

COSC 122  
Computer Fluency

Databases

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### Key Points

- 1) Databases allow for easy storage and retrieval of large amounts of information.
- 2) Relational databases organize data into tables consisting of rows and columns.
- 3) SQL is the common language to query a database for results.

Page 2

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### What is a database?

A **database** is a collection of logically related data for a particular domain.

A **database management system (DBMS)** is software designed for the creation and management of databases.

- ◆ e.g. Oracle, DB2, Microsoft Access, MySQL, SQL Server

Bottom line: A **database** is the *data* stored and a **database system** is the *software* that manages the data.

Page 3

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### Databases in the Real-World

Databases are everywhere in the real-world even though you do not often interact with them directly.

- ◆ \$20 billion dollar annual industry

Examples:

- ◆ Retailers manage their products and sales using a database.
  - ⇒ Wal-Mart has one of the largest databases in the world!
- ◆ Online web sites such as Amazon, eBay, and Expedia track orders, shipments, and customers using databases.
- ◆ The university maintains all your registration information and marks in a database that is accessible over the Internet.

Can you think of other examples?  
What data do you have?

Page 4

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### DBMS

A database management system provides *efficient, convenient, and safe multi-user* storage and access to *massive* amounts of *persistent* data.

**Efficient** - Able to handle large data sets and complex queries without searching all files and data items.

**Convenient** - Easy to write queries to retrieve data.

**Safe** - Protects data from system failures and hackers.

**Massive** - Database sizes in gigabytes and terabytes.

**Persistent** - Data exists even if have a power failure.

**Multi-user** - More than one user can access and update data at the same time while preserving consistency.

Page 5

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### Database System Approach

The diagram illustrates the Database System Approach. On the left, two boxes labeled 'PROGRAM 1' and 'PROGRAM 2' have arrows pointing to a central 'DBMS' block. The DBMS block is a stack of three layers: 'Query Processor' at the top, 'Transaction Mgr' in the middle, and 'Storage Mgr' at the bottom. Below the DBMS block is the text 'Collection of Data Management Functions'. An arrow points from the DBMS block to a large cylinder on the right labeled 'Integrated Database'.

Page 6

## Advanced: Databases and Abstraction

One of the major advantages of databases is they provide data abstraction. **Data abstraction** allows the implementation of an object to change without affecting programs that use the object through an external definition.

That is, as a database user or programmer, you do not have to worry about how the data is stored or organized.

A DBMS achieves data abstraction by allowing users to define the database and then handling all the low-level details of how to store it, retrieve it, and handle concurrent access to it.



## The Relational Model: Terminology

The **relational model** organizes database information into tables called relations.

- ◆ The relational model was developed by E. F. Codd in 1970 and is used by almost all commercial database systems.

Terminology:

A **relation** is a table with columns and rows.

An **attribute** is a named column of a relation.

A **tuple** is a row of a relation.

A **domain** is a set of allowable values for one or more attributes.

The **degree** of a relation is the number of attributes it contains.

The **cardinality** of a relation is the number of tuples it contains.

## Relation Example

relation

attributes

tuples

Product ID	Product Name	Supplier	Category	Quantity Per Unit	Unit Price	Units In Stock
1	Chai	1	1	10 boxes x 20 bags	\$18.00	39
2	Chang	1	1	24 - 12 oz bottles	\$19.00	17
3	Aniseed Syrup	1	2	12 - 550 ml bottles	\$10.00	13
4	Chef Anton's Cajun Seasoning	2	4	8 - 6 oz jars	\$22.00	53
5	Chef Anton's Gumbo Mix	2	2	36 boxes	\$21.55	0
6	Grandma's Boysenberry Spread	3	2	12 - 8 oz jars	\$25.00	120
7	Uncle Bob's Organic Dried Pears	3	7	12 - 1 lb pkgs.	\$30.00	15
8	Northwoods Cranberry Sauce	3	2	12 - 12 oz jars	\$40.00	6
9	Mishi Kobe Niku	4	6	18 - 500 g pkgs.	\$97.00	29
10	Iura	4	8	12 - 200 ml jars	\$31.00	31
11	Guero Cabrera's	5	4	1 kg pkg.	\$21.00	22

Degree = 7  
Cardinality = 77

Domain of Unit Price is currency.

