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# Towards a Methodological View on (Computer-Assisted) Music Analysis

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## Abstract

Music analysis is very often taught and practiced without reflecting on the method(s) used. Analysis is not possible without language and concepts. If 'pure' cognition of composition does not exist, then practicing analysis must include some reflection on its purposes. In this respect, analytical methods must be classified. This article reflects on methodological problems in music analysis. Traditional classifications of music analysis are re-visited and changes towards a more consistent system of classification are suggested with regards to the approaches taken. Finally, these methodological observations are applied to the use of computer technology in music analysis. Since methods of computer-assisted music analysis have not been classified yet, such a system is proposed here, based on detailed historical studies in this field. Each of the categories in this system of classification of computer-assisted music analysis are briefly characterized.

## 1. Introduction: On the Necessity of a Methodological Approach

Music analysis, including computer-assisted music analysis, is often practiced and taught without any reference to, or reflection on, the premises of the methods employed. One of the few writings acknowledging methodological concerns in the area of music analysis [7] points out that analysis is not possible without language and concepts, which means that there is nothing like 'pure cognition'. If 'pure' cognition of composition does not exist, then practicing analysis and teaching analytical methods must include some reflection on its purposes. Music analysis is not an independent discipline—and it depends on very specific theoretical systems—, nor is it an activity to be defined once and for all. Rather, music analysis is a *method*, which means it is a *way* to reach specific goals, it is a means to an end.

One way to handle these methodological problems of music analysis is to reflect on different methods; methods of music analysis need to be classified and described. While this task is partly done for 'traditional' methods of music analysis [3, 5, 6], classifications and descriptions are still lacking for new (especially computer-assisted) methods of music analysis. (An exception is, certainly, Ian Bent's monograph *Analysis* from 1987 [4].) Also, a critical evaluation is urgently needed.

So, why—in more detail—is a *methodological* approach to music analysis necessary? This question must be answered after introducing other theoretical considerations.

For Wolfgang Horn [7], analysis is, first of all, neither a doctrine nor a theory. It is not a formal-logical activity, but it has to do with the application of concepts to objects of experiences. This is the reason, why analytical activity is so hard to understand and formalize. The activity 'analyzing' is characterized by examining musical objects that are supposed to be resolved "into simpler constituent elements" [4, p. 1], and by the *manner* of resolving.

But what is 'music analysis' supposed to resolve? Ian Bent's definition continues: "Music analysis is the resolution of a musical structure into relatively simpler constituent elements, and the investigation of the functions of those elements within that structure." [4, p. 1] But the "resolution of a musical structure" into "constituent elements" is *not* the resolution of an *unknown object*, but of an *internalized*

*experience*: Acoustical events, or their notation, function as a result of experiences and concepts [7, p. 12].

Analytical resolutions are usually communicated via language. Here, language rules need to be applied. The product, the analytical text, can be verified with the help of logic. Also important, the choice of the concepts on which the analysis is based needs to conform to the goals of the analysis. The (logical) terminological frame as well as the conceptional frame are most crucial and must be explained in the analytical text.

Wolfgang Horn distinguishes between two main approaches: The first answers the question "How is this done?"; the second answers the question "What is this?". "The results have, in both cases, only illustrative character, because the theory 'knows' concepts," and you *apply* concepts, but do so within a framework relating to a specific object. These kinds of analyses are important in historical research for getting an overview, but they are better used to catalogue compositions and put them into types. Generally, analyses are dependent on their methodological basis: "Only if the frame of an analysis is discovered, can you ask for the relevance of the analysis, and even if the question is only about the relevance to my subjective, current interest." [7, pp. 13-14]

In summation, analyzing music should not only be done "right" and "logically," but the framework of the analysis needs to be *justified.* "We should not only talk about analysis, but also, and especially, about its terms and conditions!" [7, p. 16] Reflections on the framework of music analysis, its purposes, and its goals are most important, which require *then* the application of certain methods.

## 2. Existing Classifications of Music Analysis

Music analysis can be classified with regard to the kind of music analyzed, the methods used, the general approach taken, etc. Any classification needs to be based on a logical framework; that means that a certain classificational level (level of abstraction) has to be on the same epistemological level. (Epistemology is the study of the methods and grounds of knowledge, especially with regard to its limits and validity. "Epistemological level" refers, here, to a level [in a system of classification] in which all 'members' have one main common characteristic, e.g. all 'members' of that level refer to *either* a method of analysis, *or* to musical categories, *or* to kinds of music, etc.)

