

Programmation et représentation musicale interactive en composition assistée par ordinateur

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EFFICAC(e) — ANR-13-JS02-0004-01



Extended Frameworks for "In-time" Computer-Aided Composition

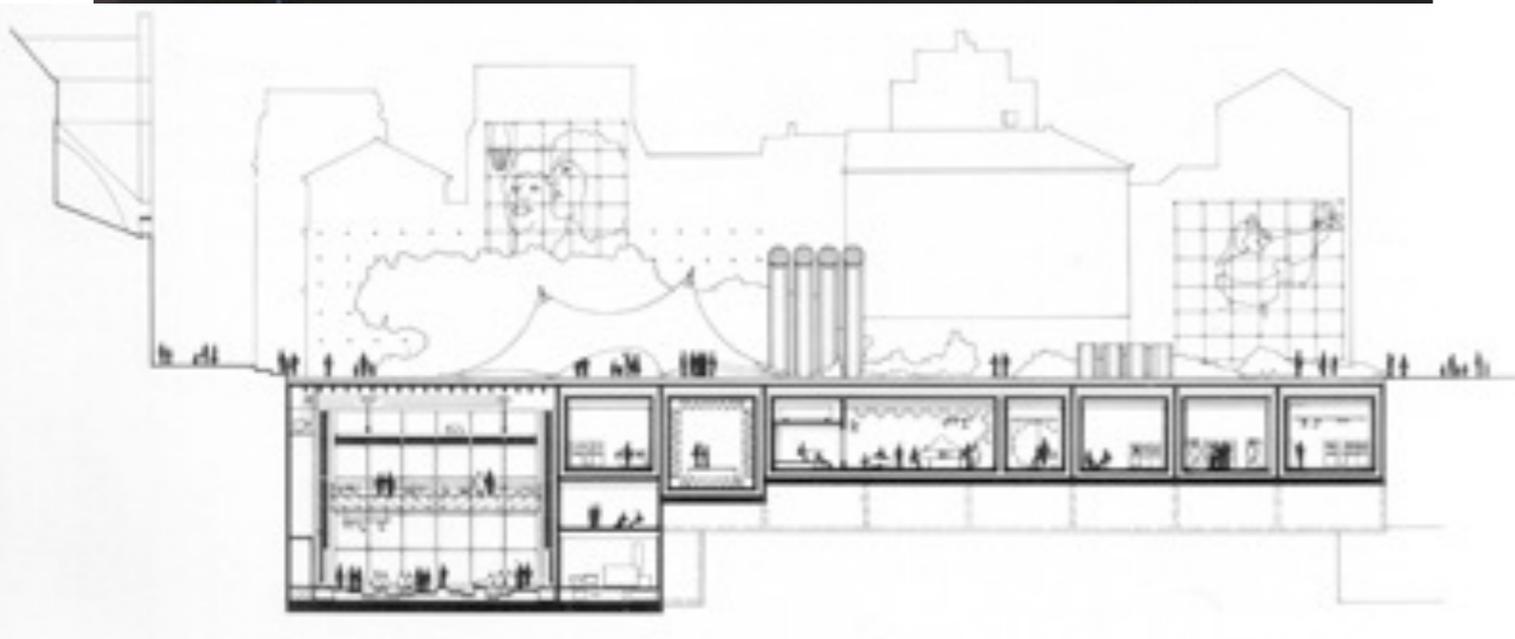
Séminaire SFR Agorantic
Université d'Avignon, 12-13/06/2014

IRCAM (quick intro)

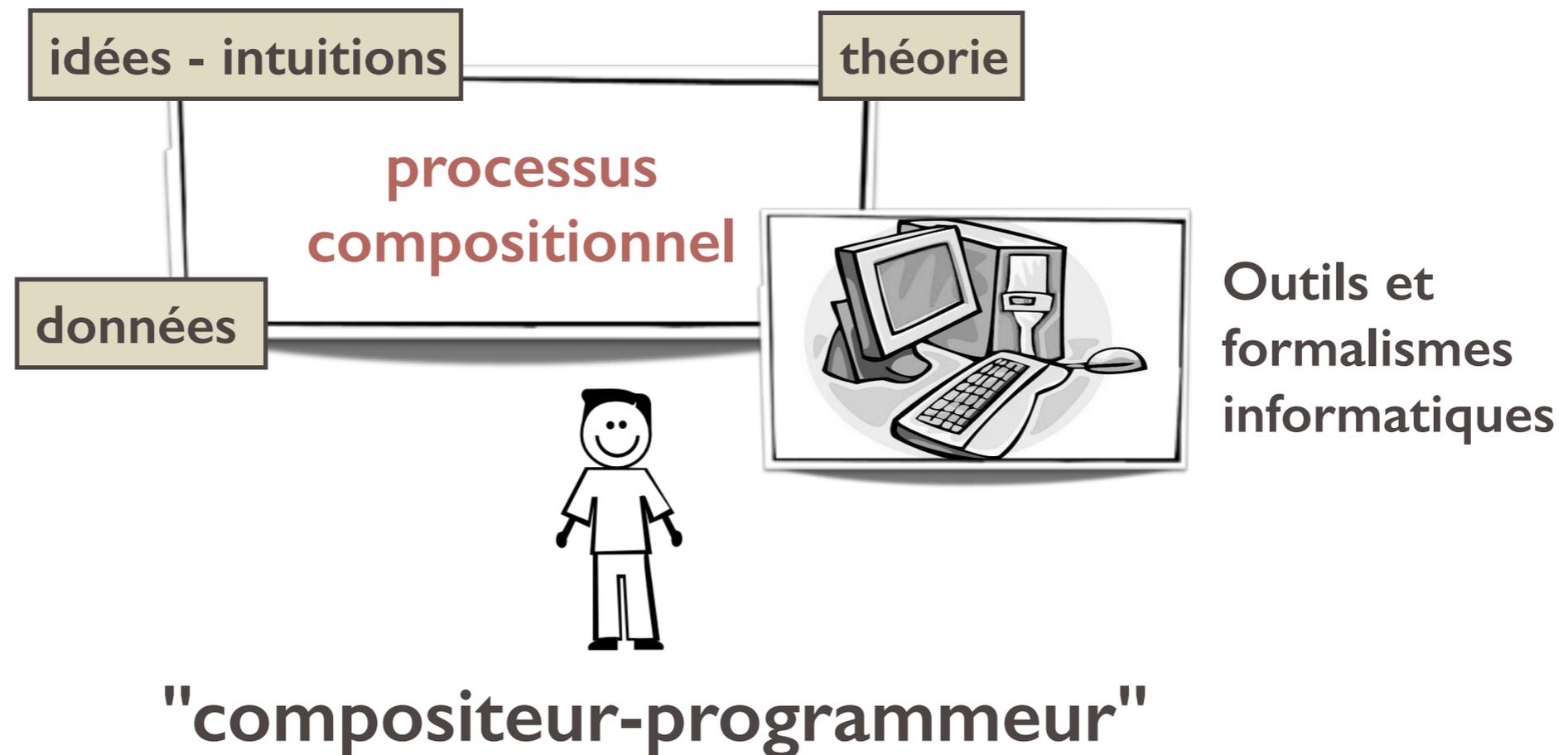


- Institut (statut asso 1901) sous tutelle du Centre Georges Pompidou
- Fondé en 1977 par Pierre Boulez
- Département R&D / UMR 9912 STMS associé au CNRS et à L'UPMC

➡ Recherches dans les domaines du son (analyse/synthèse), de l'acoustique, de la **composition**, de la perception, de l'analyse musicale.



Composition assistée par ordinateur (CAO)

