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Memory Association and Reaction by Conditioning Mechanism

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Abstract: As an interest in researching brain is growing for recent years, the researches into intelligence, mind, sensory and memory based on the brain function is getting activated. focusing on conditioning among the brain functions,we designed the strategy of memory association and reaction process. First of all, the functions of amygdala in the brain is investigate and applied to design the intelligent system. We developed memory association system considering 'conditioning'. DTAM(Dynamic Thinking Association Map)was designed for implementing 'conditioning' function. It is applied to the virtual memory and tested with sample data.

Keywords: Conditioning,Thinking chain extraction, Data selection, knowledge network

1. INTRODUCTION

Human brain has evolved for several million years and has a most optimum functions for surviving in the dynamic complex environment. That is, the brain is a final intelligent product which is adaptable in the dynamic situation.

Many of innovations introduced in the field of technology by the scientific and information revolutions set the stage for a qualitative change in the base of human society. We are standing on the dramatically changing point where human society and computer world overlap. In this situation, the importance of implementing more human friendly computer system is getting high and more convenient Human-Computer-Interface(HCI) is required. The strategy of adopting human brain functions has a strong point in two perspectives. One is that human brain is most outstanding problem solver in the circumstance enclosing the human society. Human brain is not only intelligent but also adaptable in data learning, memorizing, reasoning and memory recalling process. The other is that it has an effective communication tools and process. Recently many studies on the brain science has been made and applied to many engineering parts for making more intelligent and efficient systems.

In this paper, focusing on conditioning among the brain functions,we designed the strategy of memory association and reaction process. First of all, the functions of amygdala in the brain is investigate and applied to design the intelligent system. We developed memory association system considering 'conditioning'. DTAM(Dynamic Thinking Association Map)was designed for implementing 'conditioning' function. It is applied to the virtual memory and tested with sample data.

2. CONDITIONING AND HUMAN AMYGDALA

Since Pavlov(1927), it has been known that an initially stimulus, a conditioned stimulus(CS), can acquire affective properties upon repeated temporal pairings with a biologically significant event, unconditioned stimulus(US)[1]. As the CS-US relation is learned, innate physiological and behavioral responses come under the control of CS. Research from several laboratories combined in the 1980s to paint a relatively simple and clear picture of the neuroanatomy of fear conditioning[2,11,12,13,14]. In this studies, the CS and US are typically an audible tone and foot shock, and the responses measured include freezing. It is thought that fear conditioning is mediated by the transmission about the CS and US to a small almond-shaped area which is called 'Amygdala'. Amygdala is a group of nuclei located deep within the medial temporal lobes of the brain in complex vertebrates, including humans. Shown in research to perform a primary role in the processing and memory of emotional reactions, the amygdalae are considered part of the limbic system

The control of fear reactions is made by way of output projections from the Amygdala to behavioral autonomic, and endocrine response control systems located in a collection of nuclei, altogether referred to as the 'brain stem'. In addition to expressing fear responses to the CS, rats exhibit these when returned to the chamber in which the tone and shock were paired or a chamber in which shocks occur alone. It is called 'Contextual fear conditioning' where context refers to various visual and olfactory aspects of the chamber, and requires both the Amygdala and hippocampus, a brain structure know to enable long-term memories. Conditioning can be mediated by US inputs to the Amygdala from either thalamic or cortical area.

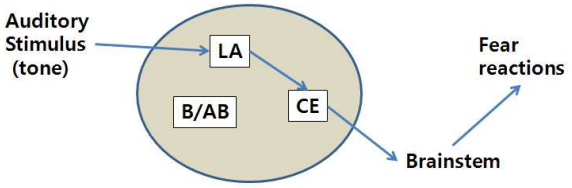

Fig. 1 Initial

As shown in figure 1, Conditioning to a tone involves projections from the auditory system to the lateral nucleus of the amygdala (LA) from LA to the central nucleus of the amygdala(CE). In contrast in figure 2, conditioning to the apparatus and other contextual cues present

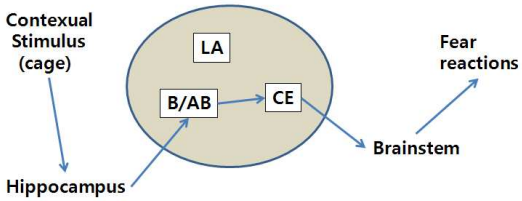

Fig. 2 Conditioning

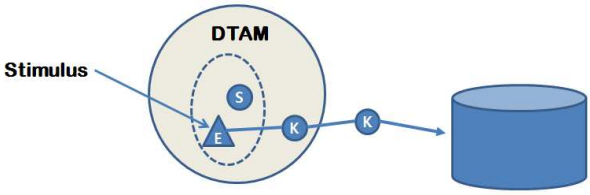

Fig. 5 Stimulus :E

when the conditioned stimulus and unconditioned stimulus are paired involves the representation of the context by the hippocampus and the communication between the hippocampus and basal(B) and accessory basal(AB) nuclei of the amygdala, which in turn project to CE. As for tone conditioning, CE controls the expression of the response.

