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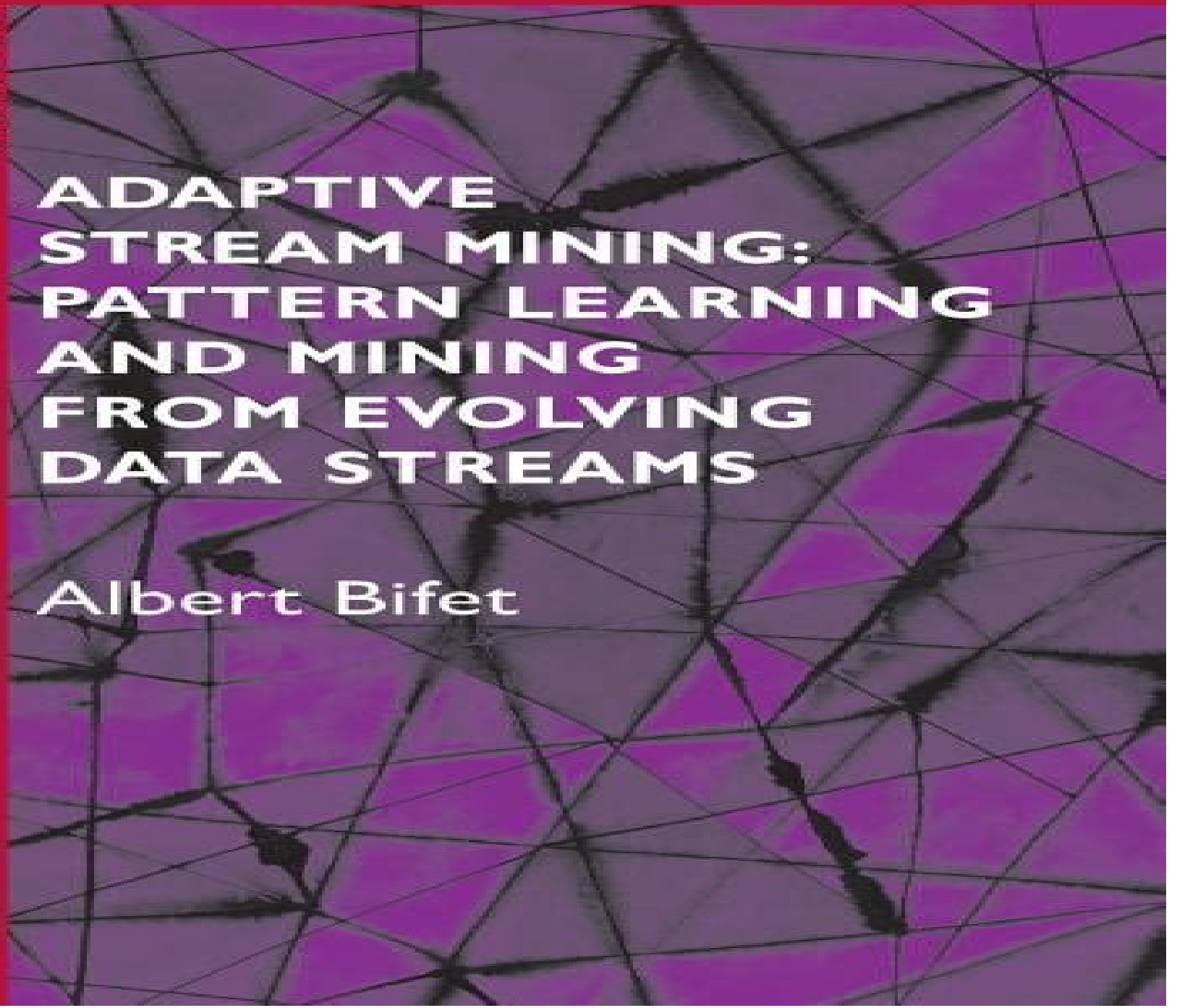

# ADAPTIVE STREAM MINING: PATTERN LEARNING AND MINING FROM EVOLVING DATA STREAMS

Albert Bifet

IOS Press

# Adaptive Stream Mining Pattern Learning And Mining From Evolving Data Streams Volume 207 Frontiers In Artificial Intelligence And Applications

