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THE EXPANDED TURING TEST APPLIED TO ALGORITHMIC MUSIC COMPOSITION

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ABSTRACT
The field of research in algorithmic music composition investigates the development of systems that have the ability to produce works automatically. In this context, gaps related to human-computer interaction via digital music are observed, with a demand for works that evaluate the material produced in relation to the listener. The present work describes the evaluation of an algorithmic music composition system through the application of the expanded Turing test. The experiment had the participation of 237 volunteers, subdivided into 3 groups: 10 professionals who work in the musical area, 39 participants with specialized musical knowledge and 188 participants with little or no musical knowledge. Excerpts from 3 compositions were used, one of them generated by the algorithmic composition system Fraseado and the other two classical compositions in the Western context. Among the results obtained, it was found that 77.1% of the participants identified the algorithmically generated excerpt as having been created by traditional composition methods, indicating the system's ability to exhibit a behavior equivalent to the human being.

Keywords: Computer Music. Algorithmic Composition. Expanded Turing Test. Artificial intelligence. Knowledge Representation. Human-Computer Interaction.

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INTRODUCTION

Computer Music (CM) is a field of research in Computer Science with strongly interdisciplinary characteristics [Miletto et al. 2004]. Studies are directed to aspects that involve concepts such as human-computer interaction, recommendation systems, computational intelligence, hardware design, computer-aided education, real-time interactive systems, among others. In its development process, diversified areas of knowledge - such as Pedagogy, Health, Engineering and Psychology - have been related in various types of applications [Gimenes et al. 2003].

A consequence This knowledge is that the developments carried out in this area make it possible to broaden the understanding of concepts related to other fields of research. One can take as an example the study of cognitive processes associated with the activity of a music composer [Lima 1998, Oliveira 2007]. In addition to these, the investigation of elements related to the branches of music therapy, communication, legal, social, ethical and business aspects, makes it possible to carry out the analysis, processing and synthesis of acoustic and symbolic data [Fornari 2015], bringing important contributions in each *Métier*. In Computer Science, studies in CM have provided assistance in the work involving human-computer interaction, programming paradigms, cognitive processes, etc [Minsky 1981].

ALGORITHMIC MUSIC COMPOSITION

Among the aspects addressed, a topic of interest is the one that deals with the issue of computer-generated music [Whalley 2005]. Historically, elements related to algorithmic composition and automatic creation of musical excerpts have gained special prominence [Francis 2015]. Methods have been developed in the sense that the computer is able to obtain knowledge and acquire experience in specialized domains. Such methods allow the machine to be able to exhibit behavior equivalent to a human being with regard to characteristics such as cultural manifestations, performative expressions and assimilation of specific styles to a given composer or historical period [Barbosa J 2015, Maximiliano et al. 2015].

Algorithmic musical composition (AC) is the field of knowledge that deals with the processes involved in the creation of musical structures (melodic, rhythmic, harmonic and timbral) from formal computational methods. These processes occur from the perspectives of areas such as Mathematics, Artificial Intelligence, Psychology and Grammar (Paz et al., 2016; Liu; Ting, 2017). The music generated by the computer can be used based on specific demands in low-cost applications, favoring accessibility, in addition to serving as support in various professional activities (Krause, 2017; Cao et al., 2015). Techniques in the field of Artificial Intelligence have received prominence due to the results obtained by incorporating aspects of cultural manifestations in a composition system (Francis, 2015). Machine learning methods have been used with the aim that applications can infer characteristics of performing expressions and assimilate specific styles to certain composers or historical periods (Maximiliano et al., 2015).

Among the applications arising from the process of Representation of Musical Knowledge, CA is characterized by being a transdisciplinary activity, involving both cognitive elements and related to programming techniques. Historically, his main field of research has focused on the domain of Artificial Intelligence, with regard to aspects such as machine learning and automatic reasoning.

The motivations that have led to the development of algorithmic composition systems can be listed according to some aspects. Among them, the interest of a composer in creating programs as a mode of expression of his particular process of creation stands out. Another factor refers to the development of programs that serve as general tools to assist other composers during this process. There is also an interest in implementing theories referring to specific musical styles. It is also possible to list the motivation in the sense of codifying theories regarding the cognitive processes associated with composition [Pearce et al. 2002]. The Figure 1 characterizes these motivations, indicating their domains and related activities.

Figure 1: Motivations for the development of Algorithmic Composition programs.

Domain	Activity	Classification
Composition	Algorithmic composition	Expansion of the compositional repertoire
Software engineering	Design of tools for composition	Development of tools for composers
Musicology	Computational modeling of musical styles	Proposal and evaluation of theories for musical styles
Cognitive sciences	Computational modeling of musical cognition	Proposal and evaluation of cognitive theories for musical composition

Source: (Pearce; Meredith; Wiggins, 2002).

The Phrasing system, used in this work, performs the algorithmic composition having the field of programming (Software Engineering) as the main motivation. In this sense, the approach presented - performing the Representation of Musical Knowledge - provides subsidies for the development of systems that, among other activities, have their application focused on automatic musical composition.

As a way of evaluating this approach, The present work proposes or *Expanded Turing Test*, applied to Computer Music. This proposal is based on the fundamental principle established by the classical Turing test (TT) [Turing 1950] and conducts a survey in order to obtain additional information, studying characteristics in the perception of compositions generated by the computer. Such information will be analyzed in order to investigate aspects produced by the composition in the human listener.

RELATED JOBS

Strasheela [Anders 2007] is a multiparadigm compositional system based on the definition of problems of satisfying musical constraints. It emphasizes the programmability of three fundamental components: musical representation, rule enforcement mechanism, and search process. Any information pertaining to the score is accessible through specific objects and can be used to obtain derivations. The user can optimize the search for the satisfaction of a particular constraint by programming distributed strategies, using dynamic variables. EV Meta-Model [Alvaro et al. 2005] is a system for the representation of musical knowledge aimed at computer-aided composition. It was proposed as a generic tool for representing different levels of musical abstraction. It is a dynamic representation system, transmitting this characteristic to the musical component represented.

