In the Lecture Series Introduction to Database Systems

SQL

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Structured Query Language

- Originally developed in the System-R project of IBM (1974)
- Industry standard for relational databases (SQL92 is an ANSI/ISO standard)

Structured Query Language

- Data Definition Language for defining relations, views, integrity constraints, triggers
- Data Manipulation Language for updating, and querying
- Database Control Language for defining access rights, concurrency control, etc….

Querying One Table

Find all the information about students

```
SELECT *
FROM student;
```

```
SELECT name, email, year, faculty, department, graduate,
FROM student;
```

name	email	year	faculty	department	graduate
XIE XIN	xiexin2011@gmail.com	1/1/2007	Faculty of Science	Chemistry	
HUANG RAN	huangran1991@yahoo.com	1/8/2007	Faculty of Science	Biology	
GOH ENG CHYE	gohengchye1992@msn.com	1/8/2007	School of Computing	CS	
GOH HUI YING	gohhuiying1989@gmail.com	1/1/2008	Faculty of Science	Biology	
…					

Selecting Columns

Find the names and emails of students

```
SELECT name, email
FROM student;
```

name	email
XIE XIN	xiexin2011@gmail.com
HUANG RAN	huangran1991@yahoo.com
GOH ENG CHYE	gohengchye1992@msn.com
GOH HUI YING	gohhuiying1989@gmail.com
…	

Selecting Rows

Find the names and emails of computer science students

```
SELECT name, email
FROM student
WHERE department='CS';
```

name	email
GOH ENG CHYE	gohengchye1992@msn.com
ZHOU HUICHAN	zhouhuichan1990@msn.com
LIU SHAOJUN	liushaojun2010@msn.com
QIN YIYANG	qinyiyang2010@hotmail.com
…	

Selecting Rows

Find the names and emails of students who graduated after '01/08/10'

```
SELECT name, email, graduate
FROM student
WHERE graduate>= '01/08/10';
```

name	email	graduate
GERALDINE LEE	glee@msn.com	01/08/10
ADELINE WONG	awong007@msn.com	01/08/10
TANG CHEE YONG	tcy@hotmail.com	01/08/10

The condition must be TRUE (not FALSE, not UNKNOWN)

Querying Multiple Tables

Find the names of students and the titles of the books they own

```
SELECT student.name, book.title
FROM student, copy, book
WHERE student.email=copy.owner
AND copy.book=book.ISBN13;
```

name	title
XIE XIN	The Law
XIE XIN	Microsoft Office Access 2007: Comprehensive Concepts and Techniques (Shelly Cashman)
XIE XIN	Student Atlas of World Geography
XIE XIN	Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor (Wiley Science Editions)
…	

Tuple Variables

Find the names of students and the titles of the books they own

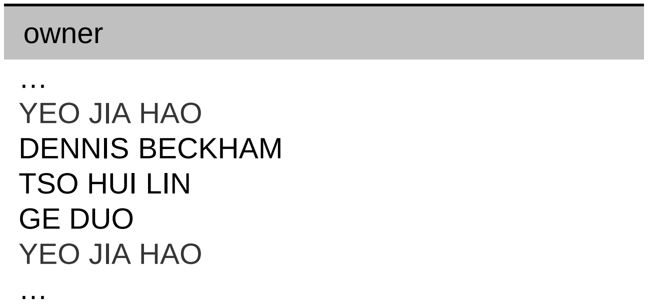
```
SELECT s.name, b.title
FROM student s, copy c, book b
WHERE s.email=c.owner
AND c.book=b.ISBN13;
```

name	title
XIE XIN	The Law
XIE XIN	Microsoft Office Access 2007: Comprehensive Concepts and Techniques (Shelly Cashman)
XIE XIN	Student Atlas of World Geography
XIE XIN	Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor (Wiley Science Editions)
…	

Renaming

Find the names of students who lent a book returned after 2010-03-04 to anniechapman1991@yahoo.com

```
SELECT s.name AS owner
FROM loan l, student s
WHERE  s.email=l.owner
   AND l.returned  > '2010-03-04'
   AND l.borrower = 'anniechapman1991@yahoo.com';
```



```
owner
…
YEO JIA HAO
DENNIS BECKHAM
TSO HUI LIN
GE DUO
YEO JIA HAO
…
```

