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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<u>Polystochastic Models for Complexity</u> 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 **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 <u>Managing Trade-offs in Adaptable Software Architectures</u> Ivan Mistrik,Nour Ali,Rick Kazman,John Grundy,Bradley Schmerl,2016-08-12 Managing Trade Offs in Adaptable Software Architectures explores the latest research on adapting large complex systems to changing requirements To be able to adapt a system engineers must evaluate different quality attributes including trade offs to balance functional and quality requirements to maintain a well functioning system throughout the lifetime of the system This comprehensive resource brings together research focusing on how to manage trade offs and architect adaptive systems in different business contexts It presents state of the art techniques methodologies tools best practices and guidelines for developing adaptive systems and offers guidance for future software engineering research and practice Each contributed chapter considers the practical application of the topic through case studies experiments empirical validation or systematic comparisons with other approaches already in practice Topics of interest include but are not limited to how to architect a system for adaptability software architecture for self adaptive systems understanding and balancing the trade offs involved architectural patterns for self adaptive systems how quality attributes are exhibited by the architecture of the system how to connect the quality of a software architecture to system architecture or other system considerations and more Explains software architectural processes and metrics supporting highly adaptive and complex engineering Covers validation verification security and quality assurance in system design Discusses domain specific software engineering issues for cloud based mobile context sensitive cyber physical ultra large scale internet scale systems mash up and autonomic systems Includes practical case studies of complex adaptive and context critical systems **Group Decision and Negotiation. A Process-Oriented View** Pascale Zaraté,Gregory E. Kersten,Jorge E. Hernández,2014-06-05 This book constitutes the proceedings of the Joint INFORMS GDN and EWG DSS International Conference on Group Decision and Negotiation GDN held in Toulouse France during June 10 13 2014 The GDN meetings aim to bring together researchers and practitioners from a wide spectrum of fields including economics management computer science engineering and decision science The contributions report on research on individual and

group decision support negotiation and auction support and the design of systems and agents supporting such processes From a total of 88 submissions 31 papers were accepted for publication in this volume The papers are organized into topical sections on collaborative decision making auctions knowledge decision support systems multi criteria decision making multi agent systems negotiation analysis preference analysis data analysis DSS GDSS use network analysis and semantic tools for group decision making *Management and Control of Production and Logistics 2004 (MCPL 2004)* Gaston Lefranc,2006-01-30 **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 **Journal of Engineering Mechanics** ,2003 **Convergence 78** ,1978 **Fishery Science and Management** Warren S. Wooster,1988-11-14 In the management of commercial marine fisheries a variety of advisors and participants interact with a decision making entity which establishes fishery regulations Of particular interest is the advisory process which should provide impartial scientific analyses of the consequences of alternative controlling actions To understand this process we first examined the objectives of management especially the biological objectives Our inquiry then extended to the contribution of biological analysis to fishery management including limitations to the methods used and the transfer of findings to managers **Index to Theses with Abstracts Accepted for Higher Degrees by the Universities of Great Britain and Ireland and the Council for National Academic Awards** ,2008 Theses on any subject submitted by the academic libraries in the UK and Ireland **Proceedings of the ... ACM SIGMETRICS Conference on Measurement and Modeling of Computer Systems** ,1989 Neural Computation ,2000 *1989 ACM SIGMETRICS and Performance '89* ,1989 **Science Abstracts** ,1993 *Assessing Hazard Mitigation* ,1995 **Proceedings of the ASME/STLE International Joint Tribology Conference** ,2004 Index to Simulation Literature, 1976-1981 Per A. Holst,1982 *The University of Michigan Bulletin* University of Michigan,2001 Each number is the catalogue of a specific school or college of the University Reservoir System Management ,1997 **Australian**

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