Database Applications and Web-Enabled Databases

University of California, Berkeley

School of Information

IS 257: Database Management

Lecture Outline

- Review
  - Database design review
  - Introduction to SQL and MySQL
- Application Development in Access
- Databases for Web Applications – Overview

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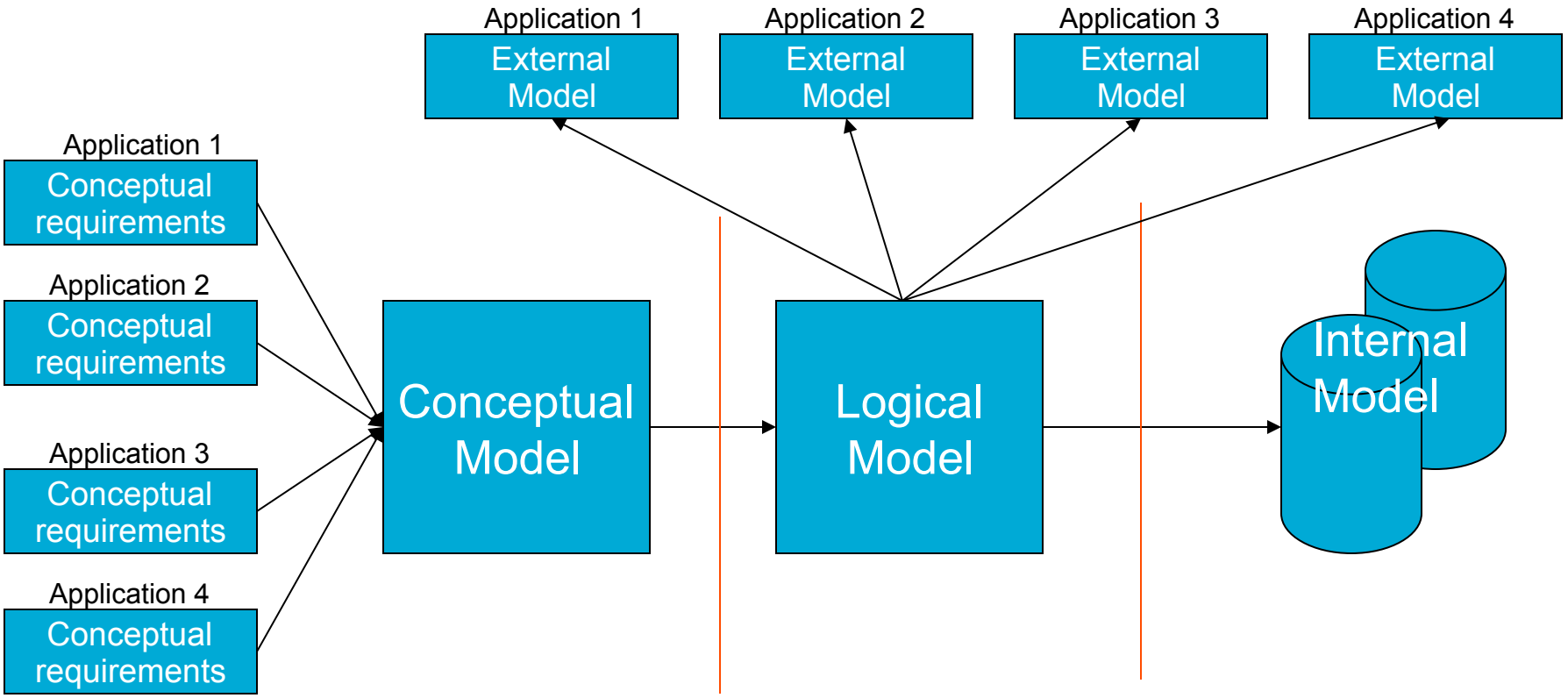
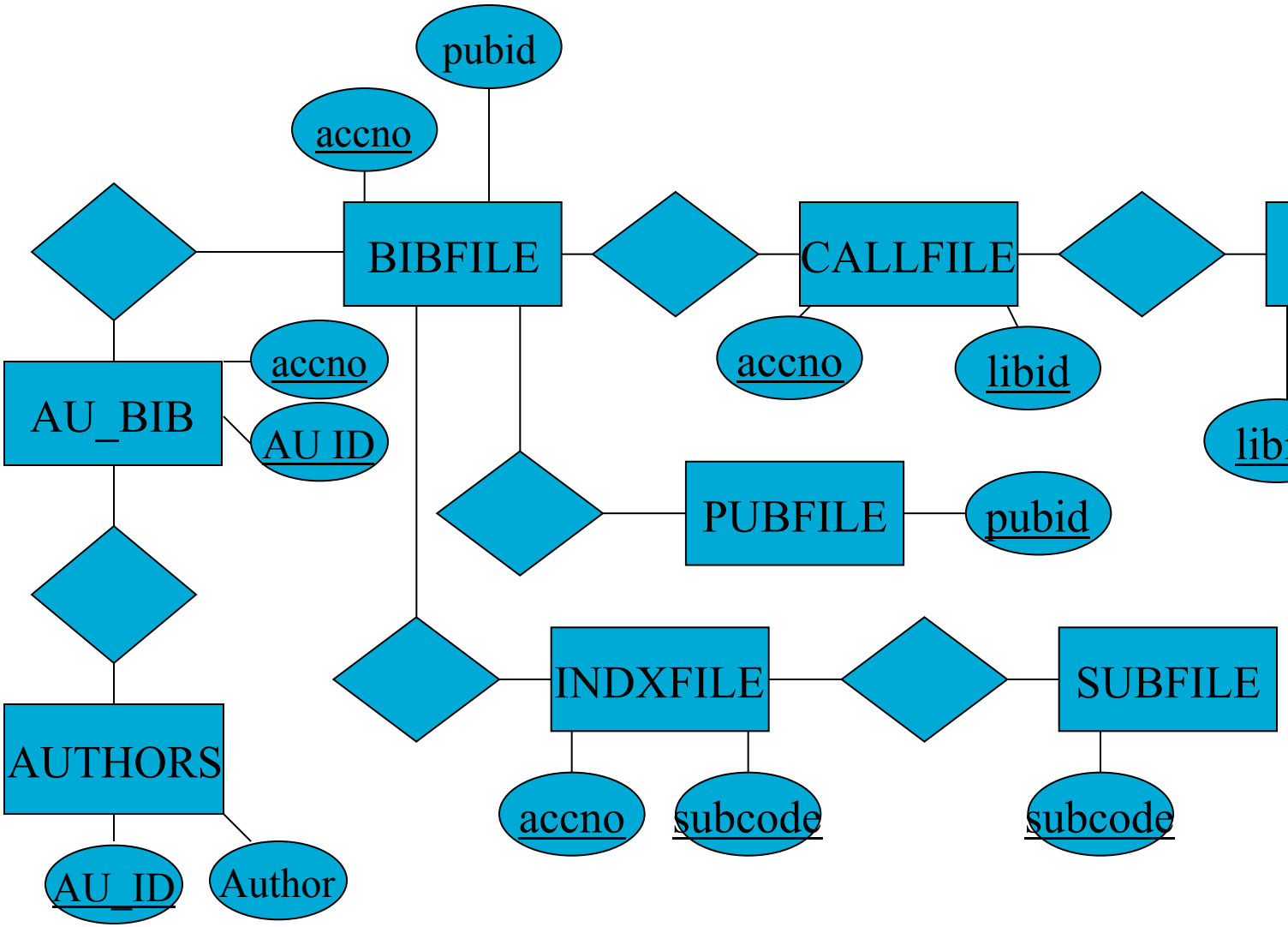
Database Design Process



