ActiveMath

combining mathmatical elements for teaching and exploration

report on current implementation

(let's be really pedagogic)

An example first

In the skin of curious student.

• She (the user) wants to learn about a concept, she has time and is curious. She is now registered and known to the system.

• She first identifies the goal content to be learned using a textual search, say, Z_m.

• this activates the presentation planner on a given *scenario*.

• The planner :
– grabs this content and all its dependent from MBase
– measures her knowledge from the model
– presents all that for pedagogical presentation rules which select the content and the grouping
– this then linearized (using dependencies again)

• The session-manager (i.e. the servlet) then presents this *static book* to her. For her to browse.

• lost ? a guide called *next best advice* can offer her a tightly guided path adapted to what she knows

• exercise ? in the middle, exercises, if available, will appear. This launches an exploration, with all proper parameters, into some mathematical assistant.

• and in the meantime... the user-model gets updated of every click

What's behind ?

(nuts, bolts, etc)

- Source content : OMdoc mathematical elements
- UserModel : a Bayes network
- Presentation planner : pedagogical rules
- A sturdy communication-layer : for inter-process-messages

And more precisely: MBase (OMdoc storage), XML-RPC (interprocess-communication), Mathweb object broker (service creation), Jess (rule expert system), Servlets (dynamic-web) and all the external systems: Omega-Loui, Maple, GAP...

OMDoc

(mathematical content finally organized by the wonders of XML)

Content is organized as mathematical elements (symbols, definitions, assertions, remarks, exercises...), and with dependencies.

Cross-references and ID marking both allow for efficient structuring.

Can be stored and efficiently queried using MBase.

To separate or not to separate

Separation of content and presentation is a reality here : it is a reality of each and every element.

The textual content, aside of referencing other elements is away of any kind of formatting. Mathematical expressions are all as OpenMath objects: a combination of symbols which are defined elsewhere.

Symbols have a presentation, yes, but this is a separated part of the symbol definition.

XML allows for an efficient combining of these produce a text that may reach the quality of TeX,

Advantages : easy parsability and transformability, polymorphic, ... big reusability !

Drawback : currently no authoring tool, hard to write by hand

User Model

(the central piece that will make it magic)

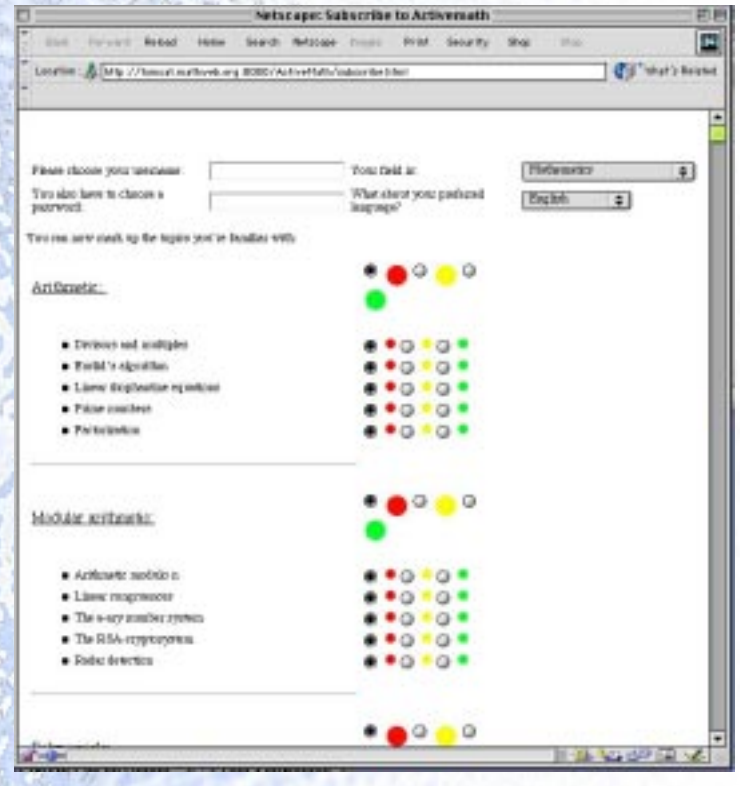
From the presentation planner view it is just a table of knowledge values for each of the items

For the session-manager, it is just a lis-tener which should receive notifications of all requests.

All in all, this central machine is a table and a sensible update mechanism of this table which reflects dependencies.

A Bayesian is the currently chosen data structure.

This model also stores abilities to use external systems and learner's kind.



One delicate task currently: initialize the user-model. Probably a teacher's job for a classroom.