## Relation Practice Questions

Order ID	Customer	Employee	Order Date	Shipped Date	Ship Via	Ship Name	Ship Address	Ship Postal Code
10249	VINET	5	04-Aug-94	10-Aug-94	3	Vins et alcools Chevalier	59 rue de Abbaye	51100
10249	TOMSP	6	05-Aug-94	10-Aug-94	1	Toms Spezialitäten	Luisenstr. 48	44087
10250	HANAR	4	08-Aug-94	12-Aug-94	2	Hanan Carnes	Rua do Paço, 67	06454-876
10251	VICTE	3	08-Aug-94	15-Aug-94	1	Victualies en stock	2, rue du Commerce	69004
10252	SUPRD	4	09-Aug-94	11-Aug-94	2	Suprêmes délices	Boulevard Tero, 265	B-6000
10253	HANAR	3	10-Aug-94	16-Aug-94	2	Hanan Carnes	Rua do Paço, 67	06454-876
10254	CHOPF	6	11-Aug-94	23-Aug-94	2	Chop-suey Chinese	Hauptstr. 31	3012
10255	RICDU	9	12-Aug-94	15-Aug-94	3	Richter Supermarkt	Starenweg 5	1204
10256	WELLU	3	15-Aug-94	17-Aug-94	2	Wellington Importadora	Rua do Mercado, 12	08273-363
10257	HILAA	4	16-Aug-94	22-Aug-94	3	HILARION Abastos	Camera 22 con Ave. Carlos	5022
10258	ERNSH	11	17-Aug-94	23-Aug-94	1	Ernst Handel	Kirchgasse 6	6010
10259	CENTC	4	18-Aug-94	25-Aug-94	3	Centro comercial Mactezuma	Sierras de Granada 9993	06022
10260	OTTIK	4	19-Aug-94	29-Aug-94	1	Ottiles Käselerden	Mehlmerstr. 369	50739

- 1) What is the name of the relation?
- 2) What is the cardinality of the relation?
- 3) What is the degree of the relation?
- 4) What is the domain of order date? What is the domain of order id?

## Databases Database and Database System

**Question:** Which of these two definitions below are an example of software?

- A) database
- B) database system

## Databases Database Properties

**Question:** True or False: The data in a database is lost when the power to the computer is turned off.

- A) true
- B) false

## Databases

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### Database Properties (2)

**Question:** True or False: More than one user can use the database managed by the DBMS at the same time.

- A) true
- B) false

Page 13

## Databases Definition Matching

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**Question:** Given the three definitions, select the ordering that contains their related definitions.

- 1) relation
  - 2) tuple
  - 3) attribute
- 
- A) column, row, table
  - B) row, column, table
  - C) table, row, column
  - D) table, column, row

Page 14

## Databases Cardinality and Degree

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**Question:** A database table has 10 rows and 5 columns. Select **one** true statement.

- A) The table's degree is 50.
- B) The table's cardinality is 5.
- C) The table's degree is 10.
- D) The table's cardinality is 10.

Page 15

## ★ Relational Keys

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Keys are used to uniquely identify a tuple in a relation.

A **superkey** is a set of attributes that uniquely identifies a tuple in a relation.

A **key** is a *minimal* set of attributes that uniquely identifies a tuple in a relation.

Question:

- ◆ What is a key to identify a student in this class?

Page 16

## Databases Keys and Superkeys

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**Question:** True or false: A key is always a superkey.

- A) true
- B) false

Page 17

## Databases Keys and Superkeys (2)

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**Question:** True or false: It is possible to have more than one key for a table and the keys may have different numbers of attributes.

- A) true
- B) false

Page 18

## Example Relations

Relations:

- emp (eno, ename, bdate, title, salary, supereno, dno)
- proj (pno, pname, budget, dno)
- dept (dno, dname, mgreno)
- workson (eno, pno, resp, hours)

Emp - one row per employee storing name, birth date, supervisor, and department that they are in

Proj - one row per project storing name and its department

Dept - one row per department storing name and manager

WorksOn - stores that an employee works on a particular project for a certain amount of time in a given role

Note: Key fields are underlined.