David Tse Jung Huang

**Adaptive Stream Mining Pattern Learning And Mining From Evolving Data Streams Volume 207 Frontiers In Artificial Intelligence And Applications:**

Machine Learning for Data Streams Albert Bifet,Ricard Gavalda,Geoffrey Holmes,Bernhard Pfahringer,2018-03-16 A hands on approach to tasks and techniques in data stream mining and real time analytics with examples in MOA a popular freely available open source software framework Today many information sources including sensor networks financial markets social networks and healthcare monitoring are so called data streams arriving sequentially and at high speed Analysis must take place in real time with partial data and without the capacity to store the entire data set This book presents algorithms and techniques used in data stream mining and real time analytics Taking a hands on approach the book demonstrates the techniques using MOA Massive Online Analysis a popular freely available open source software framework allowing readers to try out the techniques after reading the explanations The book first offers a brief introduction to the topic covering big data mining basic methodologies for mining data streams and a simple example of MOA More detailed discussions follow with chapters on sketching techniques change classification ensemble methods regression clustering and frequent pattern mining Most of these chapters include exercises an MOA based lab session or both Finally the book discusses the MOA software covering the MOA graphical user interface the command line use of its API and the development of new methods within MOA The book will be an essential reference for readers who want to use data stream mining as a tool researchers in innovation or data stream mining and programmers who want to create new algorithms for MOA

**Algorithms on Trees and Graphs** Gabriel Valiente,2021-10-11 Graph algorithms is a well established subject in mathematics and computer science Beyond classical application fields such as approximation combinatorial optimization graphics and operations research graph algorithms have recently attracted increased attention from computational molecular biology and computational chemistry Centered around the fundamental issue of graph isomorphism this text goes beyond classical graph problems of shortest paths spanning trees flows in networks and matchings in bipartite graphs Advanced algorithmic results and techniques of practical relevance are presented in a coherent and consolidated way This book introduces graph algorithms on an intuitive basis followed by a detailed exposition in a literate programming style with correctness proofs as well as worst case analyses Furthermore full C implementations of all algorithms presented are given using the LEDA library of efficient data structures and algorithms Modular Ontologies Oliver Kutz,2010 Title page Preface Contents Towards Ontology Use Re Use and Abuse in a Computational Creativity Collective Ontology Modularity Information Flow and Interaction Situated Semantics The Modular Structure of an Ontology An Empirical Study Extracting and Merging Contextualized Ontology Modules A Metric Suite for Evaluating Cohesion and Coupling in Modular Ontologies Towards a Functional Approach to Modular Ontologies Using Institutions Introducing Ontology Best Practices and Design Patterns into Robotics USAREnv Modular Upper Level Ontologies for Semantic Complex Event Processing Conditional

