A FUNCTIONAL CLASSIFICATION OF ONE INSTRUMENT'S TIMBRES

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Abstract. This article proposes a theoretical method for functional sound classification based on the timbre possibilities of one orchestral instrument each time. The focus is on the definition of the sound scale model, the way is structured and the conditions applied on it. This method can be applied for specific structural uses such as fusion or separation in sound texture and similarity relationships in sequential movement. It is a model of classification that could organize the instrumental sound possibilities and offer solutions to the compositional challenges that today's composers face. This classification is possible only through automatic audio classification methods using specialised software environments. However, the algorithms and the applications of the audio classification are not on the focus of this paper. The scope of the method is to become a functional and creative tool in the hands of a composer but also to orchestrator, musicologist or performer that aims to better organize, analyze or control his/her sound material whether refers to complex musical structures or simple sequences of sound events.

1. Sound Scale Classification

This paper will examine the sound possibilities of a single instrument in the way of distinctive timbres like whistle tone, tongue ram, roar sounds and so on in the case of flute, or pizzicato, sul-ponticello, col-legno and so on in the case of violin, and so forth.

The sound scale is not an equivalent of the tonal well-tempered scale neither any other pitch-based scale, pentatonic, macams in Arabic music or modes in Byzantine. A sound scale is a *Set* of sounds for each of the orchestral instruments and consisted of a number of *Clusters* and C*lasses*.

2. Set, Class, Cluster and combinations

Class is named each unique sound included in one instrument's Set. For example all sound possibilities of Clarinet. For instance, a sound *Set* of violin can include all the ordinary sounds in every pitch and dynamic, all pizzicato sounds in every pitch and dynamic and so on.

A class can be just a single non-articulated sound but also a rather gestural sound of the same characteristics. *Class* is called each sound within a *Cluster*. The choice of these particular sound classes can be made arbitrarily and basically determined from the number of samples found in the sound database to be used for the automatic classification measurements.

The *Cluster* is a group of several classes that share similar audio features. For instance, the multiphonic sound cluster can be consisting of tenths or hundreds of different multiphonic classes. Each class within the cluster is automatically classified and each cluster within the instrument's sound set is also automatically classified. The cluster classification is higher in the hierarchy than the class classification. A cluster could be consists even from very few classes.

Instrument's sound set

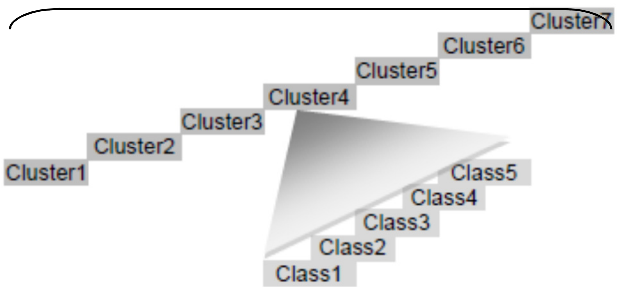

Figure 1. A paradigm of a sound scale with seven clusters and the 5 classes of cluster four.

As combined sound clusters are considered cases where two different clusters are combined, like a Key click and ordinary sound in flute's set. These cases should not constitute autonomous clusters. This is because one could easily estimate the position of the combined clusters. For instance a sound which is a balanced combination of classes from 2nd and 4th cluster is equally similar to 1st and 4th as well 3rd cluster.

3. Order and Direction

The direction of the scale has no difference either ascending or descending. However, it has a starting point, cannot start from any cluster. The starting cluster is a white noise which is applied to every instrument set. From this reference starting point an automatic classification computer system defines the order of the sounds.

Two types of ordering are proposed *raw* and *relative* [Brent, 2009]. In both cases the first class is white noise added extra to the set. This is in order to have always a common starting point for every instrumental set and to get a persistent relationship from noise to pure. The *relative* ordering starts with the white noise class, finds the nearest match in the set, then finds the nearest match to that match, and so on. The point of reference is always shifting. In the case of *Raw* ordering the set begins also with white noise, and then finds the closest match, the second closest match, the third closest match, and so on. The resulted orderings of both *row* and *relative* begin with a classification of very similar sounds which gradually shifts to more distant sounds.