## Example Relation Instances

Emp Relation

eno	ename	bdate	title	salary	supereno	dno
E1	J. Doe	01-05-75	EE	30000	E2	null
E2	M. Smith	06-04-66	SA	50000	E5	D3
E3	A. Lee	07-05-66	ME	40000	E7	D2
E4	J. Miller	09-01-50	PR	20000	E6	D3
E5	B. Casey	12-25-71	SA	50000	E8	D3
E6	L. Chu	11-30-65	EE	30000	E7	D2
E7	R. Davis	09-08-77	ME	40000	E8	D1
E8	J. Jones	10-11-72	SA	50000	null	D1

WorksOn Relation

eno	pno	resp	hours
E1	P1	Manager	12
E2	P1	Analyst	24
E2	P2	Analyst	6
E3	P3	Consultant	10
E3	P4	Engineer	48
E4	P2	Programmer	18
E5	P2	Manager	24
E6	P4	Manager	48
E7	P3	Engineer	36

Proj Relation

pno	pname	budget	dno
P1	Instruments	150000	D1
P2	DB Develop	135000	D2
P3	Budget	250000	D3
P4	Maintenance	310000	D2
P5	CAD/CAM	500000	D2

Dept Relation

dno	dname	mgreno
D1	Management	E8
D2	Consulting	E7
D3	Accounting	E5
D4	Development	null

## A Simple Query Language: Keyword Searching

**Keyword** (or English-language) **search** allows a user to type keywords or phrases and returns a best answer estimate.



This works fairly well for web searches, although we lack precision. Precision is required for many applications.

- ◆ Example: How would you return all employees with salary greater than 30,000 using keyword search?

## SQL Overview

Structured Query Language or SQL is the standard database query language to retrieve *exact answers*.

- ◆ SQL is a **declarative language** (non-procedural). A SQL query specifies *what* to retrieve but not *how* to retrieve it.
- ◆ SQL is used by Microsoft Access.

Some basic rules for SQL statements:

- ◆ 1) There is a set of *reserved words* that cannot be used as names for database fields and tables.
  - ⇒ SELECT, FROM, WHERE, etc.
- ◆ 2) SQL is generally *case-insensitive*.
  - ⇒ Only exception is string constants. 'FRED' not the same as 'fred'.
- ◆ 3) SQL is *free-format* and white-space is ignored.

## ★ SQL Queries

A query in SQL has the form:

**SELECT** (list of attributes)  
**FROM** (list of tables)  
**WHERE** (filter conditions)

Notes:

- ◆ 1) Separate the list of attributes and list of tables by **commas**.
- ◆ 2) The "\*" is used to select all attributes.

## SQL Retrieving Only Some of the Columns

The **projection operation** creates a new table that has some of the columns of the input table. In SQL, provide the table in the **FROM** clause and the fields in the output in the **SELECT**.

Example: Return only the **eno** field from the **Emp** table:

```
SELECT eno
FROM emp
```

Emp Relation

eno	ename	bdate	title	salary	supereno	dno
E1	J. Doe	01-05-75	EE	30000	E2	null
E2	M. Smith	06-04-66	SA	50000	E5	D3
E3	A. Lee	07-05-66	ME	40000	E7	D2
E4	J. Miller	09-01-50	PR	20000	E6	D3
E5	B. Casey	12-25-71	SA	50000	E8	D3
E6	L. Chu	11-30-65	EE	30000	E7	D2
E7	R. Davis	09-08-77	ME	40000	E8	D1
E8	J. Jones	10-11-72	SA	50000	null	D1

Result

eno
E1
E2
E3
E4
E5
E6
E7
E8

## SQL Projection Examples

**Emp Relation**

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

<b>SELECT</b> eno,ename	<b>SELECT</b> title
<b>FROM</b> emp	<b>FROM</b> emp

eno	ename	title
E1	J. Doe	EE
E2	M. Smith	SA
E3	A. Lee	ME
E4	J. Miller	PR
E5	B. Casey	SA
E6	L. Chu	EE
E7	R. Davis	ME
E8	J. Jones	SA

Note: Duplicates are not removed during SQL projection.

## Databases Projection

**Question:** Given this table and the query:

```
SELECT eno, ename, salary
FROM emp
```

How many columns are returned?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

**Emp Relation**

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

## Databases Projection (2)

**Question:** Given this table and the query:

```
SELECT salary
FROM emp
```

How many rows are returned?