Pachet *et al.* [Pachet et al. 1996] were based on Object-Oriented Programming, using the Smalltalk language, to create a framework in the context of tonal music. They developed the MusES system, which contains a representation of the basic concepts of tonal harmony, such as notes, intervals, chords, scales, and melodies. Serapion developed the system Chorus [Serapiao 2004], a Framework for the Representation of Musical Knowledge. Lima [Lima 1998] developed a system of musical composition based on the modeling of learning by musical style. This system is capable of creating entirely new compositions that are totally faithful to the musical style of a particular composer. Using the functional language Clean, he developed a system that analyzes a musical score lexically and syntactically, extracting the implicit musical style; another module performs the

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composition, based on the extracted information. The generated score is converted to a MIDI file.

GeNotator [Thywissen 1999] is an environment that explores the application of evolutionary techniques in musical composition. The system focuses on defining mechanisms inspired by evolutionary theory processes such as genetic algorithms using the heuristic search technique. VexPat [Santana et al. 2003] is a system to aid the task of extracting patterns from musical sequences. SOM-G [Silva 2009] is a sound processing language for granular synthesis that has a concise and efficient syntactic structure. It is aimed at both the orchestration of instruments, with a high degree of control over granular parameters, as well as the interpretation/rendering of polyphonic scores that use these instruments.

Some other works are focused on the establishment of conceptual elements. Wulfhorst [Wulfhorst et al. 2003] proposed an open architecture for a multi-agent music system. This architecture enables the simulation of the behavior of a vocal/instrumental group through the interaction of a community of agents based on musical events. Bittencourt [Bittencourt 1998] relates several techniques used with their philosophical and mathematical foundations, starting from the discovery by Pythagoras of the relationship of musical intervals associated with subjective experiences, passing through first-order logic and arriving at current methods of knowledge representation. Teixeira [TEIXEIRA 1997] used the notion of point of view in harmony to represent musical knowledge and events. Mello, in his master's dissertation [Mello 2003], used semiotic systems to propose an epistemological investigation involving current research in the field of musical cognition. Miranda, in his doctoral thesis [Miranda 1995] used formal grammars aimed at computational learning and acoustic synthesis.

Among the works presented, fundamental characteristics stand out in relation to the representation of musical knowledge, programming paradigms and algorithmic composition. It can also be observed that the use of the PLI technique does not occur in any case. This finding corroborates the survey carried out in the literature review, where, based on the application of systematic search mechanisms in a total of 7075 studies, only 3 use PLI in algorithmic composition, and none of them makes use of the multiparadigm programming resource [Goncalves and Homem 2015].

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MATERIALS AND METHODS

In the production of music software, there is a strong dependence on factors such as reasoning paradigms, programming languages, libraries, APIs and frameworks, in addition to the choice of a development environment that enables the efficient integration of the technologies used [Nierhaus 2009]. The ability to represent the knowledge involved makes it possible for intrinsic characteristics of musical activity to be maintained by a model that allows, in the most natural way possible, to express logical reasoning and the structure of the manipulated information.

In this sense, a multiparadigm approach was adopted in the present work for the configuration of a musical development environment. Such an environment enables the creation of software aimed at sound production in a comprehensive way, in addition to meeting specific requirements of the activity of automatic musical composition. Such an environment resulted in a free software platform, through the use of open source systems, which will be presented in the next session.

To this end, a programming infrastructure was developed to serve as a basis for the development of applications. In this way, the 4 fundamental programming paradigms were integrated: Imperative, Object-Oriented (both by the Java language), Functional (using Scala) and Logical (by means of Prolog). The basic sound treatment was done by the jMusic and JavaSound libraries. The application of Inductive Logic Programming was done through the Aleph system.

The integration of these components was done by the Eclipse IDE, based on the Java language. The integration of Java with Prolog was done by the JPL module. Prolog interfaces directly with Aleph (which was developed in Prolog). The jMusic and JavaSound libraries integrate with Java, as well as the Scala language, the latter being done through the Maven module.

INFRASTRUCTURE FOR SOFTWARE DEVELOPMENT

Initially, the issue of programming paradigms, which constitute the basic tool for the representation of knowledge, was addressed. Methods such as Production Systems, Semantic Networks and Frames are used for this purpose [Holden 2005]. In addition to these, current models are based on formal mathematical systems, such as Inductive Logic Programming, ASP (Answer Set Programming) and Constraint Programming [Anders

2007]. Such requirements are characteristic of the declarative paradigm and are based on First-Order Logic.

From the point of view of data abstraction, the object-oriented paradigm enables a natural description of musical components with the expressiveness that the respective languages provide. In them, the logical and procedural components, necessary for imperative programming, are also made available. The Java language, in addition to incorporating the main object-oriented characteristics, has a specific native library for audio processing ? Java Sound. Addressing declarative needs, the Prolog language directly implements first-order logic through Horn clauses.

Regarding the treatment of musical structures, a survey of the programming platforms that enable the manipulation of the musical framework was carried out. Some libraries and frameworks were tested, highlighting the jMusic environment, developed at the Queensland University of Technology [Brown 2005]. This library implements basic sound elements such as tonal frequency, timbre, and rhythmic, as well as complex musical components such as melodic sequencing, harmonic structures, chaining, and cadences. Through its API, jMusic makes it possible to use formats for various music data, including integration with tools for manipulating MIDI files (*Musical Instrument Digital Interface*), LilyPond (LATEX-based music transcription system), and conventional sheet music notation. In addition, its implementation includes the control of specific hardware, enabling the work of sound synthesis, making use of audio banks available on the controller boards.

Considering the above specifications, as well as the open source software model, the following components were installed and configured: Debian GNU/Linux operating system, utilities and graphical interface, Eclipse integrated development environment, SWI-Prolog implementation, Java Enterprise Edition platform, Java Sound and jMusic libraries. The implementation led to the establishment of a hybrid environment meeting fundamental requirements for Musical Computing. It was possible to have multiparadigm programming, sound manipulation and synthesis, as well as the representation of musical knowledge through Horn clauses.

