

Managing Dynamic Contexts Using Failure-Driven Stochastic Models

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Abstract

We describe an architecture for representing and managing context shifts that supports dynamic data interpretation. This architecture utilizes two layers of learning and three layers of control for adapting and evolving new stochastic models to accurately represent changing and evolving situations. At the core of this architecture is a form of probabilistic logic used to encode sets of recursive relationships defining Dynamic Bayesian Models. This logic is extended with a syntax for defining contextual restrictions on stochastic Horn clauses. EM parameter learning is used to calibrate models as well as to assess the quality of fit between the model and the data. *Model failure*, detected as a poor fit between model and data, triggers a model repair mechanism based on causally informed context splitting and context merging. An implementation of this architecture for distributed weather monitoring is currently under development.

Introduction

Understanding and characterizing context is critical for real-time diagnostic and prognostic reasoning. Context can mediate the interpretation of highly complex data by activating a specific set of inferential strategies and focal points, such as the temporary focus on the causal role of a particular component or subsystem state. The use of inferential strategies and selective focus can serve to reduce the computational size of an estimation task in a probabilistic model by mitigating the need to continuously link local estimation tasks to probability updating over the entire world model.

Modeling context also demands the ability to forget less relevant and/or older information and to shift attention to significant aspects of the current data. Moreover, while modeling a dramatically changing world, transforming context across time can reflect deep changes in the complex internal structure of the world model. Our probabilistic modeling environment supports these and other aspects of context revision.

Many current probabilistic modeling systems, especially those that rest on a knowledge-based model construction approach (Wellman, Breese, & Goldman 1992), map an entire knowledge base into an often complex graphical model. As the size of the resulting network grows large, it becomes

time consuming and cumbersome to manipulate, and the inference algorithm can take an exponentially longer time to finish probability updating. Thus, a primary reason for representing contexts dynamically is to reduce the complexity of the constructed model and, consequently, to streamline the inference process. Representing an evolving context requires omitting information that is no longer relevant to the current task from a knowledge base, and at the same time constructing and maintaining the graphical model of the context.

A final reason for creating dynamic contexts in probabilistic modeling systems is the ability to combine multiple *snapshot* models – those models that represent stationary or smoothly evolving stochastic processes. We can think of a single context as a snapshot model; when the context evolves, the modeling system integrates aspects of other snapshot views of the domain. This can be very useful for representing non-stationary processes with abrupt changes. Moreover, our reasoning engine includes failure detection and recovery mechanisms based on causal representations (Pearl 2000). By employing these meta-structures, we can support the explicit characterization and manipulation of context to perform diagnostic and prognostic analysis of complex distributed environments.

In the next section we describe with further detail our dynamic system in which the notion of context plays a major role. Then, after briefly summarizing research related to our approach, we focus on the role of context for reorganizing a current model. We show how context can be used to achieve non-stationary probabilistic modeling with the introduction of contextual mechanisms, such as *context splitting* and *context merging*. We then present the details of our failure-driven dynamic context system through pseudocode, describe the current developmental state of the system, and conclude.

Dynamical Systems Driven by Failure and Recovery Mechanisms

Probabilistic modeling systems that dynamically represent frequently changing data are very important for carrying out complex tasks. Complex modeling systems that can employ available domain knowledge to increase computational efficiency are of the greatest interest. With the increasing use

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Grall, Carlos Guedes Soares**



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Polystochastic Models for Complexity Octavian Iordache, 2010-03-20 Complexity understanding and management will be a main source of efficiency and prosperity for the next decades and thus is of highest industrial and scientific interest This book on the latest in polystochastic models for complexity includes case studies **Data-Driven Remaining Useful Life Prognosis Techniques** Xiao-Sheng Si, Zheng-Xin Zhang, Chang-Hua Hu, 2017-01-20 This book introduces data driven remaining useful life prognosis techniques and shows how to utilize the condition monitoring data to predict the remaining useful life of stochastic degrading systems and to schedule maintenance and logistics plans It is also the first book that describes the basic data driven remaining useful life prognosis theory systematically and in detail The emphasis of the book is on the stochastic models methods and applications employed in remaining useful life prognosis It includes a wealth of degradation monitoring experiment data practical prognosis methods for remaining useful life in various cases and a series of applications incorporated into prognostic information in decision making such as maintenance related decisions and ordering spare parts It also highlights the latest advances in data driven remaining useful life prognosis techniques especially in the contexts of adaptive prognosis for linear stochastic degrading systems nonlinear degradation modeling based prognosis residual storage life prognosis and prognostic information based decision making *Handbook of Dynamic Data Driven Applications Systems* Erik P. Blasch, Frederica Darema, Sai Ravela, Alex J. Aved, 2022-05-11 The Handbook of Dynamic Data Driven Applications Systems establishes an authoritative reference of DDDAS pioneered by Dr Darema and the co authors for researchers and practitioners developing DDDAS technologies Beginning with general concepts and history of the paradigm the text provides 32 chapters by leading experts in ten application areas to enable an accurate understanding analysis and control of complex systems be they natural engineered or societal The authors explain how DDDAS unifies the computational and instrumentation aspects of an application system extends the notion of Smart Computing to span from the high end to the real time data acquisition and control and manages Big Data exploitation with high dimensional model coordination The Dynamically Data Driven Applications Systems DDDAS paradigm inspired research regarding the prediction of severe storms Specifically the DDDAS concept allows atmospheric observing systems computer forecast models and cyberinfrastructure to dynamically configure themselves in optimal ways in direct response to current or anticipated weather conditions In so doing all resources are used in an optimal manner to maximize the quality and timeliness of information they provide Kelvin Droegemeier Regents Professor of Meteorology at the University of Oklahoma former Director of the White House Office of Science and Technology Policy We may well be entering the golden age of data science as society in general has come to appreciate the possibilities for organizational strategies that harness massive streams of data The challenges and opportunities are even greater when the data or the underlying system are dynamic and DDDAS is the time tested paradigm for realizing this potential Sangtae Kim Distinguished Professor of Mechanical Engineering and Distinguished Professor of

