



# OpenMath in SCIENCE: Evolving of Symbolic Computation Interaction

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22nd OpenMath Workshop,  
Grand Bend,  
July 9th, 2009.

[www.symbolic-computation.org](http://www.symbolic-computation.org)



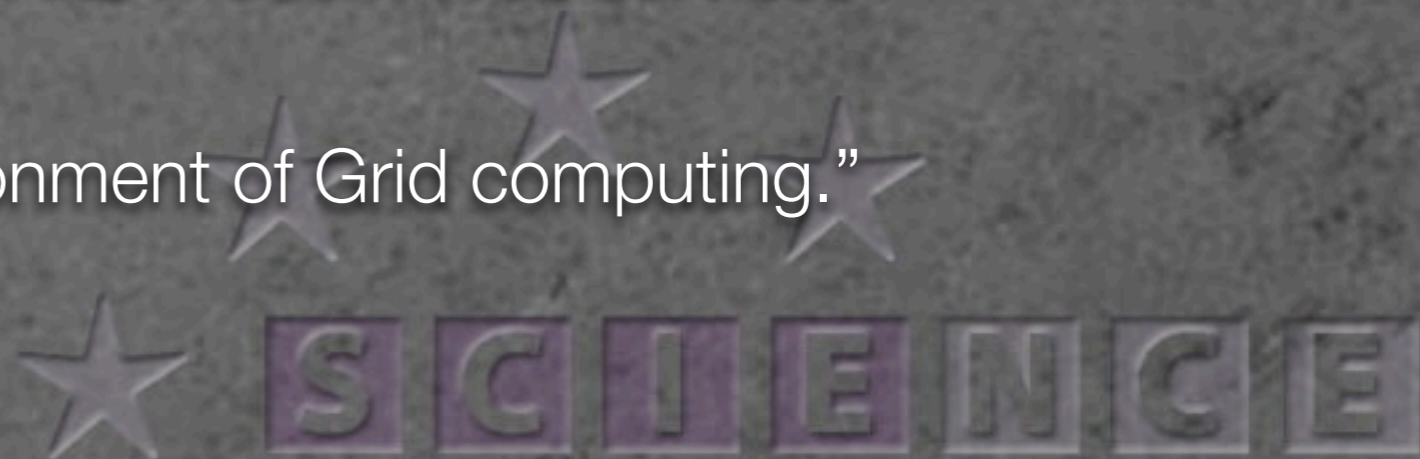




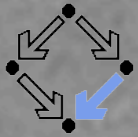
- European “Framework 6” programme,
- Started April 2006, runs for 5 years,
- Main purpose:

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

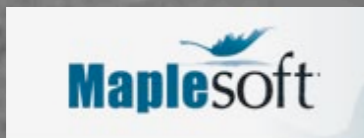
- made more efficient by sharing components and expertise;
- made more interoperable in the modern Web services environment; and
- ready for the coming environment of Grid computing.”







U N I K A S S E L  
V E R S I T Ä T



- 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 Mathematics 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



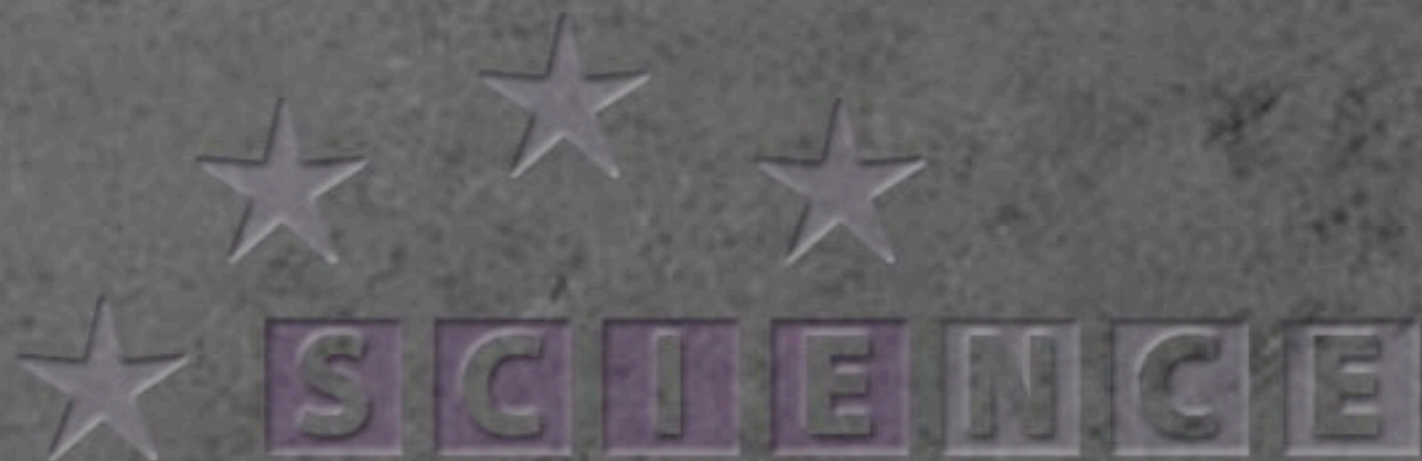
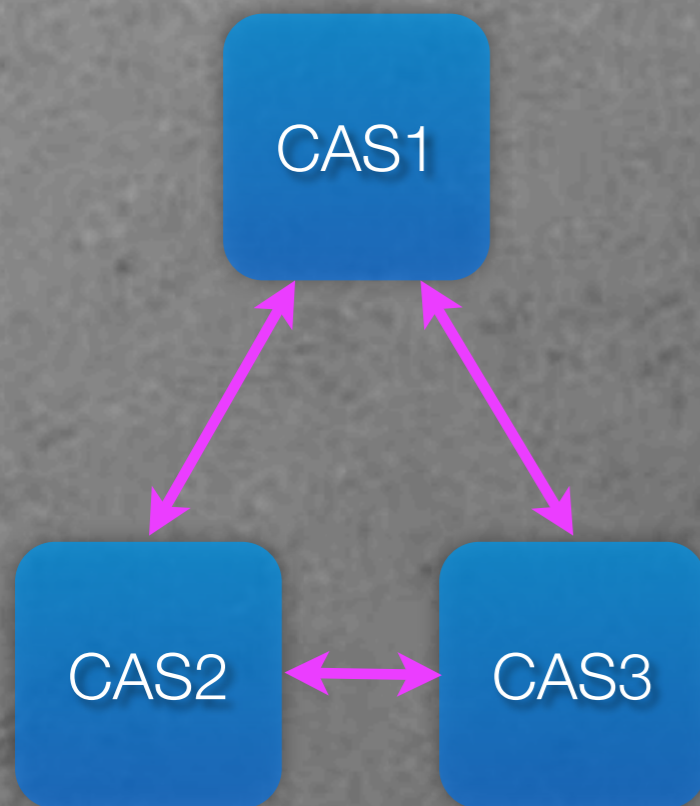
# What's it all about?





