A virtual laboratory for blended-learning: Numerical Methods using WIRIS

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Keywords:

Blended learning, Maths, Moodle, quizzes, maths web-tools

- Moodle is one of the most extended Learning Management Systems.
- Problems with Moodle arise in our scientific context:
  - Representation of math formulas.
  - Mathematical computation via web.

We present a tool to solve these problems:

WIRIS: A powerful editor and calculator via web

In 2004-05 the Málaga University choosed Moodle as LMS, so MetNum was developed in Moodle.

Moodle was born in...

- In 2002, Martin Dougiamas presented the first version of Moodle. (http://dougiamas.com)
- Born in August of 2002, until July of 2008, there existed more than 21 millions of registered users, spread over 46000 places and it is translated to more than 75 languages.
- The design of Moodle is based on socio-constructivist pedagogy.
- A set of tools that support an inquiry- and discovery-based approach to online learning.
- An environment that allows for collaborative interaction among students.

The key is the continuos process of interaction between students and teachers. The collaboration in the design of learning units provide the best method to compile the knowledge of the subject.

The key of the success...

- Compatible, flexible and easy to modify.
- It has been written using the popular and powerful PHP language.
- Moodle is built in a highly modular fashion and uses common technologies such as shared libraries, abstraction.
- Cascading Style Sheets to define the interfaces.
- Moodle is a GNU multi-platform environment used without problems in Linux, Mac, Windows, etc.

Some interesting characteristics...

- Identification of students
- Observing their work
- Forums
- Quizzes
- Glossaries
- Lessons
- Wikis

E-learning units in MetNum

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E-learning units in MetNum

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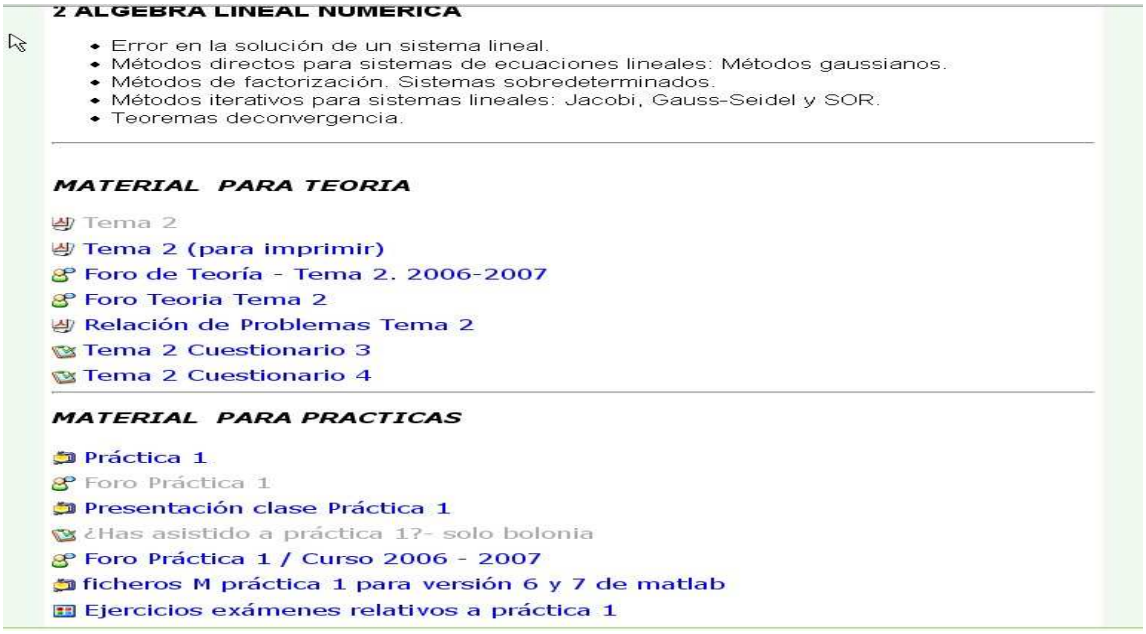
E-learning units in MetNum



2 ALGEBRA LINEAL NUMERICA

- Error en la solución de un sistema lineal.
- Métodos directos para sistemas de ecuaciones lineales: Métodos gaussianos.
- Métodos de factorización. Sistemas sobredeterminados.
- Métodos iterativos para sistemas lineales: Jacobi, Gauss-Seidel y SOR.
- Teoremas deconvergencia.