Chemical Engineering at Purdue University Advances in Safety, Reliability and Risk Management Christophe Berenguer, Antoine Grall, Carlos Guedes Soares, 2011-08-31 Covering a wide range of topics on safety reliability and risk management the present publication will be of interest to academics and professionals working in a wide range of scientific industrial and governmental sectors including Aeronautics and Aerospace Chemical and Process Industry Civil Engineering Critical Infrastructures Energy Information Technology and Telecommunications Land Transportation Manufacturing Maritime Transportation Mechanical Engineering Natural Hazards Nuclear Industry Offshore Industry Policy Making and Public Planning Handbook of Dynamic Data Driven Applications Systems Erik Blasch, Sai Ravela, Alex Aved, 2018-11-13 The Handbook of Dynamic Data Driven Applications Systems establishes an authoritative reference of DDDAS pioneered by Dr Darema and the co authors for researchers and practitioners developing DDDAS technologies Beginning with general concepts and history of the paradigm the text provides 32 chapters by leading experts in 10 application areas to enable an accurate understanding analysis and control of complex systems be they natural engineered or societal Earth and Space Data Assimilation Aircraft Systems Processing Structures Health Monitoring Biological Data Assessment Object and Activity Tracking Embedded Control and Coordination Energy Aware Optimization Image and Video Computing Security and Policy Coding Systems Design The authors explain how DDDAS unifies the computational and instrumentation aspects of an application system extends the notion of Smart Computing to span from the high end to the real time data acquisition and control and manages Big Data exploitation with high dimensional model coordination Dynamic Data Driven Applications Systems Erik Blasch, Frederica Darema, Alex Aved, 2024-02-26 This book constitutes the refereed proceedings of the 4th International Conference on Dynamic Data Driven Applications Systems DDDAS 2022 which took place in Cambridge MA USA during October 6 10 2022 The 31 regular papers in the main track and 5 regular papers from the Wildfires panel as well as one workshop paper were carefully reviewed and selected for inclusion in the book They were organized in following topical sections DDAS2022 Main Track Plenary Presentations Keynotes DDDAS2022 Main Track Wildfires Panel Workshop on Climate Life Earth Planets **Business Process Management** Claudio Di Ciccio, Remco Dijkman, Adela del Río Ortega, Stefanie Rinderle-Ma, 2022-09-06 This book constitutes the refereed proceedings of the 20th International Conference on Business Process Management BPM 2022 which took place in Münster Germany in September 2022 The 22 papers included in this book were carefully reviewed and selected from 98 submissions They were organized in topical sections as follows task mining design methods process mining process mining practice analytics and systems The book also includes one keynote talk in full paper length and 5 tutorial papers Conservation and Management of Tropical Rainforests, 2nd Edition Eberhard F Bruenig, 2016-12-07 This new edition of Conservation and Management of Tropical Rainforests applies the large body of knowledge experience and tradition available to those who study tropical rainforests Revised and updated in light of developments in science technology economics politics etc and their effects on tropical forests it describes the

principles of integrated conservation and management that lead to sustainability identifying the unifying phenomena that regulate the processes within the rainforest and that are fundamental to the ecosystem viability Features of the natural forest and the socio cultural ecosystems which can be mimicked in the design of self sustaining forests are also discussed A holistic approach to the management and conservation of rainforests is developed throughout the book The focus on South East Asian forestry will be widened to include Africa and Latin America Recent controversial issues such as biofuels and carbon credits with respect to tropical forests and their inhabitants will be discussed This book is a substantial contribution to the literature it is a valuable resource for all those concerned with rainforests

