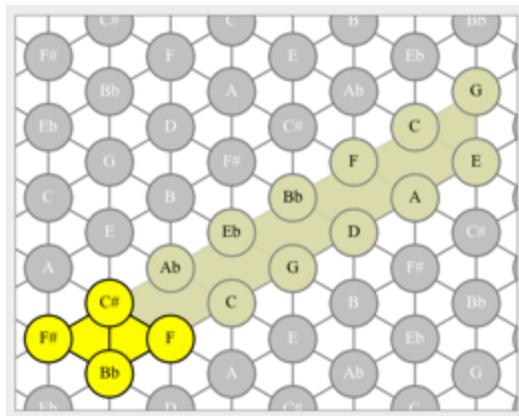




# Dalla musica alla matematica: invito al viaggio

## *seconda parte*



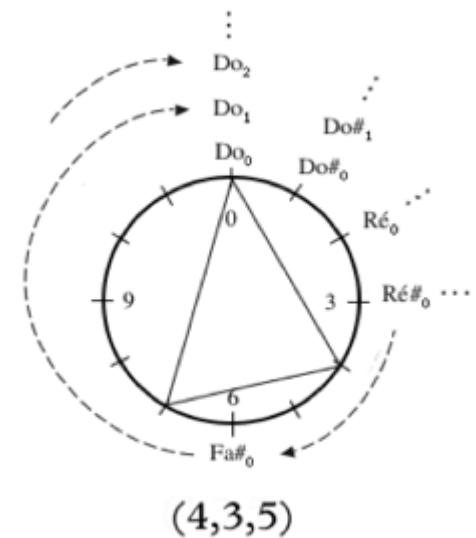


# Moreno Andreatta

## Equipe Représentations Musicales

### JRCAM / CNRS UMR 9912 / UPMC

<http://repmus.ircam.fr/moreno/>



# Un passo indietro: Mersenne e la combinatoria musicale

114. Marin Mersenne, *Harmonicorum Libri XII*, 1648

## LIBER SEPTIMVS. DE CANTIBVS, SEV CANTILENIS, EARVMQ; NVMERO, PARTIBVS, ET SPECIEBVS.

*Tabula Combinationis ab I ad 12.*

|       |                        |
|-------|------------------------|
| I     | 1                      |
| II    | 2                      |
| III   | 6                      |
| IV    | 24                     |
| V     | 120                    |
| VI    | 720                    |
| VII   | 5040                   |
| VIII  | 40320                  |
| IX    | 361880                 |
| X     | 3618800                |
| XI    | 39916800               |
| XII   | 479001600              |
| XIII  | 6117020800             |
| XIV   | 87178191200            |
| XV    | 1307674368000          |
| XVI   | 20922789888000         |
| XVII  | 335687418096000        |
| XVIII | 6401373705718000       |
| XIX   | 121645100408832000     |
| XX    | 2431901008176640000    |
| XXI   | 51090942171709440000   |
| XXII  | 1114000727777607680000 |

## HARMONICORVM LIBRI XII

IN QVIBVS AGITVR  
DE SONORVM NATURA,  
CAVSI, ET EFFECTIBVS: DE CONSONANTIS,  
Dissonantiis, Rationibus, Generibus, Modis, Cantibus, Com-  
positione, orbisque totius Harmonicis Instrumentis.

Autore F. M. MERSENNO Minimo.  
Ad Illustr. V. HENRICVM LUDOVICVM HABERTVM  
DE MONTMOR:

Laudate eum in cymbalibz benzonitibus, laudate eum in cymbalibz labiatiginis:  
Omnis spiritus laudet Dominum. PIA LV. tpo.

EDITION AVCTA.

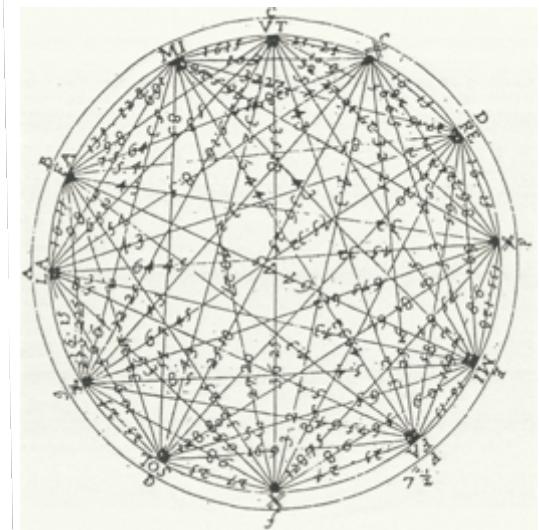


LVETETIAE PARISIORVM.  
Sumptibus GVILLEMI BAVDRY. vii Jacobz, prope Collegium Plessuum.

M. DC. XLVIII.

Cum Privilegio Regie Clichyensis & Approbatione Superiorum.

## Varietas, seu Combinatio quathor notarum.



# The Four Note Opera e altre composizioni ‘minimaliste’ di T. Johnson

| Tabula Combinationis ab I ad 22. |                        |
|----------------------------------|------------------------|
| I                                | 1                      |
| II                               | 2                      |
| III                              | 6                      |
| IV                               | 24                     |
| V                                | 110                    |
| VI                               | 710                    |
| VII                              | 5040                   |
| VIII                             | 40310                  |
| IX                               | 361880                 |
| X                                | 3618800                |
| XI                               | 39916800               |
| XII                              | 479001600              |
| XIII                             | 6117010800             |
| XIV                              | 87178191100            |
| XV                               | 1307674368000          |
| XVI                              | 10911789888000         |
| XVII                             | 333687418096000        |
| XVIII                            | 6403373705718000       |
| XIX                              | 121645100408831000     |
| XX                               | 2431901008176640000    |
| XXI                              | 510909421171709440000  |
| XXII                             | 1114000727777607680000 |



*The Four Note Opera* (1972)



*Galileo* (2001-2003)

The 78 two-note chords possible in one octave:

⋮

The 715 four-note chords possible in one octave:

etc.to



1998 EDITION CEST MOI IMPRESSIONS

Etc., playing the 1287 five-note chords, the 1716 six-note chords, the 1716 seven-note chords, the 1287 eight-note chords, the 715 nine-note chords, the 286 ten-note chords, the 78 eleven-note chords, the 13 twelve-note chords, and the 1 thirteen-note chord. 8178 chords in all.

© 1986 BY TOM JOHNSON

**Totale: 8178 accordi**

# Melodie ‘frattali’: dal Basso d’Alberti ad oggi



G. Miller, *In the Mood* (1939)



T. Johnson, *La vie est si courte, la mort est si longue* (1998), per otto strumenti

## Logique et calcul

© Jean-Paul Delahaye, *Pour la Science*, Nov. 2004

### La musique mathématique de Tom Johnson

Les dessins de l’art islamique sont de purs objets mathématiques ; Tom Johnson défend une conception analogue pour la musique.



# Carattere combinatorio della produzione artistica:

## L'Oulipo : « L'ouvroir de littérature potentielle »

« Ce petit ouvrage permet à tout un chacun de composer à volonté cent mille milliards de sonnets, tous réguliers bien entendu. C'est somme toute une sorte de machine à fabriquer des poèmes, mais en nombre limité ; il est vrai que ce nombre, quoique limité, fournit de la lecture pour près de deux cents millions d'années (en lisant vingt-quatre heures sur vingt-quatre) »

(Raymond Queneau, *Cent mille milliards de poèmes*, 1961)

➔ <http://x42.com/active/queneau.html>



Raymond Queneau



Georges Perec



*Il Castello dei destini incrociati* (1969)



Italo Calvino

# Esperienze musicali ‘oulipiane’: una canzone su un solo accordo...



A. Celentano, « Mondo in MI settima » (1966 - Beretta, Mogol, Del Prete)

Urlinie

Bassbrechung

3 2 1

I V I

Analisi  
schenkeriana



H. Schenker (1868-1935)

J. S. BACH PRELUDE No. 1 IN C MAJOR

Ursetz.

Urline

Bassbrechung

Tiefststimme

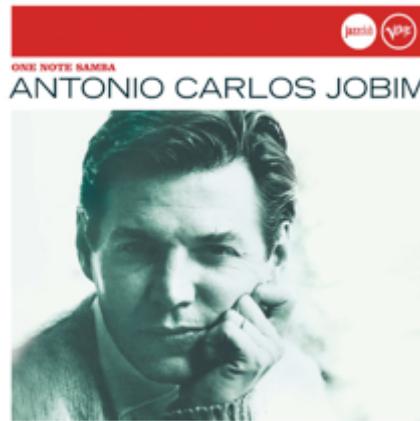
Texte:

Mtg.

Vdg.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

# ...o su una sola nota!



**Antonio Carlos  
Jobim, Samba de  
una nota sò**



**Elio e le Storie Tese, La canzone mononota**

A detailed musical score for J.S. Bach's Prelude No. 1 in C Major. The score is annotated with Schenkerian analysis, featuring numerous arrows and numbers (1, 2, 3) pointing to specific notes and chords to show the underlying harmonic structure and melodic layers. The score includes two staves: Treble and Bass.

**Una storia d'amore finisce una volta soltanto (M. Andreatta)**  
**[Canzone di una frase su una nota]**

*Una volta, una storia d'amore, soltanto una storia  
Una storia d'amore, soltanto una storia d'amore  
Una storia, soltanto una storia  
Una storia d'amore soltanto  
Una volta soltanto una storia d'amore soltanto*

*Un amore, soltanto una volta, soltanto una storia d'amore soltanto  
Una storia d'amore, soltanto una volta una storia  
Un amore, una volta soltanto  
Un amore finisce soltanto  
Una volta, una storia d'amore finisce  
Una volta soltanto  
Una storia d'amore una volta soltanto finisce*

→ <http://repmus.ircam.fr/moreno/music>

## Analisi schenkeriana

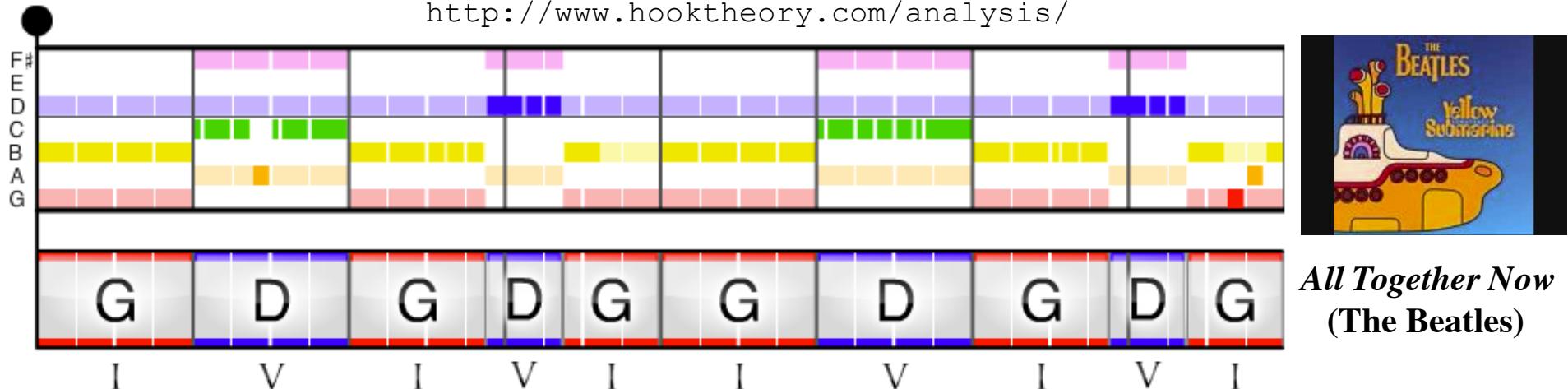
A simplified Schenkerian analysis diagram. It shows a treble clef staff with a green box highlighting the third note (the 'Urlinie') and a bass clef staff with a brace labeled 'Bassbrechung'. Below the staffs, the harmonic progression is indicated as I - V - I.



**Heinrich Schenker**

# Due o tre accordi bastano per fare una *hit!*

<http://www.hooktheory.com/analysis/>



**I → V → I** : *La Paloma* (Basque Sebastián Iradier, 1863)  
: *All Together Now* (The Beatles)

...

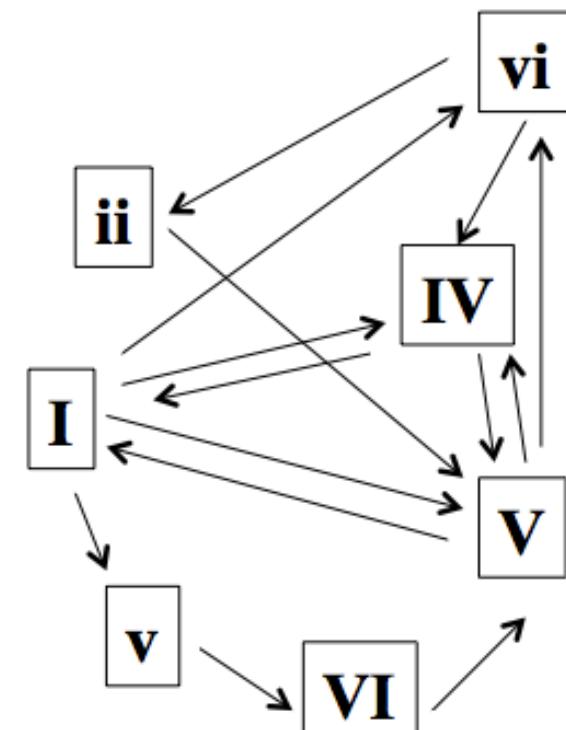
**I → IV → V → I** : *Like A Rolling Stone* (Bob Dylan)  
...

