



# Intelligent Music Abstraction Tool for improvising the Quality of Music Composition

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## ABSTRACT

All type of music pieces consist of two vital elements – rhythm structure and melody involvement. Another most important thing for automatic music improvisation is cadences that give symphonic shape to a music melody. Intelligent quality music composition is the relation of different musical elements and aggregation entity of these musical element objects. This paper introduces a new method for composing music using abstraction mechanism concept of software engineering. This paper focuses on the two main objects of music – Vocal and Instrumental and these two objects are tightly coupled and create the aggregation entity of Music Composition. The primary objective of this work is to explore the efficiency of Abstraction mechanism – Generalization, Specialization, and Aggregation to search for an optimum combination between vocal and different instrumentals with their different tempo to improve the quality of music and versatile intelligent music composition.

**Key words:** Music Composition, Abstraction, Aggregation, Indian Classical Music, Music Information Retrieval, Unified Modeling Language

## 1. INTRODUCTION

The Classical Indian Music (ICM) is not as well-liked as the western music modeling [4], [7]. ICM is fully based on the arrangement of different note structures and note structures are unique for every music origin or raga. Hence, the recognition of notes used in Indian Classical vocal tunes and instruments is in fact a harsh task and the musical gestures can never be chased the linear expressions barely. Even though, the modern skills are by now given the soft and spiky thought in the field of musical pattern appreciation with some of the unusual characteristics like Indian Classical Raga, Thhats or raga origin, sequences of notes and their several characteristics [13], [15]. The recent advances of technology also furnish the musical characteristics by using less complicated approach such as Object-Oriented Analysis and modeling perspective [8], [9] [10], [11], [12]. The Artificial

Intelligence and Soft Computing approaches are also exploited for exact computations of the vocal features and their corresponding musical instruments such as musical rhythms utilized to act as ornaments on the vocal performances owing to be pointed out that the complexity and simplicity of systems to achieve practicability, robustness, and less effort of solutions [20], [24].

Object-Oriented Programming technology is a modus operandi where a set of substances can be categorized into several classes of numerous distinctive properties and appearances. All the objects of the analogous features are used to place in the identical class and the set of objects of dissimilar properties are categorized into other types of classes which are not similar depending on their behavior [18], [19]. A subclass depicts the configuration and behavior of objects that are entirely compatible with their super-class if the sub-classes have the similar types of arguments area as the super-class and, for all procedures of the super-class, related arguments are capitulated corresponding outcomes. Absolute compatibility authorizes instances of the subclasses to be freely influenced as instances of the super-class with no terror of unacceptable behavior [27], [30]. The concepts of classifications of the data, features or objects into several classes and subclasses lead to diminish the complexities of recognizing the features of the large systems. One fundamental abstraction mechanisms is Aggregation which is combining the features of information to create a new high level feature. In this work, Vocal and Instrument is two low level features are combining to create a high level feature Music Composition. The paper introduces the software Intelligent Music Abstraction Tool (IMAT) which provides music composition and performance improvisation system based on the concept of Software Engineering “Aggregation”.

## 2. RELATED WORK

In Computer Computer-based Music Information Retrieval (MIR), music features have made of two basic classes - the vocal and instruments. Paper [1] explained that the relevance of rhythm structures and musical forms of a raga of ICM. In

the paper [2] introduce a real-time system which listen of Tabla playing performances and identify the beat strokes. Another two papers used to stores the music information using symbolic score that is used for automatic transcription in solo performance in music [2], [3]. Two approaches that have been explained to the several researchers about the rhythm cycle complexities [4], [5]. In the same rhythm cycle perspective, the authors use the note structures of Tabla through automatic procedure [6]. Paper [7] represents about the mechanism of feature selection and extraction from different kinds of musical instruments [7]. Two more papers [10], [11], [12] deal with the implementation of Musical pattern recognition by mathematical expressions. The paper [13] has explained the notes structures with ten North Indian raga origin in ICM which is imposed to be constructed the songs. Another very important paper deals with the study of vocal performance and pitch analysis in Hindustani Classical Music (HCM) [14]. Some researchers were presenting the concept of Hindustani Music which automatically transforms into the acoustic signal from the song [15]. The authors of another paper introduced the concept of Statistical Pattern Recognition of musical signals using Artificial Neural Networks (ANN) [16]. Another paper introduced the concept of Computational Ethnomusicology [17]. Another interesting contribution represented as Unified Modeling Language (UML) diagrams are the way of implementations of implementation of musical rhythmic cycles is proved as the basis for the percussion-based instruments [8], [9].

