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ANALYZING COGNITIVE SKILLS THROUGH DATA MINING

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Abstract

This is theoretical modeling and algorithmic paper about cognitive processing of human brain by using data mining techniques. This paper discusses the challenges associated with cognitive processing of human brain using brain-computer interface. Brain computer interface uses knowledge of electroencephalography systems to deliver output from human brain regarding any situation. Data base is used to store all metadata and by using classification different classes are derived where information related to different aspect (emotional, educational etc) is stored. By using decision making models this information is indexed. From this dataset cognitive skills are evaluated by analyzing from which portion of database (brain) the output is retrieved and how strong or week is the cognitive skills.

Keywords: Data mining, data base, electroencephalography, cognitive skills, brain-computer interface.

1. INTRODUCTION

1.1 Human brain memory

Memory is the storage of acquired knowledge or abilities for later calls. Two categories of memory are 1) declarative or explicit memory and 2) procedural or implicit memory. Declarative memory includes the learning of events, places, names and so on whereas procedural memory includes learning of skilled motor movements. Memory trace is the neural change which is responsible for retention or storage of knowledge. It is possible to memorize bits of information word by word. Storage of acquired information is accomplished in two stages.

First stage is short term memory and second is long term memory [1].When we learn anything firstly it is stored in short term memory which retains for minutes to hours. Short term memory has limited capacity for storage. In this stage two eventual fates are there. Either it is soon forgotten (For example forgetting any phone number after we have finished dialing it), or it can be transferred into the more permanent long term memory mode through active practice. Short term memory has 7 to 10 distinct "registers." That means human brain cannot deals with more than 7 to 10 distinct items on term of short term basis. Process by which short term memory traces are transfer and fixed to long term memory is called consolidation. For example if we cram something this is stored in short term memory but when we learn any topic by our interest this is stored in long term memory. Information in our brain is stored in a summarized way that is when we learn something we store this information in our mind and when we need to write down this we write in our own wording.

1.2 Cognitive skills

Cognitive skills are any mental skills that are used in the process of acquiring knowledge; these skills include reasoning, perception, and intuition. Mid-continent Research for Education and Learning (1998) describes the importance of cognitive skills in acquiring literacy skills [2]. For an example- If in our class our teacher is teaching and we do not find that topic interesting we will obviously not pay attention to the teacher but the words teacher is speaking will strike in our mind and these will be stored in our short term memory which we will forget within minutes or seconds. But when we find any topic interesting we will pay attention and our mind keep on practicing and thinking about that topic and therefore that topic will be stored in long term memory. However proposed approach relates how our mind reasons and does indexing to exact information from metadata.

1.3 Data mining

Data mining is the process of extraction of hidden predictive information from large

databases. Data mining tools predict future trends and behaviors, allowing businesses to make proactive, knowledge-driven decisions [3]. Databases today can range in size into the terabytes — more than 1,000,000,000,000 bytes of data. Within these masses of data lies hidden information of strategic importance [4]. Data mining is a process that uses a variety of data analysis tools to discover patterns and relationships in data that may be used to make valid predictions. Machine learning represents a sub-field of artificial intelligence and it was conceived in early 60s with the clear objective to design and develop algorithms and techniques that implement various types of learning, mechanisms capable of inducing knowledge from examples of data. Machine learning has a wide spectrum of applications including natural language processing, search engines, medical diagnosis, bio-informatics, speech and handwriting recognition, object recognition in computer vision, game playing and robot locomotion. The learning system aims at determining a description of a given concept from a set of concept. The learning algorithm then builds on the type of examples and on the size and relevance of the background knowledge. Machine learning process emphasizes the development of the algorithms and usually assumes data is already residing on the main memory. On the other hand, the first condition for a data mining project to succeed is to have data, large amounts of data.

2. LITERATURE REVIEW

Until recently many researchers have shown interest in field of analyzing cognitive behaviors of human being which gives us so many ways to analyze and improve cognitive skills which results in good decision making.

Terry Peckham and Gord McCalla (2012) uses data mining technique to analyze positive and negative cognitive skills by using reading comprehension tasks. Students were interacted with a learning environment, comprehensions were provided to them and asked questions based on those comprehensions. Time stamp data was processed to calculate reading, scanning and scrolling navigation times. Lloyd's algorithm was used to find students who behave in similar manner for different levels of difficulties. This experiment was conducted using multidimensional k-clustering approach combined with Bloom's Taxonomy. These clusters can be turned to metrics that can be used to discover the strategies the students are using and provide the cognitive skills set [5].

Charun Sanrach et al, 2012 investigate the relative ability of metacognition, data mining technique, and scaffolding to design and develop as the metacognitive learning environment to enhance learning efficiency. In this research three objectives were met metacognitive learning environment using data mining technique and scaffolding was developed and the quality and satisfaction of expert on content, and technique and process was verified and last outcomes of developing learning environment by a group of pilot students were examined. For achieving these objectives in this research paper classification, clustering, learning environment, and scaffolding technique is used to develop cognitive tool to enhance students learning skills [6].

Scott Makeig et al (2012) represented brain-computer interface model. An EEG (electrophysiological systems) sensor system is used to record and process electrical signals from the human brain, automated systems for assessing changes in user cognitive state, intent, and response to events are of increasing interest. BCI systems can make use of such knowledge to deliver relevant feedback to the user or to an observer, or within a human–machine system to increase safety and enhance overall performance [7].

Leon C. Hardy et al (2012) proposed a model of optimal decision rules for cognitive process. There theory named Neurohydrodynamics naturally arises within the framework of neural networks while utilizing the foundations of Decision Field Theory (DFT) for describing the cognitive processes of the mammalian brain in the decision-making processes. The various neural systems involved in emotion, cognition, and goal direction operate somewhat autonomously; there is also evidence for a hierarchical arrangement among regions implicated in executive function [8].