Cookie ER Diagram



Note: diagram contains only attributes used for linking

Logical Model: Mapping to Relations

- Take each entity
  - Authors
  - BIBFILE
  - LIBFILE
  - CALLFILE
  - SUBFILE
  - PUBFILE
  - INDXFILE
  - AU_BIB
- And make it a table...

Physical Model: SQL for Creation

- We looked at how an SQL “script” could be created that would create each of the relational tables, define primary keys and indexes and load data into the database

MySQL Data Types

- MySQL supports all of the standard SQL numeric data types. These types include the exact numeric data types (INTEGER, SMALLINT, DECIMAL, and NUMERIC), as well as the approximate numeric data types (FLOAT, REAL, and DOUBLE PRECISION). The keyword INT is a synonym for INTEGER, and the keyword DEC is a synonym for DECIMAL
- Numeric (can also be declared as UNSIGNED)
  - BIT(n) (variable field of n bits)
  - BOOL or BOOLEAN (internally is TINYINT with value of 0 for FALSE)
  - TINYINT (1 byte)
  - SMALLINT (2 bytes)
  - MEDIUMINT (3 bytes)
  - INTEGER (4 bytes)
  - INT (4 bytes - Synonym)
  - BIGINT (8 bytes)
  - NUMERIC or DECIMAL (Packed - up to 65 digits - DEC, FIXED synonyms)
  - FLOAT
  - DOUBLE (or DOUBLE PRECISION)
  - **SERIAL** = BIGINT UNSIGNED NOT NULL AUTO_INCREMENT UNIQUE

MySQL Data Types

- The date and time types for representing temporal values are DATETIME, DATE, TIMESTAMP, TIME, and YEAR. Each temporal type has a range of legal values, as well as a "zero" value that is used when you specify an illegal value that MySQL cannot represent
  - DATETIME '0000-00-00 00:00:00'
  - DATE '0000-00-00'
  - TIMESTAMP (4.1 and up) '0000-00-00 00:00:00'
  - TIMESTAMP (before 4.1) 00000000000000
  - TIME '00:00:00'
  - YEAR 0000

MySQL Data Types

- The string types are CHAR, VARCHAR, BINARY, VARBINARY, BLOB, TEXT, ENUM, and SET
- Maximum length for CHAR is 255 and VARCHAR is **65,535** (limited by row size)

Value	CHAR(4)	Storage	VARCHAR(4)	Storage
""	" "	4	""	1
"ab"	"ab "	4	"ab"	3
"abcd"	"abcd"	4	"abcd"	5
"abcdefg"	"abcd"	4	"abcd"	5

- **For longer things there is BLOB and TEXT**

ALTER Table

- ALTER TABLE table-name ADD COLUMN col_name col_definition;
- … DROP COLUMN col_name;
- … CHANGE col_name new_col_definition;
- Adds/removes a new column from an existing database table
- Many other options for adding constraints (like NOT NULL, or PRIMARY KEY), etc.

INSERT

- INSERT INTO table-name (attr1, attr4, attr5,…, attrK) VALUES (“val1”, val4, val5,…, “valK”);
- Adds a new row(s) to a table.
- INSERT INTO table-name (attr1, attr4, attr5,…, attrK) VALUES SELECT ...

Creating a new table data from existing tables

- Syntax:
  - INSERT INTO tablename (attr1, attr2, attr3)

    SELECT [DISTINCT] xattr1, xattr2, xattr3 FROM rel1 r1, rel2 r2,… rel3 r3 WHERE condition1 {AND | OR} condition2 ORDER BY attr1 [DESC], attr3 [DESC]

tablename has to previously exist for this to work in MySQL…

DELETE

- DELETE FROM table-name WHERE <where clause>;
- Removes rows from a table.

UPDATE

- UPDATE tablename SET attr1=newval, attr2 = newval2 WHERE <where clause>;
- changes values in existing rows in a table (those that match the WHERE clause).

DROP Table

- DROP TABLE tablename;
- Removes a table from the database.