**I → V → IV → V → I** : *You Look Wonderful Tonight* (Eric Clapton)  
...

**i → VI → V → I** : *Sweet Dreams* (Eurythmics)  
...

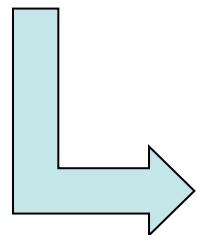
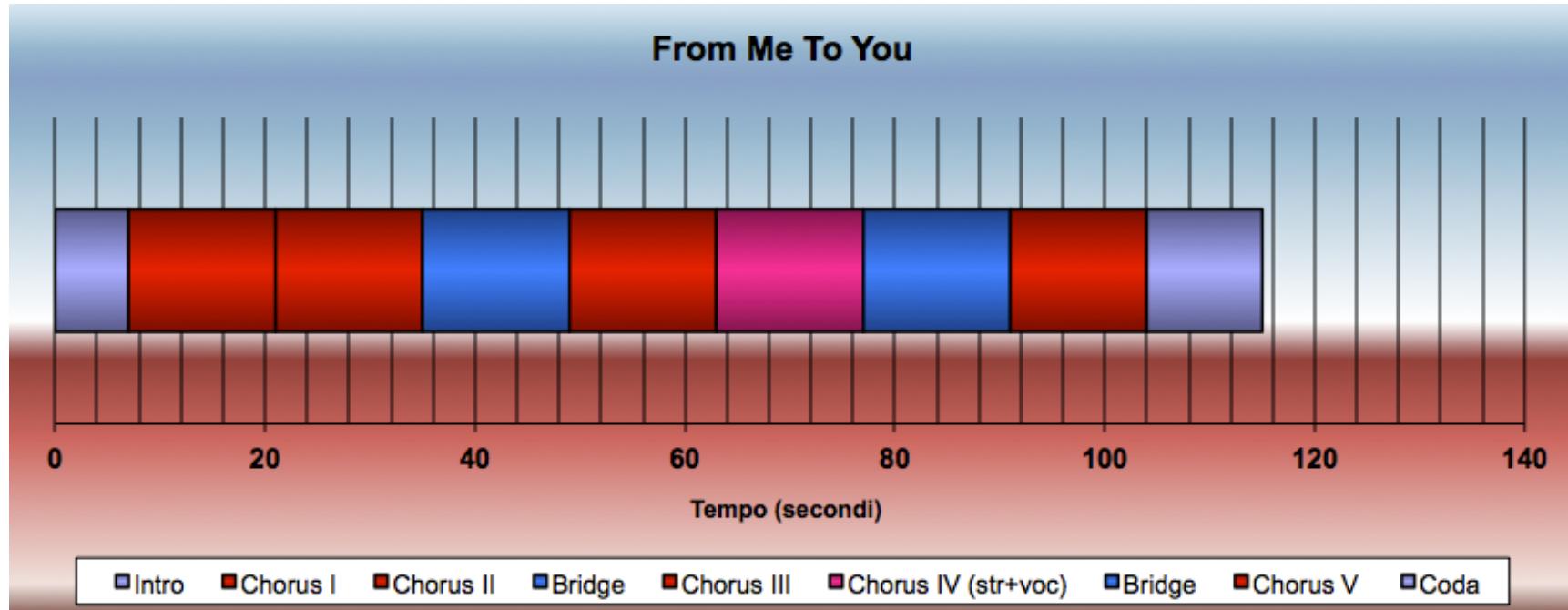
**i → V → IV → I** : *Come together* (The Beatles)  
...

**I → vi → IV → V → I** : *Every Breath You Take* (The Police)  
...

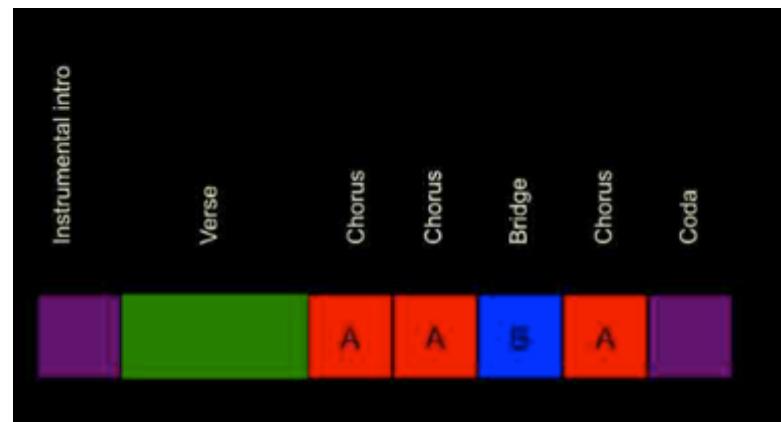


# Struttura formale delle canzoni dei Beatles

- Franco Fabbri, *Il suono in cui viviamo. Inventare, produrre e diffondere musica*, Feltrinelli, 1996
- Franco Fabbri, « Verse, Chorus (Refrain), Bridge: Analysing Formal Structures of the Beatles' Songs », *Popular Music Worlds, Popular Music Histories*, Proceedings (Geoff Stahl, Alex Gyde eds), 2012, IASPM: 92-109.

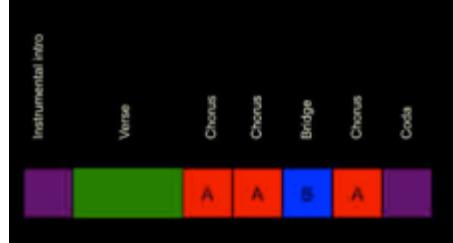


Forme AABA  
(ou CB)

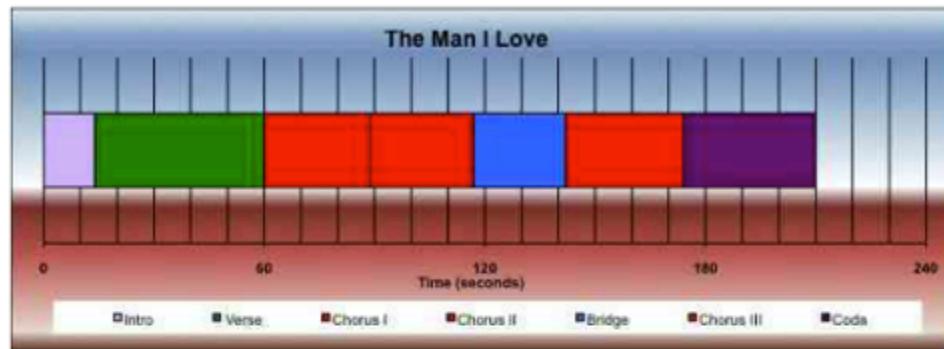


# Carattere ‘sottrattivo’ della forma Chorus-Bridge

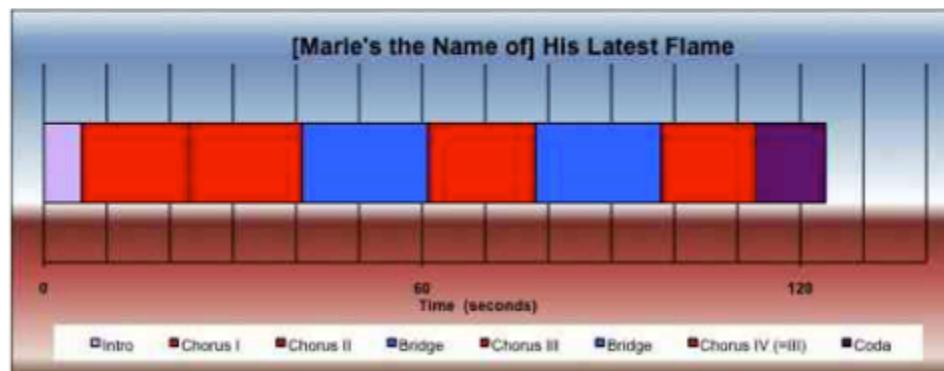
- Franco Fabbri, *Il suono in cui viviamo. Inventare, produrre e diffondere musica*, Feltrinelli, 1996
- Franco Fabbri, « Verse, Chorus (Refrain), Bridge: Analysing Formal Structures of the Beatles' Songs », *Popular Music Worlds, Popular Music Histories*, Proceedings (Geoff Stahl, Alex Gyde eds), 2012, IASPM: 92-109.



- Quasi tutte le canzoni dei Beatles (*Yesterday, ...*)
- *Unchain My Heart* (Joe Coker)
- *Every Breathg You Take* (The Police)
- *Sapore di sale* (Gino Paoli)
- ...



Ira Gershwin – George Gershwin, "The Man I Love", as recorded by Marion Harris (Victor 21116-B, 1927)



Doc Pomus – Mort Shuman, "[Marie's the Name of] His Latest Flame", as recorded by Elvis Presley (RCA 47-7908, 1961)

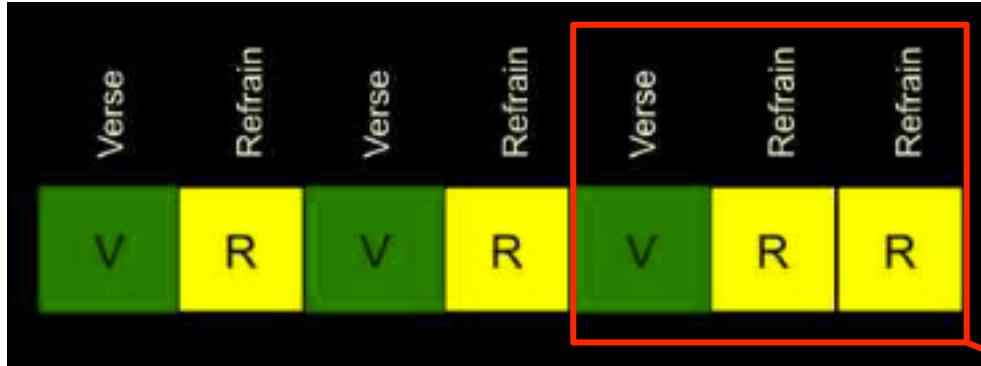
## Nota terminologica (Fabbri, 1996/2012)

- **Refrain [ritornello]:** sezione di una canzone nella quale la musica e le parole si ripetono sempre nello stesso modo in vari momenti del brano. Le parole del testo contengono il titolo delle canzoni.
- **Chorus:** sezione di una canzone nella quale la musica si ripete nello stesso modo ma le parole cambiano. Certe parti del testo, fra le quali il titolo del brano, possono, ciononostante, ripetersi identicamente.
- **Verse [strofa]:** sezione di una canzone nella quale la musica si ripete ma le parole cambiano senza alcuna eccezione.
- **Bridge [ponte]:** sezione di una canzone che si posiziona dopo il chorus e dal quale differisce per il carattere armonico e melodico.

# La narratività della forma Verse-Refrain



- Franco Fabbri, *Il suono in cui viviamo. Inventare, produrre e diffondere musica*, Feltrinelli, 1996
- Franco Fabbri, « Verse, Chorus (Refrain), Bridge: Analysing Formal Structures of the Beatles' Songs », *Popular Music Worlds, Popular Music Histories*, Proceedings (Geoff Stahl, Alex Gyde eds), 2012, IASPM: 92-109.



- *Let it Be* (The Beatles)
- *Like A Rolling Stone* (Bob Dylan)
- *The Last Time* (Mick Jagger)
- *Via Via* (Paolo Conte)
- Le canzoni d'autore in generale (Tenco, Modugno, De André, Lauzi, Endrigo, Brassens, Brel, Barbara, Ferré, Reggiani, ... )

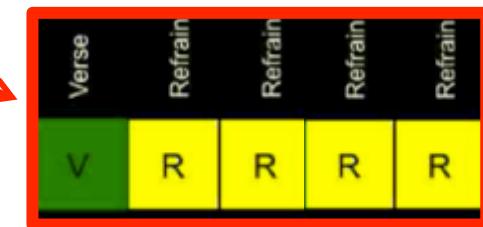
## Caratteristiche della forma V-R :

- Carattere narrativo e ‘additivo’
- Direzionalità (teleologia)
- Posizione finale del climax (o *hook*)

vs

## Caratteristiche della forma C-B

- Carattere esclamativo e sottrattivo
- Assenza di direzionalità
- Lo *hook* è all'inizio del brano



« Se telefonando » (1966, musica e  
arrangiamenti di E. Morricone)

# Strutture formali e processi musicali algoritmici



Markov constraints applied  
to text generation



**Today** (lyrics generated using the constrained Markov approach)

Innocence of a story I could leave *today*  
When I go down in my hands and pray  
She knocked upon it anyway  
*Paradise* in the dark side of love it is a sin  
And I am getting weary looking in  
Their promises of paradise  
Now I want to know you would be spared this day  
Wind is blowing in the light in your alleyway  
*Innocence* in the wind it whispers to the day  
Out the *door* but I could leave today  
She knocked upon it anyway



C<sub>7</sub> / Fmin | Bb<sub>7</sub> / Ebmin | Ab<sub>7</sub> / Db<sub>7</sub> | Dbmin / Cmin  
F<sub>7</sub> / Bbmin | Eb<sub>7</sub> / Abmin | Gmin / Gbmin | B<sub>7</sub> / Gb<sub>7</sub>  
Bmin / E<sub>7</sub> | Amin / D<sub>7</sub> | Emin / A<sub>7</sub> | Dmin / G<sub>7</sub>



