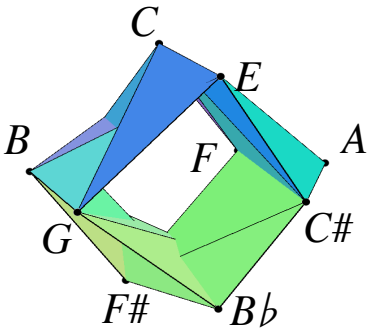
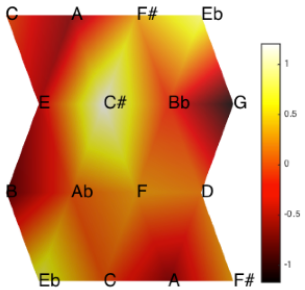


Theme : Human and Artificial Creativity (HAC)

Mathemusical Morphologies

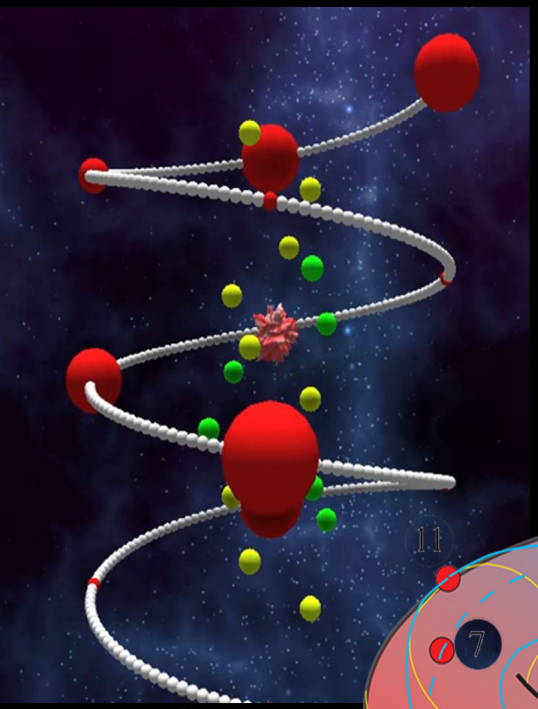


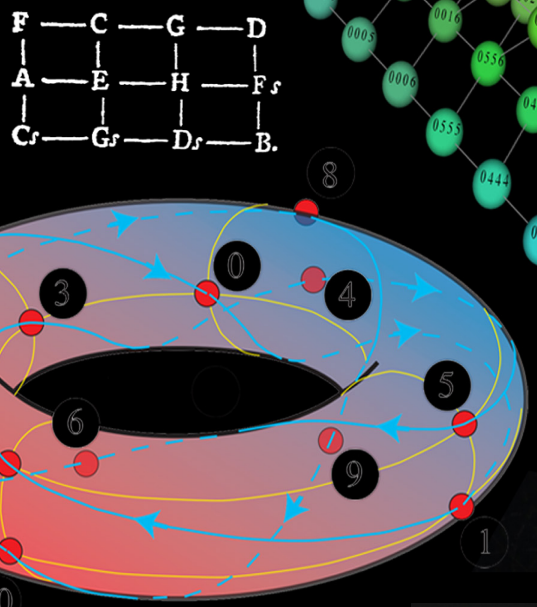
Moreno ANDREATTA[1], Jean-Louis GIAVITTO[2] *et al.*[3]

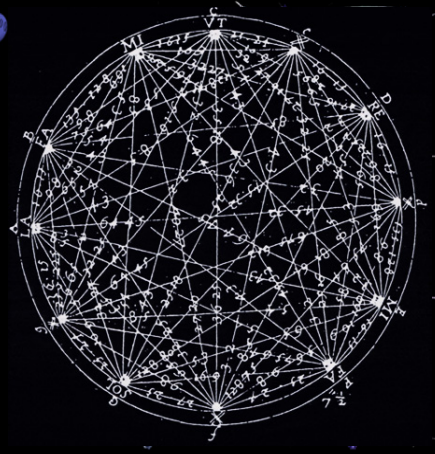
[1]CNRS / UPMC / Equipe Représentations Musicales

[2]CNRS / INRIA / Equipe MuTanT

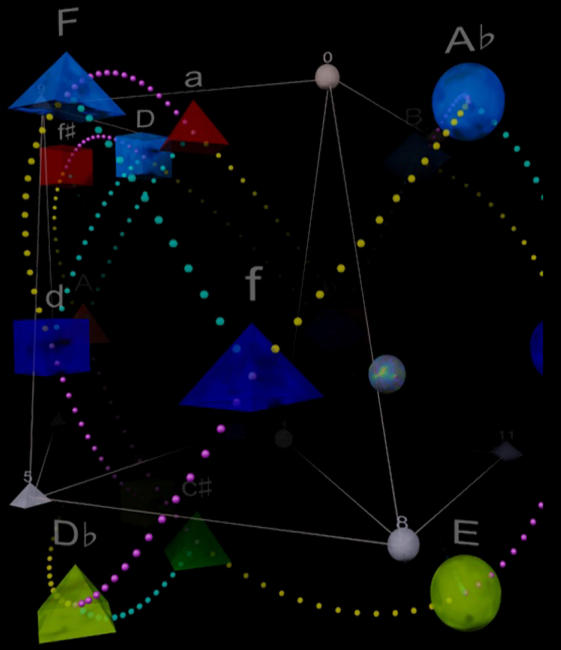
[3]RepMus, Institut of Algebra (TU-Dresden), IReMus (Sorbonne Universités), GDR ESARS, SMCM, ...

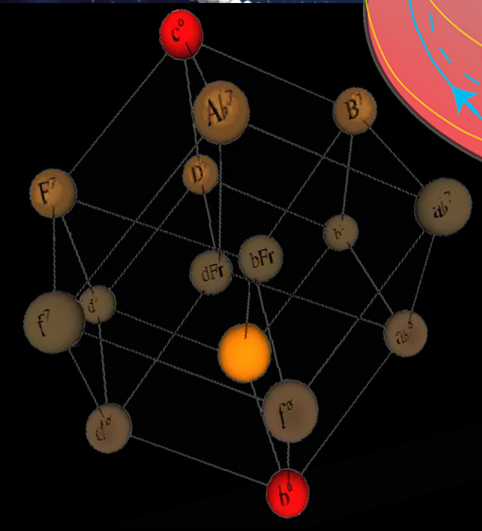


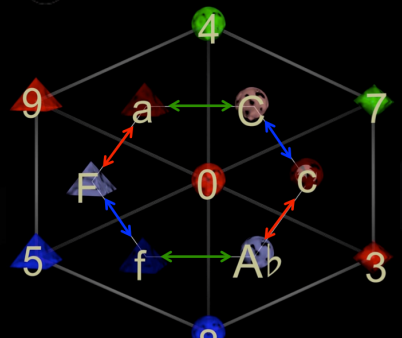

F — C — G — D
A — E — H — Fs
Cs — Gs — Ds — B.

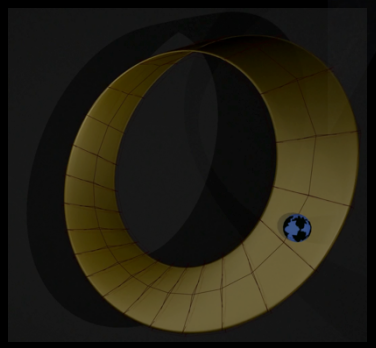


0
1
2
3
4
5
6
7
8
9
10
11

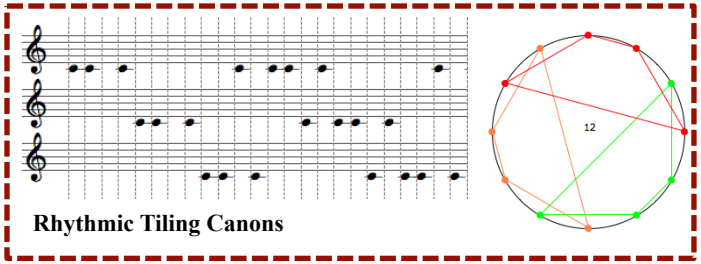

F
a
D
f#
A♭
d
f
C#
D♭
E

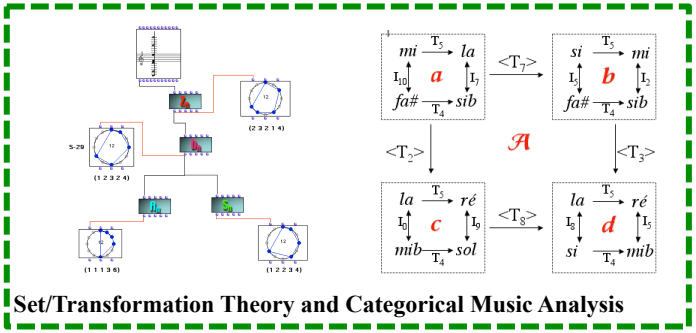


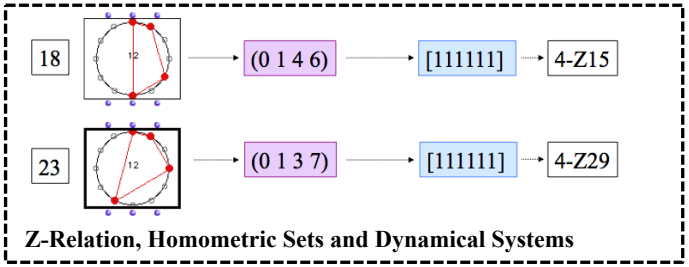

4
9
a
c
7
F
0
c
5
f
A♭
3
8

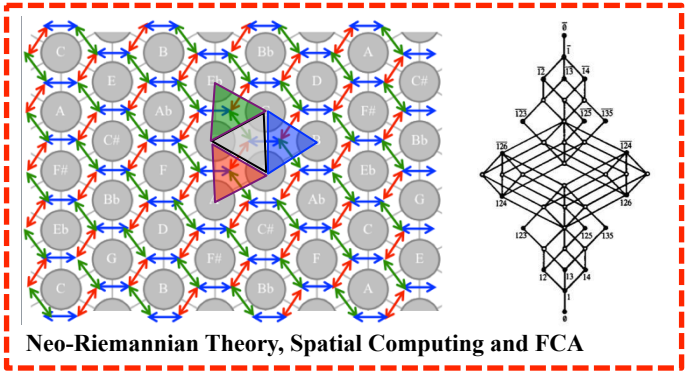


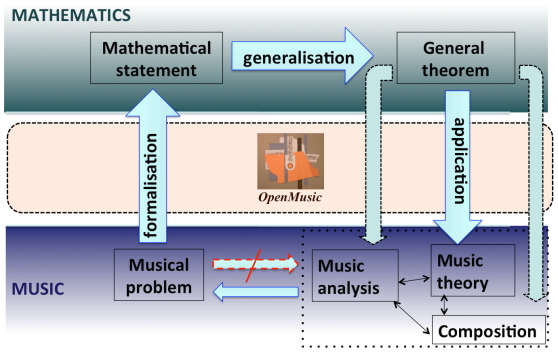
Mathemusical research within the STMS Lab