and Preferential Logics Gian Luca Pozzato,2010 Revised and updated version of the author s Ph D dissertation University of Torino *Human Language Technologies* Inguna Skadina,Andrejs Vasiljevs,2010 This book contains papers from the Fourth International Conference on Human Language Technologies the Baltic Perspective Baltic HLT 2010 held in Riga in October 2010 This conference is the latest in a series which provides a forum for sharing recent advances in human language processing and promotes cooperation between the computer science and linguistics communities of the Baltic countries and the rest of the world Bringing together scientists developers providers and users the conference is an opportunity to exchange information discuss problems find new synergies and promote i **Bridging the Socio-technical Gap in Decision Support Systems** Ana Respício,2010 The socio technical gap is the great divide between social activities such as coordination which researchers and practitioners aim to support and those that are actually supported by technology As the social interaction takes place through technology it is changed and mediated by the technology This gap between the two dimensions is being challenged by new and innovative approaches such as cognitive ergonomics and Web 2 0 3 0 Research in Decision Making DM theory and Decision Support Systems DSS shows that this gap is due in part to technical limitations and in part to the complexity of the contexts where decision support must be provided Thus DSS researchers face important questions concerned with the encapsulation of complex social aspects of managerial decision making as well as with the representation of key human cognitive mechanisms such as intuition and insight within computational systems This book presents the latest innovations and advances in decision support theory and practice with a special focus on bridging the socio technical gap These achievements will be of interest to all those involved in decision making activities and research The book covers a wide range of topics including Understanding DM Design of DSS Web 2 0 Systems in Decision Support Business Intelligence and Data Warehousing Applications of Multi Criteria Decision Analysis Intelligent DM Context in DM Knowledge Management ERP Systems Decision Support for Policy Making Decision Making in Emergency Scenarios Decision Support in Commerce and Decision Support for Production Planning **Formal Ontology in Information Systems** Antony Galton,Riichiro Mizoguchi,2010 Ontology began life in ancient times as a fundamental part of philosophical enquiry concerned with the analysis and categorisation of what exists In recent years the subject has taken a practical turn with the advent of complex computerised information systems which are reliant on robust and coherent representations of their subject matter The systematisation and elaboration of such representations and their associated reasoning techniques constitute the modern discipline of formal ontology which is now being applied to such diverse domains as artificial intelligence computational linguistics bioinformatics GIS knowledge engineering information retrieval and the Semantic Web Researchers in all these areas are becoming increasingly aware of the need for serious engagement with ontology understood as a general theory of the types of entities and relations making up their respective domains of enquiry to provide a solid foundation for their work The conference series Formal Ontology in Information Systems FOIS provides a meeting

point for researchers from these and other disciplines with an interest in formal ontology where both theoretical issues and concrete applications can be explored in a spirit of genuine interdisciplinarity This volume contains the proceedings of the sixth FOIS conference held in Toronto Canada during 11 14 May 2010 including invited talks by Francis Jeffry Pelletier John Bateman and Alan Rector and the 28 peer reviewed submissions selected for presentation at the conference ranging from foundational issues to more application oriented topics IOS Press is an international science technical and medical publisher of high quality books for academics scientists and professionals in all fields Some of the areas we publish in Biomedicine Oncology Artificial intelligence Databases and information systems Maritime engineering Nanotechnology Geoengineering All aspects of physics E governance E commerce The knowledge economy Urban studies Arms control Understanding and responding to terrorism Medical informatics Computer Sciences *Adaptive Stream Mining* Albert Bifet,2010 This book is a significant contribution to the subject of mining time changing data streams and addresses the design of learning algorithms for this purpose It introduces new contributions on several different aspects of the problem identifying research opportunities and increasing the scope for applications It also includes an in depth study of stream mining and a theoretical analysis of proposed methods and algorithms The first section is concerned with the use of an adaptive sliding window algorithm ADWIN Since this has rigorous performance guarantees using it in place of counters or accumulators it offers the possibility of extending such guarantees to learning and mining algorithms not initially designed for drifting data Testing with several methods including Na ve Bayes clustering decision trees and ensemble methods is discussed as well The second part of the book describes a formal study of connected acyclic graphs or trees from the point of view of closure based mining presenting efficient algorithms for subtree testing and for mining ordered and unordered frequent closed trees Lastly a general methodology to identify closed patterns in a data stream is outlined This is applied to develop an incremental method a sliding window based method and a method that mines closed trees adaptively from data streams These are used to introduce classification methods for tree data streams Data Streams Charu C. Aggarwal,2007-04-03 This book primarily discusses issues related to the mining aspects of data streams and it is unique in its primary focus on the subject This volume covers mining aspects of data streams comprehensively each contributed chapter contains a survey on the topic the key ideas in the field for that particular topic and future research directions The book is intended for a professional audience composed of researchers and practitioners in industry This book is also appropriate for advanced level students in computer science

