result of the analysis it becomes clear that in base of abilities and knowledge there are elements for realization of information requirement, then the system of imitation of thinking makes out realization of information requirement from elements of knowledge of information requirement and elements of knowledge for realization from the knowledge base. The system determines indexes on necessary sets of elements of knowledge in the knowledge base in the subject domain set by the user by a marking of the text of information requirement, and on procedures of realization in base of abilities, and defines the scheme of realization according to type and a marking of requirement.

Attributes of elements of knowledge are specified in a marking: circuit, *priznakovy*, grammatical (syntactic, morphological), semantic and lexical.

Indexes on elements of knowledge and realization are formed through the information receptive field. The information receptive field contains information communications with entrances of network of phrases, offers, judgments and also with realization of standard basic information requirements. It contains instructions about a necessary and sufficient set of procedures of realization for each lexical meaning of information action and about a necessary and sufficient set of elements of knowledge of each procedure of realization and also the information connections with procedures of realization which are stored in base of abilities.

Indexes for search of necessary and sufficient set of elements of realization in base of abilities, a necessary and sufficient set of elements of knowledge in the knowledge base, schemes and structures of formation of new phrases, offers, judgments are determined by a marking of information requirement and the field of knowledge set by the user.

The system of imitation of thinking starts the procedure of creation of network of step-by-step realization of information requirement from a necessary and sufficient set of elements of knowledge and procedures of realization. System builds network of step-by-step realization of information needs for knowledge bases and abilities. Then makes an initial marking of elements of knowledge and procedures of realization and their communications. The marking defines signs of participation of words in phrases, signs of situational participation of phrases in offers and situational participation of offers in judgments.

After a marking of network of step-by-step realization, it is started on realization of information requirement.

Information requirements are considered realized if the syntactic structure of realization, lexical and semantic meanings of components and also procedures of realization are defined.

If entrance information requirement is a combination of standard information requirements or their admissible modification, then she realized.

Standard incentive information requirement consists of information action and information condition. If information requirement incentive, then is obviously specified in it action.

Interrogative information requirement is a question. If information requirement interrogative, then is obviously specified in it the interrogative phrase defining the direction of realization.

Realization of interrogative information requirement is based or in network of offers, or in network of judgments. In networks the semantic value of realization of requirement or in the form of the offer, or judgment comes to light.

After realization new information requirement is entered in the knowledge base and contacts an element of knowledge which is her realization.

The technology of realization of communicative and associative logic of imitative thinking allows to develop the interactive training systems of natural language level in various objects in educational space. The subject domain of knowledge is presented in the form of communicative and associative network of the information requirements and their

realization consisting of elements of knowledge. Communicative phrases form offers, communicative offers form judgments. Between information requirement and its realization communication associative. Realization of information requirement itself can be information requirement. The words of information requirement have the marking specifying or on a lexical meaning, or on the computing procedure, or on the behavioural procedure. For example, the word "put" can be a lexical meaning, either arithmetic action, or behavioural action (to put cubes). For judgments the subject domain and a situation is specified. For offers the situational moment and signs of lexical meanings is specified. Reflection of semantics of subject knowledge is carried out by means of symbolical and language sign system on the basis of communicative and associative logic and in detail signs of situational the relations of entities of objects of a reality and abstraction with elements of knowledge of the intrinsic dictionary [3-7].

2.1. Intrinsic Dictionary

Let S - the spelling dictionary, where $S = \{Si\}$, Si - a morphological word. The word Si calls sign of Qij of the representative of Mij from a set of Mi where $Mi = \{Mij\}$. Will designate a lexical meaning of the word Si through $\{Mij, Qij, Si\}$. Will set communication of lexical meanings of words $\{Si\}$ with elements of a set Mi set of the sign of relations of Qi where $Qi = \{Qij, (Mi, Mij)\}$.

The set of lexical meanings of the sign of relations with representatives connected by set is the intrinsic dictionary. Words in the dictionary are supplied with sign of indexes according to their sign of relations with representatives. The intrinsic dictionary fixes sign of entities of representatives. The dictionary helps to use words with the lexical meaning and to distinguish representatives whom they call at the symbolical level.

Words are used on the basis of sign of indexes. Each sign has three indexes. One index indicates subject domain of knowledge, the second a situation, the third for the situational moment. Words with several lexical meanings, have several sets of indexes. For example, flour and flour. The word the field is used in various subject domains. Each set of indexes defines a lexical meaning of a word.

