

Numerical, graphical and symbolic calculations with the only requirement of a web browser

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Abstract: - In this paper two web applications are presented. These applications may be use in the field of numerical and symbolic calculation as they are linked with *Mathematica* software. They are applications that can be used as much in academic as in business worlds. The first application is useful for those that are not familiar with the mathematical tool; it is simpler but it loses part of the capacity of the mathematical software since the programming of the web page allows only very limited operations. The second one is a more useful application for advanced users since it allows to use all the capacities and abilities of the mathematical software.

Key-Words: - E-learning, numerical calculation, symbolic calculation, graphical calculation, web application, virtual classes

1 Introduction

In academic matters in process of adaptation to a different pedagogical model focuses mainly on the student's learning and the learning throughout all the life (lifelong learning), it is necessary that the teachers of university make practical exercises on a new form to plan their matters: to identify which the formative objectives are for their students, what activities are adapted to obtain these objectives and with what temporary order is due to make. These seem to be the three key points of an organization where the global formation of the students is also considered like an important element at the time of defining the planning.

Teachers will consider the total curriculum of the degree, they will determine the formative block which their subject belongs to, and they will fit the depth and the extension of the subjects that will deal with in the course as well as the type of activities that could be more suitable depending on the level of the course, the previous knowledge, the number of students, or of if the subject is main or optional, for example.

Teachers and students are used to matters where the denominated "magisterial lesson" is the only existing activity and the objective test is the only instrument of evaluation. Then, we have arrived at a point from minimum implication where as many students as teachers seem to have accommodated and it is not infrequent that the wish to converge our subjects to the model advocated by the Bologna

process is labelled as uncertain adventure by the most incredulous. Partly because there are reasons for that uncertainty, partly because there will be as much teachers as students who will not wish to increase their level of implication in the educative process, and because, even wishing it, they anticipate difficulties simply by the fact to go against something established.

Therefore, it is necessary that all the projects of adaptation of subjects to the European Higher Education Area (EHEA), which we could describe in the present scene of our universities like as pioneering projects at this moment, to be executed with maximum rigor.

We have to be aware of that our errors during the execution of these projects will be used by others to try to dynamite the process of convergence in the matter of higher education. The process of adaptation of subjects to the EHEA is only one face of a polyhedral reality in which another facet is the convergence of courses or even complete curricula of degrees.

Nevertheless, it does not correspond to the "basic" teacher of university (but to directors, committees, rectors, etc.) to make important decisions with respect to a whole course or the curriculum of the degree in which he gives classes, at least not individually. But it is his responsibility to organize his subject of the form that he understands more suitable.

According to this item, there are many efforts from teachers of university (sometimes with the inestimable help of students) to improve and to adapt their classes in the convergence to the Bologna process. Many of them are involved in the field of the e-learning.

In this paper, two web applications that can be used as much in numerical, as graphical, as symbolic calculations are presented. The aim of the authors was to use them in the subjects, and nowadays the web applications are being used.

2 .NET technology

The pattern of the applications consists of the completion of a computer that works as server, along with the accomplishment of a web page in which the necessary connections for using the software of a certain subject are introduced. The communication between the web page and the software (that would be in the own server) would be made under .NET technology.

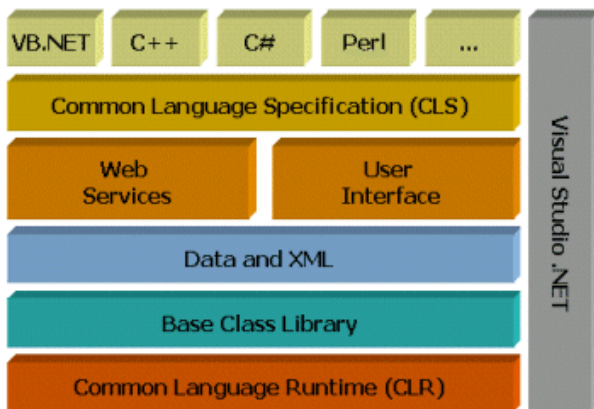


Fig. 1. Components of .NET

The main component of .NET, that is in the lowest layer of its model of layers, is Common Language Runtime (CLR), or common virtual machine. This is a program that can be executed, in principle, in any operating system, and that provides with a series of services that can be used from different programming languages.

