A COMPLETE MODEL FOR BRAIN MAPPING

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Abstract

Natural Language is an important characteristic of humans that distinguishes them from other living beings. Communication between individuals could be in the form of spoken and/or written languages, facial and other bodily gestures and signs. Hence, it is important to express and be understood and also understand and respond to the others. In this work, firstly the study of internal functioning of the brain is done which include the detailed insight of how semantic knowledge is represented in the brain, which parts of the brain are mainly involved in language processing and language understanding and Cognitive Architectures called ACT-R6 and SOAR which is based on the above processes are also studied. Some parts of brain deal with some specific tasks in language processing. To understand it we have gone through various models like model of the memorization process, model of language processing, model of comprehension and cognitive model of brain. On the basis of these models, we have design a model for both language understanding and language generation processes. The working of ACT-R6 is implemented on an application of computations of Family Relations.

Keywords:

Model of memorization, Model of comprehension, Language processing model of brain, Cognitive model of brain, Complete model of language generation and understanding, Brain mapping in computations.

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1. INTRODUCTION

1.1 Brain Structure and their function for language processing

The nervous system is your body's decision and communication center. The central nervous system (CNS) is made of the brain and the spinal

cord and the peripheral nervous system (PNS) are made of nerves. Together they control every part of your daily life from breathing and blinking to helping you memorize facts for a test. Nerves reach from your brain to your face, ears, eyes, nose, and spinal cord and from the spinal cord to the rest of your body. Sensory nerves gather information from the environment,

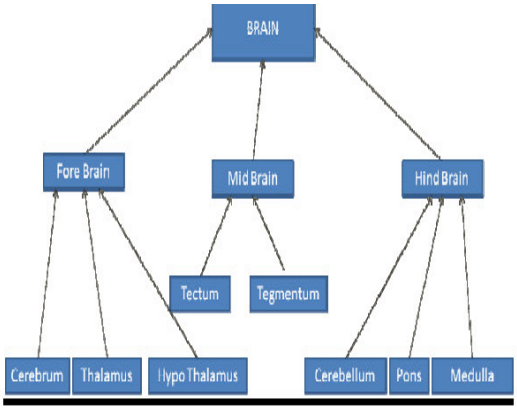

Fig 1: Parts of the brain

Send that information to the spinal cord, which then sends the message to the brain. The brain then makes sense of that message and fires off response. Motor neurons deliver the instructions from the brain to the rest of your body. The spinal cord, made of a bundle of nerves running up and down the spine, is similar to super highway, speeding messages to and from the brain at every second. As shown in Fig 1, the brain is made of three main parts: the forebrain, midbrain, and hindbrain. The forebrain consists of the cerebrum, thalamus, and hypothalamus (part of the limbic system).The midbrain consists of the tectum and tegmentum. The hindbrain is made of the cerebellum, pons and medulla. Often the midbrain, pons and medulla are referred to together as the brainstem. [1]

1.2Brain and Language: Importance of Brain in Language Processing

Neurological Basis of Language Processing and human brain that typically has some parts dealing with language processing. Some parts of brain deal with some specific tasks in language processing. This claim is found to be true to some extent. Some portions of human brain are always involved in language related specific tasks like word production and comprehension or syntax and semantic processing. But the earlier accepted hypothesis that only two classical parts of brain, Broca's area and Wernicke's area, deal with language was discarded with the evidences of involvement of other brain parts in language related tasks. [2]

2. DIFFERENT MODELS OF BRAIN

2.1 Working of memory and Hierarchical Dual Memory Structure to determine cognitive model of Human Brain

As shown in Fig 2 the model of memorization consists of following three processes. [3], [4]

1. Encoding Process:

Encoding is an active process which requires selective attention to the material to be encoded. Memories may then be affected by the amount or type of attention devoted to the task of encoding the material.

2. Storage Process:

Now a days, memory theories use a computer-based, or information processing model. The most accepted model states that there are three stages of memory storage and one more for memory retrieving:

- **Sensory store** retains the sensory image for only a small part of a second, just long enough to develop a perception. This is stored in the Sensory Buffer Memory (SFM). Action Buffer Memory (ABM) which is used as a buffer when recovering information.

Short Term Memory (STM) lasts about 20 to 30 seconds when we do not consider rehearsal of the information. On the contrary, if
rehearsal is used then short term memory will last as long as the rehearsal continues. Short term memory is also limited in terms of the number of items it can hold. Its capacity is about 7 items but can be increased by chunking, that is, by combining similar material into units.