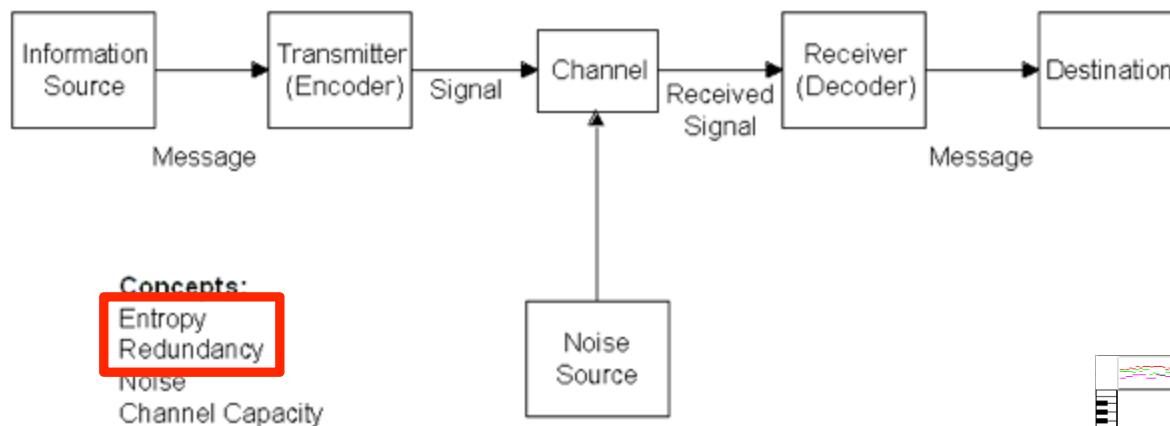
- G. Barbieri, F. Pachet, P. Roy, M. Degli Esposti, « Markov Constraints for Generating Lyrics with Style », ECAI, vol. 242 of Frontiers in Artificial Intelligence and Applications, p. 115-120. IOS Press, 2012

[http://francoispachet.fr/markovconstraints/markov\\_applet\\_style/index.html](http://francoispachet.fr/markovconstraints/markov_applet_style/index.html)  
[http://www.francoispachet.fr/markovconstraints/markov\\_constraintspaper.html](http://www.francoispachet.fr/markovconstraints/markov_constraintspaper.html)

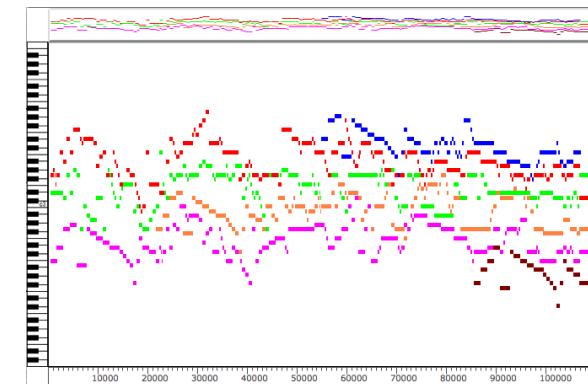
# La teoria dell'informazione e l'imitazione stilistica

« This [= **Information Theory**] is a theory so general that one does not need to say what kinds of symbols are being considered – whether written letters or words, or musical notes, or spoken words, or symphonic music, or pictures. The theory is deep enough so that the relationships it reveals indiscriminately apply to all these and to other forms of communication » (C. Shannon and W. Weaver, 1949)

## The Shannon-Weaver Mathematical Model, 1949



- Originale
- Var. 1
- Var. 2



Variazioni stilistiche su un'improvvisazione di Chick Corea e sul Ricercare a 6 voci di Bach. Progetto OMAX:  
<http://repmus.ircam.fr/omax/home>

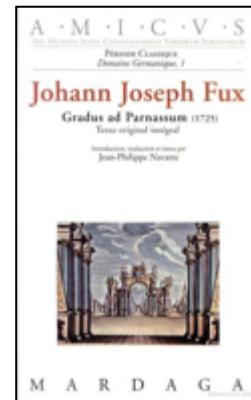
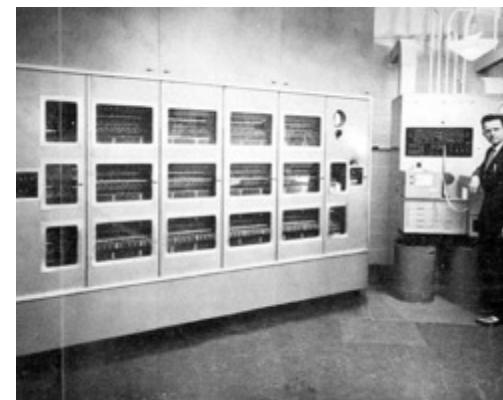
- C. Shannon and W. Weaver, *The Mathematical Theory of Communication*, 1949
- R.C. Pinkerton, « Information theory and melody », *Scientific Am.*, 194, 1956
- A. Moles, *Théorie de l'information et perception esthétique*, 1958
- ...
- G. Assayag, S. Dubnov, « Universal Prediction Applied to Music Generation with Style », *Diderot Math. Forum*, Springer, 2002

# Imitazione stilistica e composizione algoritmica

ILLIAC SUITE FOR STRING QUARTET  
I. EXPERIMENT NO. I

L.A. HILLER, JR. AND L.M. ISAACSON

PRESTO



Lejaren Hiller e Leonard M. Isaacson, *Illiac Suite* (1957).  
Estratto della musica ottenuta nell'esperimento n°1



Lejaren Hiller e Leonard M. Isaacson, *Illiac Suite* (1957).  
Estratto delle sezioni conclusive dell'esperimento n°2,  
contenenti « the best counterpoint »



# L'arte di comporre minuetti lanciando i dadi

## Minuet

A musical score for a Minuet, composed using a random number generator. The score consists of five staves of music, each with a treble clef and a key signature of one sharp. The measures are numbered as follows:

- Measure 1: M8
- Measure 2: M84
- Measure 3: MI14
- Measure 4: M63
- Measure 5: M28
- Measure 6: M87
- Measure 7: MI106
- Measure 8: M100
- Measure 9: M85
- Measure 10: MI139
- Measure 11: MI150
- Measure 12: M29
- Measure 13: -3-
- Measure 14: MI137
- Measure 15: MI115
- Measure 16: MI44
- Measure 17: M93

Measure numbers 3, 84, 114, 53, 28, 37, 106, 100, 35, 139, 150, 29, 137, 115, 44, and 93 are highlighted in red. Measure numbers 18, 3, 16, 68, 4, 27, 52, 80, 11, 20, 93, 48, 12, 23, 78, and 21 are also listed.

Here is your piece...

Your piece is composed of the following measures:

MINUET:

3 84 114 53 28 37 106 100 35 139 150 29 137 115 44 93

TRIO:

18 3 16 68 4 27 52 80 11 20 93 48 12 23 78 21



# L'arte di comporre minuetti lanciando i dadi

## Minuet

Musical score for a Minuet in G major, 3/4 time. The score consists of four staves of music with measure numbers M1 through M15. The music features eighth and sixteenth note patterns, with some measures containing triplets indicated by a '3' above the staff.

Here is your piece...

Your piece is composed of the following measures:

MINUET:

3 84 114 53 28 37 106 100 35 139 150 29 137 115 44 93

TRIO:

18 3 16 68 4 27 52 80 11 20 93 48 12 23 78 21

Musical score for a Minuet in G major, 3/4 time. The score consists of four staves of music with measure numbers M56 through M172. The music features eighth and sixteenth note patterns, with some measures containing triplets indicated by a '3' above the staff.

Here is your piece...

Your piece is composed of the following measures:

MINUET:

96 95 171 156 80 37 110 94 25 20 108 132 112 38 173 172

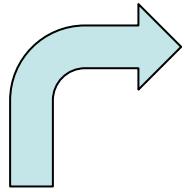
TRIO:

72 82 16 53 65 27 26 61 9 92 24 84 30 23 78 10

# L'arte di comporre minuetti lanciando i dadi

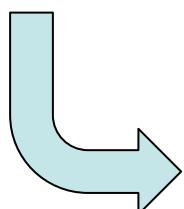
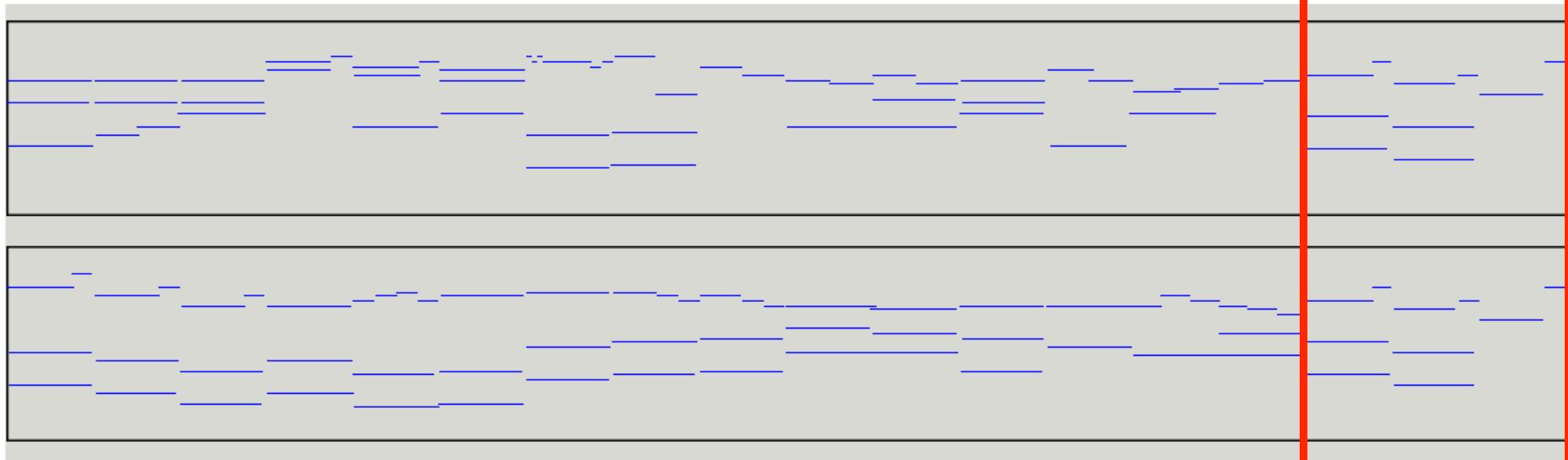


→ OpenMusic



M6 M14 M16

M69 M77 M86 M100



M86 M87 M71 M86

M89 M97 M10 M94

# Palindromi mozartiani: la fine è il mio inizio (capovolto)

Drei Scherzduette für zwei Gitarren

W.A. Mozart (1756-1791)  
Herausgegeben von Siegfried Behr

Gitarre 1

I Allegro ( $\text{♩} = 152$ )

Gitarre 2

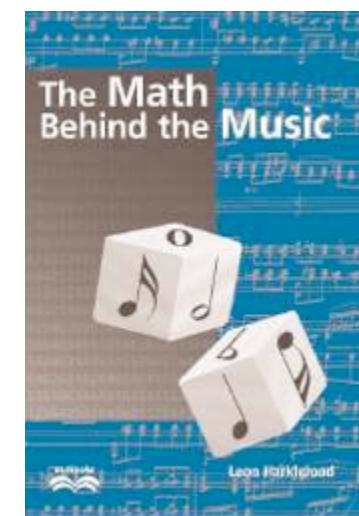
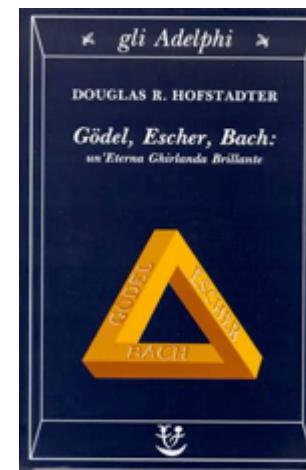
I Allegro ( $\text{♩} = 152$ )

Drei Scherzduette für zwei Gitarren

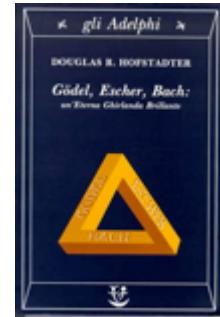
27

A red arrow points to the beginning of the first page of the score.

A red arrow points to the end of the second page of the score.



# Palindromi canonici bachiani: l'arte dei canoni enigmatici



## Canones diversi

super thema regium

Canon a 2

A musical score for 'Canon a 2' in E-flat major. The score consists of two staves of music. The first staff begins with a quarter note followed by eighth notes. The second staff begins with a half note followed by eighth notes. The music continues with various patterns of eighth and sixteenth notes.

A continuation of the musical score for 'Canon a 2'. It shows two staves of music. The first staff starts with a half note followed by eighth notes. The second staff starts with a quarter note followed by eighth notes. The music continues with various patterns of eighth and sixteenth notes.

## Canones diversi

super thema regium

Canon a 2

A continuation of the musical score for 'Canon a 2'. It shows two staves of music. The first staff starts with a half note followed by eighth notes. The second staff starts with a quarter note followed by eighth notes. The music continues with various patterns of eighth and sixteenth notes.

A continuation of the musical score for 'Canon a 2'. It shows two staves of music. The first staff starts with a half note followed by eighth notes. The second staff starts with a quarter note followed by eighth notes. The music continues with various patterns of eighth and sixteenth notes.

A continuation of the musical score for 'Canon a 2'. It shows two staves of music. The first staff starts with a half note followed by eighth notes. The second staff starts with a quarter note followed by eighth notes. The music continues with various patterns of eighth and sixteenth notes.

