SCIEnce: Composition of Symbolic Computation Software

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Dan Roozemond
TU Eindhoven, NL
d.a.roozemond@tue.nl

&

Peter Horn
University Kassel, DE
horn@math.uni-kassel.de

www.symbolic-computation.org

- European “Framework 6” programme,
- Started April 2006, runs for 5 years,
- Main purpose:

“to unite the European community of researchers in, and users of, symbolic computation. SCIEnce aims to promote the development of new software that is

- made more efficient by sharing components and expertise;
- made more interoperable in the modern Web services environment; and
- ready for the coming environment of Grid computing.”

- The Centre for Interdisciplinary Research in Computational Algebra,
  University of St Andrews, Scotland
- Research Institute for Symbolic Computation,
  Linz, Austria
- Ecole Polytechnique,
  Centre National de la Recherche Scientifique, Paris, France
- Computational Mathematicatics Group,
  Universität Kassel,Germany
- The KANT group,
  Technische Universität Berlin, Germany
- Discrete Algebra and Geometry group,
  Technische Universiteit Eindhoven, Netherlands
- Institute e-Austria Timisoara,
  Romania
- Maplesoft,
  Waterloo, Canada
- The Dependable Systems Research Group,
  Heriot-Watt University, Edinburgh, Scotland

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What's it all about?

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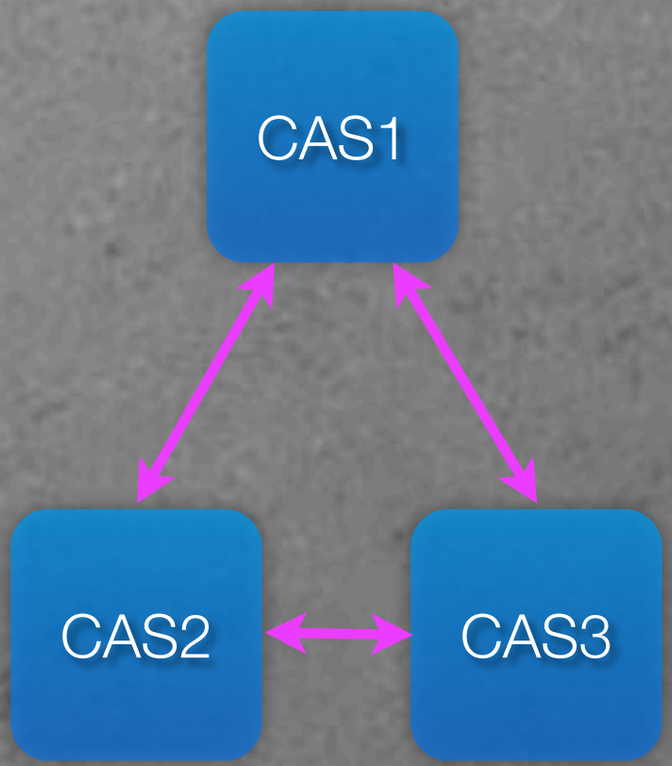
Directly linking
Symbolic
Software