Formal Methods for Industrial Critical Systems Anne Remke, Bernhard Steffen, 2025-08-27 This book constitutes the proceedings of the 30th International Conference on Formal Methods for Industrial Critical Systems FMICS 2025 held in Aarhus Denmark during August 27 28 2025 The 13 full papers included in this book together with 2 invited papers were carefully reviewed and selected from 25 submissions The papers have been organized in the following topical sections verification automotive and railway cyber physical systems and embedded systems

Data Analytics Applications in Latin America and Emerging Economies Eduardo Rodriguez, 2017-07-28 This book focuses on understanding the analytics knowledge management process and its comprehensive application to various socioeconomic sectors Using cases from Latin America and other emerging economies it examines analytics knowledge applications where a solution has been achieved Written for business students and professionals as well as researchers the book is filled with practical insight into applying concepts and implementing processes and solutions The eleven case studies presented in the book incorporate the whole analytics process and are useful reference examples for applying the analytics process for SME organizations in both developing and developed economies The cases also identify multiple tacit factors to deal with during the implementation of analytics knowledge management processes These factors which include data cleaning data gathering and interpretation of results are not always easily identified by analytics practitioners This book promotes the understanding of analytics methods and techniques It guides readers through numerous techniques and methods available to analytics practitioners by explaining the strengths and weaknesses of these methods and techniques

The Oxford Handbook of Applied Bayesian Analysis Anthony O' Hagan, Mike West, 2010-03-18 Bayesian analysis has developed rapidly in applications in the last two decades and research in Bayesian methods remains dynamic and fast growing Dramatic advances in modelling concepts and computational technologies now enable routine application of Bayesian analysis using increasingly realistic stochastic models and this drives the adoption of Bayesian approaches in many areas of science technology commerce and industry This Handbook explores contemporary Bayesian analysis across a variety of application areas Chapters written by leading exponents of applied Bayesian analysis showcase the scientific ease and natural application of Bayesian modelling and present solutions to real engaging societally important and demanding problems The chapters are grouped into five general areas Biomedical

Industry Economics Environment Policy Political and Natural Engineering Sciences and Appendix material in each touches on key concepts models and techniques of the chapter that are also of broader pedagogic and applied interest *Safety and Reliability of Complex Engineered Systems* Luca Podofillini, Bruno Sudret, Bozidar Stojadinovic, Enrico Zio, Wolfgang Kröger, 2015-09-03 *Safety and Reliability of Complex Engineered Systems* contains the Proceedings of the 25th European Safety and Reliability Conference ESREL 2015 held 7 10 September 2015 in Zurich Switzerland Including 570 papers on theories and methods in the area of risk safety and reliability and their applications to a wide range of industrial civil and social sectors this book will be of interest to academics and professionals involved or interested in aspect of risk safety and reliability in various engineering areas *ICAS2014-International Conference on Analytics Driven Solutions* Eduardo Rodriguez, Department of Leisure Studies Greg Richards, Greg Richards, 2014-09-10 **Cybersecurity Challenges in the Age of AI, Space Communications and Cyborgs** Hamid Jahankhani, 2024-02-19 This book provides an opportunity for researchers scientists government officials strategist and operators and maintainers of large complex and advanced systems and infrastructure to update their knowledge with the state of best practice in the challenging domains while networking with the leading representatives researchers and solution providers The advancement of Artificial Intelligence AI coupled with the prolificacy of the Internet of Things IoT devices are creating smart societies that are interconnected Space exploration and satellite drone and UAV technology have travelled a long way in recent years and some may debate that we are in the midst of a revolution in terms of development and the increasing number of these devices being launched But with this revolutionary progress it presents itself with new challenges in terms of governance The ethical implications of connecting the physical and digital worlds and presenting the reality of a truly interconnected society presents the realization of the concept of smart societies in reality Drawing on 14 years of successful events on Information security digital forensics and cybercrime the 15th ICGS3 23 conference aims to provide attendees with an information packed agenda with representatives from across the industry and the globe The challenges of complexity rapid pace of change and risk opportunity issues associated with modern products systems special events and infrastructures In an era of unprecedented volatile political and economic environment across the world computer based systems face ever more increasing challenges disputes and responsibilities and while the Internet has created a global platform for the exchange of ideas goods and services however it has also created boundless opportunities for cyber crime This book presents new materials and contributes to knowledge through the technological advances that are being made across artificial intelligence AI machine learning blockchain and quantum computing These technologies driven by a digital revolution are expected to be disruptive and provide major digital transformation in the way societies operate today As a result these advances provide social and economic benefits but also provide new challenges that security industry need to raise their game to combat them

