Non-Conformant Harmonization: the Real Book in the Style of Take 6



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Creativity often arises from *playing* with styles



Ghedini et al. The Flow Machines project. Ijcai 2013 and AAAI 2013 best video award

Texture and Structure



Style = Texture

Texture and Structure







Style = Texture

Constraint = Structure

Texture and Structure







Style = Texture

Constraint = Structure



New object

Style and Markov chains





Markovian Amnesia:

$$P(s_i|s_1, s_2, \dots, s_{i-1}) = P(s_i|s_{i-1})$$

Random Walk = doodling = **non controllable**

Beyond random walk: principled generation

General Solution for optimization problems:

Pachet, F. and Roy, P. Markov constraints: steerable generation of Markov sequences, **Constraints**, 2011.

Unary constraints solved in polynomial time:

Pachet, Roy & Barbieri, Finite-Length Markov Processes with Constraints, IJCAI 2011

Meter in pseudo-polynomial time:

Roy, P. and Pachet, F. Enforcing Meter in Finite-Length Markov Sequences. AAAI, 2013

MaxOrder (= enforcing novelty) in linear time !

Papadopoulos, A., Roy, P., Pachet, F. Avoiding Plagiarism in Markov Sequence Generation, **AAAI**, 2014

http://www.flow-machines.com/maxOrder

Beyond random walk: combinatorial sequence generation

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Style in Harmonization ?

- Leadsheet = melody with chord sequence given¹
- Produce a harmonization (n-parts) « in the style » of a given arranger
- Paradigmatic constraint: use only chords found in the corpus of the composer

Pachet, F., Suzda, J., Martin, D. A Comprehensive Online Database of Machine-Readable Lead Sheets for Jazz Standards. ISMIR, Curitiba (Brazil), November 2013. http://lsdb.flow-machines.com

Harmonization is an old problem !

Luc Steels, Learning the craft of musical composition, ICMC **1986**

Here is a simple example of the deep reasoning process. Given a IV chord in c-major, the problem is to find a satisfactory progression to a V-chord, given G in the bass. The constraints are (1) the root must be doubled, (2) all chord tones must occur, (3) there should be no voice crossing, (4) there should be no parallel octaves, (5) no parallel fifths, (6) no hidden octaves, and (7) no hidden fifths. More constraints could be added. The point here is not the correctness or completeness of the constraints. This is only an experiment.

Here are the possibilities generated by the program



(1) is rejected because not all chord-tones occur, (2) because there are parallel octaves. (3), (4) and (5), and (6) are rejected because not all chord-tones occur and (7) is accepted by the given constraints.

Note that a solution might still be rejected because a point was reached a few bars later that could not be resolved.

3.2. HEURISTICS

Heuristics typically take the form of if-then rules. The if-part specifies a certain condition in the problem situation. The then-part specifies a solution. A well known heuristic for the IV-V progression is to move all tones to the nearest The neuristics are applied using a straignuorward interence engine which follows the following algorithm.

- Given a problem situation, determine the truth-value of the if-part of a rule.
- 2 If this is equal to true, execute the then part of the rule. Otherwise take the next rule.

More than one rule may apply in a given situation. A backtracking controlstructure is followed to explore other rules if one rule leads to a failure.

3.3. COOPERATION BETWEEN DEEP AND HEURISTIC REASONING

When no rule is applicable, the system falls back on deep reasoning and starts exploring the search space of possible progressions again, using the constraints as filters.

4. LEARNING

Obviously the most difficult part of the project is the learning component. For this we are still in the preliminary phases of research. The IF-part of the rule must be based on what is given in the initial problem situation and the THENpart must be based on what has been added to this situation to obtain a solution. But the main problem, if we want to have rules that cover as many cases as possible, is what to generalise over, i.e. what aspects of the initial or final state must be incorporated in a rule.

