Synthesis Lectures on Data Management

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COLLECTION OF TECHNOLOGY

HweeHwa Pang · Kian-Lee Tan

Query Answer Authentication

Springer

Query Answer Authentication Kian Lee Tan

Goetz Graefe,Wey Guy,Caetano Sauer

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Query Answer Authentication HweeHwa Pang,Kian-Lee Tan,2022-05-31 In data publishing the owner delegates the role of satisfying user queries to a third party publisher As the servers of the publisher may be untrusted or susceptible to attacks we cannot assume that they would always process queries correctly hence there is a need for users to authenticate their query answers This book introduces various notions that the research community has studied for defining the correctness of a query answer In particular it is important to guarantee the completeness authenticity and minimality of the answer as well as its freshness We present authentication mechanisms for a wide variety of queries in the context of relational and spatial databases text retrieval and data streams We also explain the cryptographic protocols from which the authentication mechanisms derive their security properties Table of Contents Introduction Cryptography Foundation Relational Queries Spatial Queries Text Search Queries Data Streams Conclusion Answering Queries Using Views, Second Edition Foto Afrati,Rada Chirkova,2022-05-31 The topic of using views to answer queries has been popular for a few decades now as it cuts across domains such as query optimization information integration data warehousing website design and recently database as a service and data placement in cloud systems This book assembles foundational work on answering queries using views in a self contained manner with an effort to choose material that constitutes the backbone of the research It presents efficient algorithms and covers the following problems query containment rewriting queries using views in various logical languages equivalent rewritings and maximally contained rewritings and computing certain answers in the data integration and data exchange settings Query languages that are considered are fragments of SQL in particular select project join queries also called conjunctive queries with or without arithmetic comparisons or negation and aggregate SQL queries This second edition includes twonew chapters that refer to tree like data and respective query languages Chapter 8 presents the data model for XML documents and the XPath query language and Chapter 9 provides a theoretical presentation of tree like data model and query language where the tuples of a relation share a tree structured schema for that relation and the query language is a dialect of SQL with evaluation techniques appropriately modified to fit the richer schema **Answering Queries Using Views** Foto Afrati,Rada Chirkova,2022-11-10 The topic of using views to answer queries has been popular for a few decades now as it cuts across domains such as query optimization information integration data warehousing website design and recently database as a service and data placement in cloud systems This book assembles foundational work on answering queries using views in a self contained manner with an effort to choose material that constitutes the backbone of the research It presents efficient algorithms and covers the following problems query containment rewriting queries using views in various logical languages equivalent rewritings and maximally contained rewritings and computing certain answers in the data integration and data exchange settings Query languages that are considered are fragments of SQL in particular select project join queries also called conjunctive queries with or without arithmetic comparisons or negation and aggregate

