Imaginary Miles: Modeling Musebots after Musicians

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ABSTRACT

Musebots are autonomous musical agents that interact with other musebots to create music. Inaugurated in 2015, musebots are now an established practice in the field of musical metacreation, which aims to automate aspects of creative practice. Musebots have been presented as continuously running installations, in which ensembles, curated from the pool of community-coded agents, interact autonomously with one another for five to seven minutes, emphasising their (often) disparate styles. Imaginary Miles, while continuing the musebot tradition of open-source development, presents musebots coded only by the author. Furthermore, the generated style is quite explicit – late 1960s jazz, specifically the Miles Davis groups of that era. While individual musebots are modelled after specific musicians, Imaginary Miles is not an effort at computational musicology that attempts to perfectly replicate its models; instead, the ensemble's unique interaction and group improvisation is the basis of the exploration.

1. INTRODUCTION

1.1 Musical Metacreation

Musical metacreation, or MuMe, is a subfield of computational creativity, and is the art of "endowing machines with the ability to achieve creative musical tasks" [1]. It explores creativity as it is, and as it could be, and is populated by a diverse group of researchers, including psychologists, cognitive scientists, artificial intelligence researchers, machine learning specialists, and, perhaps most importantly, artists. There have been a number of impressive MuMe production systems that produce musical output, either off-line in the form of symbolic representation – e.g. Cope's EMI [2] – or on-line – e.g. Lewis' Voyager [3]. These systems have used a variety of methods, such as Lewis' use of improvisational heuristics, or Cope's use of machine-learning to derive production rules from a corpus of style-specific music. More recently, Google's Magenta Project (magenta.tensorflow.org) has explored Deep Learning in music creation.

1.2 Computational Musicology

Using computational methods to examine a corpus borrows from the related field of computational musicology, which is the study of music by means of computer modeling and simulation [4]. One facet of computational musicology is to prove the validity of the derived model through generation [5]; however, it should be pointed out that its specific goals are different from those of the production systems found within MuMe, in that the resulting generation is not meant to have artistic validity.

The work described in this paper is firmly within the MuMe field: while using methods derived from machine-learning to produce a loose model of a specific stylistic corpus, the goal is not to exactly reproduce the model; instead, the model is a starting point for more general compositional explorations of musical agent relationships.

1.3 Musebots

The open source musebot protocol[1] was originally developed to coordinate generative music software ensembles [6] and facilitate modularised prototyping of designs [7]. The protocol is, at its heart, a method of communicating states and intentions, sending networked messages established through a collaborative document via OSC [8]. Each musebot has tended to correspond to a single part, or layer, within the resulting music: for example, a generator of bass lines, or adaptive drumbeats. The protocol suggested that "if we make these agents smart, then the resulting music will be coherent and continually evolving in interesting ways", which has been argued as being the case [9, 10].

The self-organised model of the musebot ensemble that emerged limited the duration of any given ensemble's performance in the ongoing installations to between five and seven minutes. This limitation was entirely musical, in that the surface interaction between musebots – mainly beat, harmony, and density – provided limited longer scale interest [11]. Subsequent code-jams between musebot developers investigated the potential for musebots to determine endings to improvisations [12] as well as turn-taking [13]. This latter research, in which multiple musebots created by five coders listened to one another and negotiated when to solo, led to the research described here; in this paper, the entire musebot ensemble is created by the author in an effort to explore a homogeneous, rather than heterogeneous, musical style.

2. MILES DAVIS GROUPS 1968-70

Miles Davis is considered to be one of the preeminent figures in American jazz, spearheading several innovative

[1] tinyurl.com/ph3p6ax

movements between 1949 and his death in 1992 [14, 15]. His second great quintet from 1963-1968 – Miles on trumpet; Wayne Shorter, saxophone; Herbie Hancock, piano; Ron Carter, bass; Tony Williams, drums – defined the post-bop style that explored more formally and harmonically free playing [16], leading eventually to the fusion of jazz and rock with the release of *Bitches' Brew* in 1970 [17]. He and his band recorded several seminal albums during this period (see Table 1), documenting the transition between the two styles[2].

Album	Recording date
Miles in the Sky	January/May 1968
Filles de Kilimanjaro	June 1968
In a Silent Way	February 1969
Bitches Brew	August 1969

Table 1. Seminal albums during Miles Davis' transition from post-bop to fusion.

Along with the aforementioned loosening of accepted constraints regarding harmony and form during this time, Davis initiated electric instruments[3] into his group, as well the use of straight-eighth ("rock") rhythms, both first heard on "Stuff", recorded May 1968 on *Miles in the Sky*.