Long Term Memory (LTM) has been suggested to be permanent. However even though no information is forgotten, we might lose the means of retrieving it.

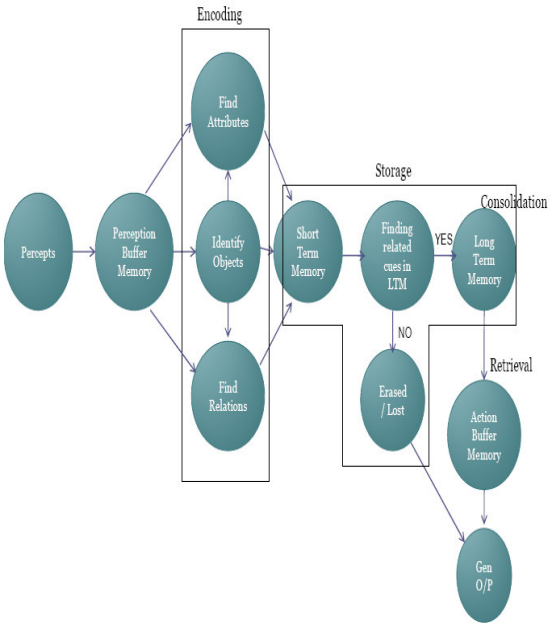

Fig 2: The model of memorization

3. Retrieval Process:

Memory retrieval is not a random process. Once a request is generated the appropriate searching and finding processes take place. This process is triggered according to the organization structures of the LTM, while the requested information is provided via the Action Buffer Memory.

2.2 The Cognitive Process of Comprehension & Formal description of the Cognitive Comprehensive Process

In cognitive psychology, comprehension involves constructing an internal representation. Comprehension has a relation with the comprehender's background knowledge. This means whatever we are trying to comprehend we rely on our existing knowledge previously gained in the brain. As shown in fig 3 in cognitive informatics, comprehension is classified as a higher cognitive process of the brain at the higher cognitive layer that searches relations between a given object or attribute and other objects (O), attributes (A), and relations (R) in the long-term memory, and establishes an OAR model for the object or attribute by connecting it to appropriate clusters of the memory. [5]

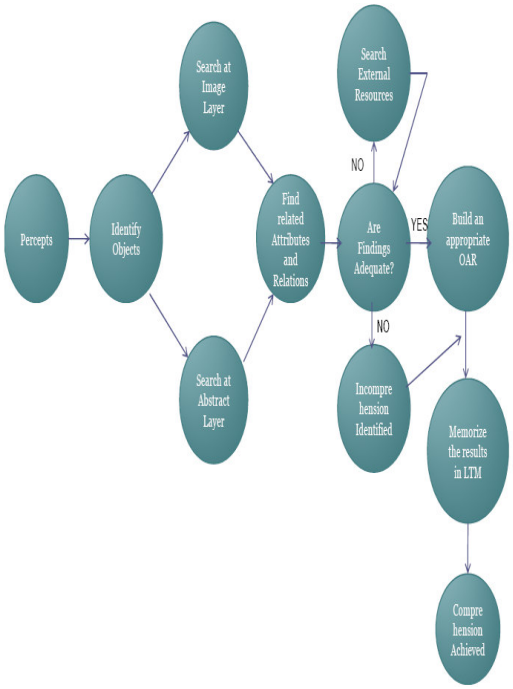

Fig 3: The model of Comprehension

2.3 Cognitive Models of Brain

In this model as shown in fig 4, some fundamental cognitive mechanisms of the brain, such as the architecture of the thinking engine, knowledge representation and establishment in long-term memory, and roles of sleep in long-term memory development. This model has demonstrated that memory is the foundation for any natural

intelligence. Structures of memories have been explored and cognitive models of the natural intelligence have been investigated. [6]

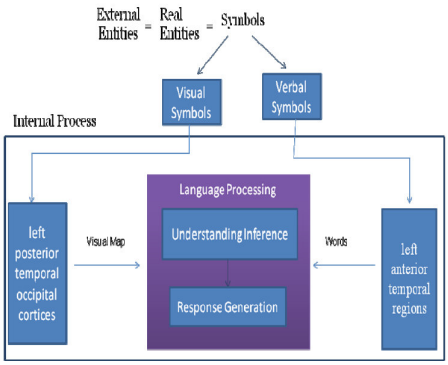

Fig 4: Cognitive model of Brain

2.4 Language processing model of Brain

This model, as shown in fig 5, concentrate on the ways how a human brain can process English and other human natural languages because taken in general sense the ability to speak English or other human languages is only serious distinguishing feature that rises humans over the rest of the world making a human an intellectual being.[7]