SQL queries *Query Processing over Uncertain Databases* Lei Chen,Xiang Lian,2022-05-31 Due to measurement errors transmission lost or injected noise for privacy protection uncertainty exists in the data of many real applications However query processing techniques for deterministic data cannot be directly applied to uncertain data because they do not have mechanisms to handle data uncertainty Therefore efficient and effective manipulation of uncertain data is a practical yet challenging research topic In this book we start from the data models for imprecise and uncertain data move on to defining different semantics for queries on uncertain data and finally discuss the advanced query processing techniques for various probabilistic queries in uncertain databases The book serves as a comprehensive guideline for query processing over uncertain databases Table of Contents Introduction Uncertain Data Models Spatial Query Semantics over Uncertain Data Models Spatial Query Processing over Uncertain Databases Conclusion *Query Processing over Incomplete Databases* Yunjun Gao,Xiaoye Miao,2022-06-01 Incomplete data is part of life and almost all areas of scientific studies Users tend to skip certain fields when they fill out online forms participants choose to ignore sensitive questions on surveys sensors fail resulting in the loss of certain readings publicly viewable satellite map services have missing data in many mobile applications and in privacy preserving applications the data is incomplete deliberately in order to preserve the sensitivity of some attribute values Query processing is a fundamental problem in computer science and is useful in a variety of applications In this book we mostly focus on the query processing over incomplete databases which involves finding a set of qualified objects from a specified incomplete dataset in order to support a wide spectrum of real life applications We first elaborate the three general kinds of methods of handling incomplete data including i discarding the data with missing values ii imputation for the missing values and iii just depending on the observed data values For the third method type we introduce the semantics of k nearest neighbor kNN search skyline query and top k dominating query on incomplete data respectively In terms of the three representative queries over incomplete data we investigate some advanced techniques to process incomplete data queries including indexing pruning as well as crowdsourcing techniques **Deep Web Query Interface Understanding and Integration** Eduard C. Dragut,Weiyi Meng,Clement Yu,2022-05-31 There are millions of searchable data sources on the Web and to a large extent their contents can only be reached through their own query interfaces There is an enormous interest in making the data in these sources easily accessible There are primarily two general approaches to achieve this objective The first is to surface the contents of these sources from the deep Web and add the contents to the index of regular search engines The second is to integrate the searching capabilities of these sources and support integrated access to them In this book we introduce the state of the art techniques for extracting understanding and integrating the query interfaces of deep Web data sources These techniques are critical for producing an integrated query interface for each domain The interface serves as the mediator for searching all data sources in the concerned domain While query interface integration is only relevant for the deep Web integration approach the extraction and understanding of query

interfaces are critical for both deep Web exploration approaches This book aims to provide in depth and comprehensive coverage of the key technologies needed to create high quality integrated query interfaces automatically The following technical issues are discussed in detail in this book query interface modeling query interface extraction query interface clustering query interface matching query interface attribute integration and query interface integration Table of Contents Introduction Query Interface Representation and Extraction Query Interface Clustering and Categorization Query Interface Matching Query Interface Attribute Integration Query Interface Integration Summary and Future Research *Generating Plans from Proofs* Michael Benedikt,Julien Leblay,Balder ten Cate,Efthymia Tsamoura,2016-03-15 Query reformulation refers to a process of translating a source query a request for information in some high level logic based language into a target plan that abides by certain interface restrictions Many practical problems in data management can be seen as instances of the reformulation problem For example the problem of translating an SQL query written over a set of base tables into another query written over a set of views the problem of implementing a query via translating to a program calling a set of database APIs the problem of implementing a query using a collection of web services In this book we approach query reformulation in a very general setting that encompasses all the problems above by relating it to a line of research within mathematical logic For many decades logicians have looked at the problem of converting implicit definitions into explicit definitions using an approach known as interpolation We will review the theory of interpolation and explain its close connection with query reformulation We will give a detailed look at how the interpolation based approach is used to generate translations between logic based queries over different vocabularies and also how it can be used to go from logic based queries to programs

On Transactional Concurrency Control Goetz Graefe,2022-05-31 This book contains a number of chapters on transactional database concurrency control This volume s entire sequence of chapters can summarized as follows A two sentence summary of the volume s entire sequence of chapters is this traditional locking techniques can be improved in multiple dimensions notably in lock scopes sizes lock modes increment decrement and more lock durations late acquisition early release and lock acquisition sequence to avoid deadlocks Even if some of these improvements can be transferred to optimistic concurrency control notably a fine granularity of concurrency control with serializable transaction isolation including phantom protection pessimistic concurrency control is categorically superior to optimistic concurrency control i e independent of application workload deployment hardware and software implementation **Databases on Modern Hardware** Anastasia Ailamaki,Erietta Liarou,Pınar Tözün,Danica Porobic,Iraklis Psaroudakis,2022-06-01 Data management systems enable various influential applications from high performance online services e g social networks like Twitter and Facebook or financial markets to big data analytics e g scientific exploration sensor networks business intelligence As a result data management systems have been one of the main drivers for innovations in the database and computer architecture communities for several decades Recent hardware trends require software to take advantage of the abundant