Lecture Outline

- Review
  - Introduction to SQL
- Databases for Web Applications – Overview

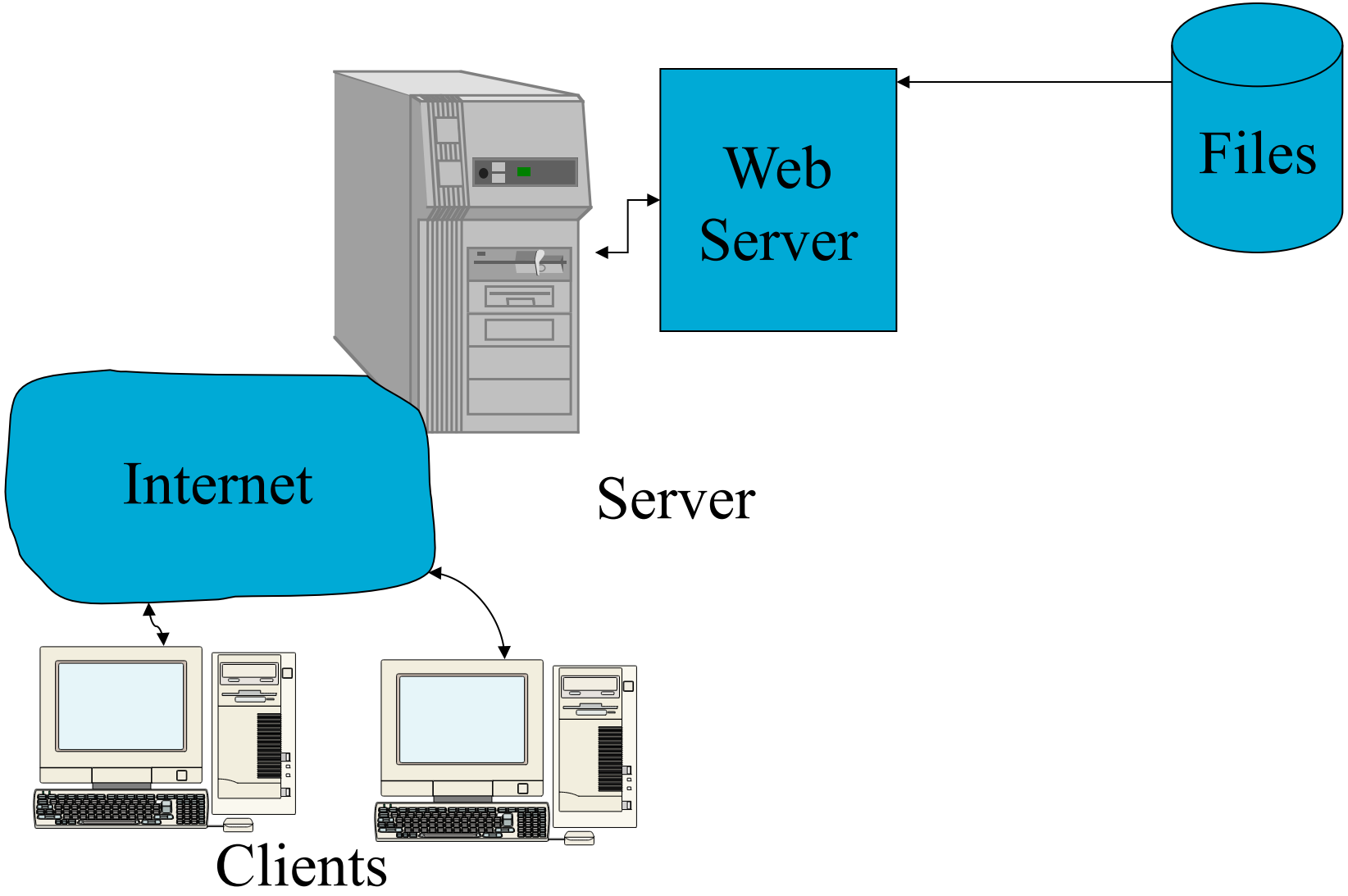
Overview

- Why use a database system for Web design and e-commerce?
- What systems are available?
- Pros and Cons of different web database systems?
- Text retrieval in database systems
- Search Engines for Intranet and Intrasite searching

Why Use a Database System?

- Simple Web sites with only a few pages don't need much more than static HTML files

Simple Web Applications



Adding Dynamic Content to the Site

- Small sites can often use HTML and JavaScript to access data files to create dynamic content for small sites.