4. Control Parameters

Control parameters include cases that cannot be considered as independent clusters in the sound scale. The control parameters cannot change the timbre quality of the sound at a significant level to consider them as independent sound clusters in the scale. The main control parameters are: dynamics, trill, tremolo, glissando and microtones, other articulations.

One can play glissando on cello with ordinary sound, breathy, harmonics, etc. without changing significantly the timbre of the particular sound so to be considered as independent cluster in the sound scale.

The dynamic changes can also be applied to almost every sound class. However, in some cases the level of amplitude to a sound is strongly related with its timbre. Dynamics like strong attack or very strong blowing or very soft can be responsible for the production of particular sound clusters, because it can alter drastically the timbre of the sound. Therefore, the dynamic changes are considered as control parameters as long as applied within the limits of a particular cluster.

The attack is also an articulation which can be applied to almost every sound. In other words, a sound with air (breathy) may have attack or not without the need to change cluster. However this difference will change the order of the classes within the cluster. Moreover, there are sounds which come to life only though the attack. In this case the attack is part of the sound and therefore cannot be considered as control parameter.

Pitch change are also control parameter since it can be applied to almost all sound clusters. Micro intervals cannot be considered as sound classes too.

Couplings (playing the instrument with various object) are excluded from the *sound scale* due to the great variety of possibilities could offer.

Table 1. List with the main control parameters and the type of controller

Attack time	Dynamics controller
Trill	Pitch controller
Tremolo	Dynamics

	controller
Glissando, Portamento, Vibrato	Pitch controller
Microtones	Pitch controller
Tone color trills (bisbigliando)	Changes of timbre
Other articulations like staccato, accent, legato, etc.	Changes of timbre

5. The Sound Classifier

The proposed model is only possible through the use of audio content classification computer software programs. The sound classifier will calculate the results of the analysis which in sum allow similarities between sounds to be determined. With the aid of the computer is simple and fast to retrieve the information we need for any number of sounds, in very short time and with the objectivity of a machine. The advantages of using the sound classifier among others are: 1) Fast processing time – the system can analyze and classify thousands of sound in a very short time. 2) Objectivity – free of personal bias or listening habits, free of perceptual limitations directly or indirectly relevant for human perception. 3) Reliability – the great amount of analysis data of such a complex and multidimensional musical element as the timbre can only become useful with the help of computer software. 4) Availability – it is important to use the classifier at any time due to new sound possibilities not included in the database and therefore to update the sound scale with new classes and even clusters.

The sound classifier as a finished or in development application and the algorithms used for the analysis and classification of the sound sets, are not subject of this paper and are not going to be further analyzed.

7. Conclusion

The proposed method of ordering the sounds of a single instrument in a functional way is the first step towards a musical system with main focus on the multidimensionality of timbre. It should not be compared with pitched scale as pitch can be measured and perceived with great accuracy but it is not the same with timbre. At this point, it is not intended to work out all the possible sound qualities every instrument can produce; somewhat which is not yet fully explored and might take time to reach to this point.

Although the sound scale is particular and unique to each instrument however, the method's aim is to extract the fundamental principles could be applicable to every instrumental sound set. The result of this work will be a catalogue with the sound scales of each orchestral instrument at the hands of a composer but not only. Future development of this project includes experimentation and optimization of *sound classifier* type of applications available for free or commercial use, as well as musicological analysis of solo or ensemble instrumental works on the basis of sound scale paradigm.

Instrumental timbre relations and classifications are essential for the structure of a composition and of central interest to the composer. However, these concepts are difficult to be investigated scientifically. The technological advantages of the recent years make this kind of computer process possible, but further progress may be possible only if composers collaborate with computer music scientists to focus on the available technology for further development.

6. References

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