parallelism existing in modern and future hardware The traditional design of the data management systems however faces inherent scalability problems due to its tightly coupled components In addition it cannot exploit the full capability of the aggressive micro architectural features of modern processors As a result today s most commonly used server types remain largely underutilized leading to a huge waste of hardware resources and energy In this book we shed light on the challenges present while running DBMS on modern multicore hardware We divide the material into two dimensions of scalability implicit vertical and explicit horizontal The first part of the book focuses on the vertical dimension it describes the instruction and data level parallelism opportunities in a core coming from the hardware and software side In addition it examines the sources of under utilization in a modern processor and presents insights and hardware software techniques to better exploit the microarchitectural resources of a processor by improving cache locality at the right level of the memory hierarchy The second part focuses on the horizontal dimension i e scalability bottlenecks of database applications at the level of multicore and multisocket multicore architectures It first presents a systematic way of eliminating such bottlenecks in online transaction processing workloads which is based on minimizing unbounded communication and shows several techniques that minimize bottlenecks in major components of database management systems Then it demonstrates the data and work sharing opportunities for analytical workloads and reviews advanced scheduling mechanisms that are aware of nonuniform memory accesses and alleviate bandwidth saturation *Information and Influence Propagation in Social Networks* Wei Chen,Carlos Castillo,Laks V.S. Lakshmanan,2022-05-31 Research on social networks has exploded over the last decade To a large extent this has been fueled by the spectacular growth of social media and online social networking sites which continue growing at a very fast pace as well as by the increasing availability of very large social network datasets for purposes of research A rich body of this research has been devoted to the analysis of the propagation of information influence innovations infections practices and customs through networks Can we build models to explain the way these propagations occur How can we validate our models against any available real datasets consisting of a social network and propagation traces that occurred in the past These are just some questions studied by researchers in this area Information propagation models find applications in viral marketing outbreak detection finding key blog posts to read in order to catch important stories finding leaders or trendsetters information feed ranking etc A number of algorithmic problems arising in these applications have been abstracted and studied extensively by researchers under the garb of influence maximization This book starts with a detailed description of well established diffusion models including the independent cascade model and the linear threshold model that have been successful at explaining propagation phenomena We describe their properties as well as numerous extensions to them introducing aspects such as competition budget and time criticality among many others We delve deep into the key problem of influence maximization which selects key individuals to activate in order to influence a large fraction of a network Influence maximization in classic diffusion models including both the independent cascade and the linear

threshold models is computationally intractable more precisely P hard and we describe several approximation algorithms and scalable heuristics that have been proposed in the literature Finally we also deal with key issues that need to be tackled in order to turn this research into practice such as learning the strength with which individuals in a network influence each other as well as the practical aspects of this research including the availability of datasets and software tools for facilitating research We conclude with a discussion of various research problems that remain open both from a technical perspective and from the viewpoint of transferring the results of research into industry strength applications *Data-Intensive Workflow Management* Daniel C. M. de Oliveira,Ji Liu,Esther Pacitti,2022-06-01 Workflows may be defined as abstractions used to model the coherent flow of activities in the context of an in silico scientific experiment They are employed in many domains of science such as bioinformatics astronomy and engineering Such workflows usually present a considerable number of activities and activations i e tasks associated with activities and may need a long time for execution Due to the continuous need to store and process data efficiently making them data intensive workflows high performance computing environments allied to parallelization techniques are used to run these workflows At the beginning of the 2010s cloud technologies emerged as a promising environment to run scientific workflows By using clouds scientists have expanded beyond single parallel computers to hundreds or even thousands of virtual machines More recently Data Intensive Scalable Computing DISC frameworks e g Apache Spark and Hadoop and environments emerged and are being used to execute data intensive workflows DISC environments are composed of processors and disks in large commodity computing clusters connected using high speed communications switches and networks The main advantage of DISC frameworks is that they support and grant efficient in memory data management for large scale applications such as data intensive workflows However the execution of workflows in cloud and DISC environments raise many challenges such as scheduling workflow activities and activations managing produced data collecting provenance data etc Several existing approaches deal with the challenges mentioned earlier This way there is a real need for understanding how to manage these workflows and various big data platforms that have been developed and introduced As such this book can help researchers understand how linking workflow management with Data Intensive Scalable Computing can help in understanding and analyzing scientific big data In this book we aim to identify and distill the body of work on workflow management in clouds and DISC environments We start by discussing the basic principles of data intensive scientific workflows Next we present two workflows that are executed in a single site and multi site clouds taking advantage of provenance Afterward we go towards workflow management in DISC environments and we present in detail solutions that enable the optimized execution of the workflow using frameworks such as Apache Spark and its extensions **Data Cleaning** Venkatesh Ganti,Anish Das Sarma,2022-05-31 Data warehouses consolidate various activities of a business and often form the backbone for generating reports that support important business decisions Errors in data tend to creep in for a variety of reasons Some of these reasons include errors during input data collection and errors

