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# Fundamentals of Physical Design and Query Compilation

David Toman  
Grant Weddell

*SYNTHESIS LECTURES ON DATA MANAGEMENT*

M. Tamer Özsü, *Series Editor*

# Fundamentals Of Physical Design And Query Compilation Grant Weddell

**CO Houle**



## **Fundamentals Of Physical Design And Query Compilation Grant Weddell:**

**Fundamentals of Physical Design and Query Compilation** David Toman, Grant Weddell, 2022-06-01 Query compilation is the problem of translating user requests formulated over purely conceptual and domain specific ways of understanding data commonly called logical designs to efficient executable programs called query plans Such plans access various concrete data sources through their low level often iterator based interfaces An appreciation of the concrete data sources their interfaces and how such capabilities relate to logical design is commonly called a physical design This book is an introduction to the fundamental methods underlying database technology that solves the problem of query compilation The methods are presented in terms of first order logic which serves as the vehicle for specifying physical design expressing user requests and query plans and understanding how query plans implement user requests Table of Contents Introduction Logical Design and User Queries Basic Physical Design and Query Plans On Practical Physical Design Query Compilation and Plan Synthesis Updating Data

**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

**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      **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      **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      Database Repairing and Consistent Query Answering Leopoldo Bertossi, 2022-05-31 Integrity constraints are semantic conditions that a database should satisfy in order to be an appropriate model of external reality In practice and for many reasons a database may not satisfy those integrity constraints and for that reason it is said to be inconsistent However and most likely a large portion of the database is still semantically correct in a sense that has to be made precise After having provided a formal characterization of consistent data in an inconsistent database the natural problem emerges of extracting that semantically correct data as query answers The

consistent data in an inconsistent database is usually characterized as the data that persists across all the database instances that are consistent and minimally differ from the inconsistent instance Those are the so called repairs of the database In particular the consistent answers to a query posed to the inconsistent database are those answers that can be simultaneously obtained from all the database repairs As expected the notion of repair requires an adequate notion of distance that allows for the comparison of databases with respect to how much they differ from the inconsistent instance On this basis the minimality condition on repairs can be properly formulated In this monograph we present and discuss these fundamental concepts different repair semantics algorithms for computing consistent answers to queries and also complexity theoretic results related to the computation of repairs and doing consistent query answering Table of Contents Introduction The Notions of Repair and Consistent Answer Tractable CQA and Query Rewriting Logically Specifying Repairs Decision Problems in CQA Complexity and Algorithms Repairs and Data Cleaning

### **Skylines and Other Dominance-Based Queries**

Apostolos N. Papadopoulos, Eleftherios Tiakas, Theodoros Tzouramanis, Nikolaos Georgiadis, Yannis Manolopoulos, 2022-06-01 This book is a gentle introduction to dominance based query processing techniques and their applications The book aims to present fundamental as well as some advanced issues in the area in a precise but easy to follow manner Dominance is an intuitive concept that can be used in many different ways in diverse application domains The concept of dominance is based on the values of the attributes of each object An object dominates another object if it is better than This goodness criterion may differ from one user to another However all decisions boil down to the minimization or maximization of attribute values In this book we will explore algorithms and applications related to dominance based query processing The concept of dominance has a long history in finance and multi criteria optimization However the introduction of the concept to the database community in 2001 inspired many researchers to contribute to the area Therefore many algorithmic techniques have been proposed for the efficient processing of dominance based queries such as skyline queries dominant queries and top dominating queries just to name a few

*Data Profiling* Ziawasch Abedjan, Lukasz Golab, Felix Naumann, Thorsten Papenbrock, 2022-06-01 Data profiling refers to the activity of collecting data about data i e metadata Most IT professionals and researchers who work with data have engaged in data profiling at least informally to understand and explore an unfamiliar dataset or to determine whether a new dataset is appropriate for a particular task at hand Data profiling results are also important in a variety of other situations including query optimization data integration and data cleaning Simple metadata are statistics such as the number of rows and columns schema and datatype information the number of distinct values statistical value distributions and the number of null or empty values in each column More complex types of metadata are statements about multiple columns and their correlation such as candidate keys functional dependencies and other types of dependencies This book provides a classification of the various types of profilable metadata discusses popular data profiling tasks and surveys state of the art profiling algorithms While most of the book focuses on

tasks and algorithms for relational data profiling we also briefly discuss systems and techniques for profiling non relational data such as graphs and text We conclude with a discussion of data profiling challenges and directions for future work in this area

