Database Fundamentals

Lecture 4 (SQL Joins and Subqueries)

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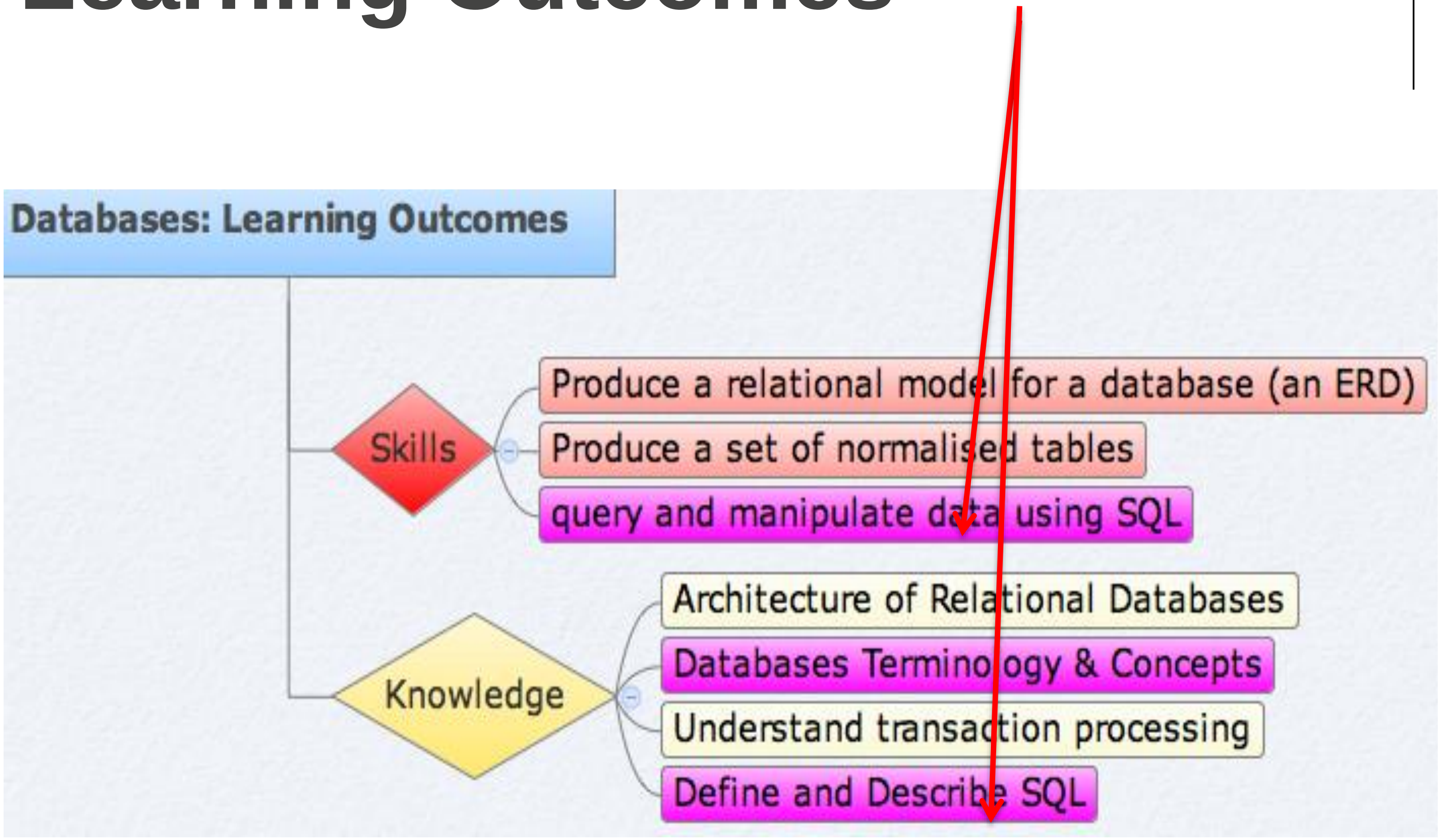
Learning Outcomes



