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A Review on Computational Economics and Finance Teaching

M. Arif Hussain *
Institute of Business & Technology, Karachi

Syed Murshid *
Fedral Urdu University, Karachi

Syed Ahmed Hassan *
Institute of Industrial And Electronics Engineering (IIEE), Karachi

ABSTRACT

Advances in computing have changed the traditional teaching styles at colleges and universities. There are many computational subjects like, computational physics, computational mathematics, computational statistics, computational economics, computational finance, computational chemistry, computational biology, computational geophysics, etc. From an academic point of view, some of this research challenges fundamental concepts in economics and finance. Students, teachers, and researchers gain better insight into the fluctuating behavior of financial markets by using methods of computational finance and economics. Moreover, researchers have also shown that the computational medium is affecting the degree of students learning. One can learn effectively problem solving using computational tools. Current communication reviews the use of computer application software, Matlab, for the solutions to some economic models. This also emphasizes use of Monte Carlo simulation approach to improve solutions to business models.

INSPEC Classification : A0270, A0650, A0140, A0150

Keywords : Computational Subjects, Problem Solving, Matlab, Monte Carlo Simulation

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* M. Arif Hussain : dr.arif@ibt.edu.pk
* Syed Murshid : smmurshid@fuuast.edu.pk
* Syed Ahmed Hassan : syed_a_hassan@yahoo.com

1. Introduction

Advances in computing have changed the traditional teaching styles at colleges and universities. There are many computational subjects like, computational physics, computational mathematics, computational statistics, computational economics, computational finance, computational chemistry, computational biology, computational geophysics, etc. From an academic point of view, some of this research challenges fundamental concepts in economics and finance. Students, teachers, and researchers gain better insight into the fluctuating behavior of financial markets by using methods of computational finance and economics. Computational methods help in getting solutions to business problems both analytically and approximately [1]. In particular, computational subjects are futuristic approach in teaching, and help in better perception of economic activities under study by changing useful parameters of models capturing business fluctuations. Such drills enable one how to translate general economic questions into a numerical task and back into an economically meaningful answer. Although business students prefer to use spreadsheet packages for accounting work and many other uses, but for analytical work requiring dynamic interaction among variables spreadsheet packages are far behind. This study aims to explain use of Matlab, which contains a rich pool of mathematical functions for analytical calculations, and provides rich plotting functions for illustrating mathematical solutions to practical problems in business sciences [2]. Matlab, a preferred application for most of the students of engineering disciplines [3], also helps to do analysis on data sets in variety of ways. Although, there are several symbolic computer programs like, Macsyma, Maple, Derive, Mathematica and others, which can be used to solve business sciences problems, but Matlab is the easiest one to understand quickly by business sciences students [4].

One can write programs similar to other computer languages [5]. This software can be useful in both business sciences and engineering sciences [6]. This is also applicable to problems related to optimization [7]. So, in methodology section we describe important commands of this application. Section 3 describes some business sciences problems and demonstrate Monte Carlo simulation approach for their solution. Finally, Section 4 concludes this study.

2. Methodology

Matlab is one of the powerful computation packages for numeric and symbolic calculations [8], and can be used in teaching of fundamental business concepts of cost minimization, profit maximization, as well as the quantitative techniques of searching for the optimal resource allocation solution in multivariate cases related to the real business world problems. This section will cover some of the commands available in Matlab. One can find details of most of the commands in a reference manual [9].

Simple calculations in this software:

Arithmetic:

>> 70 + 1/5

Ans = 70.2000

It reveals use of application software as a calculator. It also supports almost every aspects of Matrix algebra.

Derivative and Anti-derivative on Computer:

Differentiation:

For constructing symbolic objects syms command is used, (% sign is used to give comments)

```
>> syms x                    % "syms" defines x as symbolic variable
>> y=x^3; diff(y,x)          % "diff" differentiates y w.r.t. x
ans = 3*x^2
```

For its second derivative we write

```
>> y= x^3; diff(y, x, 2)
ans = 6x
```

Anti-derivative:

For this purpose **int** command is used.

```
>>  syms x ;
>>  int(x^3,x)
 ans  = x^4/4
```

In the next section, we take examples from business sciences and apply simulation technique.

3. Monte Carlo Simulation for Business Problem Solving

Essentially Monte Carlo simulation is performed using random numbers. So, Matlab uses several commands for the generation of random numbers. These commands include rand, randn, randint, etc [10].

Example 1. Generating random binary numbers "0" and "1" with Matlab

Solution:

Matlab command randint generates a "0" or "1" with equal probability. Similarly randint (m, n) generates an m by n matrix of random binary numbers. For instance, command randint(4, 8) generates 4 by 8 matrix of "0" and "1" as demonstrated below.

>> b = randint(4,8)

```
b =     1   1   1   1   0   1   1   1
        1   0   1   0   1   0   1   0
        0   0   0   1   1   1   1   1
        1   1   1   0   1   1   0   0
```

Matlab commands rand, randn are used to generate random numbers from uniform and standard normal probability distributions. Next example reveals the use of random numbers in

Monte Carlo simulation to improve parameters of a Regression model.

Example 2 Regression model between volume of production and manufacturing expenses in an electronic factory is given by [11].

$$y = 134.79 + 0.40\,x + \varepsilon \qquad (1)$$

Use Monte Carlo simulation to improve parameters of Regression model (1).

Solution:

Here, we use following Matlab program to improve parameters of Regression model (see Box 1).

```
% define parameters
b0=134.79;
b1=0.40;
σ=2.3;      % sigma = σ

% total number of trials
t=2500;
% total number of data points
d=250;
% generating data
X=randn(d,t);
e=σ*randn(d,t);
y = b0 + b1*X + e;

bhat=zeros(d,2);
for i=1:t;
XpXinv=inv([ones(d,1),X(:,i)]'*[ones(d,1),X(:,i)]);
XpY=[ones(d,1),X(:,i)]'*y(:,i);
bhat(i,:) = XpXinv*XpY;
end;
parameters=[mean(bhat);std(bhat)]
```

Box 1. Monte Carlo simulation program to improve regression parameters.

Output of above program is given below. In this case we got a little bit improvement in regression parameters. Values in parentheses are standard deviations of estimates.

Output of Simulation program:

parameters =

134.7913	0.4045
(0.1434)	(0.1462)

4. Conclusions

Present study has demonstrated that Matlab is a powerful numerical and symbolic computation application, which can be used in teaching of business sciences courses. It can also be used to explain to students the fundamental business concepts and other quantitative techniques. By teaching students simple Matlab functions and programs as a supplementary skill-builder, students can learn business mathematics, economics and finance much quicker. We expect that the simple Matlab function commands demonstrated in this study will enable our students to become better decision makers in business problem solving.

Computational approach will increase the learning outcomes, and will foster progressively problem solving skills of students of business sciences. This communication has also demonstrated use of random numbers in performing Monte Carlo simulation. While the current study has revealed the use of Matlab in solving simple economic models, there is plenty of associated research problems including business risk modeling to be addressed in future papers.

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