Outlier Detection for Temporal Data

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  Outlier Detection for Temporal Data Manish Gupta,Jing Gao,Charu Aggarwal,Jiawei Han,2022-06-01 Outlier or anomaly detection is a very broad field which has been studied in the context of a large number of research areas like statistics data mining sensor networks environmental science distributed systems spatio temporal mining etc Initial research in outlier detection focused on time series based outliers in statistics Since then outlier detection has been studied on a large variety of data types including high dimensional data uncertain data stream data network data time series data spatial data and spatio temporal data While there have been many tutorials and surveys for general outlier detection we focus on outlier detection for temporal data in this book A large number of applications generate temporal datasets For example in our everyday life various kinds of records like credit personnel financial judicial medical etc are all temporal This stresses the need for an organized and detailed study of outliers with respect to such temporal data In the past decade there has been a lot of research on various forms of temporal data including consecutive data snapshots series of data snapshots and data streams Besides the initial work on time series researchers have focused on rich forms of data including multiple data streams spatio temporal data network data community distribution data etc Compared to general outlier detection techniques for temporal outlier detection are very different In this book we will present an organized picture of both recent and past research in temporal outlier detection We start with the basics and then ramp up the reader to the main ideas in state of the art outlier detection techniques We motivate the importance of temporal outlier detection and brief the challenges beyond usual outlier detection Then we list down a taxonomy of proposed techniques for temporal outlier detection Such techniques broadly include statistical techniques like AR models Markov models histograms neural networks distance and density based approaches grouping based approaches clustering community detection network based approaches and spatio temporal outlier detection approaches We summarize by presenting a wide collection of applications where temporal outlier detection techniques have been applied to discover interesting outliers Table of Contents Preface Acknowledgments Figure Credits Introduction and Challenges Outlier Detection for Time Series and Data Sequences Outlier Detection for Data Streams Outlier Detection for Distributed Data Streams Outlier Detection for Spatio Temporal Data Outlier Detection for Temporal Network Data Applications of Outlier Detection for Temporal Data Conclusions and Research Directions Bibliography Authors Biographies   *Exploratory Causal Analysis with Time Series Data* James M. McCracken,2022-06-01 Many scientific disciplines rely on observational data of systems for which it is difficult or impossible to implement controlled experiments Data analysis techniques are required for identifying causal information and relationships directly from such observational data This need has led to the development of many different time series causality approaches and tools including transfer entropy convergent cross mapping CCM and Granger causality statistics A practicing analyst can explore the literature to find many proposals for identifying drivers and causal connections in time series data sets Exploratory causal analysis ECA

provides a framework for exploring potential causal structures in time series data sets and is characterized by a myopic goal to determine which data series from a given set of series might be seen as the primary driver In this work ECA is used on several synthetic and empirical data sets and it is found that all of the tested time series causality tools agree with each other and intuitive notions of causality for many simple systems but can provide conflicting causal inferences for more complicated systems It is proposed that such disagreements between different time series causality tools during ECA might provide deeper insight into the data than could be found otherwise   **Mining Human Mobility in Location-Based Social Networks** Huiji Gao,Huan Liu,2022-06-01 In recent years there has been a rapid growth of location based social networking services such as Foursquare and Facebook Places which have attracted an increasing number of users and greatly enriched their urban experience Typical location based social networking sites allow a user to check in at a real world POI point of interest e g a hotel restaurant theater etc leave tips toward the POI and share the check in with their online friends The check in action bridges the gap between real world and online social networks resulting in a new type of social networks namely location based social networks LBSNs Compared to traditional GPS data location based social networks data contains unique properties with abundant heterogeneous information to reveal human mobility i e when and where a user who has been to for what corresponding to an unprecedented opportunity to better understand human mobility from spatial temporal social and content aspects The mining and understanding of human mobility can further lead to effective approaches to improve current location based services from mobile marketing to recommender systems providing users more convenient life experience than before This book takes a data mining perspective to offer an overview of studying human mobility in location based social networks and illuminate a wide range of related computational tasks It introduces basic concepts elaborates associated challenges reviews state of the art algorithms with illustrative examples and real world LBSN datasets and discusses effective evaluation methods in mining human mobility In particular we illustrate unique characteristics and research opportunities of LBSN data present representative tasks of mining human mobility on location based social networks including capturing user mobility patterns to understand when and where a user commonly goes location prediction and exploiting user preferences and location profiles to investigate where and when a user wants to explore location recommendation along with studying a user s check in activity in terms of why a user goes to a certain location