MATERIAL PARA TEORIA

Tema 2
Tema 2 (para imprimir)
Foro de Teoría - Tema 2. 2006-2007
Foro Teoria Tema 2
Relación de Problemas Tema 2
Tema 2 Cuestionario 3
Tema 2 Cuestionario 4

MATERIAL PARA PRACTICAS

Práctica 1
Foro Práctica 1
Presentación clase Práctica 1
¿Has asistido a práctica 1?- solo bolonia
Foro Práctica 1 / Curso 2006 - 2007
ficheros M práctica 1 para versión 6 y 7 de matlab
Ejercicios exámenes relativos a práctica 1

E-learning units in MetNum

3. INTERPOLACIÓN Y APROXIMACIÓN

- Interpolación polinomial clásica. Fórmulas de Lagrange y en diferencias. Error.
- Interpolación osculatoria: Método de Hermite y Hermite cúbica.
- Interpolación "spline".
- Aproximación mínimo-cuadrática.

MATERIAL PARA TEORIA

Tema 3
Tema 3 (para imprimir)
Foro Teoría -Tema 3. 2006-07
Foro Teoria Tema 3
Relación de Problemas Tema 3
Cuestionario 5

MATERIAL PARA PRACTICAS

Práctica 2
Foro Práctica 2
Presentación clase Práctica 2
¿Has asistido a Práctica 2? solo bolonia
Ejercicio Práctica 2
Foro de práctica 2 / curso 2006-2007

Our virtual course

- The subject Numerical Methods is taught in a blended-learning framework.
- Nowadays, it is the meeting and working point for the students of our subject.
- We check that our students "learn best when they are engaged in a social process of constructing knowledge through the act of constructing an artefact for others" (see Martin Dougiamas and Peter C. Taylor 2003).

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Some lacks... math formulas

Teachers and students want to transmit math knowledge.

- In [Caprotti et al. 2008]: "mathemathical instruction is a recognized key asset in our society and embracing technology in mathematics education is not only economically advantageous but also promotes better learning and understanding".
- In [Cohen 2008]: mathematics to the Web. Their group has developed MathDox.
- Moodle to make a direct preview of LaTeX code, which is usually used to present mathematical material. **LaTeX is very good for scientific teachers but hard for students.**

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Some lacks... math computation

- The National Mathematics Advisory Panel has concluded that certain tools, in particular systems for automated testing and assessment, can improve the performance of students.
- It is possible to improve Moodle: creating new learning units that allow mathematical computation.

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Some lacks... SOLUTION

- Representation of math formulas: **WIRIS**
- Math Computation via web: **WIRIS**

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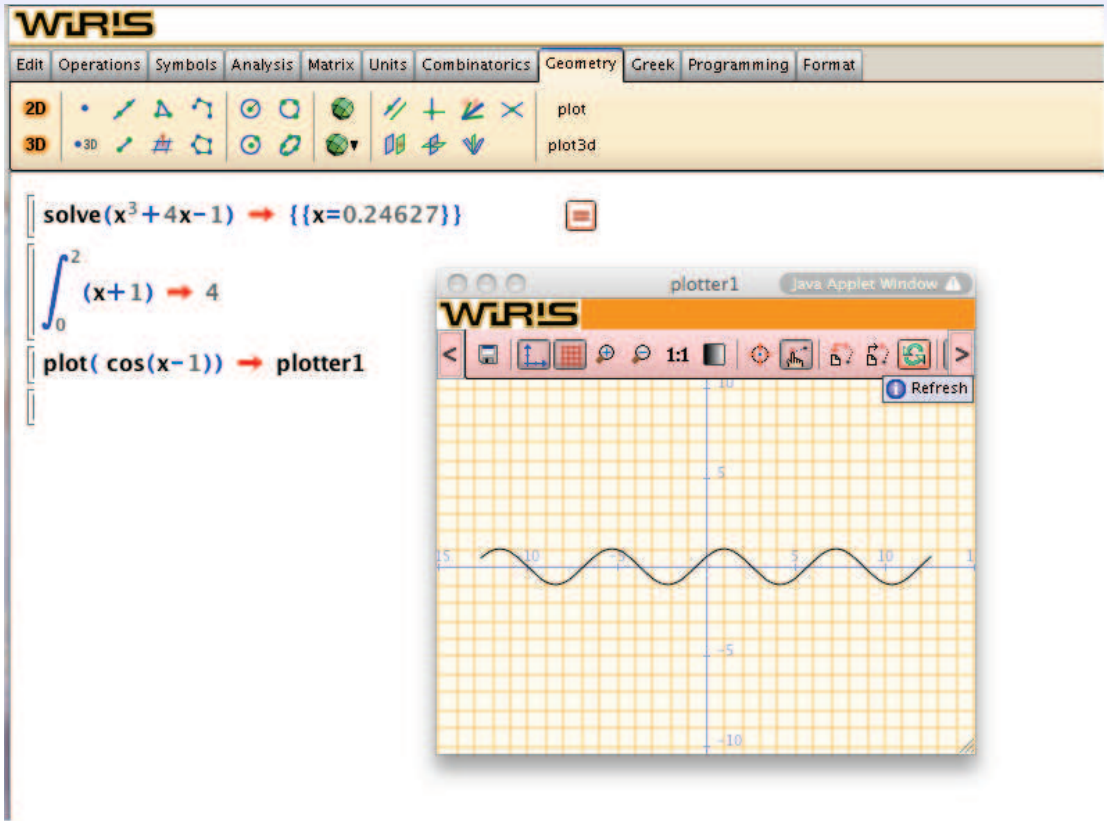
www.wiris.com