3. MEMORY ASSOCIATION AND REACTION BY CONDITIONING PROCESS

3.1 The design of DTAM

Adopting the function of amygdala Dynamic Thinking Association Map(DTAM) composed by conditioned learning process is designed. Also based on the formed Dynamic Thinking Association Map the system extracts the related knowledge fragments from the Knowledge Network.

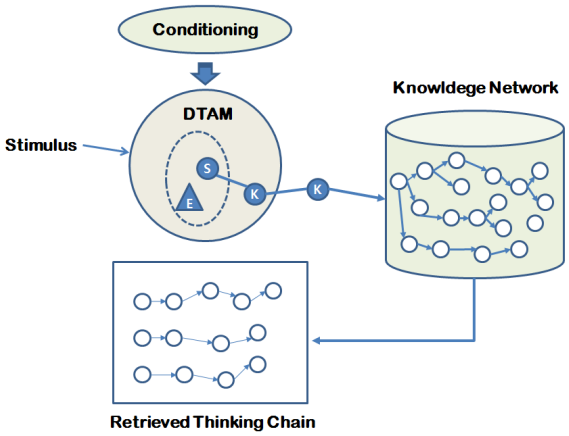

Fig. 3 Dynamic Thinking Association Map

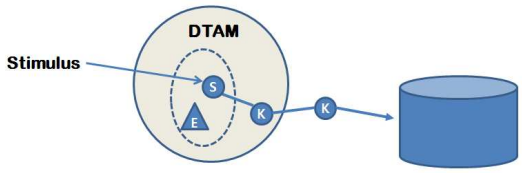

Fig. 4 Stimulus : S

As shown in figure 3, two nodes in DTAM are associated by conditioning mechanism. The associative relation between S and E node is gained by conditioning. After conditioning process, S-E pair shows the associative reaction. Especially in memory recalling process,the conditioned associative relation effects on the knowledge extraction. In the initial states, node E has no relation with the retrieved thinking chains connected to node S. But after conditioning mechanism, only stimulus of E can retrieve the thinking chains related to node S.

3.2 Hierarchical Memory Construction with Knowledge Networks

The knowledge network which construct memory consists of knowledge nodes and their associative relation. We design the knowledge network as a base of memory for the efficient reasoning and extracting process. And it also has a strong point that it is easy to express the conceptual dependence in the knowledge.

The basic unit of knowledge network consists of two nodes and their connected relations as following figure 6.

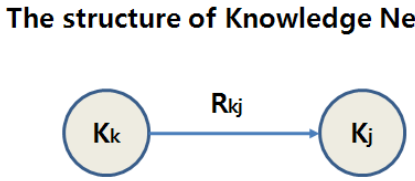

Fig. 6 The basic frame of knowledge network node and knowledge network

Knowledge node, K_j represents jth knowledge node. One knowledge node is connected to the other knowledge nodes with relational strengths. Relational strength, R_{jk},represents association degree between two nodes. The knowledge network is stored in the memory in a form of knowledge associative list[3].

$$R^i_{jk} = P(K^i_k | K^i_j) \tag{1}$$

3.3 Conditioning Mechanism in DTAM

In this system, DTAM(Dynamic Thinking Association Map) is designed for implementing Conditioned Reaction. Conceptual thinking association makes DTAM by repeated process of conditioned learning. As a Thinking activity is repeated, the new conceptual association is created and its Thinking relational strength gets high. Thinking Relational strength,T_{qs}, is calculated by equation (2).

$$T_{qs} = \frac{\sum C_{qs}}{\sum n_q + \sum n_s} \tag{2}$$

where C_{qs} is a number of Conceptual thinking association between knowledge node K_{pq} and K_{rs} and n_q, n_s is the referred number of knowledge node K_{pq} and K_{rs} respectively .

Given Firing threshold,θ, associative activating status,a_i, is determined by equation(3).

$$a_i = \begin{cases} 1 & \text{if } T_{qs} > \theta \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

3.4 Thinking chain extraction from Knowledge Network using DTAM

Using Conditioning Thinking association on DTAM, the system extracts Thinking chains from Knowledge Network. If the activation status is on, the system finds the related knowledge node and from these nodes it starts to extract the connected knowledge fragments from the knowledge associative list. The knowledge fragments extracting algorithm is as follows:

Algorithm 1 : Knowledge Fragments Extraction

** Search DTAM*
STEP1 : If(activate status = on)
STEP2 : Put the related nodes to queue;
STEP3 : while(queue != Empty) do
begin
Take out node.
** Extract the related Knowledge Fragments from knowledge associative list.*
STEP4 : Search the matched knowledge node with the Keyword in knowledge associative list.
STEP5 : while(found != true) do
begin
Attach the extracted knowledge network to the starting node;
node = node-next;
end
end
STEP6 : Output the concatenated knowledge Fragments.
STEP7 : Stop.

