CHAPTER 2

LITERATURE REVIEW

This chapter includes the review of research work (research papers) in short. The papers reviewed illustrate use of Monte Carlo methods in diverse fields. Some papers are also based on survey of Monte Carlo Method. Thus the literature reviewed will help me in planning the research.

- **Caflisch (1998)**, Monte Carlo is one of the most versatile and widely used numerical methods. It is independent of dimension, which shows Monte Carlo to be very robust but also slow. This paper describes application of Monte Carlo methods for integration problems, including convergence theory, sampling methods and variance reduction techniques. The points in a quasi-random sequence are correlated to provide greater uniformity. The resulting quadrature method, called quasi-Monte Carlo, has a good convergence rate.

- **Raychaudhari (2008)**, This paper, briefly describes the nature and relevance of Monte Carlo simulation, the way to perform these simulations and analyze results, and the mathematical techniques for performing these simulations. Monte Carlo simulation is a very useful mathematical technique for analyzing uncertain scenarios and providing probabilistic analysis of different situations. Various software’s have shown positive Monte Carlo simulation in different domains including mathematics, engineering, finance etc.

- **Alexandrov et. Al. (2011)**, this paper describes, various approaches of designing scalable algorithms. The paper proposes implementations of parallel Monte Carlo algorithms and demonstrated their huge potential regarding speedup, fault-tolerance and scalability on a variety of applications. The paper also adds Future research possibilities, for example, investigate next generation algorithms for resilience and fault-tolerance in large-scale systems. The set of problems in Computational Finance will be
expanded in order to generalise the approach. With ever increasing numbers of processors and machines, traditional ways of treating faults are not viable any more, as they impose too many constraints and too much overhead when employed in larger systems. Furthermore, additional fault tolerance techniques will be examined in response to deterministic and non-deterministic failure occurrence.

- **Mehrdoust and Vajargah (2012)**, This paper describes two types of pricing options in financial markets using quasi Monte Carlo algorithm with variance reduction procedures. Authors have evaluated Asian-style and European-style options pricing based on Black-Scholes model. The paper concludes that control variates Monte Carlo is efficient for both Asian & European style.

- **L’Ecuyer (2008)**, The paper reviews the basic principles of quasi-Monte Carlo (QMC) methods, the randomizations that turn them into variance-reduction techniques, the integration error and variance bounds obtained in terms of QMC point set discrepancy and variation of the integrand, and the main classes of point set constructions: lattice rules, digital nets, and permutations in different bases. The paper describes applications of QMC can also be used advantageously to estimate than an expectation: e.g., for estimating a quantile, or a function of several expectations, or the gradient of an expectation with respect to a vector of parameters. It can also be used to obtain an approximation of a function $f$ over a given domain, or to estimate the solution of an optimization problem in which the objective function or the constraints (or both) involve mathematical expectations. This can be used effectively in the context of computing maximum likelihood estimators, for example. QMC can also replace MC in algorithms that combine MC with approximate dynamic programming (e.g., for pricing American-style options). All these settings have applications in finance. Other QMC developments that could be of high interest in finance are special methods designed for the simulation of Markov chains over many
steps, a setting for which it is difficult to reduce the effective dimension to a small number.

- **Zhao et.al. (2013)**, This paper describes the importance of sampling Monte Carlo methods for pricing options. The classical importance sampling method is used to eliminate the variance caused by the linear part of the logarithmic function of payoff. The variance caused by the quadratic part is reduced by stratified sampling. By eliminate both kinds of variances just by importance sampling. The corresponding space for the eigenvalues of the Hessian matrix of the logarithmic function of payoff is enlarged. Computational Simulation shows the high efficiency of the new method.

- **Larcher and Leobacher (1997)**, This paper gives survey on the use of Quasi-Monte Carlo and of Monte Carlo methods especially in option pricing and in risk management. It on new techniques from the Quasi-Monte Carlo theory. The standard method for the estimation of Value at Risk is Monte Carlo simulation. Of course one can always replace random points by low-discrepancy points to obtain a Quasi-Monte Carlo method, but this can be quite unsatisfactory.

- **Joy et.al (1996)**, This paper introduces and illustrates a new version of the Monte Carlo method that has attractive properties for the numerical valuation of derivatives. The traditional Monte Carlo method has proven to be a powerful and flexible tool for many types of derivatives calculations. Under the conventional approach pseudo-random numbers are used to evaluate the expression of interest. The use of pseudo-random numbers yields an error bound that is probabilistic which can be a disadvantage. Another drawback of the standard approach is that many simulations may be required to obtain a high level of accuracy. This paper suggests a new approach which promises to be very useful for applications in finance. Quasi-Monte Carlo methods use sequences that are deterministic instead of
random. These sequences improve convergence and give rise to deterministic error bounds.

- **Morokoff and Calfisch (1994)**, This paper describes Quasi Monte Carlo Integration to evaluate multidimensional Integral. Paper also describes use of low discrepancy sequences like compares Halton, Faure & Sobol sequences with Comparison. This method is more effective for higher dimensional integral Calculation.