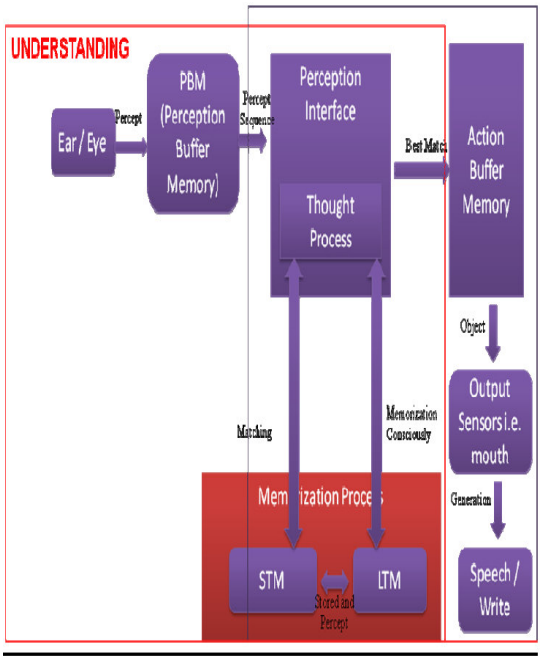

Fig 5: Language processing model of Brain

3. THE COMPLETE MODEL OF LANGUAGE GENERATION AND UNDERSTANDING

The operation of the model shown in fig 6 is as follows:

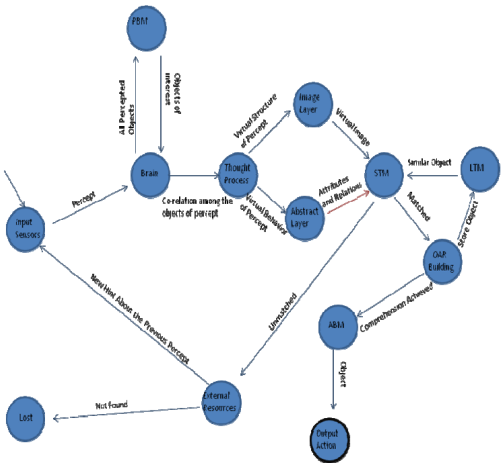

Fig 6: Complete Model

3.1 Implementation Design

Let's start with the first state, when we see something or hear something, our sensors get activated, and tend to capture the input symbols, visual or auditory. These symbols are then passed on to the brain. Now the brain gets activated and all the objects perceived by the sensor get stored into the Perceptual Buffer Memory (PBM). It is a kind of buffer which stores all the percepts, which is called as a percept sequence.It is an input oriented temporary memory and a set of queues corresponding to each of the sensors of the brain i.e. visual sensor and auditory sensor.The capacity of PBM is quite small. When new information arrives, the old one in the queue should either be moved into STM or replaced by the new one.

Now brain will filter out the objects which are of its interest and intuitively identify the correlations amongst them. The thought process is bifurcated into Image layer and Abstract layer.The virtual structure of the percept is stored in the image layer and the behavioral aspects like attributes and relations are stored in abstract layer. So these arethe two inputs to the working memory, i.e. Short Term Memory (STM).The input percept is now matched with the contents of both the image layer and the abstract layer. The STM is a set of stacks and when the virtual image and its attributes match with contents of the working memory, the Object-Attribute-Relation (OAR) model will be built. The OAR model is a model which represents the relationships amongst the objects and their attributes. The building of OAR model means thatcomprehension has been achieved.This object (language) will get stored into ABM (Action Buffer Memory). It is an output oriented temporary memory and its functional model is a set of parallel queues. TheABM now initiates an output action which is again symbolic in the form of language token.

If matching fails, the'percept understanding' needs the intervention of external resources like dictionary or another human. And if the hint / help comes from the environment then again the input sensor will get activated and now the same process will become the process of language understanding. And if it does not come from the environment, the thought process gets background or temporarily delinked, reaching a dead state. This

complete process is shown in the form of various functional processes in Fig 7 under implementation.

The memory can be made permanent by a refresh process which involves attention,repetition and associated ideas or concepts i.e. it can be converted into Long Term Memory (LTM).

