



UNIVERSITY OF NOVI SAD TECHNICAL FACULTY "MIHAJLO PUPIN" ZRENJANIN



ITROCONFERENCE¹⁰
INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT



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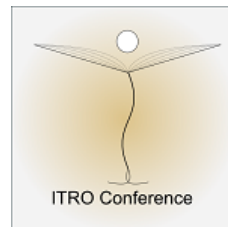
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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2019 is also published.

INTRODUCTION

International Conference on Information Technology and Education Development (ITRO 2019), was held the jubilee tenth time. Since the very beginning, the conference has been connecting science, profession and experiences in education. Information technologies influence educational processes and student achievements. Contemporary topics relate to Interactive EBooks and electronic Teachers logbooks. Thematic fields of the conference are alined with general, but also with national trends in education:

- Theoretic and methodology questions of contemporary pedagogy
- Digital didactics of media
- Modern communication in teaching
- Curriculum of contemporary teaching
- E-learning
- Education management
- Methodic questions of natural and technical sciences subject teaching
- Information and communication technologies
- Dual education.

The conference work was contributed by plenary lectures covering various aspects of ICT in education development:

- *Digital transformation of educational system in Higher Education*, Branko Perišić, Faculty of Technical Sciences, University of Novi Sad;
- *Security issues of e-learning system*, Igor Franc, E-security, Belgrade;
- *From E to ES teacher logbooks*, Žarko Mušicki, primary school “Žarko Zrenjanin”, Novi Sad;
- *Canvy, The Thruve Story of Mobile App*, Marius Marcu, Politechnica University of Timisoara, Romania.

The Proceedings contains 59 articles based on research and scientific work in the field of information technologies in education.

The conference was financially supported by the Provincial Secretariat for Higher Education and Scientific Research, Novi Sad. The Technical Faculty “Mihajlo Pupin” has provided the necessary technical support.

The ITRO Organizing Committee would like to thank to the authors of articles, reviewers and participants in the Conference who have contributed to its tradition and successful realization.

Regards until the next ITRO Conference,

Chairman of the Organizing Committee
Jelena Stojanov

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***SCIENTIFIC
PAPERS***

Using of MatLab in the Mathematical Education

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Abstract – MATLAB is a multi-paradigm numerical computing environment. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. In the paper, there is an explanation for solving problems in the field of mathematics, solved in the Matlab programming language. The goal is to show that Matlab is a user-friendly programming language, so it is easy to use. Commands are invoked in a very simple way with a simple syntax, where in comparison with other programming languages; they require detailed knowledge of the language itself.

I. INTRODUCTION

Mathematics is an essential discipline that appears in every discipline. The world is rapidly developing technologically and of which mathematics is a required instrument because without mathematics there is no modern society. The traditional educational activity at universities mostly includes lectures and practical lessons. The lecture has been one of the main components of the educational process at the universities for many centuries [1]. The traditional lectures in mathematics usually consist of theoretical material sometimes including practical examples. Usually, the teacher writes the basic information on the board. However, today, technology has become an essential tool for doing mathematics. The use of technology in teaching mathematics has become a popular component of most introductory mathematics classes. It can be used in a variety of ways to improve and enhance the learning of mathematics. Especially, engineering mathematics students are compelled to have access to an appropriate computer technology due to the perpetually increasing complexities of the engineering programs. [2] [3]. Information and communication technology can play an effective role as a cognitive tool in the teaching and learning of mathematics. The use of such technologies can present mathematics in a more authentic and tangible manner. [4] Technology can facilitate mathematical problem solving, communication, reasoning, and proof; moreover, technology can provide students with opportunities to explore different representations of mathematical ideas and support them in making connections both within

and outside of mathematics. [5] [6]. Therefore, effective use of technology has the potential to motivate and enliven the learning of mathematics.

MATLAB is one of the most popular programs that is widely used in mathematics classrooms especially at the university level. As more and more universities are adopting its use in education, it is necessary to study and analyze how the software could be used in teaching and learning of mathematics [7] [8].

II. BASIS OF MATLAB

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.