- **Boyle and Tan (1997)**, The prices of complex derivative securities are often represented as high dimensional integrals in modern finance. The basic Monte Carlo approach has proved useful in the evaluation of these integrals. The paper describes a recent development in this area that is generating considerable interest. Instead of using random points to evaluate the integrals as in standard Monte Carlo one can use a deterministic sequence that has suitable properties. These sequences are known as low discrepancy sequences and the method is known as quasi-Monte Carlo. The paper describes this approach and summarizes some of the applications to finance problems.

- **Ding (2012)**, In this paper, a Monte Carlo method, based on new techniques proposed recently, is presented to numerically price the callable bond with several call dates and notice under the Cox-Ingersoll-Ross (CIR) interest rate model. The corresponding algorithms are also presented to practical callable bond pricing. The experiments show that this method works well for callable bond under the CIR interest rate model.
Huseby et. Al (2004), The paper shows how Monte Carlo methods can be improved by putting constraints on a variable or vector. It shows that different choices of variables to condition may lead to different approaches. Paper shows that simulating from the conditional distribution can be as efficient as simulating from the unconditional distribution. The paper also discusses special case of Bernoulli variables are i.i.d. and for this case the reliability evaluation can be improved further. Paper presents a simulation algorithm which enables us to estimate the entire system reliability polynomial expressed as a function of the common component reliability. According to the authors if component reliabilities are not too different from each other, a generalized version of the improved conditional method can be used in combination with importance sampling. Paper concludes that the two conditioning methods can be combined in order to get even better results.

Rosca and Rosca (2011), Paper describes combined use of Monte Carlo and Quasi-Monte Carlo method, to evaluate barrier options. Assumption is made that the stock price of the underlying asset is driven by a Lévy process with independent increments distributed according to a NIG distribution. Paper shows that the combination of methods provide numerical results that are better compared to the Monte Carlo method. Numerical experiments indicate an increased accuracy of the combination method.

Azevedo (2012), Paper describes use of Quasi Monte Carlo methods with Sobol & Halton Sequences. There are circumstances which require a high-dimension stochastic to obtain a certain precision in probability space. As an alternative, we introduce quasi-Monte Carlo methods considering Sobol and Halton sequences for uncertainty assessment. Accuracy and efficiency are studied here sampling, the solution obtained by Monte Carlo method and numerical experiments on two-dimensional random field has some restriction when no. of iterations is increased.

Bihani (2014), This paper proposes a new approach to Monte Carlo simulation of operations thereby optimizing multi-server operations. Paper analyse the Monte Carlo methods against the deterministic methods. Monte
Carlo methods are a broad class of computational algorithms that depend on repeated random sampling to obtain numerical results. They are often used in physical and mathematical problems and are most suited to be applied when it is impossible to obtain a closed-form expression or infeasible to apply a deterministic algorithm. Monte Carlo methods are mainly used in: optimization, numerical integration and generation of samples from a probability distribution. Monte Carlo methods are especially useful for simulating systems with many coupled degrees of freedom, some of the examples are fluids, disordered materials, strongly coupled solids, and cellular structures. They are used to model phenomena with significant uncertainty in inputs. Another use is to evaluate multidimensional definite integrals with complicated boundary conditions. When Monte Carlo simulations have also been applied in space exploration and oil exploration and the results of the same were useful.

- **Adewara (2007)**, This paper describes use of double sampling and Monte Carlo Method to propose regression estimators. According to authors Monte Carlo is the solution of mathematical problem by sample method. This new method produces regression estimators with least estimated mean square error, highest percentage relative efficiency.

- **Fadugba (2012)**, Paper describes use of Monte Carlo methods in options pricing and specially in cases where there is no closed form analytic formula. Paper discusses two of the primary numerical methods that are currently used by financial professionals for determining the price of an options namely Monte Carlo method and finite difference method. Paper also provides comparison of the convergence of methods to the analytic Black-Scholes price of European option. According to the authors Monte Carlo method is good for pricing exotic options while Crank Nicolson finite
difference method is unconditionally stable, more accurate and converges faster than Monte Carlo method when pricing standard options. Paper concludes that, each of the two numerical methods has its advantages and disadvantages of use, finite difference method converges faster and more accurate, they are fairly robust and good for pricing vanilla option. Monte Carlo method works well for pricing both European and exotic options, it is flexible in handling varying and even high dimensional financial problems, hence despite its significant progress, early exercise is problematic. Paper concludes that Crank Nicolson method is unconditionally stable, more accurate and converges faster than Monte Carlo method when pricing European option.

- **Simoes & Scherrer (2014),** This paper describes use of Monte Carlo methods in risk analysis. Monte Carlo simulation allows risk analysis by designing probabilistic models. From a deterministic model of economic viability indicators, commonly used for decision investment projects, it was developed a probabilistic model with Monte Carlo method simulations in order to carry out economic and financial analysis of an agroindustrial project for orange juice processing. Paper concludes that the financial investment for orange processing is economically viable with low risk.