while merging data collected independently across different databases These errors in data warehouses often result in erroneous upstream reports and could impact business decisions negatively Therefore one of the critical challenges while maintaining large data warehouses is that of ensuring the quality of data in the data warehouse remains high The process of maintaining high data quality is commonly referred to as data cleaning In this book we first discuss the goals of data cleaning Often the goals of data cleaning are not well defined and could mean different solutions in different scenarios Toward clarifying these goals we abstract out a common set of data cleaning tasks that often need to be addressed This abstraction allows us to develop solutions for these common data cleaning tasks We then discuss a few popular approaches for developing such solutions In particular we focus on an operator centric approach for developing a data cleaning platform The operator centric approach involves the development of customizable operators that could be used as building blocks for developing common solutions This is similar to the approach of relational algebra for query processing The basic set of operators can be put together to build complex queries Finally we discuss the development of custom scripts which leverage the basic data cleaning operators along with relational operators to implement effective solutions for data cleaning tasks

Human Interaction with Graphs Sourav S. Bhowmick,Byron Choi,Chengkai Li,2022-06-01 Interacting with graphs using queries has emerged as an important research problem for real world applications that center on large graph data Given the syntactic complexity of graph query languages e g SPARQL Cypher visual graph query interfaces make it easy for non programmers to query such graph data repositories In this book we present recent developments in the emerging area of visual graph querying paradigm that bridges traditional graph querying with human computer interaction HCI Specifically we focus on techniques that emphasize deep integration between the visual graph query interface and the underlying graph query engine We discuss various strategies and guidance for constructing graph queries visually interleaving processing of graph queries and visual actions visual exploration of graph query results and automated performance study of visual graph querying frameworks In addition this book highlights open problems and new research directions In summary in this book we review and summarize the research thus far into the integration of HCI and graph querying to facilitate user friendly interaction with graph structured data giving researchers a snapshot of the current state of the art in this topic and future research directions **On Uncertain Graphs** Arijit Khan,Yuan Ye,Lei Chen,2022-05-31 Large scale highly interconnected networks which are often modeled as graphs pervade both our society and the natural world around us Uncertainty on the other hand is inherent in the underlying data due to a variety of reasons such as noisy measurements lack of precise information needs inference and prediction models or explicit manipulation e g for privacy purposes Therefore uncertain or probabilistic graphs are increasingly used to represent noisy linked data in many emerging application scenarios and they have recently become a hot topic in the database and data mining communities Many classical algorithms such as reachability and shortest path queries become P complete and thus more expensive over uncertain graphs Moreover various