MATLAB is a mathematical and graphical software package. It has numerical, graphical, and programming capabilities. It has built-in functions to do many operations, and there are toolboxes that can be added to augment these functions (e.g., for signal processing). There are versions available for different hardware platforms, and there are both professional and student editions [9].

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

Nowadays, MATLAB has roughly 1 million users across industry and academia. These users come from various backgrounds of engineering, science, and economics.

The MATLAB application is built around the MATLAB scripting language. Common usage of the MATLAB application involves using the Command Window as an interactive mathematical

shell or executing text files containing MATLAB code [10].

III. MATLAB COMPUTATION USING SCHOOL EXAMPLES

Variables in Matlab are defined using the assignment operator, =. MATLAB is a weakly typed programming language because types are implicitly converted. It is an inferred typed language because variables can be assigned without declaring their type, except if they are treated as symbolic objects, and then their type can be changed. Values can come from constants, from computation involving values of other variables, or from the output of a function. Matlab can be used for fast calculations.

example: `>> x=[3*4,pi/2]`
`x=`
 12.0000 1.5708

A simple array in Matlab is defined using the colon syntax: initial: increment terminator.

example: `>> 1:3:9`
`array=`
 1 4 7

The array starts at 1 (the initial value), increments with each step from the previous value by 3 (the increment value), and stops once it reaches (or to avoid exceeding the terminator value).

The increment value can actually be left out of this syntax (along with one of the colons), to use a default value of 1.

example: `>> ari= 1:4`
`ari=`
 1,2,3,4

An array is named *ari* and includes values 1, 2, 3, 4, since the default value of 1 is used as the incrementer.

Matrices can be defined by separating the elements of a row with blank space or comma and using a semicolon to terminate each row. The list of elements should be surrounded by square brackets: []. Parentheses: () are used to access elements and subarrays (they are also used to denote a function argument list).

example:
`>> A = [16 3 2 13; 5 10 11 8; 9 6 7 12; 4 15 14 1]`

```
A =
16 3 2 13
5 10 11 8
9 6 7 12
4 15 14 1
>> A(2,3)
ans =
11
```

A square identity matrix of size n can be generated using the function `eye`, and matrices of any size with zeros or ones can be generated with the functions `zeros` and `ones`, respectively.

example:
`>> eye(3,3)`
`ans =`
 1 0 0
 0 1 0
 0 0 1
`>> zeros(2,3)`
`>> ones(2,3)`

```
ans =
0 0 0
1 1
0 0 0
1 1
```

Most MATLAB functions can accept matrices and will apply themselves to each element. For example, `mod(2*J,n)` will multiply every element in "J" by 2, and then reduce each element modulo "n". MATLAB does include standard "for" and "while" loops, but (as in other similar applications such as R), using the vectorized notation often produces code that is faster to execute. This code, excerpted from the function `magic.m`, creates a magic square M for odd values of n (MATLAB function `meshgrid` is used here to generate square matrices I and J containing 1:n).

example:
`[J,I] = meshgrid(1:n);`
`A = mod(I + J - (n + 3) / 2, n);`
`B = mod(I + 2 * J - 2, n);`
`M = n * A + B + I;`

MATLAB, also, has structure data types. Since all variables in MATLAB are arrays, a more adequate name is "structure array", where each element of the array has the same field names. Access data in a structure using dot notation of the form *structName.fieldName*. In addition, MATLAB supports dynamic field names (field look-ups by name, field manipulations, etc.). Unfortunately, MATLAB JIT does not support MATLAB structures; therefore, just a simple bundling of various variables into a structure will come at a cost.

When creating a MATLAB function, the name of the file should match the name of the first function in the file. Valid function names begin with an alphabetic character, and can contain letters, numbers, or underscores. Functions are often case sensitive. MATLAB supports elements of lambda calculus by introducing function handles, or function references, which are implemented either in *.m* files or in anonymous-nested functions.

example:

```
function nanotabl(b) d=load(b);
figure('Position',[100, 300, 600, 460],...
'Name','TablePlot',... % Title figure
'NumberTitle','off',... % Do not show figure
number
'MenuBar','none'); % Hide standard menu bar
menus
```

MATLAB supports object-oriented programming including classes, inheritance, virtual dispatch, packages, pass-by-value semantics and pass-by-reference semantics. However, the syntax and calling conventions are significantly different from other languages. MATLAB has value classes and reference classes, depending on whether the class has handle as a super-class (for reference classes) or not (for value classes).