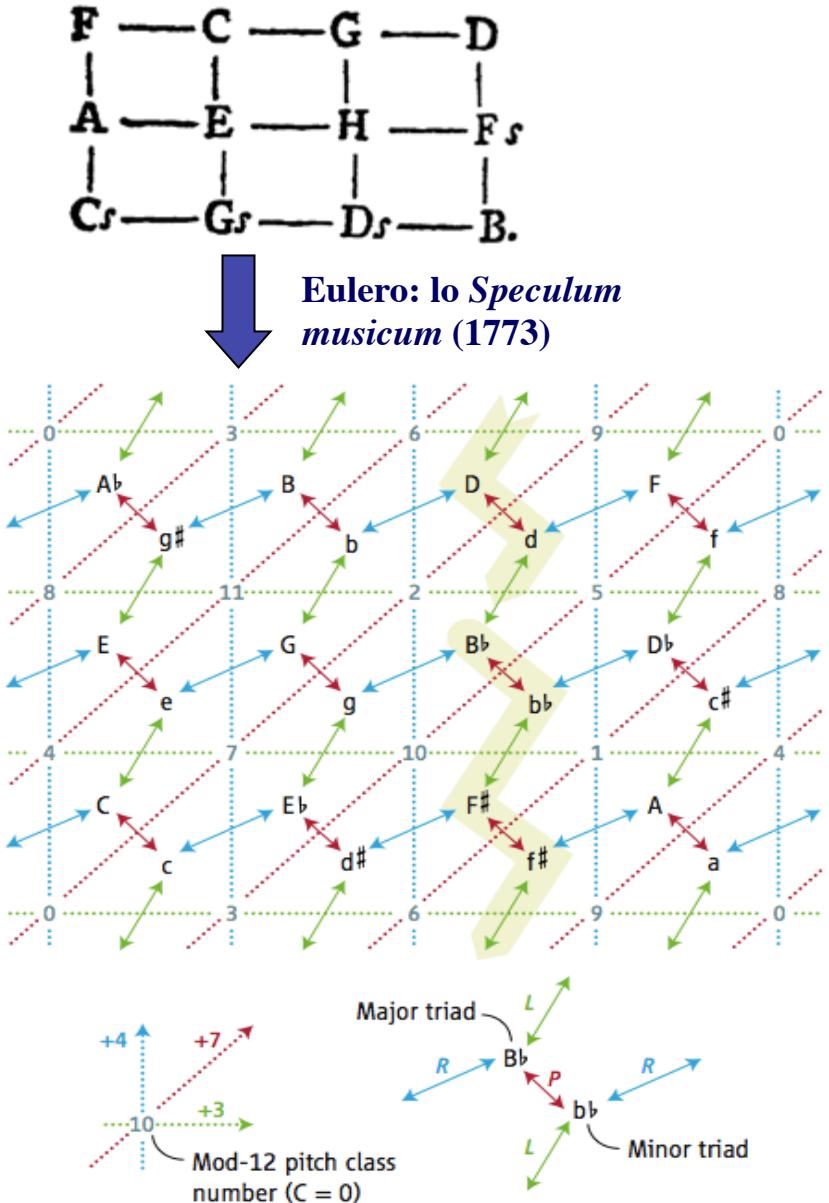
# Il nastro di Möbius: una rappresentazione geometrico-musicale

---



Jos Leys <http://www.josleys.com/Canon/Canon.html>

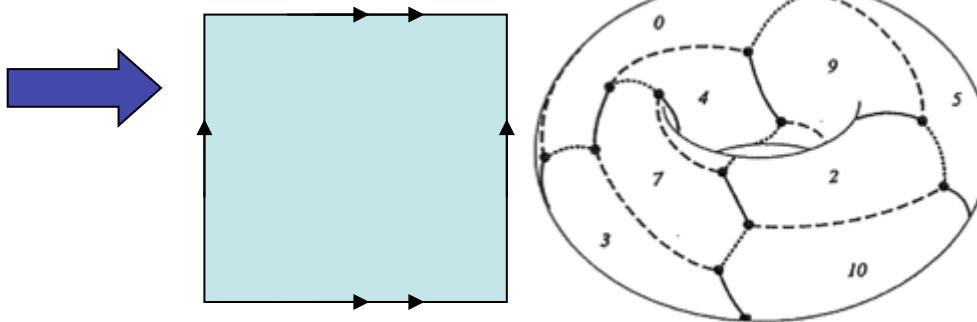
## Nastri, orologi e...ciambelle!



J. Hook, « Exploring Musical Space », *Science*, 2006

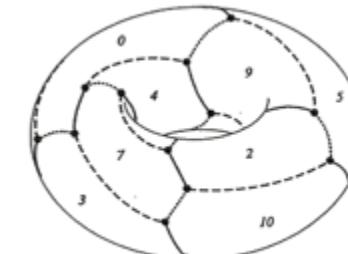
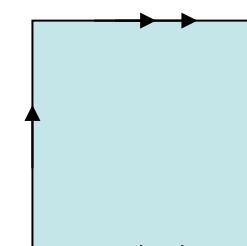
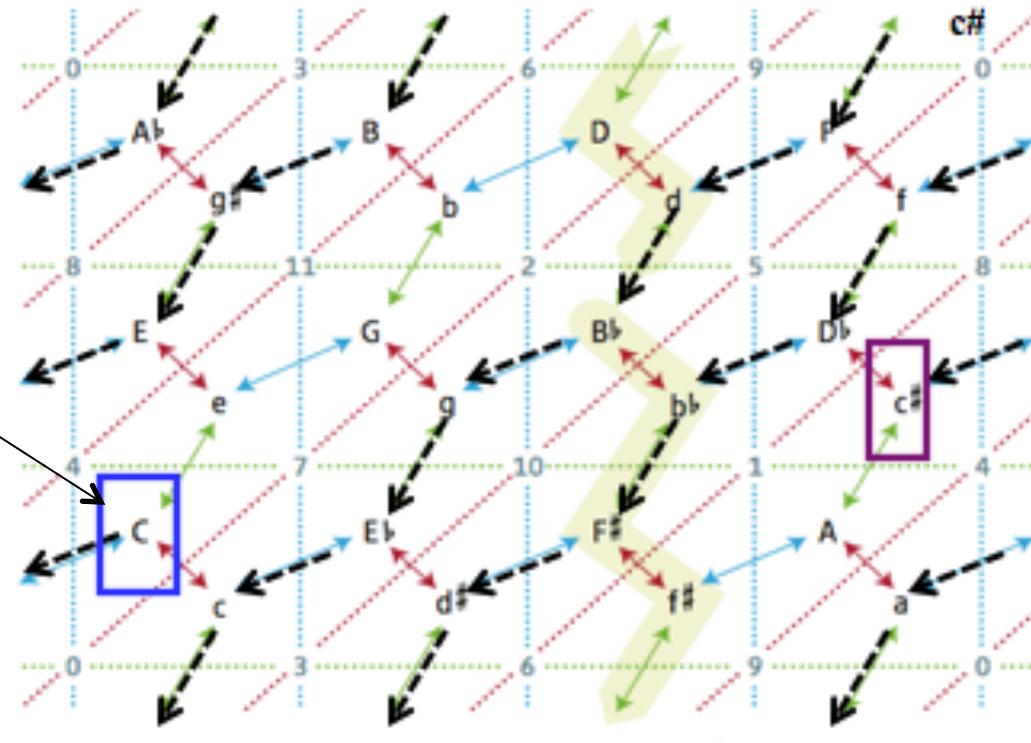
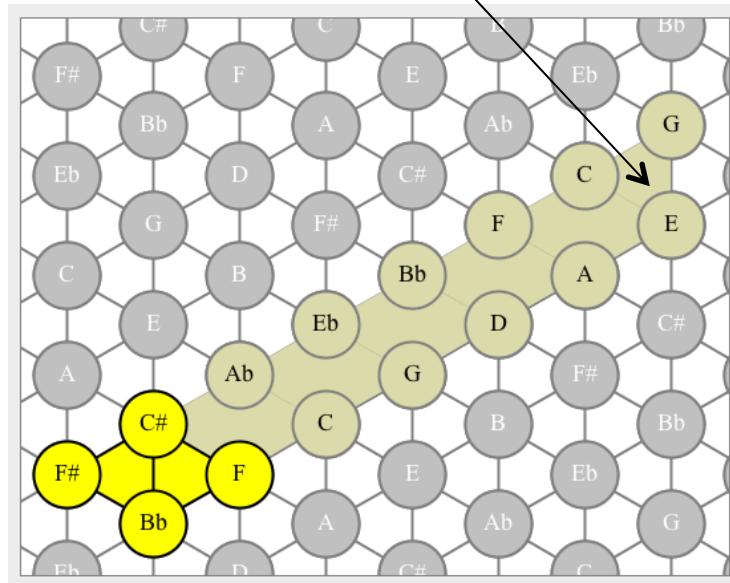
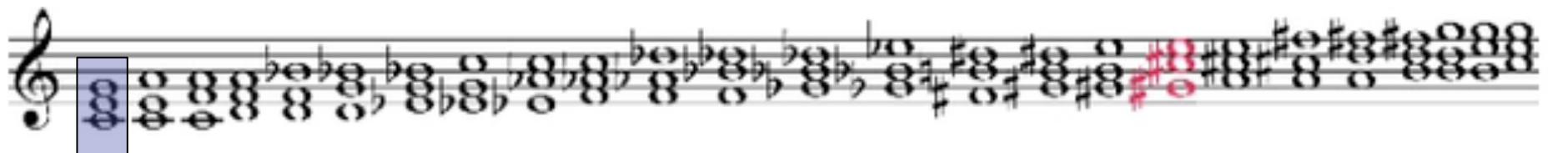


Gilles Baroin, © 2011

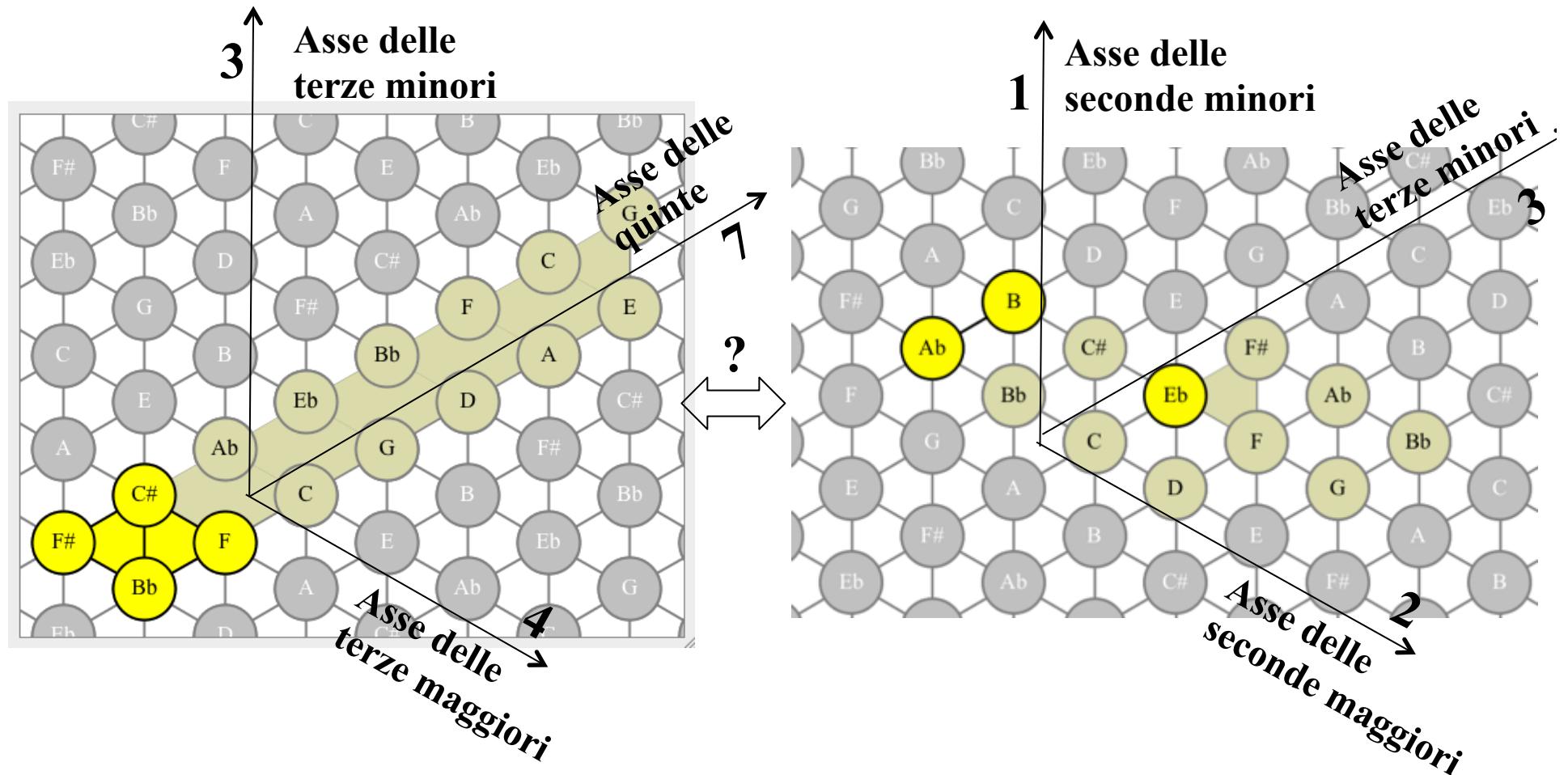
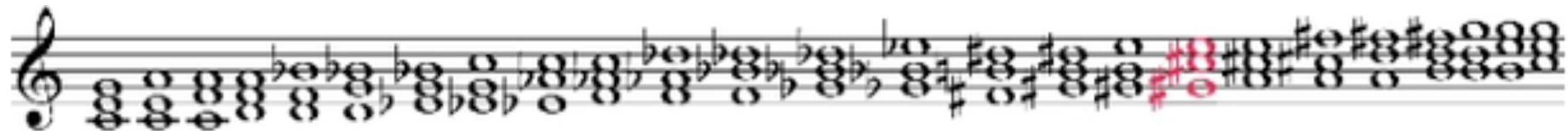