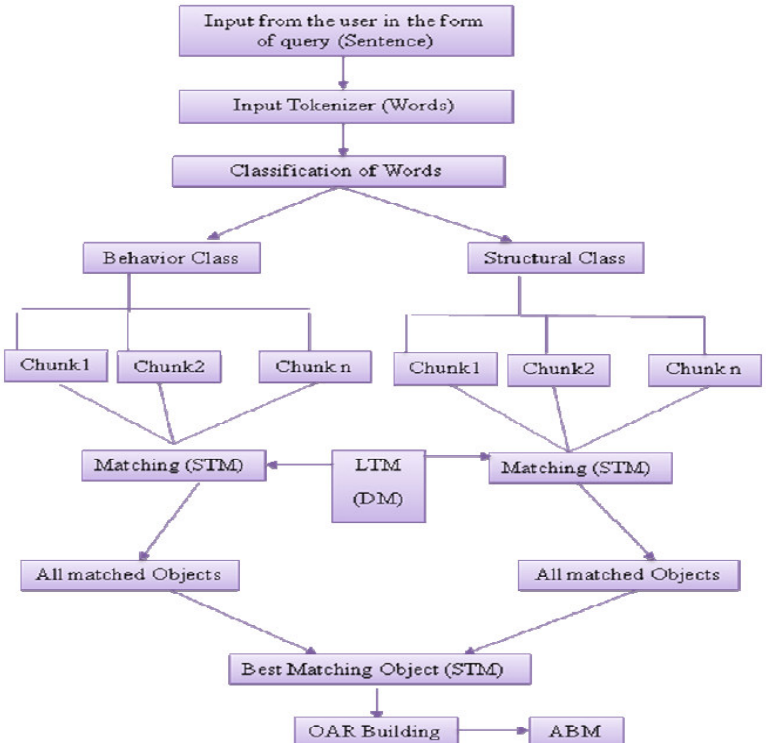

Fig 7: Implementation Model

4. RESULTS FOR BMC OF FAMILYRELATIONS

4.1 Output of Main Form

In fig 8 act as an interface in which various optionslikeProjectInfo,FamilyMembers,FamilyRelations,Enquiry are taken.

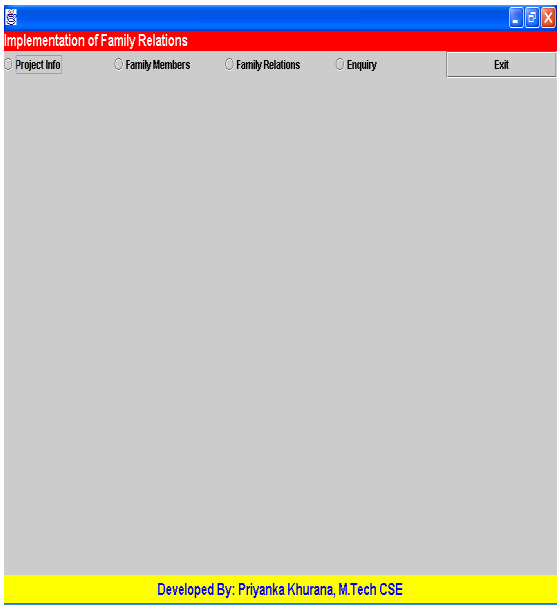

Fig 8: Main Form Output

4.2 Output of ProjectInfoPanel

Fig 9 shows how ACT-R works

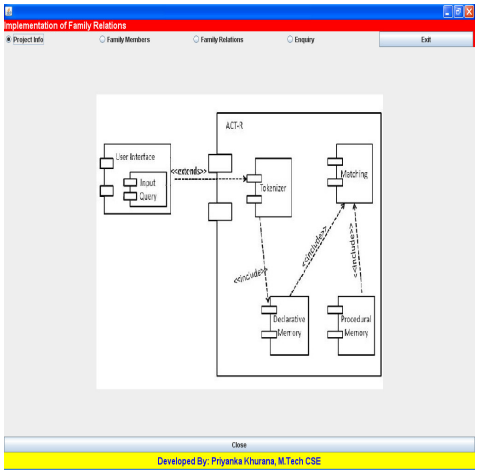

Fig 9: ProjectInfoPanel Output

4.3 Output of FamilyPanel Form

In fig 10 familymembers names are added and these names are saved into the declarative memory of brain.

