Architecture of Cognitive Ability and Decision Making of the Human Brain.

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Modeling of Cognitive Architecture of the Human Brain.

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Abstract

Scientists are making attempts to understand the connotation and logic of human brain. We presented here few classes of reasons why it is acceptable that human brain cognition is similar to various mathematical techniques and models. This understanding helped us to model cognitive architecture of the human brain. The cognition process is an ability to perform the case specific parameter based calculation on the basis of the data acquired by five human senses pertaining to different cases. The sources of case specific data are observations, understanding of various learning and training events during the lifespan of an individual. We established that decisions are dependent on the result of calculations based on the "knowledge base" e.g. the entire database of the brain obtained by learning, training and experience. Furthermore the logical ability, decision making, common sense, feelings, emotions, case specific reactions, intelligence and individual characteristics are the results of the case specific calculations supported by acquired "knowledge base". The cognitive ability of an individual is dependent on the optimization level of the knowledge base and case specific learning, training and sensitivity of senses. And secondly on a degree of deviations in actual versus processed data while 'storage processes' and 'retrieval processes'.

Keywords: Artificial Intelligence, Cognition, Intelligence, Human Brain Architecture, Logic, Senses

INTRODUCTION

The aim of the paper is to develop the cognitive [1, 2, 3] architecture of decision making using the human brain as a reference model. After careful analysis of the *cognitive process*[†] of human brain we reached to an opinion that human brain must be applying the mathematical or similar technique for data processing and case-specific decision making based on the architecture of Figure 3 and Figure 8 below. Cognition of human brain is very systematic activity based on the very efficient and dynamic algorithms of data warehousing and mining [4, 5, 6]. Cognitive ability development is

[†] Considering the storage and processing capacity of human brain, it is not possible for brain to store entire data without converting it into some compressed format. E.g. In computer programming for generating different colors, instead of storing the templates of all possible color shades we converted three basic colors into numerical values from 0 to 255. And proportion for particular is represented by a mathematical formula RGB(X,X,X) where X is a value of respective color from 0 to 255 which merely takes few bytes of storage and negligible processing overhead. Human brain must be using the similar technique for its operations as algorithms of human brain require only 1/1000 resources as compared to computational algorithms.

an unending process for the entire life of an individual.

Theoretical and Experimental Validations

Cognitive ability development process is affected by various factors like emotional factor, age, gender etc. After acquiring the basic cognitive ability further learning and training are mere optimization of the weight of case-specific parameters. Cognition [7] gives us the ability to perceive with the help of "knowledge base" acquired. Further, cognition is the output of a trigger to highly normalized "knowledge base". It means data received by one sense can be used by trigger of other sense and decision engine. E.g. when we look at food items, we can recollect its taste or if someone is speaking nearby us we can recollect face from voice samples as data is in highest possible normalized state. Other two factors which play very important role in cognitive process are psychology [8] and confidence. They are opposite to each other and they have very interesting correlation depicted in next section.

Cognitive Development

When we learn or try to learn, indirectly we are developing and optimizing the cognitive ability. Optimization of cognitive ability is finding most suitable values of parameters specific to a case. This can be explained with the help of Example in Figure 1.

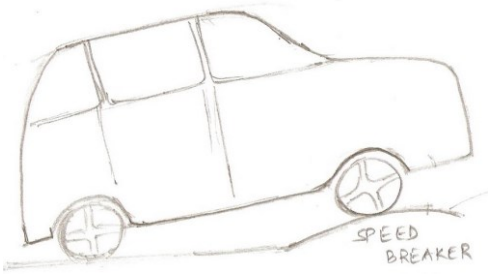

Figure 2 Vehicle and Speed Breaker

Preamble

Values of parameters, parameter weights and combination of parameters are chosen to have maximum possible resemblance of actual situation to case specific situation in "knowledge base" generated by senses input, learning and training. Parameters

