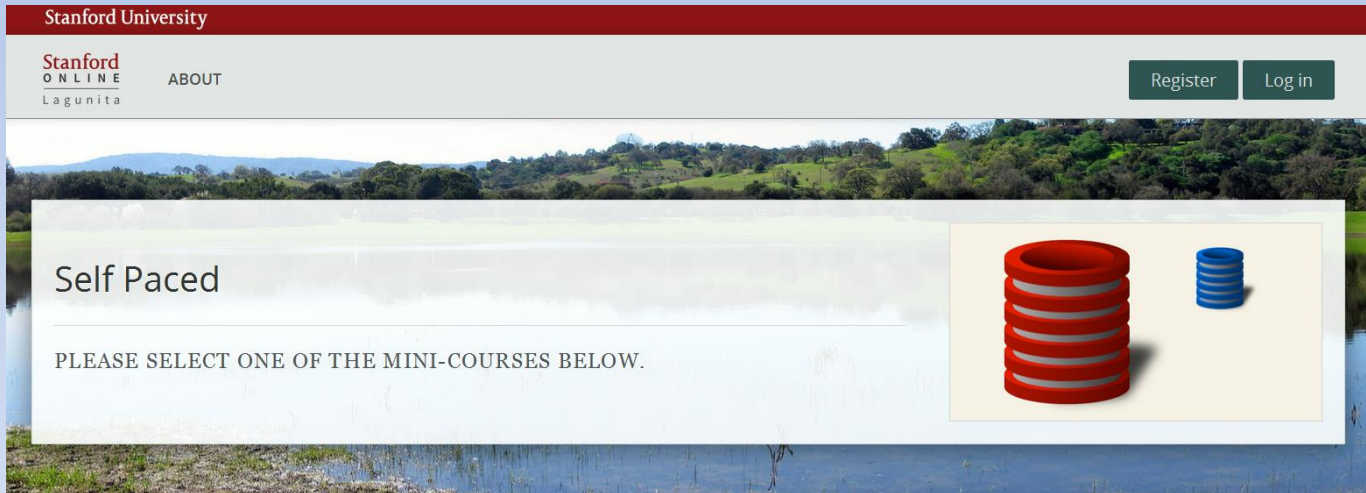


Remember: Stanford Online

- <https://lagunita.stanford.edu/courses/DB/2014/SelfPaced/about>



engineering.stanford.edu/about/dean

Dean

Jennifer Widom, Frederick Emmons Terman Dean of the School of Engineering

Jennifer Widom, a professor of computer science and of electrical engineering at Stanford University for more than two decades, became dean of the School of Engineering in March 2017.



cs.stanford.edu/people/widom/



Jennifer Widom

Frederick Emmons Terman Dean of the School of Engineering
Fletcher Jones Professor in Computer Science and Electrical Engineering

Stanford University

NEW In March 2017 I became Stanford's 10th Dean of Engineering. [News release here](#) and [new home page here](#)

NEW I spent my 2016-17 fall-winter sabbatical traveling the world offering free short-courses and workshops. [Details here](#)

NEW For an update on Stanford's MOOC offering in Databases, please visit [this page](#)

Update on Stanford's Databases MOOC

[Jennifer Widom](#)

Current Status

Stanford's free online offering in Databases is now available as a set of self-paced "mini-courses" created from the original *Introduction to Databases* course (see [History](#) below). All of the mini-courses are hosted on the [OpenEdX platform](#), with a starting page [here](#).

Recognizing that different students have different goals in learning about databases, and that many of the topics are modular and independent, in the spring of 2014 we took the original ten-week *Introduction to Databases* course and broke it into 14 mini-courses. All of the mini-courses are based around video lectures and/or video demos. Many of them include in-video quizzes, stand-alone quizzes, and/or automatically-checked interactive programming exercises. All of them are self-paced, and if a sufficiently high score is achieved, a Statement of Accomplishment is issued.

Fourteen Mini-Courses - by Area

Data Models

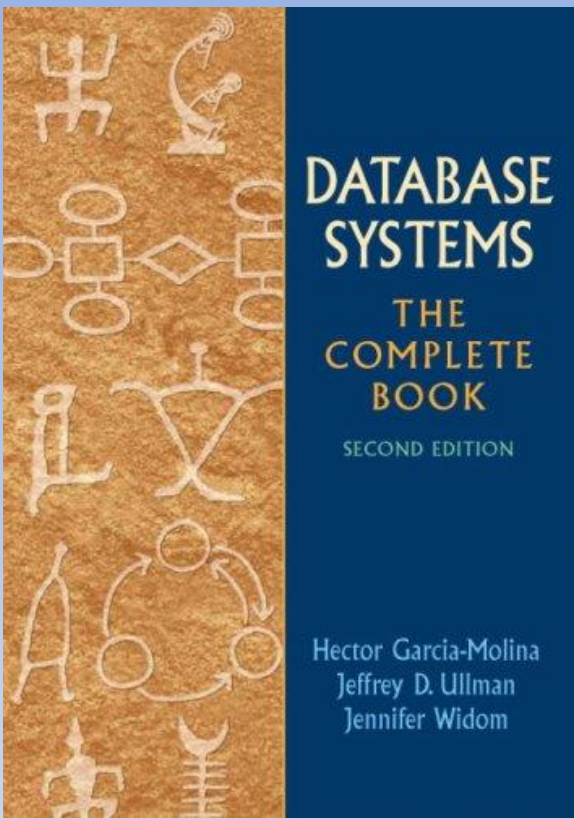
- [Introduction and Relational Databases](#)
- [XML Data](#)
- [JSON Data](#)

Querying Relational Databases

- [Relational Algebra](#)
- [SQL](#)

Querying XML Databases

- [XPath and XQuery](#)
- [XSLT](#)



Database Systems

Tonight:

- Chapter 1: Database World
 - Overview of DBMS

Overview of Database Management System

- Look at System Components
- In Memory Data Structures
- Control/Data Flow
- Data Flow Only

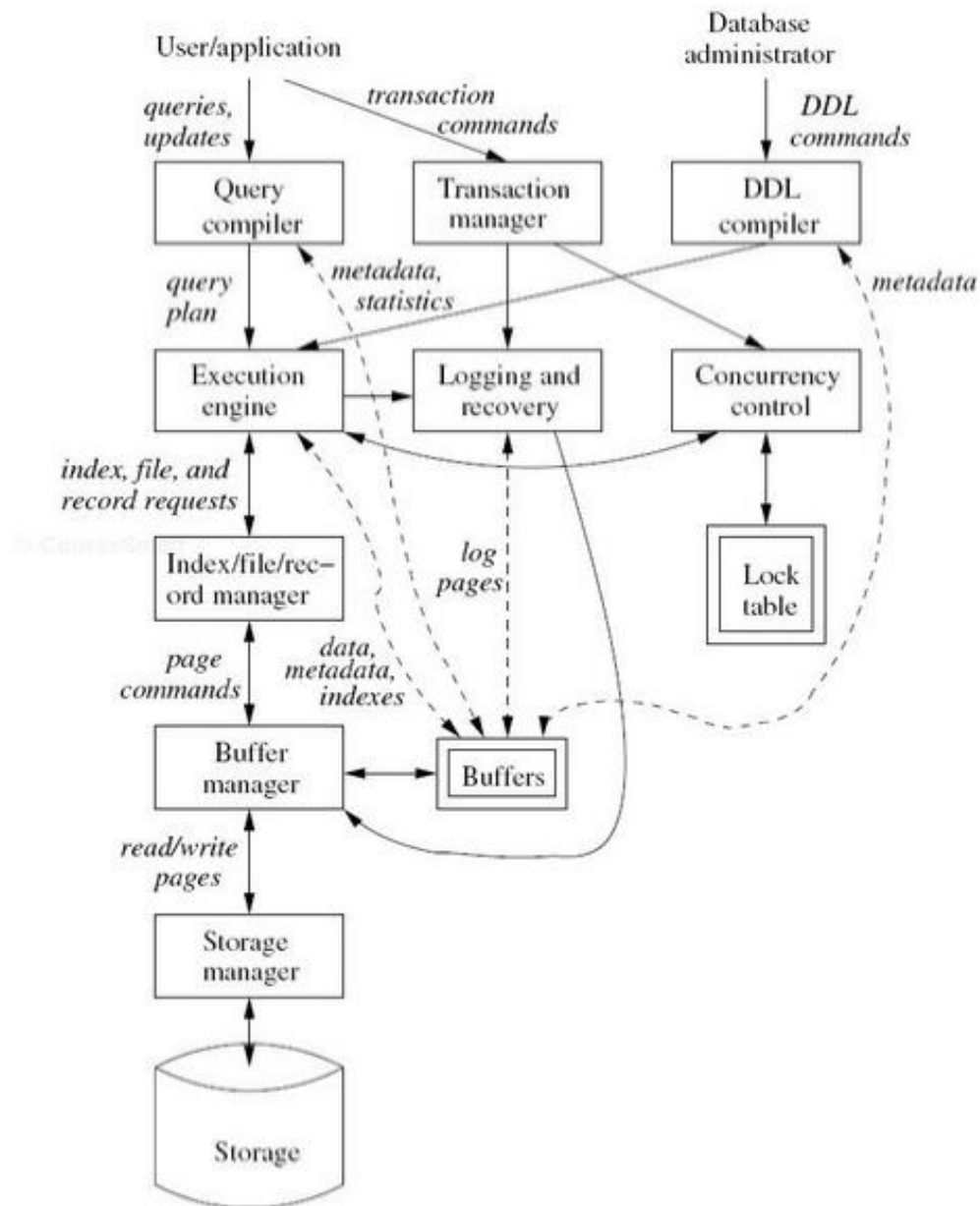
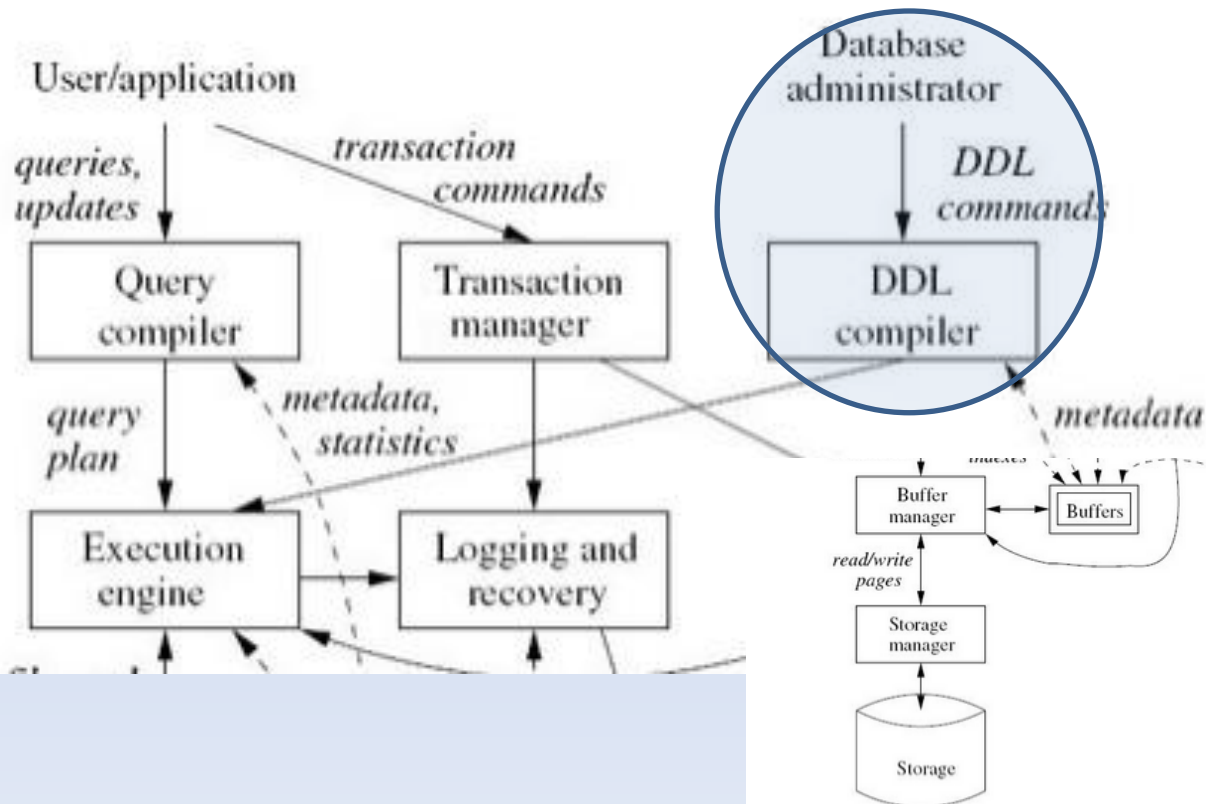