2.1 Expanded Composition

Although the recordings from 1968-69 can be viewed as transitional between his mid-60s post-bop and 1970s jazz-rock fusion, they offer a new, and seemingly unfulfilled, exploration of extended composition. As Waters points out, compositions like "Stuff" and "Tout de Suite" are 40-bar and 70-bar forms, respectively, with unusual repetitions and derivations within the melodic restatements: "the alterations made to successive melodic statement create a sense of shifting perspective upon recurring melodic objects" [18]. However, Davis pursued a different direction by the time of the recording of *Bitches Brew*, focusing upon sculpting interactions within the group, rather than dictating longer melodic ideas [19].

2.2 Group Improvisation

In 1959, Ornette Coleman released *The Shape of Jazz to Come*, one of the first albums that explored collective and democratic improvisation [19]; this record deeply affected many of the late bebop musicians, including Davis. By the mid-1960s, Davis' exploration of more structural freedom was a reaction to the "overabundance of chords" found in late bebop, requiring new notions of how to "balance freedom of the individual with membership in a collective" [19]. However, unlike Coleman who abandoned accepted notions of structure, melody, harmony, and rhythm, Davis "kept one foot planted in inherited forms and the other in the new order" [19]. Even in the much freer tunes of 1970's *Bitches Brew*, a strong pulse is retained, and at least some semblance of a constraining harmony, albeit static.

As the distinctive head melodies and cyclical chord progressions disappeared, so did the focus on a single soloist during the improvisatory sections. While the supporting roles of the rhythmic section – piano, bass, and drums – continued to allow for individualistic commentary on a soloist's material, the freedom of the rhythm section to *dictate* direction greatly increased. This became particularly evident in the interaction between piano and drums in the Lost Quintet: "the potential to foreground rhythmic interplay between (pianist) Corea and (drummer) DeJohnette increased, and space had to be consciously made for (bassist) Holland to be heard and for Corea and Holland to interact" [19]. The focus of the music became less about the soloist, and more about the interaction between the musicians: "audiences expecting a one-to-one correspondence between soloist and accompaniment would cease to follow the logic" [19].

Corea describes Davis as a "chemist" when it came to selecting the musicians of his ensemble, particularly during this time: rather than compose melodies and harmonies for any musician to play, "he chose these guys so that it went together in a way that he heard it" [19]; in other words, he curated an ensemble of possibilities and probabilities. Such curation is exactly how musebots can be honed for interaction.

3. DESCRIPTION

Imaginary Miles explores models of group improvisation found within the 1968-1970 Miles Davis groups, as well as the extended compositional forms found on the 1968 recordings. Several of the musebots are modeled after specific musicians, although not necessarily from that particular period. For example, a Mini-Moog musebot emulates Chick Corea's playing in his Return to Forever period (specifically 1974-76), and an electric guitar musebot emulates John McLaughlin's Mahavishnu Orchestra (1971-74) playing style; as such, the ensemble is very much imaginary. Although many of the modeling attributes are heuristic and decisions made through repeated personal listening and aural analysis, aspects of machine learning are also used.

3.1 Corpus-based melody and harmony

Imaginary Miles retains the earlier structural model of head-solos-head found on *Miles in the Sky* and *Filles de Kilimanjaro*. A musebot generates an overall form of intro – head – solos – head – outro. The length of the head, which determines the consistent phrase length used in a specific generated composition, is a probabilistic value derived from the corpus (see Table 2). Similarly, a chord progression is generated using a Markov model described elsewhere [20].

The rhythm section alone performs the intro and outro, with electric piano having the option of adding solistic elements. As noted, the composition's structure involves

[2] These recordings are now augmented by an increasing number of bootleg recordings and official releases by Columbia in the last twenty years, with live recordings now available of the "Lost Quintet" of Davis-Shorter-Corea-Holland-DeJohnette, never recorded in the studio.

[3] The electric piano had already been used by Duke Ellington in 1955, and the electric bass by Monk Montgomery in Lionel Hampton's band in the early 1950s.

repeating progressions over a set bar length; both the intro and outro can have their phrases repeated.

The head is comprised of a melodic phrase derived from the corpus using methods described in detail elsewhere [21]. The four solo instruments – trumpet, saxophone, electric guitar, synthesiser – play the melody in unison (although the sax may play one octave lower if the pitch centroid of the generated melody is above midi-note 79). Velocities, durations, and onset times are slightly varied between the instruments to affect a looser feeling.

Album	Tune
Miles in the Sky	"Stuff"
Filles de Kilimanjaro	"Frelon brun"
	"Tout de suite"
	"Petits machines"
	"Filles de Kilimanjaro"
	"Mademoiselle Mabry"
In a Silent Way	"Shhh /Peaceful"
	"In a Silent Way"
	"It's About That Time"
Bitches Brew	"Spanish Key"
	"Sanctuary"
	"Pharaoh's Dance"
	"Miles Runs the Voodoo Down"

Table 2. Melodic/Harmonic Corpus. Note that all tunes use electric instruments and straight-eighths in their original recordings.