Duplicates

Find the different names of students who lent a book returned after 2010-03-04 to anniechapman1991@yahoo.com

```
SELECT DISTINCT s.name AS owner
FROM loan l, student s
WHERE  s.email=l.owner
   AND l.returned  > '2010-03-04'
   AND l.borrower = 'anniechapman1991@yahoo.com';
```

owner
…
DENNIS BECKHAM
GE DUO
TSO HUI LIN
YEO JIA HAO
…

Ordering Rows

Find the names of students who lent a book returned after 2010-03-04 to anniechapman1991@yahoo.com in descending alpha-numerical order

```
SELECT s.name AS owner
FROM loan l, student s
WHERE s.email=l.owner
   AND l.returned  > '2010-03-04'
   AND l.borrower = 'anniechapman1991@yahoo.com'
   ORDER BY name DESC;
```

owner
…
ZENG YIHUI
YEO JIA HAO
YEO JIA HAO
…

Ordering Rows

Find the ISBN14 of the books that have been borrowed by anniechapman1991@yahoo.com , their borrowing and return dates in ascending order of the borrowing and return dates

```
SELECT l.book, l.borrowed, l.returned
FROM loan l
WHERE l.borrower='anniechapman1991@yahoo.com'
ORDER BY l.borrowed, l.returned;
```

book	borrowed	returned
978-1405072878	1/1/2010	17/3/2010
978-0596007126	1/1/2010	14/4/2010
978-9562913621	2/1/2010	3/1/2010
978-0470526705	4/1/2010	11/1/2010
…		

Arithmetic

Find the price of the Schaum s Outline books and add 50% to it

```
SELECT m.price * 1.5
FROM mgh m
WHERE m.title LIKE '%Schaum s Outline%’;
```

mgh

ISBN13	title	authors	price
978-0071508612	Schaum s Outline of Calculus	Frank Ayres, Elliott Mendelson	10
978-0071635264	Schaum s Outline of Chinese Grammar	Claudia Ross	12
978-0071639309	Practice Makes Perfect Spanish Verb Tenses	Dorothy Richmond	25

(No column name)
15
18

Aggregate Queries: Counting Rows

Find the total number of (different) books

```
SELECT COUNT(*)
   FROM book b;
```

```
SELECT COUNT(DISTINCT *)
   FROM book b;
```

(No column name)
311

Aggregate Queries: Counting Rows

Find the total number of titles

```
SELECT COUNT(b.title)
FROM book b;

SELECT COUNT(ALL b.title)
FROM book b;
```

(No column name)
311

Aggregate Queries: Counting Rows

Find the total number of different titles

```
SELECT COUNT(DISTINCT b.title)
FROM book b;
```

(No column name)
301

Aggregate Queries: Average, Minimum, etc.

Find the average price of a book from McGrawHill;

```
SELECT AVG(m.price)
FROM mgh m;
```

mgh

ISBN13	title	authors	price
978-0071508612	Schaum s Outline of Calculus	Frank Ayres, Elliott Mendelson	10
978-0071635264	Schaum s Outline of Chinese Grammar	Claudia Ross	12
978-0071639309	Practice Makes Perfect Spanish Verb Tenses	Dorothy Richmond	25

(No column name)
15.66

Aggregate Queries: Grouping

Find, for each day, the number of books borrowed by anniechapman1991@yahoo.com

```
SELECT COUNT(l.book)
FROM loan l
WHERE l.borrower='anniechapman1991@yahoo.com'
GROUP BY l.borrowed
```

Can we get 0?