Figure 1.1: Database management system components

Data-Definition Language Commands

- These are the commands that create/change the database structure.

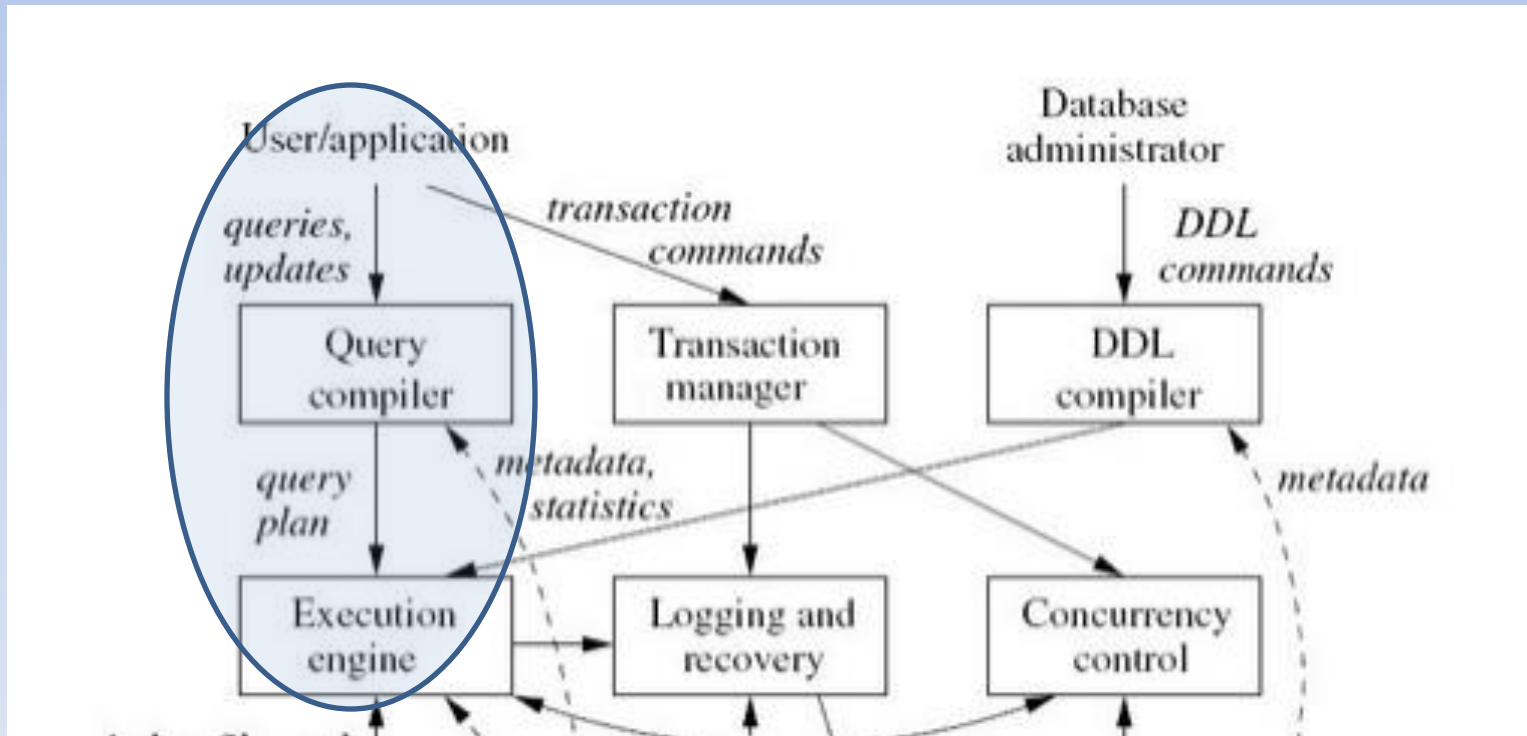


Query Processing w/ Data Manipulation Language

- Vast majority of work for DB.

Query Results

- Query Compiler generates Query Plan
- Execution Engine takes Query Plan



Query Compiler w/ Chapter 16

Chapter 16

The Query Compiler

© CourseSmart

up the architecture of the query compiler and its optimizer.
§. 15.2, there are three broad steps that the query processor

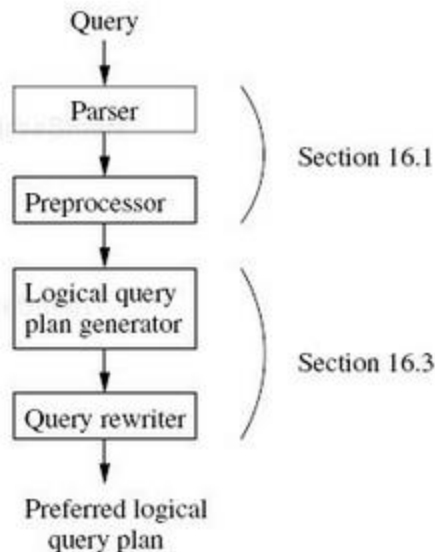


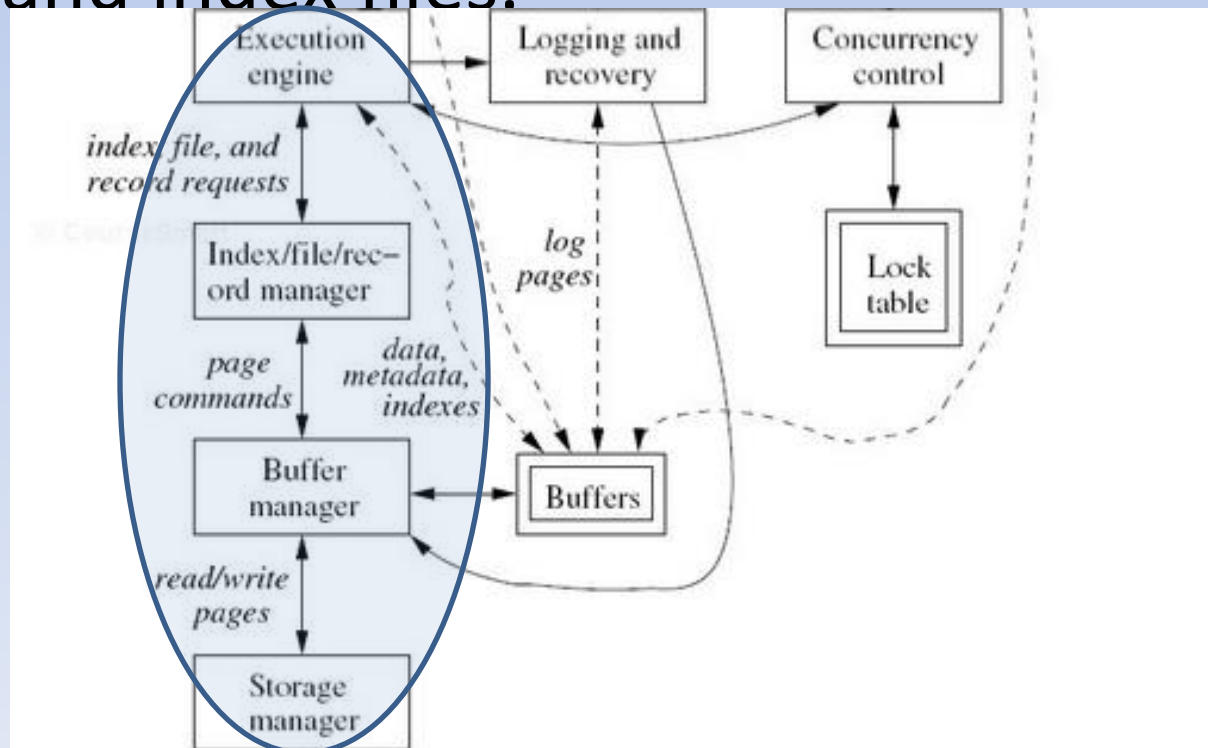
Figure 16.1: From a query to a logical query plan

Query Compiler

- Query Parser
 - Builds a tree structure from textual query
- Query Preprocessor
 - Does some checking
 - Converts parse tree into Relational Algebra Expression Tree
- Query Optimizer
 - Uses Optimization over Expression tree to generate final sequence of optimized operations on the actual data!