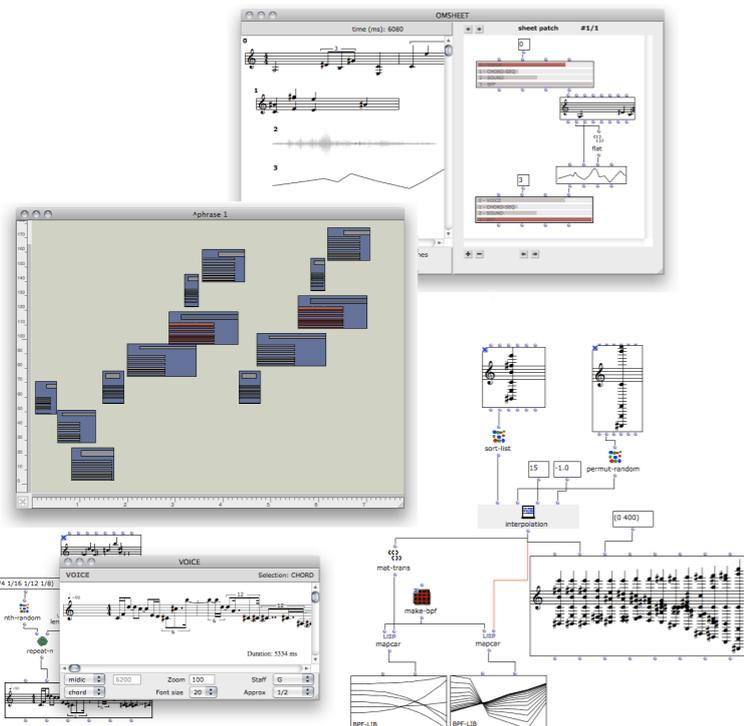
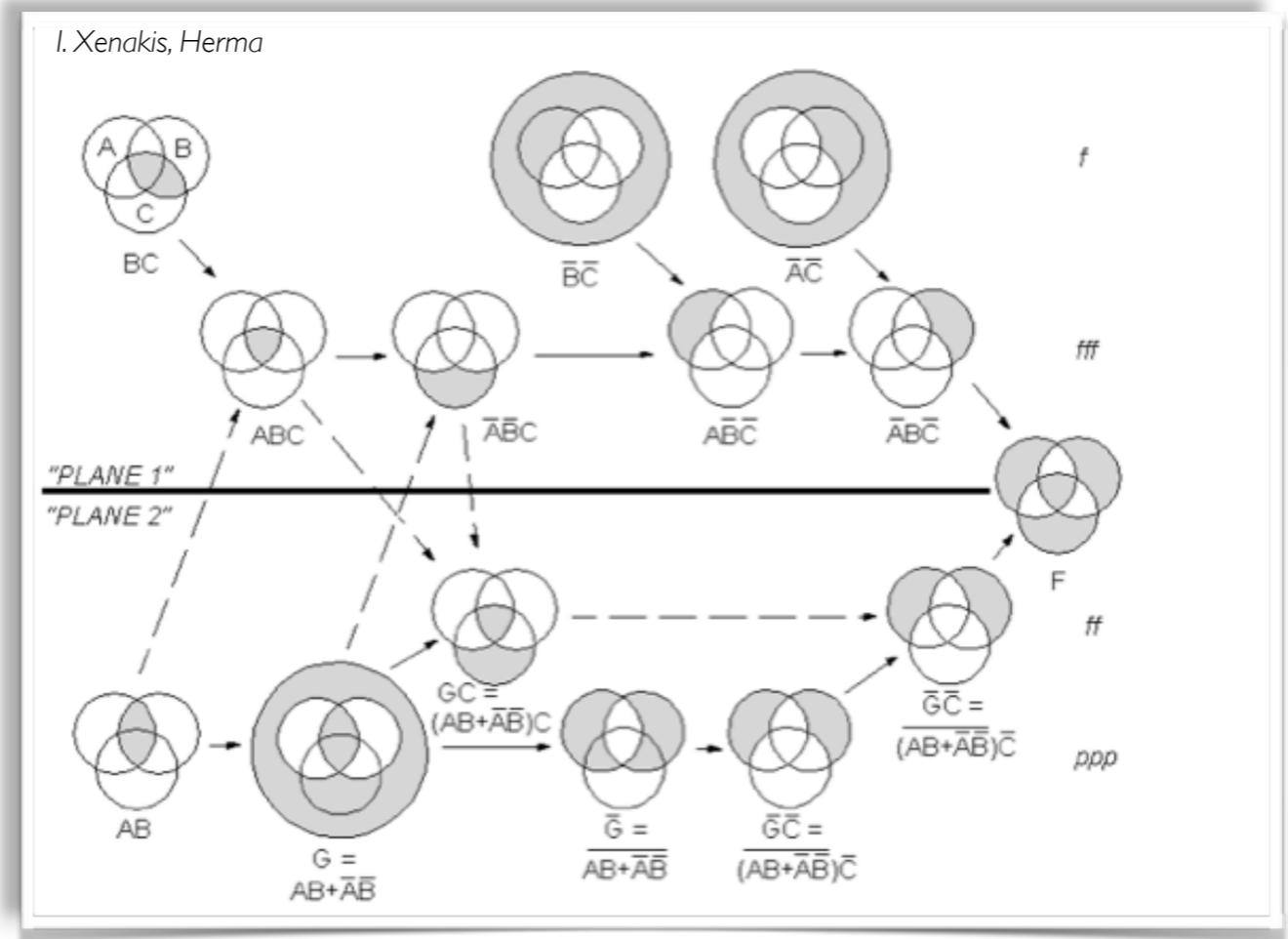
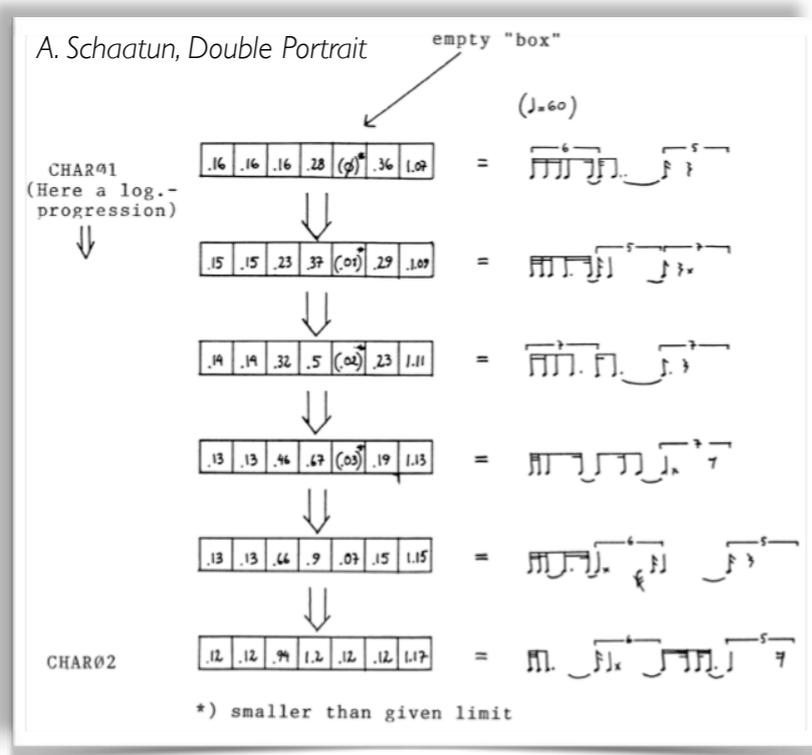


"We conceive such an environment [of computer-aided composition] as a **specialized computer language** that composers will use to build their own musical universe. [...] This leads us to reflect on the various existing programming models, as well as on the interfaces [...] which make it possible to control this programming, and on the representations of the musical structures, which will be built and transformed using this programming."

G.Assayag, *Computer Assisted Composition Today* (1998).

Composition assistée par ordinateur (CAO)

une vision formelle des processus musicaux



- Implémentation dans des langages de programmation
- Représentations / manipulations musicales grâce aux outils graphiques et à la programmation visuelle

FORMALISATION ⇔ IMPLEMENTATION ⇔ PARTITION ⇔ (SON)

The collage illustrates the relationship between formalisation, implementation, and partition. It includes:

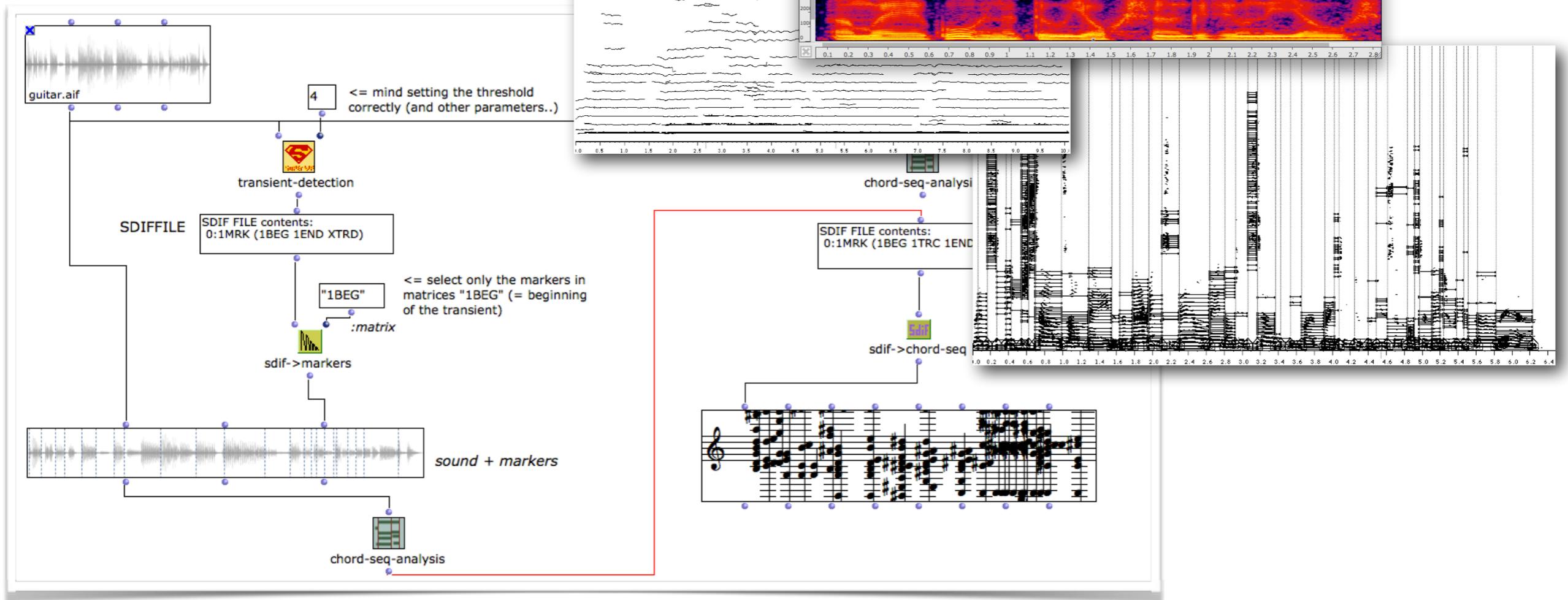
- Handwritten Manuscript (Left):** A page of handwritten musical notation on aged paper.
- Formalisation Diagram (Top Left):** A sequence of numerical characters (CHAR01, CHAR02) being processed into musical notation. CHAR01 is labeled "(Here a log.-progression)". The sequence shows a progression of numbers: .16, .16, .16, .28, (0), .36, 1.09; .15, .15, .23, 37, (0), .29, 1.09; .14, .14, .32, .5, (0), .23, 1.11; .13, .13, .46, .47, (0), .19, 1.15; .13, .13, .44, .9, .09, .15, 1.15; .12, .12, .9, 1.2, .12, .12, 1.17. An "empty 'box'" is indicated above the first row. A note at the bottom says: "*) smaller than given 1".
- Pure Data Patch (Center):** A screenshot of a Pure Data patch window. It shows various objects like 'om-scale', 'flat', 'n°elem', 'tab', 'note?', 'multi-interpol', and 'to 150'. The patch is connected to musical notation staves labeled I, IV, and III.
- Musical Score (Right):** A printed musical score for a piece titled "18 (Languid, Radiant)". The score is in 4/4 time and features staves for Flute (Fl), Clarinet (Cl), Violin (Vn), and Violoncello (Vc). The score includes dynamic markings like *mf*, *ff*, *pp*, and *f*, and performance instructions like "vibrato 1/8".

"We may view composer-program interaction along a trajectory leading from purely manual control to control exercised by some compositional algorithm (composing machine). The zone of greatest interest for composition theory is the middle zone of the trajectory, since it allows a great flexibility of approach. The powers of intuition and machine computation may be combined."

Otto Laske, *Composition Theory in Koenig's Project One and Project Two*. *Computer Music Journal* (1981)

CAO et création sonore

Conjonction de la pensée spectrale,
des musiques formelles et des
musiques électroacoustiques

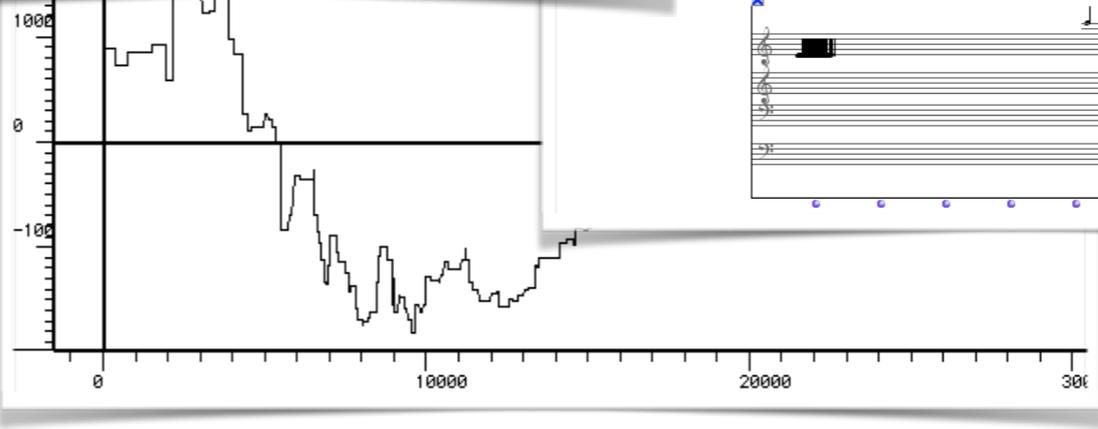
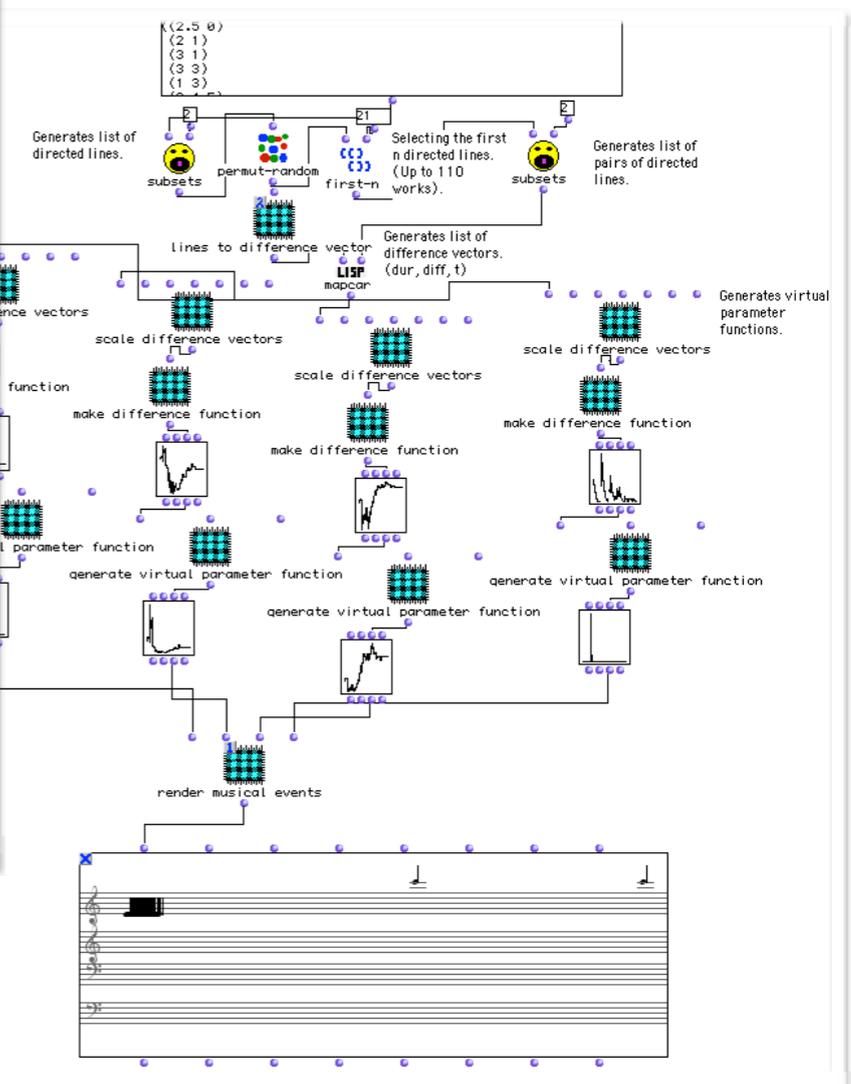
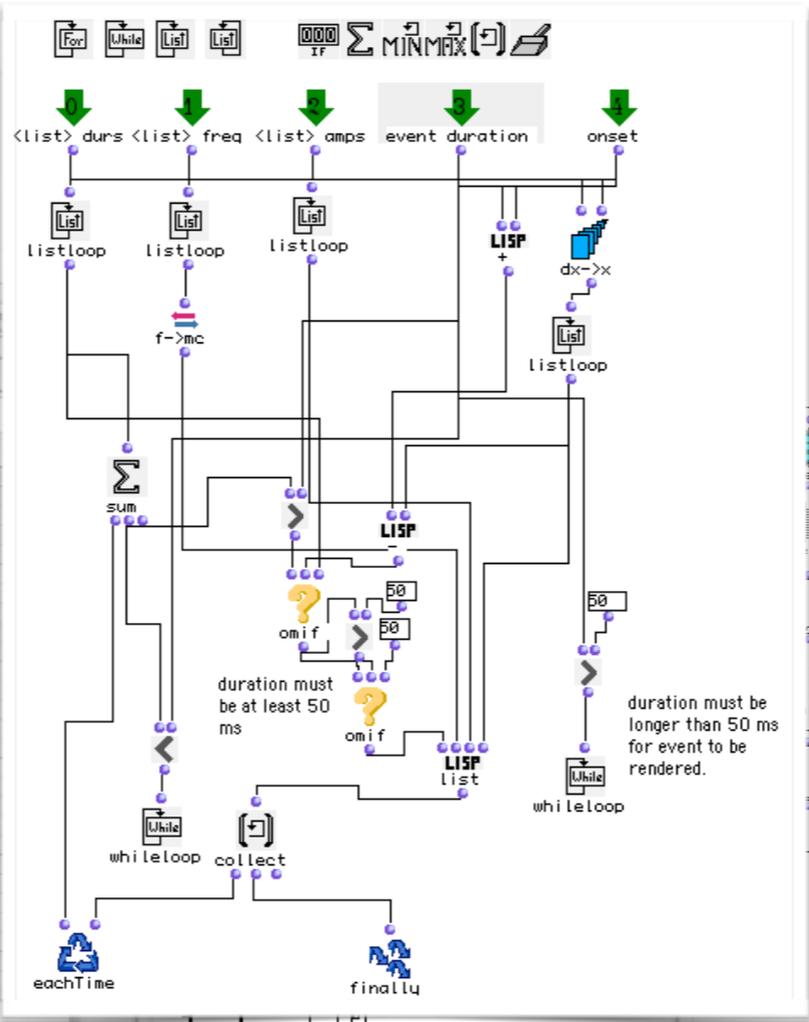
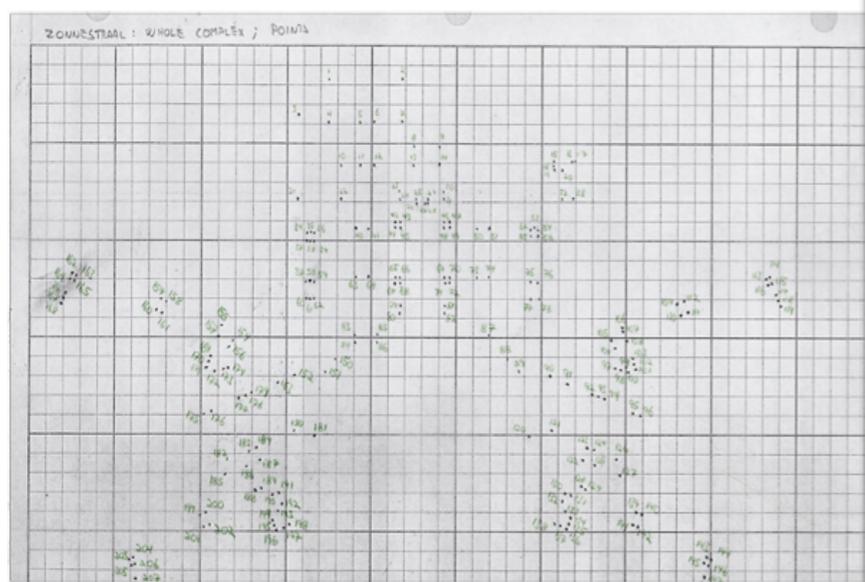
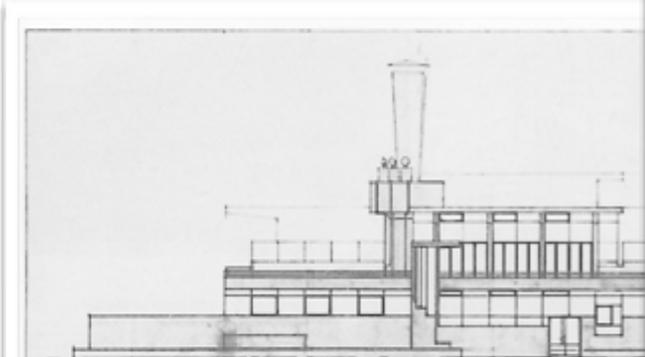


