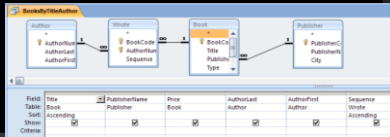## Relational Database Languages

Tuple relational calculus
- ALPHA (Codd, 1970s)
- QUEL (based on ALPHA)
- Datalog (rule-based, like PROLOG)

Domain relational calculus
- QBE (used in Access)

History of SQL

- Developed by IBM as SEQUEL in early 70s
  (Structured English Query Language)
- Renamed SQL (Structured Query Language)
- SQL-86 (ANSI, ISO)
- SQL-89
- SQL-92 (SQL2)
- SQL:1999 (SQL3)
- SQL 2003
- SQL 2006
- SQL 2008

Many different flavors of SQL:
  sqlplus, SQLServer, MySQL, etc.

Here: Accesss (roughly corresponds to SQL-89)

DDL part of SQL

Creating (CREATE),
Modifying (ALTER), and
Removing (DROP)

Catalogs
Schemas
Relations (Tables)
Constraints
Domains

DML part of SQL

Retrieving (SELECT),
Inserting (INSERT),
Modifying (UPDATE), and
Removing (DELETE).

SELECT

Combination of select, and project operations.

Basic Syntax:

SELECT <attribute_list>
FROM <table_list>
WHERE <condition>;

Example:

SELECT	fname, address
FROM	employee
WHERE	sex = "F" AND
	salary > 30000;

SELECT * and empty WHERE

SELECT *
FROM employee;

SELECT *
FROM employee, department;

SELECT *
FROM employee, department
WHERE dno=dnumber;

SELECT Examples

Company

- List the SSNs of all managers
- List the names of all projects
- List the names of all employees working for the research department.
- List the names of all departments managed by somebody with a salary less than 30.000.
- List employees with names of dependents.
- List the salaries of all employees working in Houston.

SELECT Examples

Henry Books

- List the names of all branches
- List the cities in which publishers are located

(the following queries require renaming)

- List all books by title with publisher name
- List all authors and the books they wrote
- List all publishers in New York
- List books published by Penguin
- List authors who have written philosophy books

Duplicates in SQL

Duplicates can occur if key attributes are not selected

SQL keeps duplicates, for several reasons:
- Cheaper to implement
  (duplicate elimination is expensive)
- Duplicates might be required
  (e.g., aggregate functions)

Removal of duplicates can be forced using DISTINCT

SELECT DISTINCT   SELECT ALL

Example:
    List cities in which publishers are located (Henry Books)

Excursion:
How to write SQL Queries

How to Write Simple SQL Query

3 Stages

      Before you write the SQL

      Writing the SQL

      After Writing the SQL

Before you write the SQL

Make sure you **understand** the problem.
    Clarify if necessary

Do it by **hand**.
    Reflect on what you did.

Writing the SQL

Start with **FROM**
which tables are involved, how often?

Then do **WHERE**
first join all tables (n tables need n-1 equals) - test
then add particular conditions

Finally, do **SELECT**
What info do you need to display

After Writing the SQL

Test

Run the query

Compare output to what you expected
sanity check: does it make sense?

In case of problems: read query

End of Excursion

Renaming (Aliases)

If necessary we can rename relations or attributes:

SELECT fname AS First_Name
FROM employee;

SELECT d.dname, e.dlocation
FROM department AS d,
        dept_locations AS e
WHERE d.dnumber = e.dnumber;

Renaming Examples

Company

• List the names of all employees in columns called First_Name, Last_Name
• List the names of all departments located in Houston.
• List the names of all employees supervised by Franklin Wong.
• List the names of all employees with the names of their supervisors.

Henry Books

• List books (Title) and branches at which they are available (BranchName) and how many copies are available

Types in Access

Numbers: 1, 17, -20
Text: "Pine Valley"
Currency: 125
Date/Time: #1/10/2005#

Comparisons

=	Equality
<	Less than
<=	Less than or equal
>	Greater than
>=	Greater than or equal
<> or !=	not equal (depends on system)
LIKE	Allows Wildcards (Access)

* (any number of characters)
? (single character)
(single digit)
[a-z] (range of charactes)
[#] (special character, here: #)

Operators

+	Addition (works for dates in Oracle/Access)
-	Subtraction (works for dates in Oracle/Access)
*	Multiplication
/	Division
&	Concatenation (for strings)

Functions (Access)
Strings and Numbers

String type:

Length(s)	Length of string s
Right(s,n), Left(s,n)	Last (first) n letters of string s
Rtrim(s), Ltrim(s)	Delete trailing (leading) spaces

Numeric type:

Floor(x)	Round x down
Ceiling(x)	Round x up
Abs(x)	Absolute value of x
Mod(x,k)	Remainder of dividing x by k
Power(x,k)	x^k

Functions (Access) Date/Time

Date/Time type:

Now()	Current date
day(d)	Day of date d
month(d)	Month (1-12) of date d
monthname(d)	Name of month of date d
year(d)	Year of date d

DateDiff('h', d1, d2)	# of hours between d1 and d2
DateDiff('d', d1, d2)	# of days between d1 and d2
DateDiff('m', d1, d2)	# of months between d1 and d2
DateDiff('yyyy', d1, d2)	# of years between d1 and d2

Examples

Company:
- Full names of employees
- Managers who started before 1990
- Dependents who are not spouses
- List employees that are younger than 40
- Employees and their start dates (formatted)
- Employees and their salaries in Euros

Henry Books:
- Books with prices (inclusive sales tax)
- Books for less than $10 with 10% discount

Between and Ordering

For number types, ranges can be defined using BETWEEN.

```
SELECT *
FROM employee
WHERE salary BETWEEN 30000 and 40000;
```

The ORDER BY clauses allows ordered output

```
SELECT * FROM employee
ORDER BY  lname, fname ASC, salary DESC;
```

SQL Examples (Company)

- Names and addresses of all employees working for the research department
- Names and addresses of all employees who do not work for the research department
- List project number, controlling department number, and department manager's last name, address, and birth date for all projects located in `Stafford'

- List SSNs of managers with at least one dependent

SQL Examples (Henry Books)

- List book titles, name of author, and how many copies are available at each branch
- Which publishers have published books by Stephen King?
- Which branches have multiple copies of some book?
- List all book titles available as paperbacks.
- List all fiction books by John Steinbeck for less than $10