AC SYSTEMS ASSESSMENT

Since the origins of modern computing, some questions have been raised in order to make evaluations about a software system:

- Does the system behave like a human being?

- Is it possible to model intelligence through the computer?
- How to evaluate concepts such as creativity and art?
- Does the computer exhibit intelligent behavior?

The answer to these questions is dependent on the definition used for expressions such as *intelligence*, *thought* and *creativity*. With the development of the computational area, more objective questions have been addressed. Such issues deal with aspects such as efficiency, security, portability, and optimization of resources. Regarding programming paradigms, issues such as clarity, data abstraction, reusability, polymorphism and expressiveness have been addressed. In Software Engineering, the concept of quality is related to a set of characteristics intrinsic to a product, process or system, and the degree to which these elements meet the initially stipulated objectives is evaluated. In this case, issues such as user satisfaction and compliance with requirements [dos Santos et al. 2008].

Collins highlights the existence of a series of criticisms regarding the scope of Artificial Intelligence, most of them anticipated by Turing in his original article. These criticisms refer to the impossibility of a computer behaving like a human being in sensory, emotional, intuitive aspects, etc [Collins 2006]. As Souza and Faria point out, an incorrect interpretation regarding the computability and validation components of a system can lead to fallacious arguments regarding the potential of a system [de Souza and Faria 2011]. To do so, it would be necessary to establish the concept of creativity from a formal, effective and unambiguous definition. As a result, it becomes impossible to carry out an evaluation of software that belongs to this category, which will be completely rigorous and free of controversies [Ariza 2013]. In addition to this fact, Pearce et al., point out a gap that exists in most published studies involving algorithmic composition. This gap refers to three aspects [Pearce et al. 2002]:

1. Imprecise specification of the practical or theoretical objectives of the research;
2. Use of an inappropriate methodology to achieve these objectives;
3. Lack of a model for evaluating outcomes that is controlled, measurable, and repeatable.

Ariza states that the use of the so-called "Musical Turing Test" as a way of validating an AC system only makes sense if the system's aspirations are aimed at imitating the creative process, without the objective that it is really creative, or can create a completely innovative work of art [Ariza 2009].

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DEFINING THE PURPOSE OF THE INVESTIGATION

Berrar and Konagaya present the limitations regarding the evaluation of a system with regard to concepts such as "intelligence", "thinking" or "creativity" due to their difficulty of understanding and consensus. With this, they indicate the use of Turing-style tests for the field of artificially created music.

In this sense, they highlight the importance of the TST in order to motivate the development of alternative forms of intelligence, different from the human way of thinking [Berrar et al. 2013]. As Bishop et al. state, TT is "behaviorally" consolidated through non-interactive examples such as *AARON* and *Emmy*. This does not necessarily imply genuine artistic ability or creativity by computers - for such a discussion depends on highly debatable philosophical arguments. However, this fact verifies characteristics of the performance of the computerized system, which was the main focus of Turing's work [Bishop and Boden 2010].

Kosteletos and Georgaki propose a new scope for the use of the TT, not as a criterion for assessing intelligence, but as an "instrument" for tracing certain features about human judgment in various fields. Thus, Turing-style tests establish a procedure in which "what is judged becomes the judgment itself" [Kosteletos and Georgaki].

Regarding the importance of collecting additional data, Bown shows that positive results can be achieved through TT, that is, an efficient system can pass for human. However, the greatest richness of elements consists in evaluating the cognitive and sensory artifacts produced by the test. With this in mind, this researcher applied a test in which the computational aspect of the system was not hidden. Instead, the study looked at issues of engagement, experience, and perception in an impromptu interaction, analyzing the reactions produced in participants [Bown 2015].

As an analogy in relation to the creative process, we can observe in the musical field, the compositions "Bachianas Brasileiras" by Heitor Villa-Lobos and "Bachianinha nº 1" by Paulinho Nogueira. The first are a set of nine compositions, written between 1930 and 1945, in which the Baroque style is used, taking compositions by Johann Sebastian Bach as a reference [Latham 2004].

As Felice presents, Villa-Lobos used several external influences in his work, making use of modernist compositions from Europe, and this technical and aesthetic exchange does not demonstrate a lack of originality [Felice 2016]. Felice also states that the Bachianas Brasileiras constitute a work that uses "baroque quotations with a neoclassical appropriation and, therefore, includes traditional European content and avant-garde compositional tools, while seeking a national sound", and this is carried out without detriment to the ingenious spirit and great creativity of the Brazilian author.

Despite being a contemporary of Villa-Lobos, Paulinho Nogueira did not know him personally, however the composition of this great musician had in Villa-Lobos its great inspiration, even greater than in Bach himself. Nogueira was a great appreciator of Villa-Lobos' "reinterpretation" of Bach's work, mainly because he was a composer committed to Brazilian lands. It was also through Villa-Lobos that Paulinho Nogueira came into greater contact with Bach's work [Nogueira 2017].

In view of this, the fundamentally subjective aspect of what can be understood by "creativity" becomes evident, with regard to its levels of manifestation and forms of appreciation or judgment. At this point, Berrar and Schuster raise the question, "Is it really that important for a program to be genuinely creative?" For while we stick to certain kinds of discussion, beautiful paintings are being produced, moving stories are being elaborated, anecdotes are being created, and brilliant chess moves have been developed. Peter Berrar and Schuster 2014].

PROPOSAL FOR THE EXPANDED TURING TEST

The Turing test applied to musical compositions seeks to determine whether a person can distinguish whether a piece of music was composed by a computer or by a human being [Hiraga et al. 2004]. In view of the issues covered in the evaluation of an AC system, the "Expanded Turig Test" (ETT) focuses on identifying contextualization aspects of an automatically generated composition, according to one or more specific target audiences.

With this purpose, an evaluation proposal is presented that, based on the classic test, seeks to collect information, in order to identify aspects related to the effects that the composition may produce on the human listener. While the previous section has presented a brief overview of the problems involved, the present proposal does not aim to delve into the philosophical issues raised. In addition, it does not define a conclusive work, but consists of a conception that aims to provide support elements in the evaluation of this type of system.