In an effort by the authors have been introduced a Quality Music model used for ICM using the Roulette-Wheel Selection mechanism of Genetic Algorithm [20]. Three papers [21], [22] describe the usefulness of Genetic Algorithm in the field of music composition. These papers can also be applicable as an important tool in Musicology that can create versatile music composition as well as the versatile rhythm structure generations using the different operators of Genetic Algorithm. Another paper introduces a new concept that generates of realistic drum-set rhythms automatically using Genetic Algorithm [23]. Again introduces a new concept of variable length n-gram model in the paper that incorporates multiple views of Tabla bol sequences [24]. Some researchers introduce an automatic recognition system for recognition of the music patterns by using Recursive Median Filter [25]. Further one paper introduces the concept of Normalized Compression Distance method that is applicable for automatic music composition through the use of Genetic Algorithm [26]. Numerous contributions have been quite helpful to this work to provide sufficient information about data abstraction, generalization and specialization, inheritance, polymorphism and so on of the Object-Oriented methodologies and techniques [27], [28], [29], [30]. Rests are illustrated the performances to be replicated the Unified Modeling Language for the Object Technologies [31], [32], [33], [34], [35].

Petri nets is a modeling tool that is used as music pattern recognition and music pattern analysis for Indian Classical Music where object oriented methodology is the basis for musical pattern recognition and pattern analysis. The papers [36], [37] establish that the same concept in the field of Computational Musicology. The paper introduces a mechanism is that efficiently chooses the most fitted parent rhythms of a set of rhythm chromosomes for creating offspring rhythm using Genetic Algorithm Optimization technique in the context awareness pervasive music rhythm learning education Pervasive Education for Computational Musicology [38]. The paper [39] also identifies the raga name of a song music by mapping the with Raga Knowledgebase automatically. Another paper [40] has been introduced the concept of hummed query and user query depends on feedback of user that improve retrieval performance through Genetic Algorithm.

An approach that finds the matching similarity percentage between songs by their pitch values through Correlation of Coefficient [41]. The paper [42] represents a method to generate song list for listening, age factor of users for performing online. Again one paper represents the matching similarity between songs by their pitch values through Coefficient of variance [43]. Another paper proposes the time slot song music of a particular by using Neural Network [44] and the other work is based on Music Recommendation System that classifies different song clusters of different time of a day [45]. The paper [46] introduced an intelligent mechanism to identify the density of a given music rhythm and complexity of that music rhythm through software automatically. Paper [47] illustrates the different music research areas and their applications in the field of Computational Musicology. Another paper represents that a song of a particular raga can be represented through Unified Modelling Language [48]. Automatic Raga Recognition method identifies the notes of a song and then mapping with Raga database [49]. One interesting paper represents a survey work on low level, mid level, and track level feature extraction from music signal [50]. Another paper establishes the truth that Software Testing is the most important and essential phase of developing Software [51].

### 3.FEATURE DETERMINATION AND TERMINOLOGIES

In order to erect the piece of music, numerous fundamental musical features should be scrutinized. In Indian Classical Music (ICM) perspective, the vocal fundamental features like classical ragas and their corresponding classical Thats are to be considered. In the Indian Classical rhythm domain, the actual set of notes or beats and its several sorts of variations of the corresponding rhythmic cycles imposed on the specific vocal performance. The primary attributes and features used in specifically in ICM which are to denote a specific music

fundamentally are illustrated in the Table 1. In this innovative contribution perspective, the musical abstraction analyzed the overview of this entire accomplishment of the fundamental musical features and their corresponding attributes.