Issues For Scaling Up Web Applications

- Performance
- Scalability
- Maintenance
- Data Integrity
- Transaction support

Performance Issues

- Problems arise as both the data to be managed and usage of the site grows.
  - Interpreted scripts are inherently slower than compiled native programs
  - Startup time for each connection slows down the application
  - Load on the system compounds the problem
  - Tied to other scalability issues

Scalability Issues

- Well-designed database systems will permit the applications to scale to accommodate very large databases
  - A script that works fine scanning a small data file may become unusable when the file becomes large.
  - Issues of transaction workload on the site
    - Starting a separate copy of a python program for each user is NOT a scalable solution as the workload grows

Maintenance Issues

- Dealing with multiple data files (customer list, product list, customer orders, etc.) using Python means:
  - If any data element in one of the files changes, all scripts that access that file must be rewritten
  - If files are linked, the programs must insure that data in all the files remains synchronized
  - A large part of maintenance will involve dealing with data integrity issues
  - Unanticipated requirements may require rewriting scripts

Data Integrity Constraint Issues

- These are constraints we wish to impose in order to protect the database from becoming inconsistent.
- Five basic types
  - Required data
  - attribute domain constraints
  - entity integrity
  - referential integrity
  - enterprise constraints

Transaction support

- Concurrency control (ensuring the validity of database updates in a shared multiuser environment).

No Concurrency Control: Lost updates

John	Marsha
• Read account balance (balance = $1000)	
	• Read account balance (balance = $1000)
• Withdraw $200 (balance = $800)	
	• Withdraw $300 (balance = $700)
• Write account balance (balance = $800)	
	• Write account balance (balance = $700)
	ERROR!

Concurrency Control: Locking

- Locking levels
  - Database
  - Table
  - Block or page
  - Record
  - Field
- Types
  - Shared (S locks)
  - Exclusive (X locks)

Concurrency Control: Updates with X locking

John	Marsha
• Lock account balance • Read account balance (balance = $1000) • Withdraw $200 (balance = $800) • Write account balance (balance = $800) • Unlock account balance	• Read account balance (DENIED) • Lock account balance • Read account balance (balance = $800) • etc...

Concurrency Control: Deadlocks

John	Marsha
• Place S lock	
• Read account balance (balance = $1000)	• Place S lock
	• Read account balance (balance = $1000)
• Request X lock (denied)	
• wait ...	• Request X lock (denied)
	• wait...

Deadlock!