- It is currently being used with (high) success in educational environments in Spain, Luxemburg, Netherlands, Puerto Rico and Finland.
- Nowadays, WIRIS is a software family of products dedicated to mathematical calculation
- And the most interesting point, now this tool is integrated in the LMS Moodle using a WIRIS Plugin.

www.wiris.com



www.wiris.com

We have two tools integrated in Moodle:

- WIRIS Editor is a powerful tool used via web, and permits the graphical edition of mathematical formulas.
- WIRIS CAS is a Computer Algebra System (CAS) designed for mathematical computations.

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www.wiris.com

- If Moodle integrates the WIRIS Plugin, we can edit maths expressions and compute an integral in an easy way.
- WIRIS incorporates libraries for Calculus, Algebra, and Statistics but not for numerical methods.
- Students can interact using WIRIS in Moodle to check if the result of an exercise is correct and develop new routines in WIRIS to solve other exercises.

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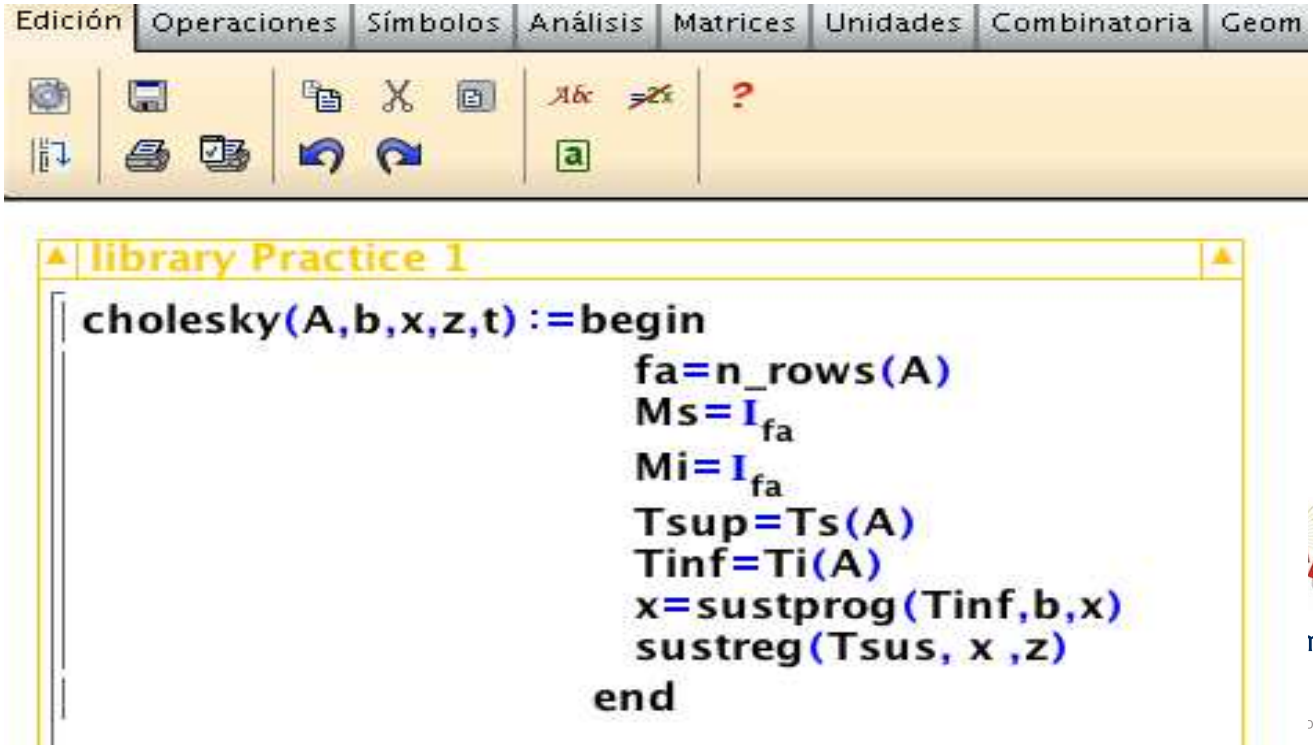
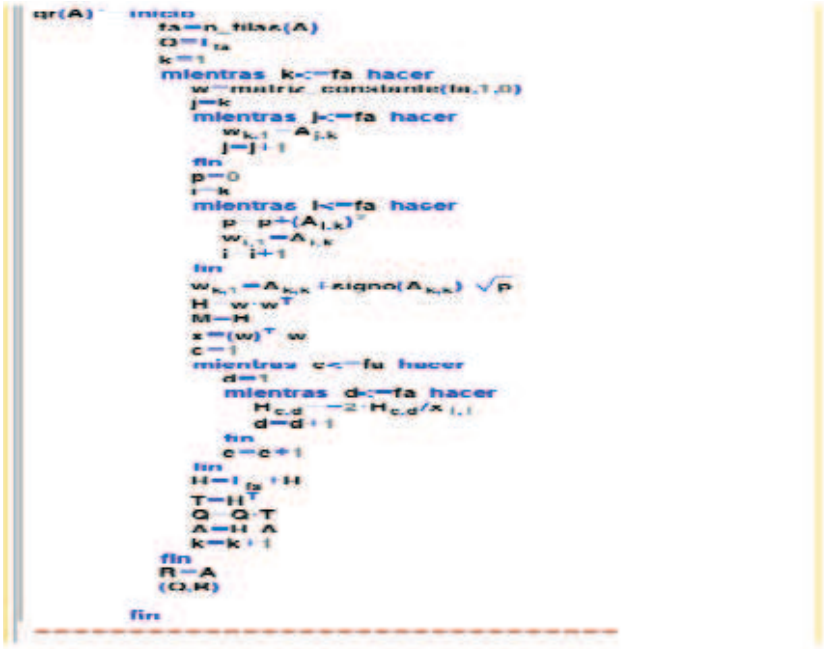
A new library for Numerical Methods



A new library for Numerical Methods



A new library for Numerical Methods

```
solqr(A,b):=inicio
              (Q,R)=qr(A)
              bb=Q^T·b
              x=sustreg(R,bb)
              [x]
            fin
```


A new library for Numerical Methods

```
simpson(F,c,d,n):=inicio
                    locales w,z,k
                            w=(d-c)/n
                            z=0
                            k=1
                    mientras k<=n hacer
                      z=z+
                      simpson1(F,c+(k-1)·w,c+k·w)
                      k=k+1
                    fin
                    z
                  fin
```

A new library for Numerical Methods

A new library for Numerical Methods

```
glague5(F,a,t):=inicio
                pesos:=[0.521755610583,
                0.398666811083,
                0.01759424496817,
                 0.00361175867992,
                 0.0000233699723858 ]
                r:=[0.2663560319718,
                1.413403059107,
                 3.596425771041,
                7.085810005859,
                12.640800844276]
                k:=1
                ff:=vector_constante(5,0)
                F2(x):=e^x
                k:=1
                mientras k<=5 hacer
                   ff_k:=F(r_k*t+a)*F2(r_k)
                   k:=k+1
                fin
                y:=pesos*ff^T
                [y]
             fin
```