Method call *behavior* is different between value and reference classes. For example, a call to a method *object.method()*; can alter any member of object only if object is an instance of a reference class.

MATLAB supports developing applications with graphical user interface (GUI) features. MATLAB includes GUIDE (GUI development environment) for graphically designing GUIs. It also has tightly integrated graph-plotting features. For example, the function *plot* can be used to produce a graph from two vectors *x* and *y*. The

code produces the Figure 1, presenting the *sine* function:

Example:

```
x = 0:pi/100:2*pi;
y = sin(x);
plot(x,y)
```

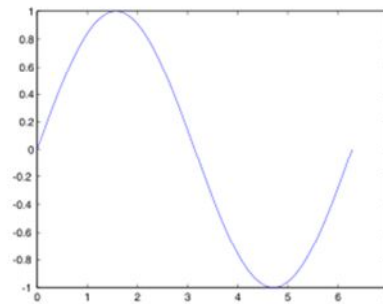


Figure 1. Sine function obtained in Matlab.

A. Solution of the equation:
 $y''+0.05x'+x^3=7.5\cos(t)$ in Matlab.

In mechanical engineering, this equation can model the motion of a forced sinusoidal structure, making great elastic deflections. Here is chosen the parameters in order to see the chaos thanks to the work of Ueda in 1980. Then is turned into a 2 ODE system with

$$y'(t) = y$$

$$y'(t) = 7.5 \cos(t) + 0.05x' + x^3$$

We use 2 Matlab *.m* codes.

```
f = @(t,z) [z(2);(7.5*cos(t)-0.05*z(2)-z(1)^3)];
[t,z]=ode45(f,[0,100],[3,4]);
hold off
figure
plot(t,z(:,1))
hold on
[t,z]=ode45(f,[0,100],[3.01,4.01]);
plot(t,z(:,1),'r')
hold off
figure
[t,z]=ode45(f,[0,100],[3,4]);
plot(z(:,1),z(:,2))
hold on
[t,z]=ode45(f,[0,100],[3.01,4.01]);
```

```
plot(z(:,1),z(:,2), 'r')
```

We begin with two numerical integrations of the neighboring state, one $x(0)=3, x'(0)=4$. This initial state is selected to minimize the initial transients, since they lie in the region of the phase space that is occupied by the long integration of the previously calculated solution. The waveform effect is quite visible in this example. There is divergence from adjacent starts. Then we plot the x-coordinates (the actual solution $x(t)$ to the original 2nd order ODE first for the initial conditions $x(0)=3, x'(0)=4$ in blue and then for the initial conditions $x(0)=3.01$ and $x'(0)=4.01$ in red. (Figure 2 and Figure 3)

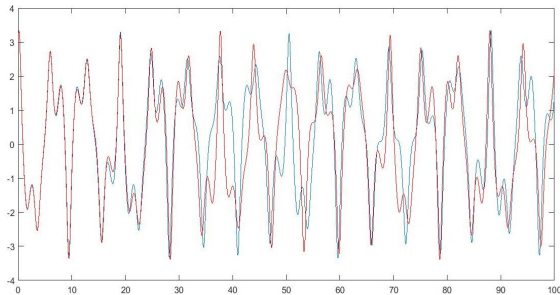


Figure 2. Divergence from adjacent starts: waveforms for Ueda's

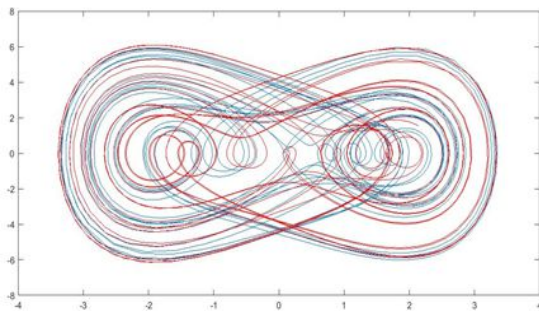


Figure 3. Divergence from adjacent starts: phase projections for Ueda

In the second example (Figure 4 and Figure 5) is shown the starting point $(x,y)=(0,0)$ which presents the initial conditions for