Assistance informatique pour l'exploration, le traitement symbolique et le rendu de structures musicales complexes.

Quelques exemples ?

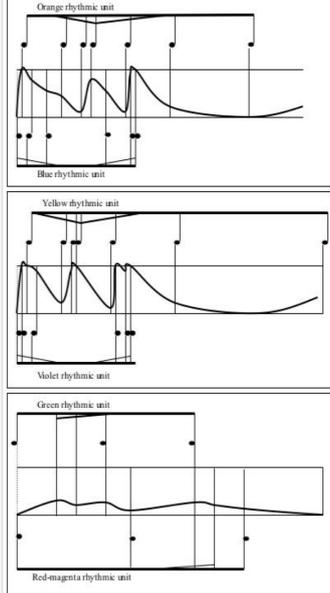
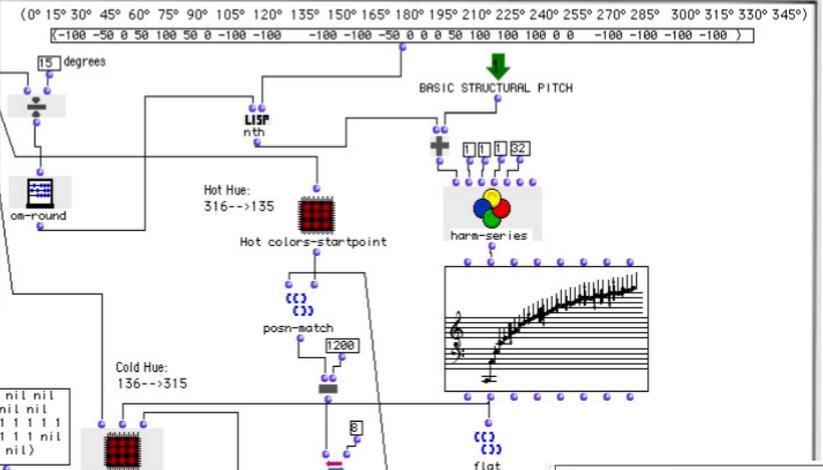
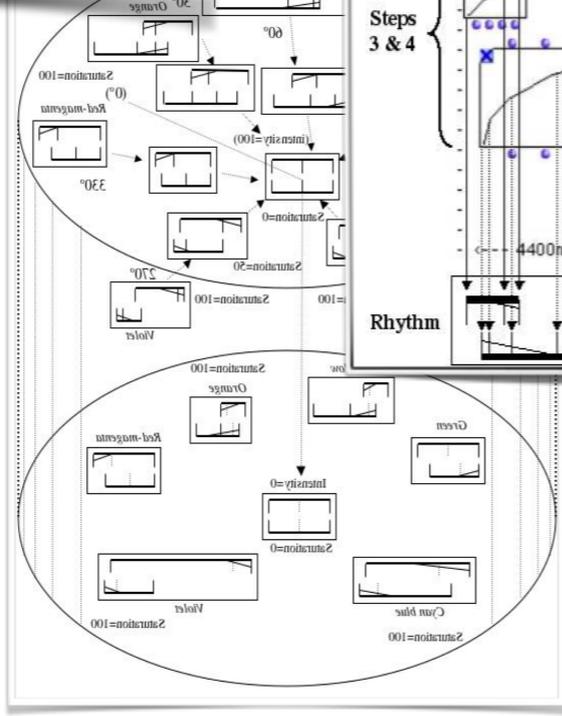
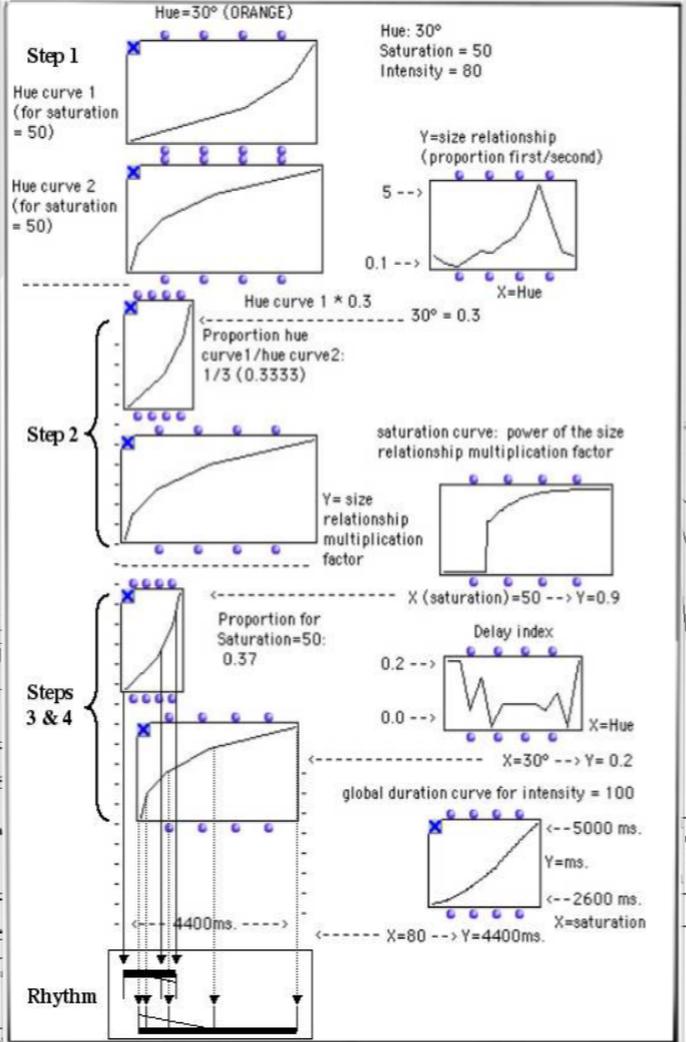
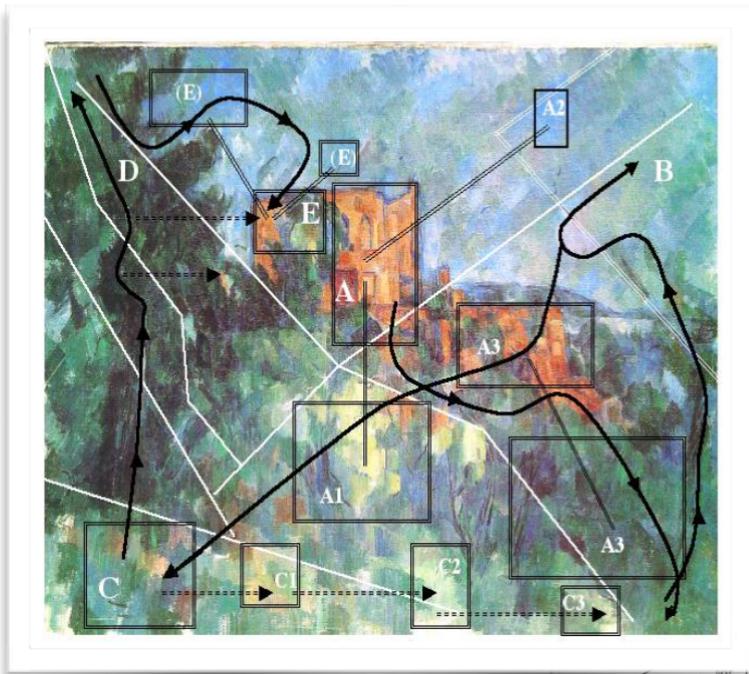
la métaphore spatiale en CAO (exemples)