Douthett & Steinbach 1998

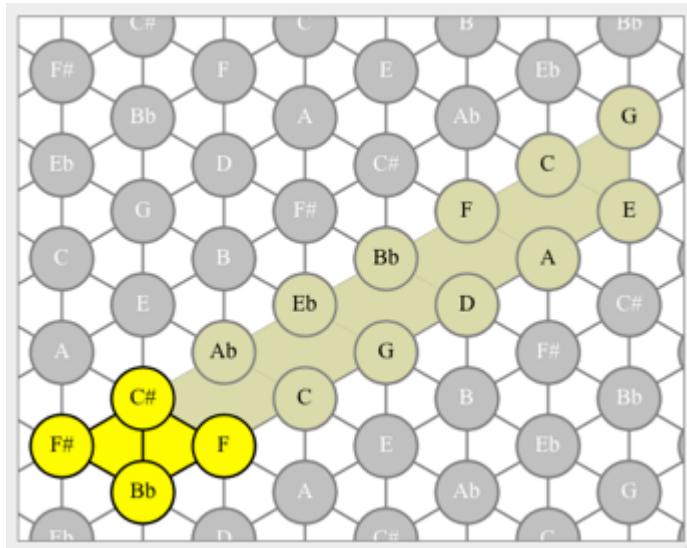
# Progressioni armoniche come traiettorie nel Tonnetz



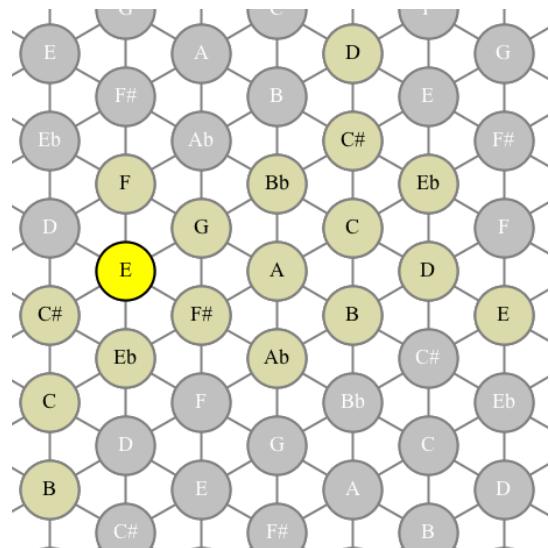
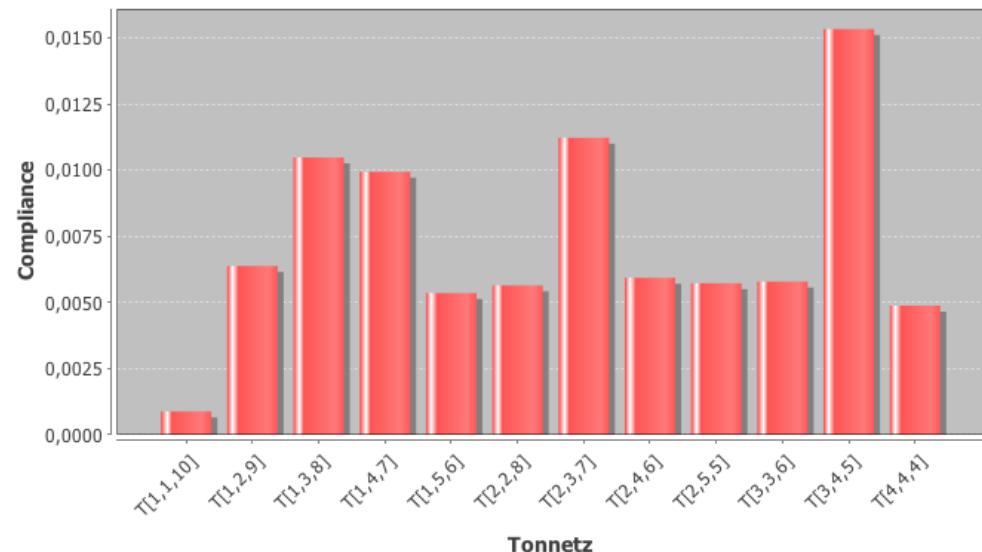
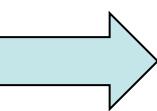
# Alla ricerca dello spazio (geometrico-musicale) perduto



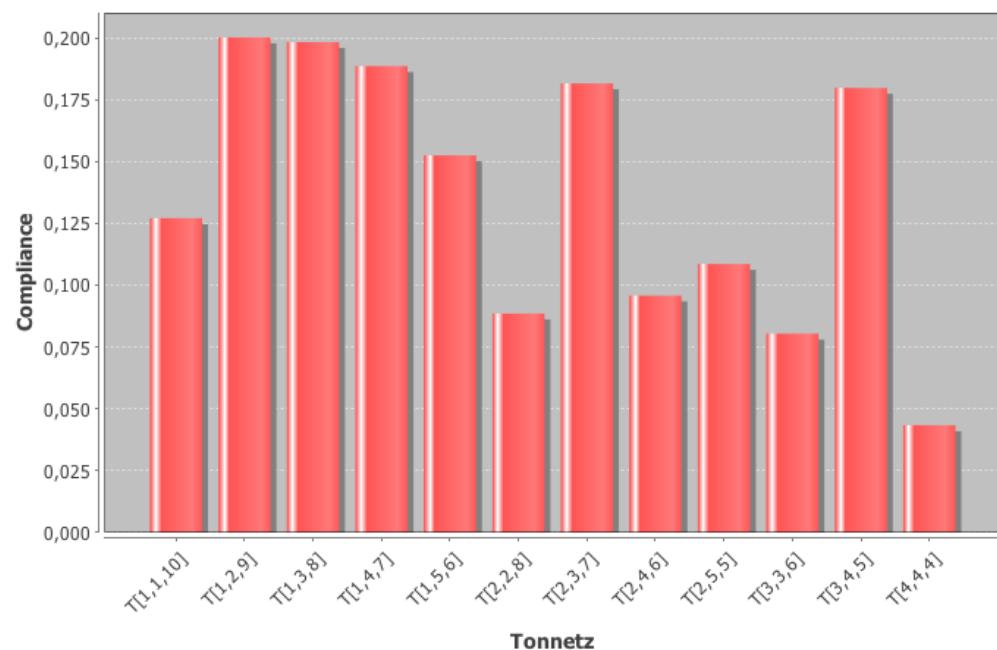
# Distribuzione statistica dei vari *Tonnetze*



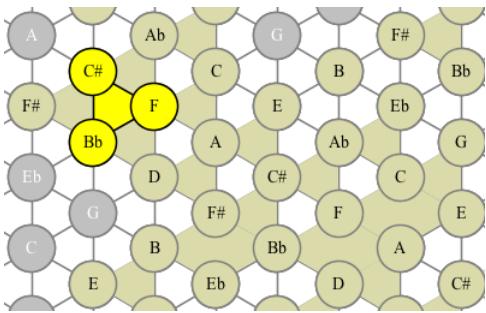
Beethoven, 2° movimento della Nona Sinfonia



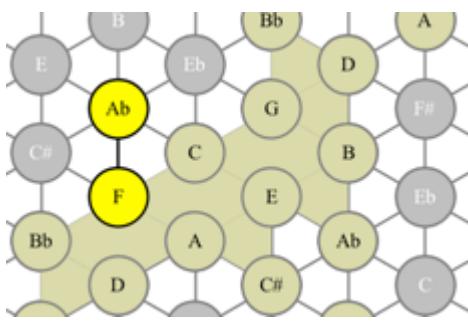
Babbitt, Semi-Simple Variation



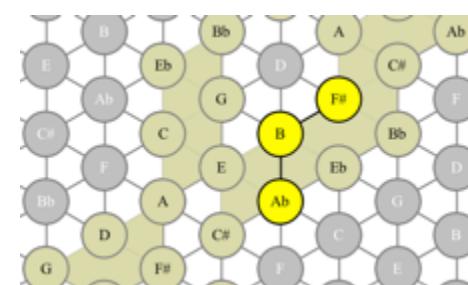
# Spazi geometrici per la musica jazz



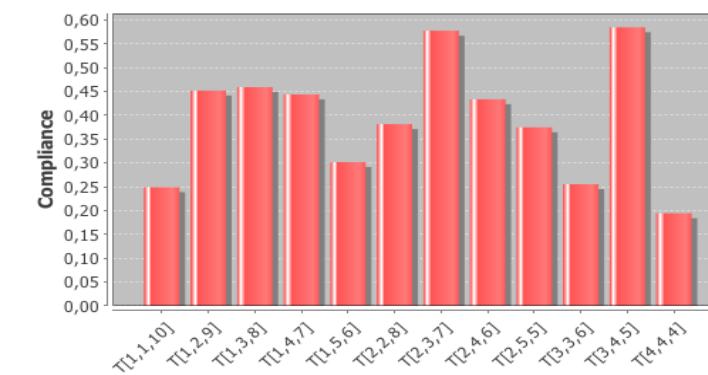
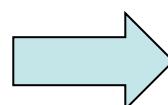
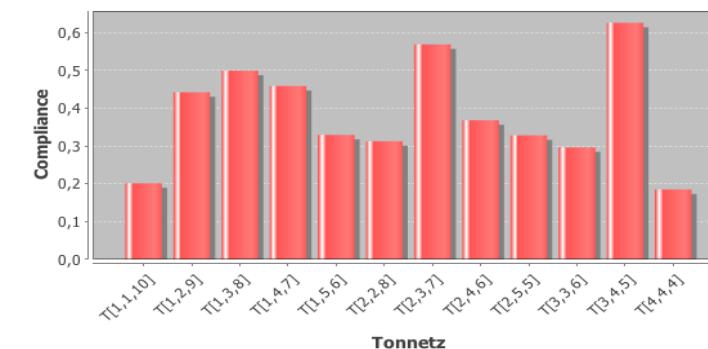
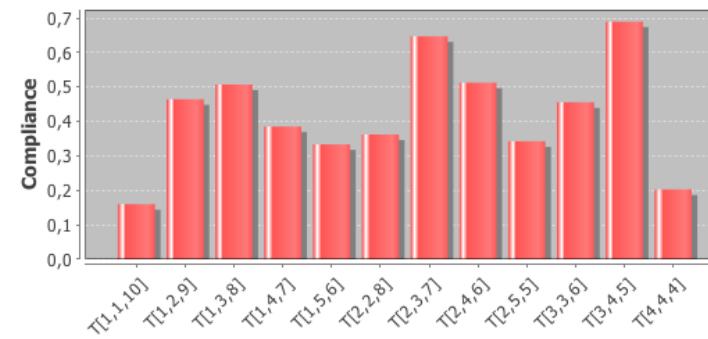
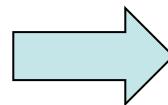
Thelonious Monk,  
Brilliant Corners



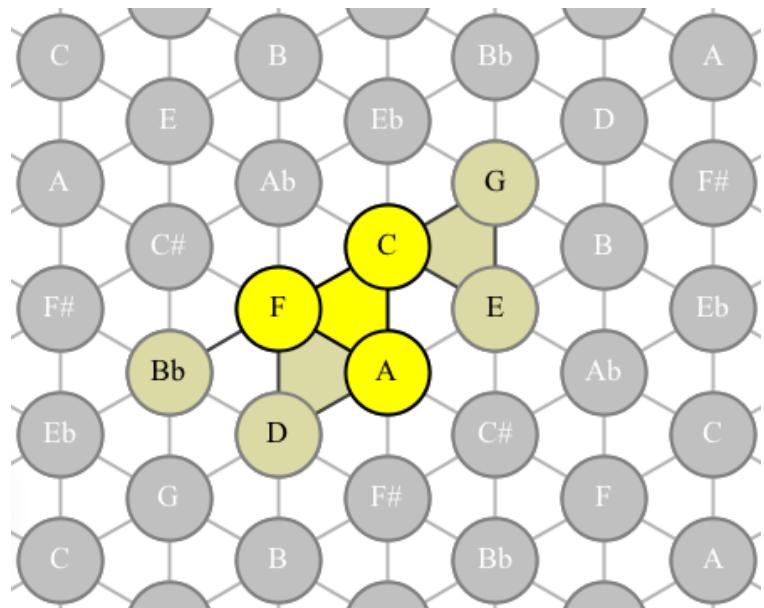
Chick Corea,  
Eternal Child



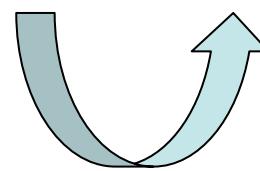
Bill Evans,  
Turn Out the Stars



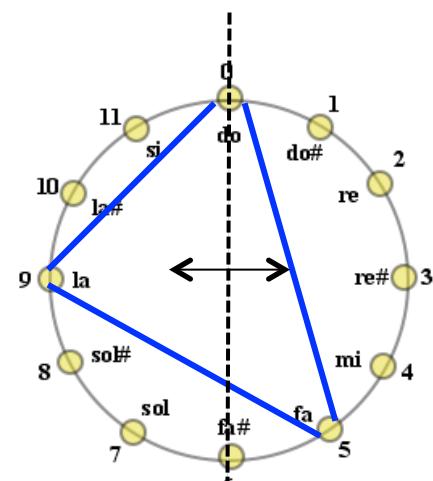
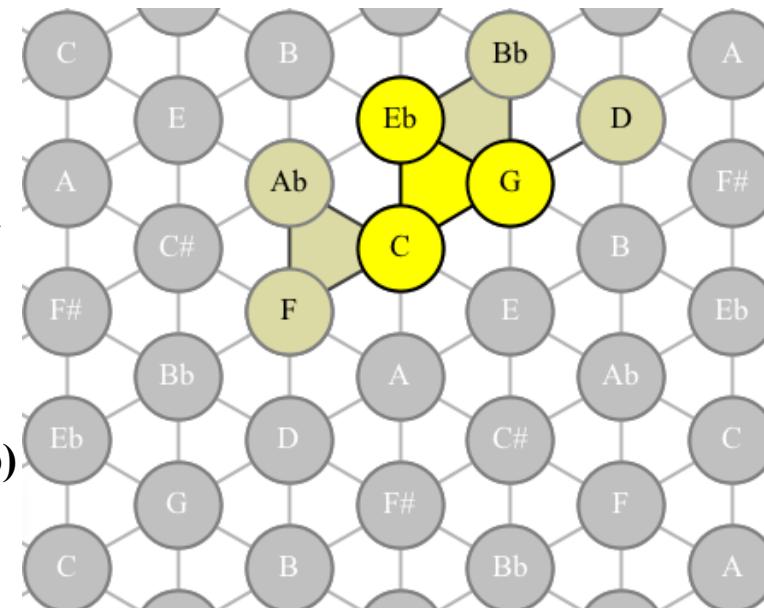
# Trasformazioni spaziali: come ‘minorizzare’ una canzone