2.2. Subject Domains of Knowledge

Subject domains of knowledge represent networks is associative the connected information requirements and their realization from communicatively coherent symbolical language elements (information traces of communicative and associative symbolical and language thinking). Realization of information requirement can be itself information requirement. Then associative network of communicatively coherent elements will be realization. The combined information requirements consist or of the enclosed information requirements of subject domain of knowledge, or of the sequence of information requirements, or of the sequence of the enclosed information requirements. The

combined information requirements consist either from simple, or from simple and combined, or of combined. Information requirements of subject domain of knowledge form the combined expanded network.

The set of elements of knowledge with a marking is the knowledge base. Imperative or the question of the knowledge base is information requirement. The set of procedures of realization of information requirement is base of abilities.

For the information requirement which is a combination of information requirements for which there is a realization there is a necessary and sufficient set of elements of knowledge in the knowledge base and procedures of realization in base of abilities. The corresponding combination of necessary and sufficient set of the available realization will be realization of the combined information requirement. The symbolical and language communicative logic connects the realized information requirements.

2.3. Algorithmic Resolvability Communicative and Associative Logic

Let ID - the intrinsic dictionary of subject domain of knowledge be set;

BIR - the basic information requirements of subject domain of knowledge made of the words of the ID dictionary. Basic information requirement is either the interrogative, or imperative offer;

$RBIP$ - realization of basic information requirements;

$RCIR$ - rules of combination of information requirements from basic;

$DCANRIR$ - the designer of communicative and associative network of realization of information requirements of the user;

$CANRBIR$ - communicative and associative network of realization of basic information requirements of subject domain of knowledge.

Let the user it is set of information requirements (IRi), made by the rules $RCIR$. We will apply to her the designer of $DCANRIR$. We will receive $CANRBIR$ (i) expansion of $CANRBIR$ network with realization (IRi).

The realization of interrogative information requirement for communicative and associative network of subject domain of knowledge is enabled as follows. Let the offer $P1$ with a marking be interrogative information requirement with a sing of situational scheme $SP1$ from the situational scheme $S1$. The interrogative word in the offer $P1$ to undescribed sign of $Q1$ of a lexical meaning of $LM1$ of information niche of $IN1$ is known.

It is necessary to find in communicative and associative network of subject domain of knowledge the offer $P2$ containing phrases and lexical meanings of the offer $P1$ and the lexical meaning of $LM2$ which is the description of sign of $Q1$.

The procedure of realization builds according to the offer $P1$ the $P2T$ template with undescribed sign of $Q1$ of the offer $P2$. On the $P2T$ template, his marking, the $SP1$, $S1$ procedure of realization looks for the offer $P2$ in network of communicative phrases of subject domain of knowledge by means of procedures of the morphological, syntactic and

semantic analysis. The found offer P2 will be realization.

Imperative information requirement for search realization is replaced with equivalent interrogative information requirement.

Conclusion shows that the communicative and associative logic is algorithmically solvable.

2.4. Modeling of Imitative Thinking of the Cognitive Robot

The technology of realization of communicative and associative logic allows to create the symbolical conceiving robot with imitative thinking. Information unit of communication between the robot and the interlocutor is information requirement either speech, or written in natural functional language [7]. The interlocutor uses information requirements which contain in the knowledge base of the robot. He communicates with the robot by means of combinations of the available information requirements, enriching, thereby, the robot with new information requirements and their realization. The robot receives basic information requirements and their realization during his training.

The system of realization of information requirement uses intrinsic dictionaries of subject domains of the knowledge base, the procedure of the analysis, merge (synthesis) and splitting from base of abilities and also network of step-by-step realization of information requirements. The robot realizes information requirement if the knowledge base contains a necessary set of elements of knowledge, the base of abilities contains a necessary set of elements of realization.

Imitation of symbolical language thinking is carried out on the basis of symbolical and language communicative logic over symbolical language elements of knowledge of subject domains. Subject domains of knowledge present to network communicatively and is associative coherent symbolical language elements with a sing of situational and a language marking.

Let imperative information requirement "is set to find the sum the X plus of Y, at X is equal 15, Y is equal to 10". "X it is equal 15, Y ravno 10" is information condition. Communicative phrases "X It Is Equal" and "equally 15" in information condition of information action "plus" initiates (Figure 1).