... où la notion d'espace (et la navigation dans l'espace) donnent lieu à la production de structures musicales.



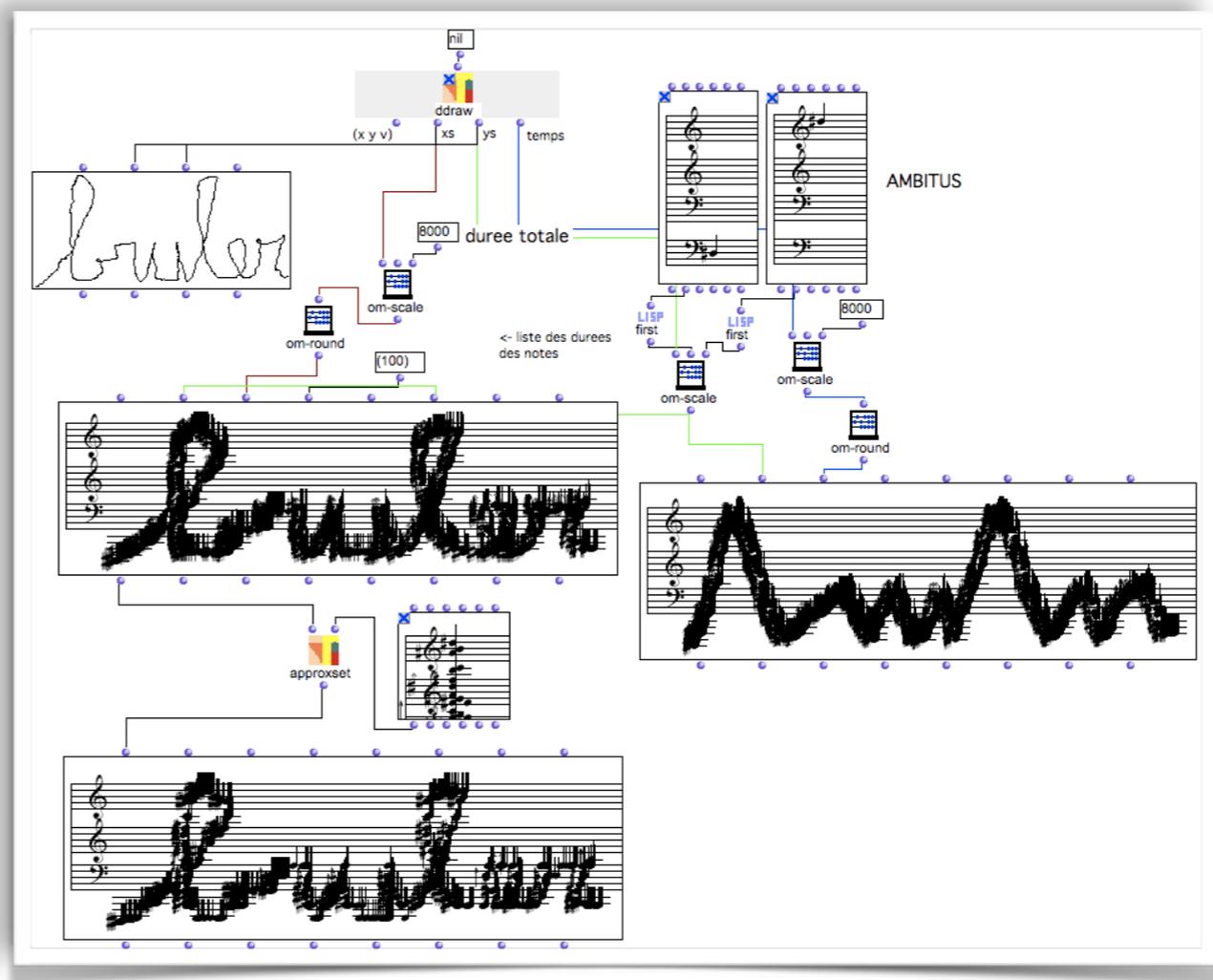
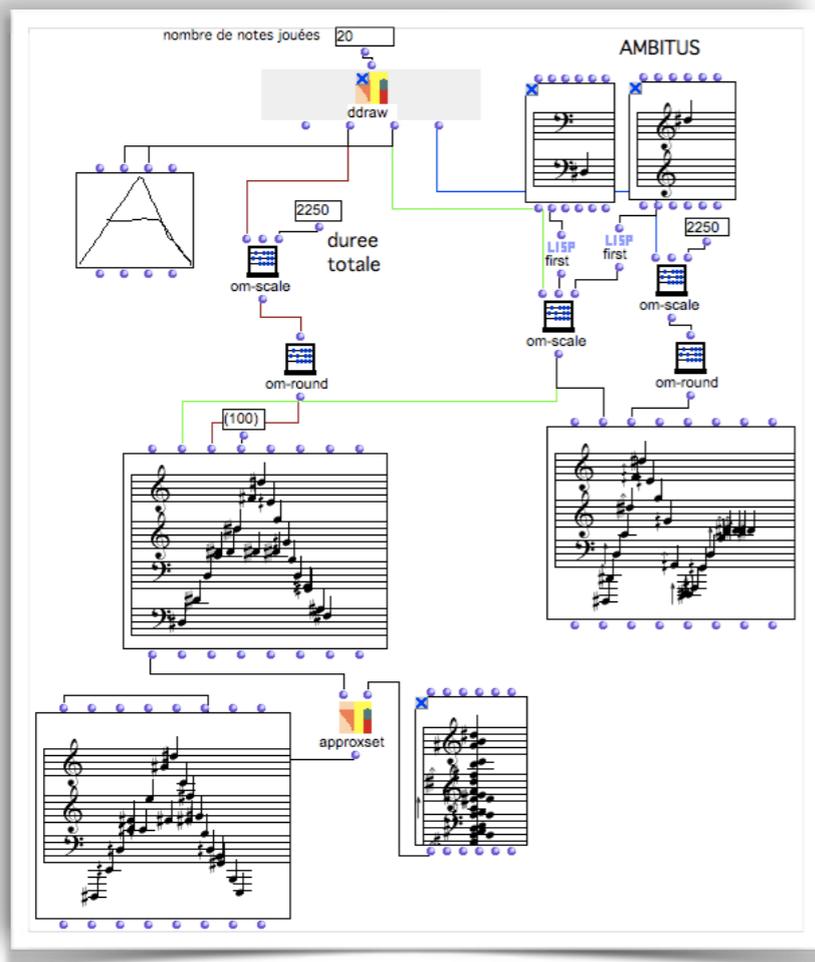
C. Jaksjo
Undergrounded [Zoonestraal] I (2002)
Zoonestraal (2008)

The OM Composer's Book vol. 2
J. Bresson, C. Agon, G. Assayag (Eds.)
Editions Delatour France / IRCAM, 2008.



H. Parra
 Strette (2006)

The OM Composer's Book vol. 2
 J. Bresson, C. Agon, G. Assayag (Eds.)
 Editions Delatour France / IRCAM, 2008.

