



AUTOMATED RHYTHMIC HUMANISATION AS A STRUCTURAL MARKER IN MUSIC

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HUMANISATION

- Live performances by professional musicians feature millisecond deviations from metronomic time and variations in intensity.
- Different musical styles feature genre-specific rhythmic features (notes égales, claves etc.)
- Overuse of quantisation and uniform velocity levels may lead to MIDI-generated music being perceived as static or mechanical.
- Humanisation applies deviations in time, velocity and genre-specific variations to increase realism in computer music.

PLAYALONGS

- Commonly used by jazz students to practice improvisation.
- “Backing tracks” featuring rhythm section (bass, drums, piano/guitar).
- Live acoustic recordings vs. MIDI generated tracks (cost vs. realism).
- Common chord progressions and forms in jazz.
 - II-V-I
 - II-VI-II-V
 - I-VI-II-V
 - Blues
 - Rhythm Changes

Aebersold



iRealPro



FUZZY PLAYALONG

- An open-source MIDI humanisation tool implemented in MaxMSP.
- Generates rhythmic section jazz “backing tracks” and applies deviations in rhythm and intensity.
- Uses genre-specific deviations to create more realistic jazz rhythms.
- Humanisation implemented through fuzzy logic and Markov chains.

RHYTHMIC FEATURES: PERFORMANCE DEVIATIONS

- Hennig et al (2011) found rhythmic deviations in the region of 10-20ms.
 - Long range correlations were found.
 - MIDI performances humanised with LRCs were found to be more realistic.
- Royal Institute of Technology (KTH) Stockholm: Director Musices system.
 - Bresin et al (2002).
 - Models performance principles to generate humanized MIDI renditions of musical scores.
 - MIDI performances found to be more realistic when altered this way.

RHYTHMIC FEATURES: GENRE SPECIFIC (JAZZ)

The image shows two musical examples side-by-side. The top example is in 3/4 time with a treble clef. It has two measures: 'Notated' with two eighth notes per measure, and 'Played' with a triplet pulse indicated by a '3' above the second note, and accents on the second eighth note of each measure. The bottom example is in 4/4 time with a treble clef. It also has two measures: 'Beat accents in other Western genres' where all eighth notes have an accent (>), and 'Beat accents in jazz' where the first note of each measure has an accent (>) and the third note of the first measure and the second note of the second measure have accents (>).

- Swung eighth notes – underlying triplet pulse.
- Accents on second eighth notes.
- Accents on 2 and 4 (bass).
- Behind-the-beat/Ahead-of-the-beat.

ANALYSIS OF DEVIATIONS IN JAZZ DRUMMING

Drummer Conor Guilfoyle, a member of the jazz drum faculty at DCU's Centre for Jazz Performance, was recorded playing 4 16-bar drum patterns in 4/4, 3/4, 5/4 and 7/4, accompanying a metronome, and a behind-the-beat/ahead-of-the-beat pattern accompanying a playalong.

Rhythmic Deviations

- Deviations of up to 40ms were found.
- Negative deviations averaged -11.5ms, positive deviations averaged +9ms.
- Long-range correlations were found.



ANALYSIS OF DEVIATIONS IN JAZZ DRUMMING

Velocity deviations

- Velocity levels were found to be higher for notes placed on 2 and 4 than those placed on 1 and 3.
- Velocity levels for "ands" (the second eighth note of a beat) were higher than on-beats.
- The highest velocities were found on the first beat of each four-bar section.

Behind-the-beat/ahead-of-the-beat

- Average rhythmic deviations for behind-the-beat playing was -82ms.
- Average rhythmic deviations for ahead-of-the-beat playing was +32ms.

IMPLEMENTATION OF FUZZY PLAYALONG

- MaxMSP is a graphical programming environment with MIDI functionality.
- “Patches” implemented in MaxMSP can be exported as stand-alone applications, or can be imported into the Digital Audio Workstation Ableton Live.
- *FuzzyLib* is a third-party library created by IRCAM (Institut Recherche et Coordination Acoustique/Musique) for implementing fuzzy logic in MaxMSP.