2.2 Indexing

Souripriya Das et al (2012) proposed semantic indexing feature introduced in

Oracle database 11g release 2 for indexing unstructured text columns. For fetching that text SPARQL is used as a query language pattern. Two methods were introduced- indexing which includes extraction of entities and associations and events from RDF. And querying includes SPARQL query pattern that are able to capture complex relationships between query terms. Indexing on RDF is done semantically and this approach provides the ability to augment the index data through inferencing. Multiple extractor output is easily combined [9].

Seema Sundra et al (2010) conducted 3S approach for visualizing large scale RDF data. 3S implies subsets, summaries and sampling. This approach maximizes the usage of visual display as fisheye views incrementally summarizes and expand the graph by using graph expansions primitives. This visualization scheme was applied to both asserted and inferred triples. To avoid cluttered data selective expand was used because it allows user to specify the SPARQL graph pattern to restrict the property expansion [10].

Techniques used in these researches-

In these research papers various methods are used for analyzing cognitive skills. For data mining k-mean clustering combined with Bloom's taxonomy used. For developing cognitive skills after proving learning environment classification is applied and then after doing clustering scaffolding is included. Developmental network model and where-what networks are used to represent spatial aspects of brain-like processing. Brain-computer interface model is introduced with combination of electroencephalography. Decision field theory and quantum hydrodynamics is used for heuristic mechanism for cognitive process decision making. To making data structured semantic indexing approach is attained on RDF through SPARQL query language pattern. 3S approach that is subset, summaries and sampling is applied on graphs with the help of fish eye view.

3. PROPOSED WORK

Proposed research is based on brain-computer interface and mapping of brain through data mining. As our brain stores different types of data and through analyzing cognitive skills it can be determined that for what kind of information out brain is more attentive and for what type of information it is less attentive and which type of information is stored where. In previous researches mapping of brain is done through biomedical instruments whereas proposed work is based on doing mapping on brain relating this to data mining process. The proposed research is based on data mining techniques. It will help to improve and develop cognitive skills by analyzing cognitive skills. Indexing helps to relate the storage of information in brain and analyzing how much time it takes to retrieve information from brain.

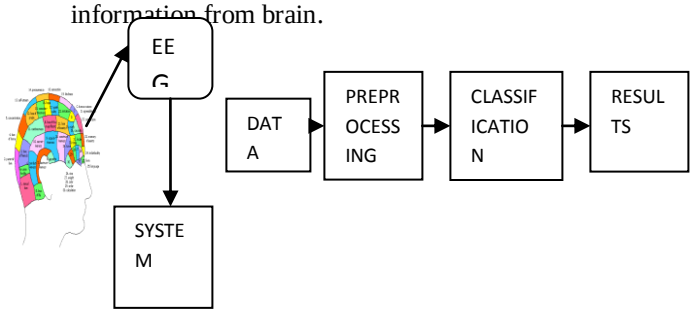

Figure1:OVERVIEW OF PROPOSED TECHNIQUE

4.PROPOSED METHODOLOGIES

Dataset – To collect data a learning environment is needed. By using electroencephalography process can be conducted. Questionnaire related to sample data set is conducted and responsiveness of human brain can be calculated. EEG can results the portion of brain from where this response is coming. By applying algorithms it can be detected that how much the brain is responding and we can apply indexing that which type of information is stored in which portion of brain.

Algorithm - Following data mining techniques can be used

classification

decision making field

First of all classification of brain field is done according which type data is stored in which

portion of brain as showen in figure 2. Bayes classification method is appropriate they give class membership probabilities such as the probability that as given tuple belongs to which particular class. Clustering is the process of organizing objects into groups whose members are similar in some way. Probabilistic clustering or k-mean clustering and its algorithm can be applicable. Decision making models address the evolution of decisions over time by means of reinforcement learning. As more data became available from brain imaging as well as single-neuron studies, these networks gradually integrated their design principles with emerging cognitive and neuroscience data. SPARQL query pattern can be used for implementing oracle database. As SPARQL contains SQL like queries. This query language is able to store and retrieve data stored in RDF (resource descriptor framework) form.

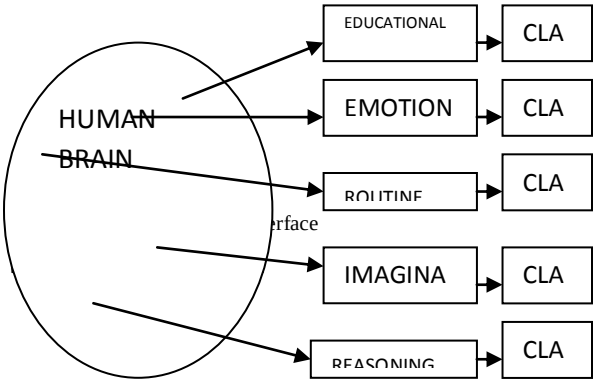

Figure 2:Human-machine Interface

Proposed As our brain stores so much information and when we need any information it is retrieved from there. If we relate our brain as a database and a query is applied on our database to fetch answer to proposed query an indexing is done that is when we listen any word or clue of any game our brain indexes that word or clue to its memory storage and retrieve information of interest. In our brain vast information is stored. By asking questions when cognitive skills are measured these results performs the preprocessing steps of data mining. The collected data measured by analyzing cognitive skills are now stored in a proper format and by applying different tools a rule base is driven which results indexing of brain that which type of data belongs to which site of brain. Like indexing that which type of information is stored in frontal lobe, auditory, motor or occipital lobes etc.

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