Databases: Learning Outcomes

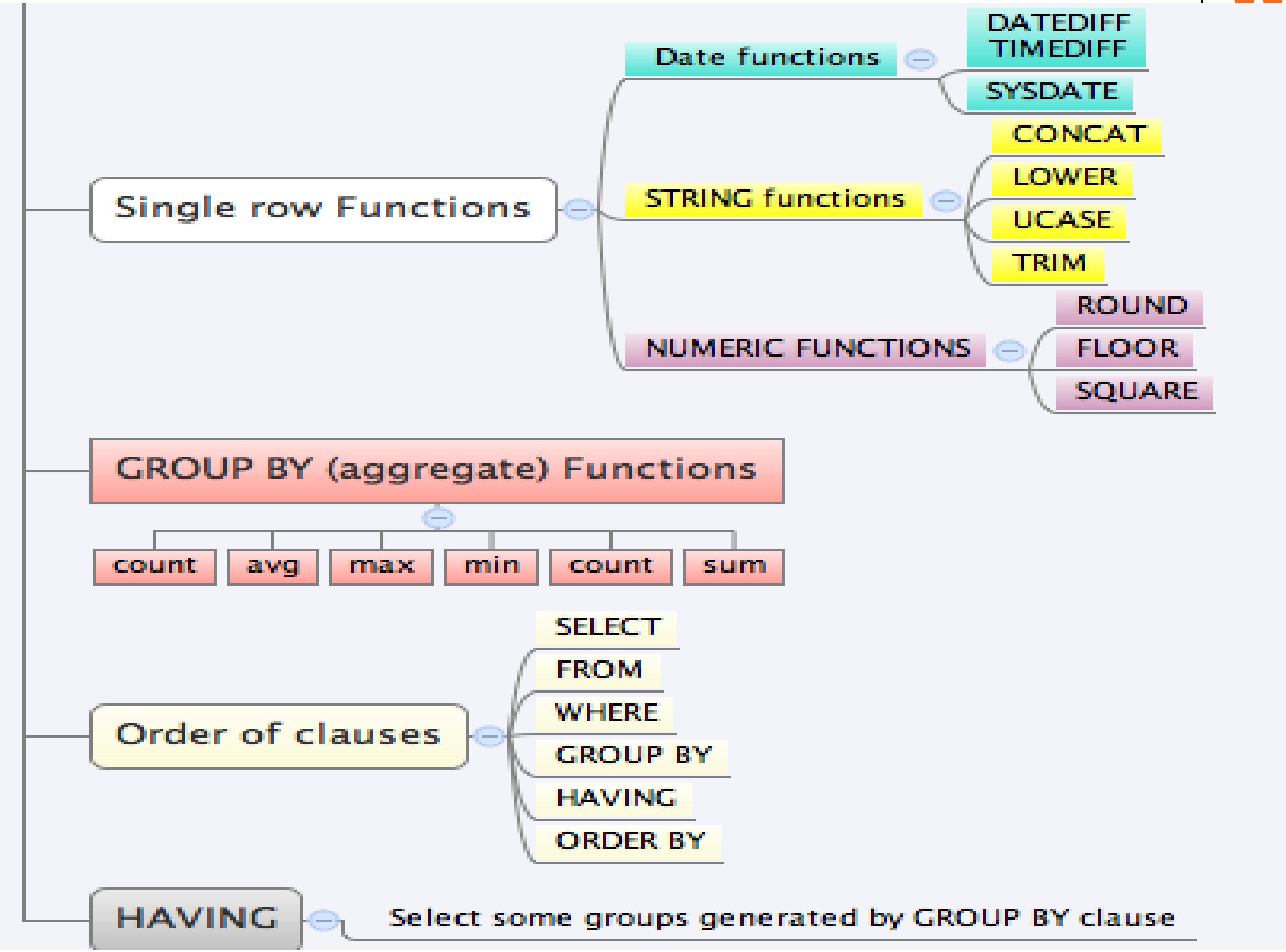
Skills

- Produce a relational model for a database (an ERD)
- Produce a set of normalised tables
- query and manipulate data using SQL

Knowledge

- Architecture of Relational Databases
- Databases Terminology & Concepts
- Understand transaction processing
- Define and Describe SQL