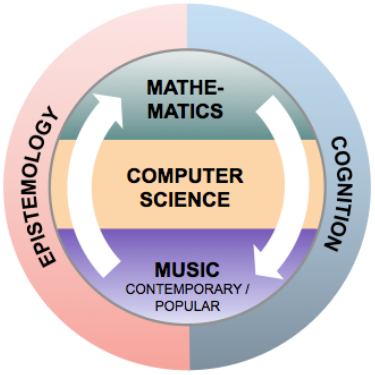












Programming paradigms for music

Computational Musicology

Symmbolic Interaction Systems

Sign-signal articulations

Specialized Languages (OpenMusic)

MISA Modélisation Informatique des Structures Algébriques en Musique

Improvisation modeling

Signal/Symbolic Unified Representations

Computer-Human Interfaces

Tempo and Rhythm extraction

Synthesis Control

Music Algorithmics (PhD H. Cauré)

Musicologie cognitive

Interactive Scores (PhD D. Ghisi)

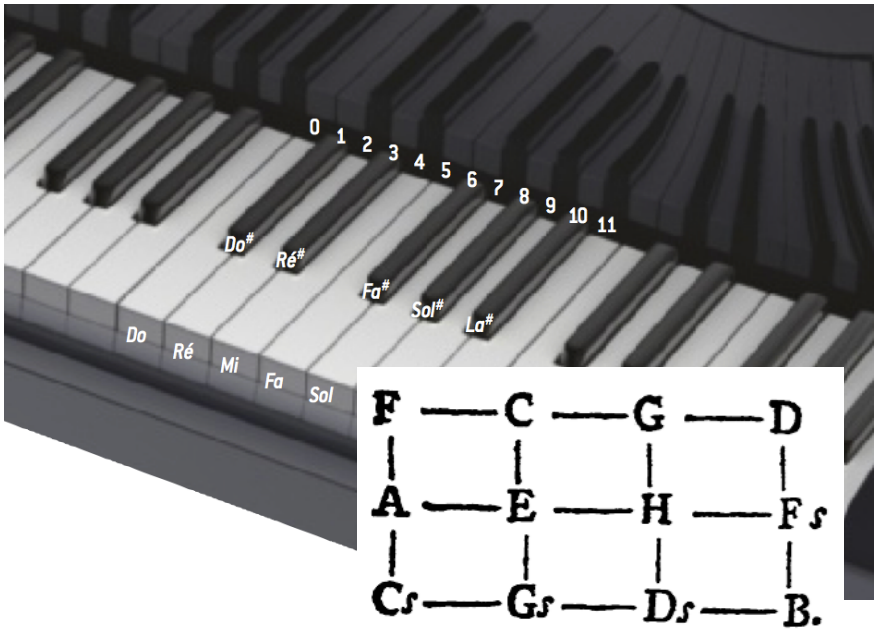
Computer-assisted Orchestration

Representation of temporal processes (PhD G. Genuys, K. Haddad)

Computer-aided music analysis and complex systems (PhD Ch. De Paiva)

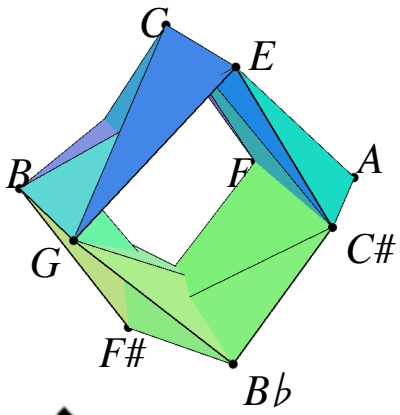
Spatial Computing, Homology Persistency and Formal Concept Music Analysis (Master A. Freund, PhD L. Bigo, M. Bergomi)

Generalizing the topological Structure of theTonnetz

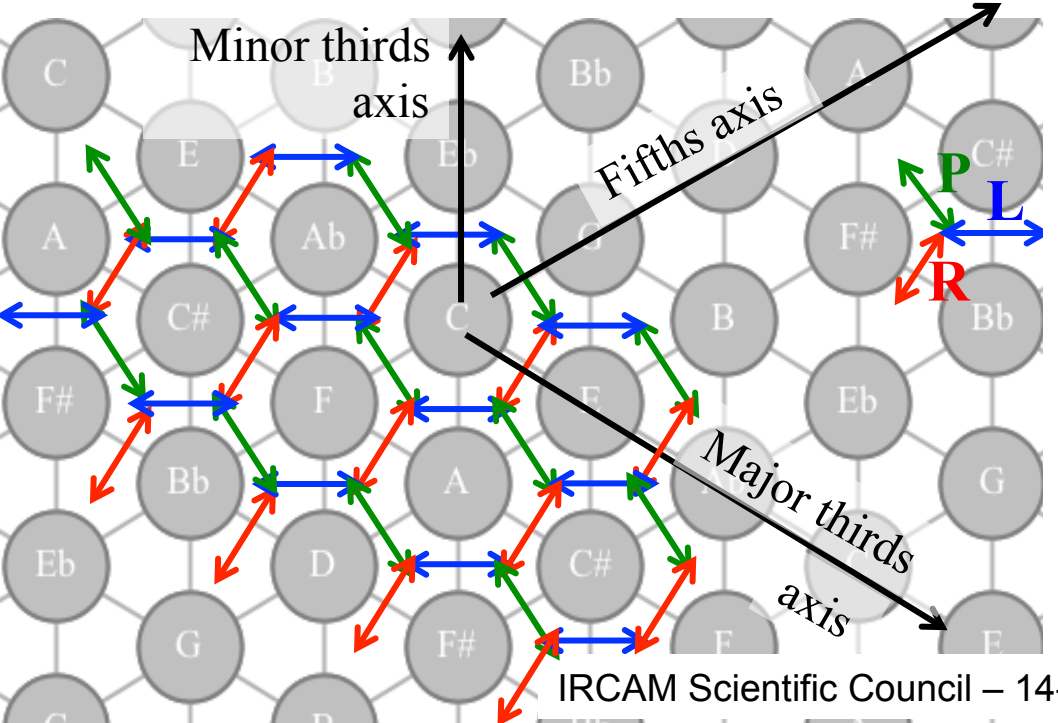


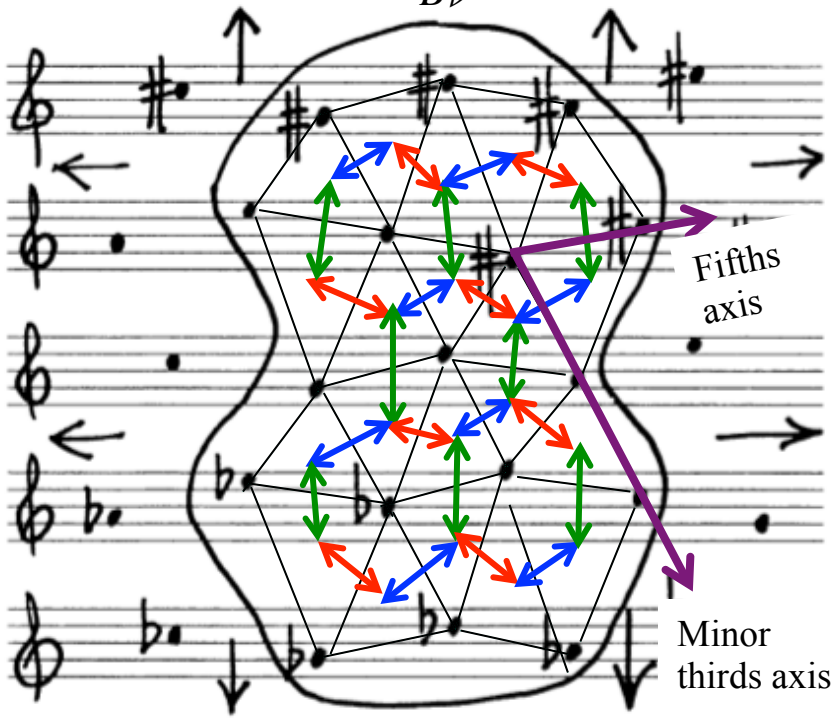
Speculum Musicum (Euler, 1773)

(L. Euler)