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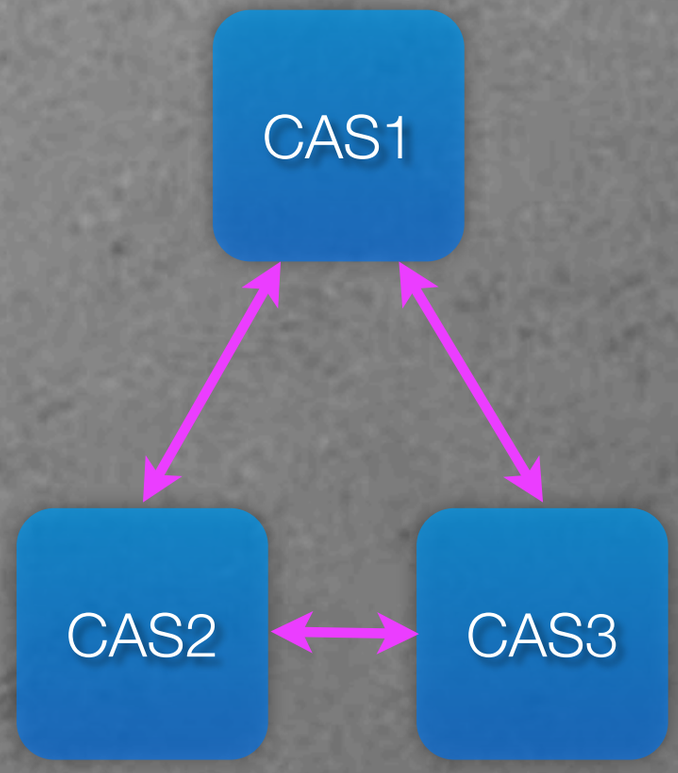
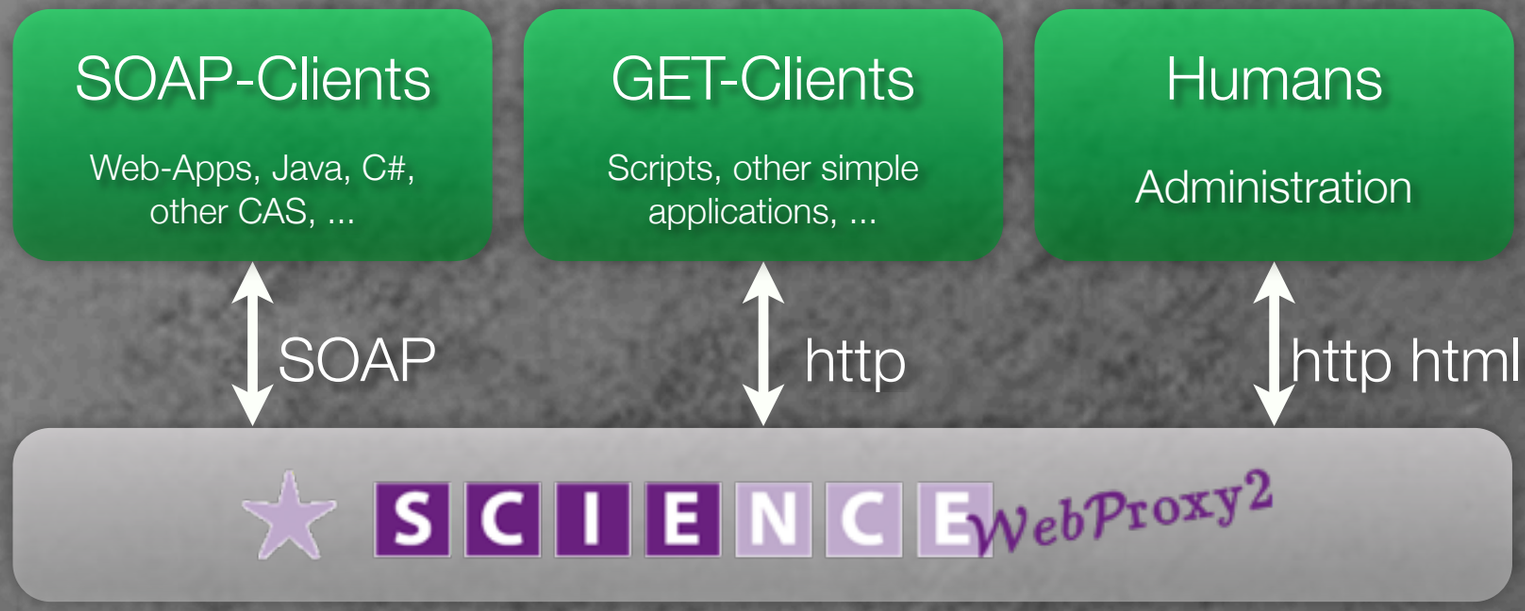
Directly linking Symbolic Software



