AUTOBUSK
AN ALGORITHMIC REAL-TIME PITCH & RHYTHM IMPROVISATION PROGRAMME

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AUTOBUSK composes in real-time according to given material, parameters and commands, outputting a maximum of three voices to MIDI-compatible (sound) devices or to disk in Clarlow's MDSK music score format, central to his MIDIDESK (MIDI Desktop score processing) package and readily convertible into standard MIDI file format. Four possible modes of input are ASCII-keyboards, mouse, a MIDI device (e.g. faders, computers, MIDI-keyboards) or a file in .PRM format (similar to .MDK). A .PRM file consists of a succession of definitions, each taking the form of a line of text containing five elements:
1. Seconds
2. Milliseconds
3. Voice
4. Identifier
5. Value

Explanation:
1 & 2. Time indication of when the definition assumes validity
3. The number of the voice for which the definition holds (0-3)
4. The identifier can be one of the following (valid for Version 4):
   a. Parameter code
      0 = metric stability [ 0 (unstable) - 24 (constant) ]
      1 = metric clarity [ 0 (syncopated) - 24 (straight) ]
      2 = pulse length [ 10 = 252 milliseconds ]
      3 = event density [ 0 (silence) - 24 (saturated) ]
      4 = event duration [ 1 = 355 pulses ]
      5 = melodic angularity [ 1 - 127 semi-tones ]
      6 = tonic pitch [ 0 - 127 MIDI pitch ]
      7 = chordal density [ 1 - 3 pitches ]
      8 = tonality [ 0 (atonic) - 12 (tonal) ]
      9 = pitch focus [ 0 - 127 MIDI pitch ]
      A = pitch range [ 0 - 127 semi-tones ]
      B = dynamic range [ 0 - 127 MIDI velocity ]
      C = dynamic deviation [ 0 - 127 MIDI velocity ]
      (parameters marked * not installed yet)
   b. Material selector
      0 = scale [ 1 - 5, freely allocatable - see below ]
      M = metre [ 1 - 5, freely allocatable - see below ]
   c. Command (selection)
      0 = change instrument [ 1 - 32 MIDI Program Change ]
      1 = switch voice [ Off, On ]
      2 = set pulse [ 1 - metre length ]
      p = play note [ 0 - 127 MIDI pitch ]
      d = damp note [ 0 - 127 MIDI pitch ]
5. The value corresponding to #4 is bounded by the square bracket limits shown above.

AUTOBUSK can be run autonomously or is using more than one computer - in series or in parallel; a serial connection causes MIDI output to be interpreted as output control by the next computer along the line, whereas a connection in parallel permits synchronized sets of at least nine or higher multiples of three voices.

ICMC GLASGOW 1990 PROCEEDINGS

166
Two peripheral programme packages associated with AUTOBUSK are pre-processors for preparation of scale and metre information (PREPROC) and a network of parameter processors (PRMPROC) for transforming .PRM score files.

PREPROC. Containing special algorithms for the qualitative evaluation of quantitatively defined scales and metres. Its main programmes:

JUSTLIST: Given a set of prime numbers and their maximum permissible powers, a list of intervals within a given pitch and harmonic range is generated in terms of number ratios. Further limits are the maximum size and indigibility of the numerator and denominator, and stored in a file called JUST.TAB. The terms harmony and indigibility have the meanings given to them in what may be called Clatow's Algorithmic Justification Of Logarithmic Entities System (CAJLES), described elsewhere; for instance, the numbers 12 to 18 have the indigibilities 4.7, 22.2, 11.3, 9.1, 4.0, 30.1 and 6.3, while the harmoncities of e.g. perfect fourth [3/4], augmented fourth [3/24] and perfect fifth (2/3) are -21.43, 5.97 and 27.27.

HRM (for Harmonic Rationalization Measures) reads JUST.TAB (see above) and renders a scale defined solely in cents (e.g. one octave of the major scale as 0 200 400 600 800 1000 1200 into just intonation (here e.g. 1/4 4/4 3/4 2 3/5 6/15 1/2 under certain conditions). Three constraints determine the result: the minimum harmony, the final intervals are permitted to have (given by JUST.TAB), the number of interval candidates varying for choice for each scale degree (e.g. 4/5 or 6/8 or 25/32 as three alternatives for 400 cents or one tempered major third) and the nominal tolerance for pitch deviations. In the case of the major scale above, the minimum harmony allowed was 4%/ setting the maximum powers for the primes 2, 3, 5, 7, 11, 13, 17... at 9, 6, 2, 1, 1, 0, 0,... the number of candidates was 3 and the nominal tolerance 50 cents or one quarter-tone. A value called the specific harmony is worked out for the tuning chosen, which is inversely proportional to the sum of the reciprocals of the harmoncities of all pairs of pitches in the said tuning. The major scale tuning above has a specific harmony of 0.258, while that of the whole-scale tuning 1/2 3/2 4/3 5/4 5/3 5/2 5/1 is 0.188.

