# Multistate System Performance Analysis Incorporating Human Error, Mathematical modeling and Reliability Approach

Amit Kumar1\*, Pardeep Kumar2, Majid Forghani-elahabad3

Symbiosis International (Deemed University) (SIU), Pune, Maharashtra, India

Lovely Professional University, Chaheru, Phagmara, Punjab, India

<sup>3</sup>Federal University of ABC, Santo André, São Paulo, Brazil

Abstract: This paper proposes a novel framework for analyzing the performance of a Sugar mill (Wahid Sugar Mill, situated in Punjab, India) with human errors, mathematical modeling, and reliability approach. The proposed framework considers the complex interactions between the different components of the Sugar mill and the potential impact of human error on the same. The performance of the considered system is affected by the different components failures and unplanned outages. Considering these facts, a mathematical model is developed for the sugar mill to calculate different reliability measures such as availability, reliability, and MTTF. The mathematical modeling aspect of the framework utilizes Markov chains to model the stochastic behavior of the sugar mill. The authors also perform sensitivity analysis to identify the impact of different components' failure on the performance of the same. The results of the paper demonstrate the potential of the proposed framework in providing valuable insights into the performance of the Sugar Mill under different scenarios, including the impact of human error.

Keywords: Reliability measures; Unplanned outages; Sensitivity analysis; Sugar mill.

#### 1. INTRODUCTION

In this age of science and technology, heavy and automated machines are being used to enhance production in industries, but at the same pace, it increases the complexity of the associated industry. So, to maintain the desired production of a system, the maintenance team takes good care of different components of the same. It can be done by obtaining the various performance measures of the system as well as by keeping the proper track of the maintenance of the components. Hence, keeping all these things into consideration, in the present study, we consider a sugar mill in Punjab, India, a complex system comprising many components like an unloader, conveyor, cutter, crusher, bagasse carrying machine, and boiler. Failure of any of these components may lead the whole system to a degraded or failed state. These failures may be mechanical, electrical or due to human operators. Human operators sometimes give wrong commands to the machines, which may cause the failure of costly components or machines. Sometimes, humans do not pay proper attention to their work because they feel tired or bored inside the mill. Sometimes failures also occur due to power outages, corrosion, manufacturing defects and wear out, natural calamities like earthquakes or tornadoes, etc. These system failures can't be avoided (expect natural calamities) but can be mitigated with proper repair and maintenance or using the redundancy in the system. Nandhini and Padmavathy [10] analyzed the year-wise production of sugarcane and described the reason for the production change in the sugar cane industry from 2000-2010. Zhao and Li [20] presented the effects of climate change on sugar cane production and described the strategies to mitigate the effects of climate change. Performance analysis of the sugar mill taking various parameters into consideration was presented by [12]. Sharma and Vishwakarma [16] utilized the Genetic Algorithm technique to analyze the performance of the feeding system in the sugar industry.

# **Mathematical Computer Performance And Reliability**

Giuseppe G. Iazeolla, Pierre Jacques Courtois, A. Hordijk

# **Mathematical Computer Performance And Reliability:**

Mathematical Computer Performance and Reliability Giuseppe G. Iazeolla, Pierre Jacques Courtois, A. Hordijk, 1984 Hardbound This book provides a review of this field and incorporates some of the most significant quantitative methods which can satisfy the demand of scientists and users interested in the mathematics of computer system engineering It emphasizes interdisciplinary aspects of applied mathematics and computer science and is the result of contributions by scientists who are active in applied mathematical research of interest to the analysis of computer performance and reliability

