Music Informatics

Alan Smaill

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- ▶ Lerdahl and Jackendoff, GTTM grammar modules
- ▶ Parsing & musical ambiguity

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Recall Lerdahl and Jackendoff's "Generative Theory of Tonal Music" (GTTM) –
an attempt to characterise tonal music via a characterisation of how a listener familiar with the style makes "musical sense" of music in these styles.

We saw before the Grouping level, which provides ideas for chunking material. Today look again at this proposal, and associated parsing notions.

A good account is given in chapter 7 of Jackendoff's "Languages of the Mind" (available on-line via University Library).

While unfortunately Jackendoff's "Consciousness and the Computational Mind" is not available on-line (it is in the University library), some other resources are available in this way:

▶ GTTM itself (there is a lot of detail)

> http://cognet.mit.edu/library/books/view?isbn=
> 026262107X

and

▶ Chapter "musical parsing and musical affect" from "Languages of the Mind":

> http://cognet.mit.edu/book/languages-of-mind

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The work from GTTM was influenced by earlier ideas from Leonard
Bernstein, who was among the first to see that Chomsky's
approach to natural language understanding though grammar
could be applied to music.
His Harvard lectures were historically influential;
they are available in video and book form:

> The Unanswered Question: six talks at
> Harvard,
> Charles Eliot Norton Lectures 1973
> (published 1976)
>
> Harvard University Press

– this is still worth watching.

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▶ Reminder of choice of musical surface as (roughly) notes in GTTM;

▶ More generally:

> *Hence a full psychological theory of music must account for the derivation of the musical surface from an acoustic signal. The musical surface, however, is the lowest level of representation that has musical significance.*
>
> *Jackendoff, Consciousness and the Computational Mind, p 219*

Levels of Musical Structure

These are built on the surface level, which is itself sequential, in hierarchical fashion.

The lowest level is that of Grouping Structure, which we already saw, with associated rules of where boundaries may occur. The Mozart example used has a history going back to Leonard Bernstein's proposals in "The Unanswered Question: Six Talks at Harvard", 1976.

The grouping analysis is itself hierarchical — groups of notes, then groups of groups, and so on. The rules as given allow many possible parses.

The examples of "good" and "bad" parses are meant to strengthen the claim that the preference rules in GTTM do point the way to the musically significant analyses.

We have seen approaches to metrical structure before, and GTTM at this level is similar to earlier approaches. Again, the metrical level is itself hierarchical. It is possible to give empirical evaluation of GTTM's specific rules for metrical structure, by comparison with human evaluations.

Note that the metrical structure is defined only up to a relatively small duration (eg two bars) — this is unlike grouping structure, which can very well scale up to larger and larger groups.

The metrical level gives us an analysis like the following. Here, grouping is up to the level of two bars — but note that the metrically stronger of the bars corresponds to the start of the second full bar. (In fact this is the third bar in the score, because there are 3 beats of background "vamp" before the melody enters).

This can be heard or played with the opposite two-bar phase – but L&J (and Bernstein before) argue this is the right version.
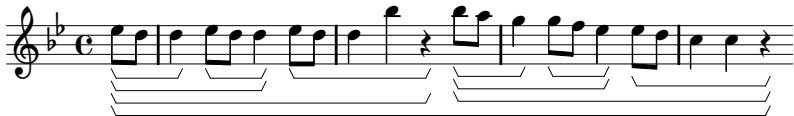
So here, the metrical and grouping analyses disagree about the hierarchies –
there is disagreement even at the "same" level.

Compare the grouping and the metrical parses:

▸ There is agreement on the significance of the two bar length.

▸ The grouping analysis recognises the four bar grouping.

▸ The boundaries of the two bar length chunks are not precisely aligned (they are out of phase).

Thus we end up with related, but distinct, decompositions of the musical surface. L&J claim these are both cognitively significant. We can see that the parsing task is getting complicated!

The levels proposed in GTTM are:

▸ Grouping level (seen earlier);

▸ Metrical level (seen earlier);

▸ Time-span reduction: introduces pitch organisation: harmonic and melodic organisation as successive reductions or simplifications of harmony;

▸ Prolongational reduction looks at the musical flow across phrases, and the building and releasing of musical tension.

