Implementing BiSM and CCL Algorithm for Managing Audio Storage

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ABSTRACT

Audio files are stored in many devices such as computers, laptops, smartphones, iPods and etc. These devices also store other multimedia files. Hence, there are limited spaces for the devices with small hard disk. Therefore, this paper analyzed the issues and proposed a solution to manage the audio storage. The elements from biological inspired components were studied and identified to seek for the requirements of Bio-Inspired Storing Model (BiSM). Then a structural architecture of BiSM was designed in addition the Cognitive and Constructive Learning (CCL) algorithm was proposed. Finally, BiSM and CCL algorithm were evaluated with exemplar application settings and the results were presented in a case study of MP3 music collections.

Keywords: Software engineering, intelligent information system, decision support system.

I INTRODUCTION

The main problem for the audio storage is duplication of records. Redundancy could happen during the storing process where the same music record was stored in different directory path. Where else, repetition could happen during the storing process where the same music record was stored in the same directory path. Hence it caused problem in managing the audio storage. Therefore, BiSM was created to determine the guidance for managing the unorganized and unstructured audio storage. A well-designed model and defined processes were necessary in assisting the audio storage management system. The system remained in the complexity of its structure that was less established. Furthermore, there is not enough study for managing the audio storage.

The biological inspired concept was chosen as the solution to the commenced problem. A new method for solving the problem was sought with the biological inspired concept. Firstly, what biological inspired elements are ideal for creating BiSM? Secondly, how the biological inspired elements can be integrated in constructing BiSM? Last but not least, would the proposed BiSM responds comparable to the biologically inspired concept? There were assumptions and limitations about this study. The data type is limited to digital music record only for music collection. Furthermore, recognition process or any digital audio signal processing was also not focused and studied.

II BIO-INSPIRED STORING MODEL (BISM)

Biologically, human listen to any sound. What happen here is the sound wave goes through the ear and hits the eardrum. Eardrum sends the signal sound to the cochlea and cochlea will filter the resonance. Here, the ear is a part of the hearing system as an interface for the brain to recognize a sound signal. Without ear, especially the eardrum, human cannot listen to any sound. The brain then recognizes the required audio signal and tells human about the information of the sound signal. Here, the issue of learning and recognizing the required sound embarks with issue of audio storage (Squire 1992). Essentially, HOW TO STORE the learned and the recognized sound were the subject matter which was the main topic (Gómez et al. 2007). Therefore, table 1 described the components of biological inspired human body part that were adapted to perform certain functions for BiSM.

Table 1. Biologically Inspired Components for BiSM.

Components	Descriptions
Human Ear	• To provide an interface to accept audio file to be processed with BiSM.
Human Brain	• To provide recognition and learning functions. • To provide temporary and permanent storage for the audio file. • To provide an interface to accept the update (cognitive learning) and the new (constructive learning) records for BiSM. • To provide an interfaces to display the output for every records.

A. Mapping the Biologically Inspired Elements

A mapping of the human ear and human brain was made to extract the features of human process. The ability of human to accept newly corrected information was mapped. The human ability to judge the right or wrong information to be accepted was also plotted. Hence, BiSM was developed on the mission to process the right informative data that could be controlled by only human judgment and any error happened was made by human failure. Therefore, table 2 described the functions and abilities of the biologically inspired elements adapted to BiSM.

Table 2. Mapping Table.

Elements	Descriptions
Ear	Provide interface to accept an inserted

	data.
Brain	Provide the capability to manipulate, store and present the data processing.
Short Term Memory	Provide the capability to view the transient recalled records and manage the storing of new added record.
Long Term Memory	Provide the permanent records of original data to be manipulated and offer storage for newly added record.
History Memory	List of protected saved records.
Recall Memory	List of related viewed records that match the inserted record.
Store Memory	List of newly added record to be stored in history memory.
Recognition	A matched process of an articulated record that similar with the inserted record.
Cognitive Learning	Process to replace (not updating, but total new record addition) a related recall memory list with a newly added record by inserting the record into the history memory.
Constructive Learning	Process to accept none matched record as a new useful record for future recognition.