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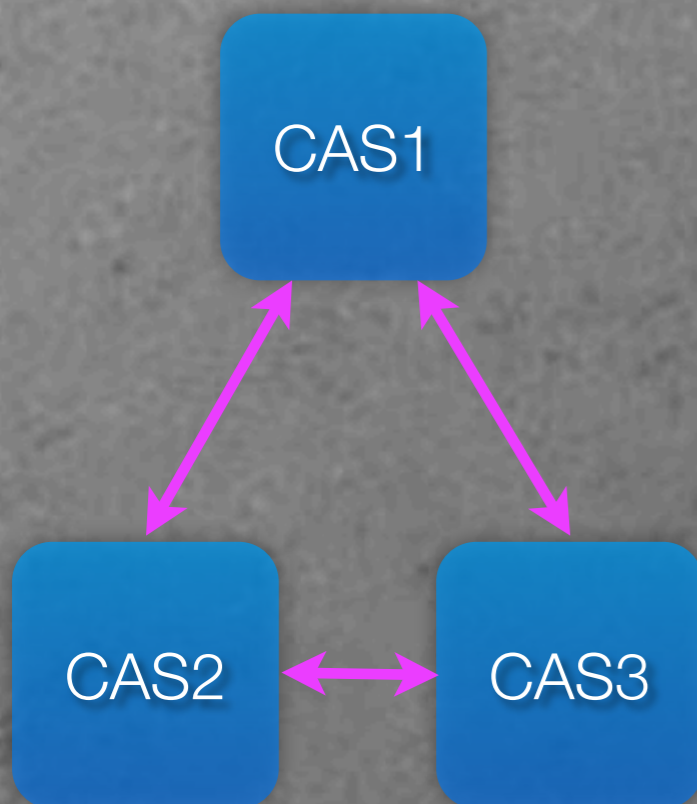
Directly linking  
Symbolic  
Software



