Will Semantic Web Mining in Music Revolutionize Musicology?

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ABSTRACT

The present authors share the characteristic of a significant participation in R&D projects for designing and implementing interactive systems in the field of digital music: tools for computer-based assistance to browsing sound and music data, assisted analysis and commenting systems for musical works, or assisted interactive environments for the creation of interactive virtual works.

In spite of the diversity of their experience and practice, the authors all together are aiming at renewing the theoretical framework of musicology, which is working in the background of their creation or engineering activities (of course, without a formal declaration, but quasi-permanently), since a massive digital inscription of music allows its objects to be handled by programs, or even to be transformed into programs executable by other programs.

To avoid any form of misunderstanding: such a theoretical framework is only a model, which functions only if it allows us to interpret artefacts and phenomena, producing at the same moment a consistent musicological language, a space for the categorisation and evaluation of realisations, as well as a number of objectives for technological deployment and theoretical evolution. But, within the research teams, we also require that these models could provide capitalisation structures for experience, know-how and acquired knowledge.

The beginning of this paper will propose a minimalist expression of the theoretical framework searched for, and then we shall exhibit the marks of its present mobilisation as a dominant model, although mainly implicit. We aim at opening a critical discussion and confrontation, for improving the appropriate character of the proposal and its internal consistency.

Then we shall examine the canonical character of the proposed theoretical framework. Can it be reduced to the theoretical framework of traditional musicology? In this case, this framework must be identified and made explicit.

It is obvious that the authors are essentially interested in epistemology, with the main objective of a renewal of the contemporaneous theoretical discussion on musicology.

KEY WORDS

Sound and Music Mining, Concept Taxonomies and Ontologies, Information Retrieval, Knowledge Representation and Engineering, Human Computer Interaction, Multimedia Systems, Searching and Browsing, Music & Musicology.

1. INTRODUCTION

If contemporaneous music exists, shall we also consider a contemporaneous musicology? In this new formulation, the question regards the nature of the links between music and musicology during a given epoch. In this sense, the characteristics of the 20th century music could suggest that a specific musicology is necessary for this period.

Nevertheless, this is not exactly the theme we are trying to develop here, since we are essentially interested in the theoretical framework of the musicological language deployment. It is true that this theoretical framework contains some elements coming from the contemporaneous musical practice, but our reflection goes far beyond it, while aiming at an epistemological research.

We shall use as a basis our own experience with projects of assisted browsing through sound and music collections, computerised analysis and commenting of musical works, or interactive creation of virtual works. It is interesting to identify and make explicit the implicit theoretical framework which acts in the background of such projects, in order to capitalise experience and know-how. This theoretical framework, has not an aesthetic or historical nature, but is essentially musicological, in the sense that the musicological language is founded on the interpretation of all phenomena present "when we are consciously listening to music", just to use the Berio's formulation [2].

2. IDENTIFICATION OF A MUSICOLOGY WHICH IS BOTH CONTINGENT AND APPROPRIATE FOR THE COMPUTATIONAL REASON

The theoretical framework we propose is appropriate by construction. Its elaboration is not the result of the transformation of an older framework, but comes from an interpretative and theoretical examination of constructions bearing the marks of present efforts aimed at a successful use of machines for interpretative activities, in the form of collaboration/co-operation with human users.

The method of explanation is here that of the reverse design: one tries to discover a model in actual use and to elicit it as our model. This is the reason why we declare that the proposed theoretical framework is "appropriate by construction".

Even if the theoretical framework is appropriate, it is however submitted to the computational reason, if different from the graphical reason studied by Jacques Goody [7]. This means that the framework is prescribed and determined by "digital aspects and computers", in a way which is both obvious and mysterious.

Such a theoretical framework may be characterised by "attractors". The meaning of this term in physical models of the movement is well known: in a global approach, the position and speed components are combined into the same vector. Then, depending on given situations, this new composite vector can follow regular trajectories which do not depend on initial conditions, or can present a divergent behaviour. Here, in the framework of the definition of the theoretical basis, we may use the term to explain the stability of the chosen framework, its irreducible character, and its lack of sensitivity with respect to given historical or aesthetic initial points.

2.1 The attractor of material hermeneutics

On the basis of the distance between the life singularities due to human concerns and their correlatives in terms of "reason" or ratio (differentiation, categorisation, classification, generalisation), one tries to identify the specificity of a computational reason, opposed to the already evoked graphical reason.