B. Recognition and Learning Process

Sound is a media that brings information. Human is capable to recognize certain sound, learn new sound, memorize sound and recall the sound information. (Atkinson and Shiffrin 1968) presented with long term storage and short term storage for a human memory. There was also audio memory according to the theory and practice for the human memory, and it also included with short term and long term memory for audio memory (Baddeley 1997). The stimulation for brain to recognize sound sharpen when the sensory information detected various kind of sound, here it means noise (Naatanen et al. 1993). Meanwhile, according to (Allen 1994), recognizing is an essential skill of human to identify the similarity and dissimilarity of the sound identity from its source.

C. Structural of the Recognition Memory

According to (Yonelinas et al. 2005), the brain region of the structural for memory allocations between the learning memory with the new learning memory and updated learning memory were separated in different structures. These differences involved in recollection and familiarity in recognition memory. To discuss further, (Yonelinas et al. 2005) described the separating brain regions involved in recollection and familiarity in recognition memory. The recollection and familiarity rely on different networks of brain regions and provide insights into the functional roles of different regions involved in episodic recognition memory. Across a variety of brain regions, the neural signature of recollection was found to be distinct from familiarity, demonstrating that recollection cannot be attributed to familiarity strength.

D. Conditions for Matching Process

There were still many steps to be listed and described before the real model can be shown. One of the steps was the conditions for matching process. With the suitable conditions to match audio records it could enhance the searching and retrieval. Therefore, the conditions for matching process were planned because audio classification enhanced searching and retrieval (Lu and Hankinson 1998), and (Zhang and Kuo 1998).

There were several stages of conditions for the CCL approach which were the recognition, the cognitive learning, and the constructive learning. Please be noted that the conditions for matching process only inspired by the CCL approach. These conditions were not inspired from the biologically inspired elements that were chosen for the developed model. These two specifications were separated from each other whereby the functions and properties were different but comprehensive requirements were blended together for the developed model. In other word, from the CCL approach, newly created conditions for the process of BiSM was established. The inserted data will be compared and determined into certain conditions. Therefore, an articulated matching will be achieved. Figure 1 had a visual description on how the conditional characterizing procedures were organized for BiSM.

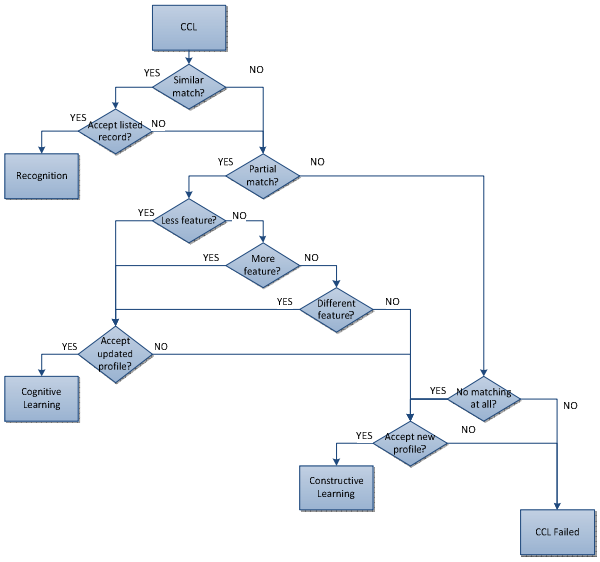

Figure 1. Matching Process Conditions.

For each condition, BiSM had different criteria to separate the category of the inserted data. If the matching falls under any category, the decision was not final until user judgment was made to control articulate record. There will not be any modification made to the original data, but user only capable to add on new record to the permanent storage. Therefore, the integrity of the unique data will be encapsulated and only useful data will be added. Table 3 described the detail about the conditions for the CCL approach. The descriptions for each

condition were different from each other. Each condition had own category of matching to be made.

Table 3. Matching Conditions Table.

Matching Conditions	Descriptions
Similar match	BiSM compared the inserted record with the history memory and recall any nearly or similar record.
Accept listed record	User agreed with the process by BiSM to accept the similar matched record as an articulated record.
Partial match	BiSM compared the inserted record with the history memory and recall any partially matched records.
Less feature	BiSM found that inserted record has fewer features from a list of recalled memory.
More feature	BiSM found that inserted record has more feature from a list of recalled memory.
Different feature	BiSM found that inserted record has some different feature from a list of recalled memory.
Accept updated profile	User agreed to add the partially match inserted record as a new record in the history record to update as useful information.
No matching at all	BiSM found that there was no matched record from the history memory with the inserted record.
Accept new profile	User agreed to add the no matching at all inserted record as a new record in the history for future recall.