complex queries and analytics are also emerging over uncertain networks such as pattern matching information diffusion and influence maximization queries In this book we discuss the sources of uncertain graphs and their applications uncertainty modeling as well as the complexities and algorithmic advances on uncertain graphs processing in the context of both classical and emerging graph queries and analytics We emphasize the current challenges and highlight some future research directions **Instant Recovery with Write-Ahead Logging** Goetz Graefe,Wey Guy,Caetano Sauer,2022-05-31 Traditional theory and practice of write ahead logging and of database recovery focus on three failure classes transaction failures typically due to deadlocks resolved by transaction rollback system failures typically power or software faults resolved by restart with log analysis redo and undo phases and media failures typically hardware faults resolved by restore operations that combine multiple types of backups and log replay The recent addition of single page failures and single page recovery has opened new opportunities far beyond the original aim of immediate lossless repair of single page wear out in novel or traditional storage hardware In the contexts of system and media failures efficient single page recovery enables on demand incremental redo and undo as part of system restart or media restore operations This can give the illusion of practically instantaneous restart and restore instant restart permits processing new queries and updates seconds after system reboot and instant restore permits resuming queries and updates on empty replacement media as if those were already fully recovered In the context of node and network failures instant restart and instant restore combine to enable practically instant failover from a failing database node to one holding merely an out of date backup and a log archive yet without loss of data updates or transactional integrity In addition to these instant recovery techniques the discussion introduces self repairing indexes and much faster offline restore operations which impose no slowdown in backup operations and hardly any slowdown in log archiving operations The new restore techniques also render differential and incremental backups obsolete complete backup commands on a database server practically instantly and even permit taking full up to date backups without imposing any load on the database server Compared to the first version of this book this second edition adds sections on applications of single page repair instant restart single pass restore and instant restore Moreover it adds sections on instant failover among nodes in a cluster applications of instant failover recovery for file systems and data files and the performance of instant restart and instant restore *Data Management in Machine Learning Systems* Matthias Boehm,Arun Kumar,Jun Yang,2022-05-31 Large scale data analytics using machine learning ML underpins many modern data driven applications ML systems provide means of specifying and executing these ML workloads in an efficient and scalable manner Data management is at the heart of many ML systems due to data driven application characteristics data centric workload characteristics and system architectures inspired by classical data management techniques In this book we follow this data centric view of ML systems and aim to provide a comprehensive overview of data management in ML systems for the end to end data science or ML lifecycle We review multiple interconnected lines of work 1 ML support in database DB systems 2 DB

inspired ML systems and 3 ML lifecycle systems Covered topics include in database analytics via query generation and user defined functions factorized and statistical relational learning optimizing compilers for ML workloads execution strategies and hardware accelerators data access methods such as compression partitioning and indexing resource elasticity and cloud markets as well as systems for data preparation for ML model selection model management model debugging and model serving Given the rapidly evolving field we strive for a balance between an up to date survey of ML systems an overview of the underlying concepts and techniques as well as pointers to open research questions Hence this book might serve as a starting point for both systems researchers and developers Data Processing on FPGAs Jens Teubner,Louis Woods,2022-05-31 Roughly a decade ago power consumption and heat dissipation concerns forced the semiconductor industry to radically change its course shifting from sequential to parallel computing Unfortunately improving performance of applications has now become much more difficult than in the good old days of frequency scaling This is also affecting databases and data processing applications in general and has led to the popularity of so called data appliances specialized data processing engines where software and hardware are sold together in a closed box Field programmable gate arrays FPGAs increasingly play an important role in such systems FPGAs are attractive because the performance gains of specialized hardware can be significant while power consumption is much less than that of commodity processors On the other hand FPGAs are way more flexible than hard wired circuits ASICs and can be integrated into complex systems in many different ways e g directly in the network for a high frequency trading application This book gives an introduction to FPGA technology targeted at a database audience In the first few chapters we explain in detail the inner workings of FPGAs Then we discuss techniques and design patterns that help mapping algorithms to FPGA hardware so that the inherent parallelism of these devices can be leveraged in an optimal way Finally the book will illustrate a number of concrete examples that exploit different advantages of FPGAs for data processing Table of Contents Preface Introduction A Primer in Hardware Design FPGAs FPGA Programming Models Data Stream Processing Accelerated DB Operators Secure Data Processing Conclusions Bibliography Authors Biographies Index **Scalable Processing of Spatial-Keyword Queries** Ahmed R. Mahmood,Walid G. Aref,2022-05-31 Text data that is associated with location data has become ubiquitous A tweet is an example of this type of data where the text in a tweet is associated with the location where the tweet has been issued We use the term spatial keyword data to refer to this type of data Spatial keyword data is being generated at massive scale Almost all online transactions have an associated spatial trace The spatial trace is derived from GPS coordinates IP addresses or cell phone tower locations Hundreds of millions or even billions of spatial keyword objects are being generated daily Spatial keyword data has numerous applications that require efficient processing and management of massive amounts of spatial keyword data This book starts by overviewing some important applications of spatial keyword data and demonstrates the scale at which spatial keyword data is being generated Then it formalizes and classifies the various types of queries that