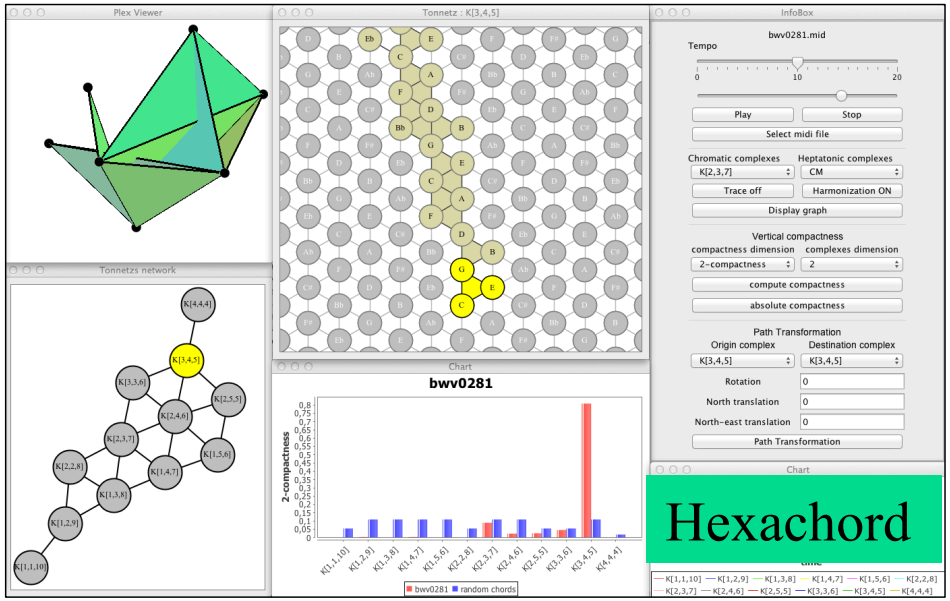


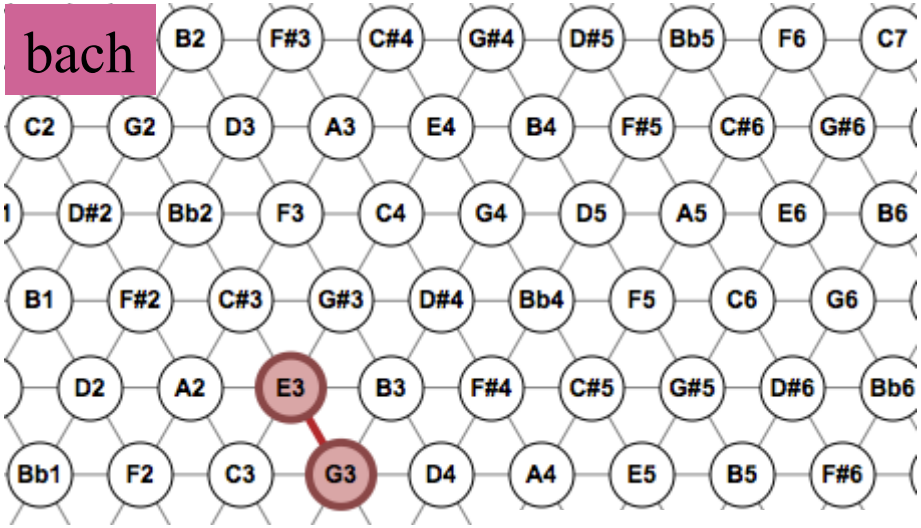
(J.-Ph. Rameau)

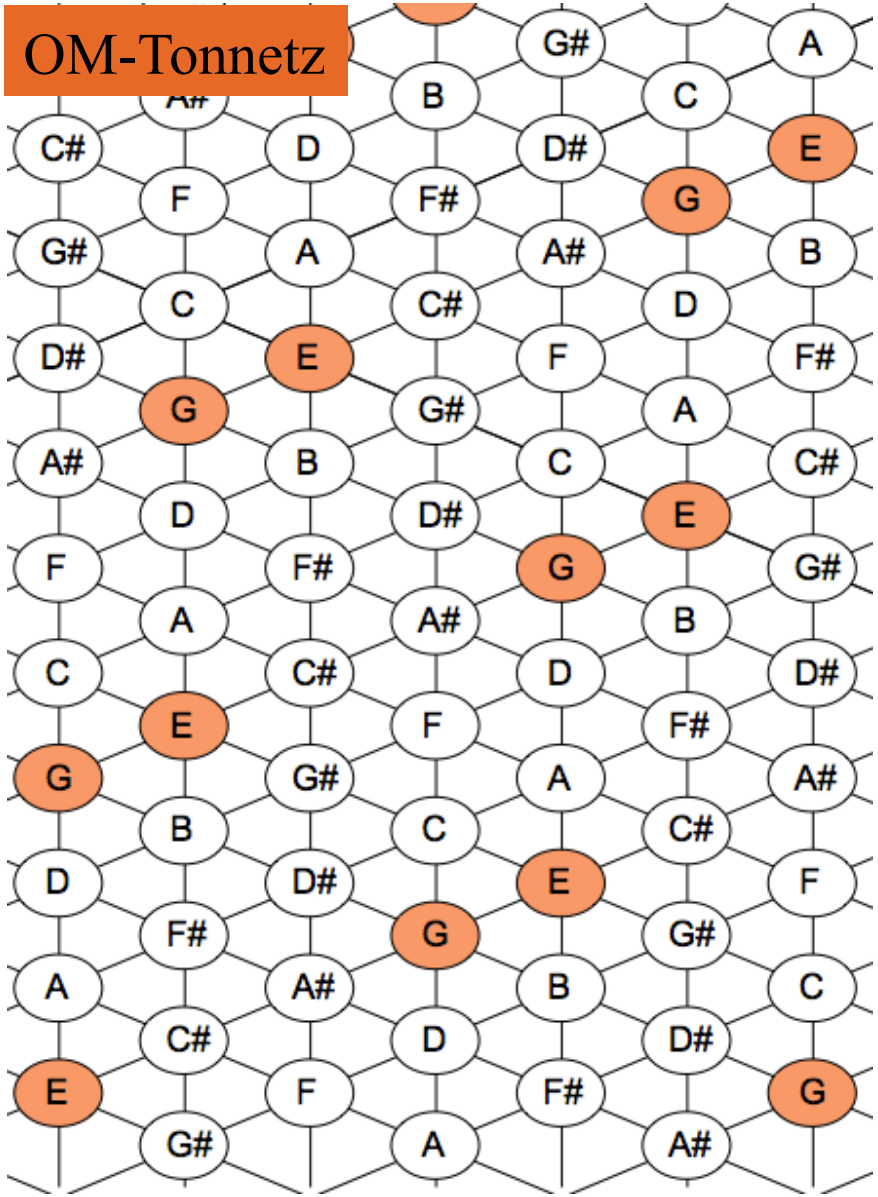




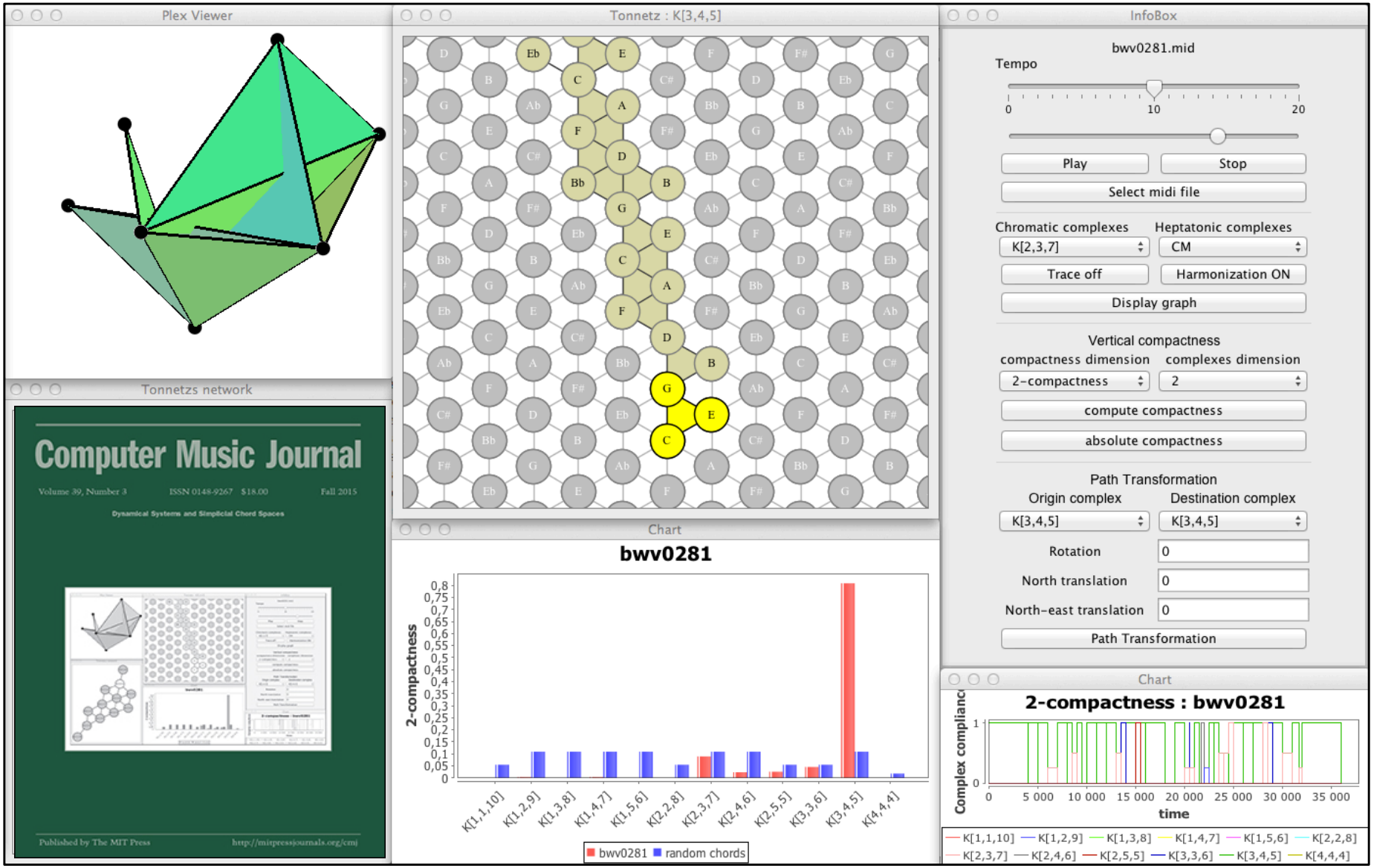
Three environments for a Tonnetz-based Analysis