- A) 0
- B) 2
- C) 4
- D) 8

**Emp Relation**

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

## SQL Projection Questions

**WorksOn Relation**

eno	pno	resp	dur
E1	P1	Manager	12
E2	P1	Analyst	24
E2	P2	Analyst	6
E3	P3	Consultant	10
E3	P4	Engineer	48
E4	P2	Programmer	18
E5	P2	Manager	24
E6	P4	Manager	48
E7	P3	Engineer	36
E7	P5	Engineer	23
E8	P3	Manager	40

Write the SQL statement that:

- 1) Returns only attributes *resp* and *dur*.
- 2) Returns only *eno*.
- 3) Returns only *pno*.

List the number of result rows and columns in each case.

## One Table Query Example Retrieving Only Some of the Rows

The **selection operation** creates a new table with some of the rows of the input table. A condition specifies which rows are in the new table. The condition is similar to an *if* statement.

Example: Return the projects in department 'D2':

```
SELECT pno, pname, budget, dno
FROM proj
WHERE dno = 'D2';
```

**Proj Relation**

pno	pname	budget	dno
P1	Instruments	150000	D1
P2	DB Develop	135000	D2
P3	Budget	250000	D3
P4	Maintenance	310000	D2
P5	CAD/CAM	500000	D2

**Result**

pno	pname	budget	dno
P2	DB Develop	135000	D2
P4	Maintenance	310000	D2
P5	CAD/CAM	500000	D2

Algorithm: Scan each tuple and check if matches condition in WHERE clause. page 29

## Retrieving Only Some of the Rows Selection Conditions

The condition in a selection statement specifies which rows are included. It has the general form of an *if* statement.

The condition may consist of attributes, constants, comparison operators (<, >, =, !=, <=, >=), and logical operators (AND, OR, NOT).

### SQL Selection Examples

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

```
SELECT eno, ename, title, salary
FROM emp
WHERE salary > 35000 OR
       title = 'PR'
```

eno	ename	title	salary
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

```
SELECT *
FROM emp
WHERE title = 'EE'
```

eno	ename	title	salary
E1	J. Doe	EE	30000
E6	L. Chu	EE	30000

### Databases Selection

Question: Given this table and the query:

```
SELECT *
FROM emp
WHERE title='EE'
```

How many rows are returned?

- A) 0
- B) 1
- C) 2
- D) 3

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

### Databases Selection

Question: Given this table and the query:

```
SELECT *
FROM emp
WHERE salary > 50000 or title='PR'
```

How many rows are returned?

- A) 0
- B) 1
- C) 2
- D) 3

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

### Databases Selection

Question: Given this table and the query:

```
SELECT *
FROM emp
WHERE salary > 50000 or title='PR'
```

How many columns are returned?

- A) 0
- B) 2
- C) 3
- D) 4

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

### SQL Selection Questions

WorksOn Relation

eno	pno	resp	dur
E1	P1	Manager	12
E2	P1	Analyst	24
E2	P2	Analyst	6
E3	P3	Consultant	10
E3	P4	Engineer	48
E4	P2	Programmer	18
E5	P2	Manager	24
E6	P4	Manager	48
E7	P3	Engineer	36
E7	P5	Engineer	23
E8	P3	Manager	40

Write the SQL statement that:

- 1) Returns all rows with a project P2.
- 2) Returns all rows with responsibility of a Manager.
- 3) Returns all rows with a responsibility of Manager and duration of more than 40 months.

List the number of result rows for each case.

### One Table Query Example Retrieving Some of the Rows/Columns

Return the employee name and salary of all employees whose title is 'EE':

```
SELECT ename, salary
FROM emp
WHERE title = 'EE';
```

Emp Relation

eno	ename	bdate	title	salary	supereno	dno
E1	J. Doe	01-05-75	EE	30000	E2	null
E2	M. Smith	06-04-66	SA	50000	E5	D3
E3	A. Lee	07-05-66	ME	40000	E7	D2
E4	J. Miller	09-01-50	PR	20000	E6	D3
E5	B. Casey	12-25-71	SA	50000	E8	D3
E6	L. Chu	11-30-65	EE	30000	E7	D2
E7	R. Davis	09-08-77	ME	40000	E8	D1
E8	J. Jones	10-11-72	SA	50000	null	D1

Result

ename	salary
J. Doe	30000
L. Chu	30000

## One Table Query Examples

Return the birth date and salary of employee 'J. Doe':

```
SELECT bdate, salary
FROM emp
WHERE ename = 'J. Doe'
```

Return all information on all employees:

```
SELECT * ← * returns all attributes
FROM emp
```

Return the employee number, project number, and number of hours worked where the hours worked is > 50:

```
SELECT eno, pno, hours
FROM workson
WHERE hours > 50
```

## Databases Projection and Selection

Question: Given this table and the query:

```
SELECT eno, salary
FROM emp
WHERE salary >= 40000
```

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

What is the degree of the result?