Query Results w/ Execution Engine

- Issues request for small pieces of information to resource manager.
- Resource manager knows about data files (tuples) and index files.



Query Execution

Chapter 15

Query Execution

15.2.1 One-Pass Algorithms for Tuple-at-a-Time Operations

The tuple-at-a-time operations $\sigma(R)$ and $\pi(R)$ have obvious algorithms, regardless of whether the relation fits in main memory. We read the blocks of R one at a time into an input buffer, perform the operation on each tuple, and move the selected tuples or the projected tuples to the output buffer, as suggested by Fig. 15.5. Since the output buffer may be an input buffer of some other operator, or may be sending data to a user or application, we do not count the output buffer as needed space. Thus, we require only that $M \geq 1$ for the input buffer, regardless of B .

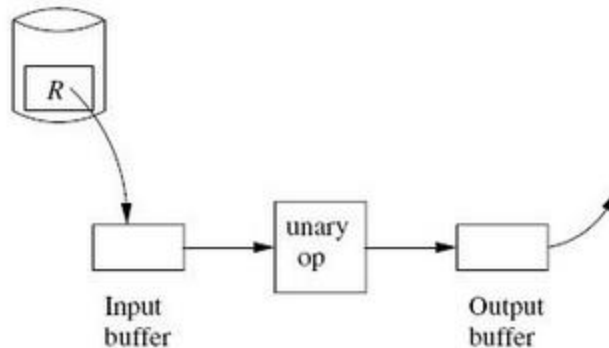


Figure 15.5: A selection or projection being performed on a relation R

Transaction Processing

- Queries and DML Operations are grouped into Transactions
- These group of operations must be executed **Atomically** and in **Isolation**
- Actions executed must also be **Durable**
- In addition **Consistency** constraints must be maintained.
- ACID Properties of Transactions

Storage Manager

- Storage manager takes care of getting data off of secondary storage and into/out of memory from secondary storage!
- Buffer Manager
 - Partitions memory into buffers
 - Transfers data between disk blocks and memory buffers

- Data:
 - Student Data
 - Movie Ratings
- Metadata:
 - Schema
 - Users
- Log Records
- Statistics
- Indexes

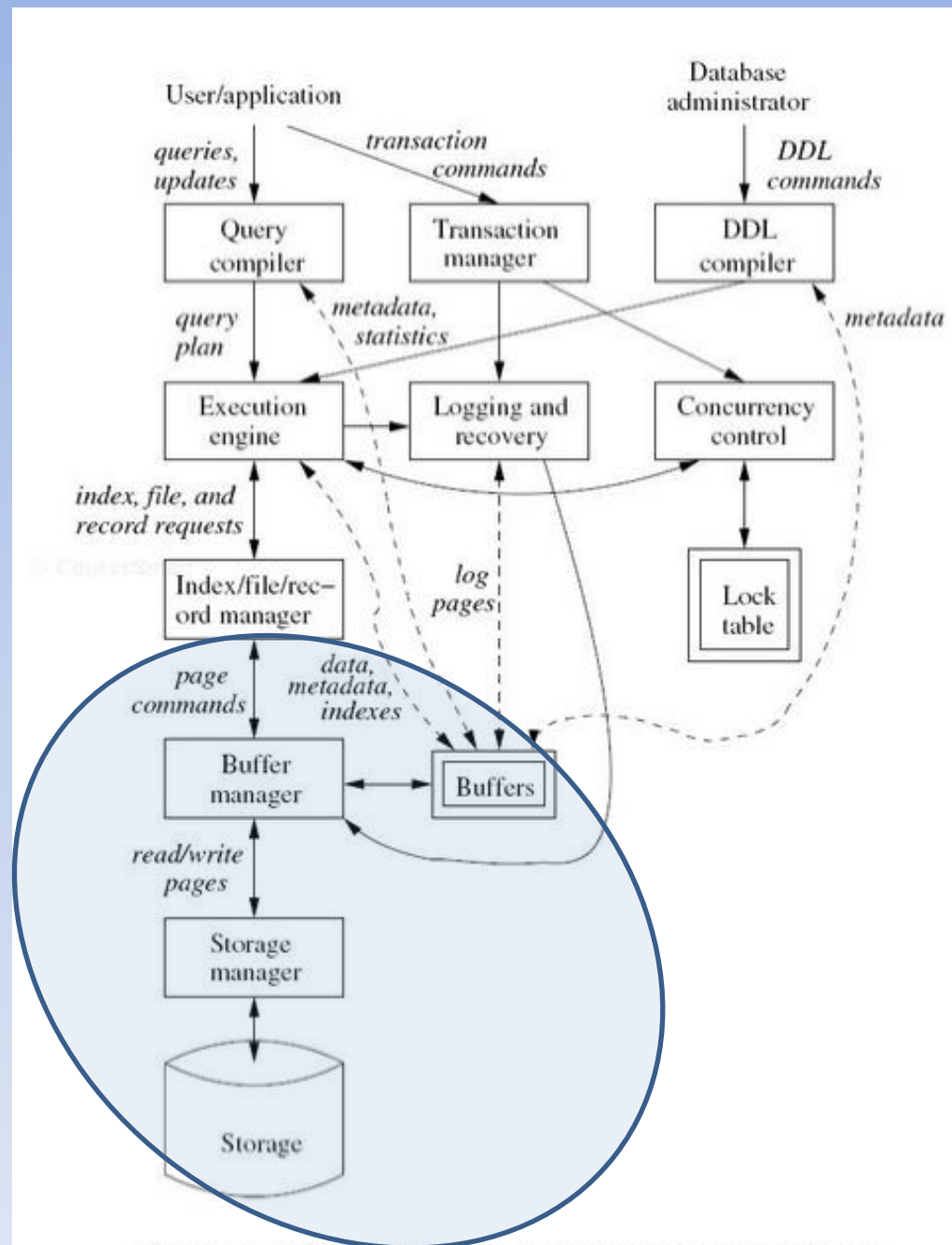
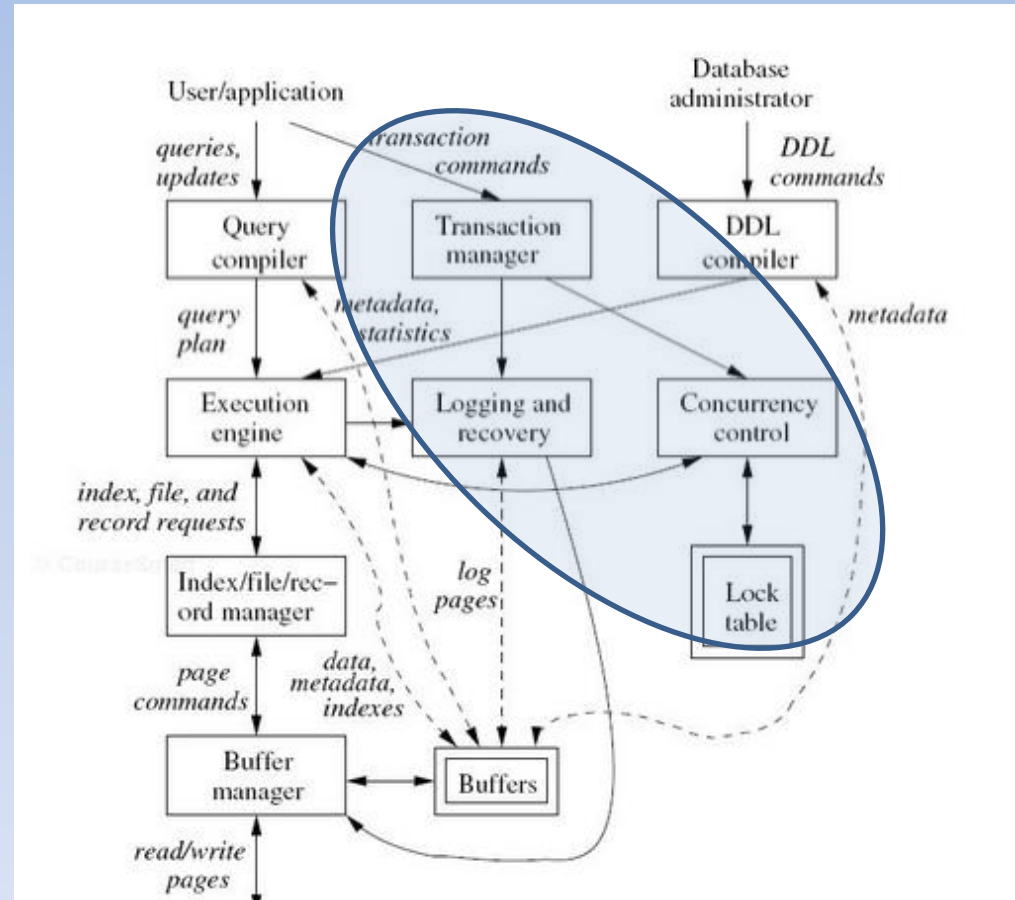