This approach tries hard to replace the apology of knowledge in the categorising thought with the study of possible technical conditions for our semiotic mediations, so that the link between thought and technology is much stronger than in other approaches.

2.1.1 The example of musical listening

Regarding the theme of musical listening, here is an example of a reflection having a character of material hermeneutics, trying to explain that "time will not necessarily come past".

Musical listening is an activity deployed in time, like any other activity. But its object participates in the prescription of this deployment and has a vocation for giving the feeling that what comes past is not the time but the silence and the noise (in Greek "to listen to" = "to obey the prescriptions of a master"; in Spanish "to listen to" = "to understand" – one listens to music like to a master). So, music tries to populate the time to stop it, in the same way as Husserl's Earth is immobile.

But the work does not work in the eternity, because it is finished. Moreover, time has to come past somewhere. The suspended time of music demonstrates the vanity of such an idea. Thanks to music, the immediate experience becomes possible. The immediate experience is even more fascinating when one thinks that it is conditioned by an artefact or a sequence of artefacts requiring a duration. We use the term "sequence of artefacts" because this naturally lends itself to sequential cutting out. By nature, it is a sequence and leads the listener himself to compose the object of his experience as a sequence, whose end will also be determined by the listener, who is or is not pleased. The fact that some links are produced by cutting out ("zapping") or some sequences have no terminal cadences does not matter.

To create a duration is to build a space ... So, musical listening prescribes its modalities, objects and targets. This activity appears as a desire to listen to something, "to listen to something else", which correlates with either the sudden appearance of the work, imposing an immediate listening, or with the determination of a similarity immediately specifying a difference as an alterity in an analogical relationship with the past.

So, our basic principle is that listening is a desire to listen to something even more (to let the experience go on), but also, paradoxically, to listen to something else (to get a new object allowing the experience to persist). The fact that continuity is required generates a need for interruption, the succession (a cognitive difference) determines and prescribes a variation (a difference of type). The need for a consistent succession can be reduced to the specification of an alterity in a similar or analogical relationship with the previous matter.

The deployment of listening towards its ideal implies the construction of a musical sequence musicale, in the mode of an elective affinity, which is always critical. Thanks to musical records, immediately attainable via access systems and restitution devices, listening means composing a preferred sequence.

Therefore, the question of listening is connected with the question of description and categorisation (cf. Deleuze in *Difference and repetition* [5] or Husserl [8] in his *Lessons on the intimate consciousness of time*, presenting the notion of a retention-protension dyad[1]). As such, it is conditioned by the technological means.

[1] The Husserl' vision is marked with the Karl Weierstrass' topology, a mathematician who was his master. The conditions of a possible synthesis of present, immediate past and immediate future would depend on the topological fold of these versions of the present, which excessively densify its place : there would be a kind of natural

2.1.2 The example of musical creation on digital support

Understanding a musical composition on digital support is inscribed in the same logic as that we have already presented, because if listening contains a composition, composition obviously contains a form of listening. The need is especially that of a consistent succession, in a form elaborated between « permanence and variation », a term which Schaeffer could use in response to Deleuze's « difference and repetition ».

Computer assisted composition tools allow us not only to mobilise immediately and to bring together some records, but, moreover, to evaluate immediately the consequences of artistic choices. The combinatorial power of these systems allows us to get very rapidly a representation of a musical idea, and therefore to compare the potential of groups of close ideas which could imply a difficult choice for the composer. The traditional time difference between musical conception and realisation is practically abolished, since the sound result can be simulated immediately after the conception.

2.2 The attractor of the « ontologies »

The ontological approach is relational and focuses on the notion of knowledge. It was founded on the assumption of the "Knowledge Level" enunciated for the first time by Alan Newell in 1982. In this assumption, knowledge plays an essential part since it is on the one hand a set of data handled by machines through semantic networks (handling can ultimately be reduced to calculation carried out by a layer-architecture system characterising Von Neuman computers), on the other hand the key place of human action simulation, depending on the following principle of rationality: "tell me what you want, what you know, what you can do, and I tell you what you have to do ". Basically, this assumption reduces thought to knowledge processing accompanied by a circuit through knowledge networks, and learning comprises operations acting on the network: edit, rebuild, deploy.

It is obvious that the ontological theory strongly assumes the possibility of reducing any interpretation to a logical processing of reified meaning units, and this processing would model in some way the contextual meaning. Thus, ontologies claim to separate two difficulties related to thought: on the one hand the choice and the constitution of thought objects, on the other hand the movement of these objects in the semiotic backgrounds.