**Adaptivity in Data Stream Mining** Conny Franke,2009 In recent years data streams became a ubiquitous source of information and thus stream mining emerged as a new field in database research Due to the inherently dynamic nature of data streams stream mining algorithms benefit from being adaptive to changes in the properties of a data stream In addition when stream mining is done in a dynamic environment like a data stream management system or a sensor network stream mining algorithms also profit from being adaptive to the changing conditions in this environment This work investigates two

kinds of adaptivity in data stream mining First a model for quality driven resource adaptive stream mining is developed The model is applied to stream mining algorithms so they efficiently utilize available resources to achieve mining results of the highest quality possible Every stream mining algorithm is unique in its parameters quality measures and resource consumption patterns We generalize these characteristics and develop a model that captures the interactions and correlations between variables involved in the stream mining process We then express resource adaptive stream mining as a multiobjective optimization problem and use its solution to tune the input parameters of stream mining algorithms which results in high quality mining and optimal resource utilization The second topic investigated in this work is feature adaptive stream mining which is concerned with adjusting the focus of the mining process to interesting features detected in the data stream This research is motivated by the need to efficiently detect environmental phenomena from sensor data streams We propose methods to detect and predict heterogeneous outlier regions which represent areas of environmental phenomena of different intensities With the help of predictions about the location and size of outlier regions the sampling rate of individual sensors is adapted such that sensors in the vicinity of environmental phenomena obtain new measurements more frequently than other sensors in the network to allow for a precise and timely region tracking The research in this work enhances the state of the art in data stream mining as it makes stream mining algorithms more flexible to adapt to changes in the data stream and the mining environment **Data Mining Applications Using Artificial Adaptive Systems** William J. Tastle,2012-08-27 This volume directly addresses the complexities involved in data mining and the development of new algorithms built on an underlying theory consisting of linear and non linear dynamics data selection filtering and analysis while including analytical projection and prediction The results derived from the analysis are then further manipulated such that a visual representation is derived with an accompanying analysis The book brings very current methods of analysis to the forefront of the discipline provides researchers and practitioners the mathematical underpinning of the algorithms and the non specialist with a visual representation such that a valid understanding of the meaning of the adaptive system can be attained with careful attention to the visual representation The book presents as a collection of documents sophisticated and meaningful methods that can be immediately understood and applied to various other disciplines of research The content is composed of chapters addressing An application of adaptive systems methodology in the field of post radiation treatment involving brain volume differences in children A new adaptive system for computer aided diagnosis of the characterization of lung nodules A new method of multi dimensional scaling with minimal loss of information A description of the semantics of point spaces with an application on the analysis of terrorist attacks in Afghanistan The description of a new family of meta classifiers A new method of optimal informational sorting A general method for the unsupervised adaptive classification for learning and the presentation of two new theories one in target diffusion and the other in twisting theory Novel Methods for Mining and Learning from Data Streams Ammar Shaker,2017 Die vorliegende Arbeit befasst sich mit dem Erwerb von

Wissen durch Lernen aus nichtstation ren Datenstr men Ein Datenstrom besteht aus einer kontinuierlichen Folge von Datenobjekten wobei sich Eigenschaften des datengenerierenden Prozesses im Laufe der Zeit ndern k nnen Sowohl die Kontinuit t und Dynamik als auch die Nichtstationarit t von Datenstr men gehen einher mit neuen Herausforderungen f r Methoden des maschinellen Lernens Zwei neue Methoden zum berwachten Lernen Klassifikation und Regression auf Datenstr men werden in der Arbeit vorgestellt IBL Streams und eFPT IBLStreams ist ein instanzbasiertes Verfahren und als solches besonders gut geeignet inkrementell zu lernen und sich adaptiv an Ver nderungen des datengenerierenden Prozesses anzupassen vor allem im Vergleich zu modellbasierten Ans tzen Der zweite Ansatz evolving Fuzzy Pattern Trees eFPT kombiniert Konzepte der Fuzzy Logik mit der Flexibilit t nichtlinearer Aggregationsfunktionen und der Ausdrucksst rke hierarchischer Strukturen um interpretierbare Modelle in Form kompakter B ume zu induzieren F r diese sogenannten fuzzy pattern trees werden Lernverfahren entwickelt die es erm glichen B ume inkrementell zu lernen und an Ver nderungen des Datenstroms anzupassen Ein weiterer Beitrag der Arbeit ist ein experimenteller Ansatz der darauf abzielt eine wichtige Eigenschaft von Methoden zum Lernen auf Datenstr men zu untersuchen n mlich die F higkeit auf einen so genannten concept change zu reagieren Hierunter versteht man eine pl tzliche oder graduelle nderung des datengenerierenden Prozesses der in der Regel zu einer tempor ren Verschlechterung der Pr diktionsg te f hrt In this thesis we elaborate on knowledge acquisition and learning from non stationary data streams A data stream is formed by consecutively arriving data examples whose data generating process may change in the course of time Both the cumulative and the non stationary nature of the data within a stream create a challenge for traditional machine learning methods Concentrating on adaptive supervised learning from data streams we introduce two novel learning methods IBLStreams and eFPT IBLStreams is an instance based learner that shows how instance based learning approaches compared to model based approaches are naturally incremental besides their inherent ability to adapt upon the occurrence of a concept change Evolving fuzzy pattern trees eFPTs utilize the potential interpretability of the fuzzy logic concepts in inducing compact trees the induced trees offer the tradeoff between compact interpretable models and generalization performance eFPTs attempt to dynamically evolve the induced tree in order to reflect any change in the underlying data generating process We also introduce recovery analysis as a new type of evaluation for adaptive supervised learners on data streams It is an experimental protocol to assess the learner s ability to learn and recover after a concept change The resulting recovery pattern of the learning method can be analyzed both graphically and numerically using recovery measures Apart from the full supervision offered in the streams studied in the previous approaches we also consider streams of events such a stream contains temporal events emitted from instances under observation For a given instance the survival time is the time this instance spends in the study until experiencing the event of interest **New Frontiers in Mining Complex Patterns** Michelangelo Ceci,Corrado Loglisci,Giuseppe Manco,Elio Masciari,Zbigniew Ras,2020-05-13 This book constitutes the refereed post conference proceedings of the 8th