Multidimensional Mining of Massive Text Data Chao Zhang,Jiawei Han,2022-06-01 Unstructured text as one of the most important data forms plays a crucial role in data driven decision making in domains ranging from social networking and information retrieval to scientific research and healthcare informatics In many emerging applications people s information need from text data is becoming multidimensional they demand useful insights along multiple aspects from a text corpus However acquiring such multidimensional knowledge from massive text data remains a challenging task This book presents data mining techniques that turn unstructured text data into multidimensional knowledge We investigate two core questions

1 How does one identify task relevant text data with declarative queries in multiple dimensions 2 How does one distill knowledge from text data in a multidimensional space To address the above questions we develop a text cube framework First we develop a cube construction module that organizes unstructured data into a cube structure by discovering latent multidimensional and multi granular structure from the unstructured text corpus and allocating documents into the structure Second we develop a cube exploitation module that models multiple dimensions in the cube space thereby distilling from user selected data multidimensional knowledge Together these two modules constitute an integrated pipeline leveraging the cube structure users can perform multidimensional multigranular data selection with declarative queries and with cube exploitation algorithms users can extract multidimensional patterns from the selected data for decision making The proposed framework has two distinctive advantages when turning text data into multidimensional knowledge flexibility and label efficiency First it enables acquiring multidimensional knowledge flexibly as the cube structure allows users to easily identify task relevant data along multiple dimensions at varied granularities and further distill multidimensional knowledge Second the algorithms for cube construction and exploitation require little supervision this makes the framework appealing for many applications where labeled data are expensive to obtain   *Exploiting the Power of Group Differences* Guozhu Dong,2022-05-31 This book presents pattern based problem solving methods for a variety of machine learning and data analysis problems The methods are all based on techniques that exploit the power of group differences They make use of group differences represented using emerging patterns aka contrast patterns which are patterns that match significantly different numbers of instances in different data groups A large number of applications outside of the computing discipline are also included Emerging patterns EPs are useful in many ways EPs can be used as features as simple classifiers as subpopulation signatures characterizations and as triggering conditions for alerts EPs can be used in gene ranking for complex diseases since they capture multi factor interactions The length of EPs can be used to detect anomalies outliers and novelties Emerging contrast pattern based methods for clustering analysis and outlier detection do not need distance metrics avoiding pitfalls of the latter in exploratory analysis of high dimensional data EP based classifiers can achieve good accuracy even when the training datasets are tiny making them useful for exploratory compound selection in drug design EPs can serve as opportunities in opportunity focused boosting and are useful for constructing powerful conditional ensembles EP based methods often produce interpretable models and results In general EPs are useful for classification clustering outlier detection gene ranking for complex diseases prediction model analysis and improvement and so on EPs are useful for many tasks because they represent group differences which have extraordinary power Moreover EPs represent multi factor interactions whose effective handling is of vital importance and is a major challenge in many disciplines Based on the results presented in this book one can clearly say that patterns are useful especially when they are linked to issues of interest We believe that many effective ways to exploit group differences power still remain to be discovered Hopefully this book will

inspire readers to discover such new ways besides showing them existing ways to solve various challenging problems

Data Science and Big Data Analytics in Smart Environments Marta Chinnici,Florin Pop,Catalin Negru,2021-07-28 Most applications generate large datasets like social networking and social influence programs smart cities applications smart house environments Cloud applications public web sites scientific experiments and simulations data warehouse monitoring platforms and e government services Data grows rapidly since applications produce continuously increasing volumes of both unstructured and structured data Large scale interconnected systems aim to aggregate and efficiently exploit the power of widely distributed resources In this context major solutions for scalability mobility reliability fault tolerance and security are required to achieve high performance and to create a smart environment The impact on data processing transfer and storage is the need to re evaluate the approaches and solutions to better answer the user needs A variety of solutions for specific applications and platforms exist so a thorough and systematic analysis of existing solutions for data science data analytics methods and algorithms used in Big Data processing and storage environments is significant in designing and implementing a smart environment Fundamental issues pertaining to smart environments smart cities ambient assisted leaving smart houses green houses cyber physical systems etc are reviewed Most of the current efforts still do not adequately address the heterogeneity of different distributed systems the interoperability between them and the systems resilience This book will primarily encompass practical approaches that promote research in all aspects of data processing data analytics data processing in different type of systems Cluster Computing Grid Computing Peer to Peer Cloud Edge Fog Computing all involving elements of heterogeneity having a large variety of tools and software to manage them The main role of resource management techniques in this domain is to create the suitable frameworks for development of applications and deployment in smart environments with respect to high performance The book focuses on topics covering algorithms architectures management models high performance computing techniques and large scale distributed systems