Figure 1.1: Database management system components

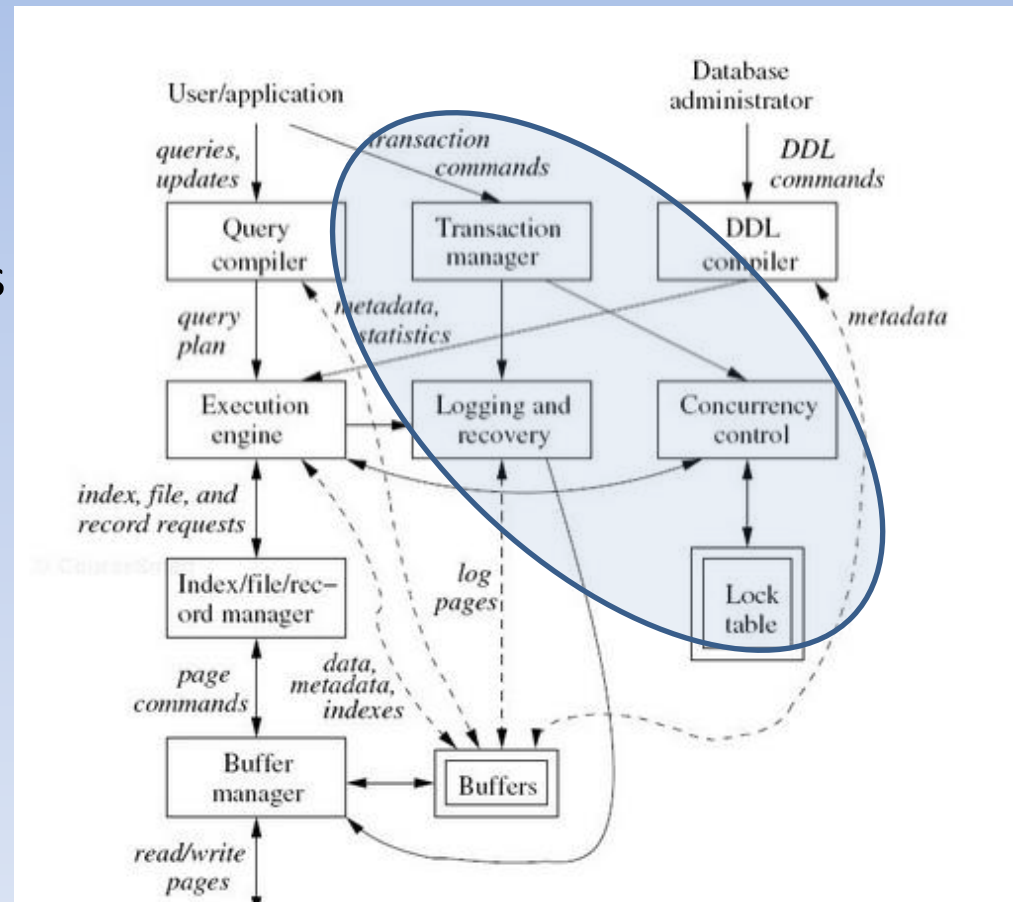
Transaction Processing

- Transaction Manager:
 - Atomicity
 - Isolation
- Logging and Recovery
 - Durability



Transaction Processing

- Logging
 - Supports durability
 - Recovery from failures.
 - Rollback from errors.
 - Recovery Manager uses logs to fix db.
- Concurrency Control
 - Insures Isolation
 - Uses Lock table
- Deadlock Resolution
 - Certain configuration create a situation where the system enters “Deadlock”
 - Recognizing deadlock, and resolving it.



Database Systems Study

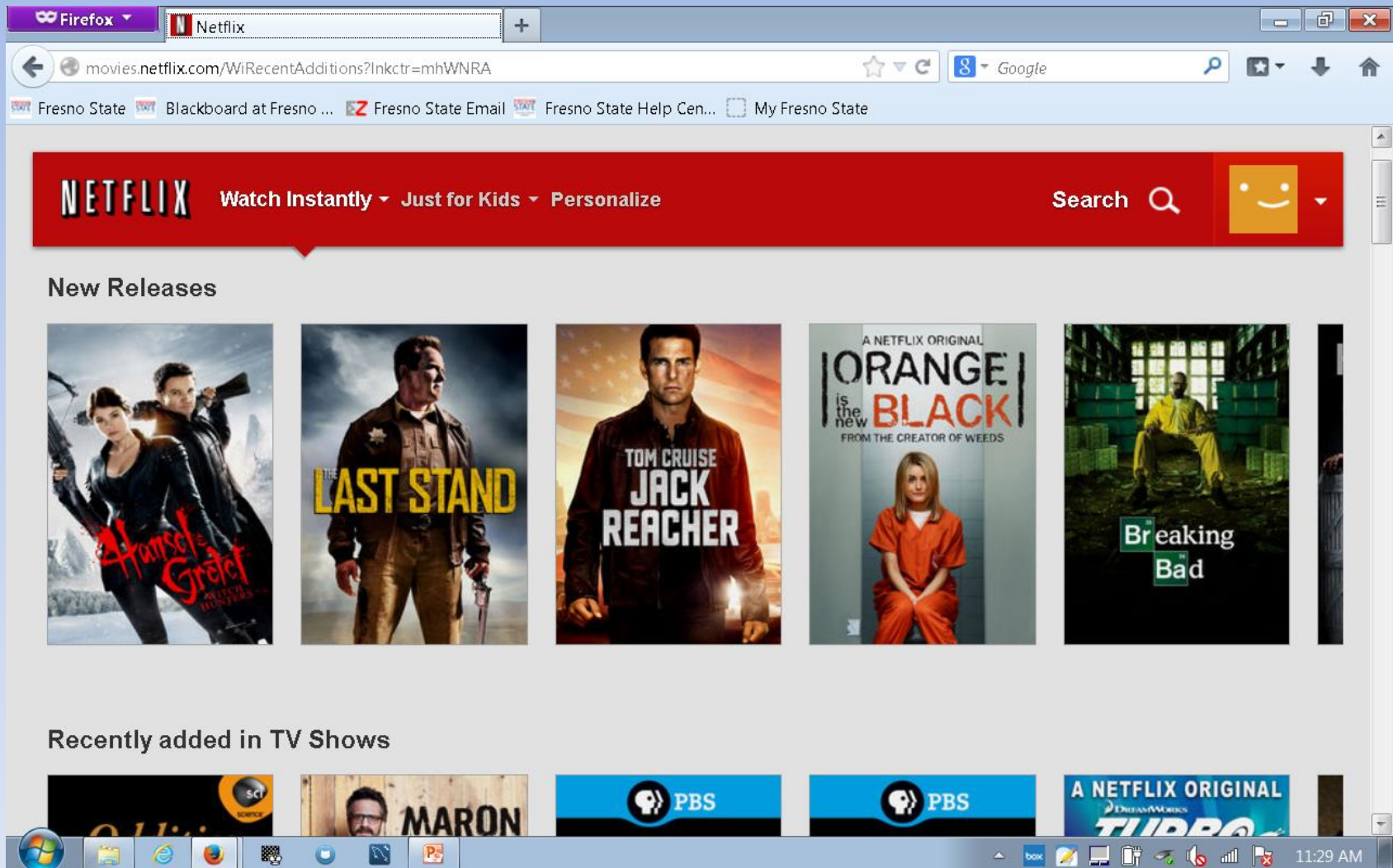
- Part III: Semi-structured Data
 - CH 11, 12
 - XML
 - JSON
- Part II: Database Programming
 - CH 5, 6, 7, 8, 9, 10
 - Relational Algebra
 - Datalog
 - SQL
- Part I: Relational Database Modeling
 - CH 2, 3, 4
 - Relational Data Model
 - Design Theory
 - E/R, UML, ODL

Database Systems Study

- Part IV: Database Systems Implementation
 - CH 13, 14, 15, 16, 17, 18, 19, 20
 - Secondary Storage
 - Index Structures
 - Query Execution, Query Compiler
 - System Failures, Concurrency Control, Transaction Management
 - Parallel and Distributed Databases
- Part V: Other Issues
 - CH 21, 22, 23
 - Information Integration
 - Data Mining
 - Database Systems and Internet

Some of My Favorite DB's

Database Example: Netflix



Netflix

- Over 40 million subscribers
- More than 75000 titles
- IMDB has 2.7 million movies
- IMDB has 5.6 million movie related personalities

Netflix / Data Mining

The screenshot shows the Netflix Prize website. At the top, the URL is www.netflixprize.com. The Netflix logo is in the top left. A large yellow banner with the text "Netflix Prize" and a "COMPLETED" stamp is across the top. Below the banner is a navigation bar with links: Home, Rules, Leaderboard, and Update. The main content area features a "Movies For You" section with a list of recommended movies. A large white box on the right side contains a "Congratulations!" message. The background of the page is dark with silhouettes of people and some code snippets.

NETFLIX

Netflix Prize

COMPLETED

Home Rules Leaderboard Update

NETFLIX

Browse Recommendations Friends Queue Buy DVDs

Home Genres New Releases Previews Netflix Top 100

Movies For You

Randy, the following movies were chosen based on your interest in watching Columbia Tristar Season 1

The Big One

You really liked it.

Now only for just \$5.99

Shed as low

Original art

OT

Light

Read More

Congratulations!

The Netflix Prize sought to substantially improve the accuracy of predictions about how much someone is going to enjoy a movie based on their movie preferences.

On September 21, 2009 we awarded the \$1M Grand Prize to team "BellKor's Pragmatic Chaos". Read about [their algorithm](#), checkout team scores on the [Leaderboard](#), and join the discussions on the [Forum](#).

We applaud all the contributors to this quest, which improves our ability to connect people to the movies they love.

Data Mining: Netflix Data

Movie Recommendations:

Netflix Challenge (excerpts)

- We're quite curious, really. To the tune of one million dollars.
- We've developed our world-class movie recommendation system: Cinematch. Its job is to predict whether someone will enjoy a movie based on how much they liked or disliked other movies.
- We use those predictions to make personal movie recommendations based on each customer's unique tastes.
- And while Cinematch is doing pretty well, it can always be made better.

Reservation Systems

- Required Data:
 - Browsing
 - Reserving
- Other opportunities w/ Data

Royal Caribbean

CRUISES

[View full cruise schedule](#)



WHERE WOULD YOU LIKE TO GO?