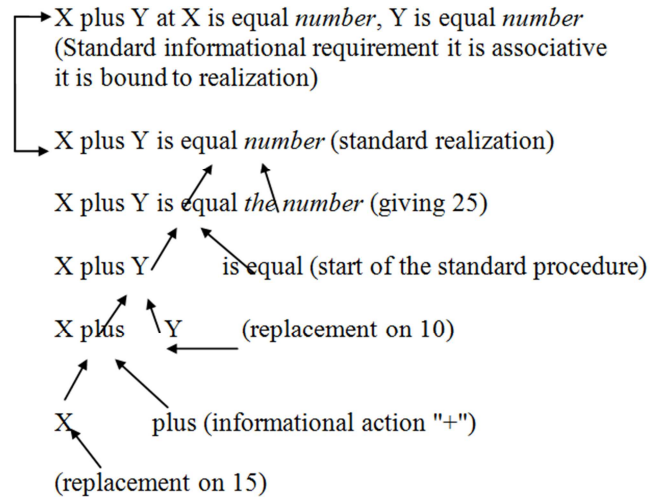


Figure 1. Network structure of addition.

2.5. System of Realization of Information Requirement

The system of realization includes the knowledge base and base of abilities. Realization of information requirement undertakes or from the knowledge base, or is developed by a standard procedure of realization of base of abilities for the current information requirement (Figure 2), or the network of step-by-step realization on the combined information requirement is formed (Figure 3).

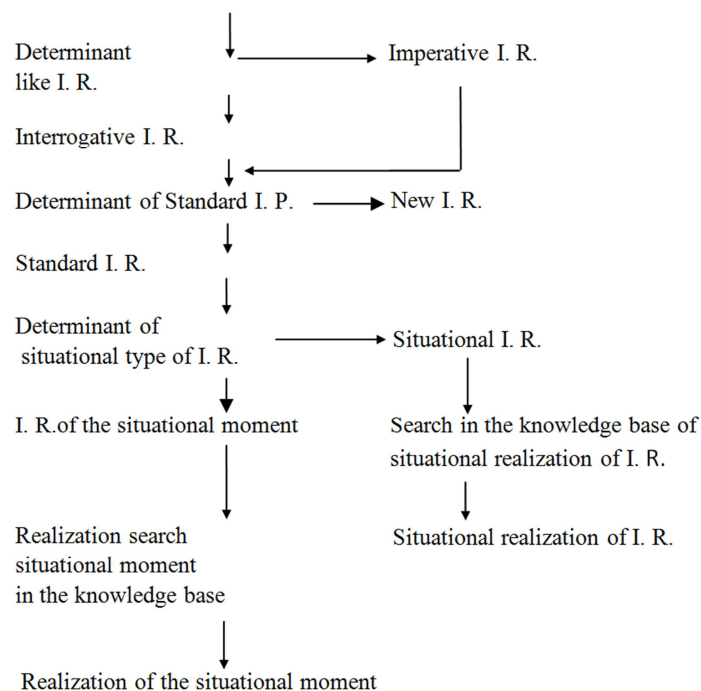


Figure 2. Realization of standard information requirement (I. R.).

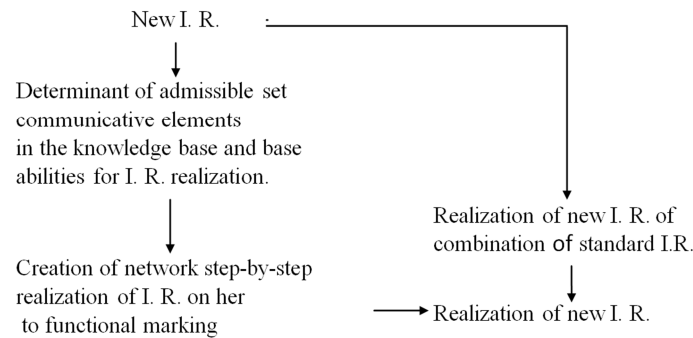


Figure 3. Realization of new information requirement (I. R.).

