

Extracting Patterns from Guitar Accompaniment Data: Some Experimental Results

Ernesto Trajano de Lima¹, Søren Madsen^{2,3}, Márcio Dahia¹,
Gerhard Widmer^{2,3} & Geber Ramalho¹

¹Centro de Informática, (UFPE)

²Austrian Research Institute for Artificial Intelligence (ÖFAI)

³Department of Computational Perception, University of Linz

X SBCM, October 2005

Questions

```
F7+           G7/5-  
Se você disser que eu desafino amor  
Gm7           Bb/C           Cm7           D7/9-  
Saiba que isso em mim provoca imensa dor  
Gm7           A7/5+           D7+           D7/9-  
Só privilegiados têm ouvido igual ao seu  
G7           Bb/C           Gb7/13  
Eu possuo apenas o que Deus me deu
```

- Where does the rhythm comes from?
- How do the players build it?
- What influences its construction?
- Do different players use the same rhythmical accompaniment?
- If not, in which way does the accompaniment differ?

Rhythm in Bossa Nova

- Building block: rhythmic pattern or *batida*
- Accompaniment = concatenation of several (possibly different) *batidas*

Further Questions

- *Batida*
 - What are they?
 - Any preferences?
 - How often?
 - Variations?
 - Is everything a “batida”?
- Dictionary of *batidas*
 - unique (performers, styles, etc.)?
- Grammar
 - rules of usage!

Outline

- 1 Data
 - Acquisition
 - Preparation
 - Representation
- 2 Experiment
 - Description
 - Algorithms
 - Results
- 3 Final Remarks

Recordings

- MIDI guitar
- Songs:
 - Garota de Ipanema, Insensatez, Wave, Barquinho, Bim Bom, Só Danço Samba, Chega de Saudade, Corcovado, Desafinado, Eu Sei Que Vou Te Amar, Felicidade, Samba de uma Nota Só, Tarde em Itapoã;
 - 16 recordings (ca. 30 min.)
- Audio from the same recordings

Preprocessing

- Filter: simple rules + visual and auditive inspection
- Metadata: right hand fingering
- Beat tracking: BeatRoot

Initial Representation

```
|-----|-----|--  
|R---R----R----|R---R----R----|R-  
|M---M----M----|M---M----M----|M-  
|F---F----F----|F---F----F----|F-  
|-----|-----|--  
|T-----T-----|T-----T-----|T-  
|+---+---+---+---|+---+---+---+---|+-
```

[...]

One-dimensional Representation

- Events can be described as “baixo” or “puxada”

```
|-----|-----|-----|
|R---R----R----|R---R----R----|R-
|M---M----M----|M---M----M----|M-
|F---F----F----|F---F----F----|F-
|-----|-----|-----|
|T-----T-----|T-----T-----|T-
|+---+---+---+---|+---+---+---+---|+-

```

[...]

```
|A---P---B-p+---|A---P---B-p+---|A-
```

One-dimensional Representation

```
|-----|-----|  
|R---R----R----|----R-----|R-  
|M---M----M----|----M-----|M-  
|F---F----F----|----F-----F----|F-   [...]  
|-----|-----|  
|T-----T-----|T-----T-----|T-  
|+---+---+---+---|+---+---+---+---|+  
  
|A---P---B-l-+---|B---P---B-s-+---|A-
```

Description

- Cyber-João: Catalogue of “good” patterns
- Could this catalogue be automatically found in the data we collected?
- Rewrote the catalogue in the form of the one-dimensional string

Catalogue

Chord

Pattern P1

Bass

Pattern P1 is a 2-measure musical pattern in 2/4 time. The Chord part (top staff) consists of two measures: the first measure has a quarter note G4, a quarter note A4, and a quarter note B4; the second measure has a quarter note C5, a quarter note B4, and a quarter note A4. The Bass part (bottom staff) consists of two measures: the first measure has a quarter note G2, and the second measure has a quarter note G2.

Chord

Pattern P15

Bass

Pattern P15 is a 2-measure musical pattern in 2/4 time. The Chord part (top staff) consists of two measures: the first measure has a quarter note G4, a quarter note A4, and a quarter note B4; the second measure has a quarter note C5, a quarter note B4, and a quarter note A4. The Bass part (bottom staff) consists of two measures: the first measure has a quarter note G2, and the second measure has a quarter note G2.

Chord

Pattern P17

Bass

Pattern P17 is a 2-measure musical pattern in 2/4 time. The Chord part (top staff) consists of two measures: the first measure has a quarter note G4, a quarter note A4, and a quarter note B4; the second measure has a quarter note C5, a quarter note B4, and a quarter note A4. The Bass part (bottom staff) consists of two measures: the first measure has a quarter note G2, and the second measure has a quarter note G2.

Matching

- Exact matcher: Boyer-Moore
- Inexact matchers:
 - FExPat
 - SimilaritySegmenter

Boyer-Moore

Song	Player1	Player2
Desafinado	0	1
Garota de Ipanema	0	6
Insensatez	4	29

- Exact matcher isn't able to cope with any sort of deviations that are usually done by the performers

```
| A---P---B-p-  
| A---P---B--p
```

FIEXPath

- Input parameters
 - $m_{min} = 17$ (minimal pattern length);
 - $m_{max} = 34$ (maximal pattern length);
 - similarity threshold: 0.75 (normalized values);

FIExPat

Pattern	Player1	Player2	Pattern	Player1	Player2
P1	yes	yes	P12	no	no
P2	yes	no	P13	no	no
P3	no	no	P14	no	no
P4	yes	no	P15	yes	no
P5	no	no	P16	no	no
P6	no	no	P17	no	no
P7	no	no	P18	no	no
P8	no	no	P19	no	no
P9	yes	yes	P20	no	no
P10	yes	yes	P21	no	no
P11	no	no	/	/	/

FIEXPAT

- Structural malformation:

--B---B---+--- | P---B---B---+--- | P

SimilaritySegmenter

- Constraints
 - $| < pattern >$ or
 - $l * | < pattern >$, where $*$ is a sequence, possibly empty, of only minuses ($-$).
- 2 mismatches per measure

SimilaritySegmenter

Pattern	Player1	Player2	Pattern	Player1	Player2
P1	yes	yes	P12	no	no
P2	no	no	P13	no	no
P3	no	no	P14	yes	no
P4	no	no	P15	no	yes
P5	no	no	P16	no	no
P6	no	no	P17	no	no
P7	no	no	P18	no	no
P8	no	no	P19	no	no
P9	yes	yes	P20	no	no
P10	no	yes	P21	no	no
P11	no	no	/	/	/

SimilaritySegmenter

- Long patterns

```
|B---P---B-p+-s-|A---P---B-s+-l-  
|B-p+-p-B-p+-l-|B-p+-p-B---P---
```

- Non-deterministic

Conclusion & Future Work

- Improve representation
- *Ad hoc* evaluation process
- Structural malformation
- Apply to Samba