**Table 1:** Different Musical Elements and their meanings

Musical Elements	Meanings
Beat	Beat is a fragment of note.
Note	Notes can be a beat or combinations of beats.
Meter or Matra	It is the length of a rhythmic structure.
Tempo	Velocity of the vocal and instrumental music.
Time Signature	This is a notational convention to identify the number of beat per measure. For 4/4, 3/4, 2/4, and 6/8.
Combining Note Values	Combinations of different notes in each measure. For example 4/4.
Even Meters	These are eventually divided by two and that is why also called duple meter.
Odd Meters	These are eventually divided by three and that is why also called triple meter.
Raga	Ragas are the basic element of music that is the unique combinations of note structures.
Raga Origin or Thhat	A thhat is the musical parent scale of different ragas.
Ascent & Descent	The increasing pitch values of note sequences of a raga is called and the decreasing pitch values of note sequences is called Descent.
Aalap or Rendition	It is the melodic improvisation of classical music performance for opening section.
Shrutis or Linking Notes	The smallest interval between different notes which are interlinked between notes to other notes.
Rhythm	It is a unit that accomplishes a set of the musical beats.
Clap or Tali	It acts as physical notation.
Wave or Khali	It also a physical notation which means null or off clap.
Sam	The primary beat or note of a particular rhythmic cycle.
Lay	The tempo in music is called the lay or laya.

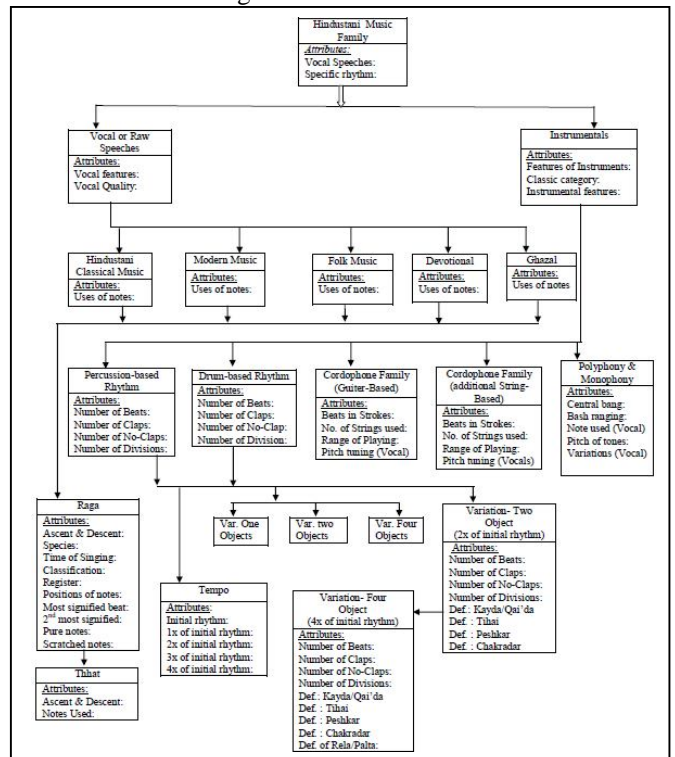
**4. EXPERIMENTAL DETAILS**

Music composition using interactive systems is not very easy task; rather it is the evaluation metric by developer which is pleasant for listening. This paper introduces a qualitative approach that provides the versatile combinations of vocal and instruments opportunities among a set of combinations and improvising best quality music composition through abstraction mechanism. An abstraction combines a set of elements by omitting some details. Specially consider the three classical abstraction principles, generalization, specialization and aggregation. Aggregation is an abstraction

principle that allows combining a set of parts to a whole. We are implementing these three concepts in our work. Unified Modeling Language (UML) is the part of the object-oriented software paradigm in a wide range of applications and it is one of the modeling languages of representing Abstraction mechanism. This paper represents a formal description of different musical elements through UML technologies and diagrams, mainly Class Diagram, Activity Diagram, Collaboration Diagram, and Sequence Diagram for visualized the specifications of our music composition in the context of Hindustani Music.

