An overview of the SCIEnce Project

Abstract

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Introduction

It should be first stated that this presentation has no claim for originality and that its author has no personnal merits in the works that are described here, his team being mostly involved in other tasks of the project.

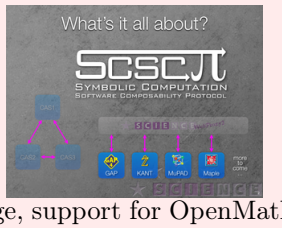
The aims of SCIEnce are to allow sharing components of computer algebra systems, to make CAS interoperable through suitable Web services and to make them ready for the use of Grid computing. The project started on april 9th 2006 for 5 years. It involves developpers of four major CAS : GAP, KANT, Maple and MuPAD.

As the DART community may be interested by computation tools that are not available in a single CAS, and also in specialized softwares, such as BLAD or Lépisme, I thought interesting to take advantage of this conference to present tools dedicated to software interoperability.

Moreover, we know that differential algebraic system solving, that is worse than algebraic system solving, may be a task of a great complexity, so that we could perhaps take advantage of Grid computing. These are the main motivations of this poster, hoping that specialists will forgive the inaccuracies, the goal being to bring attention to direct and better sources.

1 Software composability

The work on software composability is mostly centered on SCSCP (Symbolic Computation Software Composability Protocol)[5], which is a remote procedure call framework with two main specificities : it relies on OpenMath [1] [3], for both protocol messages and data, and it is implemented in the computer algebra systems, instead of using wrappers.



At this stage, support for OpenMath and SCSCP has been developped in GAP, by Alexander Konovalov and Steve Linton, Marco Costantini, Andrew Solomon ; KANT by Sebastien Freundt and Sylla Lesseni ; MUPAD by Peter Horn.

2 Related tools

A Java library has also been developped, that supports OpenMath representation and also offers LaTeXexport.

OpenMath has been designed for communication between computers, not humans. So, an OpenMath representation convenient for direct user interaction, Popcorn, which stands for "Only Practical Convenient OpenMath Replacement Notation", has been developped. The Java library mentioned above also supports Popcorn.

WUPSI (Universal Popcorn SCSCP Interface) is a command line that can be used to access an arbitrary number of SCSCP servers, possibly in parallel and to exchange data between them. It can also be used to retrieve information on OpenMath symbols or be used as a manual SCSCP sever.

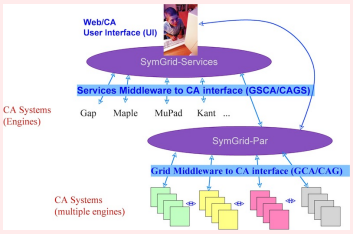
1. OpenMath is a standard to represent mathematical object with their semantics that can be used for their storage on databases, exchanges between computer programs or publication on web pages. It is strongly related to the MathML recommendation of the Worldwide Web Consortium.

With the long term goal of proving or certifying algorithms used in computer algebra systems, a Computer algebra object internalisation in Coq proof assistant has been provided[2]

3 Grid computing

A new grid framework, SymGrid has been developped. Maple, GAP, Kant and Mupad are initially integrated into the project. These heterogenous symbolic components may be used together, possibly in parallel.

The project includes two main components : SymGrid services, a generic interface to grid services, provides an interface to Grid and Web services that relies on OpenMath. SymGrid-Par is built around GRIDGUM, a system designed for parallel computation on the Grid, with adaptations for symbolic engines, using again OpenMath.



4 Differential equations in OpenMath

I will try here to give a few examples of the OpenMath syntax. The most basic definitions are to be found in OpenMath CD (Content Dictionary) `calculus1`. This is how

$$\frac{\partial^2}{\partial x \partial y}(xyz) = z$$

looks like in OpenMath.

```
<math xmlns="http://www.w3.org/1998/Math/MathML">
 <apply><csymbol cd="relation1">eq</csymbol>
  <apply>
   <apply><csymbol cd="calculus1">partialdiffdegree</csymbol>
    <apply><csymbol cd="list1">list</csymbol><cn>1</cn><cn>0</cn><cn>1</cn></apply>
    <cn>2</cn>
    <bind><csymbol cd="fns1">lambda</csymbol>
     <bvar><ci>x</ci></bvar>
     <bvar><ci>y</ci></bvar>
     <bvar><ci>z</ci></bvar>
     <apply><csymbol cd="arith1">times</csymbol><ci>x</ci><ci>y</ci><ci>z</ci></apply>
    </bind>
   </apply>
   <ci>x</ci>
   <ci>y</ci>
   <ci>z</ci>
  </apply>
  <ci>y</ci>
 </apply>
</math>
```

We see that the Popcorn notation is easier to handle.

```
calculus1.partialdiffdegree([1 , 0 , 1], 2, fns1.lambda[$x, $y, $z -> $x * $y * $z])($x, $y, $z) = $y
```

Obviously, we are still missing many objects required for differential algebra. We may however notice the existence of the CD `weylalgebra1`. The important question of data structure does not seem to be taken in account in most cases. However, the CD `equations1` privides predicates "dense" and "sparse". Some CD, such as `polyd1` provide definitions for multivariate polynomial, adapted for Gröbner bases computations, condidered in `polygb1` and `polygb2`. I found nothing for differential polynomials, or characteristic sets, even in the pure algebraic case.

Besides computer algebra, OpenMath could also be used to search information on the Web, provided that people actually use it as a standard ! The paper of Draheim *et al.*[1] considers the issue of looking for possible occurences of a given differential equations on the WEB.

Conclusion

It is not clear that the success of a standard is due to its quality, nor that it fails to be adopted because of its technical drawbacks. It seems rather in many cases that it is just a question of critical mass and initial success, for unknown reasons. People develop the standard because they feel it will become a reference and such a process is self-sustained.

Obviously, many tools are still lacking in OpenMath, mostly for specialised fields of research such as differential algebra, but enough has been done to consider the development of new definitions with a limited amount of extra work.

A few references

[1] Draheim (Dirk), Neun (Wilfrid) and Suliman (Dima), "Classifying Differential Equations on the Web", *Mathematical Knowledge Management*, LNCS 3119, 2004, 104-115.

[2] Komendantsky (Vladimir), Konovalov (Alexander) and Linton (Steve), *Interfacing Coq + SSReflect with GAP*, to appear in the ENTCS proceedings of UITP 2010.

[3] Open Math

[4] Costantini (Marco), Konovalov (Alexander), Solomon (Andrew), *OpenMath functionality in GAP Version 10.0.4*, 2009.

[5] S. Freundt, P. Horn, A. Konovalov, S. Linton, D. Roozemond, *Symbolic Computation Software Composability Protocol (SCSCP) Specification*, Version 1.3, 2009.