Link Symbolic Software to other Systems



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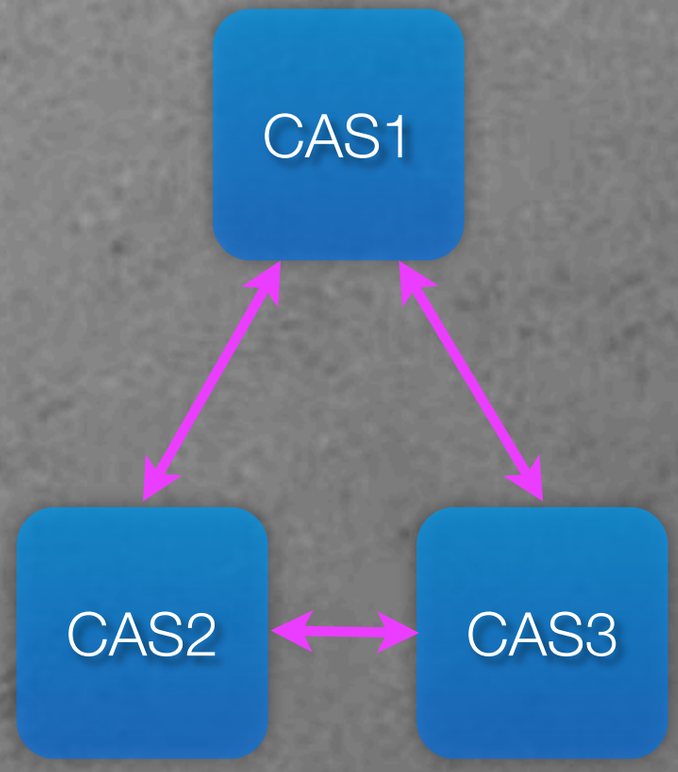
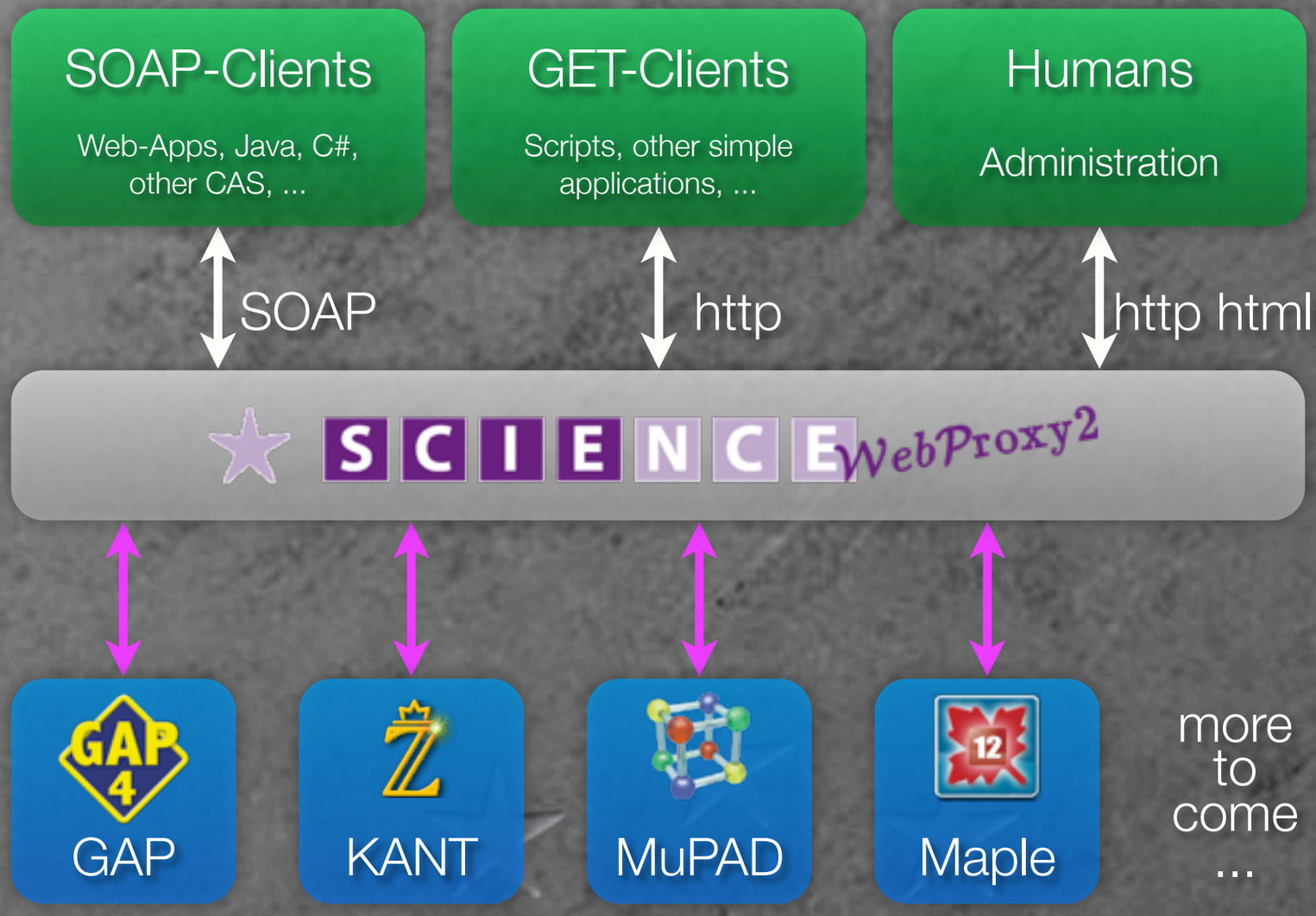
Directly linking Symbolic Software



