

Espaces de Chu et musique

Vendredi 9 avril 2010

de 10h à 18h

Ircam, Salle Shannon (matinée) et Salle I. Stravinsky (après-midi)
1, place I. Stravinsky 75004 Paris
(Entrée libre dans la mesure des places disponibles)

Cette séance exceptionnelle du Séminaire MaMuX est consacrée aux espaces de Chu, un concept dont on essaiera de présenter les aspects théoriques touchant à la fois à de questions de logique, de géométrie et d'informatique et leurs applications en musique. Si d'un point mathématique un espace de Chu n'est qu'une simple matrice de transformations, ses lignes ayant la propriété de transformer « en avant » [forwards] et ses colonnes celle de transformer « en arrière » [backwards], ce concept est très profond car il joue un rôle d'unificateur par rapport à plusieurs structures mathématiques, telles les structures de *relations* (ensembles, graphes dirigés, ensembles partiellement ordonnés, ...), les structures *algébriques* (groupes, anneaux, modules, espaces vectoriels, ...) et les structures *topologiques* (espaces topologiques, groupes abéliens localement compact, ...).

La matinée se déroulera sous la forme d'un cours introductif au cadre théorique général animé par Vaughan Pratt, l'un des spécialistes de ce domaine. Dans l'après-midi on se concentrera sur trois aspects de ce formalisme qui sont susceptibles d'ouvrir des applications nouvelles en musique.

Cette séance du Séminaire MaMuX est organisée dans le cadre du projet PEPS Interactions Maths/ST2I « Géométrie de l'Interaction et Musique ». Pour plus d'informations, voir à l'adresse : <http://recherche.ircam.fr/equipes/repmus/mamux/PEPS-GdIM.html>
La séance de l'après-midi est accessible en ligne (en directe) à travers le service "Ircam On Air". Instructions pour visionner la conférence à l'adresse : <http://video.ircam.fr/index.html>

Programme :

- 10h00 - 12h00 **Vaughan Pratt** - A Chu space tutorial
- 14h30 - 14h45 **Moreno Andreatta & Carlos Agon** - Introduction to the session
- 14h45 - 15h30 **Paul-André Melliès** - Chu spaces and the construction of a duality
- 15h45 - 16h30 **Timothy Porter** - The Geometry of Observation
-
- 17h00 - 17h45 **Vaughan Pratt** - Presketches: Algebra without algebras via categories without functors
- Discussion finale

Résumés :

Matinée pédagogique :

Vaughan Pratt (Stanford University): A Chu space tutorial

Selected topics from Chapters 1-4 of « Chu Spaces », Notes for the School on Category Theory and Applications University of Coimbra [<http://boole.stanford.edu/pub/coimbra.pdf>]. The Tutorial is divided in three parts:

A. Introduction to Chu spaces (Coimbra notes, 1999)

- Definitions, examples, properties, realizations
- Linear logic of Chu spaces

B. Process Algebra

- Linear logic as a process algebra (LL'96, TCS 294:3)
- Four-valued tempo (before, during, after, instead; "Transition and cancellation", MSCS 13:4, 2003.)
- Sequential composition and choice

C. Types and attributes

- Yoneda for the rest of us (Ms, Aug. 2009)
- Pointed categories, presheaves, density
- Qualia, duality of types and attributes

Après-midi :

Paul-André Melliès (CNRS/PPS-Jussieu) - Chu spaces and the construction of a duality

In this tutorial talk, I will review the elegant description of the Chu construction discovered by Pavlovic in the 1990s. In particular, I will explain how to see a Chu space as a canonical solution to the question of extracting a duality from the mere existence of a point (or pole) in a category. I will also relate the Chu construction to other important ideas in logic, this including the Dialectica interpretation by Godel (after ideas by Hyland and de Paiva) together with the dynamic and game-theoretic interpretation of the logical interaction.

Timothy Porter (University of Wales, Bangor) - The Geometry of Observation

We start with a simple situation: an observer makes observations about 'something'. The observer has a list of attributes and is observing a set of objects, and notes whether objects have particular attributes or not. (This gives a 2-valued Chu space and is general enough for us - for the moment.) The question is how to 'organise' the observations with respect to spatial, logical, ... aspects of the situation. We will look at classical constructions of Cech and Vietoris from the 1920s from this general point of view, and then look at a more recent uses of similar constructions in Physics and more generally in Topological Data Analysis. We will also brief look at Formal Concept Analysis, a method from A.I. and its relationship with these ideas.

