Observing Of The Euro Sales Changes By The Exchange Rate Changes Based On Monte Carlo Simulation Method With Cuda

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Abstract

Today's World, a lot of prediction can make based on prediction algorithms such as systems approach, monte carlo methods , collaborating filtering algorithms. Most of the company use to scientific prediction methods that include the simulation methods for financial future plans. Monte Carlo method is used for a lot of commercial gain predictions, profit- loss calculations, production costs. Monte Carlo method that is a prediction apporach can be used to a lot of areas such as yearly counting of companies, weakly weather forecasts, money markets etc. It is calculated that the predictions can be easily computed by the Cuda programming. In this study, it is observed that how the Euro sales changes will become for the next 6 months according to the previous 6 months. The random numbers that are needed by Monte Carlo Integration on GPU are easily generated by the CUDA APIs and the results are predicted on based Monte Carlo method. The Cuda Parallel Programming is used for prediction computing. The accuracy of the predictions are computed by chi-square test that is a statistical analysis test and the close results of the reality are observed by the chi-square test.

Key words: Monte Carlo, Cuda , Euro Changes, Prediction

1. Introduction

System is defined that it is an all that includes to a lot of components that have a relationship of physical or conceptual nature for arriving to an aim or a result. Operation research is also a discipline that deals with the application of advanced analytical methods to help make better decisions. The aim of the research is defining to problem and then a solution for the problem is developed. Simulation is the discipline of designing a model of an actual or theoretical physical system, executing the model on a digital computer and analyzing the execution output.[1]. The one of the best well-known technique is Monte Carlo simulation method for defining problem solution.

Simulation technique is a methodology for using to problem solution. The approach to problem of simulation technique depends on the system structure and its model that is built by the system structure and the solutions can change. The simulation models that are consisted of the simulation techniques are listed below.

- Static Simulation Models
- Dynamic Simulation Models
- Deterministic Simulation Models
- Stochastic Simulation Models
- Discrete Simulation Models

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- Continuous Simulation Models

A static simulation model is a representation of a system at a particular time or one that may be used to represent a system in which time simply plays no role [2]. Static means that particular factors (values) are variable or random. It is not change by the time. In dynamic simulation models ,a dynamical system is a model that depends on time. It is a fixed rule describes how a point in a geometrical space in mathematics. The aim of dynamic simulation models is to investigate the reasons of the process by understanding to shame of the process and to improve to process as a long term. Deterministic simulation model contain no random variables and no degree of randomness, and consist mostly of equations. These simulations have known inputs and they results in a unique set of outputs [3]. Stochastic simulation model is a simulation that operates with variables that can change with certain probability. Stochastic modeling is for the purpose of estimating the probability of outcomes within a forecast to predict what conditions might be like under different situations. The random variables are usually constrained by historical data. Monte Carlo simulations are defined as a stochastic simulation model [4].In discrete simulation models, The state variables change only at a countable number of points in time. These points in time are the ones at which the event occurs/change in state [5].In continuous models, the statistics are obtained by observing as a continuous to situation variables. Exhausting calculations are reduced by the continuous models

2. Methodology

2.1. Monte Carlo Method

Simulation means producing random variables with a certain distribution just to look at them. For example, it might have a model of a random process that produces clouds. it could be simulated the model to generate cloud pictures, either out of scientific interest or for computer graphics. Monte Carlo methods are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results; typically one runs simulations many times over in order to obtain the distribution of an unknown probabilistic entity [6]. It is usually expressed that regular possibilities are random numbers and the random numbers must be provided that:

1- All possibilities must be become equal chances.
2- All new values are independent the all previous values.
3- Observed numbers must be reduced to data model.

The all system is simulated a lot of times (e.g., 500) in Monte Carlo simulation. Each simulation is thought like equal to referred to as a realization of the system.All of the uncertain parameters are sampled for each realization. (i.e., a single random value is selected from the specified distribution describing each parameter). The system is then simulated through time (given the particular set of input parameters) such that the performance of the system can be computed [7].

