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Evolutionary jazz improvisation and harmony system: A new jazz improvisation and harmony system

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Aims and context

Jazz harmony has, since the birth of jazz, during the first two decades of the 20th century, been systematically organized around a tonal centre by fifth progressions, which means that each chord has been related to a base note and classified as minor or major, and optionally also enriched with colourization, such as:

Cm, Eb7, G13b9, A7#11

Blues and ragtime harmony mainly used simple major/minor triads at the distance of fifths. Swing music enriched the chords with sixths and ninths but the chord progressions were mainly the same. Bebop further enriched the chords with further colourizations such as b9, #9, #11, 13, b13 etc. and exchanged some chord progressions by inserting an extra subdominant parallel, e.g.

G7 – C was replaced by Dm7 – G7 – C

However, the focus was still on major/minor and fifth progressions. The main harmonic contribution from cool jazz and hardbop during the 50’s was further advanced chord colourizations. A few new-thinking musicians, like Ornette Coleman, Cecil Taylor, Don Cherry and others, began at the end of the 50’s to split up the harmonic foundation prevailing until then, and this development continued during the subsequent decades under stylistic classification into “modal jazz”, “avant-garde”, “free form” etc. Current jazz musicians have adopted to some extent this break-up tendency.

Experiments have also been made during the 60’s and 70’s by e.g. Herbie Hancock, Miles Davies and fusion musicians Brecker Brothers, not to mention all experiments in the classical music domain during the entire 20th century from Schoenberg and onwards.

However, mostly you can in the “modern” jazz styles trace some remainders of the functional harmony principles and the fifth circle basis. When progressive or avant-garde musicians create compositions with new harmony, there still is a risk to get stuck in conventions dictated by routine and learnt behaviour, idiomatic properties of the instrument and the musician’s physical and muscular restrictions. The computer has no such restrictions but creates harmonies controlled by the algorithms having been programmed. The aim is to be able to free oneself from traditional thinking and create a completely new kind of jazz music.

There are some publications written by the author that provide valuable background information to this project [2-4].

Dahlstedt [1], Dean [5], Levinde [6] Manning [7], Rowe [8] and Thywissen [9] have made valuable contributions in the same area and have been sources of inspiration for this project.

Methodology

Artificial Evolution

The evolutionary algorithm process starts, from a basic set of parameters (genome), by creating a first random population of pictures, melodies, chord progressions or whatever. The fitness evaluation then takes place by examining the bred material (children) and selecting the best, optionally by giving each a score. The children with the highest score have the highest probability to become parents for the next generation. The breeding is done by combining the genome (parameter values) of two parents, optionally by applying a mutation somewhere in the genome. The mutation might imply a shift between two parameter values, or a slight modification of a parameter value.

The principle of using evolutionary algorithms to develop new artistic productions, enhance artistic thinking and stimulate creativity, first started on a broader scale in the digital graphics area, such as forerunner Karl Sims [10]. The evolutionary algorithms principle is well accommodated to that area because, when using interactive evaluation of a created generation, as described by Dawkins [11], you can swiftly scan over a great number of pictures and select the best according to your personal preference. With audio material, however, the selection procedure is much slower since you will have to listen through each bred melody in a generation, one at a time. The first experiments in the music area have been made by Collin Johnson and Palle Dahlstedt [1].

The fitness selection and breeding is repeated generation by generation until you arrive at a genome good enough to be used for reproduction of artworks (pictures / melodies etc.).

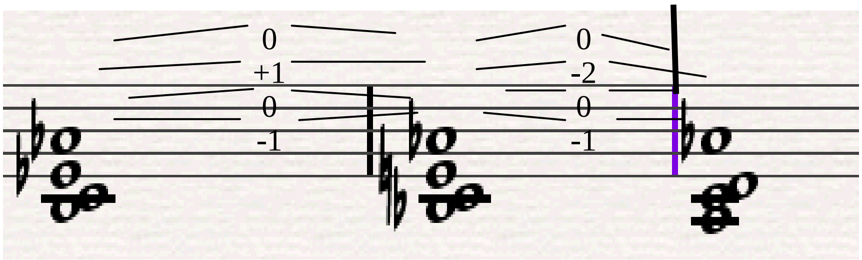
This process is much the same as the genetic process of creating a new species generation in nature, only that it must be sped up considerably to have a chance to be completed in proper time, which is accomplished by the support of the computer.

Harmony Evolution

The genome in harmony evolution consists of parameter values specifying the internal structure of each chord and the progress from one chord to the next. For each new generation one parent chord progression is combined with another by selecting various portions of each of the parents' genomes. For each child, different sections of the parents' genomes are selected, optionally also by performing a mutation, which is implemented as a slight modification of some genome parameter values.

A genome consists of an initial chord and the voice progression from chord to chord (fig. 1).

Fig. 1 Chord genome



When breeding two parents we combine different sections of the parents' genomes just like the process of combining DNA for species.

At the end of the breeding a mutation is made by amending a few values one step up or down, so -1 might be -2 or 0, etc.