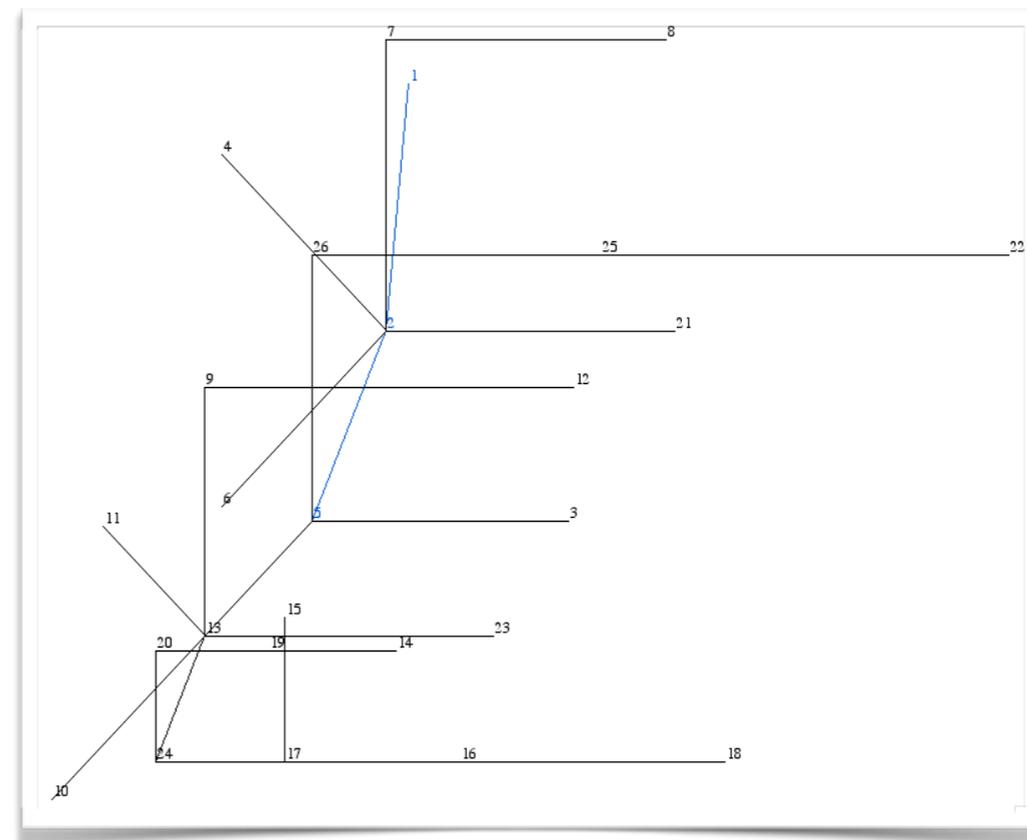
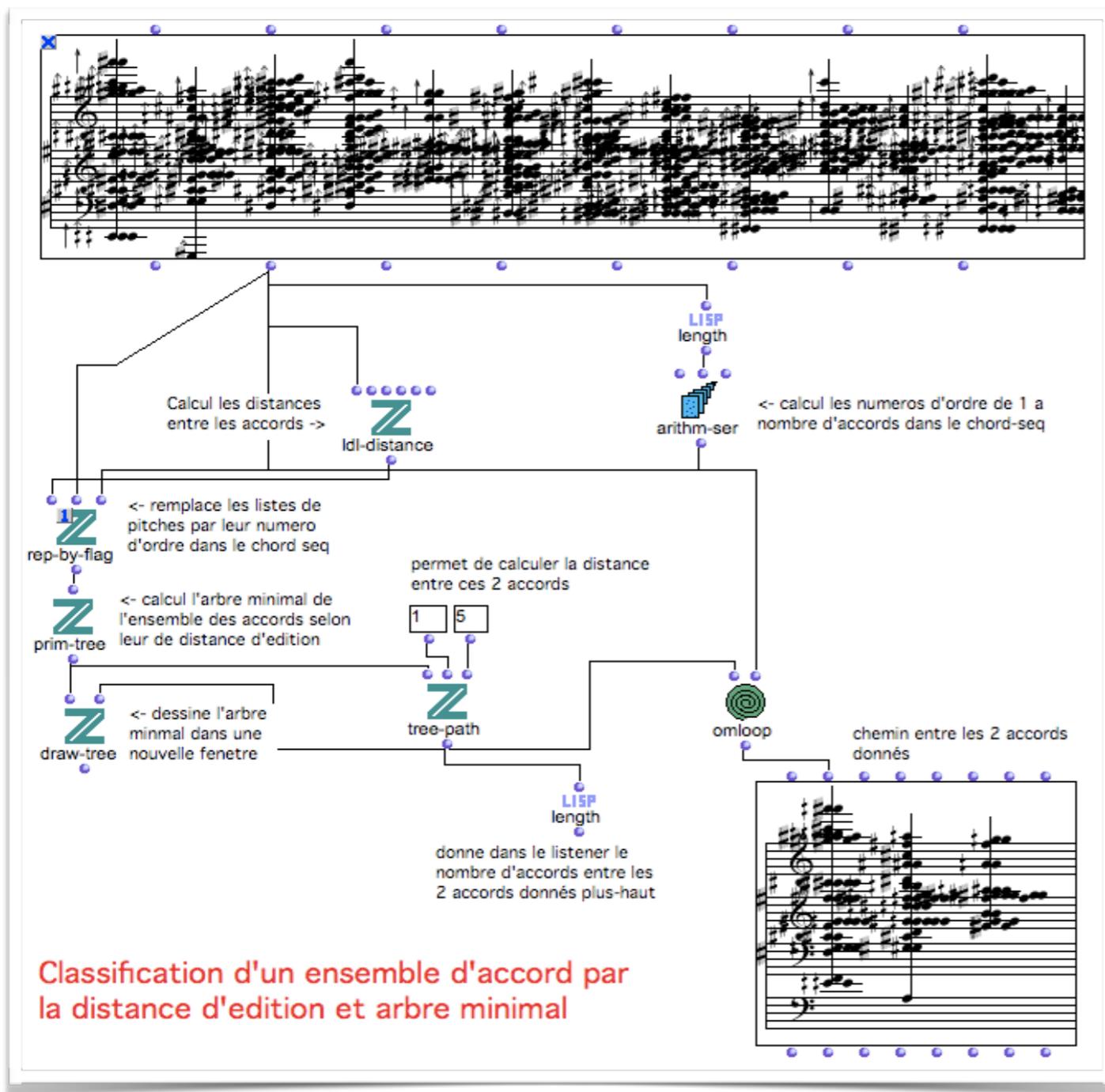


Ph. Leroux
 VOI(REX) (2006)

The OM Composer's Book vol. 2
 J. Bresson, C. Agon, G. Assayag (Eds.)
 Editions Delatour France / IRCAM, 2008.

Recherche et navigation dans les *espaces de représentation*...

Ordonnancement et parcours harmoniques



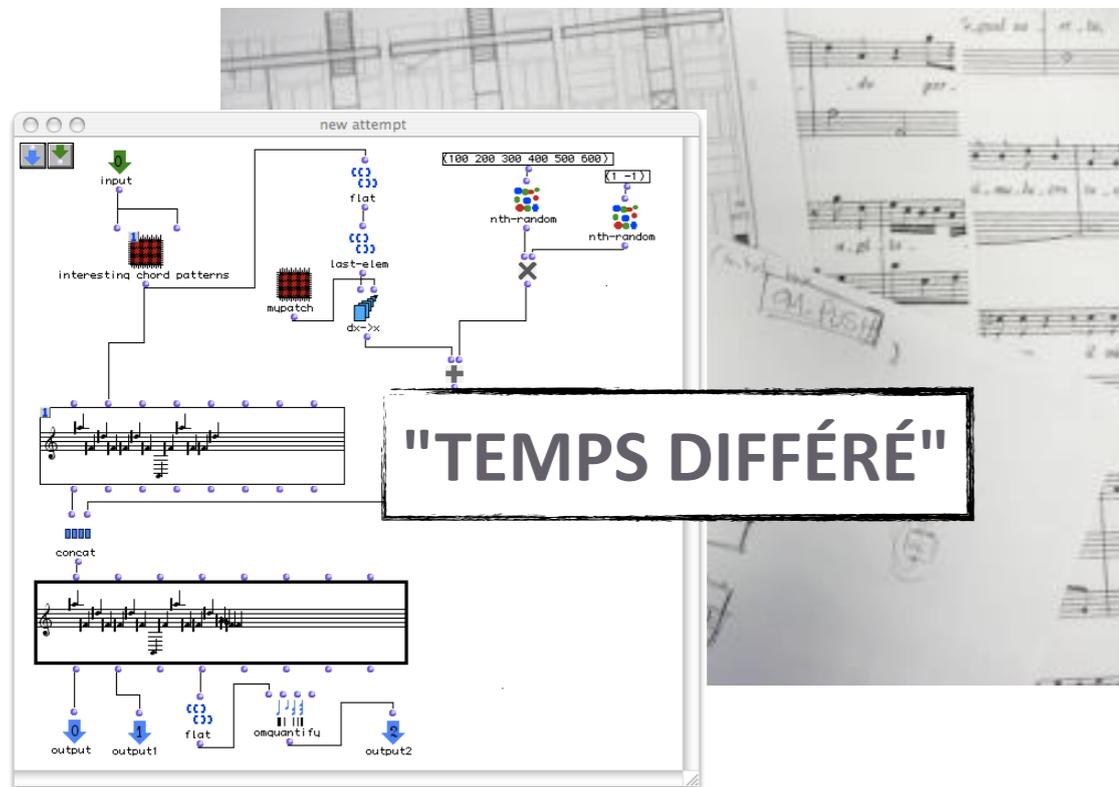
Ph. Leroux
VOI(REX) (2006)