**4.1 Class Diagram**

Normally it describes how a system is structured to a certain extent than how it acts. The preliminary components of a class diagram are the classes and their relationships: Generalization, Aggregation, Association, and a variety of dependencies. Here in this Class diagram shows how the preliminary musical features are dependant and relationships with each other in Figure 1.



**Figure 1:** Class Diagram of IMAT

**4.2 Activity Diagram**

Generally activity diagram describes the state with an internal action and one or more outgoing alteration that repeatedly chase the termination of the internal activity. This diagram centers on representing the activities or mass of processing which may or may not communicate to the methods of classes. The Figure 2 shows the fraction participated by dissimilar components of any musical tool where initially the vocal raw

data played by the vocalist. According to the vocal characteristics, the musical instruments are to be assigned by the users. After completion of all these activities the entire music can be generated and issued to the music library.

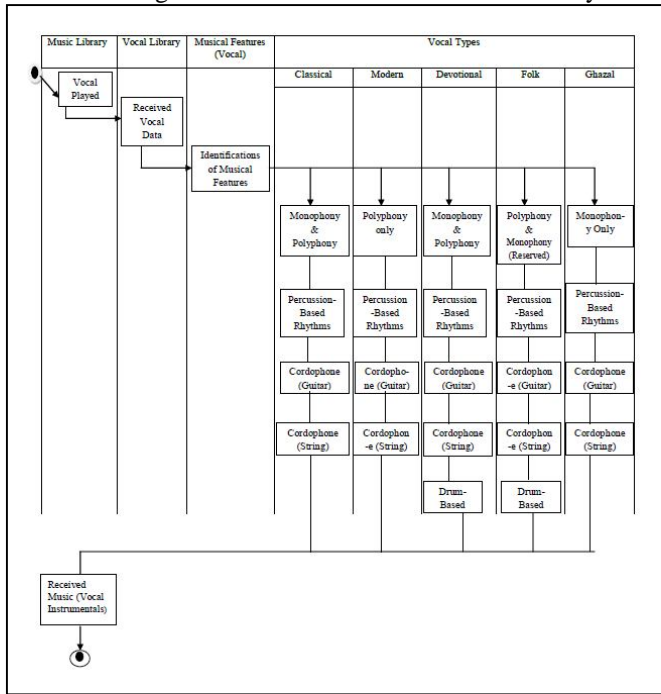


Figure 2: Activity Diagram of IMAT

### 4.3 Collaboration Diagram

A collaboration diagram displays both behavioral and structural characteristics unambiguously. The structural characteristic of a collaboration diagram consists of objects and the associations accessible between them. The figure modeled below would be to assist a designer to conclude which class is related or dependant with which class or classes in Figure 3.