The solo section involves a complex interaction between musebots, described below.

3.2 General musebot design

Musebots interact with one another via messages, thus not requiring other musebots to analyze audio. They have individual desires and intentions – for example, how active they want to be and become – but balance these in relation to other musebots.

There are two types of musebots used in *Imaginary Miles*: rhythm section players, and soloists. The former play (almost) continuously, and consist of a drummer (`TonyBot`), electric bass player (`DaveHBot`), and electric piano player (`HerbieBot`): their specific tendencies are described in Section 3.3. The soloists consist of a trumpeter (`MilesBot`), tenor saxophonist (`WayneBot`), electric guitarist (`JohnnyBot`), and synthesist (`ChickBot`); these musebots only play during the head, and take turns soloing, ostensibly waiting for an opening. `HerbieBot` also doubles as a soloist, taking a lead when no other solo musebot is active.

3.2.1 Rhythm section musebot interaction

Rhythm section musebots have an individual internal goal, continually varied using Brownian motion, for density – a probabilistic value determining how active they are at any given time: this value is translated into number of onset events per beat. The actual number of events the musebot generates – as opposed to the musebot's *desired* amount – is broadcast to the ensemble. All musebots collect the individual broadcast densities, the mean of which is considered the *ensemble density*. Rhythm section musebots compare the ensemble density to their own actual density: if the two values are significantly different (greater than 20%), the musebot will temporarily adjust its own *desired* density closer to that value for approximately two measures. This complex system of density interaction is a successful heuristic that builds upon prior musebot research [12].

3.3 Specific musebot models

3.3.1 TonyBot

Modeled after Tony Williams "thundering drumming surges" that are continually "ebbing and flowing while rarely ceasing to drive hard" [19], `TonyBot` has individual onset probabilities for kick, snare, open hihat, closed hihat, and crash cymbal which are individually modified by the current density request. When the requested density is above a threshold, a greater possibility for repetition exists for the generated collective pattern. Individual drums for each onset (i.e. snare vs. sidestick) are varied, the duration of any drum type is affected by the current density.

3.3.2 DaveHBot

There are only limited recordings of Ron Carter playing electric bass during this time, since, according to Gluck, he didn't want to play electric [19]; as such, the bass musebot is modeled more on Dave Holland's playing, emphasizing "ostinato…built from repetitive rhythmic, harmonic, and textural patterns"[19]. It uses the same probabilistic method described above, albeit with different thresholds set heuristically.

3.3.3 HerbieBot

The `HerbieBot` is a combination of Herbie Hancock's post-bop playing style and Chick Corea's more aggressive Fender Rhodes style featured during the Lost Quintet recordings. Unlike more traditional piano accompaniment, Corea's percussive attacks demonstrated a "drummer-like ability to vary his chord articulations – from highly staccato to sustained" [19]. Corea's use of ostinato and highly chromatic chordal accompaniment, "inserted when a space opened or where ever he could offer commentary on the proceedings" is emulated by having the musebot "listen" to the soloist's playing, parsing for breaks and/or silences: `HerbieBot` will respond by either filling in holes through chordal comping, or echoing individual notes it just "heard".

3.3.4 MilesBot, WayneBot, ChickBot, and JohnnyBot

The soloist musebots are based on the same agent algorithm, differentiated only by their specific parameter settings. Soloist musebots have personality attributes of patience/impatience (how long to wait before wanting to solo), politeness/rude (how willing it is to interrupt another soloing musebot), and ego (how long it wants to continue soloing), each of which are set at the start of each performance with either exponential or Gaussian

random values. These parameters are updated constantly as the environment changes; for example, while a musebot is waiting to solo when another is active, its impatience and rudeness may increase, while the opposite will occur while actually soloing.

Soloists create phrases based upon a constrained phrase length range, followed by a constrained pause length; both ranges are affected by the ensemble density and internal density desire. Pitch shapes for phrases are generated, then quantized to the current chordScale broadcast by the harmony-generating musebot, which is derived from the actual pitches used in transcribed melodies and improvisations used for the specific chords found in the corpus.

4. CONCLUSIONS

Imaginary Miles is an exploration of musebot interaction, using both the group improvisation ideas found in the Miles Davis groups of the late 1960s, as well as certain individual musician's stylistic traits, as models. While not a musicological study of the individual musicians, nor an attempt to prove a computational model, it does provide new methods of autonomous musical agent interaction. *Imaginary Miles* can be heard here[4].

Acknowledgments

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