(No column name)
2
1
1
2
…

Aggregate Queries: Grouping

This one eliminates duplicates

```
SELECT l.book
FROM loan l
GROUP BY l.book;
```

```
SELECT DISTINCT l.book
FROM loan l;
```

Aggregate Queries: Grouping

Find, for each day, the number of books borrowed by anniechapman1991@yahoo.com, print the day and the quantity

```
SELECT l.borrower, l.borrowed, COUNT(l.book)
FROM loan l
WHERE l.borrower='anniechapman1991@yahoo.com'
GROUP BY l.borrowed;
```

borrowed	Expr1001
1/1/2010	2
2/1/2010	1
4/1/2010	1
12/1/2010	1
16/1/2010	1

Aggregate Queries: Grouping

Find, for each day, the number of books borrowed by anniechapman1991@yahoo.com, print the borrower, the day and the quantity

```
SELECT l.borrower, l.borrowed, COUNT(l.book)
FROM loan l
WHERE l.borrower='anniechapman1991@yahoo.com'
GROUP BY l.borrowed
```

"not a GROUP BY expression"

Aggregate Queries: Grouping

Find, for each day, the number of books borrowed by anniechapman1991@yahoo.com, print the borrower, the day and the quantity

```
SELECT l.borrower, l.borrowed, COUNT(l.book)
FROM loan l
WHERE l.borrower='anniechapman1991@yahoo.com'
GROUP BY l.borrowed, l.borrower
```

borrower	borrowed	Expr1002
anniechapman1991@yahoo.com	1/1/2010	2
anniechapman1991@yahoo.com	2/1/2010	1
anniechapman1991@yahoo.com	4/1/2010	1
anniechapman1991@yahoo.com	12/1/2010	1
…		

Aggregate Queries: Grouping

Find, for each day, the number of books borrowed, print the borrower, the day and the quantity

```
SELECT l.borrower, l.borrowed, COUNT(l.book)
FROM loan l
GROUP BY l.borrowed, l.borrower;
```

borrower	borrowed	Expr1002
angjiayi1990@hotmail.com	1/1/2010	1
anniechapman1991@yahoo.com	1/1/2010	2
davidhall1992@yahoo.com	1/1/2010	1
dennispalmer1992@yahoo.com	1/1/2010	1
…		

Aggregate Queries: Grouping

What does this query find?

```
SELECT l.borrower, l.borrowed, COUNT(l.book)
FROM loan l
GROUP BY l.borrowed, l.borrower, l.book;
```

Aggregate Queries: Condition

Find the students who borrowed more that one book on any given day

```
SELECT l.borrower
FROM loan l
GROUP BY l.borrowed, l.borrower
WHERE COUNT(l.book) >1
```

“Incorrect syntax near the keyword 'WHERE'.”

Aggregate Queries: Condition

Find the students who borrowed more that one book on any given day

```
SELECT l.borrower
FROM loan l
GROUP BY l.borrowed, l.borrower
HAVING COUNT(l.book) >1;
```

borrower
angjiayi1990@hotmail.com
angjiayi1990@hotmail.com
anniechapman1991@yahoo.com
anniechapman1991@yahoo.com
…

Aggregate Queries: Condition

Find the different students who borrowed more that one book on any given day

```
SELECT DISTINCT l.borrower
FROM loan l
GROUP BY l.borrowed, l.borrower
HAVING COUNT(l.book) >1;
```

borrower
angjiayi1990@hotmail.com
anniechapman1991@yahoo.com
anupamaanghan2010@yahoo.com
chewsoennam1989@msn.com
…

Nested Queries

Find the names of the students from whom anniechapman1991@yahoo.com borrowed a book and returned it after 2010-03-04

```
SELECT s.name
FROM student s
WHERE s.email = ANY (SELECT l.owner
  FROM loan l
  WHERE l.returned  > '2010-03-04'
  AND l.borrower = 'anniechapman1991@yahoo.com');
```

22 rows

Nested Queries

Find the names of the students from whom anniechapman1991@yahoo.com borrowed a book and returned it after 2010-03-04

```
SELECT s.name
FROM student s
WHERE email IN (SELECT l.owner
   FROM loan l
   WHERE l.returned  > '2010-03-04'
   AND l.borrower = 'anniechapman1991@yahoo.com');
```

22 rows

Nested Queries

Find the names of the students from whom anniechapman1991@yahoo.com borrowed a book and returned it after 2010-03-04

```
SELECT s.name
FROM loan l, student s
WHERE s.email=l.owner
   AND l.returned  > '2010-03-04'
   AND l.borrower = 'anniechapman1991@yahoo.com';
```

