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A COMPUTER-BASED EDITOR FOR LERDAHL AND JACKENDOFF'S RHYTHMIC STRUCTURES

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In *A Generative Theory of Tonal Music*, Lerdahl and Jackendoff (hereafter L+J) discuss two forms of rhythmic structure which they call metrical structure and grouping structure. Together these constitute a basis for an analytical understanding of rhythmic structure in music.

A software based editor has been written which allows the interactive exploration of these two types of hierarchical rhythmic structures. It bears some relationship to simple time based editors found in commercial software, but represents an extension of such software to a much wider range of rhythmic features

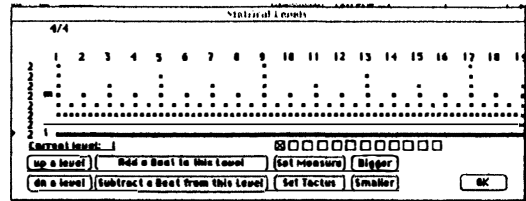


Figure 1 - regular metrical structure based on hierarchical duple divisions

The Metrical Structure Editor allows the user to specify up to eight hierarchical levels, each with strong-weak beat pattern up to sixteen elements long. The pattern can also be broken arbitrarily and restarted at any point, a feature common to the higher (i.e. greater than measure length) levels of metrical structure. The software strictly enforces L+J's Metrical Well Formedness Rules 1 and 2:

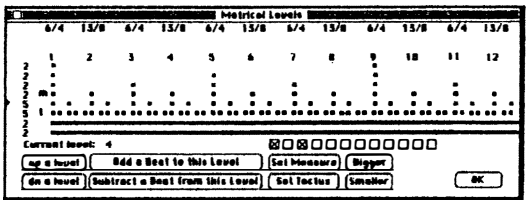


Figure 2 - complex metres created by multiple layers of 5 structured as 2+3

1. Every attack point must be associated with a beat at the smallest metrical level present.
2. Every beat at a given level must also be a beat at all smaller levels

Metrical Well Formedness Rules 3 and 4 are implemented in a freer form:

3. At each metrical level, strong beats are spaced either two or three beats apart.
4. The tactus and immediately larger metrical levels must consist of beats equally spaced.

The relaxation of these latter two rules allows for compound metrical structures such as are found in Bulgarian folk music, and for free metrical structures such as recitative and for specification of metrical structures impossible to notate conventionally, such as poly-compound meters where both the tactus and the measure are comprised of a recurring pattern of strong/weak beats (e.g 3+2+3).

The Metrical Structure Editor is shown in figures 1 and 2 above. Figure 1 shows a regular metrical structure based on a duple division at all levels. Figure 2 shows a more complex structure where two levels employ a five beat pattern structured internally as 2+3. The user can specify a strong-weak pattern for each of eight levels of metrical structure. Two of these levels have a special status: the *measure* and the *tactus*, designated with the letters 'm' and 't' along the left edge of the editing screen. The *tactus* is the metrical level used, if possible, for the denominator portion of the time signatures, and usually moves along at approximately the rate of the

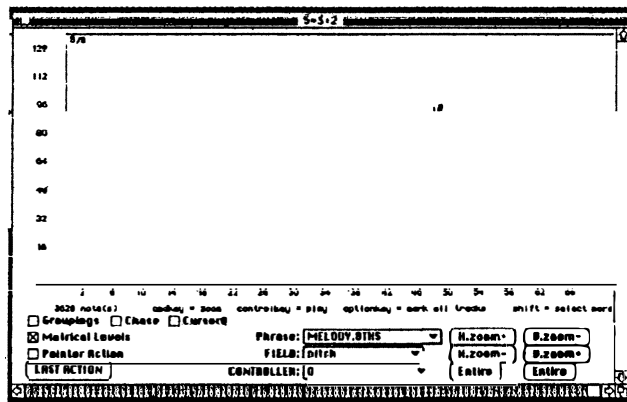


Figure 3 - metrical structures displayed superimposed on a sequence of notes

human heartbeat (about 60 to 140 beats per minute). The *measure* is the level used for the numerator portion of the time signatures, which are shown along the top of the editing screen. These levels have a special meaning in other portions of the software as well, notably in the Selection Filter, where choices can be made based on an event's *measure* or *tactus* characteristics. Levels of metrical structure can be displayed in the graphic event editor as a set of 'barlines' of varying weight (figure 3).