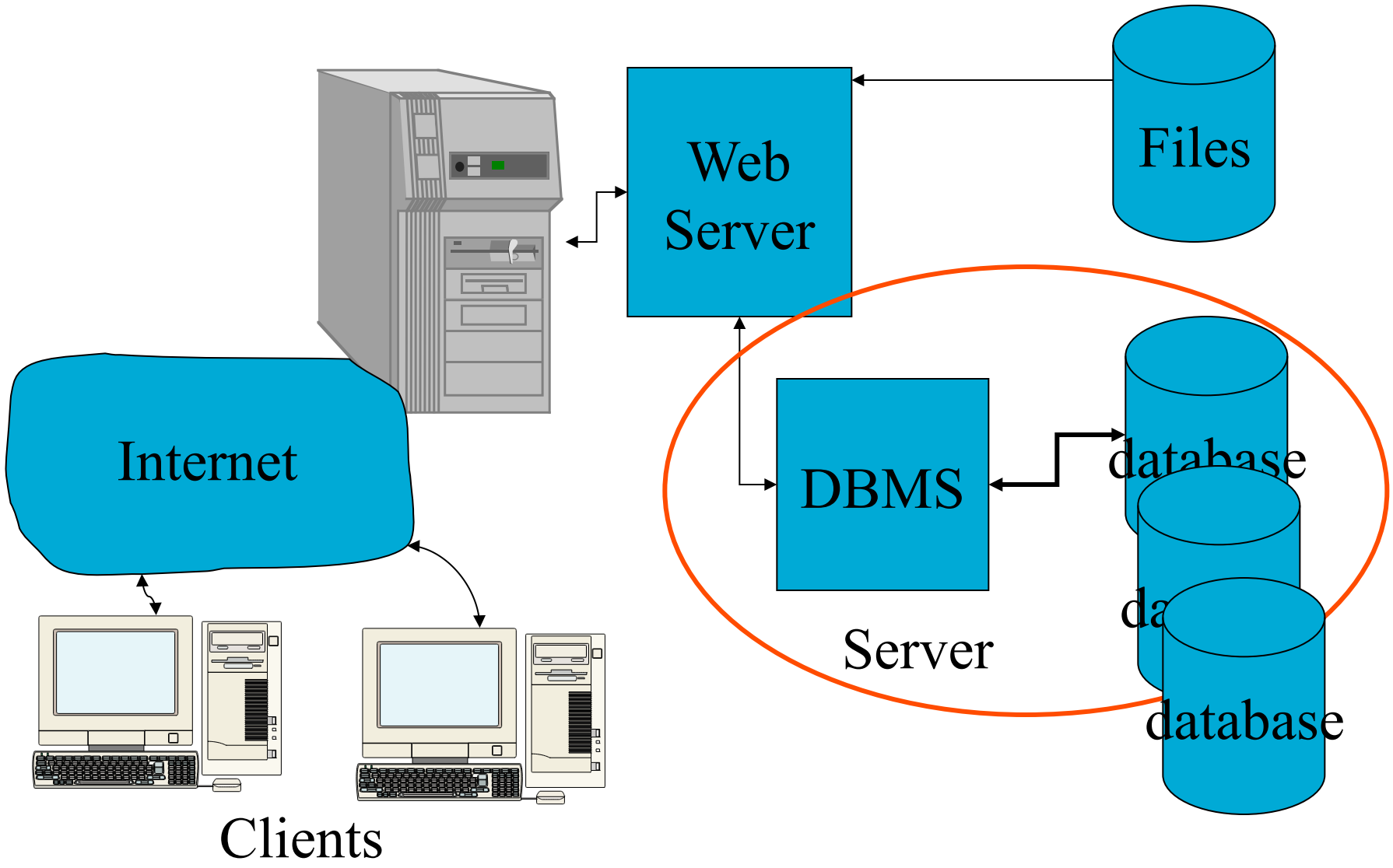
Transaction Processing

- Transactions should be ACID:
  - Atomic – Results of transaction are either all committed or all rolled back
  - Consistent – Data is transformed from one consistent state to another