- A) 2
- B) 3
- C) 4
- D) 5

## Databases Projection and Selection (2)

Question: Given this table and the query:

```
SELECT eno, salary
FROM emp
WHERE salary >= 40000
```

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

What is the cardinality of the result?

- A) 2
- B) 3
- C) 4
- D) 5

## SQL Projection/Selection One Table Questions

Relations:

emp (eno, ename, bdate, title, salary, supereno, dno)  
 proj (pno, pname, budget, dno)  
 dept (dno, dname, mgreno)  
 workson (eno, pno, resp, hours)

- 1) Returns all employees making more than \$50,000.
- 2) Show the WorksOn records with less than 20 hours but more than 10 hours.
- 3) Return only the pno and dno for each project.
- 4) Return the name for each employee in department 'D1'.
- 5) Challenge: Display the employees who make less than \$40,000 or have title 'EE' and are born after June 1, 1970.

◆ Dates are in YYYY-MM-DD format. e.g. '1970-06-01' Page 40

## Join

A join combines two tables into a single table.

If the join has no condition that specifies which rows are in the result, all possible combinations of rows are in the result.

This is called a **Cartesian or cross product**.

- ◆ If table *R* has *N* rows and *X* columns and table *S* has *M* rows and *Y* columns, then there are *N\*M* rows and *X+Y* columns in the cross product result.

In SQL, a cross product is done automatically if you put more than one table in the FROM clause and do not specify a condition on how to combine them.

- ◆ In most cases, this is **NOT** what you want to do!

## Cartesian Product SQL Example

Emp Relation

eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000

Proj Relation

pno	pname	budget
P1	Instruments	150000
P2	DB Develop	135000
P3	CAD/CAM	250000

```
SELECT *
FROM emp, proj
```

eno	ename	title	salary	pno	pname	budget
E1	J. Doe	EE	30000	P1	Instruments	150000
E1	J. Doe	EE	30000	P2	DB Develop	135000
E1	J. Doe	EE	30000	P3	CAD/CAM	250000
E2	M. Smith	SA	50000	P1	Instruments	150000
E2	M. Smith	SA	50000	P2	DB Develop	135000
E2	M. Smith	SA	50000	P3	CAD/CAM	250000
E3	A. Lee	ME	40000	P1	Instruments	150000
E3	A. Lee	ME	40000	P2	DB Develop	135000
E3	A. Lee	ME	40000	P3	CAD/CAM	250000
E4	J. Miller	PR	20000	P1	Instruments	150000
E4	J. Miller	PR	20000	P2	DB Develop	135000
E4	J. Miller	PR	20000	P3	CAD/CAM	250000

## Databases Cartesian Product

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**Question:** R is a relation with 10 rows and 5 columns. S is a relation with 8 rows and 3 columns.

What is the degree and cardinality of the cartesian product?

- A) degree = 8, cardinality = 80
- B) degree = 80, cardinality = 8
- C) degree = 15, cardinality = 80
- D) degree = 8, cardinality = 18

Page 43



## Equijoin

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In most cases, you only want to combine two tables and have rows in the result that satisfy a certain condition.

The most common type of join is an **equijoin** that combines two tables by matching columns that have the same value.

- ◆ Equijoin gets its name because the columns are compared using the equality operator (=).
- ◆ e.g. `WorksOn.pno = Proj.pno`

Page 44

## Equijoin Example

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WorksOn Relation

eno	pno	resp	dur
E1	P1	Manager	12
E2	P1	Analyst	24
E2	P2	Analyst	6
E3	P4	Engineer	48
E5	P2	Manager	24
E6	P4	Manager	48
E7	P3	Engineer	36
E7	P4	Engineer	23

```
SELECT *
FROM WorksOn, Proj
WHERE WorksOn.pno = Proj.pno
```

eno	pno	resp	dur	P.pno	pname	budget
E1	P1	Manager	12	P1	Instruments	150000
E2	P1	Analyst	24	P1	Instruments	150000
E2	P2	Analyst	6	P2	DB Develop	135000
E3	P4	Engineer	48	P4	Maintenance	310000
E5	P2	Manager	24	P2	DB Develop	135000
E6	P4	Manager	48	P4	Maintenance	310000
E7	P3	Engineer	36	P3	CAD/CAM	250000
E7	P4	Engineer	23	P4	Maintenance	310000