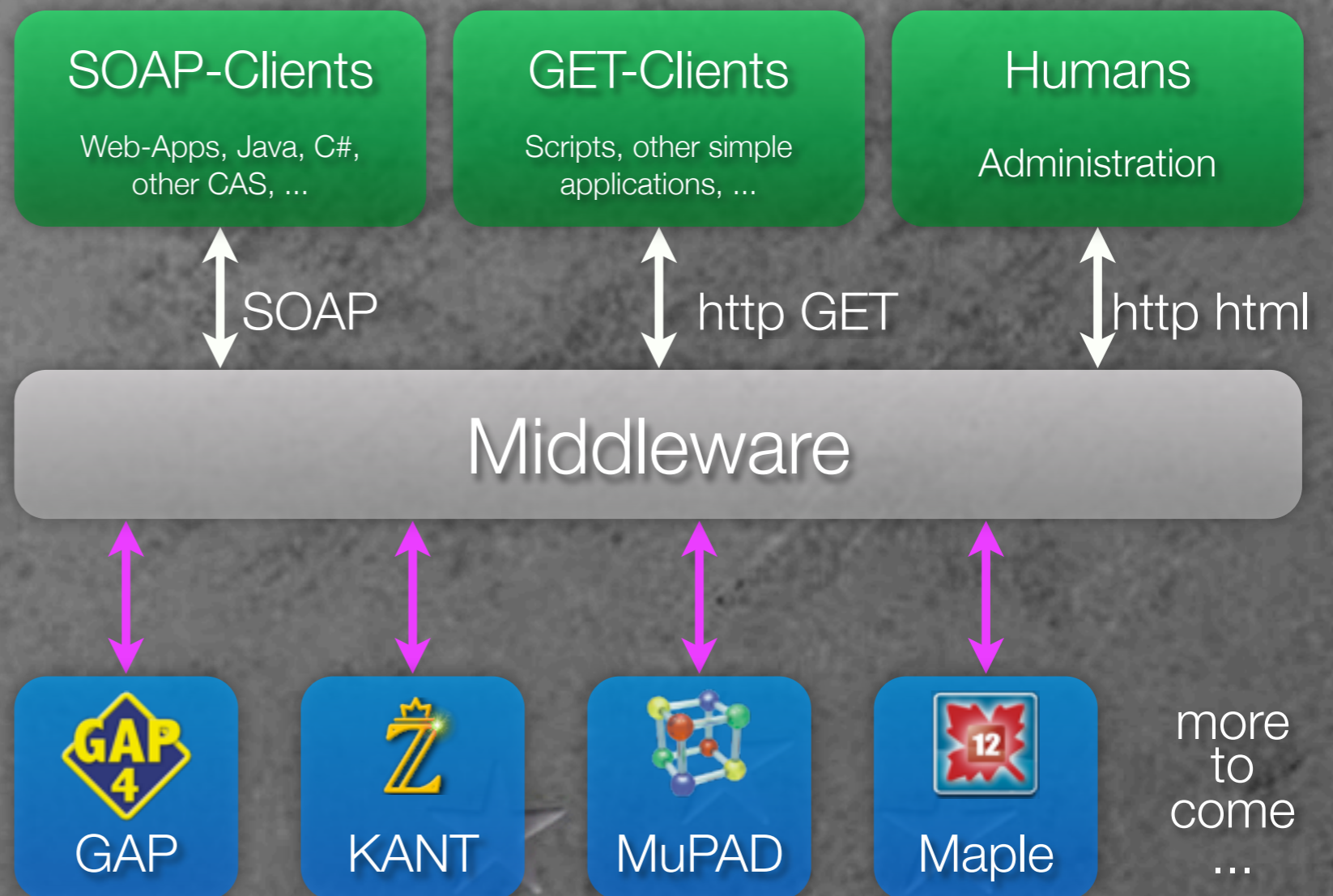


# What's it all about?

Directly linking  
Symbolic  
Software



Link Symbolic Software to  
other Systems

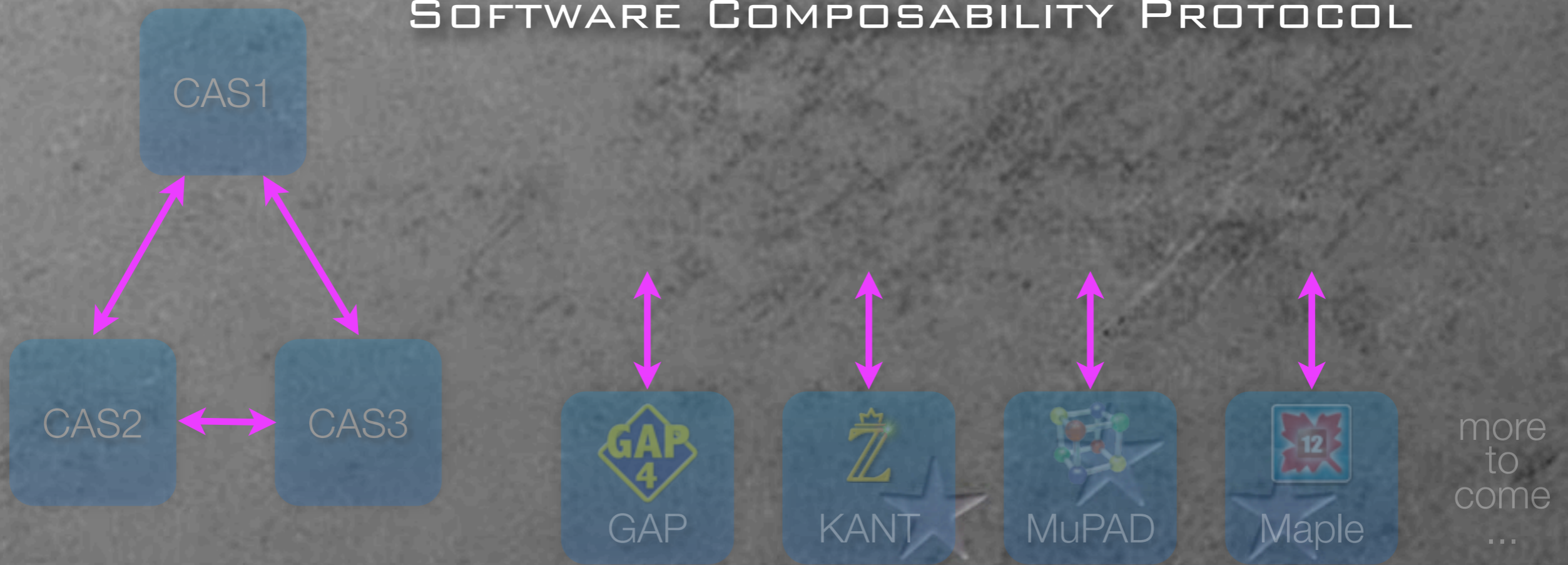




# What's it all about?

# SCSCP

SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL



★ SCIENCE

# SCSCP

SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

- ✦ Protocol for communication between CASes
- ✦ OpenMath based
- ✦ Lightweight, simple sockets
- ✦ Basis for symbolic computation on Clusters and Grids
- ✦ Described in the “SCSCP standard (version 1.3)”, and `scscp1` and `scscp2` Content Dictionaries
- ✦ More details in 20 minutes.