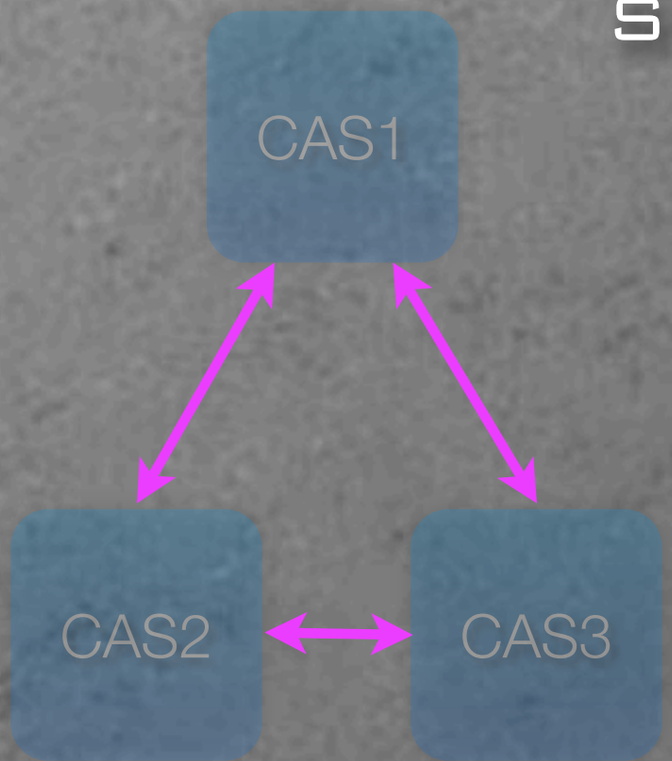
Link Symbolic Software to other Systems

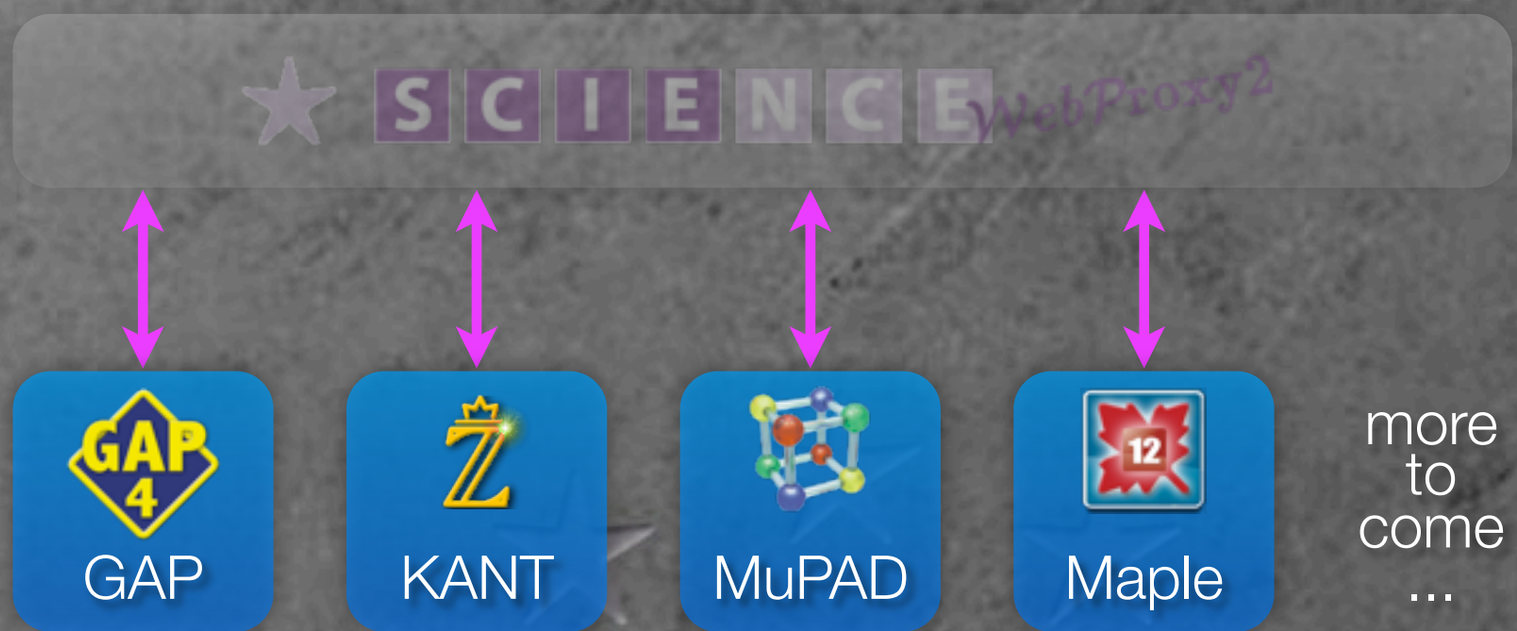


What's it all about?

SCSCP

Symbolic Computation Software Composability Protocol





OpenMath

- Standard for representing mathematical objects
- Focused on semantics
- Extensible

1+2	<OMOBJ><OMA><OMS cd="arith1" name="plus"/> <OMI>1</OMI><OMI>2</OMI></OMA></OMOBJ>
x → x·π	<OMOBJ><OMBIND><OMS cd="fns1" name="lambda"/> <OMBVAR><OMV name="x"/></OMBVAR> <OMA><OMS cd="arith1" name="times"/><OMV name="x"/> <OMS cd="nums2" name="pi"/> </OMA></OMBIND></OMOBJ>