Advances in Queueing Theory, Methods, and Open Problems Jewgeni H. Dshalalow, 2023-07-21 The progress of science and technology has placed Queueing Theory among the most popular disciplines in applied mathematics operations research and engineering Although queueing has been on the scientific market since the beginning of this century it is still rapidly expanding by capturing new areas in technology Advances in Queueing provides a comprehensive overview of problems in this enormous area of science and focuses on the most significant methods recently developed Written by a team of 24 eminent scientists the book examines stochastic analytic and generic methods such as approximations estimates and bounds and simulation The first chapter presents an overview of classical queueing methods from the birth of queues to the seventies It also contains the most comprehensive bibliography of books on queueing and telecommunications to date Each of the following chapters surveys recent methods applied to classes of queueing systems and networks followed by a discussion of open problems and future research directions Advances in Queueing is a practical reference that allows the reader quick access to the latest methods Fehlertolerierende Rechensysteme / Fault-tolerant Computing Systems Winfried Görke, Holger Sörensen, 2012-12-06 Dieses Buch enth lt die Beitr ge der 4 GI ITG GMA Fachtagung ber Fehlertolerierende Rechensysteme die im September 1989 in einer Reihe von Tagungen in M nchen 1982 Bonn 1984 sowie Bremerhaven 1987 veranstaltet wurde Die 31 Beitr ge darunter 4 eingeladene sind teils in deutscher berwiegend aber in englischer Sprache verfa t Insgesamt wird durch diese Beitr ge die Entwicklung der Konzeption und Implementierung fehlertoleranter Systeme in den letzten zwei Jahren vor allem in Europa dokumentiert S mtliche Beitr ge berichten ber neue Forschungs oder Entwicklungsergebnisse Mathematical Computer Performance And Reliability (proc.Int.Workshop) Pisa, **Sep.26-30,1983** G. Iazeolla, **Introduction to the Numerical Solution of Markov Chains** William J. Stewart, 2021-01-12 A cornerstone of applied probability Markov chains can be used to help model how plants grow chemicals react and atoms diffuse and applications are increasingly being found in such areas as engineering computer science economics and education To apply the techniques to real problems however it is necessary to understand how Markov chains can be solved numerically In this book the first to offer a systematic and detailed treatment of the numerical solution of Markov chains William Stewart provides scientists on many levels with the power to put this theory to use in the actual world where it has applications in areas as diverse as engineering economics and education His efforts make for

essential reading in a rapidly growing field Here Stewart explores all aspects of numerically computing solutions of Markov chains especially when the state is huge He provides extensive background to both discrete time and continuous time Markov chains and examines many different numerical computing methods direct single and multi vector iterative and projection methods More specifically he considers recursive methods often used when the structure of the Markov chain is upper Hessenberg iterative aggregation disaggregation methods that are particularly appropriate when it is NCD nearly completely decomposable and reduced schemes for cases in which the chain is periodic There are chapters on methods for computing transient solutions on stochastic automata networks and finally on currently available software Throughout Stewart draws on numerous examples and comparisons among the methods he so thoroughly explains **Dependable Computing for** Critical Applications 3 Carl E. Landwehr, Brian Randell, Luca Simoncini, 2013-06-29 This volume contains the papers presented at the Third IFIP International Working Conference on Dependable Computing for Critical Applications sponsored by IFIP Working Group 10 4 and held in Mondello Sicily Italy on September 14 16 1992 System developers increasingly apply computers where they can affect the safety and security of people and equipment The Third IFIP International Working Conference on Dependable Computing for Critical Applications like its predecessors addressed various aspects of computer system dependability a broad term defined as the degree of trust that may justifiably be placed in a system's reliability availability safety security and performance Because the scope of the conference was so broad we hope the presentations and discussions will contribute to the integration of these concepts so that future computer based systems will indeed be more dependable The Program Committee selected 18 papers for presentation from a total of 7 4 submissions at a May meeting in Newcastle upon Tyne UK The resulting program represented a broad spectrum of interests with papers from universities corporations and government agencies in eight countries Much diligent work by the Program Committee and the quality of reviews from more than a hundred external referees from around the world for which we are most grateful Advances in Optimization and Control Horst A. Eiselt, Giorgio significantly eased the production of this technical program Pederzoli, 2012-12-06 This conference volume is a collection of over thirty refereed contributions in the areas of optimization and control The volume is organized into the following sections Mathematics of Operations Research and Global Optimization Linear and Combinatorial Programming Tours Locations and Scheduling Dynamic Programming and Game Theory Control Theory Economic Models There is a balance between papers dealing with theoretical aspects of the field and those discussing the respective areas of application Delta-4: A Generic Architecture for Dependable Distributed Computing David Powell, 2012-12-06 Delta 4 is a 5 nation 13 partner project that has been investigating the achievement of dependability in open distributed systems including real time systems This book describes the design and validation of the distributed fault tolerant architecture developed within this project The key features of the Delta 4 architecture are a a distributed object oriented application support environment b built in support for user transparent fault tolerance c use of multicast or group