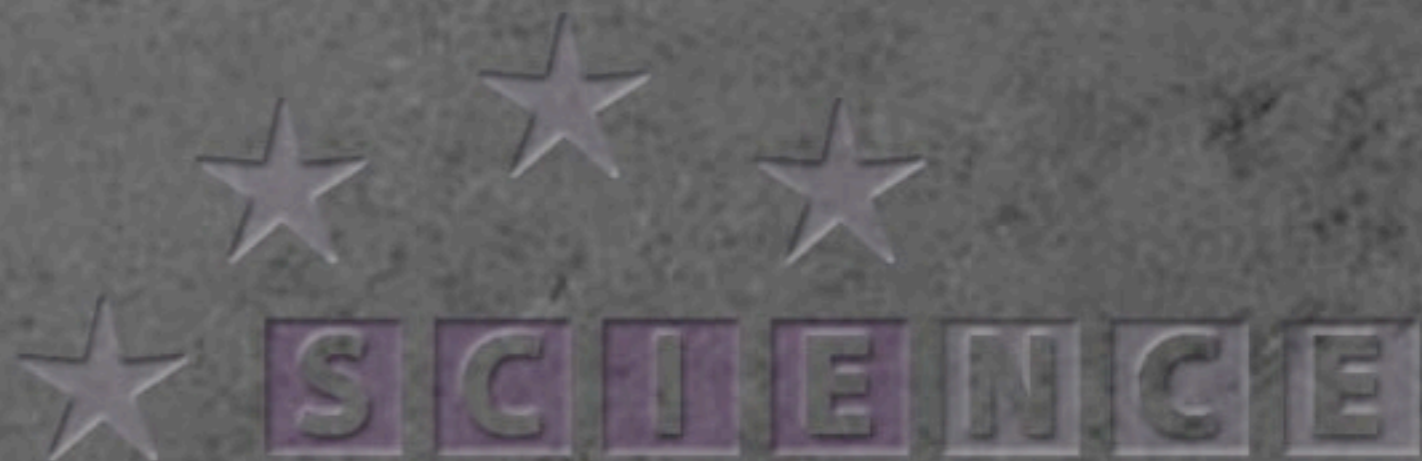




# SCSCPT

SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

Possible applications





# SCSCPT

SYMBOLIC COMPUTATION  
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## Possible applications

- Cross-program: Software A can do things B can't,





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- ✦ Cross-program: A can do things much faster than B,





# SCSCT

SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

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- ✦ etc...





- ✦ OpenMath allows for different representations:
  - ✦ XML
  - ✦ OpenMath Binary



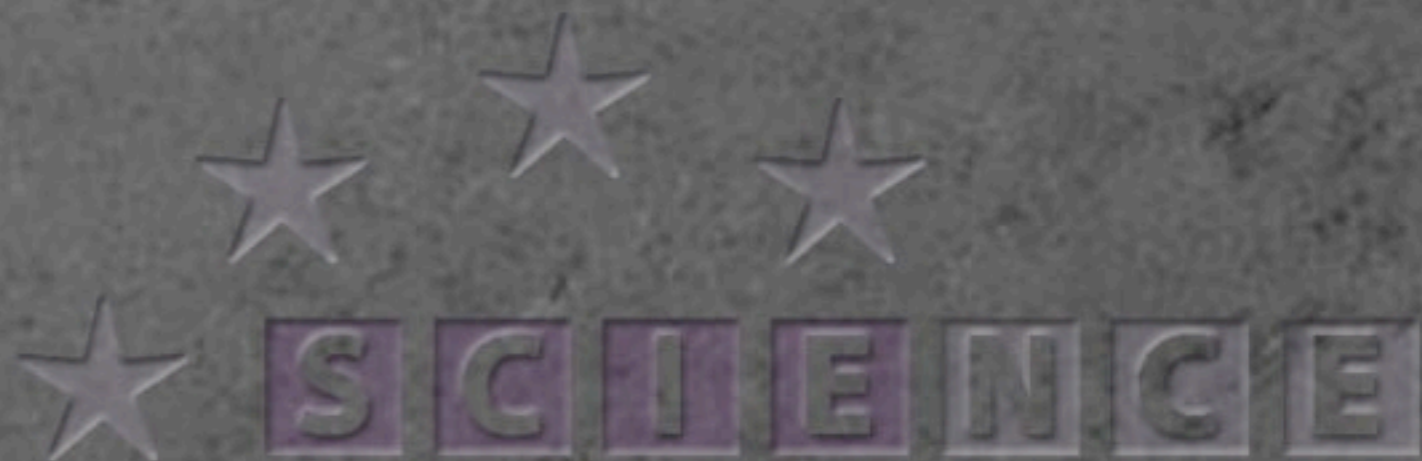




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1+2

$x \rightarrow x \cdot \pi$





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1+2

```
<OMOBJ><OMA><OMS cd="arith1" name="plus"/>  
<OMI>1</OMI><OMI>2</OMI></OMA></OMOBJ>
```