L&J use some correspondence rules to cover the relationship between different levels of the analysis. These include rules already seen, like the grouping symmetry rule:

> *... prefer groupings that respect musical parallels ...*

where "parallel" may refer to metrical similarity.

More explicitly, L&J introduce a grouping rule referring to correspondence between the grouping level and the time-span and prolongational reductions.

> *GPR 7 (Time-Span and Prolongational Stability) Prefer a grouping structure that results in more stable time-span and/or prolongational reductions.*

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The first two levels address primarily the rhythmic aspect of music. The Time-span level looks at the pitch and harmonic information, so as to regard some passages as a form of elaboration of others; an example is where a simple melody is decorated, or variations on it are built.

The claim here is the following:

Reduction Hypothesis
The pitch-events of a piece are heard in a hierarchy of relative importance; structurally less important events are heard as ornamentations or elaborations of events of greater importance.

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Parse trees indicate the analysis in terms of which groups are considered as taking priority at different levels of the reduction.

Subsidiary levels are indicated by branching away from the higher level in the tree; each end point corresponds to some local harmony.

So, in a theme with variations, or considering whether aspects like ornamentation change whether or not we are listening to the same piece, look for a common structural underpinning in the form of the time-span reduction.
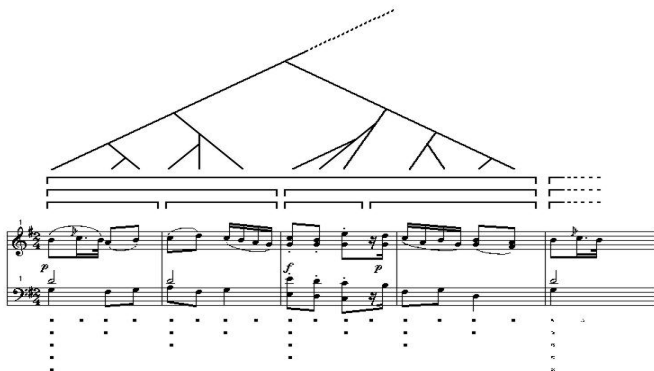
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Top: time-span reduction
Next: grouping level
Bottom: metrical level
Image due to Ian Cross, in Music Analysis, 1998, vol 17. No.1

Figure 1(a)

www.jstor.org/stable/854368

To get an idea of how the time-span tree is formed, look at sample rule from GTTM.

The head of a reduction is the part which is considered the more fundamental – others are subordinate.

Harmonic preference depends on a notion of which harmonies are more or less consonant, and how closely they relate to the tonic in a given key.

TSPR 2 (Local Harmony) Of the possible choices for head of a time-span T, prefer a choice that is

1. *relatively intrinsically consonant,*
2. *relatively closely related to the local tonic.*

Notice that this makes the time-span reduction closely dependent
on the classical tonal aspects of the style addressed (unlike
grouping, and to some extent the metrical level). Any
implementation has to address the whole language of key, cadence
and so on.

Implementations of the GTTM grammar have largely focused on
the first two levels, in practice.

This level builds on the previous levels, and is intended to capture the notion of increase or decrease of tension — in the passage from one analysed component to another, is the music heard as confirming or denying the material in the first component?

For later thoughts and details on the prolongational reduction, see "Modelling Tonal Tension" from Lerdahl and Krumhansl, Music Perception, vol 24:

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http://isites.harvard.edu/fs/docs/icb.topic133047.
        files/Lerdahl-Krumhansl_2006.pdf
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This work involved comparing predictions with records of listeners' experience of levels of musical tension.

A good starting point for looking at current systems making use of
GTTM ideas is the work of Masatoshi Hamanaka:

http://gttm.jp/hamanaka/en/exgttm/

– for example, reports on time-span reduction analysis system:

http://gttm.jp/hamanaka/en/ptta/

The Jackendoff chapter on Musical Parsing and Effect has a good discussion on the role of ambiguity in perception of music.
It suggests a parallel multiple-analysis model is the best model on cognitive grounds (in natural language as well as in music).

For ambiguity even inside the metrical analysis level, there are plenty of examples eg in jazz. Here is a less well-known example from the music of Chopin:

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https://www.reddit.com/r/piano/comments/2rbc25/
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- GTTM: the four levels;
- Time-span reduction as levels of decoration on harmonic underpinning;
- Parsing and musical ambiguity.