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CHARACTERIZATION OF THE TEST

The test collects data from qualitative parameters, seeking to identify elements aroused in listeners in relation to:

- Memories;
- Emotions;
- Cultural associations;
- Historical associations;
- Aesthetic preferences;
- Use in specific contexts.

In this sense, the focus of the evaluation is to identify whether the composition produced is suitable for certain musical systems (for example, traditional Western music). The mode of musical presentation must be defined, whether it is the composition itself, or components such as performance or interaction. According to the classic TT, it is important that along with the automatic composition, one or more human compositions are presented. In addition, the target audience must be previously established, and may be formed by participants who work professionally in the area, or who have specialized musical knowledge, the general public, or other types of categorization.

Aspects to be raised in the research are presented below. Some of them are repeated because they characterize alternative points of view about the elements analyzed.

APPROACH

As for the approach, two types can be used: Directed and Spontaneous. In the Directed approach, the aim is to awaken pre-defined elements in the participant, which does not occur in the Spontaneous approach.

Targeted Approach:

- Compositions seeking to convey specific sensations, such as tranquility or strangeness; or who are purposely indifferent;
- Identification of aroused feelings;
- Use of predefined styles.

Spontaneous Approach:

- Awakened memories;
- Identification of contexts in which the composition applies;
- Associated historical components.

TYPES OF DATA

As for data, these can be both Objective and Subjective. In the Objective data, the answers are provided to the participants, who according to the situation, can choose one, several or no answers. In the Subjective data, no alternative answers are provided, which are entirely at the discretion of the participant.

Objective Data:

- Identification with compositions already heard;
- Origin of the Human X Computer composition (classic TT);
- Identification of preference as to composition.

Subjective Data:

- Cultural identification;
- Chronological identification.

ASSOCIATIVE, CONCEPTUAL AND EXPERIENTIAL ASPECTS

Regarding the Associative, Conceptual and Experiential aspects, we seek to identify pre-established elements in the participants. In addition, the observation of their experience is carried out when listening to the excerpts, in addition to looking for associations made.

Associative Aspects:

- Identification with compositions already heard;
- Cultural identification;
- Chronological identification;
- Origin of the composition Human X Computer (classic TT).

Conceptual Aspects

- Identification of contexts in which the composition applies;
- Associated historical components;
- Chronological identification;
- Style association.

Experiential Aspects

- Awakened memories;
- Feelings aroused;
- Preference as to composition.

QUESTIONS TO BE APPLIED

Considering the aspects presented in the previous sections, it is proposed to use the following questions:

1. Have you ever listened to any music with a similar style?
2. Do you associate composition with the culture of any country? Cite if yes.
3. Are there any situations in which songs in this style could be played? Cite if yes.
4. Does the excerpt bring you any kind of memory? Cite if yes.
5. Can you associate the excerpt with any historical event? Cite if yes.
6. What feelings aroused in you when you heard the excerpt?
7. In a period of how long ago does the stretch fit better?
8. Mark one or more musical styles that you associate with the excerpt.
9. Would you like to listen to songs in the style of the excerpt presented?
10. Was the excerpt composed by a human being or a computer?

USE OF EXPLORATORY DATA

From the data collected in the test, the exploration carried out contributes to the identification of aspects concerning the participants' evaluations. In addition to the elements presented in the previous sections, statistical measures can be used in this exploration:

- Dispersion Measures: Mean, Variance, Standard Deviation and Kurtosis;
- Measures of Interrelation: Correlation, Covariance and F-Test.

This exploration seeks to identify, based on qualitative values, whether the reactions presented by people when listening to the computer excerpt have characteristics that fit the pattern of excerpts composed by human authors. The aim is to verify the degree of uniformity in the perception of the automatic stretch in relation to the others.

APPLICATION OF THE TEST

The Expanded Turing Test was applied on the premises of the Federal Institute of Education, Science and Technology of São Paulo - São Roque Campus. The application under the supervision of the Teaching Support Coordination and in partnership with the Interdisciplinary Center for Audiovisual Production and Research on campus.

There was the anonymous participation of 237 volunteers belonging to the internal and external communities of the campus, categorized into 3 types, according to the degree of involvement with the musical area, with a proportional number between each category of approximately 4 to 1.

- PROF - Work in the musical area (10 participants);
- ESP - Have specialized musical knowledge (39 participants);
- GER - They do not have specialized knowledge in music (188 participants).

Excerpts from 3 compositions were used, one of them generated by the Fraseado system, and two classical compositions. The excerpts are as follows:

- Trecho 1 (T1): Uirapuru - Heitor Villa-Lobos
- Excerpt 2 (T2) : Amethyst Calculation - Automatic Composition
- Trecho 3 (T3) : Overture - Piotr Ilitch Tchaikovsky

The musical excerpts were previously recorded using the following equipment:

- Pickup System: Hexaphonic
- MIDI Controller: Roland GK-3
- Synthesizer System: Roland GR-55 Synthesizer

Regarding the human compositions, the first excerpt (T1) was selected without the intention of a specific melodic motif, while in the second (T3), it was sought to cause the sensation of "strangeness".

For the excerpt produced by the Phrasing system (T2), 3 phrases were selected for the parts referring to the beginning, middle and end of the composition, seeking to meet 2 criteria: a) adequacy to the traditional classical pattern; b) melodic motif associated with the feeling of "tranquility".

Due to the large amount of information collected, the data below will not be presented in this work:

- Association of cultural aspects;
- Contexts of application of composition;
- Historical association;
- Membership by time period;
- Association by musical style.

The results obtained with the application of the test will be presented in the next chapter.

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EXPLORATORY DATA PRESENTATION

In this chapter, elements collected by the application of the Expanded Turing Test are presented. Initially, an exploration of the data will be carried out and then considerations will be made based on the results.