$x \rightarrow x \cdot \pi$

```
<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>
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18 10 08 06 04 61 72 69 74
68 31 70 6c 75 73 01 01 01
02 11 19
```

$x \rightarrow x \cdot \pi$

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<OMOBJ><OMBIND><OMS cd="fns1"
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OMA></OMBIND></OMOBJ>
```

```
18 1a 08 04 06 66 6e 73 31
6c 61 6d 62 64 61 1c 05 01
78 1d 10 08 06 05 61 72 69
74 68 31 74 69 6d 65 73 05
01 78 08 05 02 6e 75 6d 73
31 70 69 11 1b 19
```







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```

Bulky







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  - XML
  - OpenMath Binary

Unintelligible

$1+2$	<pre>&lt;OMOBJ&gt;&lt;OMA&gt;&lt;OMS cd="arith1" name="plus"/&gt; &lt;OMI&gt;1&lt;/OMI&gt;&lt;OMI&gt;2&lt;/OMI&gt;&lt;/OMA&gt;&lt;/OMOBJ&gt;</pre>	<pre>18 10 08 06 04 61 72 69 74 68 31 70 6c 75 73 01 01 01 02 11 19</pre>
$x \rightarrow x \cdot \pi$	<pre>&lt;OMOBJ&gt;&lt;OMBIND&gt;&lt;OMS cd="fns1" name="lambda"/&gt;&lt;OMBVAR&gt;&lt;OMV name="x"/&gt;&lt;/ OMBVAR&gt;&lt;OMA&gt;&lt;OMS cd="arith1" name="times"/ &gt;&lt;OMV name="x"/&gt;&lt;OMS cd="nums2" name="pi"/&gt; &lt;/ OMA&gt;&lt;/OMBIND&gt;&lt;/OMOBJ&gt;</pre>	<pre>18 1a 08 04 06 66 6e 73 31 6c 61 6d 62 64 61 1c 05 01 78 1d 10 08 06 05 61 72 69 74 68 31 74 69 6d 65 73 05 01 78 08 05 02 6e 75 6d 73 31 70 69 11 1b 19</pre>