Macroeconometric Models for Portfolio Management Jeremy Kwok, 2021-09-07 *Macroeconometric Models for*

Portfolio Management begins by outlining a portfolio management framework into which macroeconomic models and backtesting investment strategies are integrated. It is followed by a discussion on the theoretical backgrounds of both small and global large macroeconomic models including data selection, estimation and applications. Other practical concerns essential to managing a portfolio with decisions driven by macro models are also covered: model validation, forecast combination and evaluation. The author then focuses on applying these models and their results on managing the portfolio including making trading rules and asset allocation across different assets and risk management. The book finishes by showing portfolio examples where different investment strategies are used and illustrate how the framework can be applied from the beginning of collecting data, model estimation and generating forecasts to how to manage portfolios accordingly. This book aims to bridge the gap between academia and practising professionals. Readers will attain a rigorous understanding of the theory and how to apply these models to their portfolios. Therefore, *Macroeconometric Models for Portfolio Management* will be of interest to academics and scholars working in macroeconomics and finance, to industry professionals working in financial economics and asset management, to asset managers and investors who prefer systematic investing over discretionary investing, and to investors who have a strong interest in macroeconomic influences on their portfolio.

Outsourcing Management for Supply Chain Operations and Logistics Service Folinas, Dimitris, 2012-08-31. Logistics and Supply Chain Management has been a vital part of every economy and every business entity. Both sciences have become prestigious research fields focusing on best practices, concepts and methods. *Outsourcing Management for Supply Chain Operations and Logistics Services* is concentrated on the key players of the outsourcing paradigm: the organizations that provide logistics services, the Third Party Logistics (3PL) s as well as their clients, presenting and promoting the lessons learned by their cooperation. Specifically, this publication presents studies which are relevant to practitioners, researchers, students and clients of the application of the Outsourcing practice on the Logistics and Supply Chain Management services, giving emphasis to 3PL s.

The physical environment and health: Implications for the planning and management of healthy cities Linchuan Yang, Bao-Jie He, Long Cheng, Yibin Ao, Ruoyu Wang, 2023-08-30

Structural Health Monitoring/Management (SHM) in Aerospace Structures Fuh-Gwo Yuan, 2024-04-30. Structural Health Monitoring (SHM) Management in Aerospace and Civil Structures provides readers with the spectacular progress that has taken place over the last twenty years with respect to the area of Structural Health Monitoring (SHM) Management. The SHM field encompasses transdisciplinary areas including smart materials, sensors and actuators, damage diagnosis and prognosis, signal and image processing, algorithms, wireless intelligent sensing, data fusion and energy harvesting. This book focuses on how SHM techniques can be applied to aircraft mechanical and civil engineering structures with particular emphasis on composite materials. *Structural Health Monitoring (SHM) Management in Aerospace and Civil Structures* will be a valuable reference resource for R D managers, materials scientists and engineers working in the aerospace sector as well as for

researchers and system designers working in industry academia and government research agencies developing new systems for the SHM of aerospace mechanical and civil engineering structures Presents new developments in smart materials for sensing and actuation Discusses new developments in mechanical metamaterials Presents the latest on signal imaging processing for damage diagnosis Explores damage prognosis and integrated vehicle health management IVHM Covers new developments in machine learning and artificial Intelligence **Reliability Engineering** Mangey Ram,2019-10-14 Over the last 50 years the theory and the methods of reliability analysis have developed significantly Therefore it is very important to the reliability specialist to be informed of each reliability measure This book will provide historical developments current advancements applications numerous examples and many case studies to bring the reader up to date with the advancements in this area It covers reliability engineering in different branches includes applications to reliability engineering practice provides numerous examples to illustrate the theoretical results and offers case studies along with real world examples This book is useful to engineering students research scientist and practitioners working in the field of reliability *Service Parts Management* Nezih Altay,Lewis A. Litteral,2011-03-24 With the pressure of time based competition increasing and customers demanding faster service availability of service parts becomes a critical component of manufacturing and servicing operations Service Parts Management first focuses on intermittent demand forecasting and then on the management of service parts inventories It guides researchers and practitioners in finding better management solutions to their problems and is both an excellent reference for key concepts and a leading resource for further research Demand forecasting techniques are presented for parametric and nonparametric approaches and multi echelon cases and inventory pooling are also considered Inventory control is examined in the continuous and periodic review cases while the following are all examined in the context of forecasting error measures distributional assumptions and decision trees Service Parts Management provides the reader with an overview and a detailed treatment of the current state of the research available on the forecasting and inventory management of items with intermittent demand It is a comprehensive review of service parts management and provides a starting point for researchers postgraduate students and anyone interested in forecasting or managing inventory

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