- | | | |
|---|---|--|
| <input checked="" type="checkbox"/> Any Destination | <input type="checkbox"/> Canada/New England | <input type="checkbox"/> Panama Canal |
| <input type="checkbox"/> Alaska | <input type="checkbox"/> Caribbean | <input type="checkbox"/> Repositioning |
| <input type="checkbox"/> Asia | <input type="checkbox"/> Dubai/Emirates | <input type="checkbox"/> South America |
| <input type="checkbox"/> Australia/New Zealand | <input type="checkbox"/> Europe | <input type="checkbox"/> Transatlantic |
| <input type="checkbox"/> Bahamas | <input type="checkbox"/> Hawaii | |
| <input type="checkbox"/> Bermuda | | |



WHEN CAN YOU CRUISE?

2014

JAN	FEB	MAR
APR	MAY	JUN
JUL	AUG	SEP
OCT	NOV	DEC

2015

JAN	FEB	MAR
APR	MAY	JUN
JUL	AUG	SEP
OCT	NOV	DEC



EXCLUSIVE SAVINGS (?)

- ☐ Age 55+
- ☐ U.S. Military or Canadian Forces
- ☐ U.S. or Canadian Law Enforcement, Fire Dept, or EMT

What state or province do you live in?

State or Province



ABOUT YOUR TRIP

Any Departure Port

Any Number of Nights

Any Price

- ☒ Include nearby departure ports
(?)

- ☐ I have a mobility or other disability and need an accessible stateroom



Cruise



Cruisetours

[Learn More](#)



DO YOU HAVE A SHIP PREFERENCE?

Quantum Class

- ☐ Quantum Of The Seas

Oasis Class

- ☐ Allure Of The Seas

Voyager Class

- ☐ Adventure Of The Seas

- ☐ Explorer Of The Seas

- ☐ Mariner Of The Seas

Vision Class

- ☐ Enchantment Of The Seas

- ☐ Grandeur Of The Seas

- ☐ Legend Of The Seas



ONBOARD ACTIVITIES

- ☐ Aquatheater

- ☐ Basketball Full-Court

- ☐ Basketball Half-Court

- ☐ Broadway Shows

- ☐ North Star

- ☐ Nursery

- ☐ Ripcord by iFly

- ☐ Rock Climbing Wall

Royal Caribbean

SAVED CRUISES

COMPLETED CRUISES

David's Information

Crown & Anchor

Member Status:

Membership # :

Level: Gold

Completed Cruise Points: 15

Your Cruise History

Enroll Other Members of Your Household

Your Reservation

You do not have any active reservations at this time.

Don't see your reservation?

COMPLETED CRUISES

Take a moment to take in your cumulative cruising adventures - you'll find your entire cruise history here. Check on your Cruise Points, see what itineraries you've traveled, and if you have any questions, you can [Contact a Crown & Anchor Representative](#).

After January 21, 2011 all cruises receive one cruise point for every night you sail.

Please allow 14 days after you return from your cruise vacation for your records to be available.

Do you see an adjustment in your results? [?](#)

Want to question a Cruise Points Value? [?](#)

Are you missing Cruise Points? [?](#)

Filter by Year:

Filter by Guest:

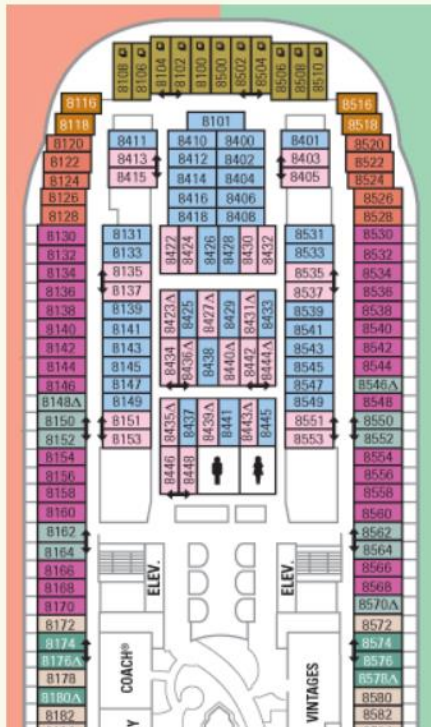
Sort By: ☐ Date Of Departure ☐ Ship ☐ Itinerary/Comments ☐ Credit Value

Guest Name	Date Of Departure	Ship Name	Itinerary/Comments	Credit Value	Reviews
David Ruby	20-Aug-2006	Freedom Of The Seas	7 Night Western Caribbean Cruise	1	Write a Review
David Ruby	20-Feb-2005	Vision Of The Seas	7 Night Mexican Riviera Cruise	1	Write a Review

2 Results

Royal Caribbean

All Deckplan Codes ▾

 **Deck Plan:**

SHOWING: ▾

D1 Your Stateroom: Superior Ocean View Stateroom with Balcony

Two twin beds that convert to a Royal King, measuring 72.5 inches wide by 82 inches long, private balcony, sitting area, and a private bathroom.
(182 sq. ft., balcony 53 sq. ft.)

- △ Stateroom with sofa bed.
- * Stateroom has third Pullman bed available.
- + Stateroom has third and fourth Pullman beds available.
- ↑ Connecting staterooms.
- ♿ Indicates accessible staterooms.

NOT READY TO BOOK?

WE'LL HOLD YOUR RESERVATION
FOR 24 HOURS FOR FREE!

BEST PRICE GUARANTEE


Royal Caribbean

David's Information

Crown & Anchor

Member Status:

Membership # :

Level: Gold

Completed Cruise Points: 15

Your Cruise History

Enroll Other Members of Your Household

Your Reservation

You do not have any active reservations at this time.

Don't see your reservation?

To compare cruises, check two or three check boxes and select the **Compare Cruises** button.

Sort By: ☒ DEALS Special Pricing ☐ Price* ☐ Number of Nights
☐ Destination ☐ Ship ☐ Departure Port

COMPARE CRUISES (3 MAX)

2 results

18 Night Transpacific Cruise

Starting from ***\$1,899.00 USD**



Honolulu

☐ ADD TO COMPARE

Ship Name: Radiance Of The Seas

Departure Port: Honolulu (Oahu), Hawaii

Ports of Call: Honolulu (Oahu), Hawaii; Moorea, French Polynesia; Papeete, Tahiti French Polynesia; Bora Bora, French Polynesia; International Dateline; Wellington, New Zealand; Picton, New Zealand; Sydney, Australia

2014 Date(s): 22 Sep

Stateroom:	Interior	Outside	Balcony	Deluxe/Suites
Prices From*:	1,899.00	2,179.00	3,159.00	12,379.00

Prices shown are current and do not reflect any previously saved Exclusive Rates for which you may qualify. [Click here](#) to include Exclusive Rates in your Advanced Search criteria.

RESERVE NOW

VIEW MORE DETAILS

REMOVE

13N Ocean Voyage on Oasis - UK & Spain

Starting from ***\$1,589.00 USD**



☐ ADD TO COMPARE

Ship Name: Oasis Of The Seas

Departure Port: Rotterdam, Netherlands

Ports of Call: Rotterdam, Netherlands; Southampton, England; Vigo, Spain; Fort Lauderdale, Florida

2014 Date(s): 14 Oct

Stateroom:	Interior	Outside	Balcony	Deluxe/Suites
Prices From*:	1,589.00	1,909.00	2,359.00	N/A

Prices shown are current and do not reflect any previously saved Exclusive Rates for which you may qualify. [Click here](#) to include Exclusive Rates in your Advanced Search criteria.

RESERVE NOW

VIEW MORE DETAILS

REMOVE

COMPARE CRUISES (3 MAX)

2 results

Royal Caribbean / Data Mining

- Which cruises were most popular last year?
- Given trends for each major cruise destination over the last 10 years, which destination should be most popular next year.
- Given the list of cruises for an individual, what is the predicted probability for their next cruise choice.
- Others????

Database Examples

- Credit Reports (Experian/TransUnion/Equifax)
- Facial Recognition (Face Print) Databases
 - Facebook, Picassa, etc...
- FBI – 12.8 Million Mugshots in new facial recognition database.
- NSA Database of cell phone calls
- New National Healthcare Website Database