III DESIGNING THE BIO-INSPIRED STORING MODEL (BISM)

BiSM was made to guide any development of audio storage management system. It exhibited the adaption of human body parts from human ear and the human brain, as well as the adjustment of human aural recognition process together with the perspectives of human cognitive learning and human constructive learning. These comprehensive combinations were applied into a computational data modeling for a useful informative scheme. Table 4 described the elements that built up BiSM.

Table 4. Elements of BiSM.

Elements	Descriptions
The input interface	• To accept audio file. • To accept update insertion. • To accept new profile insertion.
The output interface	• To display the recognized and learned records.
The processor	• To execute the recognize process, cognitive learning process, constructive learning process.
The short term memory	• To view the recalled and stored memory.
The long term memory	• To store the permanent history record.
The human ear	• To accept the audio file into the storage.
The human brain	• To provide the recognized and learned process. • To provide with the organization of memory storage • To provide view and display of recalled and stored memory.

With the full descriptions for the elements of BiSM, they were then illustrated in figure 2 which demonstrated the biologically inspired elements that created BiSM. BiSM was made based on the analysis made before, from the matching conditional and the matched table, furthermore towards the concept built up from the definitions established before. This model was prepared for easy understanding. The processes were clearly defined and the storage was well organized and structure. The ease of data manipulation was established in this model.

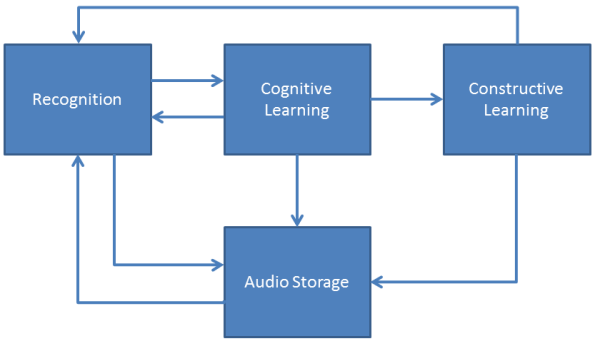

Figure 2. Bio-Inspired Storing Model (BiSM).

IV COGNITIVE AND CONSTRUCTIVE LEARNING

The recognition of any audio records should work similar to the brain process, where the brain capable to recognize any heard sound by comparing it with the permanent audio memory in the brain storage. In the other word, the recognition perspective was a capability to recall any similar memory as articulated information. Furthermore, recognition memory was supported by two forms of memory which were the familiarity and recollection (Yonelinas et al. 2005).

In the recognition perspective, the recognized record was from the familiarity in the recognition memory where the

inserted record was a perfect match with the record in the permanent storage. Meanwhile, the recollection from the recognition memory fell into the next perspective, where the inserted record only matches several features with the records in the permanent storage. With the recognition perspective, to be exact, the familiarity in recognition memory, the searching articulation could be performed with only single trial if the record was a perfect matched. But if the matching process was not a perfect match, therefore this situation should be moved into the recollection in the recognition memory. Here, for the recollection in the recognition memory, two (2) new perspectives that capable to portray the recollection for the recognition memory process were established. They were called as the cognitive learning perspective and the constructive learning perspective. They were described in the following subsections with more complete and comprehensive descriptions.

A. Cognitive Learning Perspective

The cognitive learning perspective happened when there was little support of information about any heard sound with the memory in the brain storage; hence the brain updated the new record with new profiled information. Here it meant that new learning occurred. This concept ignited when there was discrete support from memory. It provided a capability to replace the suggestions memory with new useful information. The acceptance to changes improvised responses (Greenwald 1968). It also provided user support decision to give a fresh material as an articulated data rather than the previous memory. Meanwhile, it was known that the Piaget's theory of cognitive development improvised learning (Kuhn 1979). Therefore, for the cognitive learning perspective, the searching articulation could be performed if the was acceptation to update the memory records with the new information. Therefore, successful searching could be matched only on the second searching.