Detecting Fake News on Social Media Kai Shu,Huan Liu,2022-05-31 In the past decade social media has become increasingly popular for news consumption due to its easy access fast dissemination and low cost However social media also enables the wide propagation of fake news i e news with intentionally false information Fake news on social media can have significant negative societal effects Therefore fake news detection on social media has recently become an emerging research area that is attracting tremendous attention This book from a data mining perspective introduces the basic concepts and characteristics of fake news across disciplines reviews representative fake news detection methods in a principled way and illustrates challenging issues of fake news detection on social media In particular we discussed the value of news content and social context and important extensions to handle early detection weakly supervised detection and explainable detection The concepts algorithms and methods described in this lecture can help harness the power of social media to build effective and intelligent fake news detection systems This book is an accessible introduction to the study of detecting fake news on

social media It is an essential reading for students researchers and practitioners to understand manage and excel in this area This book is supported by additional materials including lecture slides the complete set of figures key references datasets tools used in this book and the source code of representative algorithms The readers are encouraged to visit the book website for the latest information http dmml asu edu dfn **Mining Latent Entity Structures** Chi Wang,Jiawei Han,2022-05-31 The big data era is characterized by an explosion of information in the form of digital data collections ranging from scientific knowledge to social media news and everyone s daily life Examples of such collections include scientific publications enterprise logs news articles social media and general web pages Valuable knowledge about multi typed entities is often hidden in the unstructured or loosely structured interconnected data Mining latent structures around entities uncovers hidden knowledge such as implicit topics phrases entity roles and relationships In this monograph we investigate the principles and methodologies of mining latent entity structures from massive unstructured and interconnected data We propose a text rich information network model for modeling data in many different domains This leads to a series of new principles and powerful methodologies for mining latent structures including 1 latent topical hierarchy 2 quality topical phrases 3 entity roles in hierarchical topical communities and 4 entity relations This book also introduces applications enabled by the mined structures and points out some promising research directions

Probabilistic Approaches to Recommendations Nicola Barbieri,Giuseppe Manco,Ettore Ritacco,2022-05-31 The importance of accurate recommender systems has been widely recognized by academia and industry and recommendation is rapidly becoming one of the most successful applications of data mining and machine learning Understanding and predicting the choices and preferences of users is a challenging task real world scenarios involve users behaving in complex situations where prior beliefs specific tendencies and reciprocal influences jointly contribute to determining the preferences of users toward huge amounts of information services and products Probabilistic modeling represents a robust formal mathematical framework to model these assumptions and study their effects in the recommendation process This book starts with a brief summary of the recommendation problem and its challenges and a review of some widely used techniques Next we introduce and discuss probabilistic approaches for modeling preference data We focus our attention on methods based on latent factors such as mixture models probabilistic matrix factorization and topic models for explicit and implicit preference data These methods represent a significant advance in the research and technology of recommendation The resulting models allow us to identify complex patterns in preference data which can be exploited to predict future purchases effectively The extreme sparsity of preference data poses serious challenges to the modeling of user preferences especially in the cases where few observations are available Bayesian inference techniques elegantly address the need for regularization and their integration with latent factor modeling helps to boost the performances of the basic techniques We summarize the strengths and weakness of several approaches by considering two different but related evaluation perspectives namely rating prediction

and recommendation accuracy Furthermore we describe how probabilistic methods based on latent factors enable the exploitation of preference patterns in novel applications beyond rating prediction or recommendation accuracy We finally discuss the application of probabilistic techniques in two additional scenarios characterized by the availability of side information besides preference data In summary the book categorizes the myriad probabilistic approaches to recommendations and provides guidelines for their adoption in real world situations   **Correlation Clustering** Francesco Bonchi,David García-Soriano,Francesco Gullo,2022-05-31 Given a set of objects and a pairwise similarity measure between them the goal of correlation clustering is to partition the objects in a set of clusters to maximize the similarity of the objects within the same cluster and minimize the similarity of the objects in different clusters In most of the variants of correlation clustering the number of clusters is not a given parameter instead the optimal number of clusters is automatically determined Correlation clustering is perhaps the most natural formulation of clustering as it just needs a definition of similarity its broad generality makes it applicable to a wide range of problems in different contexts and particularly makes it naturally suitable to clustering structured objects for which feature vectors can be difficult to obtain Despite its simplicity generality and wide applicability correlation clustering has so far received much more attention from an algorithmic theory perspective than from the data mining community The goal of this lecture is to show how correlation clustering can be a powerful addition to the toolkit of a data mining researcher and practitioner and to encourage further research in the area