Bulky





# POPCORN

Possibly Only Practical Convenient OpenMath Replacement Notation

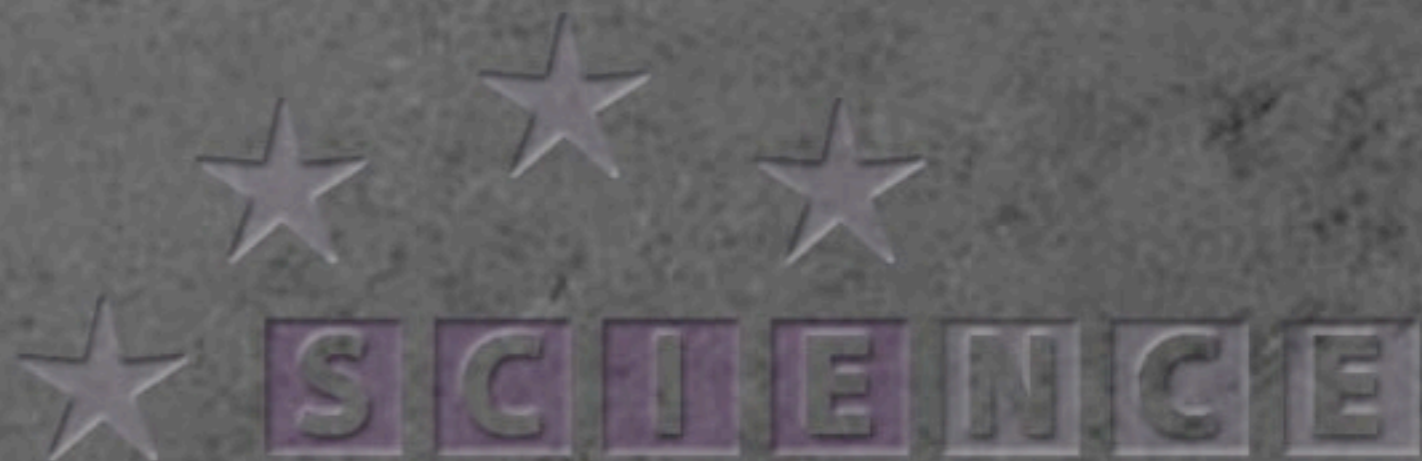
POPCORN offers an OpenMath-representation for humans:

- ✦ Integers, Floats and Strings as you expect:  
`18, 0.6, 2.09e3, "22nd OpenMath Workshop"`
- ✦ Symbols: `cdname.symbolname`
- ✦ Variables: `$name`, References: `#name`
- ✦ Application: `arith1.plus(1,2,3)`
- ✦ Binding: `fns1.lambda[$x -> $x + 1]`
- ✦ Attribution: `some.thing{aa.bb -> 1}`
- ✦ Some abbreviations and infix operators



# POPCORN

Possibly Only Practical Convenient OpenMath Replacement Notation



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Possibly Only Practical Convenient OpenMath Replacement Notation

$1 + 2$

$1+2$

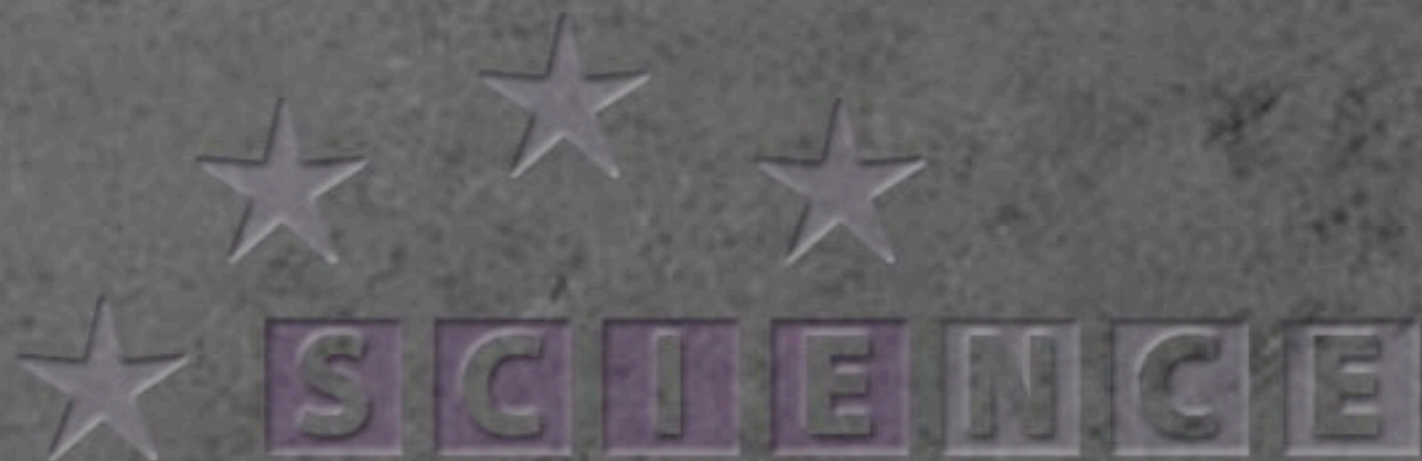




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$1 + 2$	1+2
$x \rightarrow x \cdot \pi$	lambda[\$x -> \$x*pi]



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$17.6 \cdot e$	17.6*e

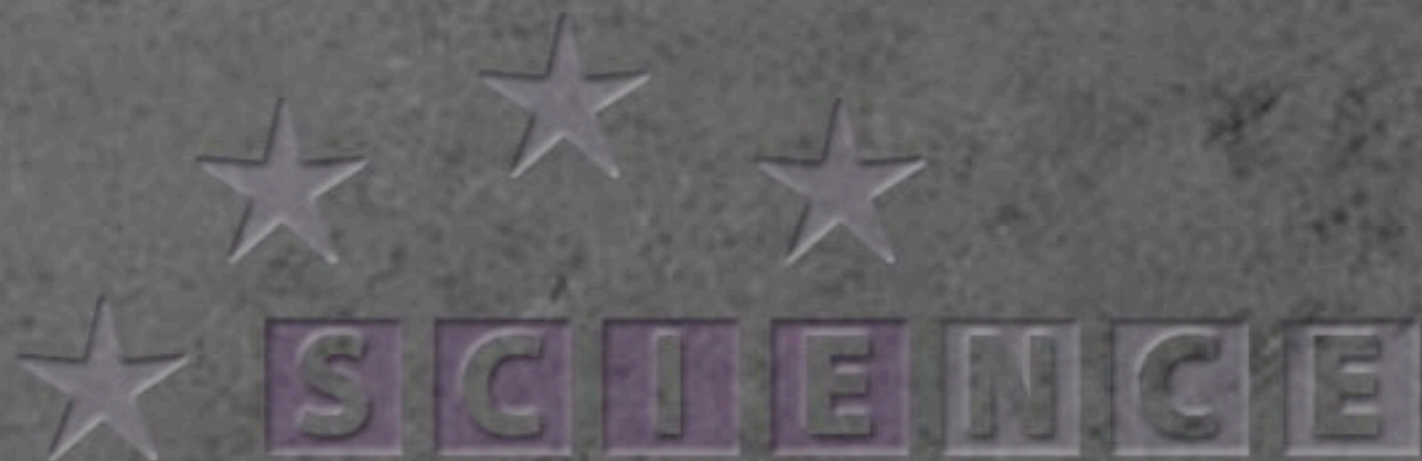




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$\frac{22}{7}$	22//7 {somecd.approx -> 3.14}



# POPCORR

Possibly Only Practical Convenient OpenMath Replacement Notation

$1 + 2$	1+2
$x \rightarrow x \cdot \pi$	lambda[\$x -> \$x*pi]