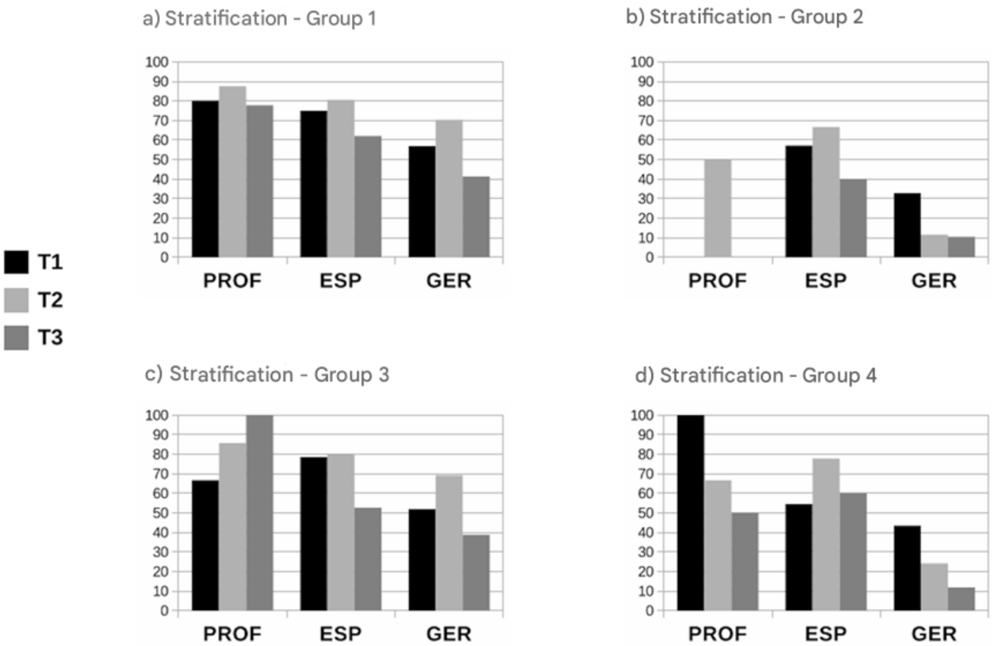
To carry out this analysis, the data sets were stratified based on the objective values collected. We sought to understand aspects related to the participants who would like to hear excerpts similar to those presented. Thus, the target group consists of groups of participants answering affirmatively to question 9 "*Would you listen to music in the style of the excerpt presented?*".

The stratification was carried out based on the sets generated by questions 1 "Have you ever heard any music with a similar style?" and 10 "Was the excerpt composed by a human being or a computer?". With this, 4 sets of origin were generated, taken as a basis for the following groups used in this analysis:

- G1: You have heard and would like to hear similar passages.
- G2: They haven't heard and would like to hear similar passages.
- G3: Excerpt composed by human and would like to hear similar excerpts.
- G4: Excerpt composed by computer and would like to hear similar excerpts.

Figure 2 shows the groups that would like to listen to the composed excerpts, categorized by participants according to the groups presented in the section

Figure 2: Participants who would like to hear excerpts similar to those presented.



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DISPERSION EXPLORATION

The dispersion exploration was performed from the following measures: Mean, Variance, Standard Deviation and Kurtosis. Figure 3 indicates these absolute values, while Figure 4 presents the respective graphs.

Figure 3: Dispersion measures.

(a) Average

	T1	T2	T3
PROF	82.22	72.47	56.94
ESP	66.31	76.25	53.67
GER	46.23	43.80	25.59

(b) Variance

	T1	T2	T3
PROF	187.65	234.97	1394.67
ESP	112.07	31.69	74.63
GER	83.86	694.41	209.65

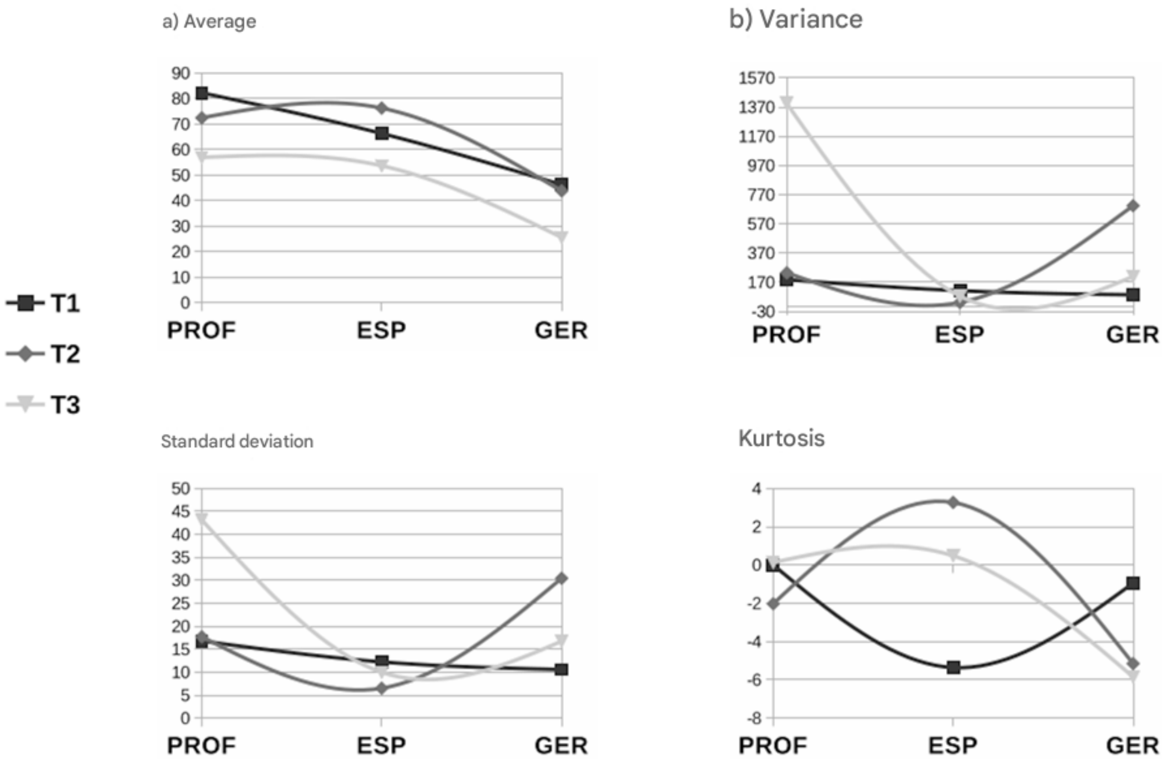
(c) Standard Deviation

	T1	T2	T3
PROF	16.77	17.70	43.12
ESP	12.22	6.50	9.97
GER	10.57	30.42	16.71

(d) Kurtosis

	T1	T2	T3
PROF	0.00	-2.02	0.13
ESP	-5.36	3.26	0.48
GER	-0.94	-5.15	-5.84

Figure 4: Scatter plots.