A new library for Numerical Methods

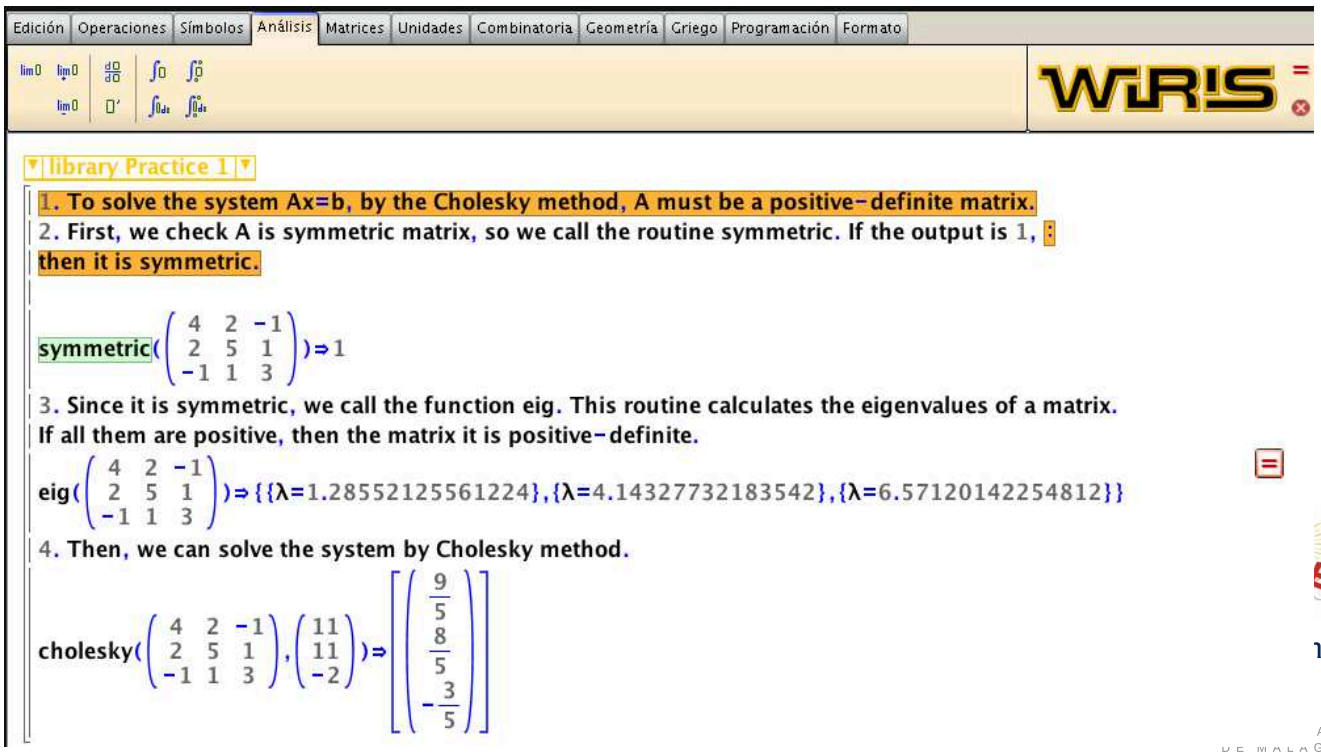
```
glegen4(F,a,b,n):=inicio
                    h:=(b-a)/n
                    l:=((b-a)/(h))+1
                    x:=vector_constante(l, 0)
                    i:=1
                    k:=a
                    mientras i<=l hacer
                       x_i:=k
                       k:=k+h
                       i:=i+1
                    fin
                    t:=[0]
                    p:=1
                    mientras p<=n hacer
                       [t]:=[t]+[glegen41(F, x_p,x_p+1)]
                       p:=p+1
                    fin
                    t

                 fin
```

A new library for Numerical Methods

A new library for Numerical Methods

New self-evaluation material



A web portal

A web portal

A web portal

A web portal

Conclusions

- Students can represent mathematical formulas in an easy way with WIRIS.
- WIRIS allows developing new libraries of numerical methods using an easy programming language.
- Students can try to solve self-evaluation exercises, and have a powerful calculator.
- The only tool necessary is a web browser.

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Conclusions

- The WIRIS package has been integrated into Moodle.
- Students have now the possibility to perform self-evaluation exercises `with WIRIS CAS in Moodle`.
- **Future work?**: Discrete Maths and Optimization libraries.

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