Proj Relation

pno	pname	budget
P1	Instruments	150000
P2	DB Develop	135000
P3	CAD/CAM	250000
P4	Maintenance	310000
P5	CAD/CAM	500000

What is the meaning of this join?

Page 45

## Equijoin in SQL

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There are two ways of using equijoin in SQL.

In WHERE clause:

```
SELECT *
FROM WorksOn, Proj
WHERE WorksOn.pno = Proj.pno
```

In FROM clause:

```
SELECT *
FROM WorksOn JOIN Proj ON WorksOn.pno = Proj.pno
```

Can simplify syntax by using alias to shorten table name:

```
SELECT *
FROM WorksOn AS W, Proj AS P
WHERE W.pno = P.pno
```

Page 46

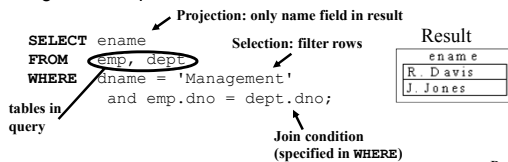
## Join Query with Selection Example

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You can use join, selection, and projection in the same query.

- ◆ Recall: Projection returns columns listed in SELECT, selection filters out rows using condition in WHERE, and join combines tables in FROM using condition specified in FROM or WHERE.

Example: Return the employee names who are assigned to the 'Management' department.



Page 47

## Join Query Examples

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Return the department names and the projects in each department:

```
SELECT dname, pname
FROM dept, proj
WHERE dept.dno = proj.dno
```

Return the employees and the names of their department:

```
SELECT ename, dname
FROM emp JOIN dept ON emp.dno=dept.dno
```

Return all projects who have an employee working on them whose title is 'EE':

```
SELECT pname
FROM emp, proj, workson
WHERE emp.title = 'EE' and workson.eno=emp.eno
and workson.pno = proj.pno
```

Page 48



## Join Practice Questions

Emp Relation			
eno	ename	title	salary
E1	J. Doe	EE	30000
E2	M. Smith	SA	50000
E3	A. Lee	ME	40000
E4	J. Miller	PR	20000
E5	B. Casey	SA	50000
E6	L. Chu	EE	30000
E7	R. Davis	ME	40000
E8	J. Jones	SA	50000

Proj Relation		
pno	pname	budget
P1	Instruments	150000
P2	DB Develop	135000
P3	CAD/CAM	250000
P4	Maintenance	310000
P5	CAD/CAM	500000

WorksOn Relation				
eno	pno	resp	dur	
E1	P1	Manager	12	
E2	P1	Analyst	24	
E2	P2	Analyst	6	
E3	P3	Consultant	10	
E3	P4	Engineer	48	
E4	P2	Programmer	18	
E5	P2	Manager	24	
E6	P4	Manager	48	
E7	P3	Engineer	36	
E7	P5	Engineer	23	
E8	P3	Manager	40	

Compute the following joins (how many tuples?):

- SELECT \* FROM Emp JOIN WorksOn ON Emp.eno = WorksOn.eno
- SELECT \* FROM Emp, Proj, WorksOn WHERE Emp.eno = WorksOn.eno AND Proj.pno = WorksOn.pno

## Ordering Result Data

The query result returned is not ordered on any column by default. We can order the data using the **ORDER BY** clause:

```
SELECT ename, salary, bdate
FROM emp
WHERE salary > 30000
ORDER BY salary DESC, ename ASC;
```

- ◆ 'ASC' sorts the data in ascending order, and 'DESC' sorts it in descending order. The default is 'ASC'.
- ◆ The order of sorted attributes is significant. The first column specified is sorted on first, then the second column is used to break any ties, etc.

## More Advanced Querying

There are many more queries that we can ask a database:

- ◆ compute expressions and functions
- ◆ group data by value and meaning
- ◆ compute summary (aggregate) functions (max, min, sum, etc.)
- ◆ subqueries (queries within queries)

We will not study the notation for this advanced querying.