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EXPLORATION OF INTERRELATION

The exploration of interrelation was carried out considering 2 aspects:

- Aspect 1: Comparing the categories of participants (PROF, ESP, GER).
- Aspect 2: Comparing the evaluated musical excerpts (T1, T2, T3)

Pearson's correlation, covariance and F-test measures were applied to each of these sets. Figures 5 and 6 show these values.

Figure 5: Measures of interrelationship between categories of participants (Aspect 1).

(a) Pearson correlation

	T1	T2	T3
PROF x ESP	-0.96	0.92	0.67
PROF x GER	-0.70	0.97	0.85
ESP x GER	0.82	0.82	0.47

(b) Covariance

	T1	T2	T3
PROF x ESP	-139.73	80.21	216.18
PROF x GER	-53.86	393.63	463.09
ESP x GER	79.67	122.17	59.64

(c) F-test

	T1	T2	T3
PROF x ESP	0.59	0.13	0.03
PROF x GER	0.45	0.39	0.39
ESP x GER	0.81	0.03	0.03

Figure 6: Measures of interrelationship between musical excerpts (Aspect 2).

(a) Pearson correlation

	PROF	ESP	GER
T1 x T2	-0.88	0.64	0.95
T1 x T3	-0.99	0.30	0.91
T2 x T3	0.96	0.88	0.98

(b) Covariance

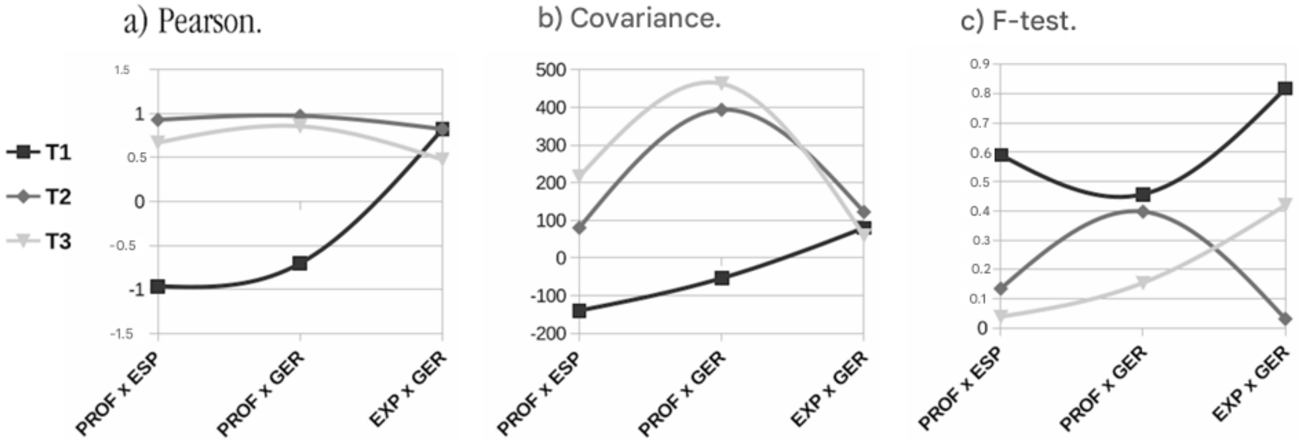
	PROF	ESP	GER
T1 x T2	-114.19	38.31	229.28
T1 x T3	-279.83	27.77	121.28
T2 x T3	550.80	43.23	377.66

(c) F-test

	PROF	ESP	GER
T1 x T2	1.01	0.32	0.11
T1 x T3	0.26	0.74	0.47
T2 x T3	0.17	0.50	0.35

Regarding Aspect 1, Figure 7 presents the graphs referring to the absolute values.

Figure 7: Graphs of the interrelationship between categories of participants (Aspect 1).



Regarding Aspect 2, Figure 8 presents the graphs referring to the absolute values.

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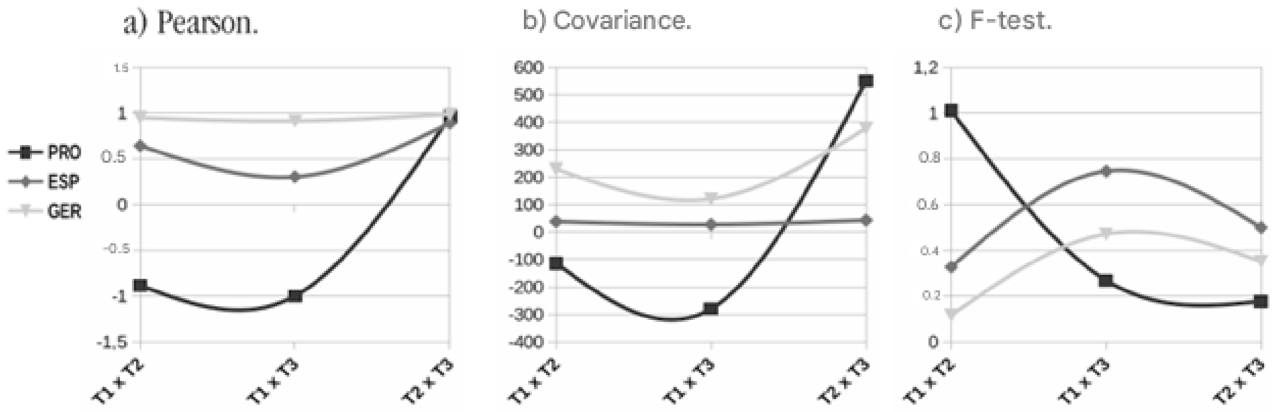
Figure 8: Graphs of the interrelationship between the musical excerpts (Aspect 2).



