Data Stream Management

Lukasz Golab

M. Tamer Özsu

Data Stream Management Synthesis Lectures On Data Management

Nikolaus Augsten,Michael Bohlen

Data Stream Management Synthesis Lectures On Data Management:

Data Stream Management Lukasz Golab,M. Tamer Ozsu,2010-11-11 Many applications process high volumes of streaming data among them Internet traffic analysis financial tickers and transaction log mining In general a data stream is an unbounded data set that is produced incrementally over time rather than being available in full before its processing begins In this lecture we give an overview of recent research in stream processing ranging from answering simple queries on high speed streams to loading real time data feeds into a streaming warehouse for off line analysis We will discuss two types of systems for end to end stream processing Data Stream Management Systems DSMSs and Streaming Data Warehouses SDWs A traditional database management system typically processes a stream of ad hoc queries over relatively static data In contrast a DSMS evaluates static long running queries on streaming data making a single pass over the data and using limited working memory In the first part of this lecture we will discuss research problems in DSMSs such as continuous query languages non blocking query operators that continually react to new data and continuous query optimization The second part covers SDWs which combine the real time response of a DSMS by loading new data as soon as they arrive with a data warehouse s ability to manage Terabytes of historical data on secondary storage Table of Contents Introduction Data Stream Management Systems Streaming Data Warehouses Conclusions **Data Stream Management** Lukasz Golab,M. Tamer Ozsu,2022-06-01 Many applications process high volumes of streaming data among them Internet traffic analysis financial tickers and transaction log mining In general a data stream is an unbounded data set that is produced incrementally over time rather than being available in full before its processing begins In this lecture we give an overview of recent research in stream processing ranging from answering simple queries on high speed streams to loading real time data feeds into a streaming warehouse for off line analysis We will discuss two types of systems for end to end stream processing Data Stream Management Systems DSMSs and Streaming Data Warehouses SDWs A traditional database management system typically processes a stream of ad hoc queries over relatively static data In contrast a DSMS evaluates static long running queries on streaming data making a single pass over the data and using limited working memory In the first part of this lecture we will discuss research problems in DSMSs such as continuous query languages non blocking query operators that continually react to new data and continuous query optimization The second part covers SDWs which combine the real time response of a DSMS by loading new data as soon as they arrive with a data warehouse s ability to manage Terabytes of historical data on secondary storage Table of Contents Introduction Data Stream Management Systems Streaming Data Warehouses Conclusions *Fundamentals of Object Databases* Suzanne Dietrich,Susan Urban,2022-05-31 Object oriented databases were originally developed as an alternative to relational database technology for the representation storage and access of non traditional data forms that were increasingly found in advanced applications of database technology After much debate regarding object oriented versus relational database technology object oriented extensions were eventually

incorporated into relational technology to create object relational databases Both object oriented databases and object relational databases collectively known as object databases provide inherent support for object features such as object identity classes inheritance hierarchies and associations between classes using object references This monograph presents the fundamentals of object databases with a specific focus on conceptual modeling of object database designs After an introduction to the fundamental concepts of object oriented data the monograph provides a review of object oriented conceptual modeling techniques using side by side Enhanced Entity Relationship diagrams and Unified Modeling Language conceptual class diagrams that feature class hierarchies with specialization constraints and object associations These object oriented conceptual models provide the basis for introducing case studies that illustrate the use of object features within the design of object oriented and object relational databases For the object oriented database perspective the Object Data Management Group data definition language provides a portable language independent specification of an object schema together with an SQL like object query language LINQ Language INtegrated Query is presented as a case study of an object query language together with its use in the db4o open source object oriented database For the object relational perspective the object relational features of the SQL standard are presented together with an accompanying case study of the object relational features of Oracle For completeness of coverage an appendix provides a mapping of object oriented conceptual designs to the relational model and its associated constraints Table of Contents List of Figures List of Tables Introduction to Object Databases Object Oriented Databases Object Relational Databases   Advanced Metasearch Engine Technology Weiyi Meng,Clement Yu,2022-05-31 Among the search tools currently on the Web search engines are the most well known thanks to the popularity of major search engines such as Google and Yahoo While extremely successful these major search engines do have serious limitations This book introduces large scale metasearch engine technology which has the potential to overcome the limitations of the major search engines Essentially a metasearch engine is a search system that supports unified access to multiple existing search engines by passing the queries it receives to its component search engines and aggregating the returned results into a single ranked list A large scale metasearch engine has thousands or more component search engines While metasearch engines were initially motivated by their ability to combine the search coverage of multiple search engines there are also other benefits such as the potential to obtain better and fresher results and to reach the Deep Web The following major components of large scale metasearch engines will be discussed in detail in this book search engine selection search engine incorporation and result merging Highly scalable and automated solutions for these components are emphasized The authors make a strong case for the viability of the large scale metasearch engine technology as a competitive technology for Web search Table of Contents Introduction Metasearch Engine Architecture Search Engine Selection Search Engine Incorporation Result Merging Summary and Future Research   **Data Management in the Cloud** Divyakant Agrawal,Sudipto Das,Amr El Abbadi,2022-05-31 Cloud computing has emerged as a successful paradigm of service