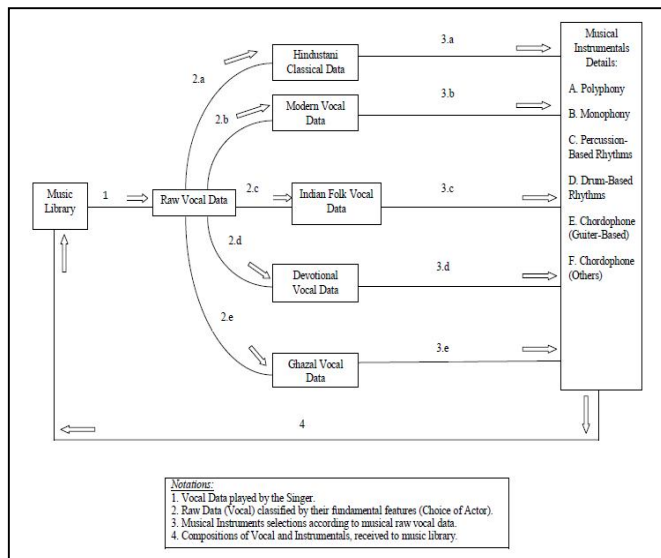


Figure 3: Collaboration Diagram of IMAT

### 4.3 Sequence Diagram

The sequence diagram demonstrates the interactions among objects as a two dimensional visual aid. The chart is to be read from peak to base. The objects contribute to the communication are to be displayed at the top of the graphic representation as boxes affixed to a vertical black stripe. The Sequence Diagram of our work is given in Figure 4.

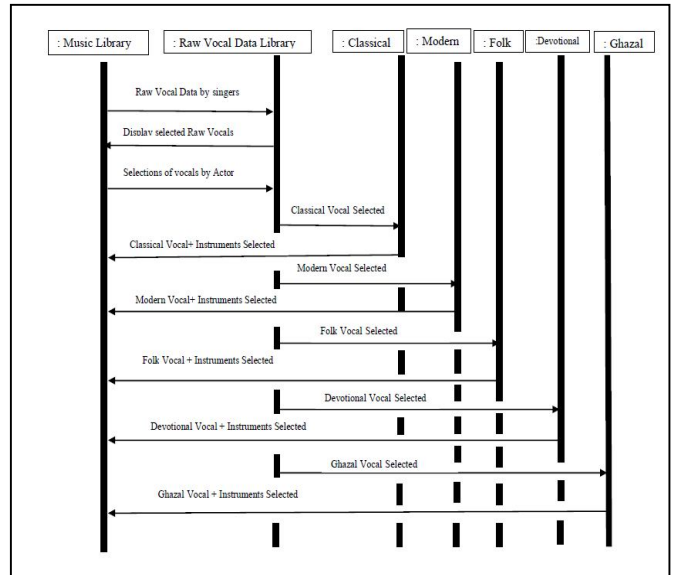


Figure 4: Sequence Diagram of IMAT

## 5. EXPERIMENTAL DETAILS

To establish the work, recorded a few vocal songs of different types using different singers and also recorded a set of musical instrumentals for every vocal performance separately. For that purpose, a lot of hardware devices are used, like Audiotechnica AT 2020, Cardioid Condenser Microphone, XLR Cable, and Sound Card: M-AUDIO FastTrackPro, etc. Java (JDK) 6.0 and JCreator IDE version 6 have been used for implementing the user interface design to establishing the working principles.

All the vocal files stored in a separate directory using the naming conventions 1.mp3, 2.mp3, 3.wav, etc. after recording of all the required data. IMAT provides user friendly or simple platform to user as it supports both .mp3 and .wav extension. We have also made a separate directory for different instrumentals using another naming convention, like 1Drum based.mp3, 1Monophony based.mp3, 1Percussion based.mp3, 1Polyphony based.mp3, 1String based.mp3, 1Woodwind based.mp3. For .wav vocal files, we also used convention like 1Drum based.wav, 1Monophony based.wav, 1Percussion based.wav, 1Polyphony based.wav, 1String



based.wav, 1Woodwind based.wav, etc. IMAT provides three types of tempo tracing system that generates normal tempo or first multiplier or second multiplier or third multiplier of tempo of different instrumentals for the same vocal and search for an optimum combination between vocal and instrumental sounds. Select a vocal from a list of vocal performances and also select one tempo then play only vocal is depicted in the Figure 5. We select a particular vocal and then select a particular instrumental as well as a tempo and then play only instrumental is depicted in Figure 6. Finally we select a particular vocal and select multiple instrumentals and also select a particular tempo that is our final destination of optimum music composition is depicted in Figure 7. IMAT also provides a “save” button to save a particular music that is the combination of vocal and different types of instrumentals (ideal combination) in the Music Library.