HUMAN ASSOCIATION BY MUSICAL STYLE

Figure 9 shows participants who have already heard excerpts similar to those presented.

Figure 9: Have you ever listened to a song with a similar style.

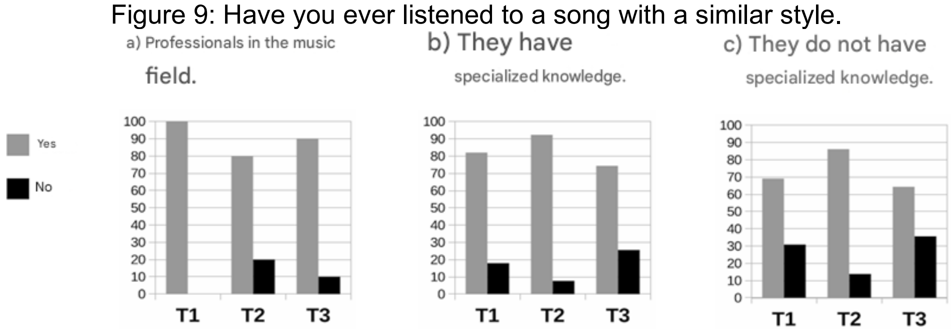
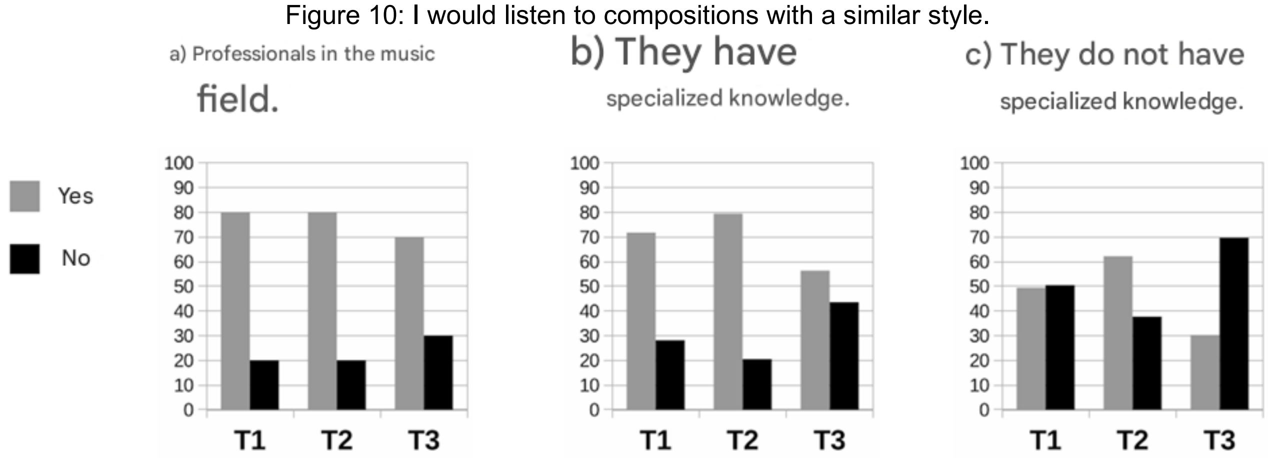


Figure 10 shows the participants who reported that they would hear excerpts similar to those presented.

Figure 10: I would listen to compositions with a similar style.



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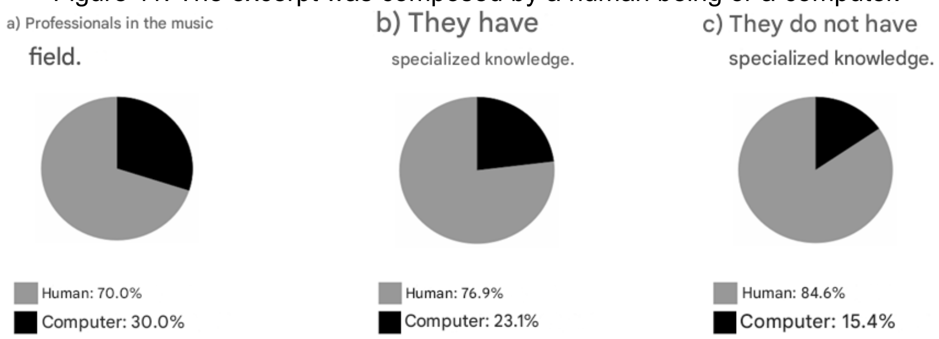
HUMAN VS. COMPUTER COMPOSITION

Figure 11 shows the classic Turing test search, applied to the computer-composed excerpt.

