

Full-Text (Substring) Indexes in External Memory

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SYNTHESIS LECTURES ON DATA MANAGEMENT

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Full-Text (Substring) Indexes in External Memory Marina Barsky, Alex Thomo, Ulrike Stege, 2022-05-31 Nowadays textual databases are among the most rapidly growing collections of data Some of these collections contain a new type of data that differs from classical numerical or textual data These are long sequences of symbols not divided into well separated small tokens words The most prominent among such collections are databases of biological sequences which are experiencing today an unprecedented growth rate Starting in 2008 the 1000 Genomes Project has been launched with the ultimate goal of collecting sequences of additional 1 500 Human genomes 500 each of European African and East Asian origin This will produce an extensive catalog of Human genetic variations The size of just the raw sequences in this catalog would be about 5 terabytes Querying strings without well separated tokens poses a different set of challenges typically addressed by building full text indexes which provide effective structures to index all the substrings of the given strings Since full text indexes occupy more space than the raw data it is often necessary to use disk space for their construction However until recently the construction of full text indexes in secondary storage was considered impractical due to excessive I O costs Despite this algorithms developed in the last decade demonstrated that efficient external construction of full text indexes is indeed possible This book is about large scale construction and usage of full text indexes We focus mainly on suffix trees and show efficient algorithms that can convert suffix trees to other kinds of full text indexes and vice versa There are four parts in this book They are a mix of string searching theory with the reality of external memory constraints The first part introduces general concepts of full text indexes and shows the relationships between them The second part presents the first series of external memory construction algorithms that can handle the construction of full text indexes for moderately large strings in the order of few gigabytes. The third part presents algorithms that scale for very large strings. The final part examines queries that can be facilitated by disk resident full text indexes Table of Contents Structures for Indexing Substrings External Construction of Suffix Trees Scaling Up When the Input Exceeds the Main Memory Queries for Disk based Indexes Conclusions and Open Problems Non-Volatile Memory Database Management Systems Joy Arulraj, Andrew Pavlo, 2022-06-01 This book explores the implications of non volatile memory NVM for database management systems DBMSs The advent of NVM will fundamentally change the dichotomy between volatile memory and durable storage in DBMSs These new NVM devices are almost as fast as volatile memory but all writes to them are persistent even after power loss Existing DBMSs are unable to take full advantage of this technology because their internal architectures are predicated on the assumption that memory is volatile With NVM many of the components of legacy DBMSs are unnecessary and will degrade the performance of data intensive applications We present the design and implementation of DBMS architectures that are explicitly tailored for NVM The book focuses on three aspects of a DBMS 1 logging and recovery 2 storage and buffer management and 3 indexing First we present a logging and recovery protocol that enables the DBMS to support near

instantaneous recovery Second we propose astorage engine architecture and buffer management policy that leverages the durability and byte addressability properties of NVM to reduce data duplication and data migration Third the book presents the design of a range index tailored for NVM that is latch free yet simple to implement All together the work described in this book illustrates that rethinking the fundamental algorithms and data structures employed in a DBMS for NVM improves performance and availability reduces operational cost and simplifies software development 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 **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 guery 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 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 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 guery 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 guery via translating to a program calling a set of database APIs the problem of implementing a guery using a collection of web services In this book we approach guery 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 gueries to programs **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 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 guery 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 guery language where the tuples of a relation share a tree structured schema for that relation and the guery language is a dialect of SQL with evaluation techniques appropriately modified to fit the richer schema **Ouerv 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 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 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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