A use of HRM not strictly pertinent to AUTOBUSK but more properly embedded in MIDIDISK is the quantization of rhythm. Given a set of durations in terms of, say, millisecond, these can be converted by HRM into rational rhythms, irrespective of their complexity. For instance the opening melody of the Chopin Valse in Ab Major Op.69 No.1 (lento "Es E>b D D>b ES E>b ES D>b C) was played into a MIDI-keyboard and stored on disk. Properly, the durations relative to the shortest value (one of the triplet notes) should be 1.5 1.5 1.5 1.0 1.0 1.0 1.5 1.5 1.5 1.5 0.6 3.0, renderable rationally as 2.3 2.3 2.3 1.1 1.1 2.3 2.3 2.3 1.1 1.3. The values measured were 76 66 71 59 29 46 46 68 68 72 141 clock ticks, or 1.95 1.69 1.92 1.51 1.00 1.18 1.69 1.74 1.72 6.31 3.62, relative to the shortest note. As if they were measurements of frequency (in Hz), these durations were logarithmized into cents to give the following "scale":

1155 911 1037 717 0 226 911 911 962 437 3189 2225.

ICMC GLASGOW 1990 PROCEEDINGS 167
It was found that by transposing the scale up and down a bit in pitch and by applying various harmonicity, candidate and tolerance limits rationalizations of varying specific harmonicity could be obtained (note that the minimum harmonicity constraint determines permissible tuples). For instance, by keeping the scale as it was and with a minimum harmonicity of 4%, 2 candidates and 250 cents nominal tolerance, the rather unusable tuning 1:2 3:5 1:2 2:3 1:1 9:8 3:5 3:5 3:5 3:5 3:5 3:5 1:1 1:4 129.2% specific harmonicity resulted. A tolerance as high as 1300 cents (1 octave) resulted in 1:2 1:2 1:2 1:2 1:1 1:1 1:1 1:2 1:2 1:2 1:2 1:8 1:4 1:3 (125 specific harmonicity), with no triplets at all! But by setting the tolerance at 450 cents and lowering the scale by 250 cents to 905 661 787 467 -250 36 661 661 712 687 2939 1975 the result was 2:3 2:3 2:3 2:3 1:1 1:1 2:3 2:3 2:3 2:3 1:6 1:6 (1:597 specific harmonicity), very close to the intended values. Thus if the right constraints are found, it is possible to effectively rationalize even random durations, so as to render them playable.

IDP (for Indispensability Determination Programme) evaluates the relative importance of the individual pulses of a metre, given the latter's stratification scheme: for instance a 12/8 metre can be said to result from the successive subdivision of a bar into 2, 2 and 2 (12=2x2x2x3). The resulting indispensability values for the 12 pulses are: 0 0 4 8 2 6 10 1 5 9 3 7. By comparison, the indisponibilities for the 12 sixteenth-notes (semi-quavers) of a 6/8 bar (6=2x2x3) are: 11 0 6 2 3 4 10 1 7 3 9 5. These values are used by AUTOBUSK for the completion of probability tables.

JOIN concatenates and FUSE merges several scores, while PART splits a score into two according to given criteria: VARY can alter the values of selectable identifiers of a score and TIDY cleans up the syntax, eliminating redundancies and/or deficiencies.

AUTOBUSK was first written in the autumn of 1986 in Pascal on a CP/M computer. Previous work in this direction was a set of Fortran programmes written in 1978 on a PDP 11/10 to compose the piano piece Coig"uautobus-
ibletmesi in nos-real-time and programmes in C written at IRCAM (Paris) in 1981 aimed at real-time performance. Unfortunately the memory of IRCAM's PDP 11/34 was too large, occupied by drivers for the attached 4C synthesizer for any viable result. It was the advent of MIDI and of personal computers with larger memories that made this programme a reality. It now runs on an ATARI ST 1040.

AUTOBUSK has been used to compose a number of pieces: they include variazioni e un piano/ora meccanica (1986) for piazzola and pianist, parts of documissa 87 (1987) for choir and tape, most of frutti d'amore (1988) for violoncello and electronics, most of Orchidees Ordinaires or The Twelfth Root of Truth (1989) for large orchestra. A series of free real-time improvisations called The Flying Autobus is being launched at present.


ICMAC GLASGOW 1980 PROCEEDINGS

68