3. Robotic Smart Drugstores

Cognitive professional robot is possible to train and use as sellers of clever cafes or drugstores [8-12]. Visitors of smart drugstores are served by cognitive professional robot (Figure 4) and the automatic machine of piece drugs. The robot has the neural network trained system of communication with visitors for booking, the device of reading of electronic money from the plastic card of the visitor and the device of distance steering by the program controller of the automatic machine for delivery of drugs. The automatic machine of delivery of products under control of the robot serves orders of visitors. The visitor inserts the plastic calculated card into the device of reading of electronic money, reports to the robot the list of drugs of the order. The robot through the system of booking and the program versatile controller of the automatic machine activates trays with drugs according to the order. When the order is created by automatic machine for

delivery of drugs, the robot reads out electronic money from the plastic card of the visitor, at the prices of drugs. After the visitor receives a set of drugs of the order from the automatic machine, takes away the calculated plastic card and the check.

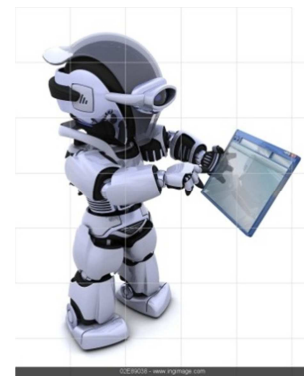


Figure 4. Cognitive professional robot.

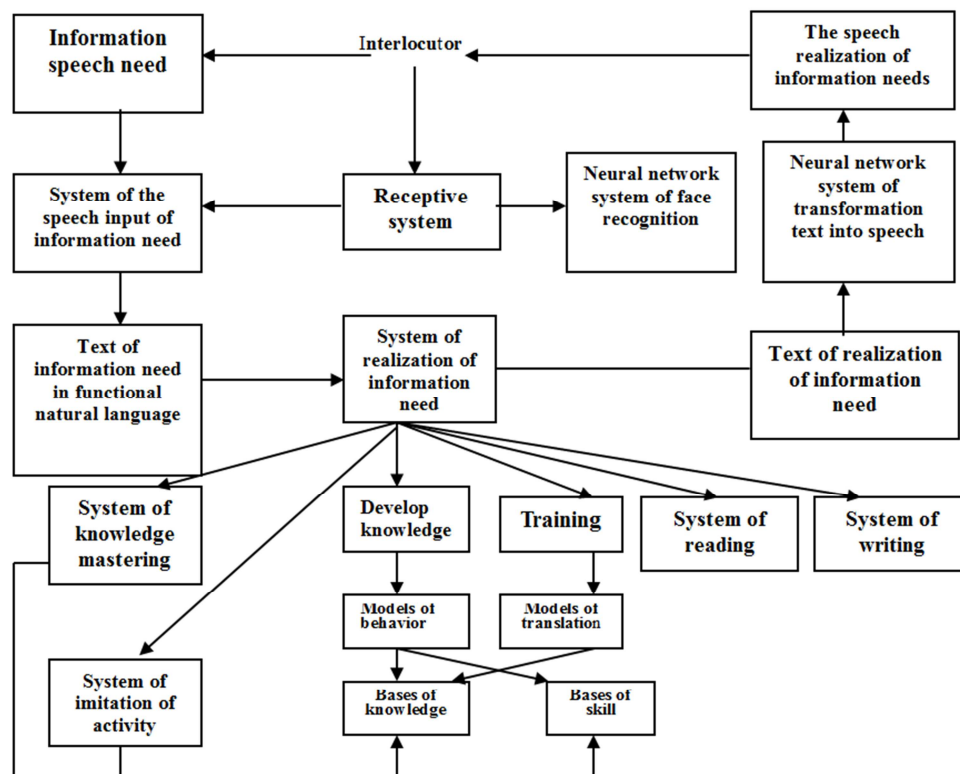


Figure 5. Functional structure of the cognitive professional robot.

The functional structure of the cognitive professional robot with retraining consists of various systems with artificial intelligence (Figure 5).

4. Conclusion

The cognitive robots with communicative and associative logic of thinking having the systems of machine retraining of realization of information requirements will be able quickly to change professional qualification and competences.

The robot with communicative and associative logic of imitative thinking, having remote communication with the person, is capable to carry out cognitive information needs of the person for many spheres of activity.

The international scientific and engineering society gradually moves to technical realization of the cognitive professional robot with retraining.

In the future in labor market cognitive robots with retraining will perform professional works, and the person will occupy a niche of scientific research of creative innovative activity.

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