NSA Database of Phone Logs

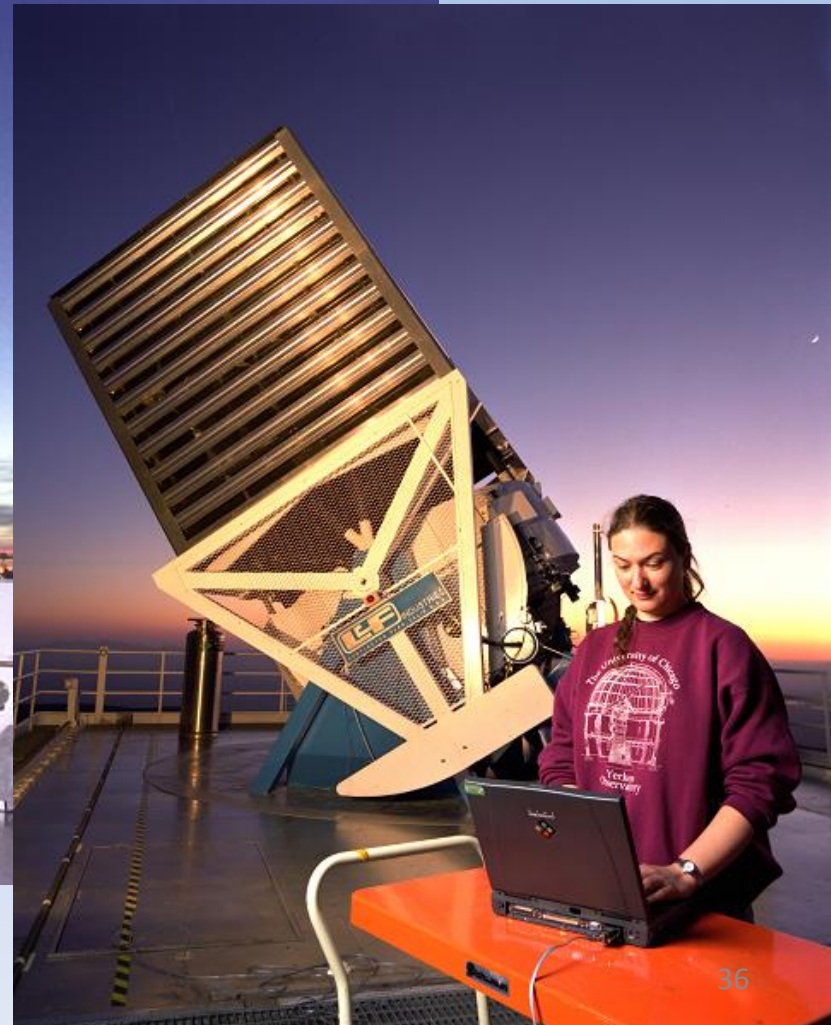
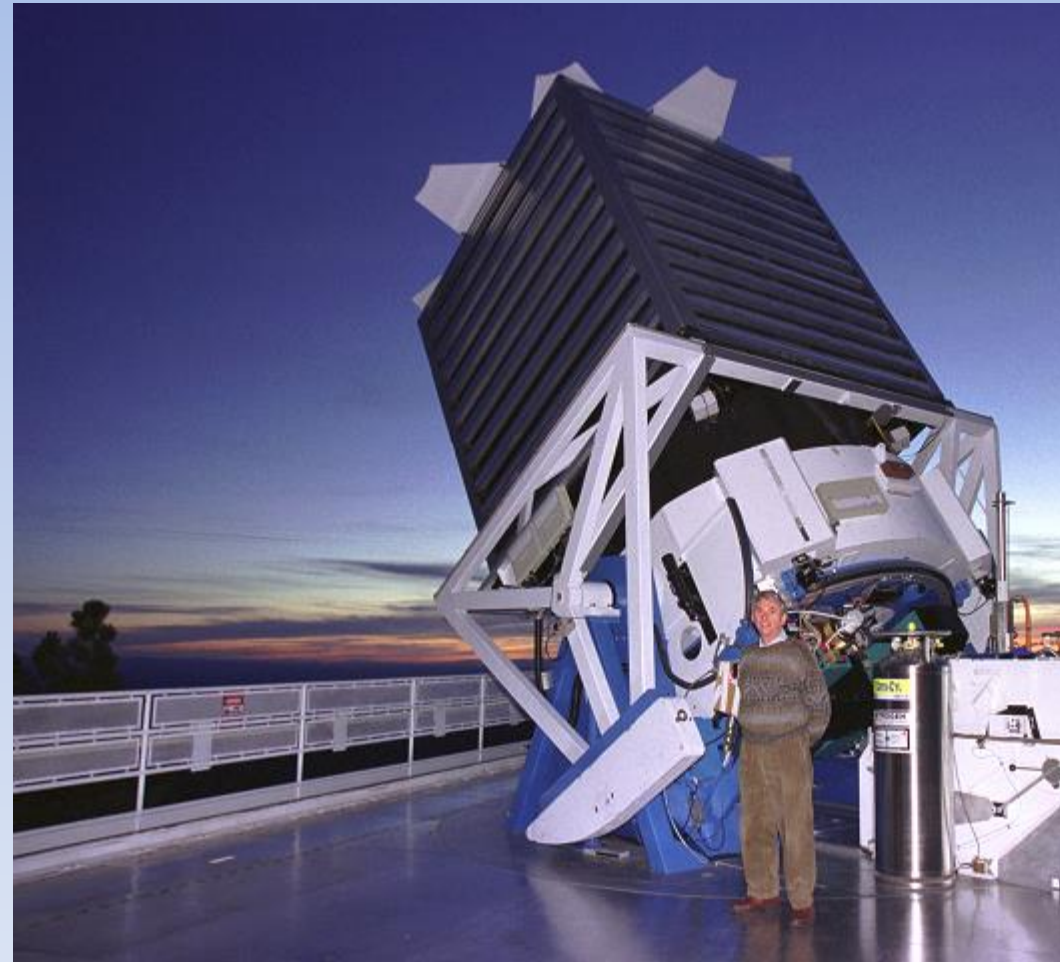
- Data Warehousing:
 - Nightly dumps of phone logs from each phone carrier in US to central warehouse
- Phone Carriers all registered

NSA Database / Data Mining

- What area in America is most likely to place a call to Switzerland?
- Given a list of calls for an individual, what is the probability they will make a call to Switzerland.
- Others????

eScience

- Sloan Digital Sky Survey:



eScience

- Sloan Digital Sky Survey:
- Dedicated 2.5-meter telescope
- A pair of spectrographs fed by optical fibers measured spectra (hence distances) of more than 600 galaxies and quasars in a single observation
- 80TB ($80 * 10^{12}$ bytes) raw image data over a 7 year period



SDSS Database

- About the Database
- <http://skyserver.sdss3.org/dr8/en/help/docs/intro.asp#sqlcl>
- Commercial Relational Database Management system (DBMS) - Microsoft's SQL Server.
- **SDSS Command Line Query Tool**

Author: Tamas Budavari, JHU

Date: April 2003, updated January 2005 (DR3) **sqlcl.py** is a (very) simple [Python](#) program that can run SQL queries against [SkyServer](#). Python runs on your favourite OS including the most exotic ones. The query goes through the same .asp page that you use in the web form or using *wget*.

- <http://skyserver.sdss3.org/dr8/en/help/download/sqlcl/default.asp>

SDSS

sqlcl.py

```
formats = ['csv','xml','html']
```

```
astro_url='http://skyserver.sdss3.org/dr8/en/tools/search/x_sql.asp'  
public_url='http://skyserver.sdss3.org/dr8/en/tools/search/x_sql.asp'
```

```
default_url=public_url  
default_fmt='csv'
```

```
def query(sql,url=default_url,fmt=default_fmt):  
    "Run query and return file object"  
    import urllib  
    fsql = filtercomment(sql)  
    params = urllib.urlencode({'cmd': fsql, 'format': fmt})  
    return urllib.urlopen(url+'?%s' % params)
```


Database Roles

- Database Administrator
- Database Systems Programmer
- Database Analyst
- Database Applications Developer
- Data Analyst
- Data Scientist

DB2 Systems Programmer

Aon Hewitt - Lincolnshire, US-IL (Greater Chicago Area)



Job Description

Aon Hewitt is the global leader in human capital consulting and outsourcing solutions. The company and related financial challenges, communicates and administers a h care, compensation and talent ntries, Aon Hewitt makes the world tion on Aon Hewitt, please visit

DB2 Analyst with Provisioning experience

Advantage Technical Resourcing - Minneapolis, MN (Greater Minneapolis-St. Paul Area)



Job Description

As one of the world's leading staffing companies, our primary objective is clear-cut: To perfectly align the best people with appropriate positions for our clients everywhere. Every day, we talk to hiring managers, HR directors, procurement managers, and senior management to learn their needs. At the same time, we're bringing in candidates and associates with a variety of skills and backgrounds, seeing how we can best put their skills to use.

Check out below this exciting DB2 Provisioning Analyst opportunity with our direct client for their Minneapolis, Minnesota location!

dded in enterprise services, boast expert global setting, possess good ly and in team settings. You also provide ing IT systems, applications, processes ses and standards. You will be part of a th Oracle 10G/11G and MS SQL Server allation, troubleshooting, performance

is or
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and
for
ve

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Key Features of the Database

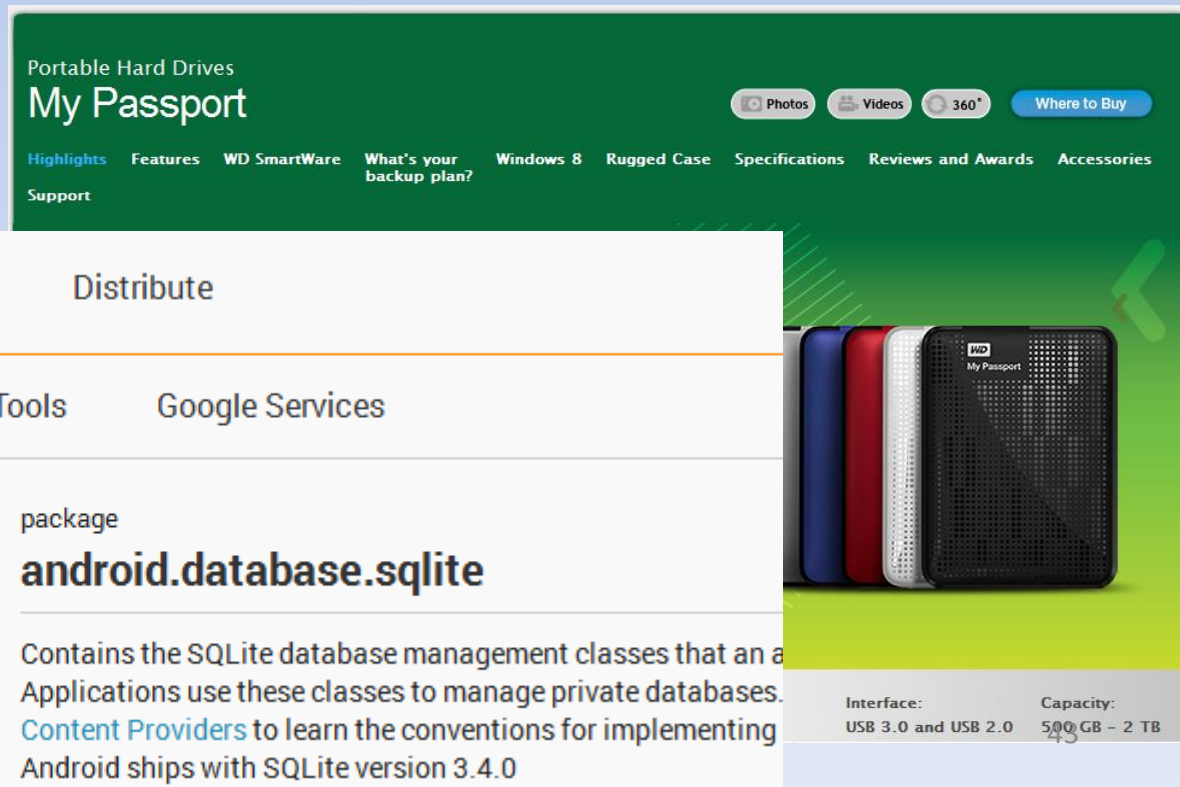
- Store large amounts of data (terabytes)
 - 1 Kilobyte = 1,000 bytes
 - 1 Megabyte = 1,000,000 bytes
 - 1 Gigabyte = 1,000 * 1 MB = 1,000,000,000 (10^9)
 - 1 Terabyte = 1000 * 1GB = 1, 000, 000, 000, 000 (10^{12})
 - 1 Petabyte = 1000 * 1TB = 1, 000,000, 000,000, 000 (10^{15})
- Durability
 - Logging
- Concurrent Users
 - Transactions