OpenMath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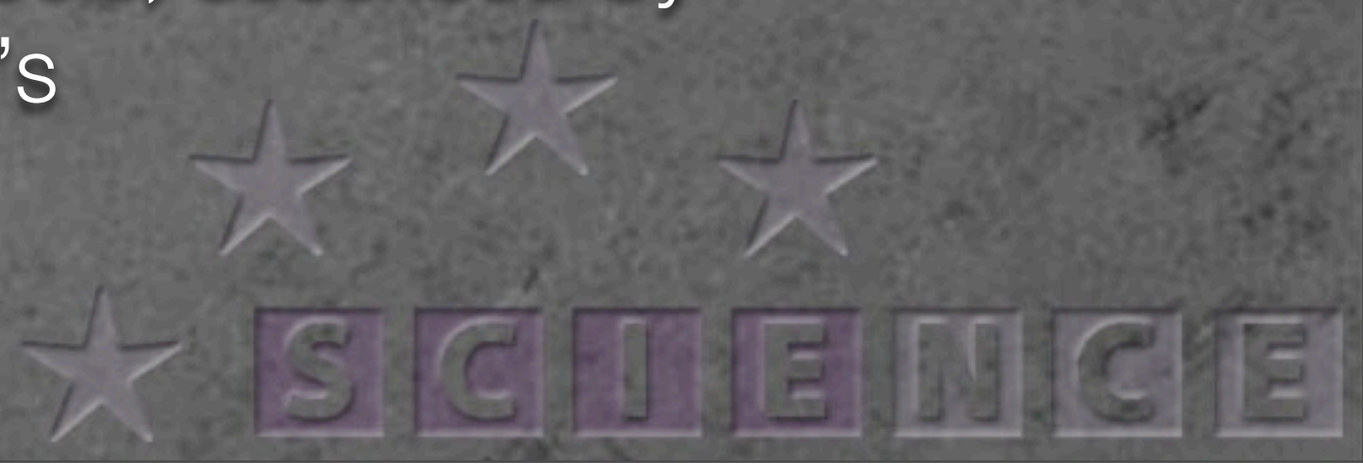
- Very simple, only 12 language elements:
  - Integers, Floats, Strings, Vaiables, References, Symbols
  - Binary, Foreign,
  - Application, Binding, Error, Attribution
- All semantics is the Symbols, described by ContentDictionaries “CD”s



CD/Symbol Example

OpenMath Content Dictionary: arith1

Canonical URL:
http://www.openmath.org/cd/arith1.ocd
CD Base:
http://www.openmath.org/cd
CD File:
arith1.ocd
CD as XML Encoded OpenMath:
arith1.omcd
Defines:
abs, divide, gcd, lcm, minus, plus, power, product, root, sum, times, unary_minus
Date:
2004-03-30
Version:
3
Review Date:
2006-03-30
Status:
official

CD/Symbol Example

OpenMath Content Dictionary: arith1

plus

Role:

application

Description:

The symbol representing an n-ary commutative function plus.

Commented Mathematical property (CMP):

for all a,b | a + b = b + a

Formal Mathematical property (FMP):

xml | prefix | mathml

∀ a , b . a + b = b + a

Signatures:

sts

- OpenMath allows for different Representations:
  - XML
  - OpenMath Binary
- Neither of these are intended for typing and reading by humans (such as ourselves).... ➽

POPCORN

Possibly Only Practical Convenient OpenMath Replacement Notation

- POPCORN offers a typeable and readable OpenMath-representation:
- Integers, Floats and Strings as you expect:
  `18, 0.6, 2.009e3, “MEGA”`
- Symbols: `cdname.symbolname`
- Variables: `$name`, References: `#name`
- Application: `arith1.plus(1,2,3)`
- Binding: `fns1.lambda[$x -> $x + 1]`
- Attribution: `some.thing{“ping” -> 1}`

SCSCP

Symbolic Computation Software Composability Protocol

- Protocol for communication between CASes
- OpenMath based
- Lightweight, simple sockets
- Implementation in GAP, KANT, Maple, MuPAD
- Basis for symbolic computation on Clusters and Grids
- At this point GAP, KANT, Maple and MuPAD can be client or server for SCSCP