Communicating Processes

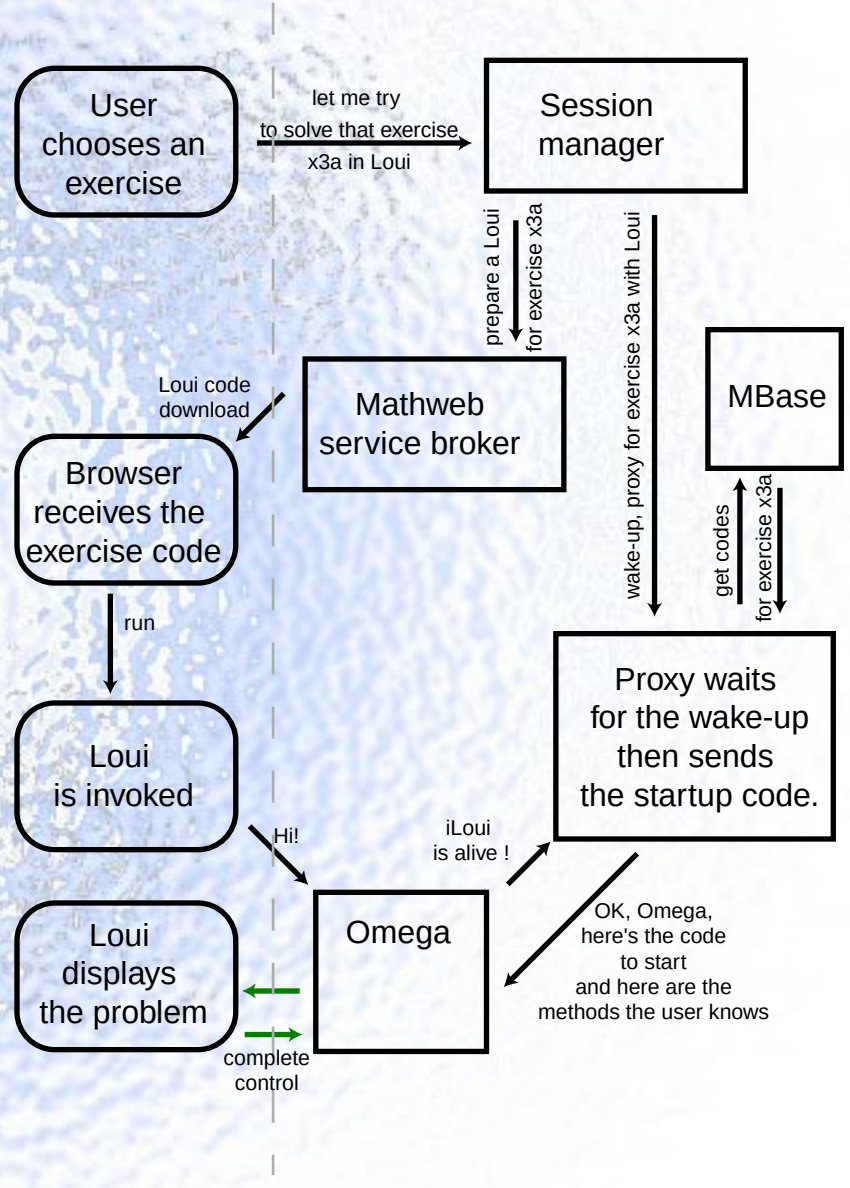
Some individualities...

- the servlet-container
- MBase
- the bayesian network
- the mathweb-broker
- mathematical assistants
- a teacher's console

We have chosen xml-rpc as the choice protocol for communications. It has been implemented here for Oz and Lisp to be used with existing packages for java.

It very ressembling to the old RPC, except it has standard encoding and allows easily a complete object treatement.

A little example diagram... the invokation of Loui on an exercise.



Current state

(did you know that the first letter of VIL stands for Vorprojekt ?)

OMdoc	Almost at release 1.0. Authoring tools missing. Sturdy transformation engines to HTML and other presentation languages.
MBase	Currently running. Query interfaces still missing. (a RAM based version is implementing them currently)
Session manager	Fair and running. Not connected yet with the rest.
Presentation planner	Almost at version 0. Rule application machine running. Linearizer buggy. *Next best engine* awaited to be connected.
User-model	Demos are running. No connectivity yet. Update mechanisms have to be refined.
External systems	One connection achieved (Omega-Loui). Others' being made (computer algebra consoles, among others)

Possible extensions

- Collaborative learning : the server identification mechanisms allows easily sharing and pointing to content in messages.
- Collaborative mathematical exploration (we're not too far from a collective Maple).
- Developpement of an authoring tool.
- Stronger user-monitoring, including teacher watch of exercise sessions

Plans

Collaborations have been planned and are waiting for funding with :

- Mexico Monterrey Tech (focus on user-monitoring and application in distant education)
- a group-work with Koblenz and Paderborn using µPad
- usage in a Formal Methods course
- developpement and usage in Gymnasiums in Saarland.