International Workshop on New Frontiers in Mining Complex Patterns NFMCP 2019 held in conjunction with ECML PKDD 2019 in W rzburg Germany in September 2019 The workshop focused on the latest developments in the analysis of complex and massive data sources such as blogs event or log data medical data spatio temporal data social networks mobility data sensor data and streams Data Mining Patterns: New Methods and Applications Poncelet, Pascal,Masseglia, Florent,Teisseire, Maguelonne,2007-08-31 This book provides an overall view of recent solutions for mining and explores new patterns offering theoretical frameworks and presenting challenges and possible solutions concerning pattern extractions emphasizing research techniques and real world applications It portrays research applications in data models methodologies for mining patterns multi relational and multidimensional pattern mining fuzzy data mining data streaming and incremental mining Provided by publisher **Pattern Discovery from Evolving Transactional Data Streams** Carlos Coronel Rojas,2009 Recent changes in technological infrastructure have resulted in a huge increase in the amount of available digital data Typically this surge means that larger amounts of data are generated in shorter times These massive flows of data are called data streams and naturally require online incremental processing with a very small memory footprint compared to the whole stream We focus on evolving data streams i e those that reflect ever changing environments that are inherently unstable and fluid and that impose on any data mining technique the additional burden of adaptation to change Our work provides significant theoretical algorithmic and empirical contributions to the goal of discovering meaningful regularities from evolving data streams We concentrate on transactional evolving data streams where every record in the data is assumed to be represented in transactional form i e as a list of attributes e g visited web pages words or bought items In this context regularities are sets of attributes that occur several times Meaningful regularities are the sets of attributes whose number of occurrences is hardly explainable as the result of random interactions among the individual attributes and that are not an artifact of the technique that was used to mine these regularities An important aspect of transactional data amplified by the scale of the data streams is that they follow so called long tail distributions which means that they are spread over a large range of possibilities as opposed to the thin tail distributions such as the Gaussian or normal distribution which are concentrated around a small range A common approach to capture these small scale regularities is through frequent itemset mining techniques These techniques have the downside of generating very large amounts of results which is an especially problematic issue for data streams Our approach is a direct improvement over frequent itemset mining techniques Instead of focusing only on the number of co occurrences i e frequency we focus on how consistent they are We present a novel formulation that uses concepts from information theory to frame the problem of consistent co occurrence as one of encoding that assesses quality based on the reduction in size of the encoded message given a coding scheme We use this formulation to rigorously develop a measure the Gain measure that distinguishes between sets of attributes that consistently co occur and those that do not using a single parameter We provide compelling empirical and analytical evidence that the Gain