Database History

- Early History: File System - Hierarchical
- 1960's First DB's (Banking, Reservations, Corporate Records)
 - Extension of File System
 - Hierarchical
 - Programmatic - Difficulty
- 1970: TED CODD gave the world *Relations*
- Relations had powerful mathematical properties
- Relations provided Data Abstraction
- 1990's RDMS are The Norm

Database History

- Smaller & Smaller:
 - MySQL for multiple PC Platforms
 - SQLite for Android
 - Terabyte Drives for PC's



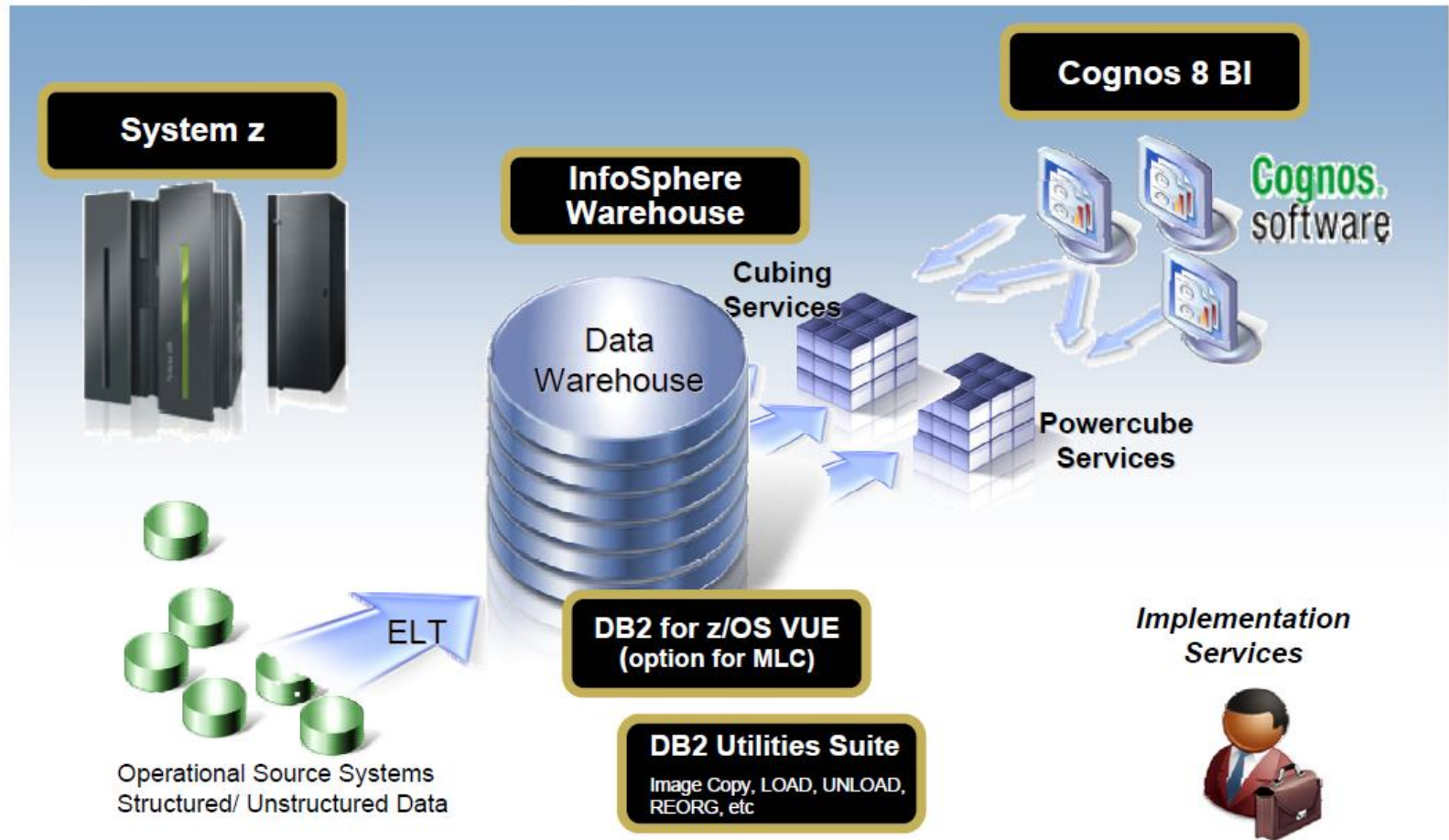
Database Future

- Bigger & Bigger
 - Google holds petabytes of data from web crawls
- Information Integration
 - Legacy Systems
 - Data Warehousing
- Parallelism:
 - Hadoop