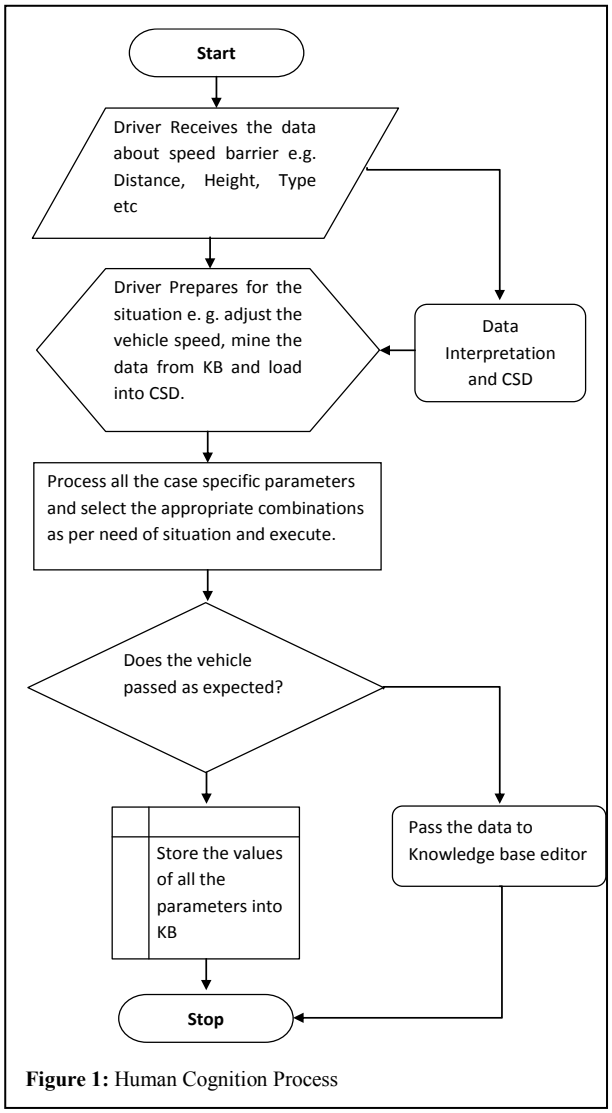

Figure 1: Human Cognition Process

and weight are of two types e.g. compulsory and optional depending on the situation.

Case 1 Expected Result

When new driver crosses the speed breaker first time, driver will apply the suitable combination clutch, break and accelerator along with appropriate speed gear and if results of combination are within acceptable range then data of parameters used e.g. weights of parameters, situation specific parameters are passed for updating to knowledge based for optimization as shown in figures 2 and 3.

Case 2: Unexpected Results

When driver crossed speed breaker with unexpected results means values of applied parameters, parameters weights and combination values are passed to knowledge base editor for suitable modification .e. g. modification of parameter weight, parameter value and parameter combination as shown in Figures 2 and 3. The process of modification is repeated till we get expected results. The repetitions of 'parameter modification process' is learning in general term. General cognition process followed with respect to given case is represented in Figure 2 algorithm whereas different functional blocks participating in a process is shown in Figure 3. When a driver receives data about speed barrier (Breaker) on a road by any of senses, data will be sent to interpretation system which then prepares for action. While preparing for appropriate action system considers all previous results of learning and training and parameter values that have been used, the weight of each parameter value e. g. weight (Importance) of speed, gear, break etc. The importance here means the weight of the parameter in a process. Weights of the parameters are highly situation dependent. A young driver might give less importance to a speed of vehicle where as experience and old driver will give more weight to speed of vehicle, weight of speed will also vary with driver's psychology [6] and confidence. Parameters like type of vehicle empty or loaded, passenger vehicle or goods carrier in each case the speed will have different weight and value.

Repetition Process

Repetition process is responsible for development of psychology and confidence of an individual. The repetition process is carried out in both cases i.e. in case of expected and unexpected result. In case of expected result modification process is executed for going near to accuracy in general term becoming expert in doing the task. The number of trials (Repetition) required to achieve the desired result is proportional to the square of complexity of task. Complexity is calculated with Big-Oh notation

Big-Oh notation is something that f(x) is asymptotic to.

$$f(x) = \sum_{n=2}^{N} (x-1) \quad (1)$$

$$= O(F(x)) \ldots\ldots (2)$$

Further the outcome of each state may be summed as factorial sum expansion. The square of complexity is number of trials required to learn or to adapt. To simplify, measure of square of complexity value is scaled down to 0 to 10. Now each expected outcome will add positive and negative weight to psychology as specified below. But again it depends on the biasing factors like values of confidence and psychology calculated as below.

a. Add + **0.1** to confidence and **-0.1** psychology for each expected result
b. Add - **0.1** to confidence and **+0.1** psychology for each unexpected result

The threshold of acceptable range of expected result is plus minus 10% of the complexity of the expected outcome. There is again an interesting relation between psychology and confidence based on their current values. The results of the comparison are as shown in **Figure 4**.