Dieter de la Motte [5], for instance, distinguishes the following analytical categories:

- Large-Scale Form → Detail Structure
- Measure-by-Measure Analysis
- Analysis of Vocal Music
- Category Analysis
- Comparative Analysis
- Special Analysis
- Tendency Analysis
- Statistical Analysis
- Analytical Details
- Analysis with no Prerequisites

Here, different epistemological levels are mixed, such as classifying with regard to musical categories (e.g., form, structure), with regard to the kind of music (e.g., vocal music), with regard to certain methods (statistics), etc.

Ian Bent and his analytical categories offer a better example. Bent's categories of analysis are within the same epistemological level, since he only aims at specific theories. To support that notion, he mentions the author of each theory in parentheses:

- Fundamental Structure (Schenker)

- Thematic Process (Réti) and Functional Analysis (Keller)
- Formal Analysis
- Phrase-Structure Analysis (Riemann)
- Category and Feature Analysis (Lomax; LaRue)
- Musical Semiotics (Ruwet and Nattiez)
- Information Theory
- Set Theory

However, if Bent whishes to consider all existing, specific theories, his list is far too short and eclectic. Other theories would have to be added: different theories of harmony (e.g., Rameau, Hindemith, Perle), melody (e.g., de la Motte), rhythm, and so on.

## 3. Towards New Classifications of Music Analysis

For the reasons of insufficiency mentioned above, another classification of music analysis, characterized by its categories of musical elements, at which the analysis is aimed, shall be suggested here:

- Form Analysis
- Melodic Analysis
  - Thematic Analysis
  - Motivic Analysis
  - Phrase Structure Analysis
- Harmonic Analysis
- Contrapuntal Analysis
- Rhythmic Analysis
- Analysis of the Relations Between Text and Music
- Analysis of Instrumentation

Each of these categories can be sub-divided (indicated here already for "melodic analysis"). Musical categories such as range, type of motion, type of patterns, timbre, texture, sound, etc. are included.

To classify with regard to the approach used—depending on the goal of the analysis—the following categories could be distinguished:

- Schenkerian Analysis
- Transformational Grammar Analysis
- Comparative Analysis
- Measure-by-Measure Analysis
- Statistical Analysis
- Information Theoretical Analysis
- Semiotical Analysis
- Category and Feature Analysis
- Cognitive and AI Analysis
- Process Analysis

However, such a classification, based on the approach used for the analysis, cannot be complete, since new approaches are always being developed. (In this respect, the new classification of music analysis given earlier, i.e. characterized by its categories of musical elements, should be preferred. However, for certain goals of analytical research, a classification based on the approach used, will be useful.) In some of the categories shown above, specific theories are implied; however, since these are very broad and established categories of music analysis, a classification of such 'analytical approaches' seems to be

justified. An additional sub-category could distinguish between the basis of the analysis: whether it is notational based or performance based (i.e. is the object to be analyzed notated music or performed music).

Another classification would be possible within the epistemological level that would refer to the "kind of presentation" of, and to the logical order within, the analytical text. (Here, de la Motte's 'Special Analysis' would fit in, which does not seek to prove something postulated in the beginning but to discover something unknown by following a specified procedure.) However, there are so many different kinds of presentation possible that a classification in this respect does not seem appropriate. The more interesting question would be if there is a classification possible with regard to *goals of analyses*, since this is the ultimate aim of any analytical work. Such a classification of analytical goals as well as the unification of the variety of classificational levels mentioned above in one system of classification, remains to be done.

## 4. A Classification of Methods of Computer-Assisted Music Analysis

Another methodological point needs to be made, relating to the use of technology: All analytical methods can be supported by the use of computers in music analysis. Computer-assisted music analysis provides analytical tools to help solve problems of analyzing music with traditional methods. For instance, it may clarify stylistic characterizations and questions of unclear authorship, it helps investige (historical) musical developments, it is useful for developing new theoretical systems, for research on acoustics and performance, as well as for cognitive and artificial intelligence research.

Introductory reading materials about the history of computer-assisted music analysis, such as overview articles by Bo Alphonce [1, 2] are highly selective; dozens of dissertations and numerous American and European articles are excluded. Also, most of this material fails to reflect on the subject critically. More specifically, it does not show the limits of the applications discussed. They do not show, for example, how some of the first experiments with computer-assisted music analysis are not complex enough and do not use enough musical material to support their findings.