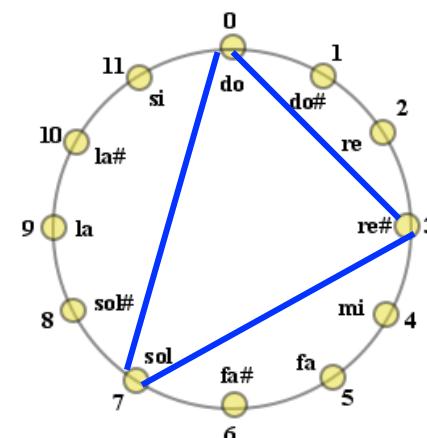
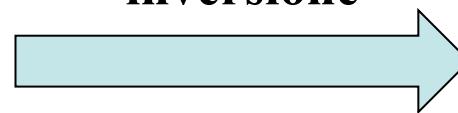
Beatles, Hey Jude



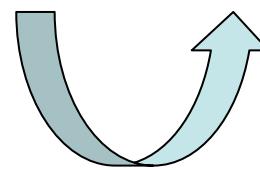
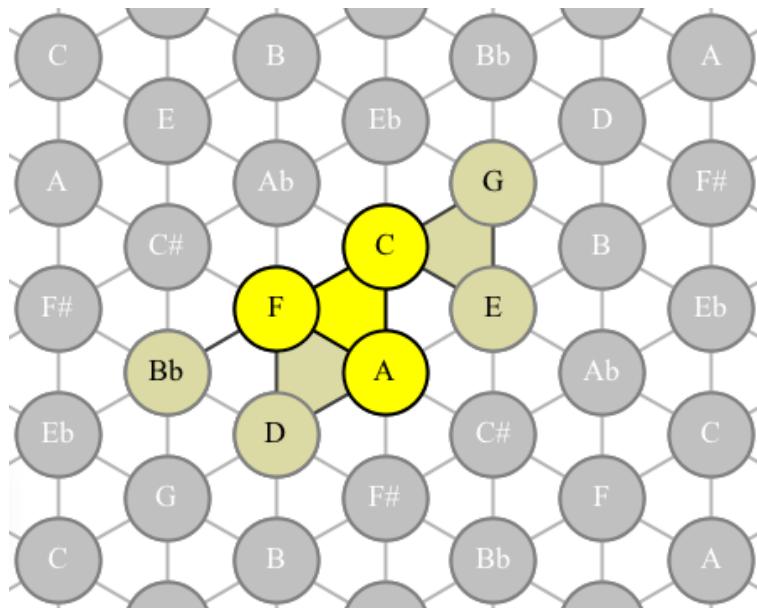
**Rotazione  
(attorno al do)**



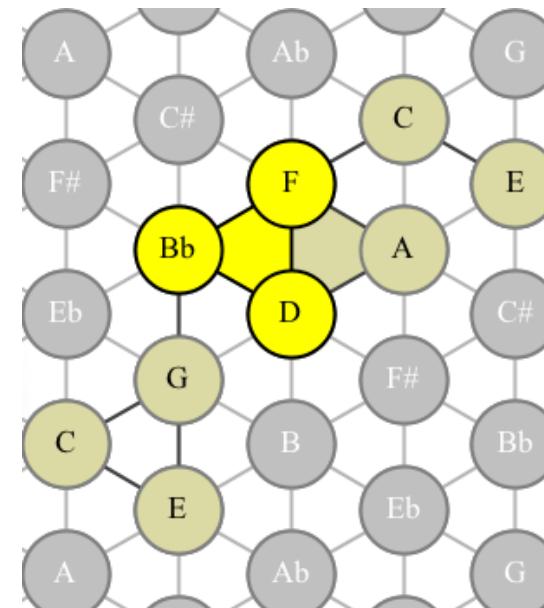
**inversione**



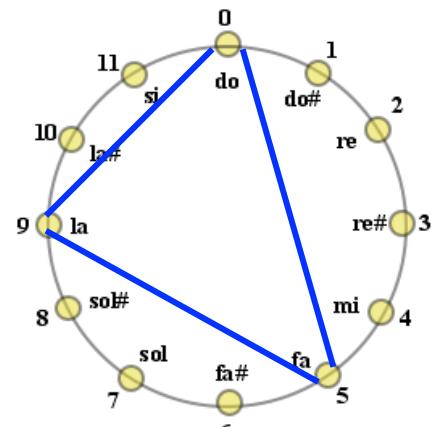
# Ad ogni rotazione una trasformazione musicale



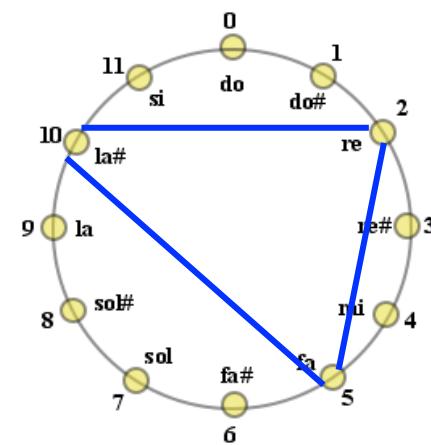
**Rotazione  
(attorno al fa)**



Beatles, Hey Jude



**rotazione**



# Spazi e rappresentazioni geometriche per la musica pop

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

Synthesizer

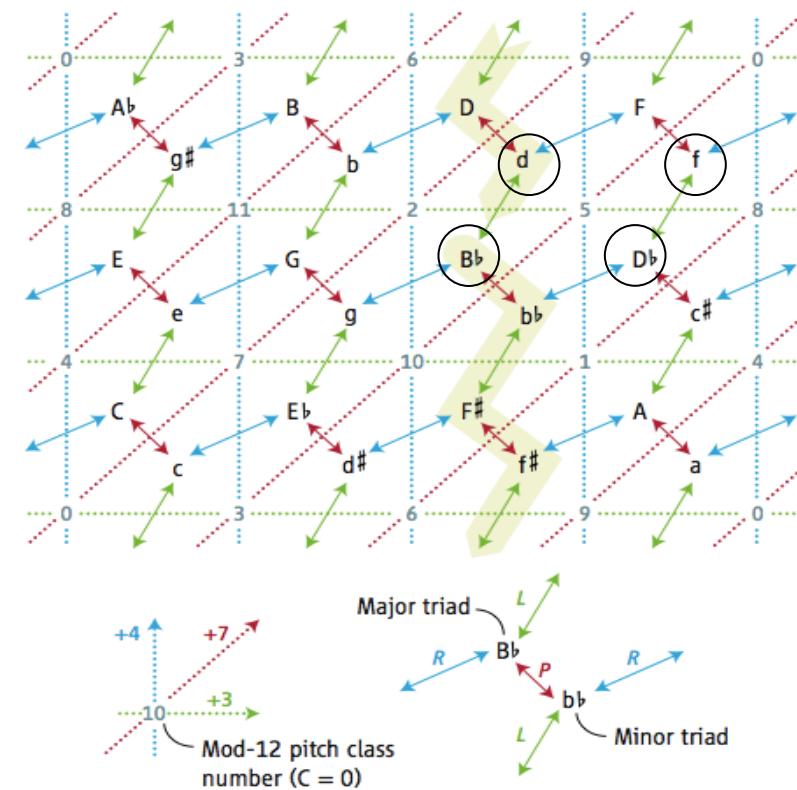
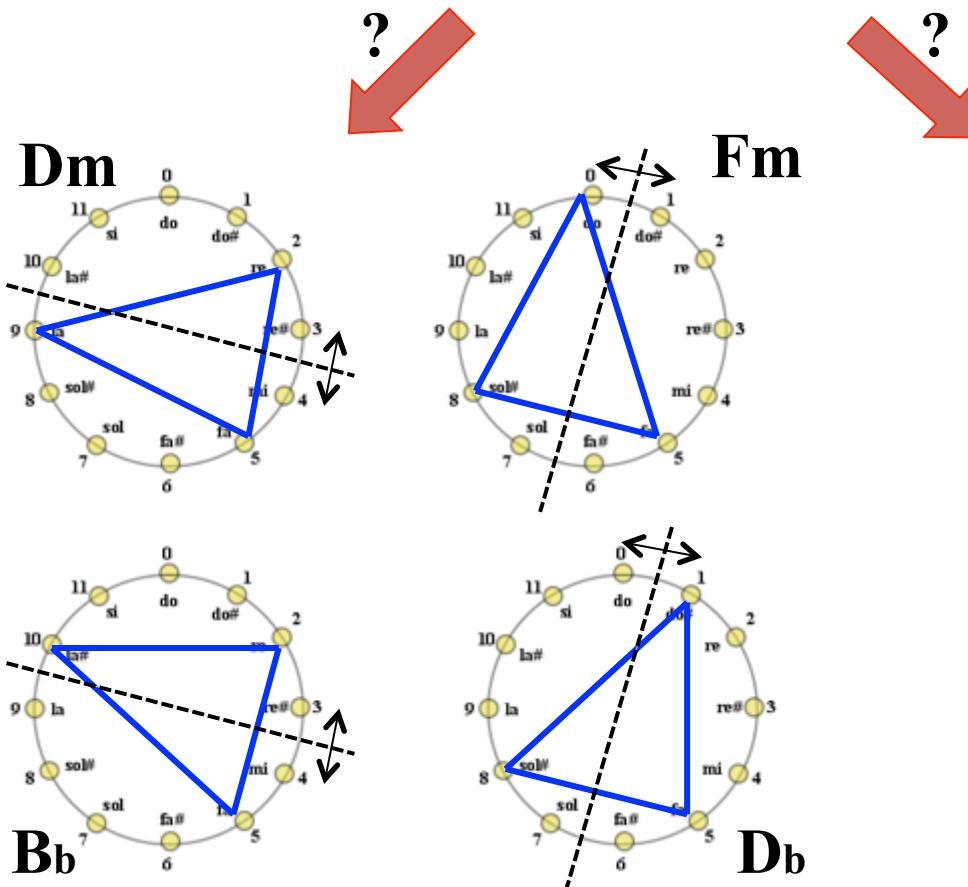
D-      F-      D $\flat$ +      B $\flat$ +



Depeche Mode, *Shake the disease* – 1985

[http://www.youtube.com/watch?v=Hx\\_XPN\\_tDys](http://www.youtube.com/watch?v=Hx_XPN_tDys)

(min. 2'17")



# Traiettoria della progressione armonica nel Tonnetz

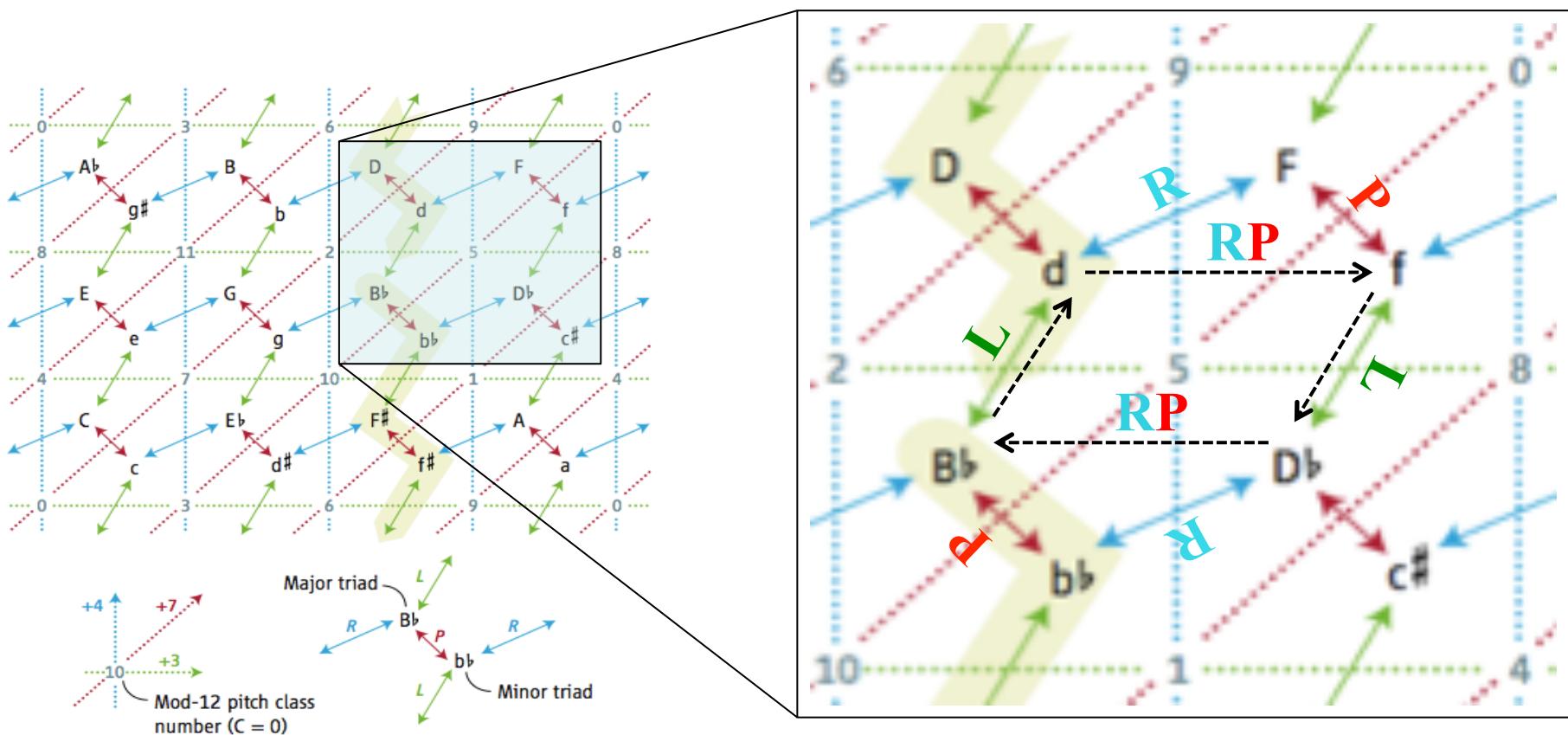
- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