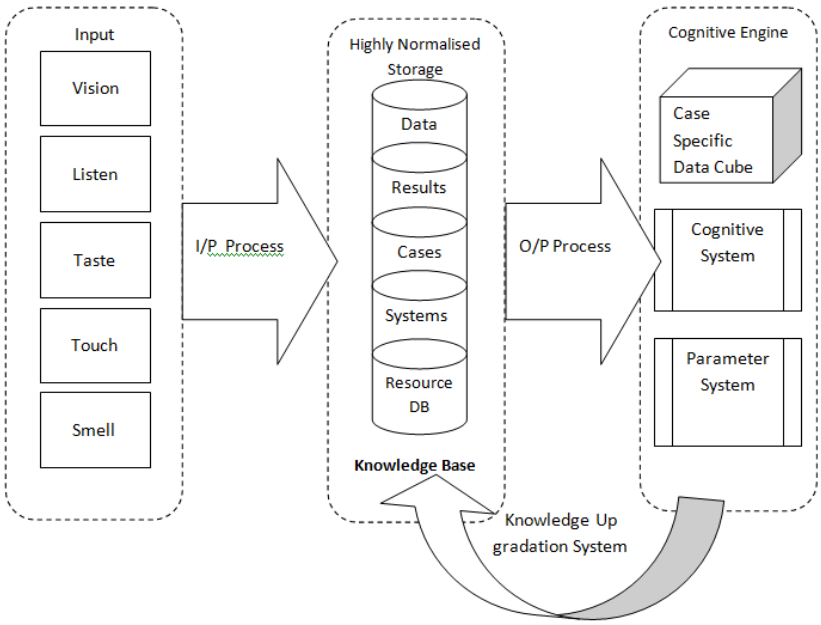

Figure 3 Development of Knowledge Base

1. Psychology > Confidence = Wrong Decision
2. Psychology < Confidence = Right decision
2. Psychology = Confidence = Confusion

Figure 4 Comparison between Psychology and Confidence

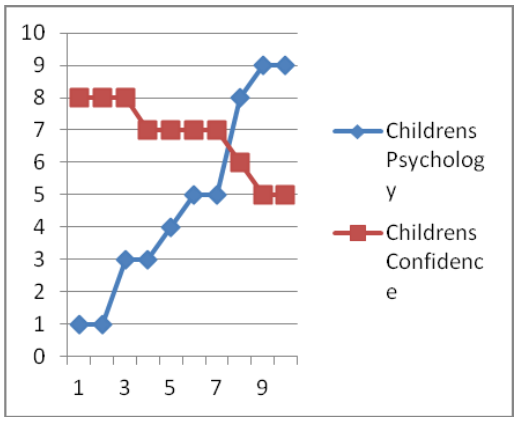

Figure 5 Psychology vs. Confidence of Children

Outcomes shown in Figure 4 are common in all age group and genders. They show the same trends in entire scenario i.e. age group and gender. The difference is it shows slight little deviations as per age group and gender. These outcomes mentioned in

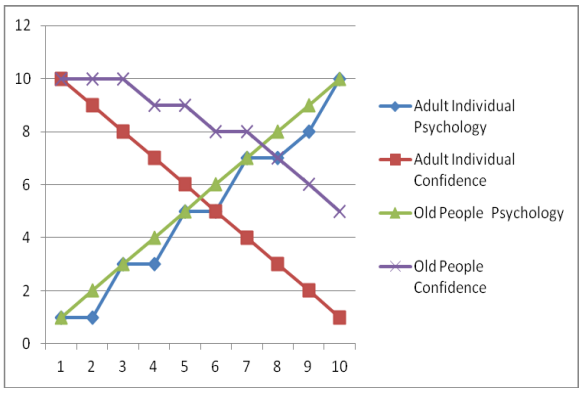

Figure 6 Psychology vs. Confidence of Adults and Old People

Figure 4 are made after giving due consideration to scientifically unexplored areas like common sense, emotions and feeling of individuals. The result of analysis of gender and different age groups are as follows. It supports the outcomes of Figure 4. Figures 5 and 4. It shows that there is significant variation in psychology and confidence with respect to the age group. Here in this research age exactly does not refer to age of person but it refers to data an individual is aquring through senses with respect to age. To make it more clear data was collected after specific training for basic activities like receiving instruction and repeating task, making an arrangement showing them particular video, music or both. For representation purpose data was converted on Likert scale of 10. We also collected data from disabled people which gave us great clues to obtain our results. Due to the ethical binding data for disabled people in not presented. Figure 7 depicts the psychology and confidence relation of male and female. All the variations of psychology and confidence and their explanation are beyond the scope of this paper. Only important aspects of these experiments form the point of view of this paper are taken into consideration.

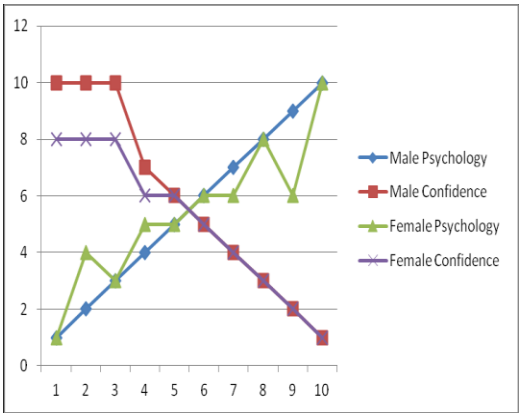

Figure 7 Psychology vs. Confidence of Male and Female

Result

On the basis of our understanding and models built, we designed architecture of human intelligence Figure 8 considering all parameters, systems and subsystems involved in a process of decision making and intelligence. Important parameters are confidence, psychology along with case specific parameters from knowledgebase and weight estimation and modification system. The knowledge building is an ongoing process. It keeps continuously updating “knowledge base” with learning and training. Continuous modification of weight and parameters of knowledge base improve our decision making ability and we call it as “experience”. As we know with experience our decision keeps on improving because we reach to more and more optimized level of parameter values

and weights.