2.2. Cuda Parallel Programming

GPU computing model is the use of a GPU for general scientific and engineering computations. The usage of CPU and GPU together heterogeneously is called GPU computing model. [8]

CUDA (Compute Unified Device Architecture) is a parallel computing platform and programming model invented by NVIDIA. It enables dramatic increases in computing performance by harnessing the power of the graphics processing unit (GPU)[9] . The CUDA platform is accessible to software developers through CUDA-accelerated libraries and extensions to industry-standard programming languages, including C, C++ and Fortran. We can show that OpenMP, POSIX Threads and Win 32/64 Threads that are widely used shared-memory programming softwares that work on CPU. [10] When compared to CPU, they have higher memory bandwidth and floating point. Nvidia developed CUDA programming model which enables software developers to use parallel computing by utilising C programming language. CUDA programming model allows programmers to use multithreaded GPU's effectively in parallelization. [11]

2.3. Problem Definition

The Research for Simulation trials must be done before the trials. In this step, simulation problem can be review for the each step. The borders and contents must be point out in problem definition step. The second step of the simulation method is to plan to model and to set up the simulation model. The model must be real datas for the simulation. The way of developing a simulation model is to understand to system process and the ability that consist of the random variable values that is affect to system behaviors [12]. While the model set up for simulation, it is important that the types of the alternatives between model and test. The test datas must be reduced to enough level of the detail. The model must be represent to in level of the detail.

2.4. Data Analysis

Monte Carlo data generation can include the following special features [15]:
• Single or multiple group analysis for non-mixture models
• Missing data
• Complex survey data
• Latent variable interactions and non-linear factor analysis using maximum likelihood
• Random slopes
• Individually-varying times of observations
• Linear and non-linear parameter constraints
• Indirect effects including specific paths
• Maximum likelihood estimation for all outcome types
• Wald chi-square test of parameter equalities
• Analysis with between-level categorical latent variables

Firstly, it is decided that by using experience datas or theoretical probability distribution the for Monte Carlo simulation design . A simulation success depends on that criterias:

• Validity
• Distribution of the data
• Compliance with the theoretical distribution

In any experiment, output depends on the average of then period independent observation. N is defined as simulation number that depends on the data model.

2.5. Obtaining of the Random Numbers

For the stochastic events are generated in Monte Carlo method with the probability distribution , the random numbers are needed. Firstly, the cumulative distribution function (CDF) is observed and then the random numbers are integrated to CDF. Let X is a random number and it is obtained an f(x) function that is equal to cumulative distribution function with the previous values. A number is generated between the 0 and 1. .A lot of programming language generate random numbers via their random functions such as Random , rand(), srand(1) . In Cuda Programming random numbers are obtained with rand() and RAND_MAX for the random border like that C++ Programming.

2.6. Hypothesis Tests

There are numerous types of statistical tests, associated with different forms of application problems, such as significance tests that determine whether a hypothesis ought to be rejected, parametric tests to verify hypotheses concerning parameter values, goodness of fit tests to determine whether an observed distribution is compatible with a theoretical one, etc. Statistically significant results are those that are unlikely to have occurred by chance. Significance Tests are procedures for establishing the probability of an outcome, on a null hypothesis of no effect or relationship for determining the last values of used parameters, the sensitivity analysis is used. The sensitivity analysis is a process that includes to investigate to model parameters intervals. The applications are tried with a lot of values. A lot times the application is tried.

2.7. Simulation Results and Feedback

After the first simulation additional Monte Carlo Simulations are possible and the input values could be analyzed via sensitivity analysis. That means, every input value has to be changed, for example in 10 % steps, and the Monte Carlo Simulation will be started successively with different input values. The results of the sensitivity analysis are interpretable and showing the influences of the alteration of every individual input value. For accuracy of the simulation, it is utilized that is chi square test.
Chi square test is an statistical analysis test that controls to simulation results. If any result has a huge differences than the real data model, it must be controlled by the Chi square test. A system is set up and then the solution is observed by the accuracy tests. In Chi-square test, there are generally two cases for the control.

H_0: There are not any differences between the observed values and theoretical values and the hypothesis is accepted.

H_1: There is a difference between the observed values and theoretical values and the hypothesis is

accepted and the hypothesis must be controlled.

3. APPLICATION

In Money Markets, the money values change a lot of times in a year according to World market. The next financial values are determined by the previous economic fluctuations. Because of this, the economists need to scientific predictions. In this study, the Euro sales changes are observed by the Exchange Rate Changes based on Monte Carlo simulation method with CUDA.

3.1. Selection of The Dataset

For the application ,the data model is taken from TCMB Euro sales values and it is shown that Figure 1. [20]
In study, according to the previous 6 months Euro sales values, the next 6 months Euro sales values are predicted with Monte Carlo method in CUDA. In dataset,145 data values that include to rates of weekly days are used and the date-rate values are taken for the simulation and it is shown that Figure 1.