27 rows

Nested Queries

Find the different students from whom anniechapman1991@yahoo.com never borrowed

```
SELECT s.email
FROM student s
WHERE s.email NOT IN (SELECT l.owner
   FROM loan l
   WHERE l.borrower = 'anniechapman1991@yahoo.com');
```

72 rows

Nested Queries

Find the different students from whom anniechapman1991@yahoo.com never borrowed

```
SELECT s.email
FROM student s
WHERE s.email  <> ALL (SELECT l.owner
   FROM  loan l
   WHERE l.borrower ='anniechapman1991@yahoo.com');
```

72 rows

Nested Queries

Find the different students from whom anniechapman1991@yahoo.com never borrowed

```
SELECT s.email
FROM student s
WHERE NOT EXISTS (SELECT l.owner
   FROM loan l
   WHERE s.email = l.owner
   AND l.borrower = 'anniechapman1991@yahoo.com');
```

72 rows

Nested Queries (Scope)

An attribute can only be used within the SELECT and WHERE clauses of the query in which its relation is declared (FROM clause) and within sub-queries queries

Nested Queries

- There can be multiple nested queries and multiple levels of nested queries
- Nested queries can appear in the WHERE but also the HAVING clauses

Union

```
SELECT *
FROM student T
WHERE T.department=‘CS’
UNION
SELECT *
FROM student T
WHERE T.department=‘IS’
```

Find all the information about students in the computer science department or in the information systems department

Intersection

```
SELECT T1.email
FROM student T
WHERE T1.department=‘CS’
INTERSECT
SELECT T2.owner AS email
FROM copy T2
WHERE T2.book='978-0262033848’
```

Find the emails of students in the computer science department owning a book with ISBN14 ‘978-0262033848’

(Non-Symmetric) Difference

```
SELECT T1.email
FROM student T1
WHERE T1.department=‘CS’
MINUS
SELECT T2.owner AS email
FROM copy T2
WHERE T2.book='978-0262033848’
```

Find all the mails of students in the computer science department but those owning a book with ISBN14 ‘978-0262033848’

Join

```
SELECT T1.email
FROM student T1, copy T2
WHERE T1.department=‘CS’
AND T2.owner=T1.email
AND T2.book='978-0262033848’
```

Find all the mails of students in the computer science department owning a book with ISBN14 ‘978-0262033848’

Inner Join

```
SELECT T1.email
FROM student T1 INNER JOIN copy T2
ON T2.owner=T1.email
WHERE T1.department=‘CS’
AND T2.book='978-0262033848’
```

Find all the mails of students in the computer science department owning a book with ISBN14 ‘978-0262033848’

Left Outer Join

```
Select T1.name,T2.book
FROM student T1, copy T2
WHERE T1.email=T2.owner
UNION
SELECT T3.name, CAST(NULL AS CHAR(14)AS book
FROM student T3
WHERE NOT EXISTS (SELECT *
                  FROM copy T4
                  WHERE T3.email=T4.owner)
```

Find the names of the students and the titles of the books they own. If a student does not own any book, print a NULL value

Left Outer Join

```
Select DISTINCT T1.name,T2.book
FROM student T1 LEFT OUTER JOIN copy T2
ON T1.email=T2.owner
```

Find the names of the students and the titles of the books they own. If a student does not own any book, print a NULL value

Right Outer Join

```
Select DISTINCT T2.title, T1.owner
FROM copy T1 RIGHT OUTER JOIN book T2
ON T1.book=T2.ISBN14
```

Find the title of books and the emails of their owner. If a book does not have an owner , print a NULL value

Full Outer Join

```
Select DISTINCT T2.a, T1.c
FROM table1 T1 FULL OUTER JOIN table T2
ON T1.b=T2.b
```

Other Join

- (EQUI) JOIN
- NATURAL JOIN USING
- CROSS JOIN

Summary

1. FROM
2. WHERE
3. GROUP BY
4. HAVING
5. ORDER BY
6. SELECT

Credits

The content of this lecture is based on chapter 5 of the book "Introduction to database Systems"
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