Java-Libraries

Java Runtime

Java-Libraries

org.symcomp.openmath

Java Runtime

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Java-Libraries

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Symbolic Computation
Software Composability Protocol

org.symcomp.openmath

org.symcomp.scscp

Java Runtime

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org.symcomp.scscp

Standard Libraries

Java Runtime

Java-Libraries

SCSCP enabled Java-Application

org.symcomp.openmath

org.symcomp.scscp

Standard Libraries

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SCSCP

Symbolic Computation

Software Composability Protocol

org.symcomp.scscp

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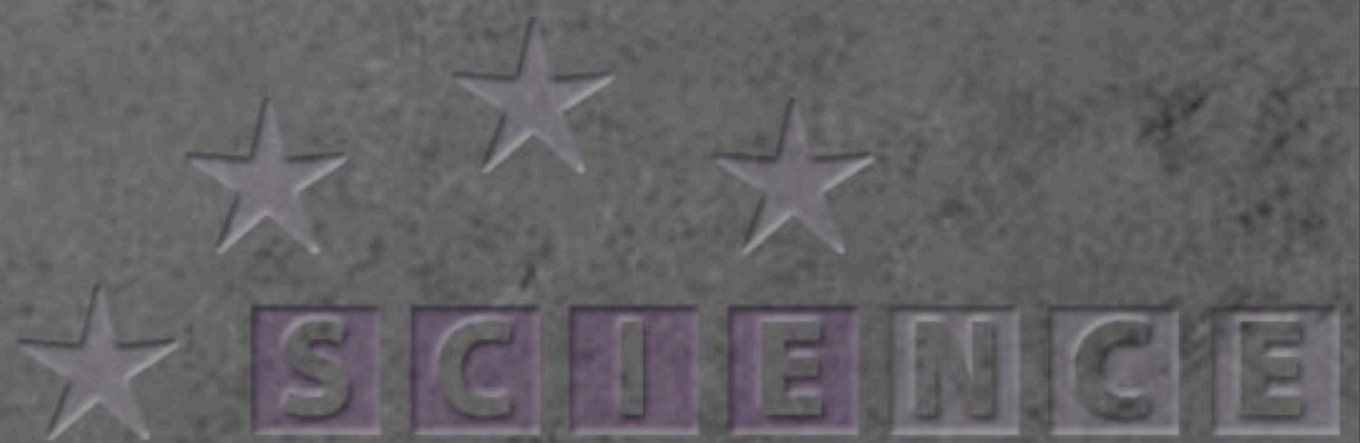
SCSCP
Symbolic Computation
Software Composability Protocol

org.symcomp.scscp

- Representation and Manipulation of OM
- Many convenience methods
- Reads and writes different formats
- Extensible



Java-Libraries

org.symcomp.openmath

- Representation and Manipulation of OM
- Many convenience methods
- Reads and writes different formats
- Extensible

org.symcomp.scscp

- Wraps all SCSCP functionality
- Turning a Java-application into a SCSCP server/client is a one-liner
- Comes with many examples

SCSCP

SYMBOLIC COMPUTATION
SOFTWARE COMPOSABILITY PROTOCOL

What else?

- Grid and Cluster Infrastructure
- WUPSI, the Wonderful Universal Popcorn SCSCP Interface: a great testing and demo tool
- Webproxy, a Web based Administration and orchestration tool offering SOAP access

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Symbolic Computation Software Composability Protocol

State of the systems

SCSCP

SYMBOLIC COMPUTATION
SOFTWARE COMPOSABILITY PROTOCOL

State of the systems

- GAP: Client and (single) server

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SYMBOLIC COMPUTATION
SOFTWARE COMPOSABILITY PROTOCOL

State of the systems

- GAP: Client and (single) server
- KANT: Client and server

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Symbolic Computation
Software Composability Protocol

State of the systems

- GAP: Client and (single) server
- KANT: Client and server
- MuPAD: Client and server (using Java libs)

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SOFTWARE COMPOSABILITY PROTOCOL

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- Maple: (First prototype of) client and server

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Symbolic Computation

Software Composability Protocol

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- TRIP (celestial mechanics): Server and client (using their own, public, SCSCP C-library)

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- .... more to come

Demo....

SCSCJT

Symbolic Computation Software Composability Protocol

Licensing and availability

SCSCP

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- Java libraries: Free, open source

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Thank you!

SCIEnce homepage

`http://www.symbolic-computation.org/`

The java libraries are available at

`http://java.symcomp.org/`