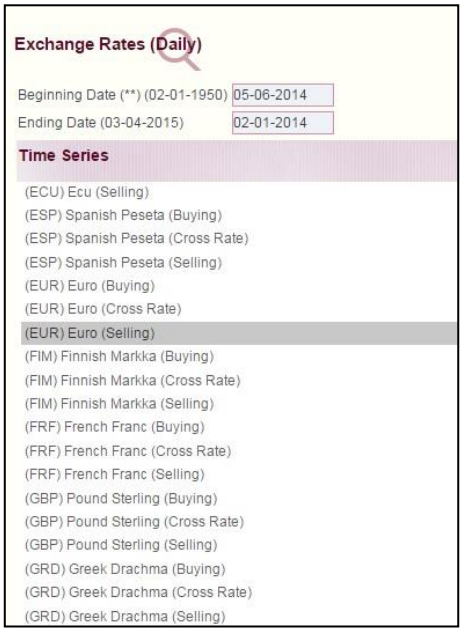

Figure 1. Exchange Rates for Euro Selling

3.2. Simulation Steps

Firstly, The periodic returns that is called continuous compounding are calculated for each day. Because of this, rate values of the exponential values are calculated in CUDA and the average of all rate values are computed. Periodic return (continuous compounding) is computed like Eq. (B1). The Secondly, varience of the rate values are computed. In study, all varience value is computed as 0.00003603.

If the x value is a daily rate value and the average is S_n value, sum of the varience value is like Eq. (B2). After the varience computing, the whole deviation mean is computed like Equation B3. The deviation mean of the all euro sales rate is computed as 0.00600284
After the computing the deviation mean values, for computing the cumulative distribution function , the drift constants (α) are computed for each rate value like Eq.(B4). [21]. The all drift constant is computed as 0.000125398 . Standard normal distribution cumulative distribution function (CDF) is calculated in this step. It is shown that Eq.(B5). If erf(x) is a error function, CDF function is like Eq.(B6). For each periodic return value, the random number (z_1) is generated like Eq.(B7)

4. EVALUATION OF THE SIMULATION RESULTS

The results of the simulation must be controlled as a scientific analysis test. In this study, The chi- square test is applied for the simulation accuracy.

Table 1. Comparison of the values with Chi- Square Table

	0.995	**0.10**	**0.02**	**0.001**
1	0.0000393	2.706	5.412	10.828
2	0.0100	4.605	7.824	13.816
…				
143	103.196	165.056	196.546	201.002
144	104.044	166.132	197.716	202.184
145	104.892	167.207	198.885	**203.366**
146	105.741	168.283	200.054	204.547

The chi square test controls accuracy of between observed values and used data values.[22] The square test values are computed like Eq.(C1).

$$x^2 = \sum_1^n \frac{(O-U)^2}{U} \qquad \text{Eq.(C1)}$$

Where O is observed value and U is used value. The all chi-square values are computed and the chi-square values are summed and it is computed as nearly 0.015262.In an alpha level of 0.01 that is the most sensitive level, it is evaluated by the chi-square table. The chi-square table is shown Table 1.In study, the chi-square value is computed as:

$$x_{cal}^2 \cong 0.15262$$

According to the chi-square table, an alpha level of 0.01 , the value is: [23]

$$x_{table}^2 = 203.366$$

According to the $x_{cal}^2 < x_{table}^2$ the hypothesis is H_0 and because of this, our hypotesis is valid.

5. RESULTS AND CONCLUSION

Monte Carlo simulation method on based CUDA programming is used effectively and the simulation results are observed to accuracy. By Cuda Parallel Programming, we generated to random number effectively [24] and we provided to accuracy of hypothesis with chi-square test.
A lot of financial calculations for the future can be predicted by the simulation methods such as Monte Carlo. In this study, we computed the next 6 monthly Euro sales changes by the previous 6 monthly Euro sales.
The results can be developed with the time and the other effects and also the more factors can be considered such as possible political developments, petrol prices, export-import rates etc. A lot of predictions can be computed by this method such as weather forecasts, yearly cost rates of the companies.

Appendix

$$\ln\left({S_t}/{S_{t-1}}\right) \qquad \text{Eq.(B1)}$$

$$P(x) = \sum_1^n (x - S_a)^2 \qquad \text{Eq.(B2)}$$

$$\sigma = \sqrt{P(x)} \qquad \text{Eq. (B3)}$$

$$\alpha = a - \left(\frac{P(x)}{2}\right) \qquad \text{Eq.(B4)}$$

$$\text{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} \times dt \qquad \text{Eq.(B5)}$$

$$\phi(x) = \frac{1}{2}\left[1 + \text{erf}(\frac{x}{\sqrt{2}})\right] \qquad \text{Eq.(B6)}$$

$$\mathrm{Ln}\left(S_t/S_{t-1}\right) = \alpha + z_1 \times \sigma \qquad \text{Eq. (B7)}$$

Acknowledgements

CUDA : Compute Unified Device Architecture
CPU : Central Processing Unit
CDF : Cumulative Distibution Function
TCMB : Turkish Republic Central Bank

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