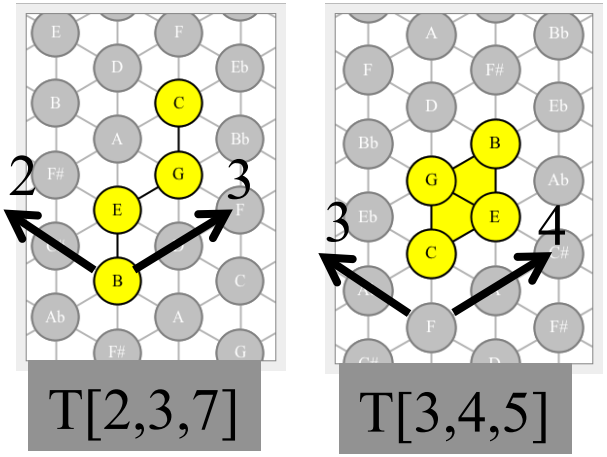


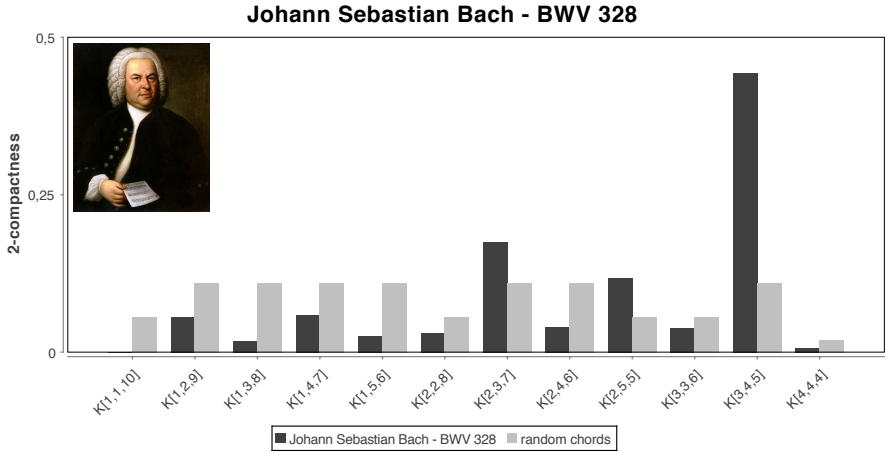
Spatial music analysis via *Hexachord*

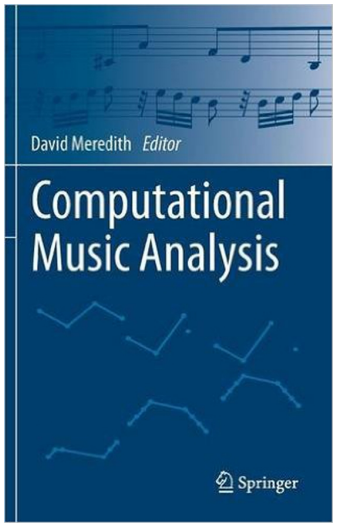


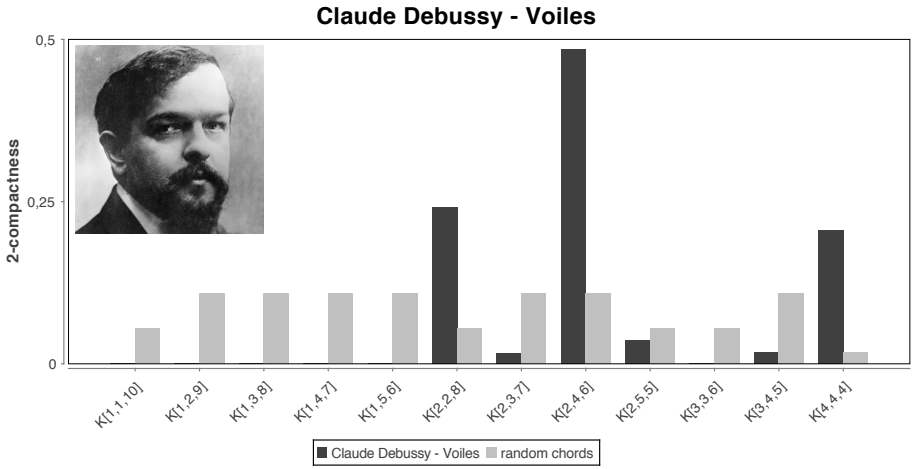
➔**http://www.lacl.fr/~lbigo/hexachord**

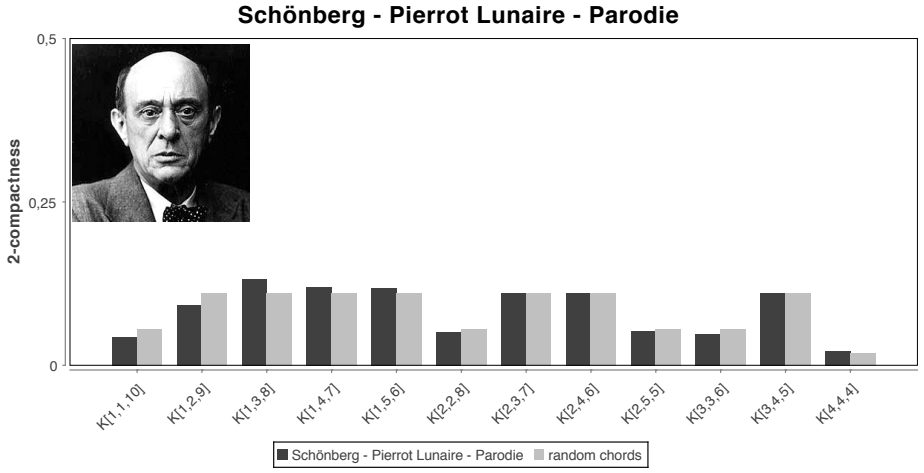
The geometric character of musical logic



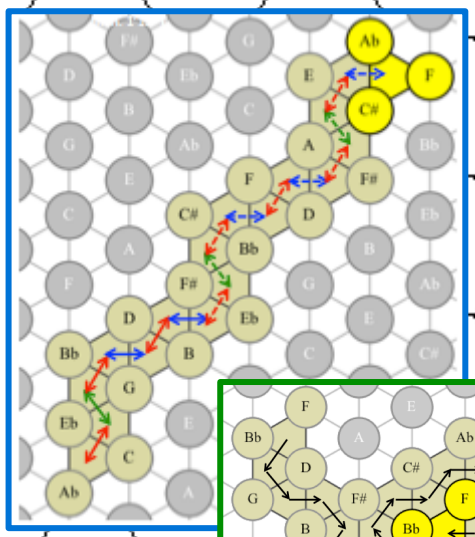


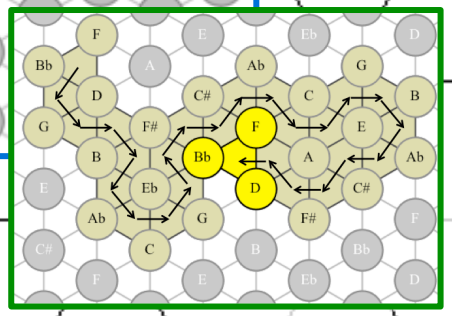


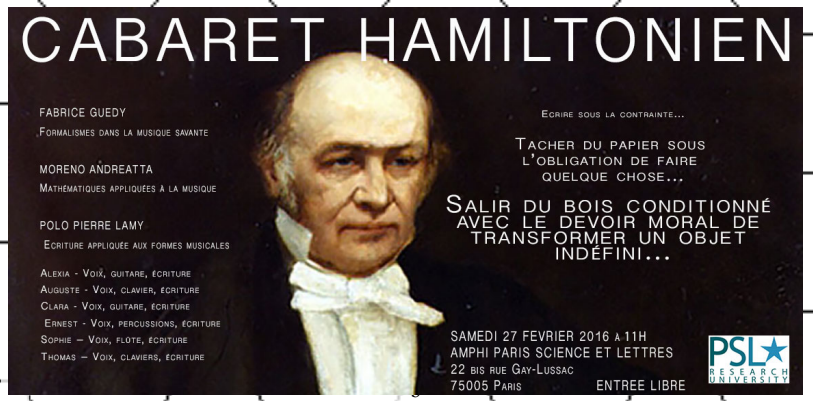


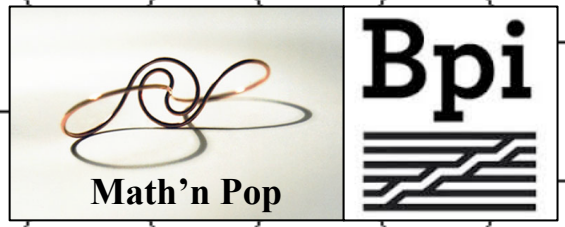


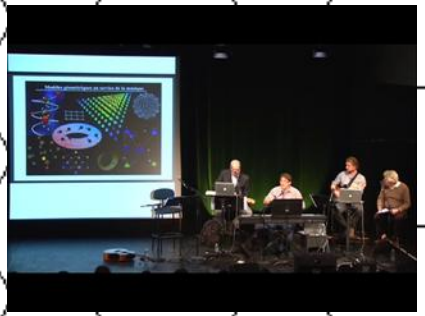
Pedagogical applications in Popular Music
Hamiltonian cycles / Hamiltonian Songs