D-  $\xleftarrow{\text{RP}}$  F-  $\xleftarrow{\text{L}}$  D $\flat$ +  $\xleftarrow{\text{RP}}$  B $\flat$ +  $\xleftarrow{\text{L}}$

*Shake the disease - 1985  
(Depeche Mode)*

Synthesizer

**Sequenza RPLRPL**



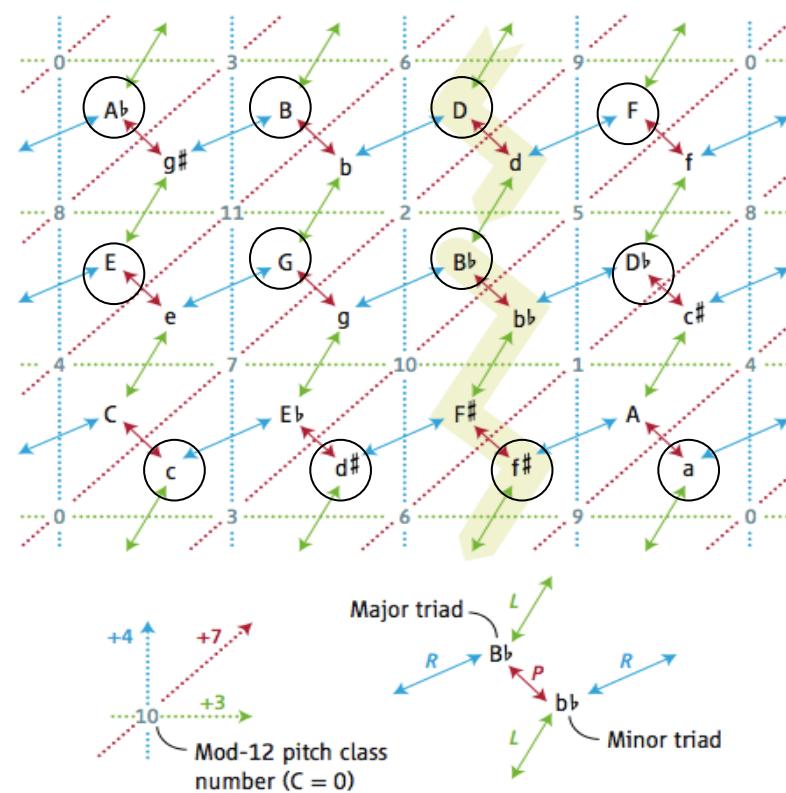
# Progressione nella musica di Zappa: differenza o ripetizione?

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", *Music Theory Spectrum* 26(2), p. 177-199, 2004

« Easy Meat » - 1981 (Frank Zappa)



<http://www.youtube.com/watch?v=-MyVgK3osVk>  
(min. 2'29")



# Progressione nella musica di Zappa: sequenza generatrice

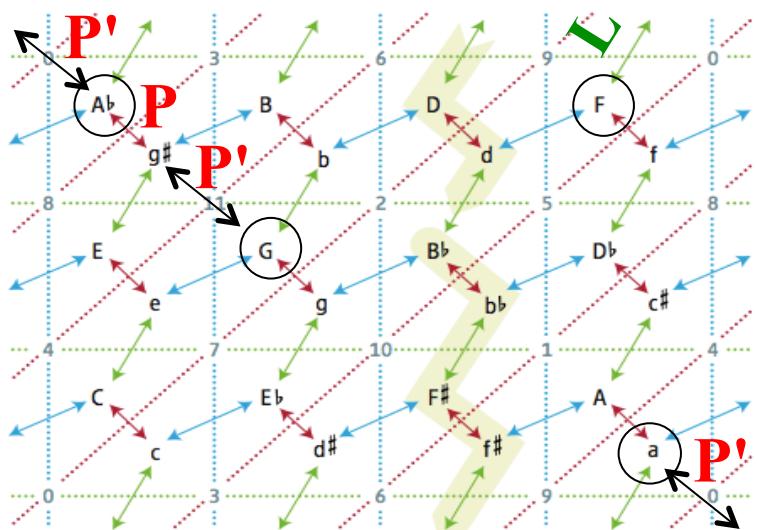
- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

Synthesizer

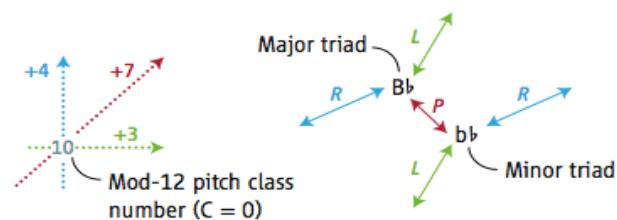
*Fine*

*D.C. al Fine*

« Easy Meat » - 1981 (Frank Zappa)



$F_+ \xrightarrow{L} A_- \xrightarrow{P'} A_\flat \xrightarrow{PP'} G_+$



# Progressione nella musica di Zappa: sequenza generatrice

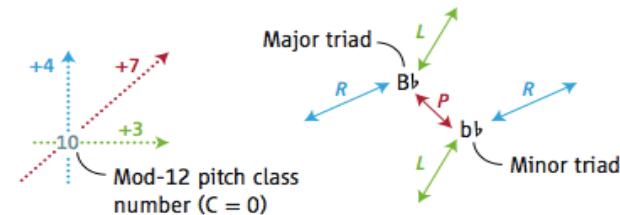
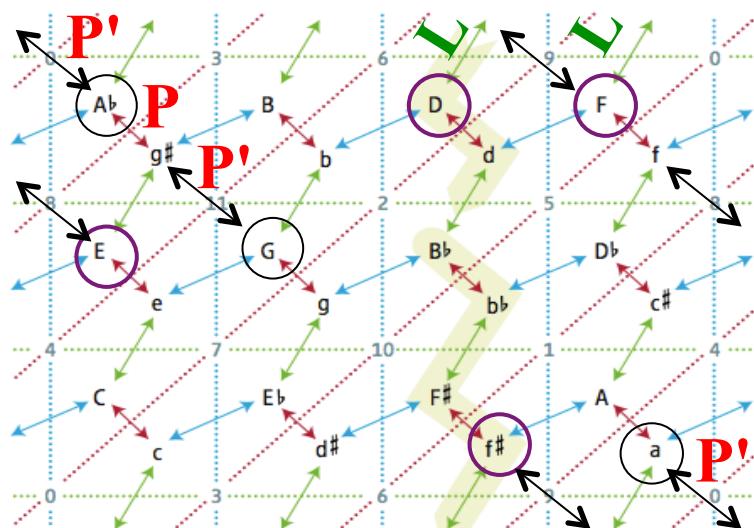
- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

The musical score shows two staves. The top staff is for a Synthesizer, and the bottom staff is for a guitar. The guitar staff includes a key signature of  $\#$  major. The score is divided into measures by vertical bar lines. Above the staff, labels indicate chords:  $G+$ ,  $A+$ ,  $F+$ ,  $A-$ ,  $A\flat+$ ,  $G+$ ,  $D+$ ,  $F\sharp-$ ,  $F+$ , and  $E+$ . Below the staff, labels indicate notes:  $5$ ,  $6$ ,  $5$ ,  $5$ ,  $6$ ,  $5$ ,  $B+$ ,  $D\sharp-$ ,  $D+$ ,  $C\sharp+$ ,  $A\flat+$ ,  $C-$ ,  $B+$ ,  $B\flat+$ ,  $E+$ ,  $B+$ ,  $F\sharp-$ ,  $C\sharp+$ ,  $F\sharp+$ ,  $A+$ ,  $E+$ , and  $E-$ . The score ends with a repeat sign and the instruction *D.C. al Fine*.

Annotations in green and red highlight specific chords and progressions:

- L**: Circles the first four chords ( $F+$ ,  $A-$ ,  $A\flat+$ ,  $G+$ ) in a green oval.
- P'**: Circles the second four chords ( $D+$ ,  $F\sharp-$ ,  $F+$ ,  $E+$ ) in a red oval.
- PP'**: Circles the last four chords ( $F+$ ,  $A-$ ,  $A\flat+$ ,  $G+$ ) in a red oval.

Below the score, the title « Easy Meat » - 1981 (Frank Zappa) is written.



$F_+ \xrightarrow{L} A_- \xrightarrow{P'} A\flat_+ \xrightarrow{PP'} G_+$

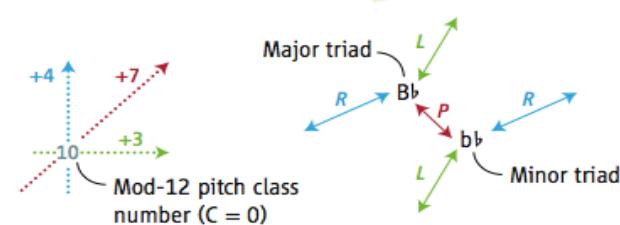
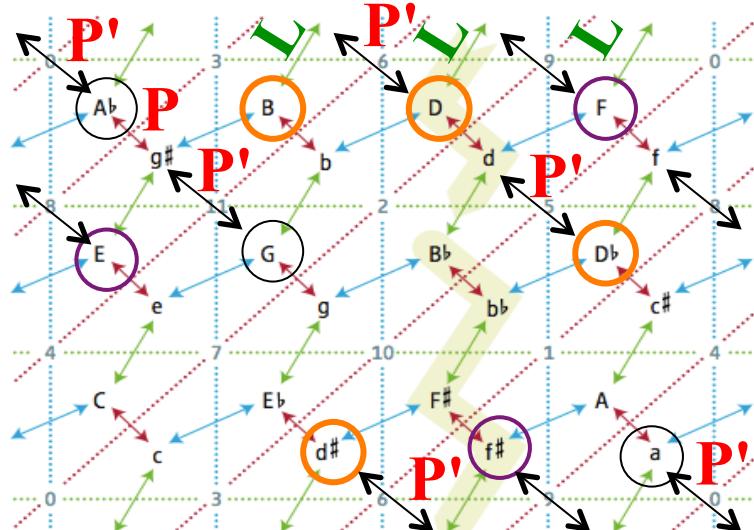
$D_+ \xrightarrow{L} F\sharp_- \xrightarrow{P'} F_+ \xrightarrow{PP'} E_+$

# Progressione nella musica di Zappa: sequenza generatrice

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

Musical score for "Easy Meat" by Frank Zappa, featuring two staves for Synthesizer. The top staff shows chords G+, A+, F+, A-, Ab+, G+, D+, F#, F+, and E+. The bottom staff shows chords B-, D-, D+, C#, A-, C-, B+, B-, E+, B+, F#-, C#, F#+, A+, E+, and E-. Orange ovals highlight segments L, P', and PP' in the first section, and purple ovals highlight segments L, P', and PP' in the second section. The score includes markings "Fine" and "D.C. al Fine".

« Easy Meat » - 1981 (Frank Zappa)



$F_+ \xrightarrow{L} A_- \xrightarrow{P'} A_\flat + \xrightarrow{PP'} G_+$

$D_+ \xrightarrow{L} F\sharp_- \xrightarrow{P'} F_+ \xrightarrow{PP'} E_+$

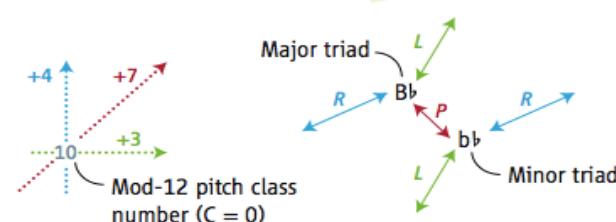
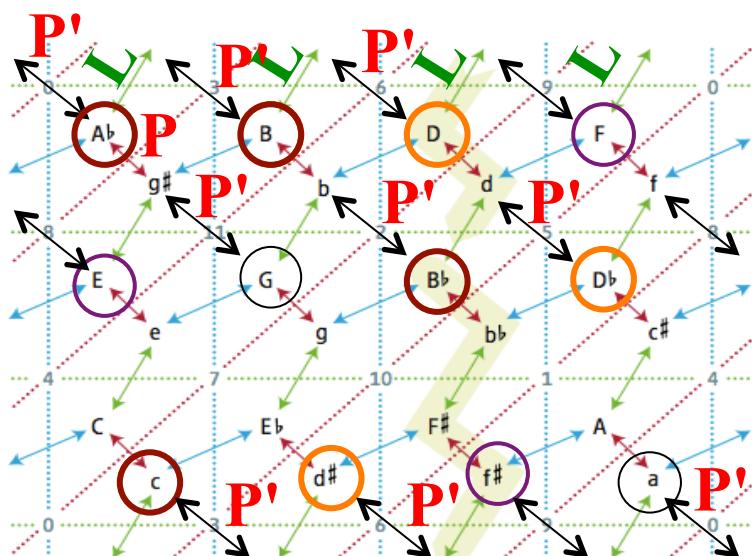
$B_+ \xrightarrow{L} D\sharp_- \xrightarrow{P'} D_+ \xrightarrow{PP'} C\sharp_+$

# Progressione nella musica di Zappa: schema formale

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

Musical score for "Easy Meat" by Frank Zappa, featuring two staves for Synthesizer. The top staff shows chords G+, A+, F+, A-, Ab+, G+, D+, F#, and E+. The bottom staff shows chords B-, D-, C+, Ab-, C-, B+, Bl-, E+, B+, F#-, C#+, F#+, A+, E+, and E-. Orange ovals highlight a sequence of chords: B-, D-, C+ (labeled L), Ab-, C-, B+ (labeled P'), and Bl- (labeled PP'). Red ovals highlight a sequence of chords: E+, B+, F#-, C#+, F#+, A+, E+ (labeled L), and E- (labeled P' PP'). The score includes markings "Fine" and "D.C. al Fine".