Solo Improvisation Evolution

The evolution of jazz solos follows the same principles as for the harmony evolution. The internal representation is however quite different. A jazz solo genome consists of a basic melody line with energy constraints ("rubber band") and a hierarchic structure of operators that processes the various parts of this basic melody.

The creation of the raw material uses a similar technique as the one used in the mid-point displacement algorithm for landscape generation. It is created by originating from start and end pitches, then dividing the interval recursively. The middle pitch is stored for each interval division (fig. 2).

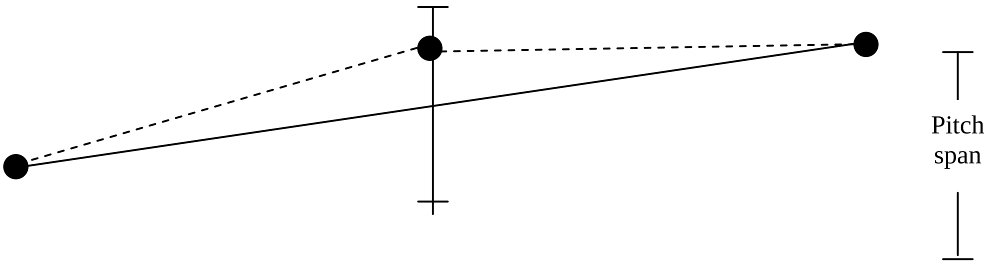
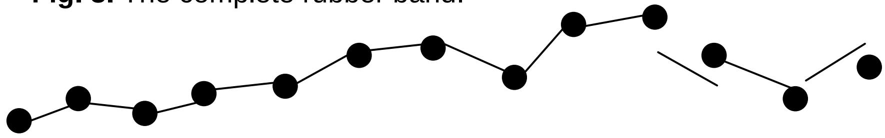


Fig. 2. The middle point is created by stretching the rubber band.

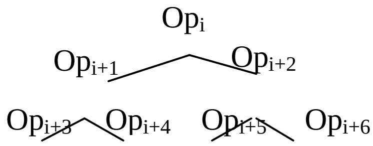
The final melody is stretched like a rubber band for each interval. An example is shown in fig. 3.

Fig. 3. The complete rubber band.



The purpose of organizing operators hierarchically into an operator tree is to allow each small portion of the rubber band (delta phrase) to be processed hierarchically by a series of operators. Fig. 4 shows the structure of an operator tree.

Fig. 4. The structure of an operator tree



Each operator modifies a delta phrase in one particular way (add or remove a note, inversion, retrograde, repeat etc.)

Both the rubber band and the operator tree are included in the genome. The genomes of two parents are combined by crossover to generate a population of new children (solos). After a number of generations we hopefully arrive at a solo good enough.

Results

The harmonic result shows a feeling of continuous progress towards new heights without arriving at rest points, which is the case with traditional functional harmony, where some chords have a striving character to dissolve into tonics.

The solo melodies show a continuous flow of small motives hooked onto each other, now and then interrupted by small rests inserted into the flow. The melodies have some kind of intensity curves rolling up and down, trying to imitate melody curves of good jazz music.

When jamming with a jazz group on tunes with the new harmony system, it has the effect on the soloist to continuously proceed towards a climax never completely reached. The soloist is compelled to go on and on and on. The listener will be involved in this forward-striving feeling of wanting some more all the time. Whether this is good or bad I am not sure, but anyhow it is an interesting feature that some people might find valuable.

In the live jazz group, it turned out that the musicians had apparent difficulties in keeping chords and scales in their minds during their solos, since they had to learn completely new chords and scales. Clever and experienced musicians appeared to be relative beginners, at least during the first rehearsals.

Provided with this paper are a couple of sound examples

Chord progression:
http://oden.ei.hv.se/kjell/comp/chords1.mid

Pre-composed tunes with a virtual jazz combo orchestration, where I play a couple of acoustic piano solos:
http://oden.ei.hv.se/kjell/comp/GeneticSamba.mp3
http://oden.ei.hv.se/kjell/comp/gate.mp3
http://oden.ei.hv.se/kjell/comp/chaos.mp3

Rehearsal with the live jazz group:
http://oden.ei.hv.se/kjell/live2/Chaos2.mp3

Conclusions

Do evolutionary algorithms provide any valuable artistic material? At least some sounding examples are of interest, maybe not of high professional musician class, but provide interesting and unexpected artistic output. A jazz tune composer often uses standard chord progressions learnt during a long time of practicing and concerting. He relies on routines built up through repeated usage of similar chord colourizations.

The new harmonic system presented in this paper provides a tool for creating a new kind of harmonic base by means of evolutionary algorithms. The resulting harmonic schemes can be used as a foundation for new jazz tunes and as a foundation for exploring the world of jazz improvisation.

An improviser often uses standard phrases and motives trained during a long time of practicing and concerting. The main purpose of using computers to produce jazz improvisation is that it opens your mind to new thinking and frees you from old habitual paces of playing.

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