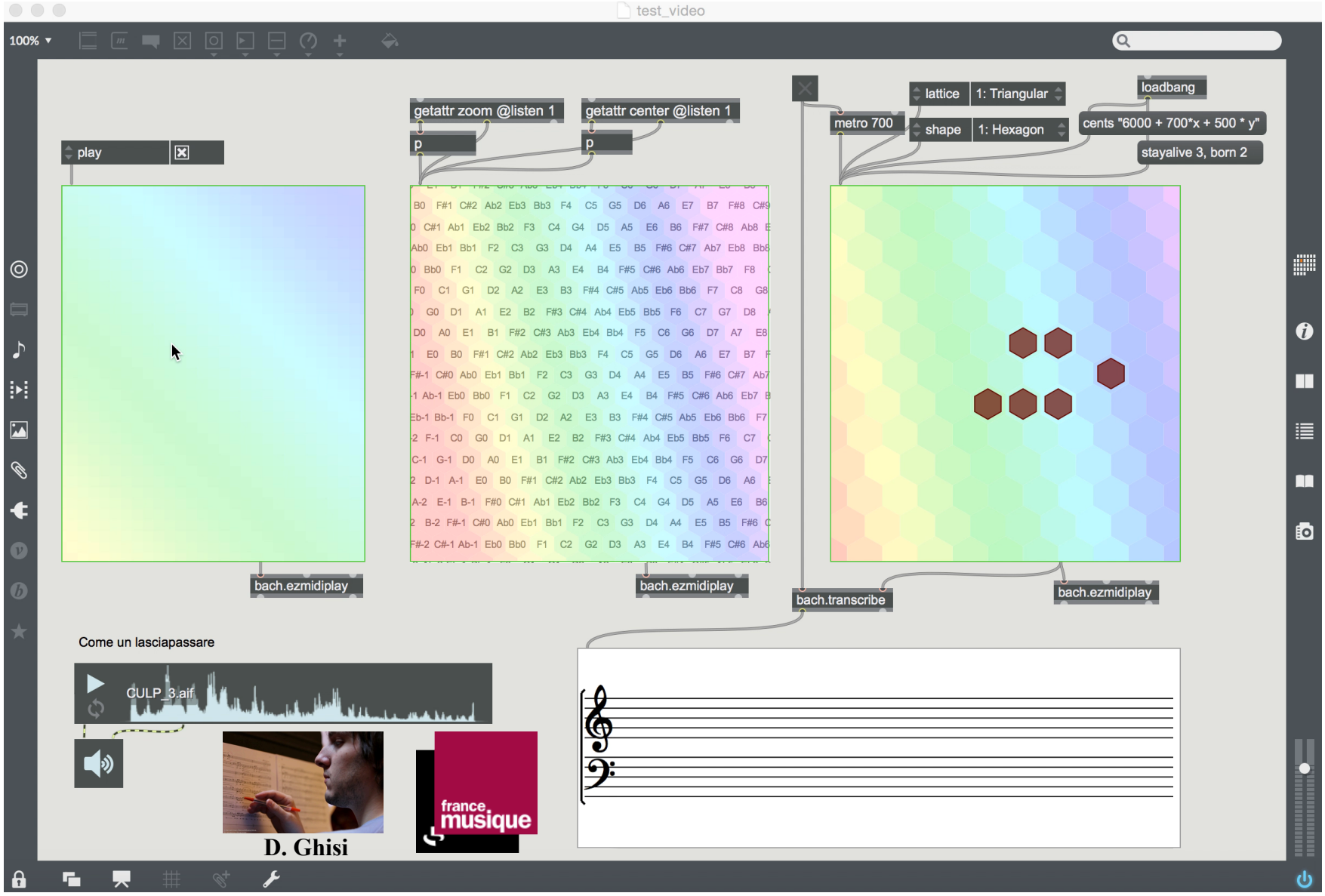




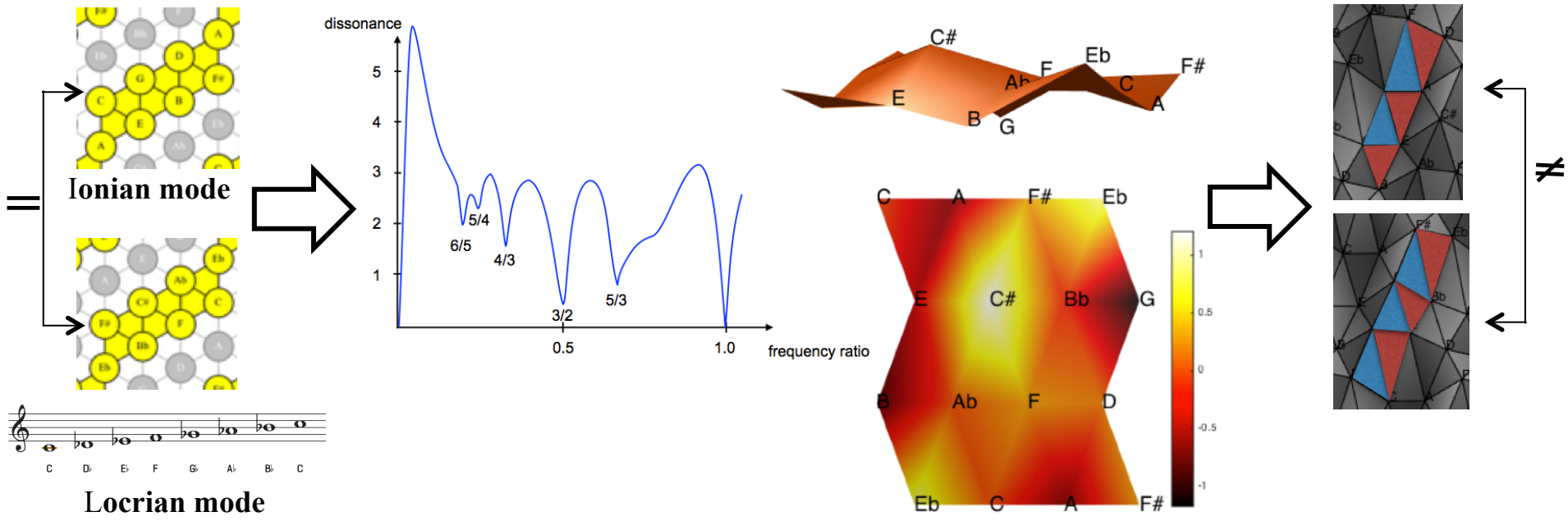




Towards a Tonnetz-computer-aided composition



Signal/Symbolic articulation in MIR



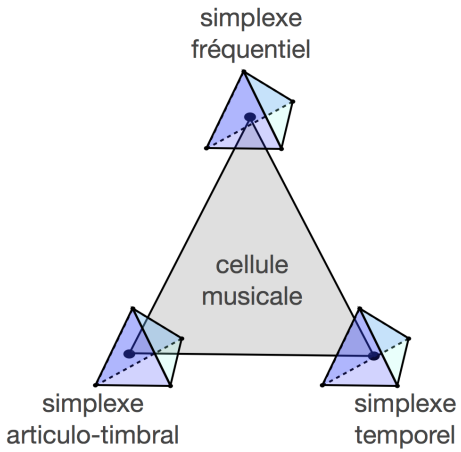
M. Bergomi, *Dynamical and Topology Tools for Modern Music Analysis*, PhD, LIM-Milan/UPMC/Ircam, Dec. 2015

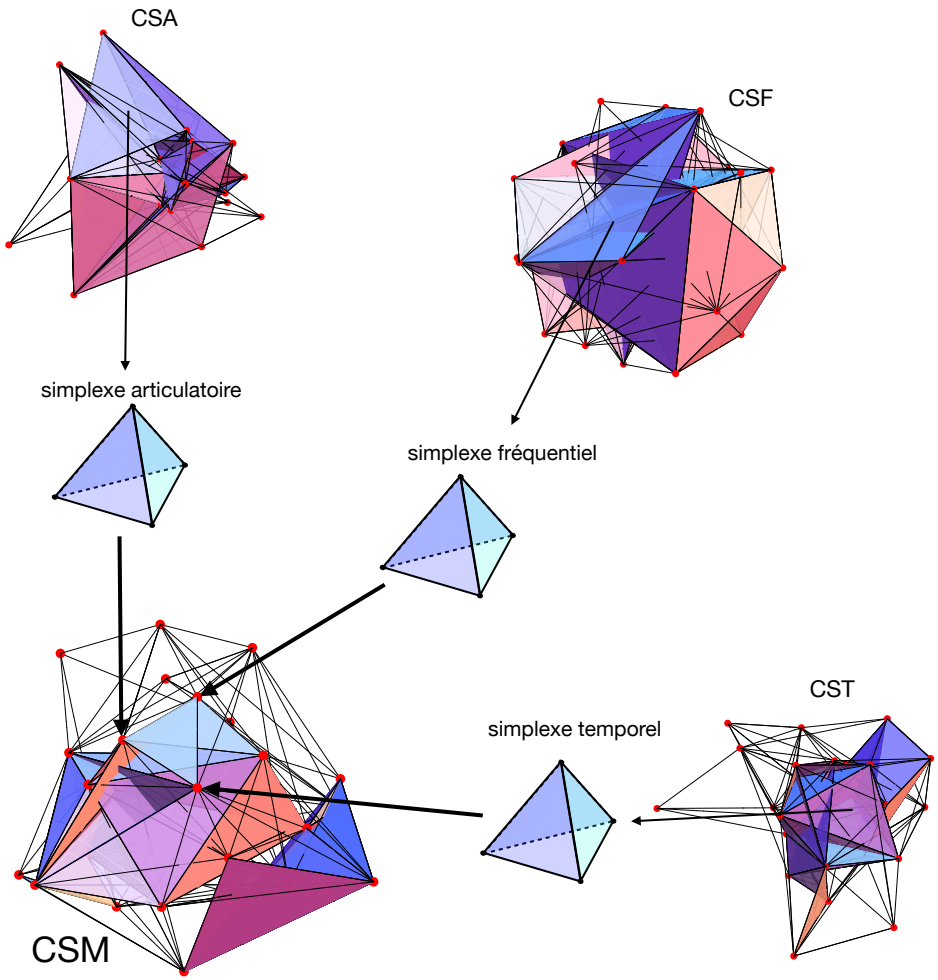
➔ **Towards a geometric dynamic modeling of a musical piece ?**