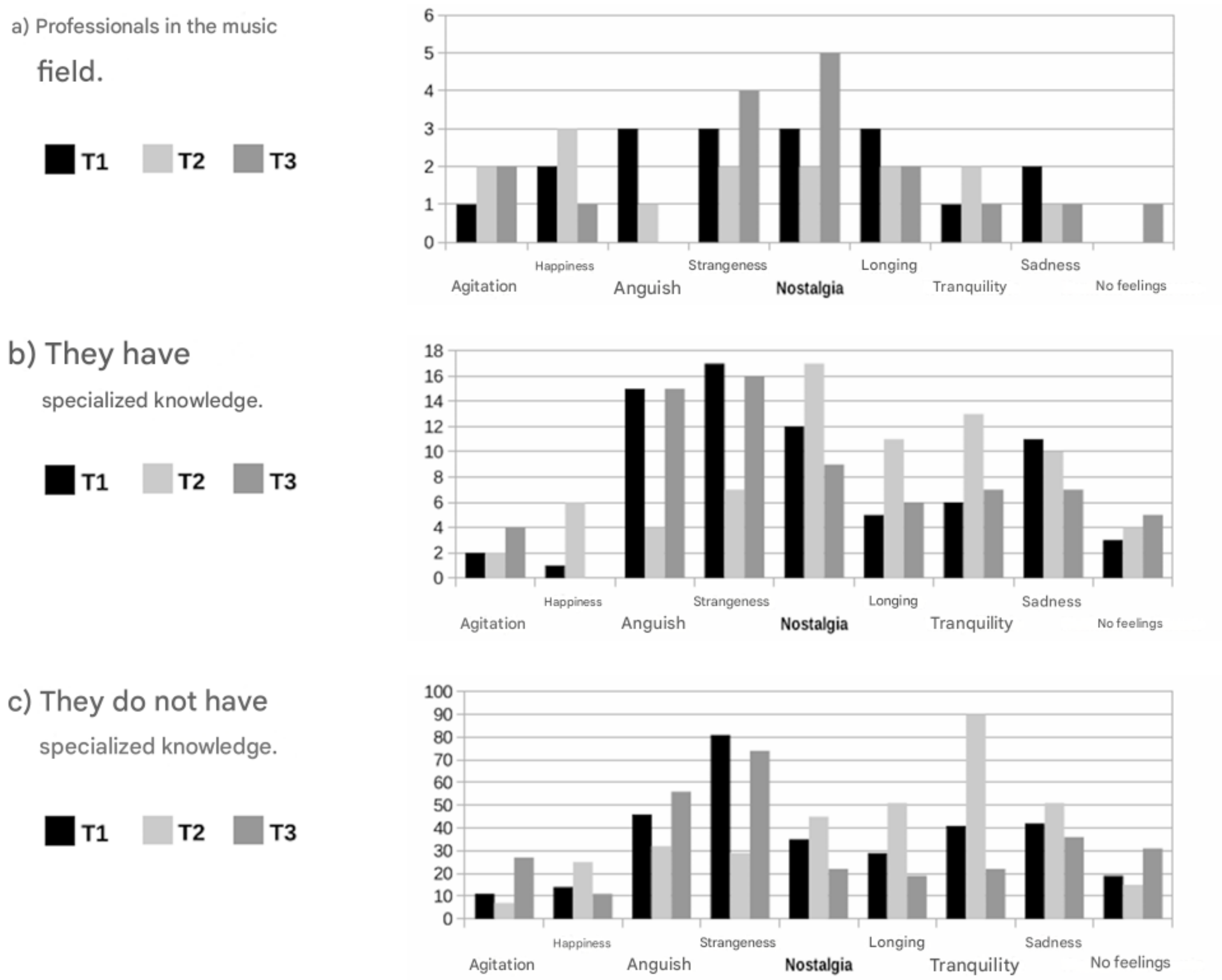
Figure 11: The excerpt was composed by a human being or a computer.



AROUSED FEELINGS

Figure 12 shows the feelings aroused when listening to each musical excerpt.

Figure 12: Feelings aroused when listening to the excerpt



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ASSOCIATION BY MEMORY

Figure 13 shows the memories that come from listening to the musical excerpts.

Figure 13: Association by memory.

I once went to an opera and there was music like this.	My presentations
Silent film films	A bike ride
My family	Films that have medieval times as their main theme
The death of a loved one	Exercise with musical instrument
Something around classical music like Frédéric Chopin	From the movie "My First Love"
When I was part of a ballet group	17th century Europe
This type of music brings to mind sacred music.	My grandfather's wake
I remember a movie "The Sound of the Heart"	The September 7th parade
Somewhat similar to the songs of the renowned Beethoven	It reminds me of sad moments in my life Moments of tranquility
My wedding day	
It reminds me of the movie Amadeus	Lindsey Stirling Clips
Bolshoi ballet performances	A musica "Suite No. 1 In G Major for Solo Cello"
Chocolate and pepper soundtrack	The time when I did Ballet
It reminds me of a wedding or a debutante party.	When I started watching Lord of Rings
My childhood, maybe a nostalgia	The death of my dog
As if someone I loved had once let go of my hand When I was	Old Disney Movies
younger and my father showed me songs like this My first performance,	TV Cultura
when I was about 10-11 years old	Reminds me of the song "Somewhere Over The Rainbow"
The birth of my 7 children	When I got my first toy
It reminds me of the time when I took violin lessons	What our lives were like
My parents	Hard times I went through
The movie "Shindler's List"	People dancing
A ballet performance that my queue performed	Memories of my childhood

RESULTS AND CONCLUSIONS

According to the 4 groups of participants who would listen to excerpts similar to those presented (Figure 2), it is observed that the lowest values are found in the groups: G2 - where there were no associations of similarity; and G4 - in which the excerpts are identified as composed by a computer. Thus, in relation to the automatic stretch, the high values presented in the classic test, indicating the composition as being made by a human being, corroborate the identification of preference made by the participants. This demonstrates a particular association with the automatic excerpt.

As indicated in Figure 14 the three excerpts show a uniform behavior in relation to the 4 stratified groups, which is also observed by the graphs in the Figures and . It can be observed that as the degree of expertise of the participants decreases, the feeling that the excerpt was composed by a human being increases (Figure 11). In this case, the higher degrees of musical familiarity indicate a greater perception of the origin of the composition, which does not influence the other aspects related to contextualization or "involvement" with the automatic excerpt.

It is also noteworthy that the lowest values for the classical Turing test, among the 3 categories of participants, were in the range of 70%. This represents a high indication that a composition was produced in the context of the computerized system. According to the directed component covered by the test, the graphs in Figure 12 show that the feelings that were sought to be aroused with excerpts 2 and 3 were achieved, considering the aspects of "tranquility" and "strangeness".

Regarding the aspects involving memories, preference associations and feelings, the collected elements highlight the identification of the participants with the automatic composition. This points in the direction that the fundamental purpose of computer-generated composition has been achieved. Based on the results presented, it can be concluded that the approach used in the present study satisfactorily achieved its objective. The multiparadigm programming technique combined with Inductive Logic Programming enabled an effective method for the development of the process of Musical Knowledge Representation. Among the possibilities of applying this approach, the Phrasing system enables algorithmic musical composition, with the ability to produce excerpts that can be associated with certain human contexts. This capacity could be evaluated by the proposed method - the Expanded Turing Test.

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