If there are branches in knowledge network, several paths of knowledge fragments are extracted. We define this knowledge fragment as Thinking chain. For the decision making process, the efficient selection process is needed for choosing the best matching knowledge path. The selection process has two steps: First step is filtering the path by the threshold of Relational strength. In this step the connected path which has the relational strength greater than threshold value. The next step is to select the best matching path by Maximum Likelihood method.

$$K_B = argmax_v P(v) \prod_i P(K_i|v) \quad (4)$$

4. EXPERIMENTS

We apply Conditioning process to the example of virtual memory as following Figure 7. In the example, there is no conceptual relation between K_1 and E node in the initial state, but the new association in DTAM was made by Conditioning process. As shown in figure 8, when input data stimulates E node in the initial state,there is no reaction because there are no related knowledge node to node E. But in the case of DTAM=active, E-K1 pair is formed and K1 node is activated. Then the system starts to extract the connected knowledge nodes with node K1.

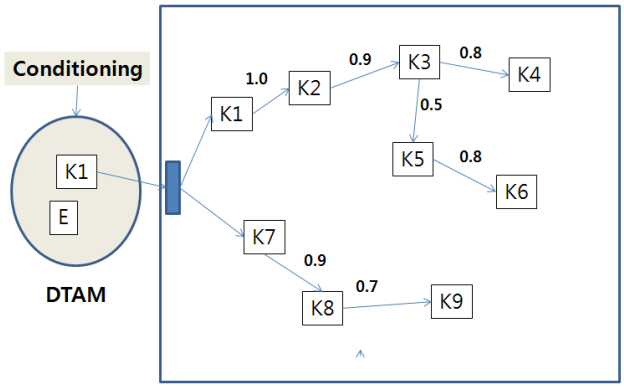

Fig. 7 Example of virtual memory:Initial state

K_1	1.0	K_2
K_2	0.9	K_3
K_3	0.8	K_4
K_4	1.0	Null
K_3	0.5	K_5
K_5	0.8	K_6
K_6	1.0	Null
K_7	0.9	K_8
K_8	0.7	K_9
K_9	1.0	Null

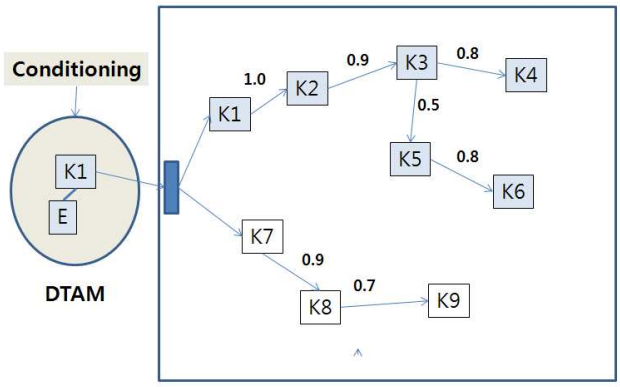

Fig. 8 The activation of Knowledge Network: After conditioning

In the experiments, the new creating process of Thinking Chain and DTAM made by conditioned Learning module was shown. The conditioning mechanism can be usefully used for reasoning process, conceptual dependency and data extraction. Like a main function of amygdala in human brain, the concept of knowledge association including emotional factor can be designed and implemented naturally in the future work. This system also can be applied to construct core brain like frame of Intelligent System.

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Conditioning test...
DTAM? N
STIMULUS?E
DTAM = not active

No Reaction.

Conditioning test...
DTAM? Y
STIMULUS?E
DTAM = active

Knowledge extraction...

K1 1.0 K2 0.9 K3 0.8 K4 1.0 NULL
K1 1.0 K2 0.9 K3 0.5 K5 0.8 K6 1.0 NULL
```

Fig. 9 DTAM test

5. CONCLUSION

As a Thinking Association system by conditioning mechanism, DTAM was designed for representing internal conceptual association. Based on DTAM the system extracts the related thinking chains from the Knowledge network. The knowledge extracting process is made in various ways of level extraction by threshold. It means that this system can control the depth of Knowledge extraction by threshold values. As a results of experiments, we could find that the extracted knowledge fragments were successfully obtained in the different conditions. This system can be applied to construct core brain like frame of Intelligent System.

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