*Data Exploration Using Example-Based Methods* Matteo Lissandrini, Davide Mottin, Themis Palpanas, Yannis Velegrakis, 2022-06-01 Data usually comes in a plethora of formats and dimensions rendering the exploration and information extraction processes challenging Thus being able to perform exploratory analyses in the data with the intent of having an immediate glimpse on some of the data properties is becoming crucial Exploratory analyses should be simple enough to avoid complicate declarative languages such as SQL and mechanisms and at the same time retain the flexibility and expressiveness of such languages Recently we have witnessed a rediscovery of the so called example based methods in which the user or the analyst circumvents query languages by using examples as input An example is a representative of the intended results or in other words an item from the result set Example based methods exploit inherent characteristics of the data to infer the results that the user has in mind but may not be able to easily express They can be useful in cases where a user is looking for information in an unfamiliar dataset when the task is particularly challenging like finding duplicate items or simply when they are exploring the data In this book we present an excursus over the main methods for exploratory analysis with a particular focus on example based methods We show how that different data types require different techniques and present algorithms that are specifically designed for relational textual and graph data The book presents also the challenges and the new frontiers of machine learning in online settings which recently attracted the attention of the database community The lecture concludes with a vision for further research and applications in this area

**Veracity of Data** Laure Berti-Équille, Javier Borge-Holthoefer, 2022-05-31 On the Web a massive amount of user generated content is available through various channels e.g. texts, tweets, Web tables, databases, multimedia sharing platforms etc. Conflicting information, rumors, erroneous and fake content can be easily spread across multiple sources making it hard to distinguish between what is true and what is not This book gives an overview of fundamental issues and recent contributions for ascertaining the veracity of data in the era of Big Data The text is organized into six chapters focusing on structured data extracted from texts Chapter 1 introduces the problem of ascertaining the veracity of data in a multi source and evolving context Issues related to information extraction are presented in Chapter 2 Current truth discovery computation algorithms are presented in details in Chapter 3 It is followed by practical techniques for evaluating data source reputation and authoritativeness in Chapter 4 The theoretical foundations and various approaches for modeling diffusion phenomenon of misinformation spreading in networked systems are studied in Chapter 5 Finally truth discovery computation from extracted data in a dynamic context of misinformation propagation raises interesting challenges that are explored in Chapter 6 This text is intended for a seminar course at the graduate level It is also to serve as a useful resource for researchers and practitioners who are interested in the study of fact checking, truth discovery or rumor spreading

Datalog and Logic Databases Sergio Greco, Cristian

Molinaro,2022-05-31 The use of logic in databases started in the late 1960s In the early 1970s Codd formalized databases in terms of the relational calculus and the relational algebra A major influence on the use of logic in databases was the development of the field of logic programming Logic provides a convenient formalism for studying classical database problems and has the important property of being declarative that is it allows one to express what she wants rather than how to get it For a long time relational calculus and algebra were considered the relational database languages However there are simple operations such as computing the transitive closure of a graph which cannot be expressed with these languages Datalog is a declarative query language for relational databases based on the logic programming paradigm One of the peculiarities that distinguishes Datalog from query languages like relational algebra and calculus is recursion which gives Datalog the capability to express queries like computing a graph transitive closure Recent years have witnessed a revival of interest in Datalog in a variety of emerging application domains such as data integration information extraction networking program analysis security cloud computing ontology reasoning and many others The aim of this book is to present the basics of Datalog some of its extensions and recent applications to different domains