B. Constructive Learning Perspective

When there was no support about the heard sound where the sound was provided with new information about it and the brain accepted to memorize the new sound to be kept in the brain storage for future recognition. This acceptation was totally for new sound. Similar to the previous concept, here new learning occurred. This concept ignited when there was no information provided from memory. It provided the capability to decide what is right or wrong. It also improved support for recognition (Parekh et al. 2000). It provided user support decision to accept the new additional information as an articulated data for future recall. It also improved learning (Leidner and Fuller 1997). For the constructive learning perspective, the searching articulation could be improved when the searching trial was failed for the second time. This could be achieved by the acceptation to update the memory records with additional new record of different kind from that were in the memory storage. Therefore, the perfect searching articulation could be happened only on the third trial of the searching process.

C. CCL Approach

From all of the perspectives introduced above, a new approach for the biologically inspired model was created. The respected approach was freshly introduced and established as a new state of the art approach known as the Cognitive and Constructive Learning (CCL). CCL was a comprehensive combination to recognize audio data by providing several layers of data recognition. CCL increased searching articulation and improvised auto recognition. CCL escalated data integrity and ensured data originality. It could possibly increase the faster searching articulation with the updated memory records upon the user acceptation. This could contribute to the faster generation of searching result. The articulation also could be precise when the memory records expanded and provided perfect matching. However, when there were no acceptations from user to update the history memory records, for the upcoming search there will be no articulation because no matching was happened. This concept was known as the CCL failed.

D. Formulating the CCL Algorithm

An algorithm for BiSM created and introduced. This algorithm was called the CCL algorithm; shorten of the cognitive and constructive learning algorithm. To formulate the algorithm correctly and workably, a concept flowchart was created. Figure 3 portrayed how the CCL approach supposed to execute. With the CCL concept flowchart, the formulation of CCL algorithm was developed such as in figure 4.

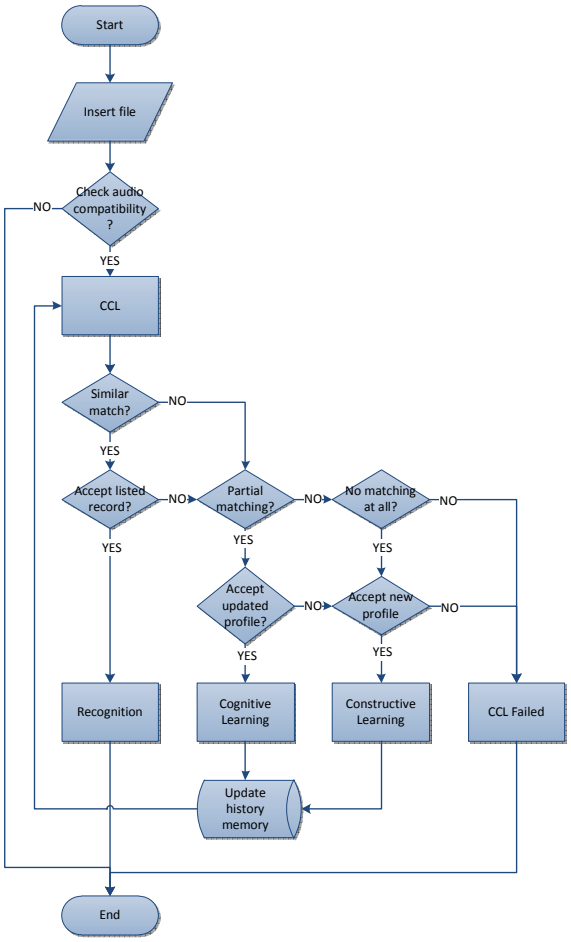

Figure 5. CCL Concept Flowchart.

```
=====================================
THE CCL ALGORITHM
=====================================
START
INSERT file;
IF checkAudioCompatibility THEN
     EXECUTE ccl;
          IF similarMatch THEN
               IF acceptListedRecord THEN
                    DO recognition;
               ENDIF
          ELSEIF partialMatch THEN
               IF acceptNewUpdate THEN
                    DO cognitiveLearning;
                    UPDATE historyMemory;
                    RETURN ccl;
               ELSE acceptNewLearn;
               ENDIF
          ELSEIF no matching THEN
               IF acceptNewLearn THEN
                    DO cognitiveLearning;
                    UPDATE historyMemory;
                    RETURN ccl;
               ELSE cclFailed;
               ENDIF
          ELSE cclFailed;
          ENDIF
ENDIF
END
=====================================
```

Figure 4. The CCL Algorithm.