Mining Structures of Factual Knowledge from Text Xiang Ren,Jiawei Han,2022-05-31 The real world data though massive is largely unstructured in the form of natural language text It is challenging but highly desirable to mine structures from massive text data without extensive human annotation and labeling In this book we investigate the principles and methodologies of mining structures of factual knowledge e g entities and their relationships from massive unstructured text corpora Departing from many existing structure extraction methods that have heavy reliance on human annotated data for model training our effort light approach leverages human curated facts stored in external knowledge bases as distant supervision and exploits rich data redundancy in large text corpora for context understanding This effort light mining approach leads to a series of new principles and powerful methodologies for structuring text corpora including 1 entity recognition typing and synonym discovery 2 entity relation extraction and 3 open domain attribute valuemining and information extraction This book introduces this new research frontier and points out some promising research directions

Individual and Collective Graph Mining Danai Koutra,Christos Faloutsos,2022-06-01 Graphs naturally represent information ranging from links between web pages to communication in email networks to connections between neurons in our brains These graphs often span billions of nodes and interactions between them Within this deluge of interconnected data how can we find the most important structures and summarize them How can we efficiently visualize them How can we detect anomalies that indicate critical events such as an attack on a computer system disease formation in the human brain

or the fall of a company This book presents scalable principled discovery algorithms that combine globality with locality to make sense of one or more graphs In addition to fast algorithmic methodologies we also contribute graph theoretical ideas and models and real world applications in two main areas Individual Graph Mining We show how to interpretably summarize a single graph by identifying its important graph structures We complement summarization with inference which leverages information about few entities obtained via summarization or other methods and the network structure to efficiently and effectively learn information about the unknown entities Collective Graph Mining We extend the idea of individual graph summarization to time evolving graphs and show how to scalably discover temporal patterns Apart from summarization we claim that graph similarity is often the underlying problem in a host of applications where multiple graphs occur e g temporal anomaly detection discovery of behavioral patterns and we present principled scalable algorithms for aligning networks and measuring their similarity The methods that we present in this book leverage techniques from diverse areas such as matrix algebra graph theory optimization information theory machine learning finance and social science to solve real world problems We present applications of our exploration algorithms to massive datasets including a Web graph of 6 6 billion edges a Twitter graph of 1 8 billion edges brain graphs with up to 90 million edges collaboration peer to peer networks browser logs all spanning millions of users and interactions **Phrase Mining from Massive Text and Its Applications** Jialu Liu,Jingbo Shang,Jiawei Han,2022-06-01 A lot of digital ink has been spilled on big data over the past few years Most of this surge owes its origin to the various types of unstructured data in the wild among which the proliferation of text heavy data is particularly overwhelming attributed to the daily use of web documents business reviews news social posts etc by so many people worldwide A core challenge presents itself How can one efficiently and effectively turn massive unstructured text into structured representation so as to further lay the foundation for many other downstream text mining applications In this book we investigated one promising paradigm for representing unstructured text that is through automatically identifying high quality phrases from innumerable documents In contrast to a list of frequent n grams without proper filtering users are often more interested in results based on variable length phrases with certain semantics such as scientific concepts organizations slogans and so on We propose new principles and powerful methodologies to achieve this goal from the scenario where a user can provide meaningful guidance to a fully automated setting through distant learning This book also introduces applications enabled by the mined phrases and points out some promising research directions *The Art of Feature Engineering* Pablo Duboue,2020-06-25 A practical guide for data scientists who want to improve the performance of any machine learning solution with feature engineering *Machine Learning and Knowledge Discovery in Databases* Peter A. Flach,Tijl De Bie,Nello Cristianini,2012-09-11 This two volume set LNAI 7523 and LNAI 7524 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2012 held in Bristol UK in September 2012 The 105 revised research papers presented together with 5 invited talks were carefully