measure captures meaningful regularities from the data rather than only those based on frequency meets important properties for the restricted case of pairs of attributes behaves in a smooth and predictable way that allows to control the desired level of detail and generates sets of results that are up to two orders of magnitude more compact than those from frequent pattern mining We show analytically how our formulation can be translated exactly to the evolving data stream scenario by expressing it in terms of record addition and deletion from a sliding window We also provide approximate expressions that reduce the computational requirements and give precise algorithms for the more specific issues involved in the updating process We demonstrate empirically that our approximations represent savings of about 30% in computation time while maintaining accurate results measured with a consistent performance of the F 1 measure above 90% with respect to the exact case We present strategies to navigate the discovered patterns through selected snapshots and with timelines that are extracted automatically Taking into account the changes the amount of the data and the compactness of the results that our approach generates these strategies allow to observe easily at a human scale what is relevant in the data stream at a particular instant and how it changes with time We present the results of extensive experiments to support our claims We performed more than two hundred experiments using synthetic data with known ground truth that supports an objective analysis of how sensitive our approach is to increasingly complex interactions in the data and our control parameter The results point out to ranges of the parameter that allow the recovery of the ground truth patterns F1 measure above 60% rather than specific values Moreover since the major computational cost still comes from the frequent pattern mining techniques whose results are improved by our work it is possible to generate results at different values of the parameter excessive additional computational cost We also performed experiments with two large collections of documents that have a temporal dimension the well known 20 Newsgroups dataset and a custom collection of RSS News Feeds from the New York Times Besides validating our expectations about the behavior of the Gain measure and the performance of our algorithms these datasets allow us to validate how meaningful the patterns are in a qualitative manner when combined with the visualization strategies described above For the case of the 20 Newsgroups we validate our results by identifying specific newsgroups that where unusually active at particular times providing a high level content temporal label and by comparing the discovered patterns at those times with what was expected from the specific newsgroup For the New York Times RSS Feeds we selected specific news stories and corroborate that they were captured by our approach with the right temporal connections Moreover we compare the results of our timeline visualizations with a supervised approach namely by querying a repository of news for the dates in question using salient terms from the patterns in the timeline We also present a detailed discussion about how to efficiently construct and maintain a compact summary for evolving transactional data streams This data structure is a prefix tree with an ordering criterion that can change with time such as an activity time stamp or attribute frequency We provide rigorous derivations of computational complexity bounds for the variables involved in the structural

updating of the tree with an emphasis on a class of probability distributions governing the change in ranking We also give empirical evaluations also with the 20 Newsgroups dataset using the long tailed distribution of attribute frequency as the ranking criterion which is a power law that belongs to the specific class of probability distributions mentioned above We show that our theoretical results agree very well with the experiments and that the computational burden of the tree updating decays with time for this type of ranking functions **Complex Pattern Mining** Annalisa Appice,Michelangelo Ceci,Corrado Loglisci,Giuseppe Manco,Elio Masciari,Zbigniew W. Ras,2020-01-14 This book discusses the challenges facing current research in knowledge discovery and data mining posed by the huge volumes of complex data now gathered in various real world applications e g business process monitoring cybersecurity medicine language processing and remote sensing The book consists of 14 chapters covering the latest research by the authors and the research centers they represent It illustrates techniques and algorithms that have recently been developed to preserve the richness of the data and allow us to efficiently and effectively identify the complex information it contains Presenting the latest developments in complex pattern mining this book is a valuable reference resource for data science researchers and professionals in academia and industry **Change Mining and Analysis for Data Streams** David Tse Jung Huang,2015 In 2015 it is estimated that around 500 million Tweets are generated each day and more than 300 hours of video are uploaded to YouTube every minute Characterized by large volume and fast speed of arrival these data arriving in the form of data streams contain valuable knowledge that data scientists and businesses across the globe are desperately trying to gain access to Mining these data using traditional techniques designed for databases is no longer feasible and new algorithms must be developed to overcome the constraints Data streams are dynamic and fast changing and adapting the learning models to react to the presence of change is essential Currently change mining only discovers when changes occur and does not consider further characteristics such as how frequently changes occur and how severe or drastic the changes are This thesis first studies change mining in combination with supervised classification learning and discovers additional change characteristics to further improve how the learning models adapt to the changes in the data stream Second the thesis studies change mining in combination with unsupervised association rule mining to find changes in rare association rules In the first part we propose a novel change detector SEED that finds when changes occur 8 times faster than the current state of the art technique We then propose and find stream volatility which characterizes how frequently changes occur and also discover the magnitude and slope of the changes which characterizes how severe or drastic the changes are Further we show both empirically and theoretically that we can use these additional characteristics to establish a more effective change detection approach with more than 90% false positive reduction and build a better learning model in the presence of changes in data streams Change mining is traditionally studied in combination with supervised classification learning Currently there is limited research that investigates when changes occur in data streams in combination with unsupervised learning techniques such as association