oriented computing and has revolutionized the way computing infrastructure is used This success has seen a proliferation in the number of applications that are being deployed in various cloud platforms There has also been an increase in the scale of the data generated as well as consumed by such applications Scalable database management systems form a critical part of the cloud infrastructure The attempt to address the challenges posed by the management of big data has led to a plethora of systems This book aims to clarify some of the important concepts in the design space of scalable data management in cloud computing infrastructures Some of the questions that this book aims to answer are the appropriate systems for a specific set of application requirements the research challenges in data management for the cloud and what is novel in the cloud for database researchers We also aim to address one basic question whether cloud computing poses new challenges in scalable data management or it is just a reincarnation of old problems We provide a comprehensive background study of state of the art systems for scalable data management and analysis We also identify important aspects in the design of different systems and the applicability and scope of these systems A thorough understanding of current solutions and a precise characterization of the design space are essential for clearing the cloudy skies of data management and ensuring the success of DBMSs in the cloud thus emulating the success enjoyed by relational databases in traditional enterprise settings Table of Contents Introduction Distributed Data Management Cloud Data Management Early Trends Transactions on Co located Data Transactions on Distributed Data Multi tenant Database Systems Concluding Remarks   **Database Replication** Bettina Kemme,Ricardo Jimenez-Peris,Marta Patino-Martinez,2022-05-31 Database replication is widely used for fault tolerance scalability and performance The failure of one database replica does not stop the system from working as available replicas can take over the tasks of the failed replica Scalability can be achieved by distributing the load across all replicas and adding new replicas should the load increase Finally database replication can provide fast local access even if clients are geographically distributed clients if data copies are located close to clients Despite its advantages replication is not a straightforward technique to apply and there are many hurdles to overcome At the forefront is replica control assuring that data copies remain consistent when updates occur There exist many alternatives in regard to where updates can occur and when changes are propagated to data copies how changes are applied where the replication tool is located etc A particular challenge is to combine replica control with transaction management as it requires several operations to be treated as a single logical unit and it provides atomicity consistency isolation and durability across the replicated system The book provides a categorization of replica control mechanisms presents several replica and concurrency control mechanisms in detail and discusses many of the issues that arise when such solutions need to be implemented within or on top of relational database systems Furthermore the book presents the tasks that are needed to build a fault tolerant replication solution provides an overview of load balancing strategies that allow load to be equally distributed across all replicas and introduces the concept of self provisioning that allows the replicated system to dynamically decide on the number of replicas that are

needed to handle the current load As performance evaluation is a crucial aspect when developing a replication tool the book presents an analytical model of the scalability potential of various replication solution For readers that are only interested in getting a good overview of the challenges of database replication and the general mechanisms of how to implement replication solutions we recommend to read Chapters 1 to 4 For readers that want to get a more complete picture and a discussion of advanced issues we further recommend the Chapters 5 8 9 and 10 Finally Chapters 6 and 7 are of interest for those who want get familiar with thorough algorithm design and correctness reasoning Table of Contents Overview 1 Copy Equivalence and Consistency Basic Protocols Replication Architecture The Scalability of Replication Eager Replication and 1 Copy Serializability 1 Copy Snapshot Isolation Lazy Replication Self Configuration and Elasticity Other Aspects of Replication

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 *User-Centered Data Management* Tiziana Catarci,Alan Dix,Stephen Kimani,Giuseppe