By proposing knowledge models which structure some reified elements, ontologies lead to thinking the objects of thought as available on the shelf, and open the possibility of building a meaning from artificial confrontation of such structures: therefore, the ontological theory perfectly agrees with the virtualities offered on the Web[2], where such parallels are proposed at every moment and procure something like a cheap form of inter-subjectivity.

This approach is assumed by the knowledge elicitation research community. We shall not deny the heuristic value of the "Knowledge Level" assumption, because it allows us to design natively co-operative man-machine systems at this "knowledge level". We have yet to solve the difficult question of eliciting these ontologies, which represents a true paradigm for modelling through elicitation. There is also the problematic question of their dynamic evolution, and finally, the discussion on their cognitive pertinence (the mystery of an intelligent approach of such systems by their users).

2.2.1 The example of reduced listening ontologies proposed by Pierre Schaeffer

An example of an ontology in the domain of sound objects is the sound description in the reduced listening mode, proposed by Pierre Schaeffer in his *Treaty on musical objects* [13], as shown below.

2.2.2 The example of computer assisted tools for composition

In the field of musical composition, score digital coding systems are based on musical ontologies which can be handled by such software interfaces as editors.

2.3 The attractor of algorithmic calculation

On the basis of computer power, we search for calculable descriptor forms which can define object classes with an interesting interpretation, giving way to potential novel applications. This approach is typical for the "Motion Picture Expert Group" consortium (MPEG) practices.

The calculation approach has an atomic character and focuses on quantity. It is based on an evaluation of the current state of science and (algorithmic) calculation techniques, as well on a kind of market intuition. Since the question is about sound and music, the question could be this one: is it possible to find out algorithms applicable to digital signals in order to extract from them some values, which could be called descriptor attributes of the signals and assigned mnemonic names in order to represent the signal within particular application? A descriptor contains a name, a retrieval algorithm, and a list of potential applications increasing its value on the market.

This approach is based on the idea that digital inscription is excessive; the result must be "refined" until specific products, responding to specific needs, are obtained. The heuristic character of this approach can open new interpretation fields, prescribed by computer power. Nevertheless, everybody can feel that the approach is due to a mere purpose of standardisation. This idea assimilates problem translation to an actual solution.

2.3.1 The example of a psycho-acoustic descriptor: the "actual duration" of a sound signal

The "actual duration" of a sound signal is the evaluation of a duration, when the signal is meaningful in the perceptual plane. It is calculated on the basis of an energy envelop threshold whose value is proposed by some psycho-acoustic studies, and its implementation allows you, for instance, to discriminate between a percussive sound and a maintained sound. This attribute has been promoted as a descriptor by the MPEG7 standardisation consortium.

2.3.2 The case of musical creation

The automatic follow-up of scores, which have become compulsory for the design and actualisation of musical works implying a real-time performance which associates human instrument players and computers, is based on descriptors which isolate and recognise notes, energy profiles, envelops, signal parts, contributing to a parameterised musical composition, where sound computer processing is modulated by the extracted values.

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impenetrability between the ingredients), and therefore the synthesis would be passive, by a reduction of the excess, and a compilation of retention, present and protension.

[2] The Web offers the possibility to bring together artificially distal forms, via moving closer and juxtaposition, which can cause a synthetical interpretation: this principle of heuristical capture is the probable basis of what is presently named « assisted discovery ». This possibility is conditioned by the digital inscription, now massive, of semiotic forms, which can be reproduced and handled by programs of the same semiotic nature as the handled forms (the only difference is that these programs can be executed by other programs).

3. VALIDITY, EXPRESSIVE POWER AND GENERICITY IN THE DISPLAYED THEORETICAL FRAMEWORK

First, we shall show, via a few examples, that the theoretical framework is spontaneously used in many activities including the analysis of a contemporary piece of music or the automatic generation of formally constrained musical programs.

3.1 The question of the validity of the proposed theoretical framework

3.1.1 Example 1: analysis of Jupiter *by Philippe Manoury*

Let's consider the *Jupiter* musical piece composed by Philippe Manoury (1987), written for solo flute and real-time electronics. In this work, the composer anticipates rhythmic interpolation processes from the capture of the dates of notes-events played by the flutist, which are transformed by calculation (progressive interpolation) until a given rhythm is attained. The calculated result is separated in time from the capture: the computer will play these sequences several sections later after having "listened" to the flutist. The basis of this compositional approach is both technological and musical:

- technical capability of capture;
- storage of events;
- real-time calculation of musical entities without any musical *a priori* notation, because only the possible conditions are defined before the performance;
- real-time dual modality of the musical events follow-up, i.e. waiting and immediate recognising of figures emerging from the depth, while triggering real-time calculations for the previous point.