rule mining Due to the inherent differences between supervised and unsupervised learning current change detection methods cannot be directly applied to discover changes in association rules In the second part we propose a tree structured technique that finds rare association rules in data streams and we further define the problem of finding changes in rare association rules We propose a novel M measure that facilitates the discovery of changes in rare association rules when used in conjunction with SEED We show experimentally that changes in rare patterns can be discovered with high true positive rate and low false positive rate In answering the questions of when and how changes occur we hope that we may be a step closer to figuring out the even more difficult question exactly what has changed **Advanced Data Mining and Applications** Xiaochun Yang,Chang-Dong Wang,Md. Saiful Islam,Zheng Zhang,2021-01-05 This book constitutes the proceedings of the 16th International Conference on Advanced Data Mining and Applications ADMA 2020 held in Foshan China in November 2020 The 35 full papers presented together with 14 short papers papers were carefully reviewed and selected from 96 submissions The papers were organized in topical sections named Machine Learning Text Mining Graph Mining Predictive Analytics Recommender Systems Privacy and Security Query Processing Data Mining Applications

**Trends in Deep Learning Methodologies** Vincenzo Piuri,Sandeep Raj,Angelo Genovese,Rajshree Srivastava,2020-11-12 Trends in Deep Learning Methodologies Algorithms Applications and Systems covers deep learning approaches such as neural networks deep belief networks recurrent neural networks convolutional neural networks deep auto encoder and deep generative networks which have emerged as powerful computational models Chapters elaborate on these models which have shown significant success in dealing with massive data for a large number of applications given their capacity to extract complex hidden features and learn efficient representation in unsupervised settings Chapters investigate deep learning based algorithms in a variety of application including biomedical and health informatics computer vision image processing and more In recent years many powerful algorithms have been developed for matching patterns in data and making predictions about future events The major advantage of deep learning is to process big data analytics for better analysis and self adaptive algorithms to handle more data Deep learning methods can deal with multiple levels of representation in which the system learns to abstract higher level representations of raw data Earlier it was a common requirement to have a domain expert to develop a specific model for each specific application however recent advancements in representation learning algorithms allow researchers across various subject domains to automatically learn the patterns and representation of the given data for the development of specific models Provides insights into the theory algorithms implementation and the application of deep learning techniques Covers a wide range of applications of deep learning across smart healthcare and smart engineering Investigates the development of new models and how they can be exploited to find appropriate solutions *Metalearning* Pavel Brazdil,Christophe Giraud Carrier,Carlos Soares,Ricardo Vilalta,2008-11-18 Metalearning is the study of principled methods that exploit metaknowledge to obtain efficient models and solutions by

adapting machine learning and data mining processes While the variety of machine learning and data mining techniques now available can in principle provide good model solutions a methodology is still needed to guide the search for the most appropriate model in an efficient way Metalearning provides one such methodology that allows systems to become more effective through experience This book discusses several approaches to obtaining knowledge concerning the performance of machine learning and data mining algorithms It shows how this knowledge can be reused to select combine compose and adapt both algorithms and models to yield faster more effective solutions to data mining problems It can thus help developers improve their algorithms and also develop learning systems that can improve themselves The book will be of interest to researchers and graduate students in the areas of machine learning data mining and artificial intelligence

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