Santucci,2022-05-31 This lecture covers several core issues in user centered data management including how to design usable interfaces that suitably support database tasks and relevant approaches to visual querying information visualization and visual data mining Novel interaction paradigms e g mobile and interfaces that go beyond the visual dimension are also discussed Table of Contents Why User Centered The Early Days Visual Query Systems Beyond Querying More Advanced Applications Non Visual Interfaces Conclusions **Perspectives on Business Intelligence** Raymond T. Ng,Patricia C. Arocena,Denilson Barbosa,Giuseppe Carenini,Luiz Gomes,Stephan Jou,Anthony Leung,Evangelos Milios,Renée J. Miller,John Mylopoulos,Rachel A Pottinger,Frank Tompa,Eric Yu,2022-05-31 In the 1980s traditional Business Intelligence BI systems focused on the delivery of reports that describe the state of business activities in the past such as for questions like How did our sales perform during the last quarter A decade later there was a shift to more interactive content that presented how the business was performing at the present time answering questions like How are we doing right now Today the focus of BI users are looking into the future Given what I did before and how I am currently doing this quarter how will I do next quarter Furthermore fuelled by the demands of Big Data BI systems are going through a time of incredible change Predictive analytics high volume data unstructured data social data mobile consumable analytics and data visualization are all examples of demands and capabilities that have become critical within just the past few years and are growing at an unprecedented pace This book introduces research problems and solutions on various aspects central to next generation BI systems It begins with a chapter on an industry perspective on how BI has evolved and discusses how game changing trends have drastically reshaped the landscape of BI One of the game changers is the shift toward the consumerization of BI tools As a result for BI tools to be successfully used by business users rather than IT departments the tools need a business model rather than a data model One chapter of the book surveys four different types of business modeling However even with the existence of a business model for users to express queries the data that can meet the needs are still captured within a data model The next chapter on vivification addresses the problem of closing the gap which is often significant between the business and the data models Moreover Big Data forces BI systems to integrate and consolidate multiple and often wildly different data sources One chapter gives an overview of several integration architectures for dealing with the challenges that need to be overcome While the book so far focuses on the usual structured relational data the remaining chapters turn to unstructured data an ever increasing and important component of Big Data One chapter on information extraction describes methods for dealing with the extraction of relations from free text and the web Finally BI users need tools to visualize and interpret new and complex types of information in a way that is compelling intuitive but accurate The last chapter gives an overview of information visualization for decision support and text Advanced Data Management Lena Wiese,2015-10-29 Advanced data management has always been at the core of efficient database and information systems Recent trends like big data and cloud computing have aggravated the need for sophisticated and flexible data storage and processing solutions This book

provides a comprehensive coverage of the principles of data management developed in the last decades with a focus on data structures and query languages It treats a wealth of different data models and surveys the foundations of structuring processing storing and querying data according these models Starting off with the topic of database design it further discusses weaknesses of the relational data model and then proceeds to convey the basics of graph data tree structured XML data key value pairs and nested semi structured JSON data columnar and record oriented data as well as object oriented data The final chapters round the book off with an analysis of fragmentation replication and consistency strategies for data management in distributed databases as well as recommendations for handling polyglot persistence in multi model databases and multi database architectures While primarily geared towards students of Master level courses in Computer Science and related areas this book may also be of benefit to practitioners looking for a reference book on data modeling and query processing It provides both theoretical depth and a concise treatment of open source technologies currently on the market