The CLR executables are written in a language denominated MSIL (Microsoft Intermediate Language). In principle, any program written in MSIL (although nobody writes in MSIL, it is assumed that the compilers do it) can be executed in any operating system where a CLR works; the format of those files is named "portable executable" or PE. In addition to that, the executable file contains metadata, that inform on the functions and types that implement. But the concept of executable goes a

little further on: in .NET assemblies are used, that can include parts of code, data, codes of security, and all the necessary to turn it to movable and trustworthy code (in the sense that it is signed by somebody), that can be moved throughout Internet.

The assemblies, as well, contain metadata, in a section named manifest (just as it happens in the .jar of Java).

3 webMathematica

The first web application has been developed by means of *webMathematica*. In this case a series of applications directed to the solution of certain problems related to the numerical analysis has been made. Later on, other applications can be developed using the web services.

This type of applications, as it is displayed in the next image, only allows to execute the commands implemented in the web page in the corresponding button, so that from a point of view of initiation to a subject and the solution of problems, they can be very useful.

Software *webMathematica* adds interactive calculations and visualization to a website by integrating Mathematica with the latest web server technology.

Nevertheless, if we are trying to give the student an opportunity to face the own problems of each exercise and not to be so directed to its solution, which is a second step and more important one within the learning of a matter, it is necessary to give him the possibility of having a tool that allows him to conduct all the operations necessary to solve the problems, so that he himself must make the decisions about which the method he is going to use to solve them is. This last point is what we try to create in the application of the following section.

In the next figure, it can be seen in the left menu (the first column) that there are various items (they are marked with arrows) according to different exercises in order to resolve non linear equations. Student can "only" click one item and "only" use the text boxes and buttons that programmer put. It is because in the background of the web application the software is *webMathematica*, a good mathematical software but very less powerful than *Mathematica* (but with the great advantage of the low cost of a license). So, it will be a good application from a point of view of initiation to a subject and the solution of problems.



Fig. 2. Web application with *webMathematica*

4 Web application for *Mathematica* developed with .NET

It is an application that allows the student to use all the potential of the *Mathematica* tool, with no tie, so that the own student makes his decisions to solve the problems. We have denominated it as *MateOnLine*.

In this case, we need a server who supports the .NET technology in the university, and we need to purify some more the prototype so that the student finds no difficulties when using it.

We must give him guidelines of use, help, so that knowledge of language of *Mathematica* application is not an obstacle to solve problems, since although the installation of the *Mathematica* program is not necessary on the part of the student in its computer (simply it is necessary to be connected to a web page), he needs to know some commands of the program to be able to use it. That is, this web application has the enormous advantages of that: it is not necessary to install the software (*Mathematica*) in the user's computer, so user has not to buy a license to use *Mathematica* (university buy the license and install the software in its server in order to user use from home, for example).

4.1 Recommended requirements

MateOnLine has been designed to be supported by most of the available platforms and operating systems, independently of the browser used. However, there are recommended minimum requirements to use the application:

- PC: Microprocessor Pentium or AMD at 350 Mhz or higher
- Memory: 64 MB RAM or higher
- Operating system:
 - Windows 98/2000/Me/XP

- Linux
- Installed browser:
 - Microsoft Explorer 5.0 or higher
 - Mozilla Firefox 1.0 or higher
 - Netscape 7.0 or higher
 - Others: Konqueror, Opera, Safari, etc.
- Connection to Internet: modem of 56 Kbps or higher

However, the only essential requirement to accede to the application is to have a computer with connection to Internet and an installed browser.