The calculation approach takes into account all algorithmic processes implemented by Manoury. Computational reason represents the inscription of phenomena in the form of acoustic and musical processing, as well as in the traditional graphical form. The framework of this new chamber music can be explained by the ontologies of man-machine interaction in a situation of musical play.

In the case of constrained musical program generators, the calculation approach allows us to extract new stylistic characteristics from the audio records and symbolic files implemented. Besides, the design of this system includes necessarily, for its dynamics, a computer support. Finally, the whole is based on the ontologies of the target repertoires and, even more, on musical styles.

3.1.2 Example 2: automatic generation of formally constrained musical programs

The principle is as follows: you have at your disposal both a database of musical pieces with appropriate descriptors, and a constraint input interface (listener's tastes as well as elements of stylistic modelling); an automaton is able to generate an interesting musical program, proposing a certain continuity and giving, at every moment, a longing for listening even more to the present piece, but also to a different one (cf. the MusicBrowser of CUIDADO).

If the validity of the theoretical framework proposed as a model is recognised, this does not exempt us from the necessity of trying to improve its expressive power. In fact, if an attractors' table is established, one must admit that their explanation raises a large number of difficult questions:

Approach	**Via computing**	**Via ontologies**	**Via material hermeneutics**
Sign	Excess of **inscription**	Mediation of **classification**	Exhaustion of **categorisation**
Modality	Digital signal calculation	Knowledge representation	Study of possible material conditions for conceptual deployment
Stakes	Definition of new interpretative descriptions, prescribed by computer power and proposed to Mankind for use and reflection	The interpretation is represented as a synthesis of knowledge elements handled by both human thought and automata	Thinking on the gap between conceptual categories and the process leading to a singular position, which characterises the actual life of consciousness, in its "always-already" technologic relationship with the world
Aporias and difficulties	Only two ordering patterns can be envisaged for the proposed descriptors: 1° order of calculation 2° order of economic profitability	Knowledge elicitation and ordering are the two sides of a unique modelling activity, which has the hard choice between theoretical ordering (abstraction or generalisation) and practical ordering (user-oriented value); this causes elicitation/maintenance problems to appear in ontologies	- Life cannot be reduced to a singularity in consciousness - Explain (for instance) that the artificial advent of knowledge causes the interpretative synthesis and stimulates further discoveries
Development places	The MPEG standardisation consortium	Academic communities involved in "knowledge elicitation"	Supporters of material hermeneutics as a "first philosophy"
Musical example	The "actual duration" of a sound signal is a MPEG descriptor is in the process of standardisation	In his *Treaty on musical objects*, Pierre Schaeffer proposed an ontology for describing sounds in the reduced listening mode (in the sense of phenomenology)	In *Difference and repetition*, G.Deleuze demonstrates the incommensurability between "singular" and "particular" (in the case of theatre)

3.2 The question of a canonical character in the case of the proposed theoretical framework

Supposing that we have at our disposal a theoretical framework, both contingent and suitable for computational reason, and also operational and effective as a model, we have to decide on its canonical character: can we reduce this theoretical framework to musicology's traditional framework?

This question is important: in fact, why should we leave the traditional framework? If some persons are prone to play necessarily with these new difficult concepts, are we not able to ultimately demonstrate that the modelling they produce can be brought back to the precedent framework via a given transformation, whose validity has been clearly established?

To answer this question, we shall show the aporias of the theoretical framework traditionally supporting the musicological language, and the irreducible inadequacies making it definitely unable to say anything pertinent about the musicological objects which concern us.

4. APORIAS AND INADEQUACIES OF THE THEORETICAL FRAMEWORK SUPPORTING THE TRADITIONAL MUSICOLOGICAL LANGUAGE

Let's begin by rebuilding the traditional theoretical framework, while trying to elicit its true nature.