While a critical history of computer-assisted music analysis has just been written [8], historizing computer-assisted approaches of music analysis on the one hand and classifying those on the other leads to an important epistemological problem. Even though computer-assisted music analysis has been conducted for only four and a half decades (which is very little time compared to the history of 'traditional' methods of music analysis), it has been developed under various premises, using a variety of methodologies. For that reason, it is almost impossible to talk about a real "history" of computer-assisted music analysis. Rather, approaches of computer-assisted music analysis must be initially placed within a classificational system based on their methods. On the other hand, the development of a system of classification is only possible after a thorough study of all existing approaches.

Finally, the following classificational system of computer-assisted music analysis shall be suggested here:

- Statistical and Information-Theoretical Analyses
- Set Theoretical Analyses
- Other Mathematical Analyses
- Hierarchical Analyses
- Transformational Analyses
- Schenkerian Analyses
- Spectral Analyses
- Cognitive & AI Analyses
- Combined Analyses

These categories can be divided into sub-methods. But the methods applied strongly depend on the form in which the music is analyzed; thus, "notation-based analysis" and "performance-based analysis" should

create the second highest epistemological level in such a system of classification. The kind of music analyzed could be the basis for the third epistemological level.

In the following, each of the categories of computer-assisted music analysis will be briefly characterized.

Statistical and information-theoretical approaches are historically the first methods applied to computer-assisted music analysis. Even though statistical methods and information-theoretical methods are distinct from each other, in computer-assisted music analysis they are usually applied together. Statistical and information-theoretical approaches comprise frequency, mean (average), variance, standard deviation, correlation, regression, the chi square test, entropy, Markov chains, probability, redundancy, and other measurements.

For the analysis of atonal music, a number of computer programs draw on Allen Forte's set theory and on further developments of Forte's theory. Most of these programs comprise such standard procedures as calculating prime forms (most often using Forte names), interval vectors, number of occurrences, as well as (Forte's) similarity and set complex relations.

In some approaches, mathematical procedures, other than those of statistical, information-theoretical and set theoretical nature, were applied to music analysis. Structural relationships can be explicated in many mathematical ways, some of which are fractal-like descriptions, formulas for symmetrical structures or for the relationships between groups of motives (describing their characteristics) as well as formulas for calculating the inner tempo of a composition, depending on meter, metrical relationships and rhythmical structures, etc.

Hierarchical approaches to music analysis try to apply reduction procedures to music in a sense that different hierarchies of musical structures show certain dependencies as well as, on a high abstraction level, large-scale relationships (especially melodic and harmonic relationships). The basis for hierarchical approaches to music analysis is twofold: linguistic methods, especially those from the structuralistic grammar developed by Noam Chomsky, and Heinrich Schenker's concept of musical grammar. Regarding to those two main approaches, "hierarchical approaches" can be divided into "transformational analyses" and "Schenkerian analyses". Both methodological approaches comprise different abstraction levels, which can be obtained by applying certain abstraction rules.

In some cases of performance-based music analysis, spectral analysis is involved. Usually in those approaches, the sound spectrum is broken up to identify, for instance, the chord structure. While spectral analysis has been used in pure sound analysis for several decades, it became part of structural analysis of music not before the late 1980s and early 1990s.

Computer-assisted approaches of music analysis that draw on cognitive research and artificial intelligence use computer systems to simulate functions that are usually associated with human intelligence. Those functions include reasoning, learning, and self-organization (or self-improvement). Artificial intelligence approaches can exist in forms of neural network systems or expert systems. With neural networks (net-like connections of units [neurons]) as a class of dynamic systems, music theorists are trying to simulate the architecture of the human brain. Activities in single units of this network entail changes in the whole system. On the contrary, the goal of expert systems is to solve problems by drawing inferences from a knowledge base acquired by expertise; expert systems process information pertaining to a particular application and perform functions in a manner similar to that of a human who is an expert in that field.

In some applications of computer-assisted music analysis, several methodological approaches are combined in one computer system. Those systems are oriented towards interactivity, so that the user can choose which methods of music analysis to apply, depending on the goal of the specific research.

## 5. Conclusions

In music analysis in general, the reflection on the methods used and the awareness of how they affect the outcome and the goal of the analysis is most important. Every method of music analysis has its

advantages for certain goals of the analysis. But every analytical method has also its limits. It is most crucial to know both, as well as to know when to apply which method. For methods of computer-assisted music analysis, the integration of traditional *and* computer-aided methods seems to be most crucial.

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