SPACE ⇄ MUSIC

➔ **Towards new perspectives on topological compositional spaces ?**

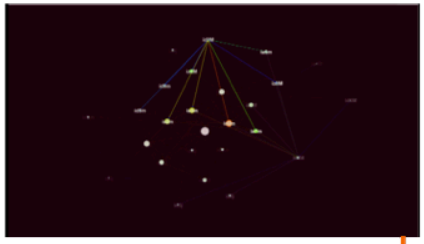
Julia Blondeau: Compositional spaces





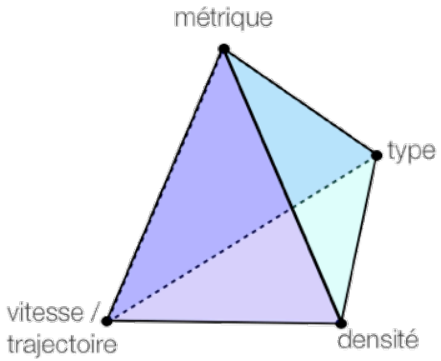
Julia Blondeau: Compositional spaces

Réseau d'intervalles

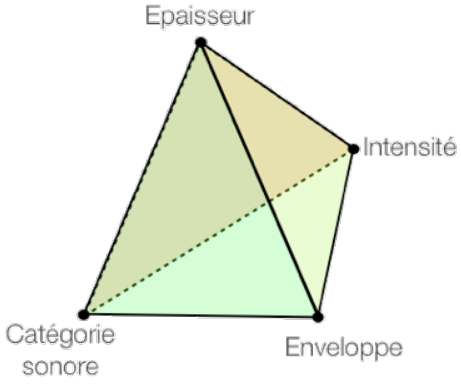


Espaces compositionnels et réseaux intervalliques

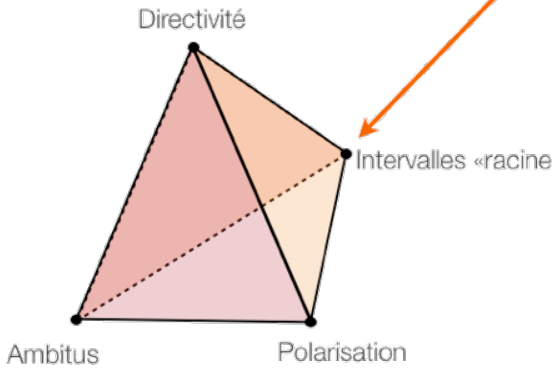
3-simplexe temporel



3-simplexe articulatoire



3-simplexe fréquentiel



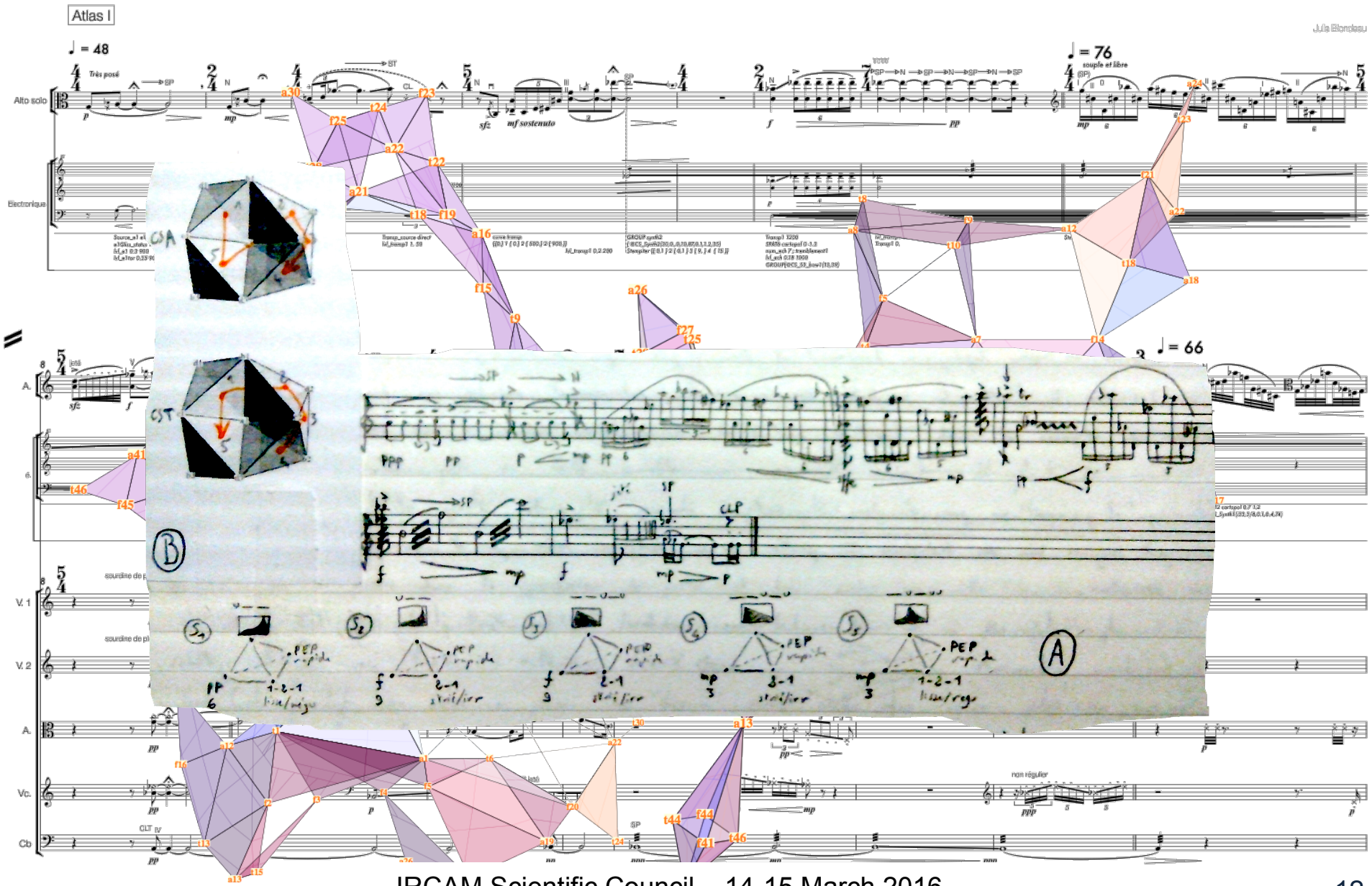
métrique	division d'une durée en segments «relatifs» courts ou longs
vitesse	très lent —> très rapide, accel, ral, rit ...etc
catégorie	régulier / irrégulier / lisse / strié
densité	faible, moyenne, forte, très forte

enveloppe	Enveloppes => // enveloppes en synthèse
	Q, trajectoire, fonction d'évolution dyn...

épaisseur	épaisseur «polyphonique» Largeur de bande, champ de propagation.....
«catégorie»	pur, mat, bruité, enrichi => liens vers modes de jeu Forme d'onde, nb de partiels, type de filtrage.....
intensité	pppp —> mp mf —> ffff .... Amplitude *moyenne*

Directivité	V, Λ, /, \, mixte ...etc.
Intervalles	intervalle(s) racine dans le réseau d'intervalles
Ambitus	restreint, moyen, large, très large
Polarisation	faible, moyenne, forte..

Julia Blondeau: TESLA ou l'effet d'étrangeté



Many musical applications:

classification using topological characteristics: can we catch the notion of style ?

generative power of topological transformation ?

representation of other musical relationships…

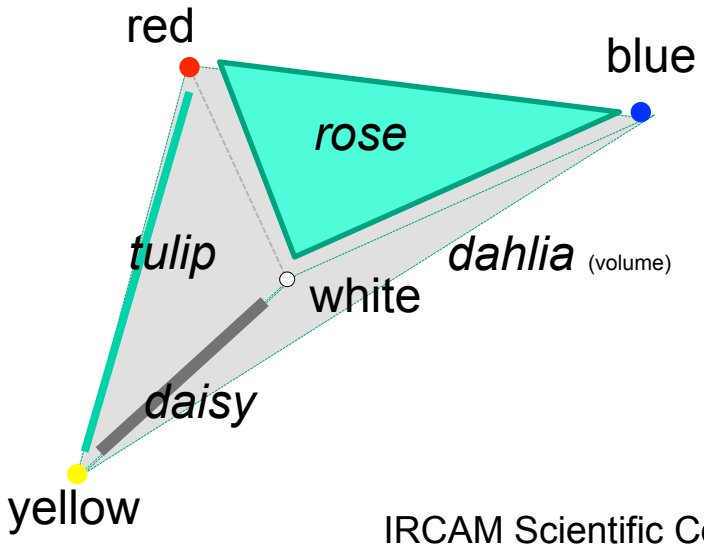
… What kind of relationships ?