The Grouping Structure Editor allows for the specification of three levels of grouping structure, arranged hierarchically according to L+J's Grouping Well-Formedness Rules:

1. Any contiguous series of events, and only contiguous events, can constitute a group.
2. A piece constitutes a group.
3. A group may contain smaller groups.
4. If a group G1 contains a group G2, it must contain all of G2.

Grouping structure is displayed along the bottom of the graphic editor screen (figure 4), using lines with curved ends which resemble L+J's notation. Six levels of grouping structure are allowed, with the current levels designated by a small letter 'G' along the left edge of the screen. A series of notes can be designated as a group by selecting them with the mouse and choosing 'Group Notes' from the Edit Menu. Notes already grouped can be selected with the 'Select Group' command. L+J's Grouping Well-Formedness Rules are not enforced at the time of selection; instead a separate pass can be made using the 'Check Group Structure...' command.

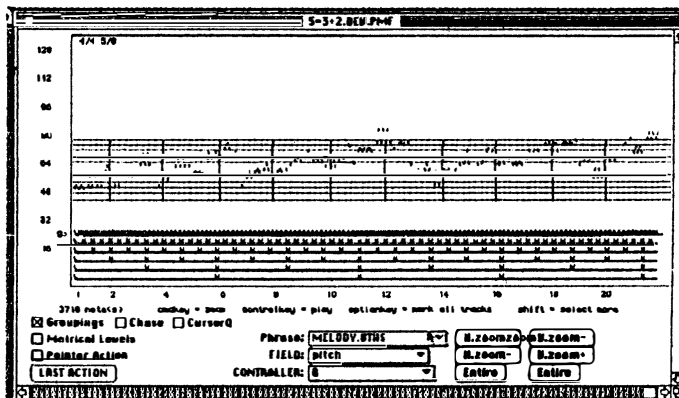


Figure 4 - graphic editor with grouping structure displayed along bottom

Two other commands allow the automatic creation of group structures. "Make Repeating Groups..." (figure 5) creates regularly repeating groups at the current level of grouping structure. This may be used, for example, to group measures or beats, if these are suitably regular. A more complex command is "Auto Group..." (figure 6), which uses a measurement similar to that discussed by James Tenney and Larry Polanski to automatically create groups based on a selection of intrinsic musical parameters. These include: pitch, velocity, duration, articulation (i.e. onset delay) and pitch class. Only pitch weighting is currently implemented.

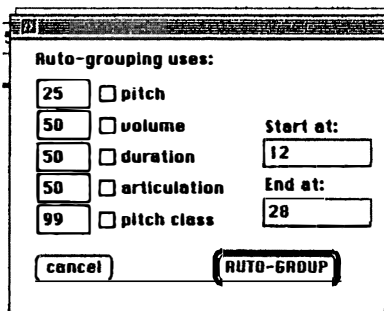


Figure 6 - "Auto Group..." dialog

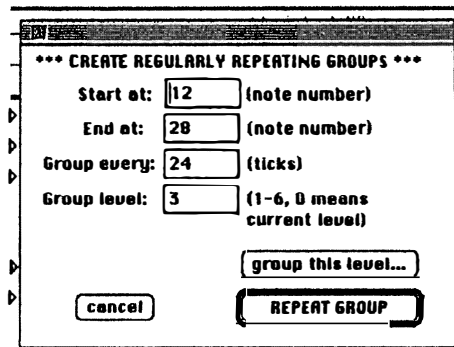


Figure 5 - "Create Repeating Groups..." dialog

Acknowledgements

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