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Recherches actuelles en CAO

Temps et calcul musical

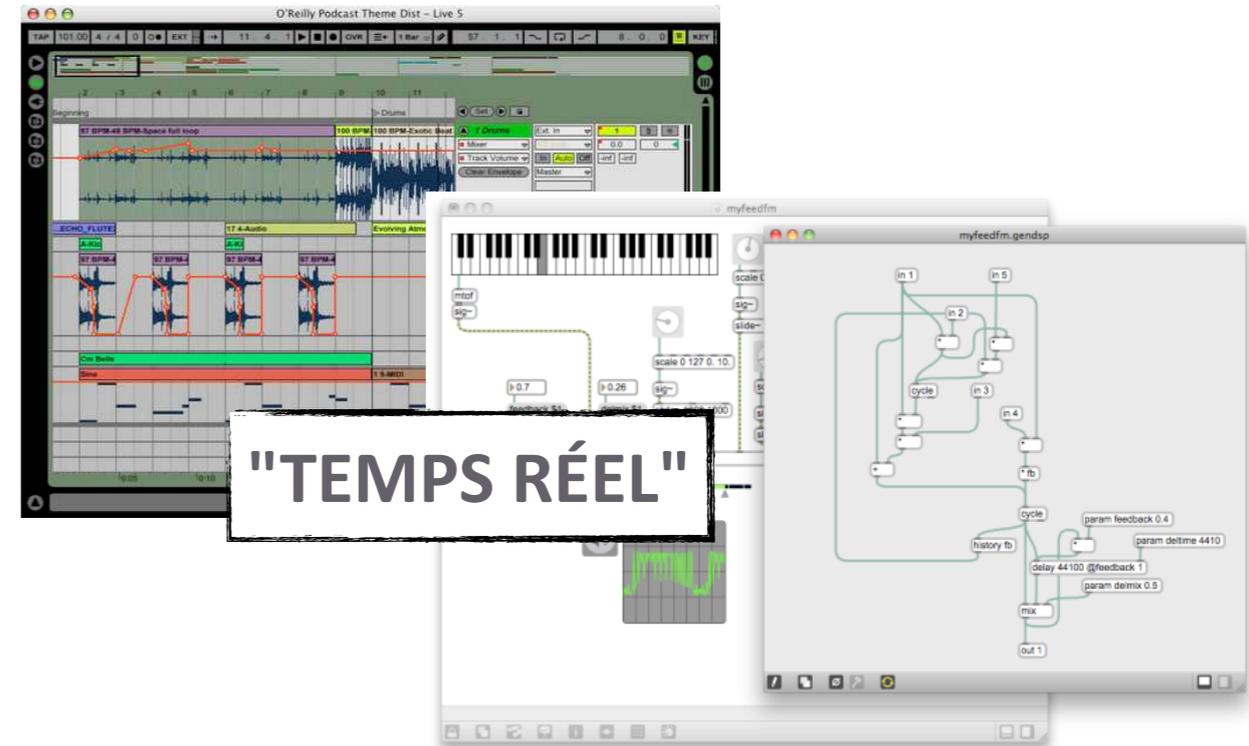
[critères discriminants dans les outils actuels de création musicale]



Composition

Manipulation/calcul symbolique

Données complexes et structurées



Performance/concert

Interaction "live"

Traitement audio temps réel

Fonctionnel
Demand-driven
Transformationnel



Data-flow
Event/data-driven
Réactif

Temps et calcul musical

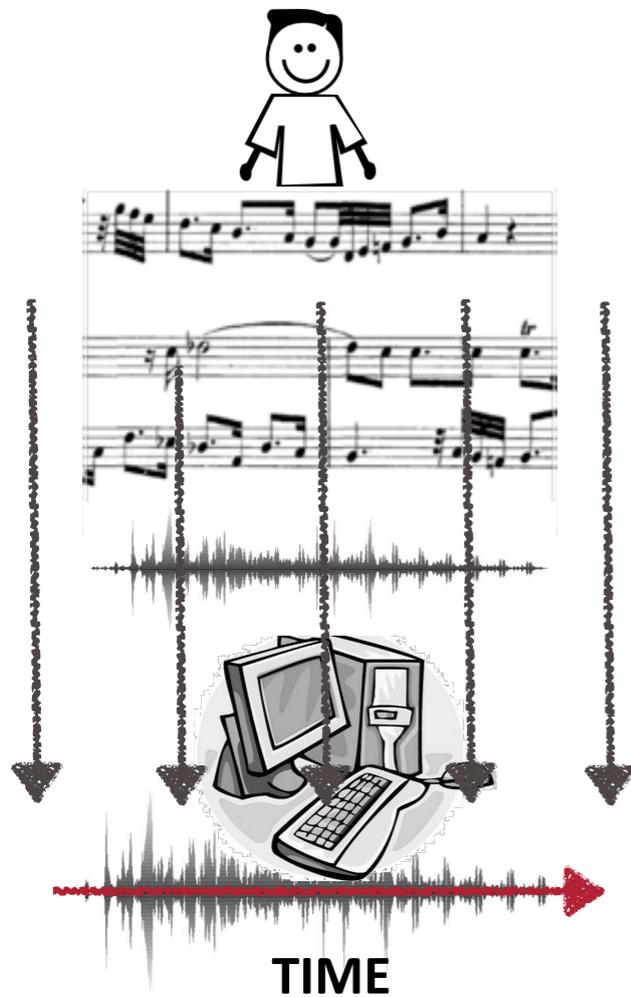


TIME

Approche "composition" / CAO - temps différé:

- Structures musicales générées "hors-temps"
temps du calcul \neq temps "réel" musical
- Formalisation et traitement de structures complexes non contraintes par le temps réel.

Temps et calcul musical



Approche "performance" / Temps-réel :

- Processus *réactifs*
- Structures musicales produites "à la volée" par le système.
- **temps du calcul \approx temps "réel" musical**

Vers des environnements de CAO réactifs



EFFICACE *Extended Frameworks For In-time Computer-Aided Composition*
 (ANR-13-JS02-0004-01)
<http://repmus.ircam.fr/efficace/>

Unification des paradigmes d'execution "demand-driven" et "data-flow réactif"

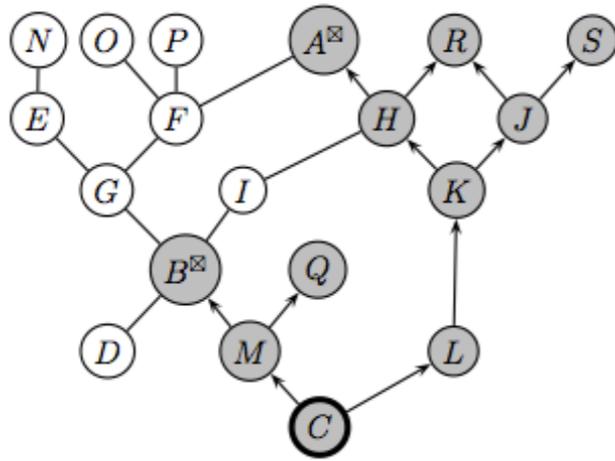


Figure 3: Call graph of the evaluation of C in Fig. 1.