4.2 Window of the application

The window of the application is made up of a toolbar with diverse buttons, in addition to several text-pictures and images used to show the entrance commands, as well as the results, graphs, error messages and/or commentaries obtained after each operation.



Fig. 3. Interface of the application

MateOnLine offers the possibility of selecting the fields that will be added to the file by means of their corresponding selection box. It is also possible to choose between visualizing the result in text or graphical mode.

In the next table it is shown the description of the functions of each button that compose the toolbar of *MateOnLine*.

	<p>Obtain result This makes the indicated operation in the entrance text picture.</p>
	<p>Add to historical file This adds the selected fields to the historical file.</p>
	<p>Create matrix Tool that introduces matrices in visual mode.</p>






	Write comment This adds to the historical file a comment that user has written.
	Download the historical file This save the present copy of the historical file in the user's hard disk.
	Documentation of <i>Mathematica</i> Link to the web page of Wolfram Research, with all the documentation of <i>Mathematica</i> .
	Help of the application This shows a quick guide of <i>MateOnLine</i> and links to the help of the application.
	Close the application This closes the open session and disconnects user from the server, releasing resources.

Table 1. Buttons of the toolbar of *MateOnLine*

In the next table, the most important constructors, methods and properties that are members of the *MathKernel* class and that has been used in the development of *MateOnLine* are included, as well as an explanation of the function that they make.

Constructor of the <i>MathKernel</i> class	
MathKernel	This initializes a new instance of the <i>MathKernel</i> class.
Properties of the <i>MathKernel</i> class	
CaptureGraphics	This checks or updates whether the object <i>MathKernel</i> has to capture the output of the graphics generated by <i>Mathematica</i> during an operation.
Graphics	This obtains the images of the output of the graphics of <i>Mathematica</i> during the last call to <i>Compute</i> .
IsComputing	This obtains whether <i>Mathematica</i> is at the moment occupied running an operation, that is, whether <i>Compute</i> is running at this moment.
IsConnected	This checks whether the link with <i>Mathematica</i> has been connected. Usually, it means that the Kernel has been launched and it is ready for its use.
LinkArguments	This obtains or writes the command string that will be passed to <i>CreateKernelLink</i> .
Messages	This obtains the strings of

	the outputs of messages of <i>Mathematica</i> during the last call to <i>Compute</i> .
Result	This obtains the result of the last call to <i>Compute</i> .
ResultFormat	This obtains or updates the output format of the results.
Methods of the <i>MathKernel</i> class	
Abort	This sends a request to abort the operation that is being run.
Compute	This executes an operation of <i>Mathematica</i> .
Connect	This creates and connects the link with <i>Mathematica</i> , if it has not been previously connected.
Dispose	This releases the assigned resources.

Table 2. Members of the *MathKernel* class

The code necessary to send a request to the server, to verify that another operation is not being executed, to make the required tasks and to show the results obtained in the browser, is the following:

```

if (mathKernel.IsComputing)
{
    // Send a request to abort the computation
    // currently in progress
    mathKernel.Abort();
}
else
{
    // Clear out results from previous
    // computation
    resultBox.Text = "";
    messagesBox.Text = "";
    printBox.Text = "";

    // Create the link if it has not already been
    // connected
    mathKernel.Connect();

    // Perform the computation
    mathKernel.ResultFormat =
    Wolfram.NETLink.MathKernel.ResultFormatType.
    OutputForm;
    mathKernel.Compute(inputBox.Text);

    // Show the results of the computation
    resultBox.Text =
    mathKernel.Result.ToString();
    
```

```
foreach (string m in mathKernel.Messages)
    messagesBox.Text += (m + "\r\n");
foreach (string p in mathKernel.PrintOutput)
    printBox.Text += p;
if (mathKernel.Graphics.Length > 0)
```

```
graphicsImage.ImageUrl =
"Graphics.aspx";
}
```