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 **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 **Principles of Distributed Database Systems** M. Tamer Özsu,Patrick Valduriez,2019-12-02 The fourth edition of this classic textbook provides major updates This edition has completely new chapters on Big Data Platforms distributed storage systems MapReduce Spark data stream processing graph analytics and on NoSQL NewSQL and polystore systems It also includes an updated web data management chapter that includes RDF and semantic web discussion an integrated database integration chapter focusing both on schema integration and querying over these systems The peer to peer computing chapter has been updated with a discussion of blockchains The chapters that describe classical distributed and parallel database technology have all been updated The new edition covers the breadth and depth of the field from a modern viewpoint Graduate students as well as senior undergraduate students studying computer science and other related fields will use this book as a primary textbook Researchers working in computer science will also find this textbook useful This textbook has a companion web site that includes background information on relational database fundamentals query processing transaction management and computer networks for those who might need this background The web site also includes all the figures and presentation slides as well as solutions to exercises restricted to instructors **An Introduction to Duplicate Detection** Felix Nauman,Melanie Herschel,2022-06-01 With the ever increasing volume of data data quality problems abound Multiple yet different representations of the same real world objects in data duplicates are one of the most intriguing data quality problems The effects of such duplicates are detrimental for instance bank customers can obtain duplicate identities inventory levels are monitored incorrectly catalogs are mailed multiple times to the same household etc Automatically detecting duplicates is difficult First duplicate representations are usually not identical but slightly differ in their values Second in principle all pairs of records should be compared which is infeasible for large volumes of data This lecture examines closely the two main components to overcome these difficulties i Similarity measures are used to automatically identify duplicates when comparing two records Well chosen similarity measures improve the effectiveness of duplicate detection ii Algorithms are developed to perform on very large volumes of

data in search for duplicates Well designed algorithms improve the efficiency of duplicate detection Finally we discuss methods to evaluate the success of duplicate detection Table of Contents Data Cleansing Introduction and Motivation Problem Definition Similarity Functions Duplicate Detection Algorithms Evaluating Detection Success Conclusion and Outlook Bibliography   *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   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   *Incomplete Data and Data Dependencies in Relational Databases* Sergio Greco,Cristian Molinaro,Francesca Spezzano,2022-06-01 The chase has long been used as a central tool to analyze dependencies and their effect on queries It has been applied to different relevant problems in database theory such as query optimization query containment and equivalence dependency implication and database schema design Recent years have seen a renewed interest in the chase as an important tool in several database applications such as data exchange and integration query answering in incomplete data and many others It is well known

that the chase algorithm might be non terminating and thus in order for it to find practical applicability it is crucial to identify cases where its termination is guaranteed Another important aspect to consider when dealing with the chase is that it can introduce null values into the database thereby leading to incomplete data Thus in several scenarios where the chase is used the problem of dealing with data dependencies and incomplete data arises This book discusses fundamental issues concerning data dependencies and incomplete data with a particular focus on the chase and its applications in different database areas We report recent results about the crucial issue of identifying conditions that guarantee the chase termination Different database applications where the chase is a central tool are discussed with particular attention devoted to query answering in the presence of data dependencies and database schema design Table of Contents Introduction Relational Databases Incomplete Databases The Chase Algorithm Chase Termination Data Dependencies and Normal Forms Universal Repairs Chase and Database Applications   Data Protection from Insider Threats Elisa Bertino,2022-05-31 As data represent a key asset for today s organizations the problem of how to protect this data from theft and misuse is at the forefront of these organizations minds Even though today several data security techniques are available to protect data and computing infrastructures many such techniques such as firewalls and network security tools are unable to protect data from attacks posed by those working on an organization s inside These insiders usually have authorized access to relevant information systems making it extremely challenging to block the misuse of information while still allowing them to do their jobs This book discusses several techniques that can provide effective protection against attacks posed by people working on the inside of an organization Chapter One introduces the notion of insider threat and reports some data about data breaches due to insider threats Chapter Two covers authentication and access control techniques and Chapter Three shows how these general security techniques can be extended and used in the context of protection from insider threats Chapter Four addresses anomaly detection techniques that are used to determine anomalies in data accesses by insiders These anomalies are often indicative of potential insider data attacks and therefore play an important role in protection from these attacks Security information and event management SIEM tools and fine grained auditing are discussed in Chapter Five These tools aim at collecting analyzing and correlating in real time any information and event that may be relevant for the security of an organization As such they can be a key element in finding a solution to such undesirable insider threats Chapter Six goes on to provide a survey of techniques for separation of duty SoD SoD is an important principle that when implemented in systems and tools can strengthen data protection from malicious insiders However to date very few approaches have been proposed for implementing SoD in systems In Chapter Seven a short survey of a commercial product is presented which provides different techniques for protection from malicious users with system privileges such as a DBA in database management systems Finally in Chapter Eight the book concludes with a few remarks and additional research directions Table of Contents Introduction Authentication Access Control Anomaly Detection Security Information and Event Management and Auditing

Separation of Duty Case Study Oracle Database Vault Conclusion   **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   *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

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