4.1 The triad of the traditional theoretical framework

It seems to us that three attractors may be distinguished within the traditional framework:

- The composer's or interpreter's hagiography, presented as an outstanding creator; we have to know and understand his/her origins, life conditions and psychology. Understanding the musical phenomenon is thus connected to understanding a person, who composes or plays music. Many positions may be envisaged, from total disjunction, as in the Boucourechliev's assertion («everybody may be in love, but *Tristan* is due to a single person», [3]) until a supposed parallelism, following the track of all cognitive science researches on human creativity.
- Organology, born together with a technical perspective where mechanics plays the first role. This is the reason why musical instruments are present in museum collections, such as that of the "Arts et Métiers" in Paris, reflecting the fantastic development of invention in the mechanic field, until the second half of the 20th century. Then, the very conditions of possible music, at a material level, were envisaged, including all their consequences.
- The attractor of graphical reason and musical theories, from Antiquity until now, tackles a large number of musical composition parameters, from constitution of scales, harmony and counterpoint, to the orchestration, while presenting as a « law» the great model scores of the past. One has to acknowledge the contribution of the material inscription to all these theories, and particularly the appropriateness of the support: the two-dimensional plane sheet on which are written x/y scores where height (proportional notation: the higher the pitch, the grater the number of necessary new lines) and duration (algebraic notation, where there is a fixed ratio between abstract entities: so, it is said that one crotchet is equal to two quavers) are marked. Therefore, we find here a graphical reason, which stands out as the basis of all possible theories. Hugues Dufourt [6] upholds that the old Greek music, following the example of philosophy, searched for « the one within the multiple, the invariable within the change », whilst the Western polyphony and modern form of mind « require a deployment of the time, then a deployment of the space ». This difference is perfectly understood while examining musical notation: the old Greek notation is only an alphabet expressing height, denying the time while occupying all its one-dimensional support. Western notation takes into account the full structure of its support plane, as well as those of the two-dimensional forms of thought, opening the way to polyphony.

4.2 Aporias of the traditional theoretical framework

This theoretical framework (based on the three attractors: an "inspired artist", a "mechanical organology", and a "theory founded on graphical reason") allowed the deployment of the musicological language in the West. The three attractors constitute a consistent and unavoidable basis, used by both music teaching and interpretative reflection (or a major part of the musical thought).

4.2.1 Example 1: analysis of Jupiter by Philippe Manoury

The analysis of this work turns out to be dangerous in the traditional theoretical framework, without taking into account the hagiographic attractor, that Manoury moves at once, by asserting the re-usability of his works (as a MAX/MSP library named PMA-LIB, distributed to all the Ircam Forum users) – himself partially resumed some elements and programs already developed. There is in digital music a culture of something "already present and ready to be used", also inspiring the composers. The organologic attractor may imply that computers are musical instruments, with sensors and actuators, but how could we explain within this framework the deterministic yet undetermined character of note generators?

The theoretical attractor is even less able to maintain the graphical reason, and Manoury's notation choices in his successive scores clearly show this: if the composer tries to translate the electronic « parts » into a traditional notation (by writing the result of some operators such as the harmonizer), the success is very partial because processing, e.g. through the frequency shifter, acts while leaving no possibility of inscription in the score plane (there is a twofold movement of an infinity of sound partials) and this leads to a notation containing only operator names, as in the *Neptune* score (1991).

4.2.2 Example 2: automatic generation of constrained musical programs

This difficult inscription in the traditional theoretical framework is not a characteristic of only recent creations. Other musical activities, operating on various repertoires, are also concerned, e.g. the software allowing us to generate constrained musical programs.

In this case, the traditional framework is even less able to represent this practice: there is no longer a single composer, but a multitude; we have neither musical instruments nor any score, but a pure digital inscription.

In other words, the traditional musicological framework ignores computational reason, except if this is artificially reduced to a graphical reason.

5. CONCLUSION

We have submitted a new theoretical framework to the discussion; its only merit is that it seems to serve spontaneously

(although often implicitly) as a model for researches and developers immersed into the world of computational reason and digital music. This framework is in itself very problematic, because each attractor contributing to its status of a modelling field raises difficult questions.

However, this new framework could hardly be reduced to the traditional musicological framework, in the same way as computational reason cannot be reduced to a mere graphical reason.

We must choose between two attitudes: in the first case, a hard struggle for masking the "aporia" by introducing computers which will submerge each attractor of the old theoretical framework into a bath of "new technologies". There are only a few musicologists, formed by the graphical reason, who attempt to stand up to this temptation.

The other attitude would be to constitute a musicology, suitable for computational reason, but free of a blind dependency on it. One may think that this task is quite extensive, decrete that this requires a full epistemological understanding of computational reason (different from graphical reason), and be patient.

But, we must also assert that both questions are intimately connected with each other, so that musicology could contribute to clear up one of the most enthralling questions in this beginning century.

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