communication protocols and d use of standard off the shelf processors and standard local area network technology with minimum specialized hardware The book is organized as follows The first 3 chapters give an overview of the architecture s objectives and of the architecture itself and compare the proposed solutions with other approaches Chapters 4 to 12 give a more detailed insight into the Delta 4 architectural concepts Chapters 4 and 5 are devoted to providing a firm set of general concepts and terminology regarding dependable and real time computing Chapter 6 is centred on fault tolerance techniques based on distribution The description of the architecture itself commences with a description of the Delta 4 application support environment Deltase in chapter 7 Two variants of the architecture the Delta 4 Open System Architecture OSA and the Delta 4 Extra Performance Architecture XPA are described respectively in chapters 8 and 9 Both variants of the architecture have a common underlying basis for dependable multicasting i e **Numerical Solution of Markov Chains** William J. Stewart, 1991-05-23 Papers presented at a workshop held January 1990 location unspecified cover just about all aspects of solving Markov models numerically There are papers on matrix generation techniques and generalized stochastic Petri nets the computation of stationary distributions including aggregation disagg Analysis of Queueing Networks with Blocking Simonetta Balsamo, Vittoria de Nitto Persone, Raif Onvural, 2013-03-14 Queueing network models have been widely applied as a powerful tool for modelling performance evaluation and prediction of discrete flow systems such as computer systems communication networks production lines and manufacturing systems Queueing network models with finite capacity queues and blocking have been introduced and applied as even more realistic models of systems with finite capacity resources and with population constraints In recent years research in this field has grown rapidly Analysis of Queueing Networks with Blocking introduces gueueing network models with finite capacity and various types of blocking mechanisms It gives a comprehensive definition of the analytical model underlying these blocking queueing networks It surveys exact and approximate analytical solution methods and algorithms and their relevant properties It also presents various application examples of queueing networks to model computer systems and communication networks This book is organized in three parts Part I introduces queueing networks with blocking and various application examples Part II deals with exact and approximate analysis of queueing networks with blocking and the condition under which the various techniques can be applied Part III presents a review of various properties of networks with blocking describing several equivalence properties both between networks with and without blocking and between different blocking types Approximate solution methods for the buffer allocation problem are presented **Dependability: Basic Concepts and Terminology** Jean-Claude A Selected Listing of NASA Scientific and Technical Reports for ... United States. National Aeronautics Laprie,2013-12-28 and Space Administration. Scientific and Technical Information Division, 1966 The Evolution of Fault-Tolerant **Computing** A. Avizienis, H. Kopetz, J.C. Laprie, 2012-12-06 For the editors of this book as well as for many other researchers in the area of fault tolerant computing Dr William Caswell Carter is one of the key figures in the formation and development

of this important field We felt that the IFIP Working Group 10 4 at Baden Austria in June 1986 which coincided with an important step in Bill's career was an appropriate occasion to honor Bill's contributions and achievements by organizing a one day Symposium on the Evolution of Fault Tolerant Computing in the honor of William C Carter The Symposium held on June 30 1986 brought together a group of eminent scientists from all over the world to discuss the evolution the state of the art and the future perspectives of the field of fault tolerant computing Historic developments in academia and industry were presented by individuals who themselves have actively been involved in bringing them about The Symposium proved to be a unique historic event and these Proceedings which contain the final versions of the papers presented at Baden are an authentic reference document Predictably Dependable Computing Systems Brian Randell, Jean-Claude Laprie, Hermann Kopetz, Bev Littlewood, 2013-11-11 NASA Scientific and Technical Reports United States. National Aeronautics and Space Administration Scientific and Technical Information Division, 1967 A Selected Listing of NASA Scientific and Technical Reports for 1966 United States. National Aeronautics and Space Administration. Scientific and Linear Algebra, Markov Chains, and Queueing Models Carl D. Meyer, Robert I. Technical Information Division, 1967 Plemmons, 2012-12-06 This IMA Volume in Mathematics and its Applications LINEAR ALGEBRA MARKOV CHAINS AND QUEUEING MODELS is based on the proceedings of a workshop which was an integral part of the 1991 92 IMA program on Applied Linear Algebra We thank Carl Meyer and R J Plemmons for editing the proceedings We also take this opportunity to thank the National Science Foundation whose financial support made the workshop possible A vner Friedman Willard Miller Jr xi PREFACE This volume contains some of the lectures given at the workshop Lin ear Algebra Markov Chains and Queueing Models held January 13 17 1992 as part of the Year of Applied Linear Algebra at the Institute for Mathematics and its Applications Markov chains and queueing models play an increasingly important role in the understanding of complex systems such as computer communication and transportation systems Linear algebra is an indispensable tool in such research and this volume collects a selection of important papers in this area. The articles contained herein are representative of the underlying purpose of the workshop which was to bring together practitioners and re searchers from the areas of linear algebra numerical analysis and queueing theory who share a common interest of analyzing and solving finite state Markov chains The papers in this volume are grouped into three major categories perturbation theory and error analysis iterative methods and applications regarding gueueing models **Security in Computer and Information** Sciences Erol Gelenbe, Paolo Campegiani, Tadeusz Czachórski, Sokratis K. Katsikas, Ioannis Komnios, Luigi Romano, Dimitrios Tzovaras, 2018-07-13 This open access book constitutes the thoroughly refereed proceedings of the First International ISCIS Security Workshop 2018 Euro CYBERSEC 2018 held in London UK in February 2018 The 12 full papers presented together with an overview paper were carefully reviewed and selected from 31 submissions Security of distributed interconnected systems software systems and the Internet of Things has become a crucial aspect of the performance of computer systems