Recap



Single row Functions

Date functions

DATEDIFF
TIMEDIFF

SYSDATE

STRING functions

CONCAT

LOWER

UCASE

TRIM

NUMERIC FUNCTIONS

ROUND

FLOOR

SQUARE

GROUP BY (aggregate) Functions

count

avg

max

min

count

sum

Order of clauses

SELECT

FROM

WHERE

GROUP BY

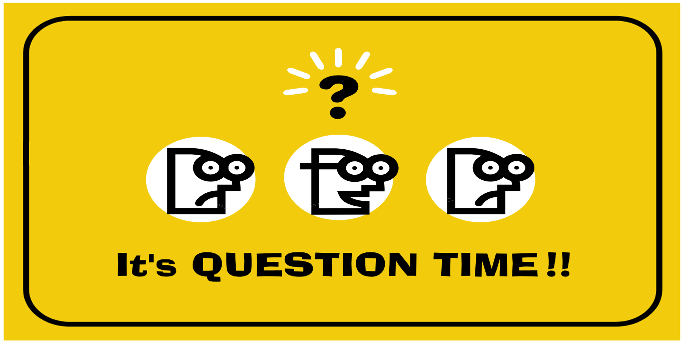
HAVING

ORDER BY

HAVING

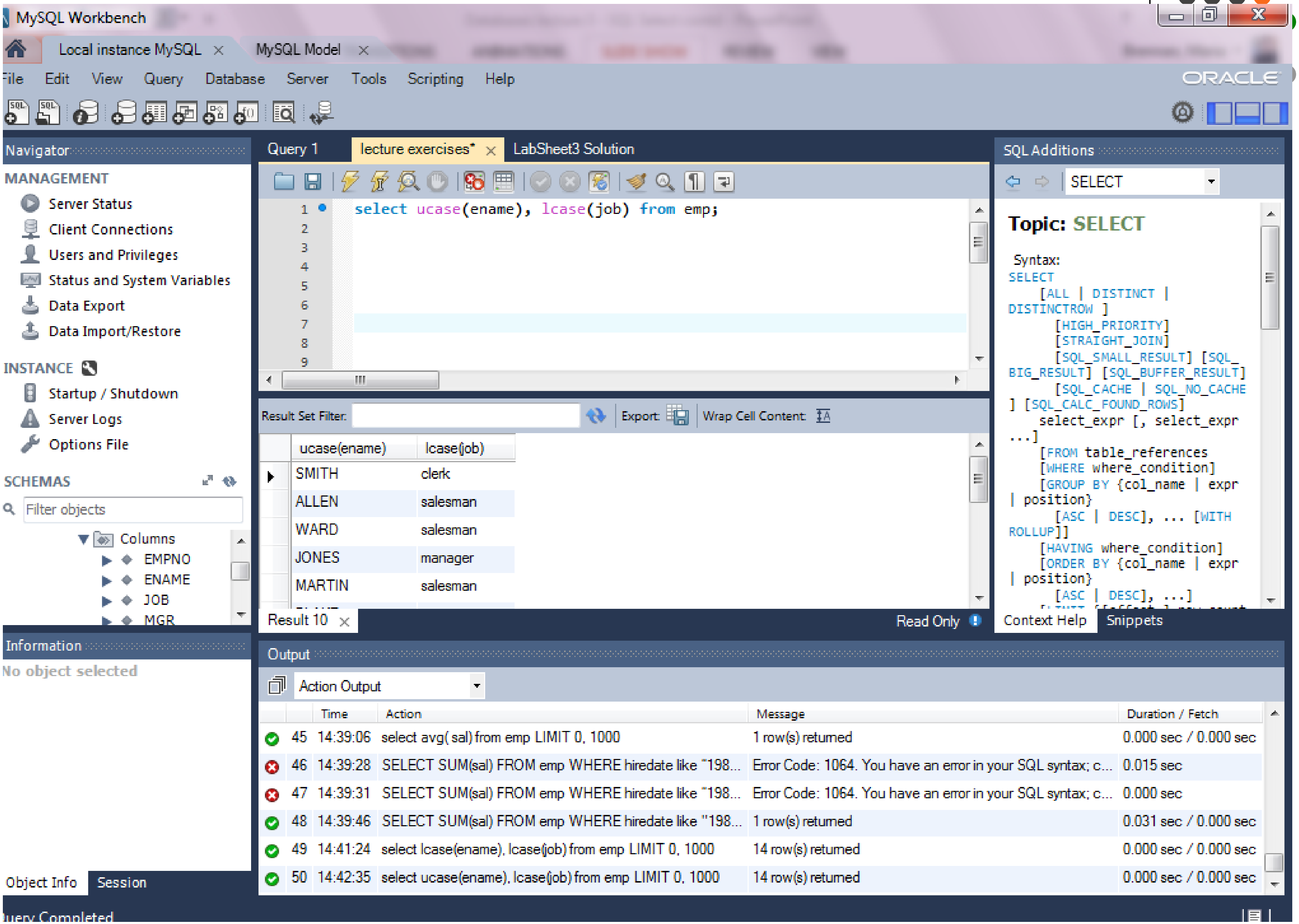
Select some groups generated by GROUP BY clause

Exercises - In class (Single Row Functions)



- Write a query which displays all employee names in uppercase, and the job name in lower case

- Calculate to the nearest year how many years each employee has worked with the company