Fig. 4. Introducing a function



Fig. 5. Integrating the function

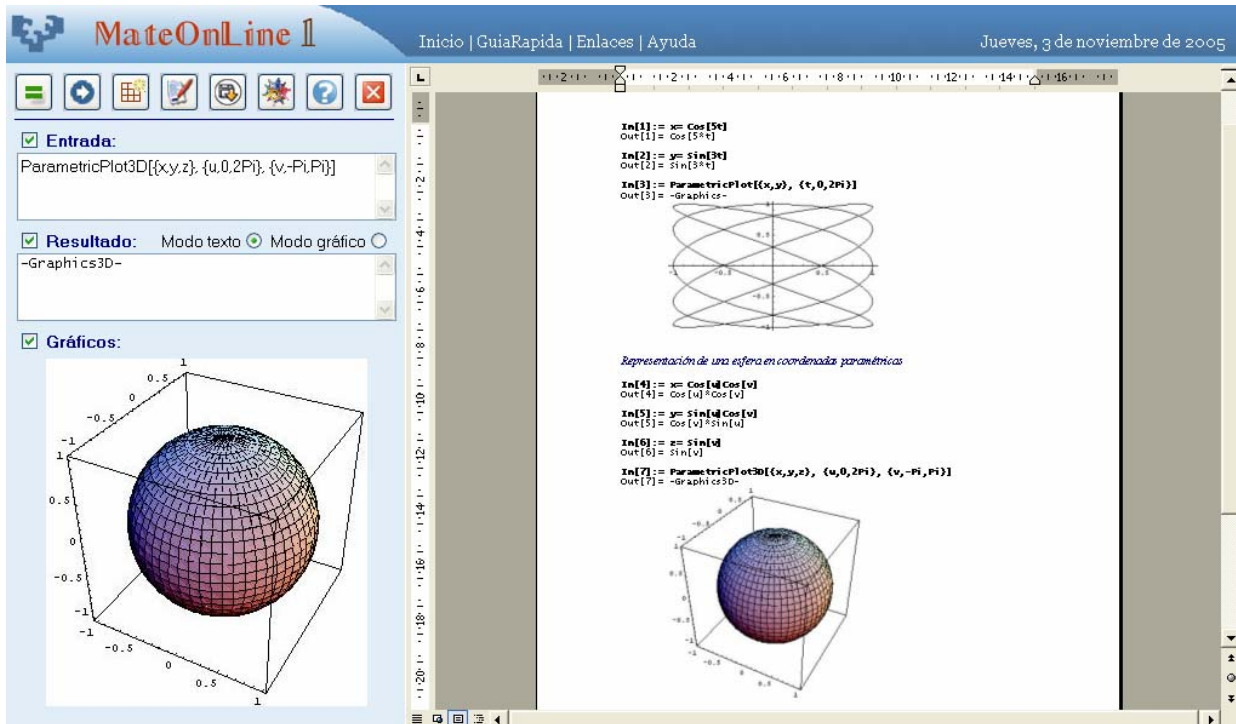


Fig. 6. Graphical calculation

5 Conclusions

Two web applications that may be use in the field of numerical, graphical and symbolic calculation are presented. They are linked with *Mathematica* software by means of .NET and Java technologies.

The first application is useful for those that are not familiar with the mathematical tool; it is simpler but it loses part of the capacity of the mathematical software since the programming of the web page allows only very limited operations, so it will be a

good application from a point of view of initiation to a subject and the solution of problems.

The second one is a more useful application for advanced users since it allows to use all the capacities and abilities of the mathematical software. We have denominated it as *MateOnLine*.

The installation of the *Mathematica* program is not necessary on the part of the student in its computer (simply it is necessary to be connected to a web page). That is, the web applications have the enormous advantages of that: it is not necessary to

install the software (*Mathematica*) in the user's computer, so user has not to buy a license to use *Mathematica* (university buy the license and install the software in its server in order to user use from home, for example).

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