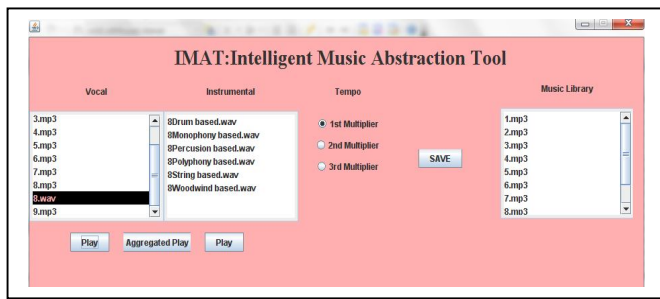


Figure 5: Snapshot of UID of IMAT that plays only Vocal

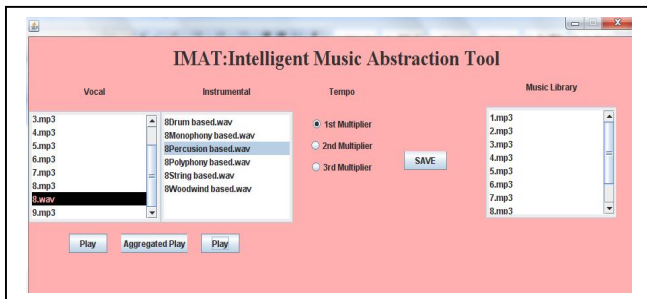


Figure 6: Snapshot of UID of IMAT that plays only Instrumental

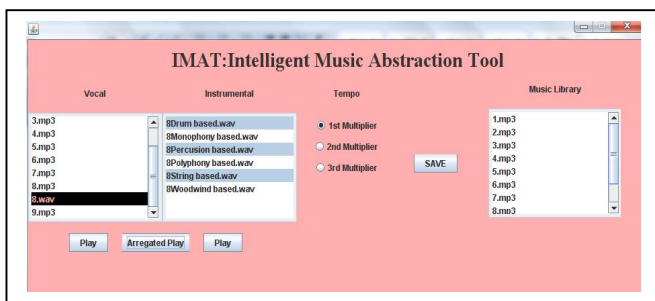


Figure 7: Snapshot of UID of IMAT that plays only Instrumental

## 6. EXPERIMENTAL DETAILS

The IMAT is a music software editor package that is used to provide music composition and performance improvisation system based on the concept of Software Engineering “Aggregation”. In this article there are two music entities: Vocal and Instrumentals which will allow musicians to create an ideal combination of both and generate Music. This application is intended to enrich the possibilities of computer assisted music composition.

It has been conducted a comprehensive multiple state-of-the-art survey work to assess the utilization and effectiveness of IMAT. The primary aim of the survey work is to find out whether the IMAT is technically, operationally, and economically feasible or not. Twenty participants (10 men and 10 female, average aged between 20 to 40) took part in this analysis. Male participants and Female participants are represented by M and F respectively. Each participant gave written informed consent before taking part in this study. The experiment consisted of three parts: a training portion, a freeform composition portion, and a post-experiment paper questionnaire. Participants were introduced to the equipment and allowed to familiarize themselves with the music composition process using the object oriented concept of abstraction mechanism.

The overall experiment required approximately one hour. The freeform composition portion occurs after the training session has been completed. The questionnaire, using a 0 - 10 Grading Scale, asked questions about the difficulty of the task, enjoyment of the task, Tempo Tracking of the composed music composition, features of music extension support files, and overall ratings by the each participants. The survey report given in the Table 2. Participant M means Men and Participant F means Female.