## Putting it All Together

The steps to write an English query in SQL are:

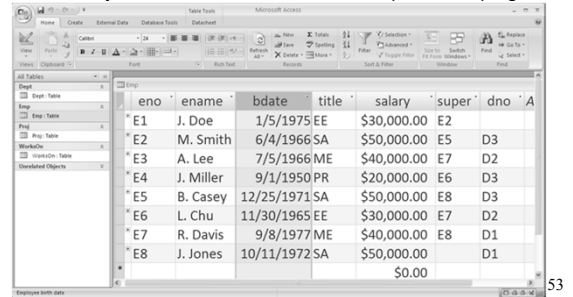
- ◆ 1) Find the columns that you need and put in **SELECT** clause.
- ◆ 2) List the tables that have the columns in the **FROM** clause. If there is more than one, join them together.
- ◆ 3) If you must filter rows, add a filter criteria in **WHERE** clause.

Example: List project name and budget where a 'Manager' is working on the project.

```
SELECT pname, budget
FROM WorksOn, Proj
WHERE resp='Manager' AND WorksOn.pno = Proj.pno
```

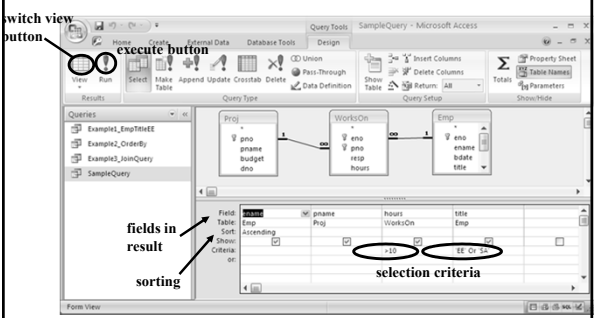
## Microsoft Access

Microsoft Access is a simple database management system. It allows you to create databases, forms, reports, and programs.



## Microsoft Access Query Interface

Tables are boxes. Relationships are lines. Condition specified on bottom.



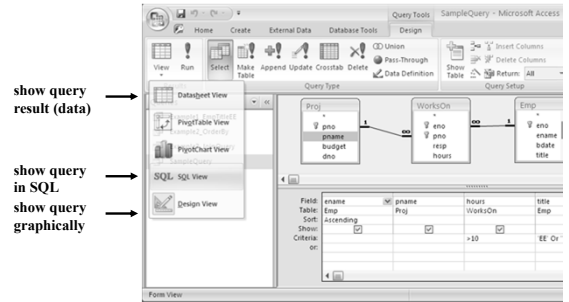
## Microsoft Access Querying Basics

- 1) Projection is performed by selecting the fields in the output in the field row in the table at the bottom of the screen.
- 2) Selection is performed by entering the condition in the criteria box. The criteria applies to the field in that column.
- 3) The tables used are added to the query by the **Show Table...** option.
- 4) Joins (based on relationships) are often automatically added, but if not, you can add them by selecting the join field in one table, holding the mouse button, then dragging to the join field in the other table.

Page 55

## Microsoft Access Query Views

You may view your data, your query graphically, or your query in SQL.



## Practice Questions

Relational database schema:

emp (eno, ename, bdate, title, salary, supereno, dno)  
 proj (pno, pname, budget, dno)  
 dept (dno, dname, mgreno)  
 workson (eno, pno, resp, hours)

- 1) Return the project names that have a budget > 250000.
- 2) List all project names in department with name 'Accounting'.
- 3) For employee 'M. Smith' list the project number and hours for all projects that he worked on.
- 4) Return a list of all department names, the names of the projects of that department, and the name of the manager of each department.

Page 57

## Conclusion

A **database** is a collection of related data. A **database system** allows storing and querying a database.

The basic query operations are selection (subset of rows), projection (subset of columns), and join (combine two or more tables).

**SQL** is the standard query language for databases, although Microsoft Access also provides a graphical user interface.

Page 58

## Objectives

- ◆ Define: database, database system
- ◆ Explain how a DBMS achieves data abstraction.
- ◆ Define: relation, attribute, tuple, domain, degree, cardinality, superkey, key
- ◆ Given a relation, know its cardinality, degree, domains, and keys.



Given a relational schema and instance be able to translate very simple English queries into SQL.

Page 59