Vaughan Pratt (Stanford University) - Presketches: Algebra without algebras via categories without functors

Bypassing the traditional separation of theory and model, we introduce the notion of presketch as a pointed category, one with a set of distinguished objects as its points or types. Algebras and homomorphisms arise simply as the objects and morphisms of a presketch. As a generalization of the completion of the rationals to the reals, a presketch is full when it densely embeds its points, and complete when it is full and maximal up to equivalence. Every complete presketch is a topos by virtue of being equivalent to a presheaf category, and every presheaf category arises as a complete presketch. The category of models of an Ehresmann sketch arises as a full subcategory of a presketch consisting of those algebras respecting specified limits and colimits; as such the models of a sketch in general do not form a topos.

The passage to a disketch as a category with two sets of distinguished objects, positive and negative, or types and properties, generalizes the passage from sets (more generally the objects of the ambient enriching category V) to Chu spaces by interpreting the morphisms from a type to an algebra A as its individuals of that type, and those from A to a property as the local states of observation in A of that property. C.I. Lewis's problematic qualia (1929) are accounted for in this framework simply as those entities that are ambiguously an individual and a state. As often happens, the previous absence of any mathematically plausible account of qualia might explain the strongly partisan division of philosophers into qualiaphiles and qualiaphobes.

Presketches exploit the Yoneda Lemma to move functors and natural transformations out of the passenger compartment and under the bonnet where they can be accessed as needed without intruding unnecessarily on the working mathematician's day-to-day use of algebra. At the conclusion, we will offer a Chu perspective on the problem of evolution of music and speech under the following topics:

1. Time-tone interference in pitch and rhythm.
2. Common roots of timbre and harmony.
3. Compositionality in composition: the sequential soloist, the parallel orchestra, etc.

Références :

- Chu Spaces Webpage : <http://chu.stanford.edu/>
- Vaughan Pratt, « Chu Spaces », Notes for the School on Category Theory and Applications University of Coimbra July 13-17, 1999. Available online at : <http://boole.stanford.edu/pub/coimbra.pdf>
- J. Gratus and T. Porter, « A Spatial View of Information », *Theoretical Computer Science* 365, 206-215, 2006
- Kurt Godel, *Collected Works*, Vol II, Publications, 1938-1974. Eds Feferman, Dawson, Kleene, Moore, Solovay, van Heijenoort, Oxford University Press, 1990.
- Martin Hyland, « Proof theory in the abstract », *Annals of Pure and Applied Logic*, 114, Issues 1-3, 15 April 2002, p. 43-78
- Valeria de Paiva, « Dialectica categories » *Categories in Computer Science and Logic Contemporary Mathematics*, 92, p. 47-62, American Mathematical Society, 1989.
- C. I. Lewis, *Mind and the World Order : Outline of a Theory of Knowledge*, Scribner's Sons.
- Dusko Pavlovic, « Chu I: cofree equivalences, dualities and *-autonomous categories », *Mathematical Structures in Computer Science*, Volume 7, Issue 1 (February 1997), p. 49-73.

Planning du séminaire :

- Samedi 10 octobre 2009 : Géométrie de l'information et musique.
- Vendredi 13 novembre 2009 : Géométrisation de la logique et de l'informatique musicale.
- Vendredi 4 décembre 2009 : Approche fonctorielle en informatique musicale
- Samedi 5 décembre 2009 : école mathématique pour musiciens et autres non-mathématiciens animée par Pierre Cartier
- Vendredi 15 janvier 2010 : Théorie des nœuds et musique
- Vendredi 12 mars 2010 : Représentations pour l'informatique musicale. Graphes et S-langages
- Samedi 13 mars 2010 : école mathématique pour musiciens et autres non-mathématiciens animée par Pierre Cartier
- Vendredi 9 avril 2010 : *Espaces de Chu et musique*
- Vendredi 14 mai 2010 : Musique algorithmique
- Samedi 15 mai 2010 : école mathématique pour musiciens et autres non-mathématiciens animée par Pierre Cartier

Contacts :

Le Séminaire est organisé par L'Equipe Représentations Musicales de l'IRCAM, en collaboration avec Guerino Mazzola (MultiMediaLab de Université de Zürich / School of Music, University of Minnesota), Franck Jdrzejewski (CEA Saclay - INSTN/UESMS), Thomas Noll (Escola Superior de Musica de Catalunya) et avec le soutiens du CNRS (UMR STMS - Sciences et technologies de la musique et du son).

Pour tout renseignement, contacts et propositions :

Moreno Andreatta (andreatta@ircam.fr)

Carlos Agon Amado (agonc@ircam.fr)