Table 2: Survey Report of the user of IMAT (Here, M = Male Participants and F = Female Participants)

Participants	Difficulty	Enjoyment	Tempo Tracking	Music File Supports	Ratings
M1	1	7	7	9	8
M2	1.5	6.5	6	9	8
M3	0	7.8	8	10	8.5
M4	1.2	9	8	10	9
M5	1	10	8	10	9
M6	1	9	8	10	9
M7	2	8	7	9	8
M8	0	8	9	10	8.5
M9	0	9	10	10	10

M10	0	8	8.5	10	8.5
F1	1	7	8	9	8
F2	1.2	7.5	9	10	8.5
F3	1.5	8	7.5	9	8
F4	1.5	9	9	10	9
F5	1	9	10	10	10
F6	1	8	7	9	8
F7	2	8	7	10	8.5
F8	1	10	8	10	8.5
F9	1	6	8	9	8
F10	0	7	8	10	7.5

Fig. 8 shows the distribution of Grading Scale by the each participant we received from the questionnaire session and it clearly shows that IMAT is a less difficult or complex, highly enjoyable, good variations of tempo tracking facilities, supports a great number of music files for generating music composition and overall rating of IMAT is remarkable by the participants. It provides a promising step toward creating an intelligent combination between vocal performances and instrumentals with different tempo for improvising the music composition based on the real time. Qualitative data from the above Fig. 8, it indicates that the IMAT is very simple that is not difficult interface for generating music improvisation, very good rating for both user enjoyment and applicable for tempo tracking, outstanding rating for both music file supports for IMAT and user' given rating. The combinations of these five grading features of IMAT, its user that is music composers used to create an intelligent innovative music editor that capable of creating unique melody which can constantly be updated or modified.

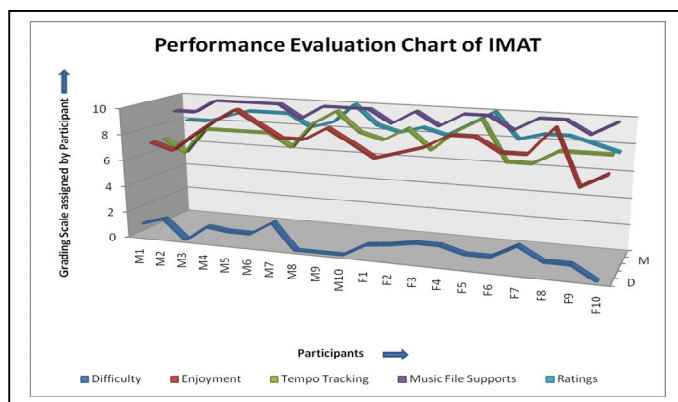


Figure 8: Performance Evaluation Chart of IMAT

## 7. CONCLUSION

Computer-assisted music composition is an emerging field. The traditional way of Music Composition is the application of computer to improvisation of innovative music composition through the use music software with some musical instruments like guitar, piano, ukulele, violin,

accordion, flute, keyboard, drum etc. The improvisation of Music Composition is a critical task that can be classified into major three categories – (1) Sound Oriented Composition, (2) Notation Oriented Composition, and (3) Analysis Oriented Composition. The work is fully based on sound oriented optimum combination. IMAT or Intelligent Music Abstraction Tool is a music editor that allows to the music composer to create different innovative music pieces by using some specific input vocal files and their corresponding different instrumental files and their one particular tempo. Innovative music composition process using the IMAT software solution by utilizing the optimum combination of vocal sound, tempo tracking, and instrumental sounds, becoming the one emerging tool for manipulating innovative music media editor.

The paper implemented as a step towards developing a music editor software tool to assist and evaluate the different musical pieces by combining the same vocal performance with different combinations of instrumentals pieces with different levels of tempo which is useful for different listeners for pleasant listening. The music editor software is very simple and user friendly as it supports both .mp3 files and .wav files for improvisation of music composition. In this paper, we do not incorporate the music features like score calculation, calculation of time signature, extraction of fundamental frequencies or note structures, etc. In future, we intended to combine all of the advanced types of musical features like polyphony score generation, generation of higher-level score structures for arranging of music elements, generation of relation and ordering musical gestures, real time music synthesis, extraction of music note structures using IMAT and evaluate each of the solutions again.

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