Staggered Evaluation. The previous framework leads to a *staggered evaluation*

$$[[\cdot]]^t(\cdot) : \mathcal{B} \times \mathbb{N} \rightarrow \mathcal{V},$$

where only the values of the boxes required to compute the outputs of r^t are updated:

$$[[b]]^t(k) = \begin{cases} \star & \text{if } b \notin \mathcal{B}^t \\ e^t(b, k) & \text{if } \text{flag}^t(b) = \boxplus \\ [[b]]^{t-1}(k) & \text{if } \text{flag}^t(b) = \boxtimes \\ u & \text{if } \text{flag}^t(b) = \boxminus \\ [[b]]_k(v_1, \dots, v_{in(b)}) & \text{if } b \in \uparrow\{r^t\} \\ [[b]]^{t-1}(k) & \text{otherwise} \end{cases}$$

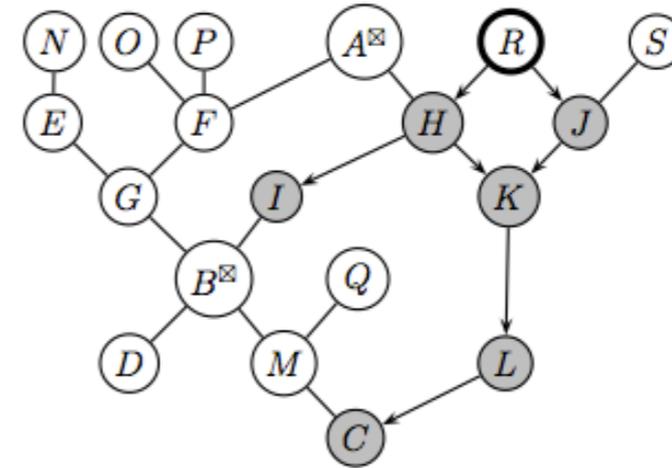


Figure 4: Propagation of event $\{R\}$ in the *reactive patch* from Fig. 1. We suppose that all boxes are active. Notice that $R \notin \downarrow\{R\}$: the values associated to R are obtained by edition, not by evaluation.

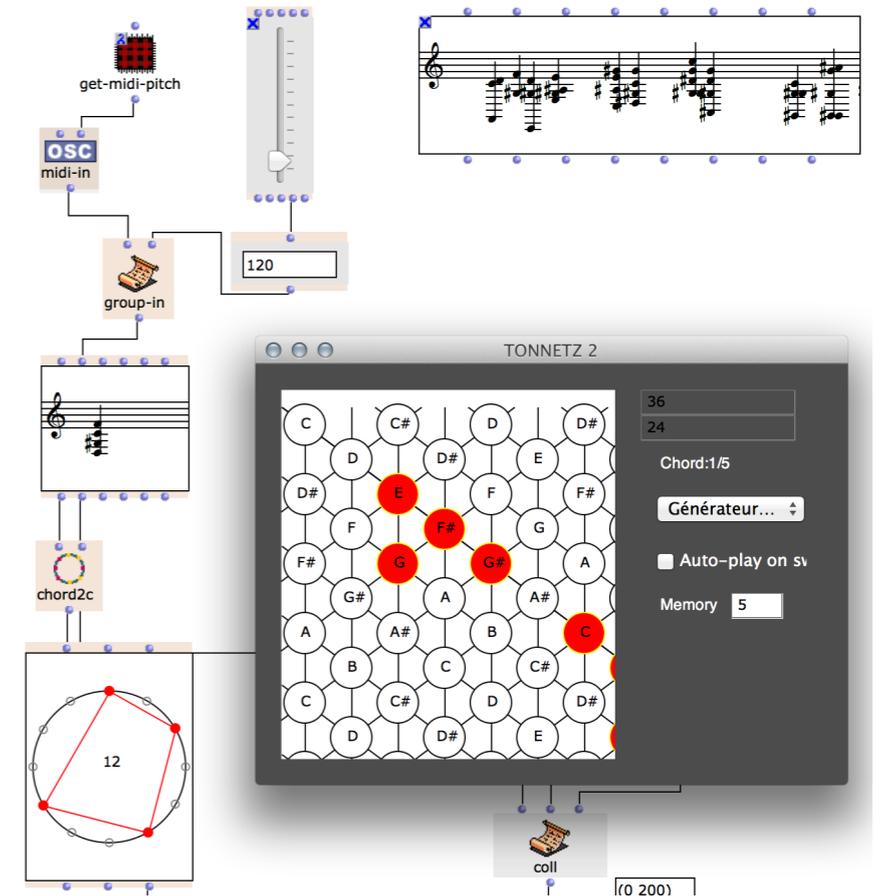
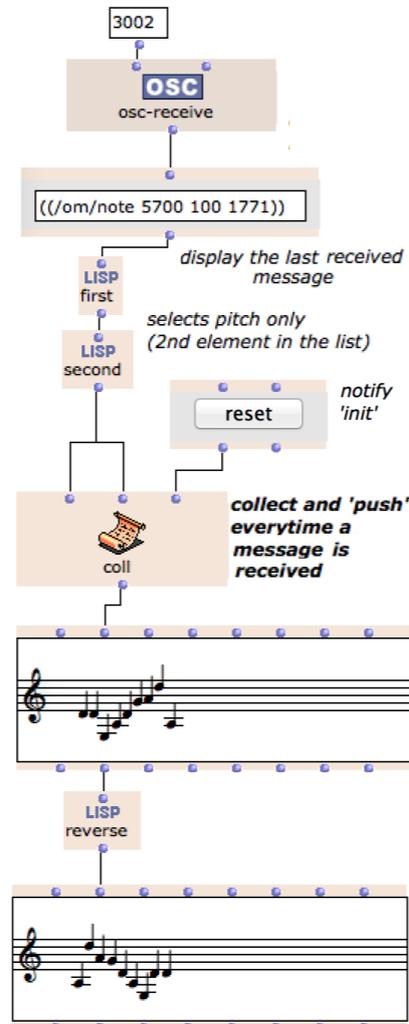
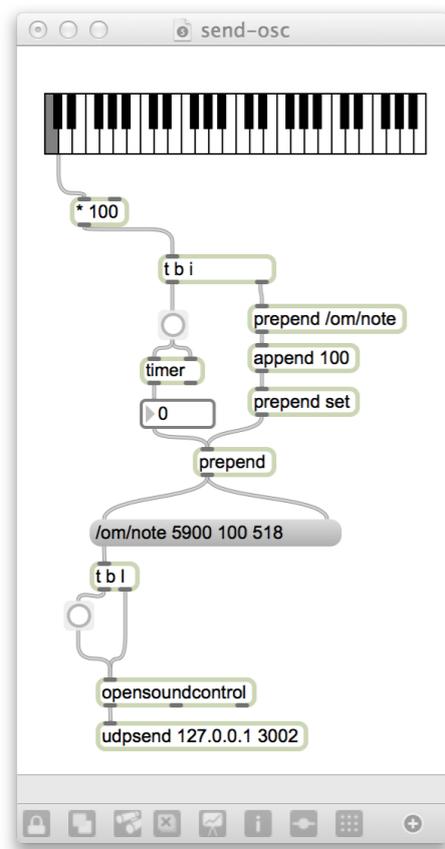
J. Bresson, J.-L. Giavitto, "A Reactive Extension of the OM Visual Programming Language", **Journal of Visual Languages and Computation**, 2014.

Quelques résultats

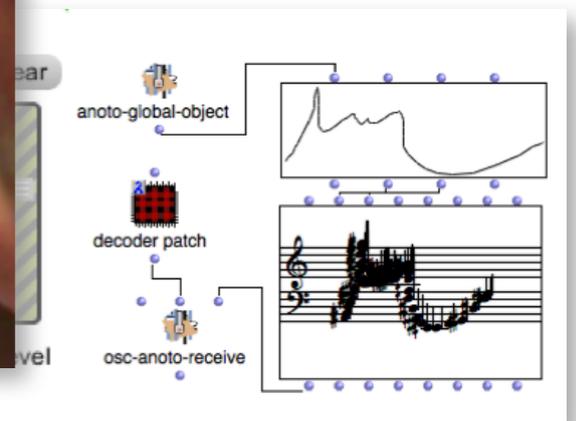
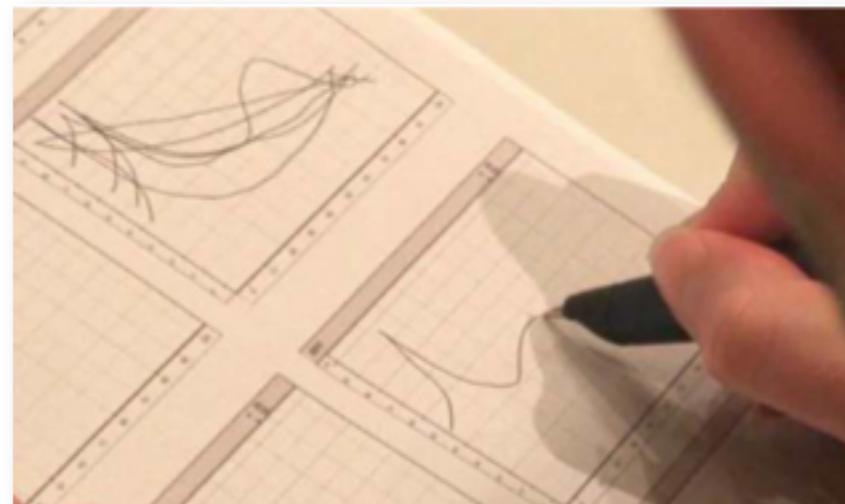
Programme de CAO réactifs pour l'analyse et la composition

Connections inter-application et extension du jeu instrumental (liens vers l'improvisation et l'accompagnement automatisé)

Visualisation dynamique des processus (analyse)



Captation et traitement de données gestuelles.
 Quit sit musicus ? de Philippe Leroux,
 première le 18 juin 2014, IRCAM Manifeste.



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