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*Toward Multilingual Mechanized
Mathematics Assistants*

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Abstract

The aim of this note is to present recent work in the area of **Multilingual Mechanized Mathematics Assistants**.

We will describe some of the key **features** expected from such systems, sketch some of the strategies envisioned for their **realization** and report on the current state of the **Mathematical Grammar Library**.

Main points

- **Contexts**
- **Word problems**
- **MGL**
- **Ancillary SMs**
- **gfsage**
- **Conclusions and further work**
- **References**

Contexts

Increasing role of computational methods

EACA-2012

- Effective Methods in Algebra, Analysis, Geometry and Topology.
- Algorithmic Complexity.
- Scientific Computation by means of Symbolic-Numerical Methods.
- Symbolic-Numeric Software Development.
- Analysis, Specification, Design and Implementation of SCS
- Applications to Science and Technology.

Multidisciplinarity

Mathematical Knowledge Management (QED manifesto)

Theorem provers

Mechanized Mathematical Assistants (Calculemus-07, MKM-07)

Educational needs

Word problems

In a family party, uncle Tom asks Alice how old she is.

The day before yesterday I was 15, said Alice, and next year I will be 18.

What day is Alice's birthday?

Prominent role in learning mathematical modeling and reasoning.

Most of the relevant information is given as a natural language text.

Crucial skills needed:

Translation of sentences into mathematical expressions

Reasoning with those expressions

Checking solutions

Difficulties

Key terms, facts and relations may not be explicitly indicated.

yesterday, day before, year, this year, next year, age.

Common knowledge about the terms is required.

There are terms, facts and relations that are irrelevant.

family, family party, uncle, uncle Tom

MGL

Modular library programmed in GF GF

- Based on functional programming and type theory
- Abstract grammars (formal/computational semantics)
- Concrete grammars (multilingual parsing/rendering)

Demo: **mathbar**

Historical

WebALT

language-independent mathematical didactical material

mOlto (<http://www.molto-project.eu/>)

to develop a set of tools for translating texts between multiple languages in real time with high quality.

Example

```
abstract Arith = {  // semantic structure of application domain
  cat
    Nat, Prop ;      // types

  fun                  // constructor signatures
    Zero : Nat ;
    Succ : Nat -> Nat ;
    Even, Prime : Nat -> Prop ;
    Not : Prop -> Prop ;
    And, Or : Prop -> Prop -> Prop ;
}
```

How to get MGL

Publicly available using subversion as

```
svn co svn://molto-project.eu/mgl
```

A stable version can be found at

```
svn co svn://molto-project.eu/tags/D6.1
```

Ancillary SMs

SM (Symbolic machine)

CAS

ATP

...



gfsage

Sage commands in natural language (input and output)



GF Cats: **Command, Answer.**

Compute:

Kind → Value Kind → Command

Simple answer:

$k \in \text{Kind} \rightarrow \text{Value}$ $k \rightarrow \text{Answer}$

“it is 5”

Feedback answer:

$k \in \text{Kind} \rightarrow \text{Value}$ $k \rightarrow \text{Value}$ $k \rightarrow \text{Answer}$

“the factorial of 3 is 6”

Assume:

Prop → Command

“I assume that x is greater than 2”

Assign:

$k \in \text{Kind} \rightarrow \text{Var}$ $k \rightarrow \text{Value}$ $k \rightarrow \text{Command}$

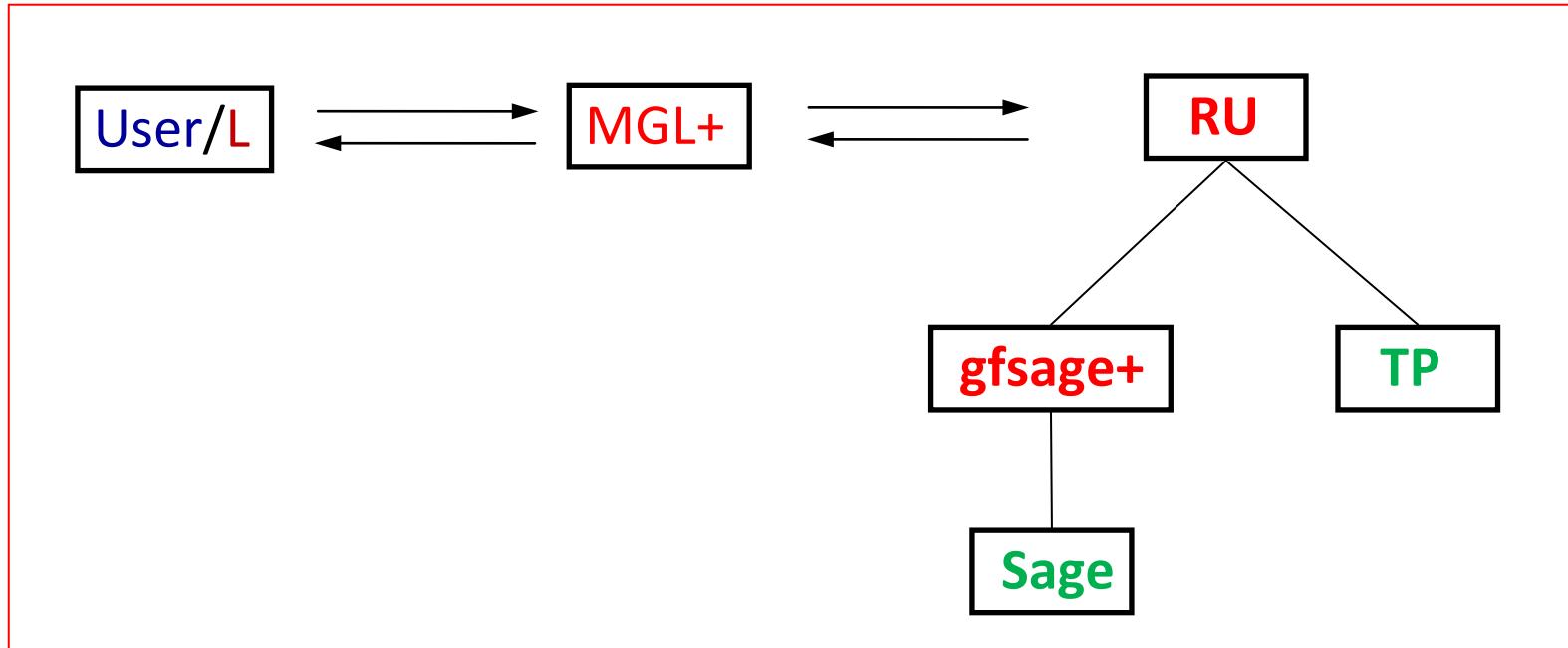
Example

```
sage> compute the integral of the function mapping x  
to the square root of x on the closed interval  
from 1 to 2.  
waiting...  
[4] 4/3*sqrt(2) - 2/3
```

[http://www.molto-project.eu/wiki/living-deliverables/
d62-prototype-comanding-cas/gfsage-natural-language-interface-sage](http://www.molto-project.eu/wiki/living-deliverables/d62-prototype-comanding-cas/gfsage-natural-language-interface-sage)
→ <http://www.molto-project.eu/>

Conclusions and further work

Dialog system



MGL+ Fully functional MGL

RU Reasoning Unit

gfsage+ Fully functional gfsage

TP Theorem Prover

References

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... se engendró en una cárcel, donde toda incomodidad tiene su asiento y donde todo triste ruido hace su habitación ...



¡Muchas gracias!
Thank you!