Data Warehousing

IBM Smart Analytics System 9600

High Value Data Warehousing



Big Data

Characteristics of big data

Volume



Data at scale

Terabytes to
petabytes of data

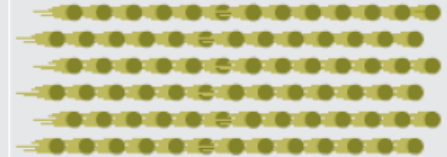
Variety



Data in many forms

Structured, unstructured,
text, multimedia

Velocity



Data in motion

Analysis of streaming data
to enable decisions within
fractions of a second

Veracity

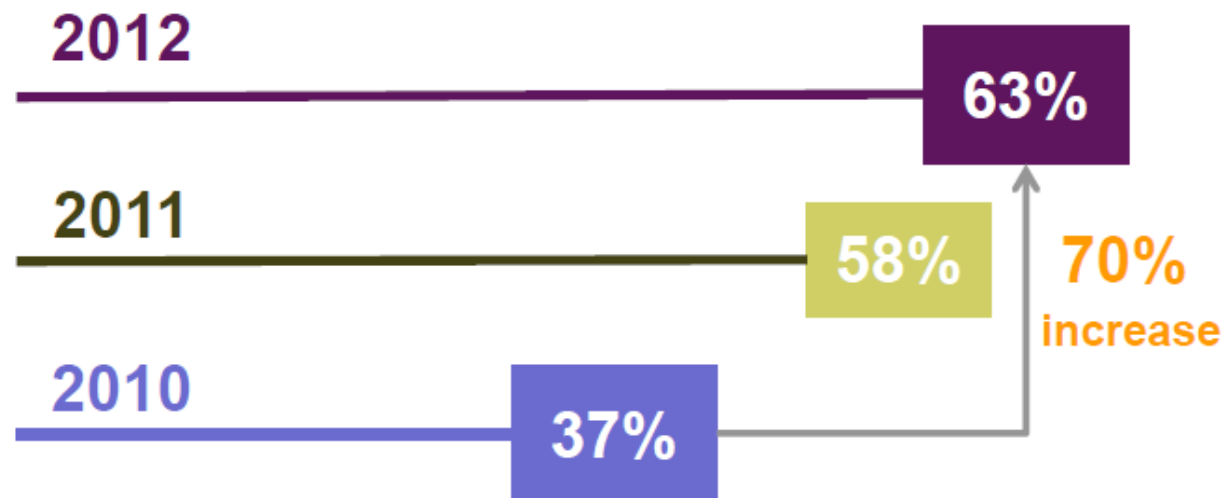


Data uncertainty

Managing the reliability and predictability
of inherently imprecise data types

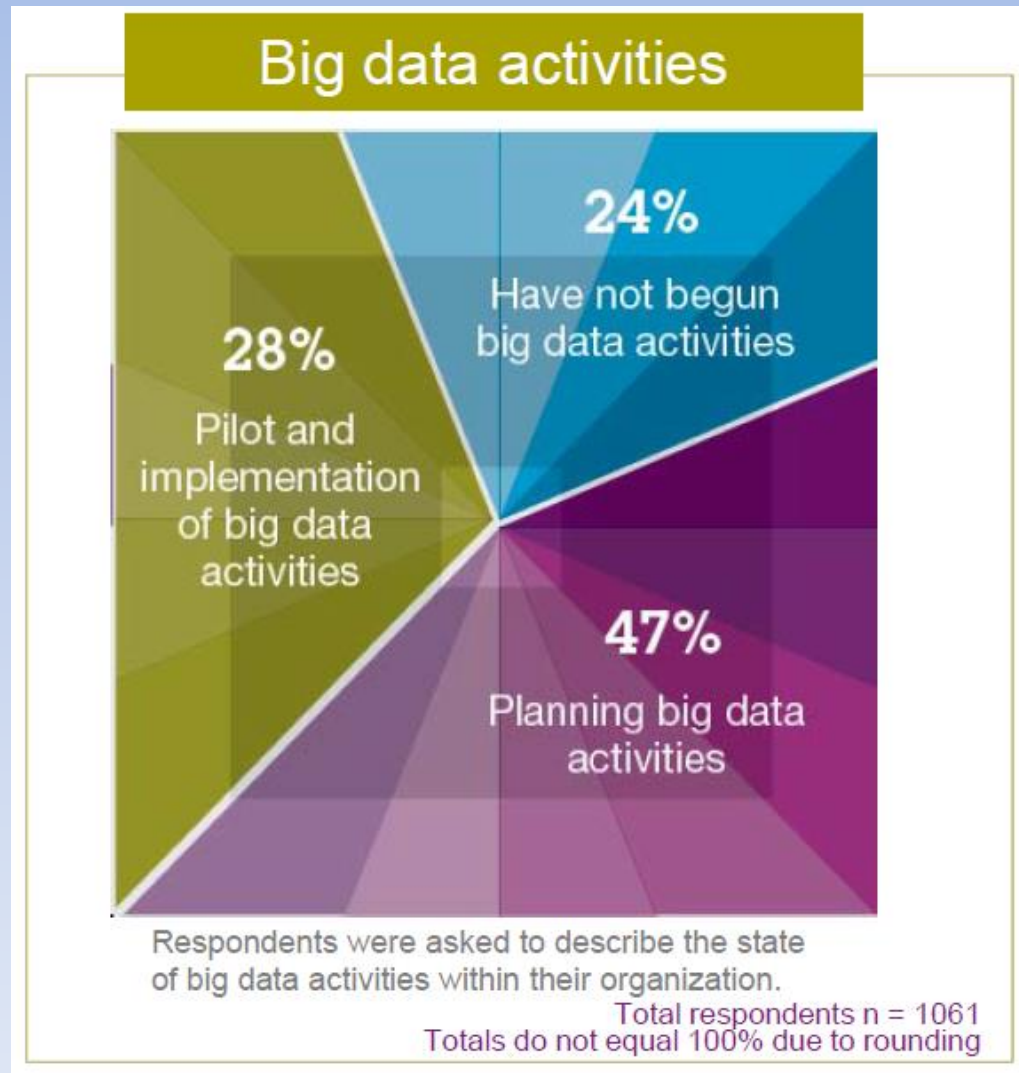
Big Data

Realizing a competitive advantage



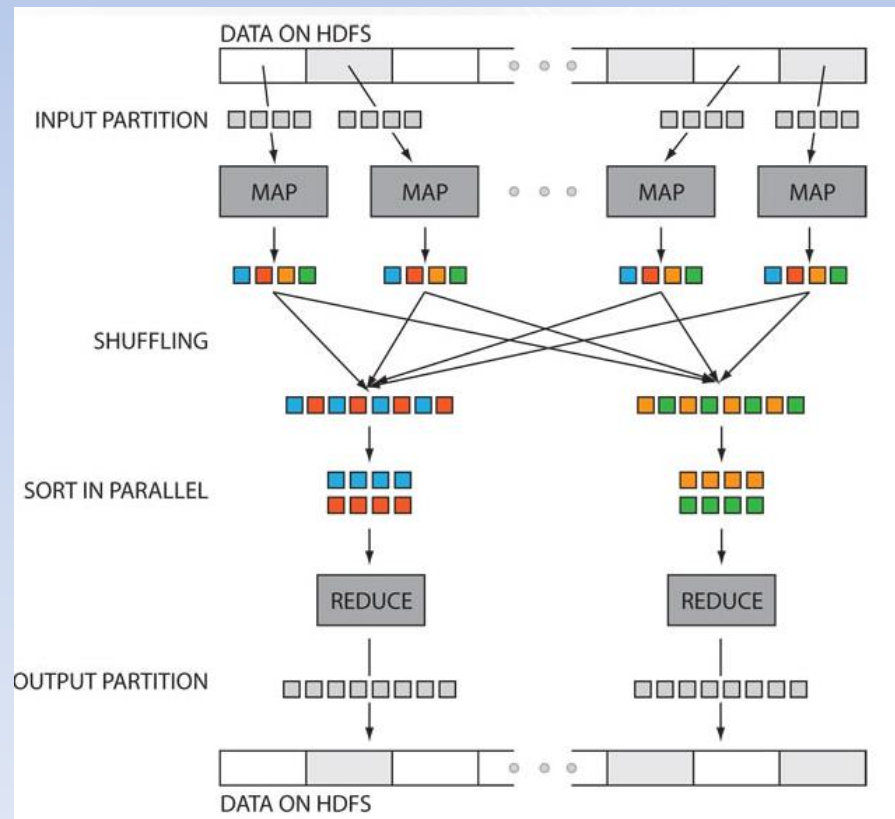
Respondents were asked "To what extent does the use of information (including big data) and analytics create a competitive advantage for your organization in your industry or market." Respondent percentages shown are for those who rated the extent a [4] or [5 Significant extent]. The same question has been asked each year.

Big Data

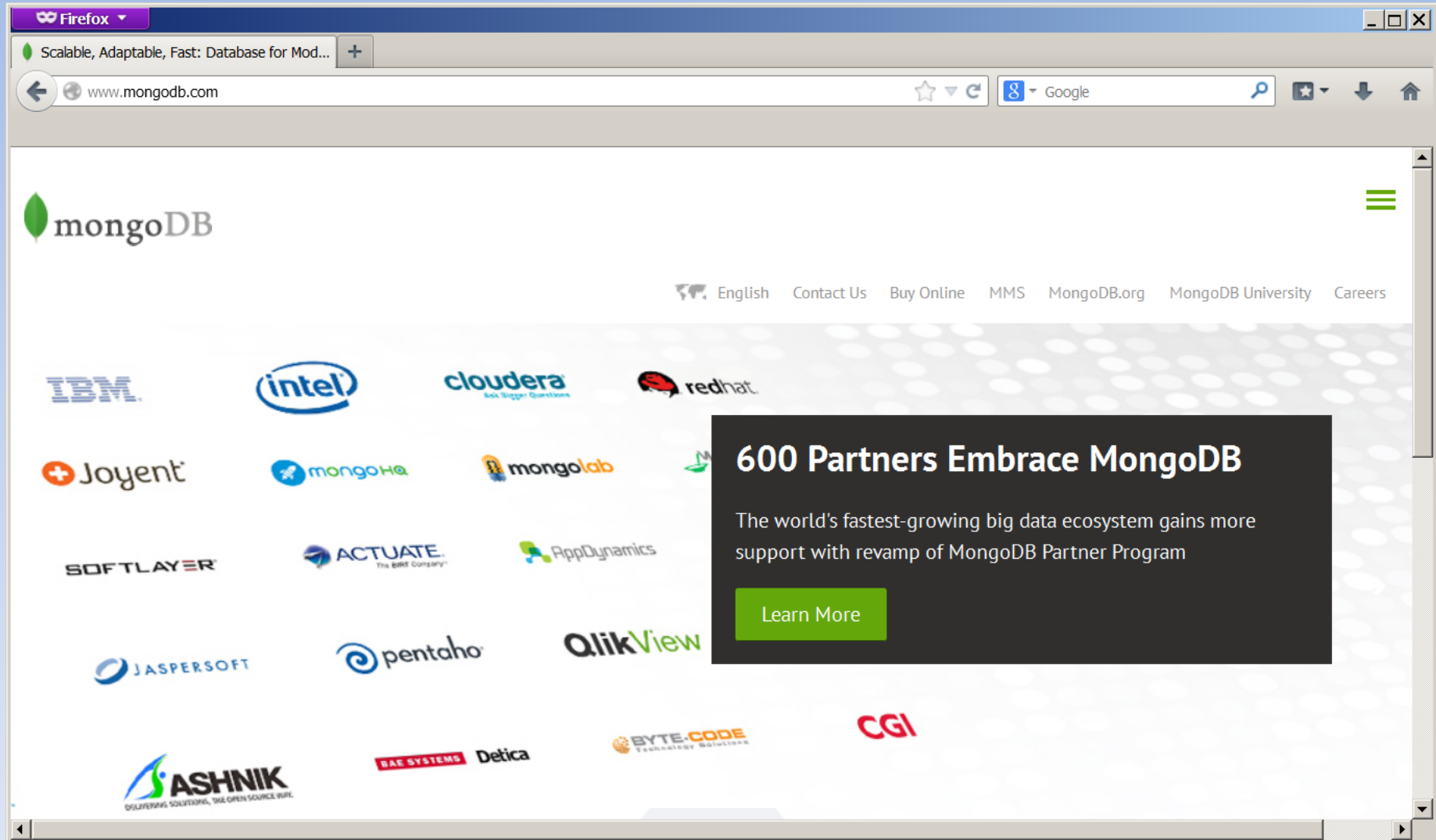


Parallelism: Hadoop

- Hadoop is both a parallel computing system and a parallel database.



MongoDB



Research

The screenshot shows a Firefox browser window with the address bar displaying `xerxes.calstate.edu/fresno/databases/subject/computer-science`. The page header features the **FRESNO STATE** logo and **Henry Madden Library** text. A navigation bar includes links for **RESEARCH**, **SERVICES**, **COLLECTIONS**, **ABOUT**, and **ASK US!**, along with a **QUICK LINKS** dropdown. The breadcrumb trail reads: [Library Home](#) > [Journal Articles & Databases](#) > [Computer Science](#).

Computer Science

Article Databases - Most Useful

ACM Digital Library ⓘ

This source provides tables of contents, abstracts for selected articles, reviews, and over 31,000 full-text articles from ACM journals, magazines, and conference proceedings since 1985. While full-text is available for most articles, full-text is not yet available for every proceedings article publ . . .

My Account

- [Log-in](#)
- [My Saved Records](#)
- [My Saved Databases](#)

Got Questions?

- [Need help? Ask us!](#)
- [Research Guides](#)



Firefox Publication: CSUR ACM Computing Surveys

csur.acm.org

ACM ACM Computing Surveys Home Editorial Board Editorial Charter Information for Authors Upcoming Issues

ACM Computing Surveys

A journal of the *Association for Computing Machinery (ACM)*, which

Top 10 Downloaded Articles (past 6 weeks) / Top 10 Most Cited Articles

1. Data clustering: a review - 1999
A. K. Jain, M. N. Murty, P. J. Flynn
Downloaded 455 times
2. Collaborative Filtering beyond the User-Item Matrix: A Survey of the State of the Art and Future Challenges - 2014
Yue Shi, Martha Larson, Alan Hanjalic
Downloaded 372 times
3. Anomaly detection: A survey - 2009
Varun Chandola, Arindam Banerjee, Vipin Kumar
Downloaded 366 times
4. Interconnected Cloud Computing Environments: Challenges, Taxonomy, and Survey - 2014
Adel Nadjaran Toosi, Rodrigo N. Calheiros, Rajkumar Buyya
Downloaded 335 times
5. Machine learning in automated text categorization - 2002
Fabrizio Sebastiani
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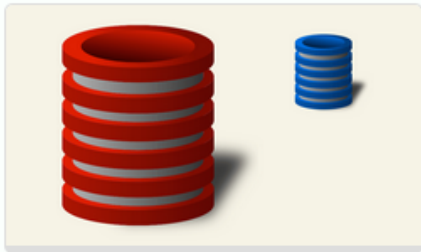
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