- **Kuczynski & Hendel (2014),** This paper analysis, an offshore CO2-EOR project, based on real data. The oilfield operator and the emitter (heat power plant) are in one capital group, so reduction of CO2 emission provides additional income. Due to limited experience in CCS projects implementation, especially in Europe, project costs are difficult to estimate. Monte Carlo simulation method is used to evaluate the economic efficiency of this CO2-EOR & CCS project. Based on literature and industrial experience, probability distributions for CAPEX and OPEX are defined. Various scenarios of oil and CO2 permits prices are discussed and implemented to economic model. Net present values (NPV) and internal rate
of return (IRR) are calculated. To show the impact of selected input data on the project efficiency, sensitivity analysis is created.

- **Chela et.al. (2014)**, The paper proposes an implementation on the resolution of the credit optimization problem using the Monte Carlo simulation. In this paper, authors propose a simple methodology for generating the distribution of credit losses through the Monte Carlo simulation. Additionally, authors propose a strategy of optimizing a credit portfolio using a risk measure that considers extreme events, different from methods that use risk measures considering only normal market conditions. The formulation used has theoretical properties that facilitate the determination of optimal conditions. The addition of a simple methodology for generating the distribution of credit losses with a suitable optimization strategy in one study represents an innovation that can be easily implemented by financial institutions in Brazil.

- **Vrugt et.al. (2009)**, This paper shows that significant improvements to the efficiency of MCMC simulation can be made by using a self-adaptive Differential Evolution learning strategy within a population-based evolutionary framework. This scheme, entitled Differential Evolution Adaptive Metropolis or DREAM, runs multiple different chains simultaneously for global exploration, and automatically tunes the scale and orientation of the proposal distribution in randomized subspaces during the search. Ergodicity of the algorithm is proved, and various examples involving nonlinearity, high-dimensionality, and multimodality show that DREAM is generally superior to other adaptive MCMC sampling approaches. The DREAM scheme significantly enhances the applicability of MCMC simulation to complex, multi-modal search problems.

- **Somvir Arya et.al. (2012)**, In this Paper, Monte Carlo simulation is proposed for tolerance analysis of final assembly. In tolerance analysis the
upper and lower boundary tolerances of the final assembly is determined. The component tolerances are all known or specified and the resulting assembly variation is calculated. The adherence of the assembly tolerance is a measure of the quality level. The quality is expressed in terms of percentage of the assemblies which meet the engineering tolerance limits. For high quality levels, the rejection may be expressed in parts-per million (ppm), that is, the number of rejection per million. This paper pays attention to the tolerance analysis for low volume, large variety production, in which parts with certain common characteristics are typically interchangeable. In this paper, Monte Carlo Simulation technique is applied to predict assembly tolerances with different statistical distributions for parts and components assemblies.

Li & Gardner (2012), This paper describes use of Monte Carlo method to simulate the detector response has been developed to predict both spectral shape characteristics and detector efficiency for any incident X-ray energy. The benchmark of the detector response function on Si (Li) detector was performed on elements Al, Si, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, and Pb, which are excited by a 17.5 keV mono-energetic X-ray source using a micro-focused X-ray spectroscopy analyzer. The semi-empirical parameters are optimized by nonlinear regression with experimental spectra of pure-element samples. The model fitted results are presented and indicate good agreement with experimental data. The detector response functions are pre-calculated with high statistical precision. Consequently, it can be used in X-ray spectroscopy and elemental analysis with great accuracy.

Farber & Paez (2013), This paper explores the extent to which individual and groups of observations impact optimal window size determination, and whether one can explain why some points are more influential than others. In addition, authors examine the impact neighbourhood specification has on model quality in terms of predictive capabilities and the ability of the method to retrieve spatially varying processes. The analysis is based on several datasets and using simulated data in order to compare and validate
results. The results provide some practical guidelines for the use of cross-validation.

- **Krishna et. Al.(2013)**, This paper analyses error correlation through concepts of error region, channel signature, and correlation distance. This framework provides a deeper insight into joint error behaviours in high-speed links, extends the range of statistical simulation for coded high-speed links, and provides a case against the use of biased Monte Carlo methods in this setting.

- **Akgun & Yilmaz (2011)**, The paper describes the use of Monte Carlo algorithm to measure the effectiveness of computing systems. Since the system will change for various reasons, a useful tool for probabilistic load flow analysis of system performance under various conditions for exploitation. The variable behavior of wind power in the system, the number of states Operation likely to increase the use of randomized load flow analysis reaffirms system. With the growing load in the system. Power and increasing uncertainty in the system, specific methods and load flow calculations cannot answer satisfactory energy such as wind, and growing uncertainty in the load. The random time, which is defined as If probabilistic acquires. Various methods have already been proposed to solve this problem. In most of the Simple linear models for load flow equations are used. In some studies, it is assumed that the output variables Normal distribution. Since one of the main sources of error in calculations, probabilistic load flow in a linear approximation of the equations The most common methods of error is relatively large and the time needed to solve the computer network are numerous. It is used in. The method is used in general and other uncertainties may be needed in the system.