$$x(0) = 0 = x'(0)$$

example

```
clear all
```

```
f=@(t,z) [z(2);(7.5*cos(t)-0.05*z(2)-z(1)^3)];
```

```
[t,z]=ode45(f,[0,100],[0,0]);
```

```
hold off
```

```
figure
```

```
plot(t,z(:,1))
```

```
hold on
```

```
[t,z]=ode45(f,[0,100],[0.01,0.01]);
```

```
plot(t,z(:,1), 'r')
```

```
hold off
```

```
figure
```

```
[t,z]=ode45(f,[0,100],[0,0]);
```

```
plot(z(:,1),z(:,2))
```

```
hold on
```

```
[t,z]=ode45(f,[0,100],[0.01,0.01]);
```

```
plot(z(:,1),z(:,2), 'r')
```

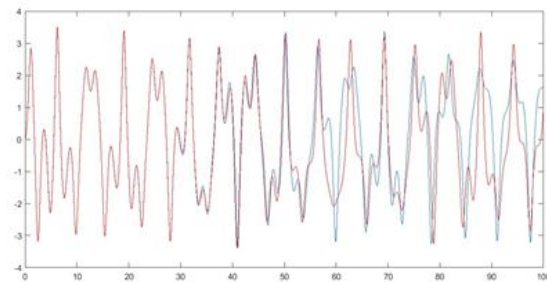


Figure 4. Steady-state of chaos

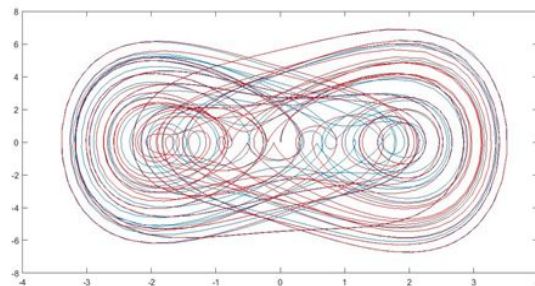


Figure 5. Phase projections for steady-state of chaos

IV. CONCLUSION

The use of technology innovation like Matlab software can improve active involvement of the student in the classroom instruction and enhances their performances. Calculations with Matlab can be performed fast and easily. Matlab software can be integrated in the process of teaching of the various topics such as vectors and matrices as well as plotting graphs of sine, 3D bar, simultaneous and different quadratic equations. Matlab is a very powerful tool for computing, simulations, and powerful software package that has many built in tools for solving problems and developing graphical illustrations. Matlab does not require compiler to execute like C, C++. It just executes each sentence as it is written in code. This increase productivity and coding efficiency. It is higher-

level language. Using Matlab Coder the codes written in Matlab can be converted to C++, Java, Python, .Net etc. This makes this language more versatile. So, scientific theories can be implemented in other languages also. Moreover, those library files, or dll s can be directly implemented in other languages.

Matlab has inbuilt rich library of Neural Network, Fuzzy Logic, Simulink, Power System, Hydrolins, Electricl , Communication, Electromagnetics etc. Thus, developing any scientific simulation is easy to do using such rich library.

Disadvantage is its cost of License. It is very costly and user has to buy each module and pay for it. Disadvantage is during cross compiling or converting Matlab to other language code is very difficult. It is very difficult or requires deep level Matlab knowledge to deal with all errors.

Matlab is not suggested to make any product. Because, Matlab does not create application deployment (installation) like task (like setup files and other executable which copies during installation). Therefore, Matlab is the most suitable for learning mathematics and scientific research. Matlab can be used to improve the understanding difficult topics of Mathematics, especially for students. The experience of using Matlab to support the teaching and learning of mathematics topics may have a strong impact on the learning strategies of students.

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