The papers deal with these issues with a specific focus on societally critical systems such as health informatics systems the Internet of Things energy systems digital cities digital economy mobile networks and the underlying physical and network infrastructures Stochastic Analysis of Computer and Communication Systems Hideaki Takaqi, 1990 Analytical techniques for evaluating the performance of computer and communication systems have evolved hand in hand with the progress in these systems since the late 1960 s and an enormous amount of knowledge has been accumulated in this interplay of applied mathematics and computer science This book includes nineteen lengthy surveys of the state of the art of performance evaluation techniques and an extensive bibliography The topics include stochastic processes and queueing theory applied to performance analysis and performance models of computer systems and communication networks Articles have been contributed by leading scientists from five continents Random Walks in the Quarter Plane Guy Fayolle, Roudolf Iasnoqorodski, Vadim Malyshev, 2017-02-06 This monograph aims to promote original mathematical methods to determine the invariant measure of two dimensional random walks in domains with boundaries Such processes arise in numerous applications and are of interest in several areas of mathematical research such as Stochastic Networks Analytic Combinatorics and Quantum Physics This second edition consists of two parts Part I is a revised upgrade of the first edition 1999 with additional recent results on the group of a random walk The theoretical approach given therein has been developed by the authors since the early 1970s By using Complex Function Theory Boundary Value Problems Riemann Surfaces and Galois Theory completely new methods are proposed for solving functional equations of two complex variables which can also be applied to characterize the Transient Behavior of the walks as well as to find explicit solutions to the one dimensional Quantum Three Body Problem or to tackle a new class of Integrable Systems Part II borrows special case studies from queueing theory in particular the famous problem of Joining the Shorter of Two Queues and enumerative combinatorics Counting Asymptotics Researchers and graduate students should find this book very useful

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#### **Table of Contents Mathematical Computer Performance And Reliability**

- 1. Understanding the eBook Mathematical Computer Performance And Reliability
  - The Rise of Digital Reading Mathematical Computer Performance And Reliability
  - Advantages of eBooks Over Traditional Books
- 2. Identifying Mathematical Computer Performance And Reliability
  - Exploring Different Genres
  - o Considering Fiction vs. Non-Fiction
  - $\circ \ \ Determining \ Your \ Reading \ Goals$
- 3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Mathematical Computer Performance And Reliability
  - User-Friendly Interface
- 4. Exploring eBook Recommendations from Mathematical Computer Performance And Reliability
  - Personalized Recommendations

- Mathematical Computer Performance And Reliability User Reviews and Ratings
- Mathematical Computer Performance And Reliability and Bestseller Lists
- 5. Accessing Mathematical Computer Performance And Reliability Free and Paid eBooks
  - Mathematical Computer Performance And Reliability Public Domain eBooks
  - Mathematical Computer Performance And Reliability eBook Subscription Services
  - Mathematical Computer Performance And Reliability Budget-Friendly Options
- 6. Navigating Mathematical Computer Performance And Reliability eBook Formats
  - o ePub, PDF, MOBI, and More
  - Mathematical Computer Performance And Reliability Compatibility with Devices
  - Mathematical Computer Performance And Reliability Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mathematical Computer Performance And Reliability
  - Highlighting and Note-Taking Mathematical Computer Performance And Reliability
  - Interactive Elements Mathematical Computer Performance And Reliability
- 8. Staying Engaged with Mathematical Computer Performance And Reliability
  - o Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Mathematical Computer Performance And Reliability
- 9. Balancing eBooks and Physical Books Mathematical Computer Performance And Reliability
  - ∘ Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mathematical Computer Performance And Reliability
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Mathematical Computer Performance And Reliability
  - Setting Reading Goals Mathematical Computer Performance And Reliability
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Mathematical Computer Performance And Reliability
  - Fact-Checking eBook Content of Mathematical Computer Performance And Reliability

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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