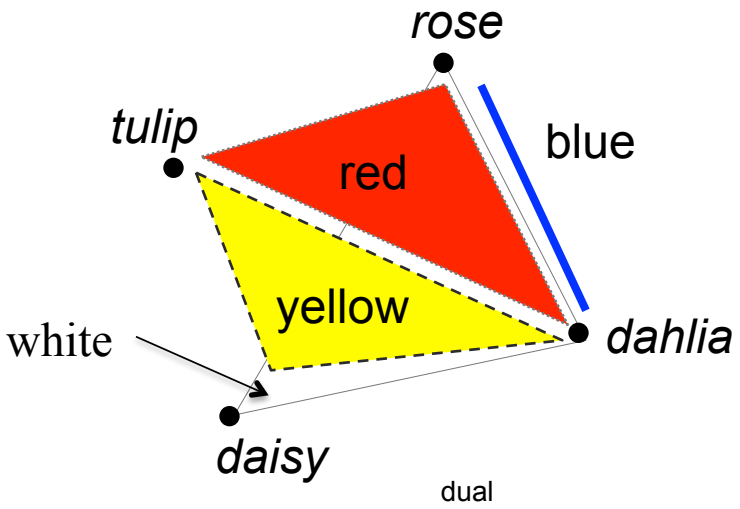
TOPOLOGICAL *vs* ALGEBRAIC ANALYSIS OF (MUSICAL) RELATIONS

Q-analysis: a topological representation of a binary relationship

$\lambda \subset$ {tulipe, rose, marguerite, dahlia} $\times$ {rouge, bleu, blanc, jaune}

λ	red	blue	white	yellow
tulip	1	0	0	1
rose	1	1	1	0
daisy	0	0	1	1
dahlia	1	1	1	1



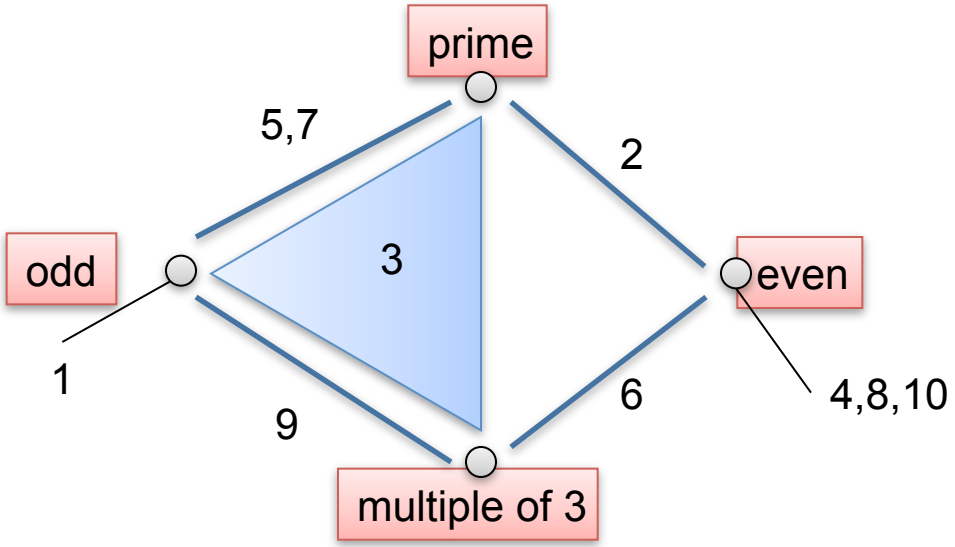


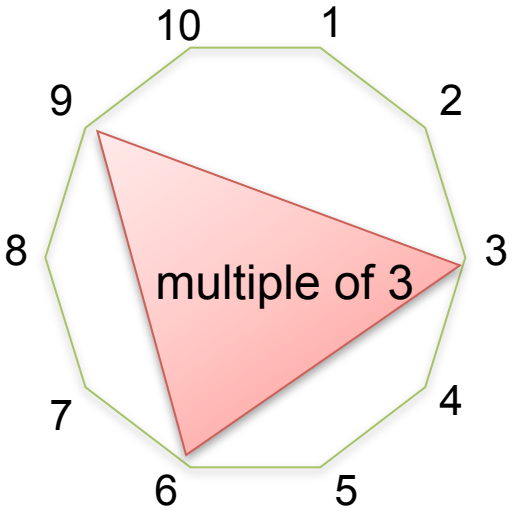
Representation of a set of predicates

$$\lambda \subset \text{Objects} \times \text{Predicates} : (o,p) \in \lambda \Leftrightarrow p(o)$$

Objects = {1, 2, 3, …, 10}

Predicates = {prime, even, odd, multiple-of-3}

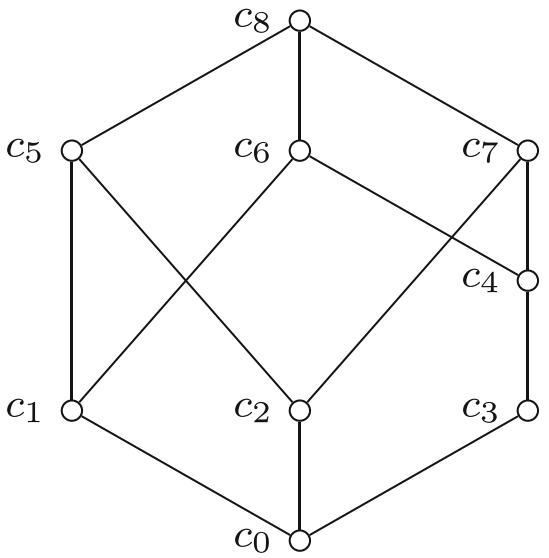




Formal Concept Analysis (FCA)
it can also be represented as a lattice

λ: interval g_i appear in a musical motive m_j

	m_1	m_2	m_3	m_4
g_1	×	×		×
g_2	×	×		
g_3	×		×	
g_4		×	×	
g_5			×	



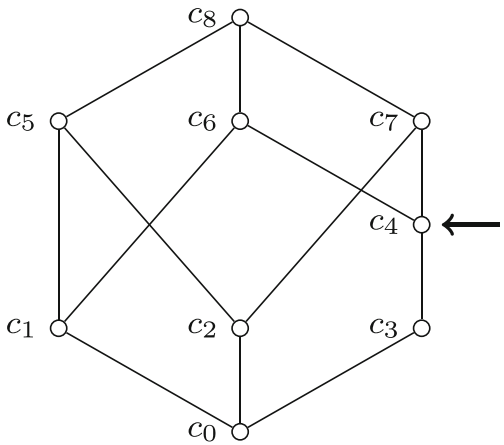
let H ∈ G and N ∈ M

- H' = { m in M | (h, m) ∈ λ for all h ∈ H }
- N' = { g in G | (g, n) ∈ λ for all n ∈ N }

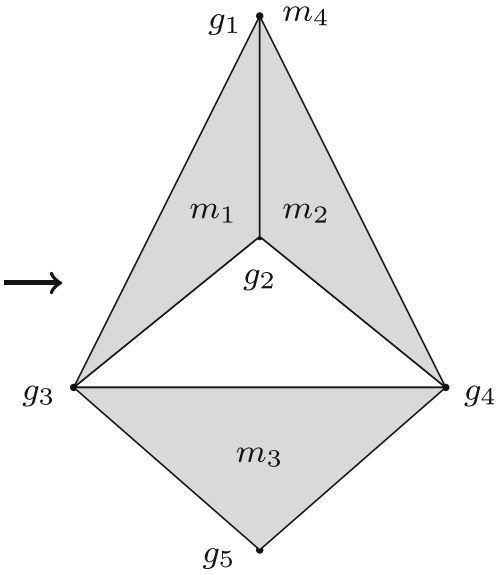
- (H, N) is a *formal concept* iff H' = N and H = N'