The IV-V progression used earlier on as example illustrates the problem. Here is a print-out of the properties of the internal and external intervals:

CHORD: #<ART-Q-24 -26477217>

key: <C-MAJOR>, chord-function <CHORD-FUNCTION IV> Bass:[<F-TONE> <GREAT>]Tenor:[<C-TONE> <PRIME>] Alto: [<F-TONE> <PRIME>]Soprano:[<A-TONE> <PRIME>] INTERNAL INTERVALS:

1. Soprano to Bass:

Interval: <INTERVAL #134>

From:[<F-TONE> <GREAT>], To:[<A-TONE> <PRIME>] Direction: <UP>, Step-distance: <TERTS>,

Goal: leadsheet given, produce N-voices, in a given style



A classical problem, but

Existing approaches generate at best:

- Conformant harmonization: C major has C, E, G
- General, agnostic approaches
- Would you, author, dare to play these examples to top musicians?

Musically not interesting, surprinsing, novel Well-defined problem but the *real* problem has been « defined away » ¹

=> Not creative (whatever this means)

¹ Expression is from Stuart Russell, Ijcai computer and thoughts award ceremony, 1995



What do I mean by non-conformant ?



« Hark the herald angels sing » by Take 6

How to model non-conformance ?

• Random ? Beurk

 Unleash homophonic constraint with controlled boundaries

== Unary Markov constraints

- Guarantees that all solutions are found with their right probabilities
- Polynomial time !

A famous leadsheet: Giant Steps by J. Coltrane



Varying Harmonic Distance does not work !







Fioritures as controlled walks









Giant Steps by Wagner





Why Take 6 ?



One of the best vocal arranging style

Rich harmonisations, very recognizable

10 Grammy awards

Very hard to imitate (even to transcribe!)

NI D Giant Steps by Take 6



Ivan Lins – Começar de Novo (The Island)



Grammy-winning Brazilian songwriter. His 1989 hit song "Love Dance" is one of the most re-recorded songs in musical history

Começar de Novo harmonized by Take 6





Rio, October 31st, 2013

Solar With Fioritures



Giant Steps by Wagner







Style: Wagner, Take 6, etc.

Constraints: Giant Steps by John Coltrane

Or by any composer for which we have enough polyphonic scores

Gesualdo, Bach, Haydn, Mozart, Debussy, Bill Evans, Luc Steels (!)

The « Boulez Blues » (aka the « Blouze »)





Constraints 24 chords, all different

All blues composed by Charlie Parker

And we want the most probable ! (the most « Charlie Parkerian ») **Optimize** $P(s_1, s_2, ..., s_n) = P(s_1) \prod_{i=2}^{n} P(s_i | s_{i-1})$

Pachet, F. and Roy, P. Markov constraints: steerable generation of Markov sequences, **Constraints**, 2011

Yesterday by Bob Dylan



Style: All lyrics by Bob Dylan

Constraints:

Prosody and rhymes of Yesterday

And we get yesterday by Bob Dylan, ACDC, Madonna, etc.

Barbieri, Pachet, Roy & Degli Esposti, Markov Constraints for Text Generation with Style, ECAI 2012

Conclusion

- *Style* as a constrainable texture
- Constraints *outside the genre* usually generate interesting artefacts
- But homophonic harmonization for melodies outside the harmonization style does **not** work well
- *Fioritures* enable style expression and become a device for creation: a paradox !
- But enables the generation of musically challenging productions that I am not ashamed to play to experts
- Web radio soon online to listen to examples endlessly

The paper:www.flow-machines.com/harmonizationThe radio:http://lsdb.flow-machines.com/radio-sonycsl.php

Style + constraint











Lyrics





harmonization





But also melodies (solos), leadsheets, accompaniments, etc.

Preliminary studies

- Real Book (about 400 leadsheets)
- Homophonic harmonization: 1 note = 1 chord
- Markov model of chords
- Various viewpoints, from very precise to very degraded

=> does not work !

Markov models too sparse

Study on the Real Book



Harmonization examples

- Jobim: A Felicidade
- T. Monk: Around Midnight
- J. Coltrane: Giant Steps
- Jobim: Desafinado
- Bill Evans: Very Early
- P. McCartney: Yesterday
- Bill Evans: Turn out the stars



http://www.flow-machines.com/harmonization

Virtuoso



Pachet, F. Bebop Virtuosity Explained *McCormack & d'Inverno, Eds.* <u>Computers and Creativity</u>, Springer, 2012