  - Isolated – The results of a transaction are invisible to other transactions
  - Durable – Once committed the results of a transaction are permanent and survive system or media failures

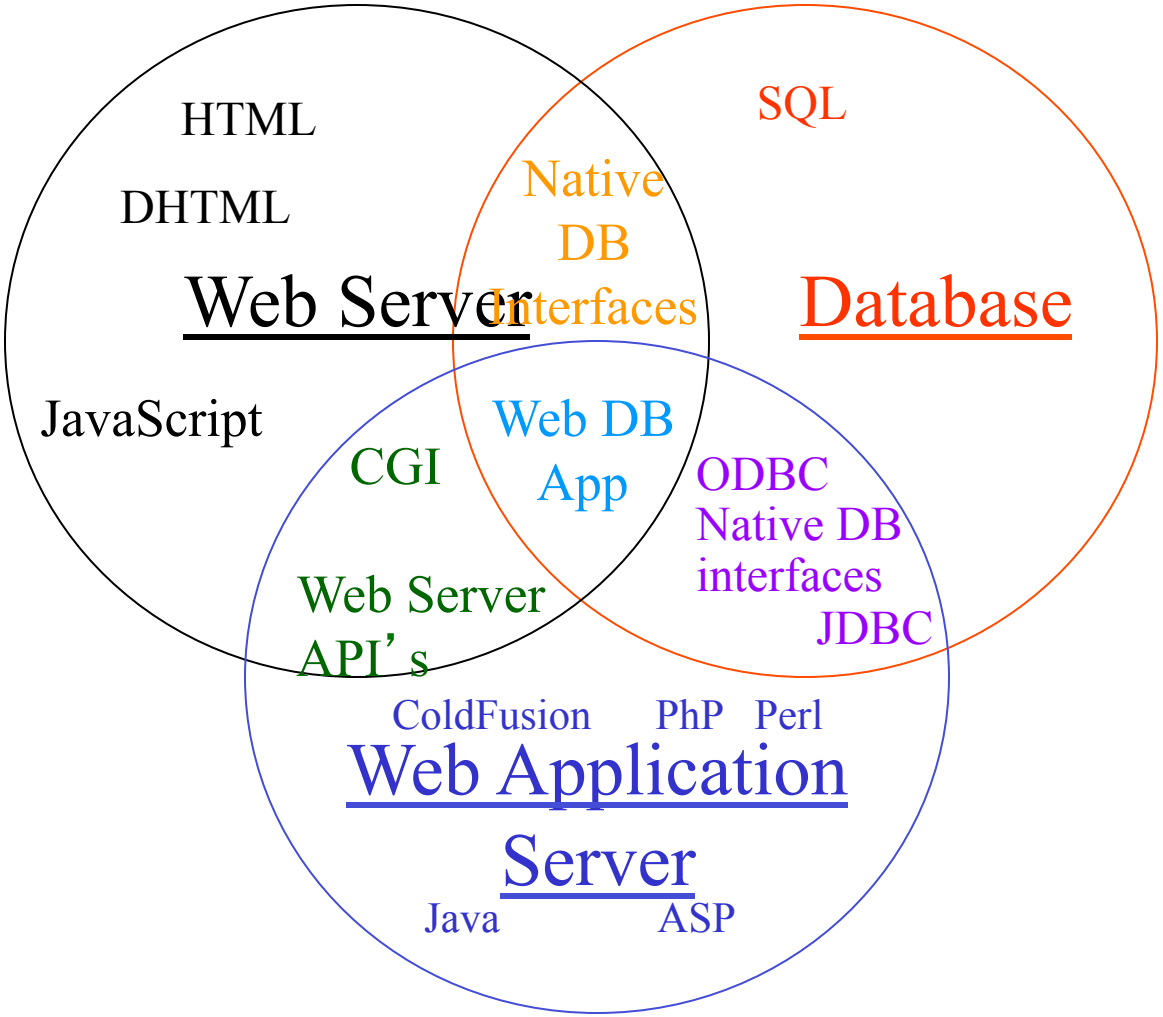
Why Use a Database System?