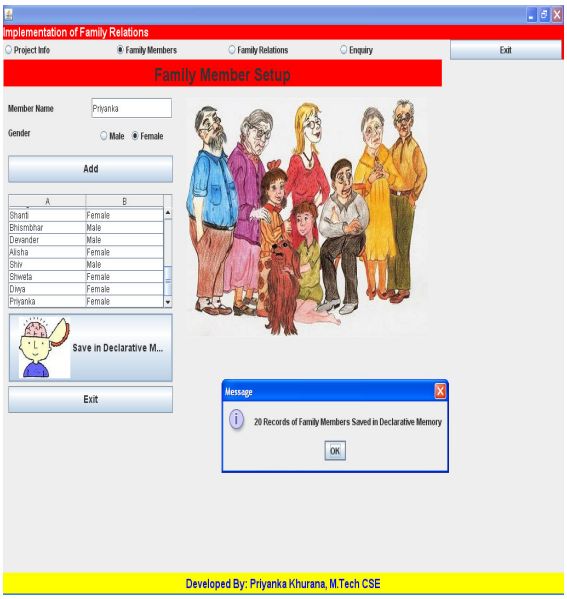

Fig 10: FamilyPanel Output

4.4 Output of RelationPanel Form

In fig 11 familymembers relations are added and these relations are saved into declarative memory of brain.

Fig 11: RelationPanel Output

4.5 Output of InferencingFrame Form

In fig 12 inferencing of familyrelations was done we can select the name of two familymembers and it can infer the relations between these two with the help of pattern matching process in procedural memory.

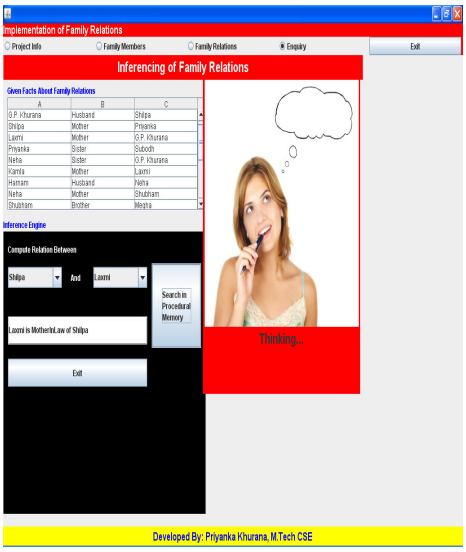

Fig 12: InferencingFrame Output

5. CONCLUSION

The major assumption of this thesis is that both language understanding and generation are based upon an individual's memorization capability. Some parts of brain deal with some specific tasks in language processing. To understand it we have gone through various models like model of the memorization process, model of language processing, model of comprehension and cognitive model of brain. On the basis of these models, we have design a model for both language understanding and language generation processes. The working of ACT-R6 is implemented on an application of computations of Family Relations. Various forms like Main Form,ProjectInfoPanel,FamilyPanelform,RelationPanel Form was made. MainForm act as an interface where as in ProjectInfoPanel shows how ACT-R works.In FamilyPanel and RelationPanel Form family members name and their relations are added and save into declarative memory and in InferencingFrame it can infer the relations between two

familymembers with the help of pattern matching process in procedural memory and came up with some conclusions.

REFERENCES

[1] http://serendip.brynmawr.edu

[2] Sumit Mundhra(under guidance of Dr. Harish Karnick And Dr. Achala Raina.), *Brain and Language: Importance of Brain in LanguageProcessing, 2005.*

[3] Fernando L. Pelayo, Fernando Cuartero, Valentin Valero, Maria L. Pelay And Mercedes G. Merayo, *How does the Memory Work?,* Dept. Inform´atica E. Polit´ecnica Superior Albacete, Universidad de Castilla-La Mancha..2003.

[4] Sherwin Han, *Hierarchical Dual Memory Strucrure Determines Cognitive Model Of Human Brain***,** Moka, LLC,2008.

[5] Yingxu Wang and Davrondjon Gafurov, *The Cognitive Process of Comprehension,* Theoretical and Empirical Software Engineerin Research Centre, Dept. of Electrical and Computer Engineering,University of Calgary, UNU Visiting Fellow at Univ. of Calgary, Department of Informatics and IT,Technological University of Tajikistan,2003.

[6] Yingxu Wang and Ying Wang, *Cognitive Models Of The Brain,* Theoretical and Empirical Software Engineering Research Centre, Dept. of Electrical and Computer Engineering,University of Calgary,2002.

[7] Alexander BORZENKO, *Language Processing in Human Brain,2008.*