V SIMULATING THE CCL ALGORITHM

To evaluate the CCL algorithm, several examples were simulated to express how BiSM capable to execute. The examples were planned to show the recognition function, the new learning function, and the update learning function. The simulation of all functions were arranged to exhibit the CCL algorithm based on the recognition, cognitive learning and the constructive learning perspectives. These simulations used several samples of MP3 format music records. The settings were planned as below. Assuming that the historyMemmory was empty and therefore recognition could not be performed. Since there was null data to be compared and matched, with the BiSM implementation it capable to execute learning process, and hence, the constructive learning should be performed based on the condition of matching procedure mentioned in the earlier section in this chapter. The simulated example for the constructive learning was arranged like below.

A. Constructive Learning – Null Record

This simulation started with an empty storage. Table 5 starts the setting for the historyMemory with null record.

Table 5. Initial Record in historyMemory.

Record	Title	Artist	Album
-	-	-	-

For the first example, the simulation requested the user to add new file since the historyMemory was empty. Therefore, after adding the new file into the storage, the table was added with the first record as shown in table 6.

Table 6. New Learning in historyMemory.

Record	Song	Artist	Album
1.	Selamat Tinggal Akhirnya.mp3	Aizat	Percubaan Pertama

Since this example exhibited the new learning process with using BiSM, hence the next example showed the recognition process.

B. Recognition – Similar Object

The simulation of the example for recognition process only could be performed after the historyMemory table was not null. A perfect match occurred due to the same file matched. Therefore, no user response was needed due to this process. BiSM capable to handle it automatically.

C. Cognitive Learning – Similarity in Object Features

The next examples showed two different files added in the historyMemory table. The first example is for showing how cognitive learning process was executed. This setting was with the same artist and the same album, however the song was different. Therefore, after adding the new the file into the storage, the records in the historyMemory increased. This can be seen in the table 7.

Table 7. Update Learning in historyMemory.

Record	Song	Artist	Album
1.	Selamat Tinggal Akhirnya.mp3	Aizat	Percubaan Pertama
2.	Cintai Diriku.mp3	Aizat	Percubaan Pertama

The other simulation for the cognitive learning also tested an example of using object recognition sample. The same artist was used but with different album setting. Here the example for another cognitive learning. The example setting used different album from the same artist. Therefore, after adding the new file using different setting of the same artist but with the different album, it increased the record in the history memory. Table 8 showed the records in the historyMemory.

Table 8. Update Learning in histoyMemory with Different Object.

Record	Song	Artist	Album
1.	Selamat Tinggal Akhirnya.mp3	Aizat	Percubaan Pertama
2.	Cintai Diriku.mp3	Aizat	Percubaan Pertama
3.	I Go.mp3	Aizat	OST Talent Time

However, there was another example to show that BiSM capable to organize audio storage, here it meant with totally different object. Hence, the example was shown in the next subsection.

D. Constructive Learning – New Object Features

Table 9 was to exhibit the constructive learning perspective of a totally different object.

Table 9. New Learning in histoyMemory with Different Object

Record	Title	Artist	Album
1.	Selamat Tinggal Akhirnya.mp3	Aizat	Percubaan Pertama
2.	Cintai Diriku.mp3	Aizat	Percubaan Pertama
3.	I Go.mp3	Aizat	OST Talent Time
4.	Faizal Tahir – Hanyut (Akustik).mp3	Faizal Tahir	Adrenalin

Therefore, with all the examples exhibited above, it covered the whole CCL algorithm capabilities. It described the recognition function, the new learning function, and the update learning function. Besides that, it also simulated the recognition, cognitive learning, and the constructive learning perspectives.

VI CONCLUSION

A model was created as guidance for the organization of audio storage called by the name of Bio-Inspired Storing Model or also known as BiSM. An algorithm was formulated as the processor to maintain the audio storage organization. The algorithm was made based on the new concept introduces, which was the Cognitive and Constructive Learning or also known as CCL. The CCL algorithm was based on the recognition and learning concept, update learning concept, and new learning concept. Music collection contains many music file. Meanwhile, the music file contains media information and media content. On the other hand, BiSM main function was based on media information only. To conclude, biological inspired entities were identified, the CCL algorithm was formulated, and BiSM was developed.

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