On the evaluation of GALAAD/SymB

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First, we thank the reviewers for the important, precise and structured evaluation they provide on the work of the team GALAAD.
The following strong points have been emphasis:

- Our mathematical inclinations and strong background in this domain,
- Our national and international visibility, through high scientific quality publications and our commitment in conference organisations.
- Our strong implication in Ph.D. research training.
- Our effective participations to several national, European projects, and international scientific collaborations.

The following weak points have been mentioned:

- the need to clarify the interaction between theory and applications in our future activities.
- the need to reinforce the development and dissemination of our software.

Applications

Our scientific proposal identifies CAGD as the main domain of applications of our works. This orientation started 4 years ago with our partnership with the CAGD company Think3 in the context of the GAIA European project. We are involved in the NoE Aim@Shape, regrouping several European leading teams in geometric modeling. This orientation is becoming more and more visible in our current activities.

During the European project GAIA, software has been developed to solve some critical problems in CAGD, such as (self-)intersection computation. This software was embedded in Think Design (the product of Think3) for testing and validations. The feedback on industrial examples was very good. We fully agree on the proposition to connect our tools with a CAD platform and are willing to do it with the plateform of Missler (contacts have already started). Let us mentioned also that some

of our published algorithms have been reimplemented in BOEING and yield significant improvements, compared with the previous tools.

Connected to the "modeling life" strategic action, we are also working now on applications in agronomy in collaboration with CIRAD and INRA (reconstructions of leaves and ramified structures from scanned points). These problems involve representation and manipulation of shapes by models similar to those used in CAGD, for which we exploit our expertise in algebraic-geometric computation, on noisy data.

At a second level, we consider applications in signal processing, where we are historically involved through the collaboration with P. Comon (I3S). This is a long-standing activity, with applications of mathematical methods for solving important problems of another domain. Our works on structured matrices with approximate coefficients, as they appear in approximate gcd, resultant, discriminant computation or factorisation problems are directly involved in this collaboration.

Future activities

The topics on which we plan to focus our research activities are the resolution of polynomial systems in low dimension, computational topology for (semi-algebraic) curves and surfaces. In particular, this includes the treatment of singularities and arrangement problems on curved objects. Our important activity on resultants will continue with a focus on discriminant problems, as well as our work on structured matrices, and on factorisation and decomposition questions. The study of specific families of surfaces such as quadric, ruled surfaces, low degree parameterisation, canal surfaces, ... will be developed further. The interaction between symbolic and numeric computation is another important topic, where a lot of work is needed.

We should emphazise that these topics are motivated and driven by application problems. The need to manipulation models, which are known with some error and to guarantee if possible the results, is ubiquitous in many domains such as CAGD, Signal processing. However, taking algebraic techniques which work in an exact context, and applying them on data with incertitude usually fails. A significant research work is required to analyse and develop such certified algebraic methods on approximate data. For instance, intersection or singularity problems, which have been identified as critical issues in CAGD, lead us to consider subdivision techniques for solving polynomial equations. These problems raise new theoretical questions on the behavior of such methods in the presence of singularities. Their analysis help us to device new algorithms, which improved the existing one. Some of them have been implemented and successfully embedded into an industrial environment.

The reconstruction problem of plant models from discrete data leads to the manipulation of cylinders, canal surfaces or low degree parameterised surfaces. Specific tools dedicated to such family of surfaces are needed, which involve specific resultant constructions or discriminants. This activity is exactly in the spirit of our work on sparse or toric, residual resultants, or with separated variables. In many cases, the corresponding theory is not there and has to be developed. This theoretical develop-

ments are moreover expected from the application domain, with which we interact. Our research activity is thus focusing on these problems, motivated by (geometric) applications, and for which we aim at providing theoretical results as well as optimised algorithms and implementations for these applications.

Software

The development of software and its dissemination is a task which is very time consuming and for which we need a strong support. Currently, in the context of the ANR GECKO, we are contributing to an open software platform devoted to algebraic and analytic computation, with the aim to strength software collaboration.

In this context, we are working on the connections with external software (partially illustrated with AXEL) in order to have simple ways to embed our dedicated tools into preferably free or even proprietary software. In particular, our tools for the manipulation and visualisation of curves and surfaces can be connected to general environments such as SINGULAR, PYTHON, SCILAB, MATLAB, MAPLE, ... as well as to the industrial products of THINK3, MISSLER ... This is also illustrated by the interaction (under construction) between CGAL and AXEL for interactive modelisation purposes.

In order to reach such software integration and diffusion, we really need a support from INRIA. We fully agree with the proposition to dedicate a long-term software engineer to help us in this task of developments, maintenance and connections, which as mentioned, is important for applications and to reach an industrial impact.

Positioning

The reviewers provided a very good analysis of our specificities, which we want to emphasis:

- The resolution of strutured, small dimensional systems. The development of tools for intensive reliable computation in non-linear computational geometry (eg. for computing the topology of 3D implicit curves or surfaces), where polynomial solvers are fundamental ingredients. Algebraic models, such as quadrics, low degree parameterised or implicit surfaces, ... are used as geometric primitives to represent complex shapes and dedicated methods are developed to handle them. The treatment of singularities is a key issue, on which we are concentrating important efforts.

- Symbolic-Numeric computation, in order to approximate and certify the results, taking into account noisy data, and based on strong mathematical foundations. This is illustrated by our works on approximate gcd computation, factorisation, structured linear algebra, resultants, and discriminants. It is directly linked to the analysis and treatment of singularities. It combines analytic and algebraic techniques.

Our activity is complementary with the approach of SALSA, using general methods and which focuses on (large) polynomial systems coming from different applications areas (eg. robotics). The activity of GEOMETRICA is focusing on "discrete" (or piecewise linear) models such as meshes; we are working in non-linear computational geometry. In addition to the international collaborations we have developed (Athens, Oslo, Linz, Santander, Barcelona, Rice university, Buenos Aires, City Univ. New York, Hong Kong), we are also working with INRIA projects such as ALGO and university groups in France on symbolic-numeric computations, in the context of the ANR GECKO.

General comments on the theme SymB

The important production of software by the program SymB has been noticed. Its scope includes arithmetic, algebraic, geometric, differential computations. Its is suggested that a concrete plan of measures should be taken to guarantee a long lasting availability of this code, its maintenance, while improving its strength and encouraging software collaborations. For this purpose, we agree that there is a need to reinforce our activities with the help of a shared permanent software engineer, having strong connections with the research activity. The questions of scientific valorisation of software development and of software publications are also raised.