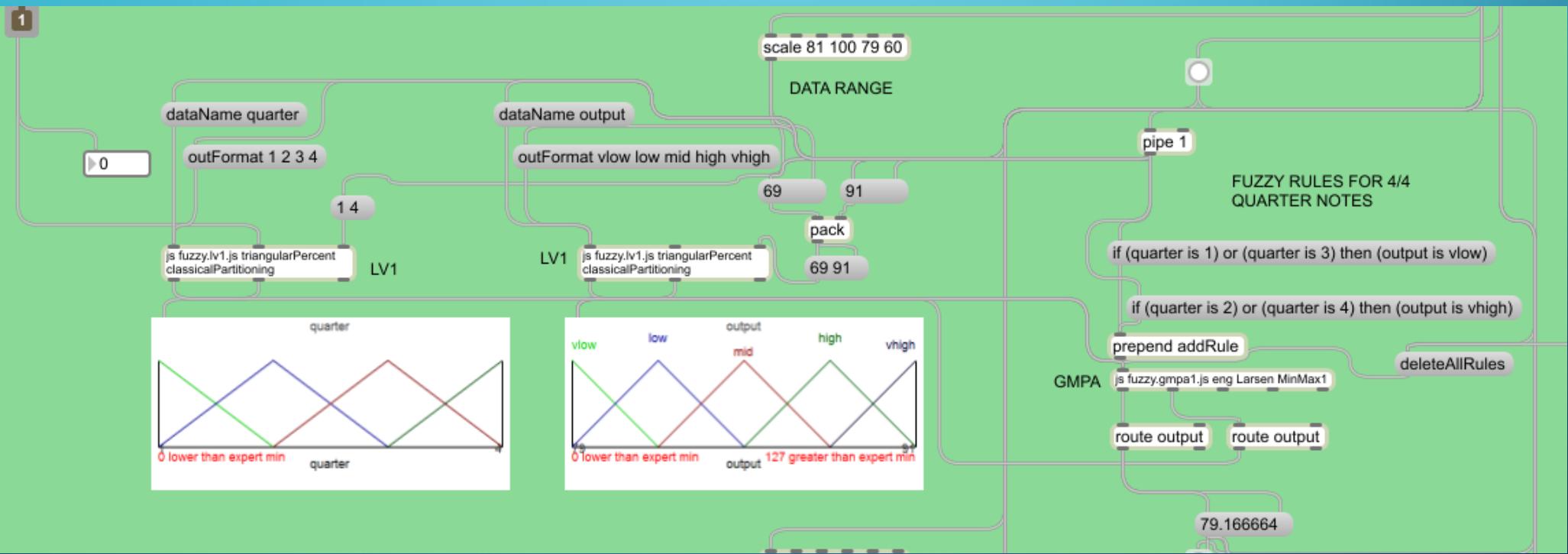
FUZZY LOGIC

- A form of logic that deals with approximate values rather than fixed binary values.
- Better approximates how humans think: elements in fuzzy set theory may have partial membership of more than one set.
- Allows for *linguistic labels* to classify elements.
- Easy for expert user to incorporate knowledge into the system.

FUZZY LOGIC IN MUSIC APPLICATIONS

- Yilmaz & Telatar (2010) – Note-against-note two-voice counterpoint by means of fuzzy logic.
- Cadiz (2006) – A Fuzzy-Logic Mapper for Audiovisual Media.
- Monti & Sandler (2002) - Automatic Polyphonic Piano Note Extraction using Fuzzy Logic in a Blackboard System.
- O'Sullivan & Boland (2016) - Towards a fuzzy logic approach to drum pattern humanization.
- KTH Director Musices System: Bresin et al (1995) – A fuzzy approach to performance rules.

FUZZY LOGIC ENGINE



IMPLEMENTATION OF PLAYALONG

- An engine to generate pitch and velocity values for rhythm section jazz patterns was created in MaxMSP.
- First-order Markov chains were used to algorithmically compose “walking basslines”.
- Velocity values were routed through a patch containing a fuzzy logic engine. The fuzzy logic engine applied deviations based on what was determined by the previous investigation into deviations in live jazz drumming.

IMPLEMENTATION OF PLAYALONG

- Rhythmic deviations, as found in the study of jazz drumming, were applied by a separate fuzzy logic engine.
- Capability for behind-the-beat and ahead-of-the-beat playing was implemented using the values found in the jazz drumming study.
- Users can apply low, medium or high deviation preset values, or can alter more specific deviation settings for rhythm, velocity and the extent of ahead-of-the-beat/behind-the-beat playing, in expert mode.

AUDIO EXAMPLES OF FUZZY PLAYALONG



Unhumanised



Bass behind-the-beat



Humanised



Bass ahead-of-the-beat

FUZZY PLAYALONG INTERFACE

BASIC SETTINGS

Time Signature: ▾

Key: 

Chord Progression: ▾

CONTROLS

MUTE DRUMS MUTE BASS

ON/OFF

TEMPO CONTROL

HUMANISATION PRESETS

HUMANISATION ON/OFF

LOW

MEDIUM

HIGH

EXPERT MODE

1/4 NOTE SWING BEHIND THE BEAT AHEAD OF THE BEAT

1/8 NOTE SWING LRCS

LOW MID HIGH

RESULTS

- Listening tests were held at Newpark Music Centre, with students from the Bachelor of Arts in Jazz Performance.
- Students were played samples of the humanized MIDI rhythm section tracks from the Fuzzy Playalong and asked to compare them with tracks generated by the popular MIDI playalong app iReal Pro.
- They were also given the opportunity to interact with the Fuzzy Playalong and alter the settings using presets and expert mode.
- On a Likert scale, the average rating for realism comparison between the Fuzzy Playalong and iRealPro was 7.5/10.
- Feedback was generally very positive regarding the ease-of-use and realism of the Fuzzy Playalong.

FUTURE WORK

- Ongoing research following on from this project involves the analysis of harmonic information in MIDI and audio files.
- Since the rhythmic placement of a chord affects its harmonic function, correct rhythmic labelling of notes is necessary.
- Listening tests for this follow-on project will involve measuring listeners' expectation levels for harmonic resolutions. Increased realism of harmonic stimuli, through humanisation, will assist in correctly gauging listeners' perceptual reactions.