### **Semantics Empowered Web 3.0**

Amit Sheth,Krishnaprasad Thirunarayan,2022-05-31 After the traditional document centric Web 1 0 and user generated content focused Web 2 0 Web 3 0 has become a repository of an ever growing variety of Web resources that include data and services associated with enterprises social networks sensors cloud as well as mobile and other devices that constitute the Internet of Things These pose unprecedented challenges in terms of heterogeneity variety scale volume and continuous changes velocity as well as present corresponding opportunities if they can be exploited Just as semantics has played a critical role in dealing with data heterogeneity in the past to provide interoperability and integration it is playing an even more critical role in dealing with the challenges and helping users and applications exploit all forms of Web 3 0 data This book presents a unified approach to harness and exploit all forms of contemporary Web resources using the core principles of ability to associate meaning with data through conceptual or domain models and semantic descriptions including annotations and through advanced semantic techniques for search integration and analysis It discusses the use of Semantic Web standards and techniques when appropriate but also advocates the use of lighter weight easier to use and more scalable options when they are more suitable The authors extensive experience spanning research and prototypes to development of operational applications and commercial technologies and products guide the treatment of the material Table of Contents Role of Semantics and Metadata Types and Models of Semantics Annotation Adding Semantics to Data Semantics for Enterprise Data Semantics for Services Semantics for Sensor Data Semantics for Social Data Semantics for Cloud Computing Semantics for Advanced Applications

### **Fault-Tolerant Distributed Transactions on Blockchain**

Suyash Gupta,Jelle Hellings,Mohammad Sadoghi,2022-06-01 Since the introduction of Bitcoin the first widespread application driven by blockchain the interest of the public and private sectors in blockchain has skyrocketed In recent years blockchain based

fabrics have been used to address challenges in diverse fields such as trade food production property rights identity management aid delivery health care and fraud prevention This widespread interest follows from fundamental concepts on which blockchains are built that together embed the notion of trust upon which blockchains are built 1 Blockchains provide data transparency Data in a blockchain is stored in the form of a ledger which contains an ordered history of all the transactions This facilitates oversight and auditing 2 Blockchains ensure data integrity by using strong cryptographic primitives This guarantees that transactions accepted by the blockchain are authenticated by its issuer are immutable and cannot be repudiated by the issuer This ensures accountability 3 Blockchains are decentralized democratic and resilient They use consensus based replication to decentralize the ledger among many independent participants Thus it can operate completely decentralized and does not require trust in a single authority Additions to the chain are performed by consensus in which all participants have a democratic voice in maintaining the integrity of the blockchain Due to the usage of replication and consensus blockchains are also highly resilient to malicious attacks even when a significant portion of the participants are malicious It further increases the opportunity for fairness and equity through democratization These fundamental concepts and the technologies behind them a generic ledger based data model cryptographically ensured data integrity and consensus based replication prove to be a powerful and inspiring combination a catalyst to promote computational trust In this book we present an in depth study of blockchain unraveling its revolutionary promise to instill computational trust in society all carefully tailored to a broad audience including students researchers and practitioners We offer a comprehensive overview of theoretical limitations and practical usability of consensus protocols while examining the diverse landscape of how blockchains are manifested in their permissioned and permissionless forms

### **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

*Natural Language Data Management and Interfaces* Yunyao Li, Davood Rafiei, 2022-06-01 The volume



of natural language text data has been rapidly increasing over the past two decades due to factors such as the growth of the Web the low cost associated with publishing and the progress on the digitization of printed texts This growth combined with the proliferation of natural language systems for search and retrieving information provides tremendous opportunities for studying some of the areas where database systems and natural language processing systems overlap This book explores two interrelated and important areas of overlap 1 managing natural language data and 2 developing natural language interfaces to databases It presents relevant concepts and research questions state of the art methods related systems and research opportunities and challenges covering both areas Relevant topics discussed on natural language data management include data models data sources queries storage and indexing and transforming natural language text Under natural language interfaces it presents the anatomy of these interfaces to databases the challenges related to query understanding and query translation and relevant aspects of user interactions Each of the challenges is covered in a systematic way first starting with a quick overview of the topics followed by a comprehensive view of recent techniques that have been proposed to address the challenge along with illustrative examples It also reviews some notable systems in details in terms of how they address different challenges and their contributions Finally it discusses open challenges and opportunities for natural language management and interfaces The goal of this book is to provide an introduction to the methods problems and solutions that are used in managing natural language data and building natural language interfaces to databases It serves as a starting point for readers who are interested in pursuing additional work on these exciting topics in both academic and industrial environments

*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 be 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

