New perspectives in algebraic systems theory

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The purpose of this talk is to present the algebraic analysis approach to mathematical systems theory developed in recent years. Algebraic analysis, pioneered by B. Malgrange and the Japanese school of M. Sato, is a mathematical theory which studies linear systems of partial differential equations based on module theory, homological algebra and sheaf theory. Ideas, techniques and results of algebraic analysis have recently been extended to different classes of linear systems such as discrete systems, differential time-delay systems, multidimensional systems or infinite-dimensional systems.

The module-theoretic approach to linear systems developed within algebraic analysis gives a unified mathematical framework (common concepts, techniques, results, algorithms and implementations) for the study of the structural properties of different classes of multidimensional linear systems and infinite-dimensional linear systems and for the study of synthesis problems (e.g., optimal control, stabilization problems). In particular, the module characterizations of the structural properties developed in this approach are intrinsic in the sense that they do not depend on particular representations of the linear system (e.g., state-space or input-output representations for $1D$ linear systems, Roesser or Fornasini-Marchesini models for multidimensional systems). Within algebraic analysis, the behavioural approach to linear systems can be found again and more intrinsically developed. Using powerful tools of homological algebra, we can then obtain general characterizations for the module properties corresponding to the system properties. Finally, using constructive algebra (e.g., non-commutative Gröbner or Janet bases) and symbolic computation, those homological characterizations can be made constructive over certain classes of multidimensional systems (e.g., differential time-delay systems, under-determined systems of partial differential or difference equations) and can be implemented in dedicated symbolic computation packages (e.g., OreModules, OreMorphisms, JanetOre, QuillenSuslin, Stafford).

Alban Quadrat was born in 1973 at Le Chesnay in France. After studies in pure and applied mathematics at the University of Versailles and a Master's Degree at the University of Orsay (Paris XI) in control theory and signal processing, he was awarded a PhD thesis in mathematics by the Ecole Nationale des Ponts et Chaussés (one of the oldest French Engineering Institutes in France) under the supervision of Jean-François Pommaret (1999).

Following his employment as a postdoctorate, under the guidance of J. R. Partington, at the Department of Pure Mathematics at the University of Leeds (United Kingdom), he joined, as a researcher, INRIA Sophia-Antipolis (a branch of The French National Institute for Computer Science and Control located near Nice, France) in 2001.

He is an associated editor of the journal "Multidimensional Systems and Signal Processing". His main interests are algebra (algebraic analysis, module theory, homological algebra, symbolic computation), mathematical systems theory (multidimensional systems, behavioural approach, infinite-dimensional systems, stabilization problems), (algebraic, differential and non-commutative) geometry, mathematical physics, and history of science.