Conclusion

The learning and training happens as shown in the Figures 3 and 8. The learning and training system helps in developing the cognitive ability of individuals. The cognitive ability development involves optimization of parameters involved in process of cognition development process. Acquired data by senses is stored into an 'Entire Database of Brain' under the supervision of "Knowledge Update" and "Learning Management" systems. "Entire Database of Brain" then provides abstract data to "Working Database" to act as per situation demand. Experience goes on optimizing parameter value which results in more precise decisions with experience. Optimization of values is depended on age, gender, psychology and confidence as explained in Figure 5-7. Based on discussion we drafted a cognitive architecture of human brain as shown in Figure 8.

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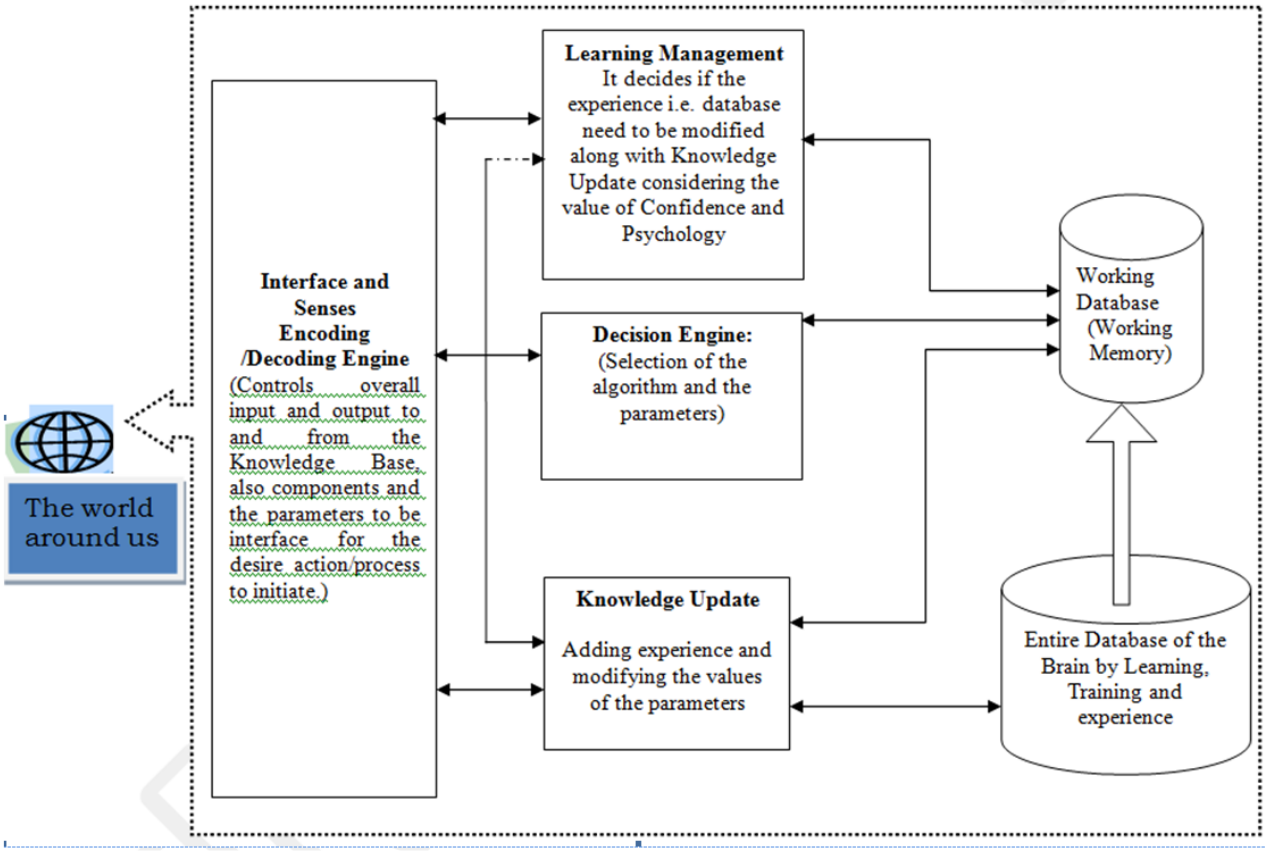

Figure 8 Cognitive Decision Making Architecture

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