execute over spatial keyword data Next it discusses important and desirable properties of spatial keyword query languages that are needed to express queries over spatial keyword data As will be illustrated existing spatial keyword query languages vary in the types of spatial keyword queries that they can support There are many systems that process spatial keyword queries Systems differ from each other in various aspects e g whether the system is batch oriented or stream based and whether the system is centralized or distributed Moreover spatial keyword systems vary in the types of queries that they support Finally systems vary in the types of indexing techniques that they adopt This book provides an overview of the main spatial keyword data management systems SKDMSs and classifies them according to their features Moreover the book describes the main approaches adopted when indexing spatial keyword data in the centralized and distributed settings Several case studies of SKDMSs are presentedalong with the applications and query types that these SKDMSs are targeted for and the indexing techniques they utilize for processing their queries Optimizing the performance and the query processing of SKDMSs still has many research challenges and open problems The book concludes with a discussion about several important and open research problems in the domain of scalable spatial keyword processing **Similarity Joins in Relational Database Systems** Nikolaus Augsten,Michael Bohlen,2022-05-31 State of the art database systems manage and process a variety of complex objects including strings and trees For such objects equality comparisons are often not meaningful and must be replaced by similarity comparisons This book describes the concepts and techniques to incorporate similarity into database systems We start out by discussing the properties of strings and trees and identify the edit distance as the de facto standard for comparing complex objects Since the edit distance is computationally expensive token based distances have been introduced to speed up edit distance computations The basic idea is to decompose complex objects into sets of tokens that can be compared efficiently Token based distances are used to compute an approximation of the edit distance and prune expensive edit distance calculations A key observation when computing similarity joins is that many of the object pairs for which the similarity is computed are very different from each other Filters exploit this property to improve the performance of similarity joins A filter preprocesses the input data sets and produces a set of candidate pairs The distance function is evaluated on the candidate pairs only We describe the essential query processing techniques for filters based on lower and upper bounds For token equality joins we describe prefix size positional and partitioning filters which can be used to avoid the computation of small intersections that are not needed since the similarity would be too low

The Four Generations of Entity Resolution George Papadakis,Ekaterini Ioannou,Emanouil Thanos,Themis Palpanas,2022-06-01 Entity Resolution ER lies at the core of data integration and cleaning and thus a bulk of the research examines ways for improving its effectiveness and time efficiency The initial ER methods primarily target Veracity in the context of structured relational data that are described by a schema of well known quality and meaning To achieve high effectiveness they leverage schema expert and or external knowledge Part of these methods are extended to address Volume

processing large datasets through multi core or massive parallelization approaches such as the MapReduce paradigm However these early schema based approaches are inapplicable to Web Data which abound in voluminous noisy semi structured and highly heterogeneous information To address the additional challenge of Variety recent works on ER adopt a novel loosely schema aware functionality that emphasizes scalability and robustness to noise Another line of present research focuses on the additional challenge of Velocity aiming to process data collections of a continuously increasing volume The latest works though take advantage of the significant breakthroughs in Deep Learning and Crowdsourcing incorporating external knowledge to enhance the existing words to a significant extent This synthesis lecture organizes ER methods into four generations based on the challenges posed by these four Vs For each generation we outline the corresponding ER workflow discuss the state of the art methods per workflow step and present current research directions The discussion of these methods takes into account a historical perspective explaining the evolution of the methods over time along with their similarities and differences The lecture also discusses the available ER tools and benchmark datasets that allow expert as well as novice users to make use of the available solutions

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