- Database systems have concentrated on providing solutions for all of these issues for scaling up Web applications
  - Performance
  - Scalability
  - Maintenance
  - Data Integrity
  - Transaction support
- While systems differ in their support, most offer some support for all of these.

Dynamic Web Applications 2



Server Interfaces



Adapted from
John P Ashenfelter,
Choosing a Database for Your Web Site

What Database systems are available?

- Choices depend on:
  - Size (current and projected) of the application
  - Hardware and OS Platforms to be used in the application
  - Features required
    - E.g.: SQL? Upgrade path? Full-text indexing? Attribute size limitations? Locking protocols? Direct Web Server access? Security?
  - Staff support for DBA, etc.
  - Programming support (or lack thereof)
  - Cost/complexity of administration
  - Budget

Desktop Database Systems

System (producer)	Platform	SQL	ODBC	Scaling	Price
Access (Microsoft)	Windows	Yes	Yes	SQL Server	~$200
FoxPro (Microsoft)	Windows, Mac	Yes	Yes	SQL Server	~$200
FileMaker (FileMaker)	Windows, Mac	No	No	FileMaker Server	~$200
Excel (Microsoft)	Windows, Mac	No	Yes	Convert to Acces	~$200
Files (owner)	Windows, Mac	No	No	Import into DB	?

- Individuals or very small enterprises can create DBMS-enabled Web applications relatively inexpensively
- Some systems will require an application server (such as Python/Flask) to provide the access path between the Web server and the DBMS

Pros and Cons of Database Options

- Desktop databases
  - usually simple to set up and administer
  - inexpensive
  - often will not scale to a very large number of users or very large database size
  - May lack locking management appropriate for multiuser access
  - Poor handling for full-text search
  - Well supported by application software (Python, PHP, etc.)

Enterprise Database Systems

System	Platform	SQL	ODBC	JDBC	Web?
SQL-Server (Microsoft)	WIndowsNT -2000	Yes	Yes	?	Yes (IIS)
Oracle Internet Platform	Unix, Linux, NT	Yes	Yes	Yes	Yes
Informix Internet Foundation.2000	Unix, Linux, NT	Yes	Yes	Yes	Yes
Sybase Adaptive Server	Unix, Linux, NT	Yes	Yes	Yes	Yes
DB2 (IBM)	IBM Unix, Linux, NT	Yes	Yes	Yes	Yes?