- formal concept are ordered: (H, N) < (I, P) iff H ⊂ I

Relation between FCA and Q-analysis



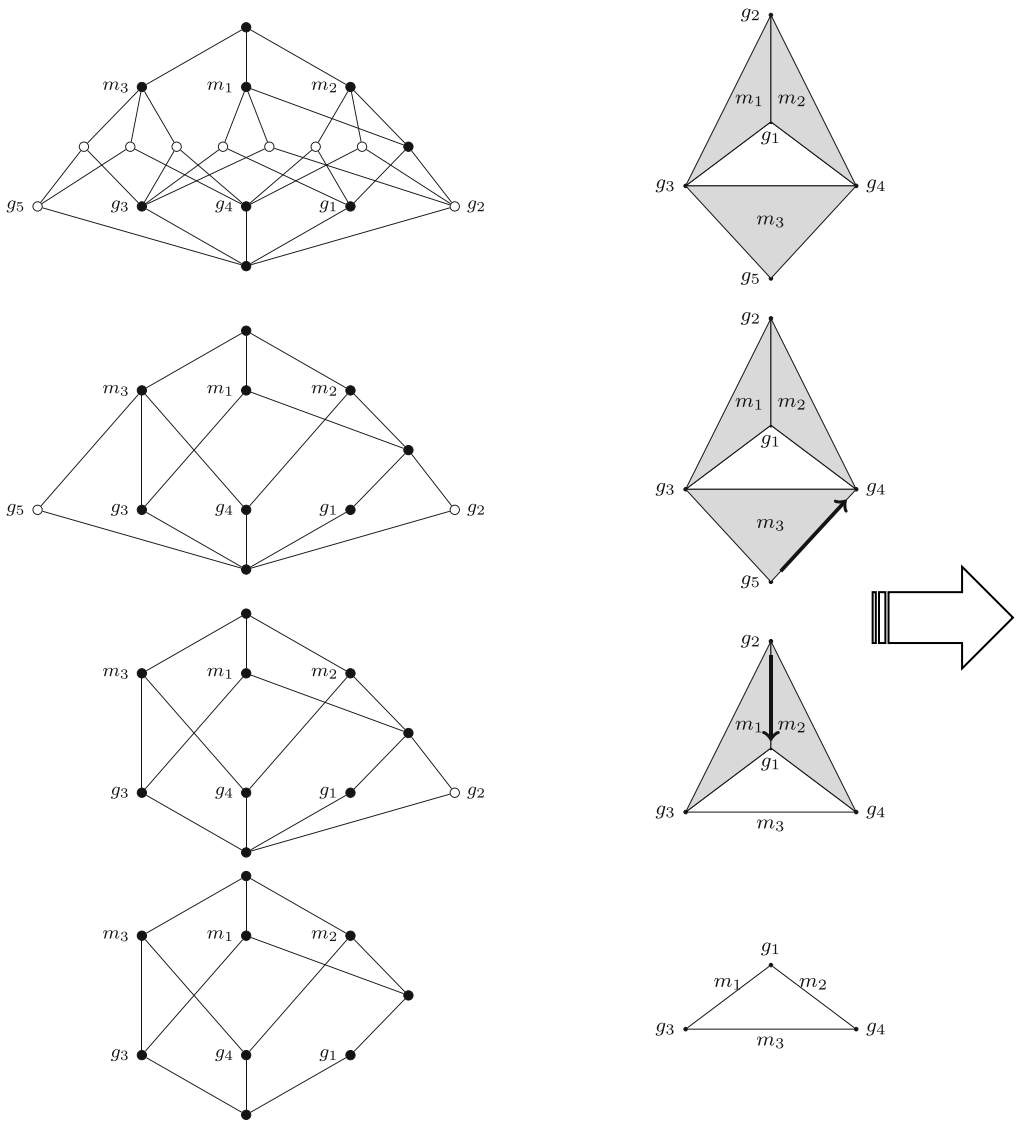
	m_1	m_2	m_3	m_4
g_1	×	×		×
g_2	×	×		
g_3	×		×	
g_4		×	×	
g_5			×	

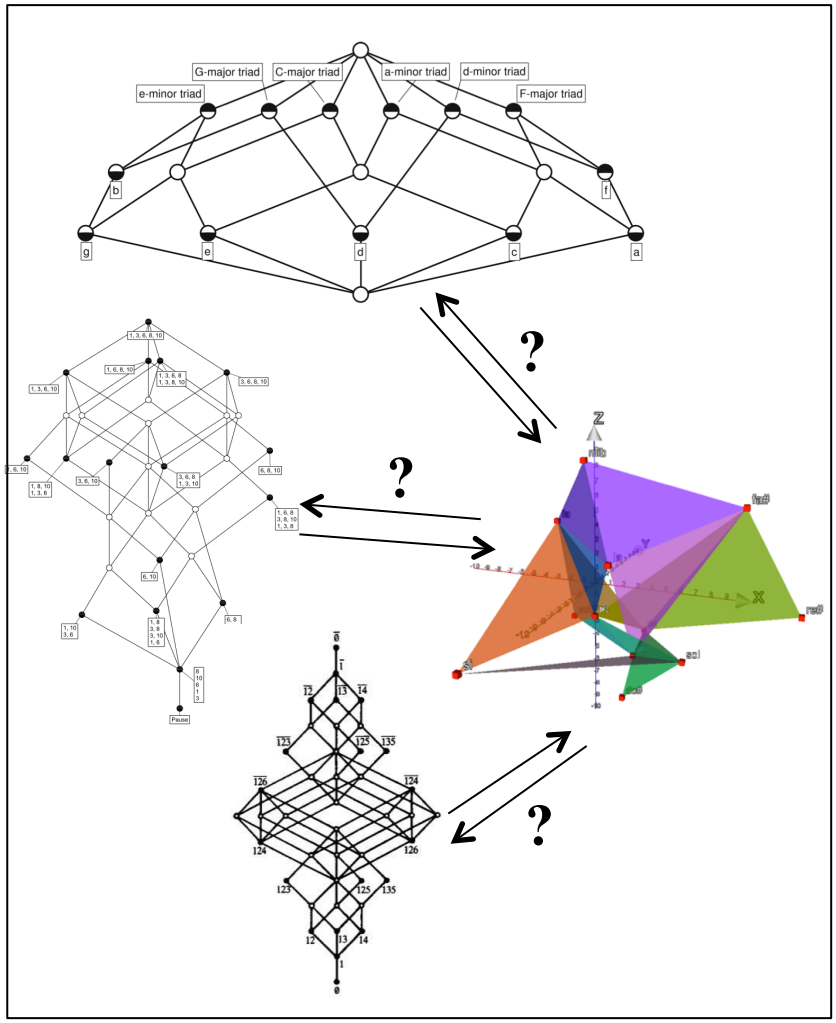


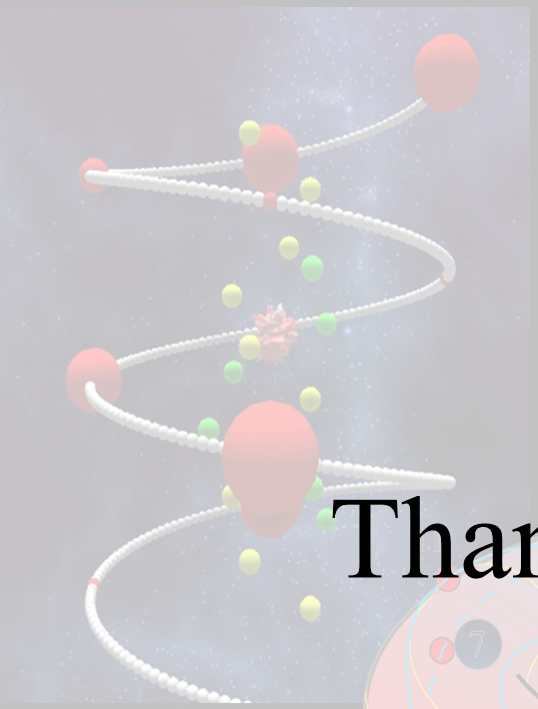
?

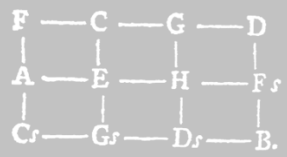
Relation between FCA and Q-analysis

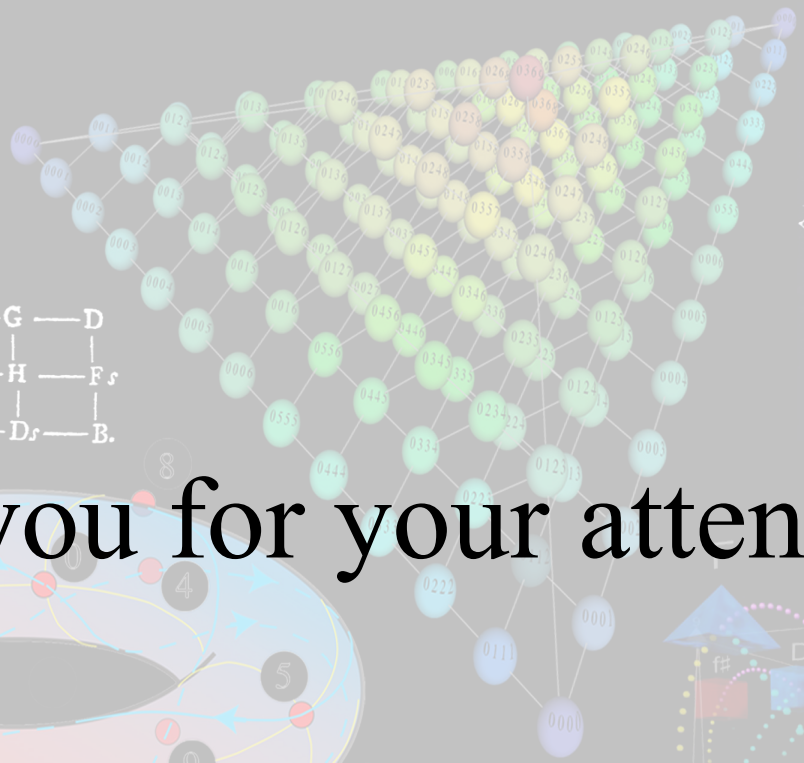
➔ **Freund A., M. Andreatta, J.-L. Giavitto (2015), « Lattice-based and Topological Representations of Binary Relations with an Application to Music », *Annals of Mathematics and Artificial Intelligence***

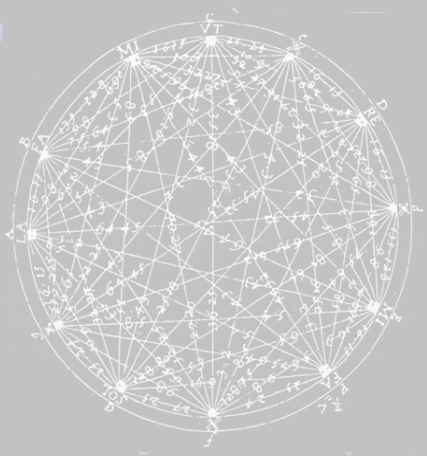












Thank you for your attention