$17.6 \cdot e$	17.6*e
$\frac{22}{7}$	22//7 {somecd.approx -> 3.14}
$\int_0^1 \frac{1}{x^3 + \sin x} dx$	calculus1.defint(interval1.interval(0,1), lambda[\$x -> 1/(\$x^3 + sin(x))])





# Java Libraries for OpenMath and SCSCP



# Java Libraries for OpenMath and SCSCP



[org.symcomp.openmath](http://org.symcomp.openmath)





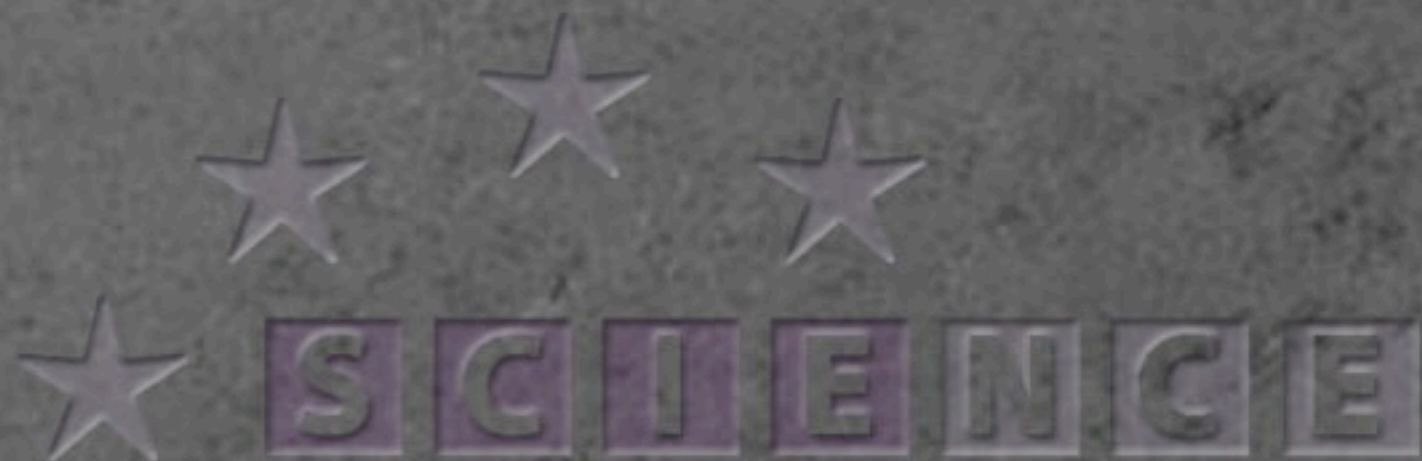
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# Java Libraries for OpenMath and SCSCP



[org.symcomp.openmath](http://org.symcomp.openmath)



[org.symcomp.scscp](http://org.symcomp.scscp)

Standard  
Libraries





# Java Libraries for OpenMath and SCSCP

SCSCP enabled Java-Application

**SCSCP**  
SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

Standard  
Libraries



[org.symcomp.openmath](http://org.symcomp.openmath)

[org.symcomp.scscp](http://org.symcomp.scscp)



# Java Libraries for OpenMath and SCSCP



[org.symcomp.openmath](http://org.symcomp.openmath)



SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

[org.symcomp.scscp](http://org.symcomp.scscp)





# Java Libraries for OpenMath and SCSCP



[org.symcomp.openmath](http://org.symcomp.openmath)



SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

[org.symcomp.scscp](http://org.symcomp.scscp)

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





# Java Libraries for OpenMath and SCSCP



org.symcomp.openmath