- Enterprise servers are powerful and available in many different configurations
- They also tend to be VERY expensive
- Pricing is usually based on users, or CPU's

Pros and Cons of Database Options

- Enterprise databases
  - Can be very complex to set up and administer
    - Oracle, for example recommends RAID-1 with 7x2 disk configuration as a bare minimum, more recommended
  - Expensive
  - Will scale to a very large number of users
  - Will scale to very large databases
  - Incorporate good transaction control and lock management
  - Native handling of Text search is poor, but most DBMS have add-on text search options
  - Support for applications software (Python, PHP, etc.)

Free Database Servers

System	Platform	SQL	ODBC	JDBC	Web?
mSQL	Unix, Linux	Yes	Yes	No(?)	No?
MySQL	Unix, Linux, NT	Yes	Yes	No(?)	No?
PostgreSQL	Unix, Linux, NT	Yes	Yes	Yes	No?

- System is free, but there is also no help line.
- Include many of the features of Enterprise systems, but tend to be lighter weight
- Versions may vary in support for different systems
- Open Source -- So programmers can add features

Pros and Cons of Database Options

- Free databases
  - Can be complex to set up and administer
  - Inexpensive (FREE!)
  - usually will scale to a large number of users
  - Incorporate good transaction control and lock management
  - Native handling of Text search has improved, and there are IR-like capabilities in MySQL and PostgreSQL
  - Support for applications software (ColdFusion, Python, etc.)

Embedded Database Servers

System	Platform	SQL	ODBC	JDBC	Web?
Oracle Berkeley DB	Unix, Linux, Win	No	No	Java API	No?
Solid	Unix, Linux, Win	Yes	Yes	Yes	Yes
SQLite	Unix,Linux,Win	Yes	No	No	Yes

- May require programming experience to install
- Tend to be fast and economical in space requirements
- Includes many NOSQL databases

Pros and Cons of Database Options

- Embedded databases
  - Must be embedded in a program
  - Can be incorporated in a scripting language
  - inexpensive (for non-commercial application)
  - May not scale to a very large number of users (depends on how it is used)
  - (May) Incorporate good transaction control and lock management
  - Text search support is minimal
  - May not support SQL

NOSQL Databases

System	Platform	SQL	ODBC	JDBC	Web?
MongoDB	Unix, Linux, Win	No	No	No	?
REDIS	Unix, Linux, Win	NO	NO	No	?

Evaluation Criteria	Tokyo Cabinet + Tokyo Tyrant	Berkeley DB + MemcacheDB	Voldemort + BDB JE	Redis	MongoDB
Insertion (small data set)	4	2	2	4	4
Insertion (large data set)	1	1	1	1	3
Random Read (small data set)	4	2	2	4	4
Random Read (large data set)	2	2	1	3	3
Speed Consistence	1	3	2	4	4
Storage Efficiency	4	2	1	2	3
Horizontal Scalability	4	3	2	3	4
Manageability	4	4	2	2	4
Stability	4	4	2	3	4
Feature Set	1	1	1	1	2
Project Activeness and Community Support	2	1	1	2	4

PerfectMarket Content Matters

Database Security

- Different systems vary in security support:
  - Views or restricted subschemas
  - Authorization rules to identify users and the actions they can perform
  - User-defined procedures (and rule systems) to define additional constraints or limitations in using the database
  - Encryption to encode sensitive data
  - Authentication schemes to positively identify a person attempting to gain access to the database

Views

- A subset of the database presented to some set of users.
  - SQL: CREATE VIEW viewname AS SELECT field1, field2, field3,…, FROM table1, table2 WHERE <where clause>;
  - Note: “queries” in Access function as views.

Authorization Rules

- Most current DBMS permit the DBA to define “access permissions” on a table by table basis (at least) using the GRANT and REVOKE SQL commands.
- Some systems permit finer grained authorization (most use GRANT and REVOKE on variant views.
- Some desktop systems have poor authorization support.

Database Backup and Recovery

- Backup
- Journaling (audit trail)
- Checkpoint facility
- Recovery manager

Web Application Server Software

- Python + Flask
- Java/Spring Struts
- Ruby on Rails
- PHP
- ASP
- JSP

Next Couple Weeks

- Python + Flask
- Twitter Bootstrap