MAX Team

An overview of the SCIEnce Project

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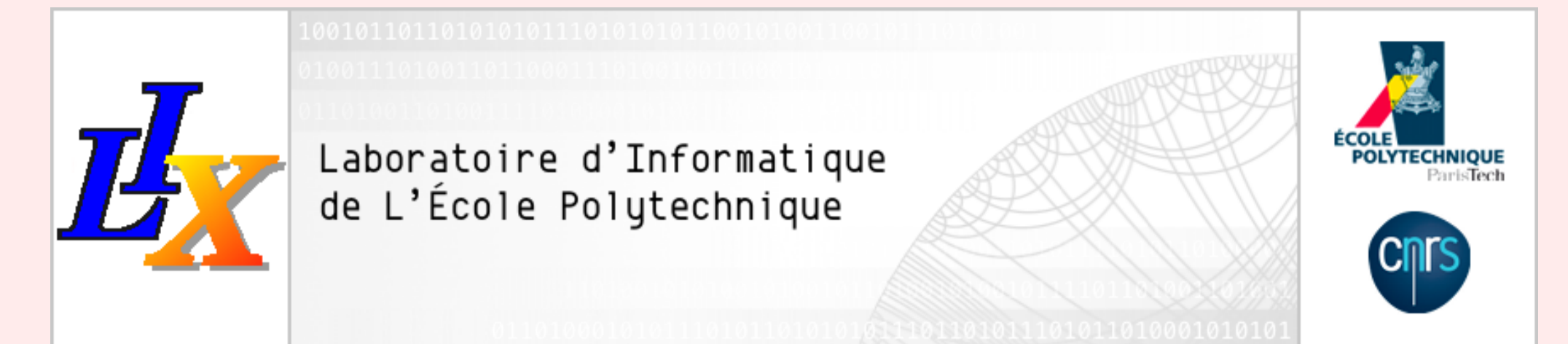
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Introduction

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 [1] 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 1st 2006 for 5 years. It involves developers 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 [2] or *Lépisme* [3], 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.

Software composability

The work on software composability is mostly centered on SCSCP (Symbolic Computation Software Composability Protocol)[8, 9], which is a remote procedure call framework with two main specificities: it relies on OpenMath—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 [6]—, 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.

Related tools

A Java library has also been developed, 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 developed. 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.


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[5]

Grid computing

A new grid framework, SymGrid has been developed. 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 GRID-GUM, a system designed for parallel computation on the Grid, with adaptations for symbolic engines, using again OpenMath.
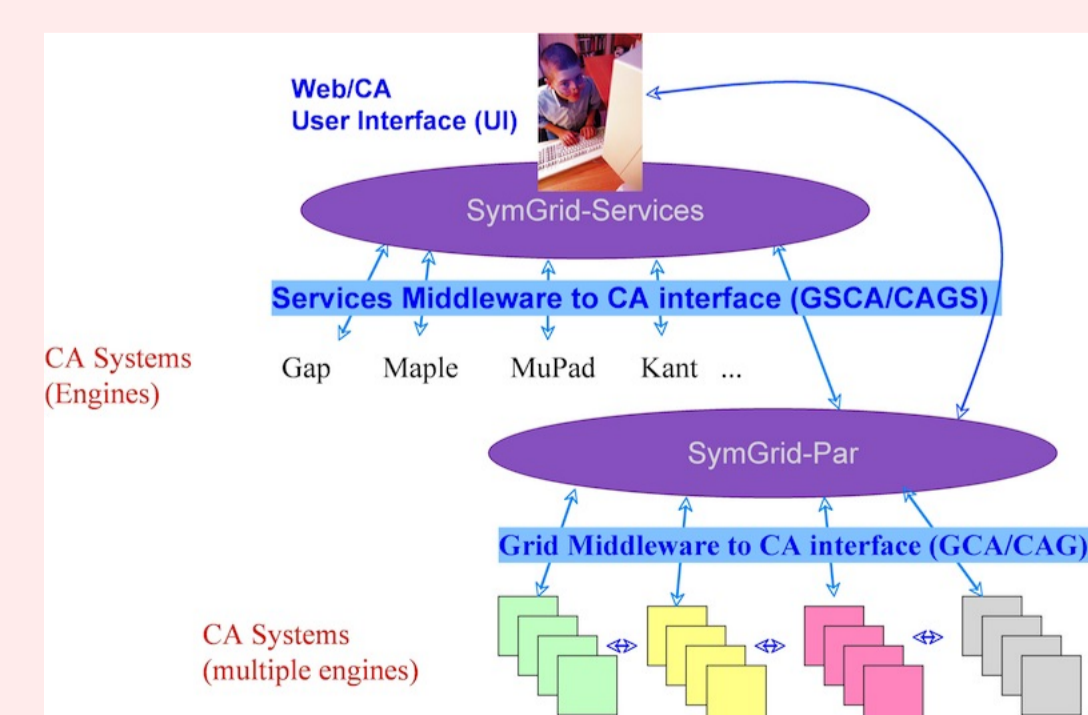
Differential equations in OpenMath

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></ci>
 </apply>
</math>
```

We see that the Popcorn notation is easier to handle. It is nevertheless possible for specific applications to use their own format, encoded in a private CD, or using *OMSTRING*, *OMBYTES* or *OMFOREIGN*.

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, considered in `polygb1` and `polygb2`. I found nothing for differential polynomials, or characteristic sets, even in the pure algebraic case.

It should be noticed that one is not limited to data structures for which CDs already exist. It is allowed to use *transcient* CDs obtainable from the server on request and containing specific data.

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.*[4] 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] SCIEnce Project, `http://www.symbolic-computation.org/The_SCIEnce_Project`

[2], BLAD, `http://www2.lifl.fr/~boulier/pmwiki/pmwiki.php/Main/BLAD`

[3], *Lépisme*, `http://www.lifl.fr/~lemaire/lepisme/`

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

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

[6] Open Math, `http://www.openmath.org/`

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

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

[9] Konovalov (Alexander], *A New Lingua Franca for Symbolic Computation: Easy Composition of Symbolic Computation Software*, communication to SCIEnce Workshop at CICM 2010.

Thanks to Alexander Konovalov for very valuable comments and suggestions.

Mathemagix + TeXmacs

A special advertising for good friends doing good work. . .
Mathemagix is a free computer algebra system under development. The main contributors are Joris van der Hoeven, Grégoire Lecerf and Bernard Mourrain. It provides a high level, strongly typed language, together with packages, written in C++. These packages are connected to the interpreter, but can also be used separately. A compiler is under development.

The existing libraries cover the basic needs of computer algebra, and more. . .

The program is connected to the algebraic-geometric modeler axel as a tool for visualisation and geometric computation. An other interesting particularity is that the programm can be used within GNU TeXmacs as a primary interface.

TeXmacs is a free wysiwyw (what you see is what you want) editing platform with special features for scientists. The software aims to provide a unified and user friendly framework for editing structured documents with different types of content: text, graphics, mathematics, interactive content, etc. The rendering engine produces professionally looking documents, which can either be printed out or presented from a laptop. A very interesting point is that slides may be corrected during a talk and that computation in Mathemagix can also be done from TeXmacs.

TeXmacs runs on all major Unix platforms and Windows. Documents can be saved in TeXmacs, Xml or Scheme format and printed as Postscript or Pdf files. Converters exist for TeX/LaTeX and Html/Mathml.
`http://www.mathemagix.org/`
`http://www.texmacs.org/`