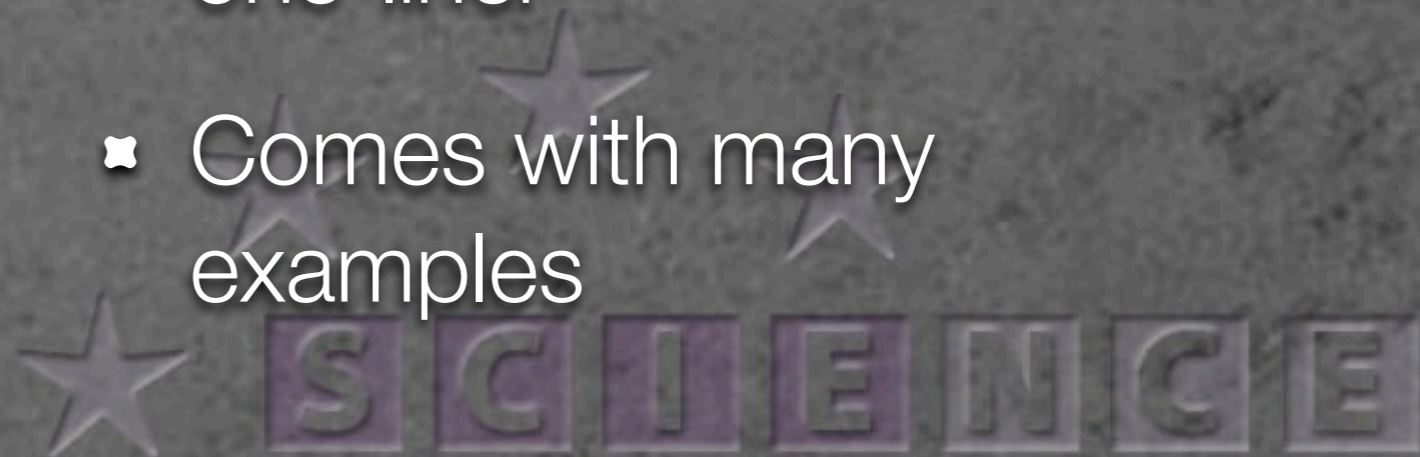
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SYMBOLIC COMPUTATION  
SOFTWARE COMPOSABILITY PROTOCOL

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

SCIENCE

Demo....



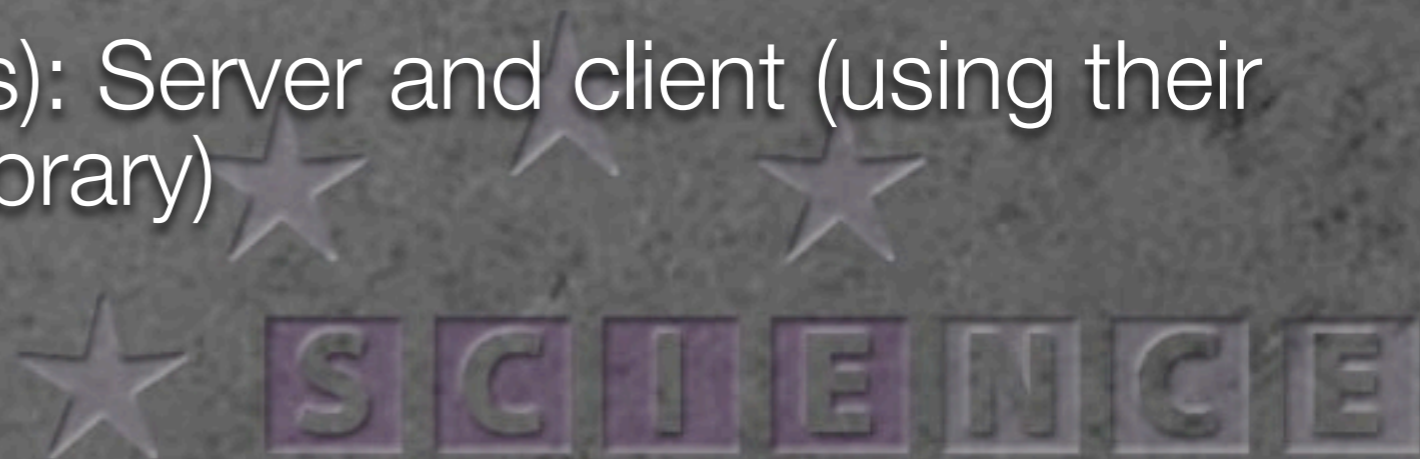


# SCSCP

SYMBOLIC COMPUTATION  
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## State of the systems

- ✦ GAP: Client and (single) server
- ✦ KANT: Client and server
- ✦ MuPAD: Client and server (using Java libs)
- ✦ Maple: (First prototype of) client and server
- ✦ Magma: Server (using Java libs)
- ✦ TRIP (celestial mechanics): Server and client (using their own, public, SCSCP C-library)
- ✦ .... more to come



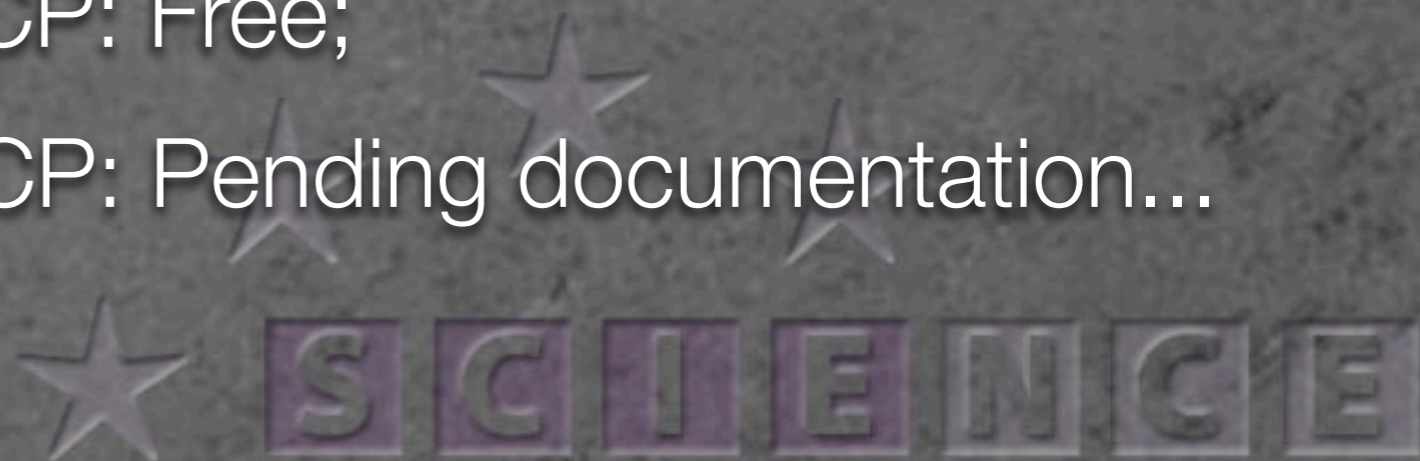


# SCSCP

SYMBOLIC COMPUTATION  
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## Licensing and availability

- ✦ GAP: Free and open source; SCSCP/OpenMath libraries now included with GAP distribution
- ✦ KANT: Free; binaries from KANT homepage
- ✦ TRIP SCSCP C-library: open source, free
- ✦ Java libraries: Free, open source
- ✦ MuPAD OpenMath/SCSCP: Free;
- ✦ Magma OpenMath/SCSCP: Pending documentation...
- ✦ .... more to come





# Thank you!

SCIENCE homepage

<http://www.symbolic-computation.org/>

The java libraries are available at  
<http://java.symcomp.org/>