« Easy Meat » - 1981 (Frank Zappa)



$F_+ \xrightarrow{L} A_- \xrightarrow{P'} A_{\flat} \xrightarrow{PP'} G_+$

$D_+ \xrightarrow{L} F_{\sharp}- \xrightarrow{P'} F_+ \xrightarrow{PP'} E_+$

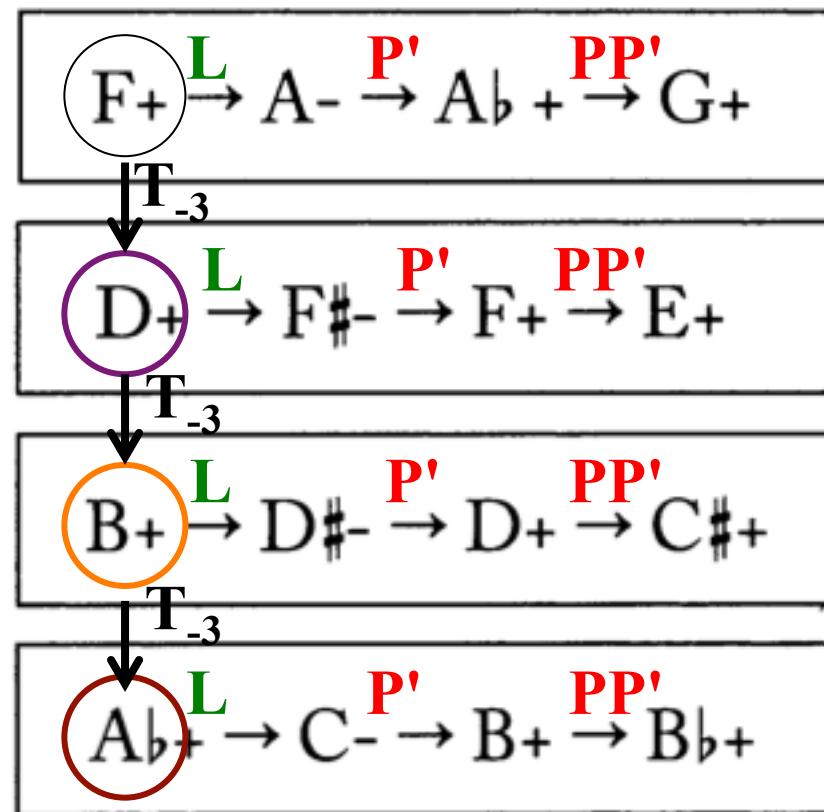
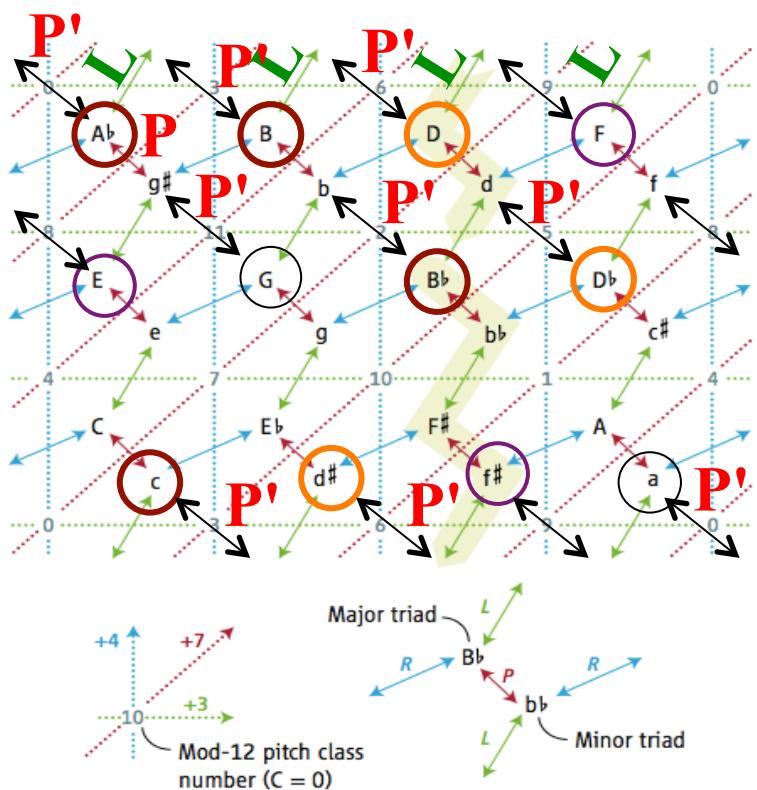
$B_+ \xrightarrow{L} D_{\sharp}- \xrightarrow{P'} D_+ \xrightarrow{PP'} C_{\sharp}+$

$A_{\flat}+ \xrightarrow{L} C- \xrightarrow{P'} B_+ \xrightarrow{PP'} B_{\flat}+$

# Progressione nella musica di Zappa: rapporti di trasposizione

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

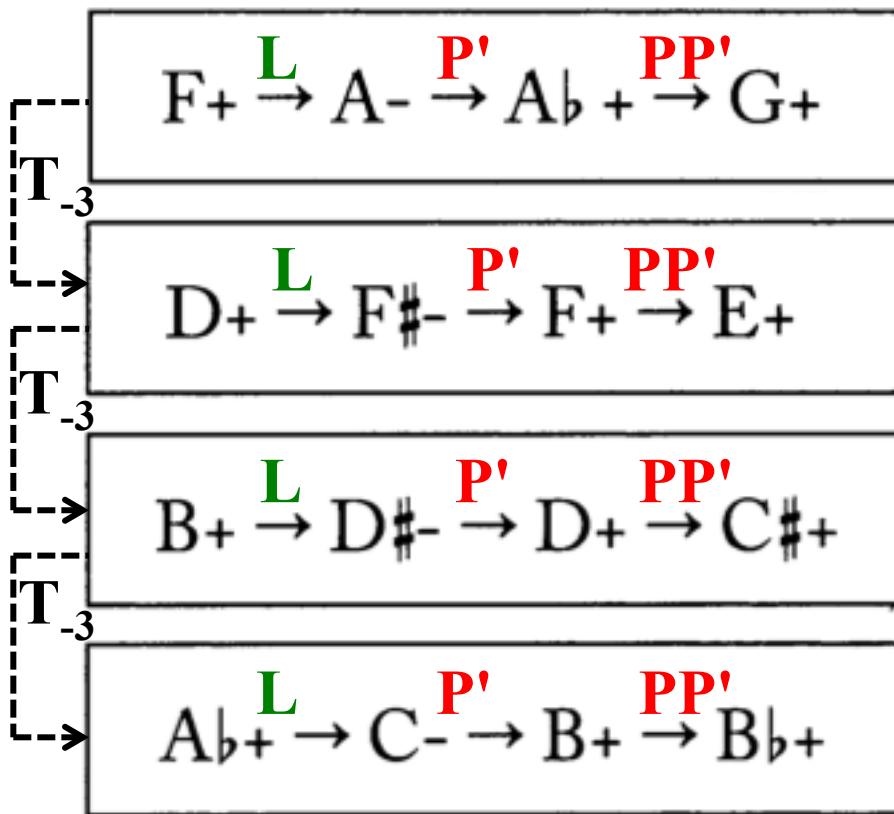
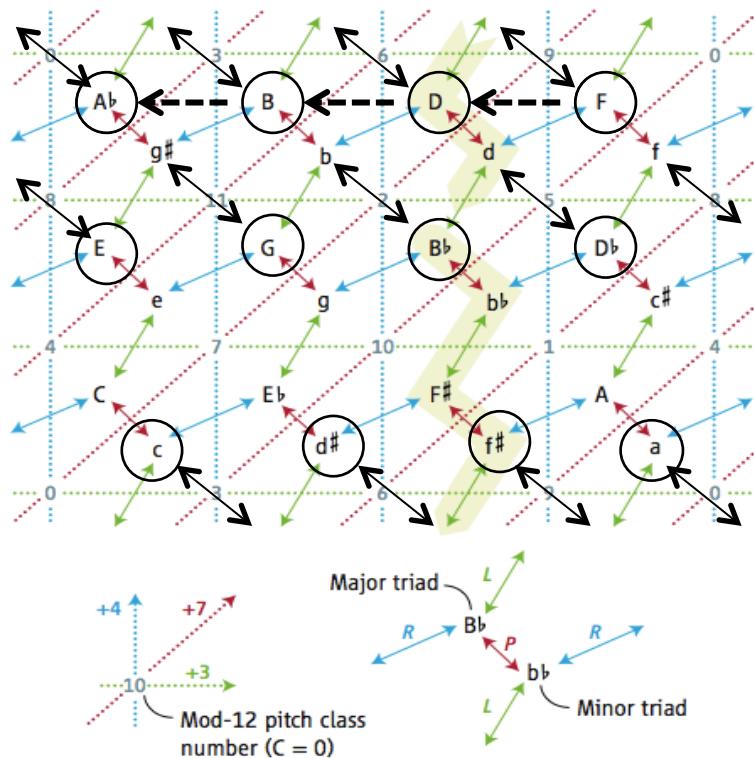
« Easy Meat » - 1981 (Frank Zappa)



# Progressione nella musica di Zappa: schema « trasformazionale »

- Guy Capuzzo, "Neo-Riemannian Theory and the Analysis of Pop-Rock Music", Music Theory Spectrum 26(2), p. 177-199, 2004

Musical score for "Easy Meat" by Frank Zappa, featuring two staves of musical notation. The top staff is labeled "Synthesizer". The bottom staff shows harmonic progressions with Roman numerals and arrows indicating transformations. Red and green circled labels "L", "P'", and "PP'" mark specific chords or transformations. The score concludes with "Fine" and "D.C. al Fine". The title "« Easy Meat » - 1981 (Frank Zappa)" is centered below the score.



## **Una trasformazione geometrica ricorrente nella musica pop e jazz**

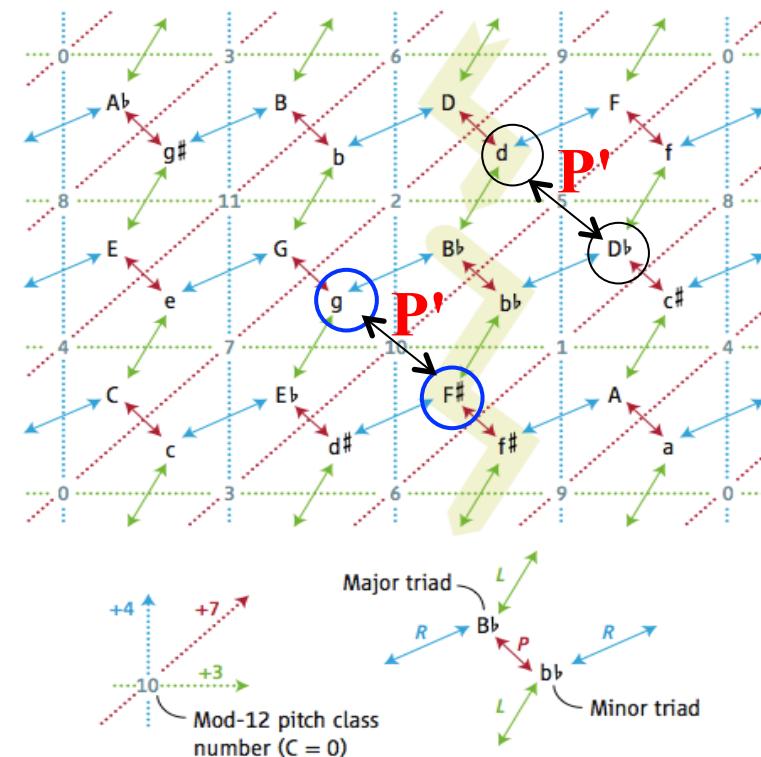
- **Sara B. P. Briginshaw**, « A Neo-Riemannian Approach to Jazz Analysis », *Nota Bene*, 5(1), 57-87

A musical score in 2/4 time with a key signature of one sharp. The melody consists of eighth and sixteenth notes. Two specific notes are circled: the first note of the second measure and the third note of the third measure. A large red letter 'P'' is placed above the staff, with a horizontal arrow pointing from the circled note in the second measure to the circled note in the third measure.

« One Note Samba » - 1961 (Antonio Carlos Jobim)

A musical score consisting of two measures. The first measure starts with a G note (circled in blue) followed by a rest, then a G sharp note (circled in blue). The second measure starts with a G note (circled in blue) followed by a rest, then a G sharp note (circled in blue). A red double-headed arrow labeled 'P'' connects the first G note of the first measure to the first G note of the second measure.

« The Girl from Ipanema » - 1965 (Antonio Carlos Jobim)



→ E l'analisi della dimensione ritmica?