reviewed and selected from 443 submissions The final sections of the proceedings are devoted to Demo and Nectar papers The Demo track includes 10 papers from 19 submissions and the Nectar track includes 4 papers from 14 submissions The papers grouped in topical sections on association rules and frequent patterns Bayesian learning and graphical models classification dimensionality reduction feature selection and extraction distance based methods and kernels ensemble methods graph and tree mining large scale distributed and parallel mining and learning multi relational mining and learning multi task learning natural language processing online learning and data streams privacy and security rankings and recommendations reinforcement learning and planning rule mining and subgroup discovery semi supervised and transductive learning sensor data sequence and string mining social network mining spatial and geographical data mining statistical methods and evaluation time series and temporal data mining and transfer learning **Data Mining** Jiawei Han,Jian Pei,Hanghang Tong,2022-07-02 Data Mining Concepts and Techniques Fourth Edition introduces concepts principles and methods for mining patterns knowledge and models from various kinds of data for diverse applications Specifically it delves into the processes for uncovering patterns and knowledge from massive collections of data known as knowledge discovery from data or KDD It focuses on the feasibility usefulness effectiveness and scalability of data mining techniques for large data sets After an introduction to the concept of data mining the authors explain the methods for preprocessing characterizing and warehousing data They then partition the data mining methods into several major tasks introducing concepts and methods for mining frequent patterns associations and correlations for large data sets data classificcation and model construction cluster analysis and outlier detection Concepts and methods for deep learning are systematically introduced as one chapter Finally the book covers the trends applications and research frontiers in data mining Presents a comprehensive new chapter on deep learning including improving training of deep learning models convolutional neural networks recurrent neural networks and graph neural networks Addresses advanced topics in one dedicated chapter data mining trends and research frontiers including mining rich data types text spatiotemporal data and graph networks data mining applications such as sentiment analysis truth discovery and information propagattion data mining methodologie and systems and data mining and society Provides a comprehensive practical look at the concepts and techniques needed to get the most out of your data Visit the author hosted companion site https hanj cs illinois edu bk4 for downloadable lecture slides and errata **Advanced Data Mining and Applications** Longbing Cao,Yong Feng,Jiang Zhong,2010-11-05 This book constitutes the refereed proceedings of the 6th International Conference on Advanced Data Mining and Applications ADMA 2010 held in Chongqing China in November 2010 63 carefully reviewed regular papers and 55 revised short papers were presented The papers are organized in topical sections on data mining foundations data mining in specific areas data mining methodologies and processes and data mining applications and systems **Advances in Knowledge Discovery and Data Mining** David Cheung,2005-05-10 This book constitutes the refereed proceedings of the

9th Pacific Asia Conference on Knowledge Discovery and Data Mining PAKDD 2005 held in Hanoi Vietnam in May 2005 The 48 revised full papers and 49 revised short papers presented together with abstracts or extended abstracts of 3 invited talks were carefully reviewed and selected from 327 submissions The papers are organized in topical sections on theoretical foundations association rules biomedical domains classification and ranking clustering dynamic data mining graphical model discovery high dimensional data integration of data warehousing knowledge management machine learning novel algorithms spatial data temporal data and text and Web data mining   Advanced Data Mining and Applications Bohan Li,Lin Yue,Jing Jiang,Weitong Chen,Xue Li,Guodong Long,Fei Fang,Han Yu,2022-01-31 This book constitutes the proceedings of the 17th International Conference on Advanced Data Mining and Applications ADMA 2021 held in Sydney Australia in February 2022 The 26 full papers presented together with 35 short papers were carefully reviewed and selected from 116 submissions The papers were organized in topical sections in Part II named Pattern mining Graph mining Text mining Multimedia and time series data mining and Classification clustering and recommendation The conference was originally planned for December 2021 but was postponed to 2022   *Proceedings of the Sixth SIAM International Conference on Data Mining* Joydeep Ghosh,2006-04-01 The Sixth SIAM International Conference on Data Mining continues the tradition of presenting approaches tools and systems for data mining in fields such as science engineering industrial processes healthcare and medicine The datasets in these fields are large complex and often noisy Extracting knowledge requires the use of sophisticated high performance and principled analysis techniques and algorithms based on sound statistical foundations These techniques in turn require powerful visualization technologies implementations that must be carefully tuned for performance software systems that are usable by scientists engineers and physicians as well as researchers and infrastructures that support them

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