**Community Search over Big Graphs** Xin Huang, Laks V.S. Lakshmanan, Jianliang Xu, 2022-05-31 Communities serve as basic structural building blocks for understanding the organization of many real world networks including social biological collaboration and communication networks Recently community search over graphs has attracted significantly increasing attention from small simple and static graphs to big evolving attributed and location based graphs In this book we first review the basic concepts of networks communities and various kinds of dense subgraph models We then survey the state of the art in community search techniques on various kinds of networks across different application areas Specifically we discuss cohesive community search

attributed community search social circle discovery and geo social group search We highlight the challenges posed by different community search problems We present their motivations principles methodologies algorithms and applications and provide a comprehensive comparison of the existing techniques This book finally concludes by listing publicly available real world datasets and useful tools for facilitating further research and by offering further readings and future directions of research in this important and growing area

**Foundations of Data Quality Management** Wenfei Fan, Floris Geerts, 2022-05-31

Data quality is one of the most important problems in data management A database system typically aims to support the creation maintenance and use of large amount of data focusing on the quantity of data However real life data are often dirty inconsistent duplicated inaccurate incomplete or stale Dirty data in a database routinely generate misleading or biased analytical results and decisions and lead to loss of revenues credibility and customers With this comes the need for data quality management In contrast to traditional data management tasks data quality management enables the detection and correction of errors in the data syntactic or semantic in order to improve the quality of the data and hence add value to business processes While data quality has been a longstanding problem for decades the prevalent use of the Web has increased the risks on an unprecedented scale of creating and propagating dirty data This monograph gives an overview of fundamental issues underlying central aspects of data quality namely data consistency data deduplication data accuracy data currency and information completeness We promote a uniform logical framework for dealing with these issues based on data quality rules The text is organized into seven chapters focusing on relational data Chapter One introduces data quality issues A conditional dependency theory is developed in Chapter Two for capturing data inconsistencies It is followed by practical techniques in Chapter 2b for discovering conditional dependencies and for detecting inconsistencies and repairing data based on conditional dependencies Matching dependencies are introduced in Chapter Three as matching rules for data deduplication A theory of relative information completeness is studied in Chapter Four revising the classical Closed World Assumption and the Open World Assumption to characterize incomplete information in the real world A data currency model is presented in Chapter Five to identify the current values of entities in a database and to answer queries with the current values in the absence of reliable timestamps Finally interactions between these data quality issues are explored in Chapter Six Important theoretical results and practical algorithms are covered but formal proofs are omitted The bibliographical notes contain pointers to papers in which the results were presented and proven as well as references to materials for further reading This text is intended for a seminar course at the graduate level It is also to serve as a useful resource for researchers and practitioners who are interested in the study of data quality The fundamental research on data quality draws on several areas including mathematical logic computational complexity and database theory It has raised as many questions as it has answered and is a rich source of questions and vitality

Table of Contents Data Quality An Overview Conditional Dependencies Cleaning Data with Conditional Dependencies Data Deduplication Information Completeness Data Currency

Interactions between Data Quality Issues      **Big Data Integration** Xin Luna Dong, Divesh Srivastava, 2022-05-31 The big data era is upon us data are being generated analyzed and used at an unprecedented scale and data driven decision making is sweeping through all aspects of society Since the value of data explodes when it can be linked and fused with other data addressing the big data integration BDI challenge is critical to realizing the promise of big data BDI differs from traditional data integration along the dimensions of volume velocity variety and veracity First not only can data sources contain a huge volume of data but also the number of data sources is now in the millions Second because of the rate at which newly collected data are made available many of the data sources are very dynamic and the number of data sources is also rapidly exploding Third data sources are extremely heterogeneous in their structure and content exhibiting considerable variety even for substantially similar entities Fourth the data sources are of widely differing qualities with significant differences in the coverage accuracy and timeliness of data provided This book explores the progress that has been made by the data integration community on the topics of schema alignment record linkage and data fusion in addressing these novel challenges faced by big data integration Each of these topics is covered in a systematic way first starting with a quick tour of the topic in the context of traditional data integration followed by a detailed example driven exposition of recent innovative techniques that have been proposed to address the BDI challenges of volume velocity variety and veracity Finally it presents merging topics and opportunities that are specific to BDI identifying promising directions for the data integration community

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

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