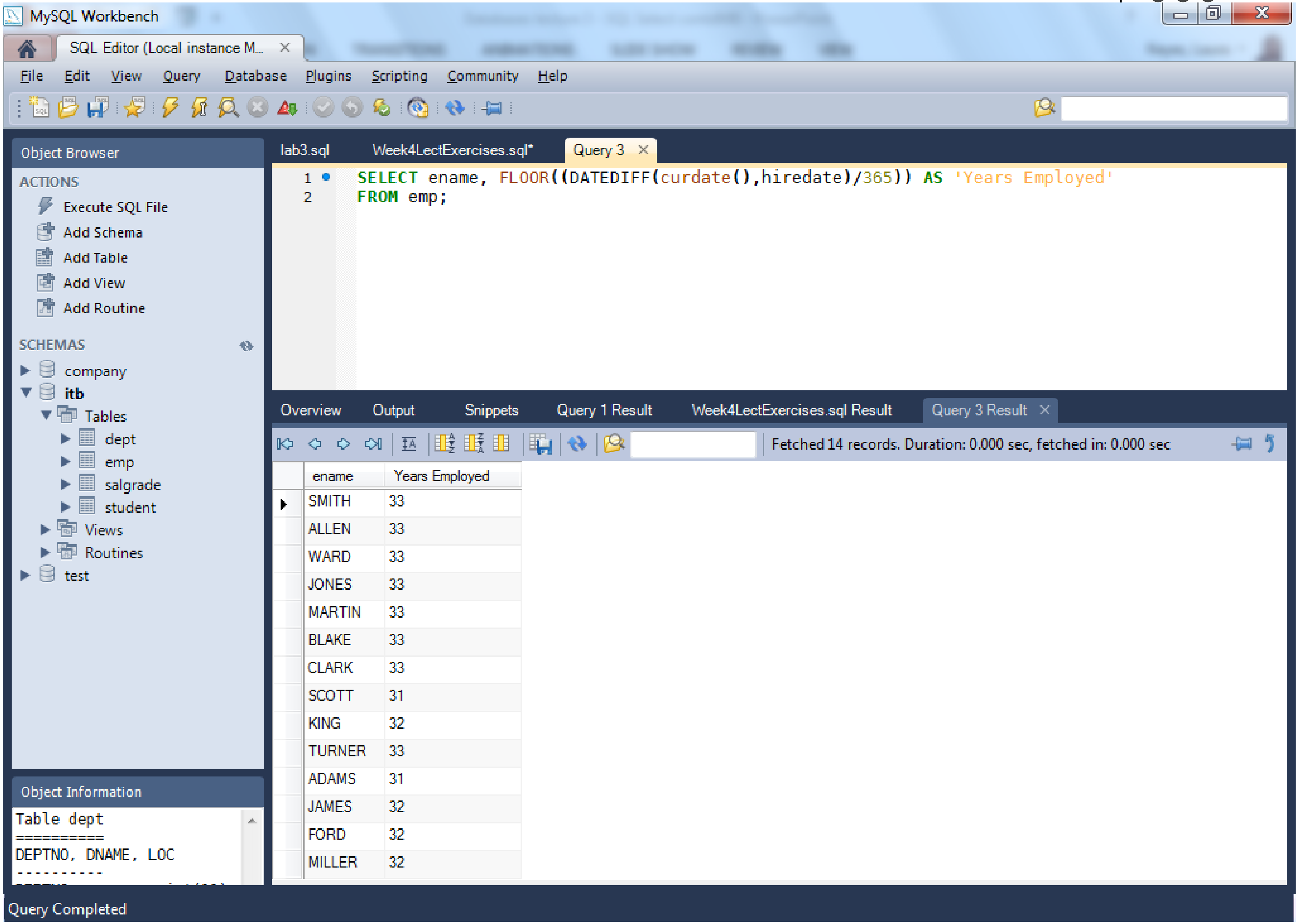
```
select ucase(ename), lcase(job) from emp;
```

ucase(ename)	lcase(job)
SMITH	clerk
ALLEN	salesman
WARD	salesman
JONES	manager
MARTIN	salesman

Topic: SELECT

```
Syntax:
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
```

	Time	Action	Message	Duration / Fetch
✓ 45	14:39:06	select avg(sal) from emp LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec
✗ 46	14:39:28	SELECT SUM(sal) FROM emp WHERE hiredate like "198...	Error Code: 1064. You have an error in your SQL syntax; c...	0.015 sec
✗ 47	14:39:31	SELECT SUM(sal) FROM emp WHERE hiredate like "198...	Error Code: 1064. You have an error in your SQL syntax; c...	0.000 sec
✓ 48	14:39:46	SELECT SUM(sal) FROM emp WHERE hiredate like "198...	1 row(s) returned	0.031 sec / 0.000 sec
✓ 49	14:41:24	select lcase(ename), lcase(job) from emp LIMIT 0, 1000	14 row(s) returned	0.000 sec / 0.000 sec
✓ 50	14:42:35	select ucase(ename), lcase(job) from emp LIMIT 0, 1000	14 row(s) returned	0.000 sec / 0.000 sec



```sql
SELECT ename, FLOOR((DATEDIFF(curdate(),hiredate)/365)) AS 'Years Employed'
FROM emp;
```

Fetched 14 records. Duration: 0.000 sec, fetched in: 0.000 sec

ename	Years Employed
SMITH	33
ALLEN	33
WARD	33
JONES	33
MARTIN	33
BLAKE	33
CLARK	33
SCOTT	31
KING	32
TURNER	33
ADAMS	31
JAMES	32
FORD	32
MILLER	32

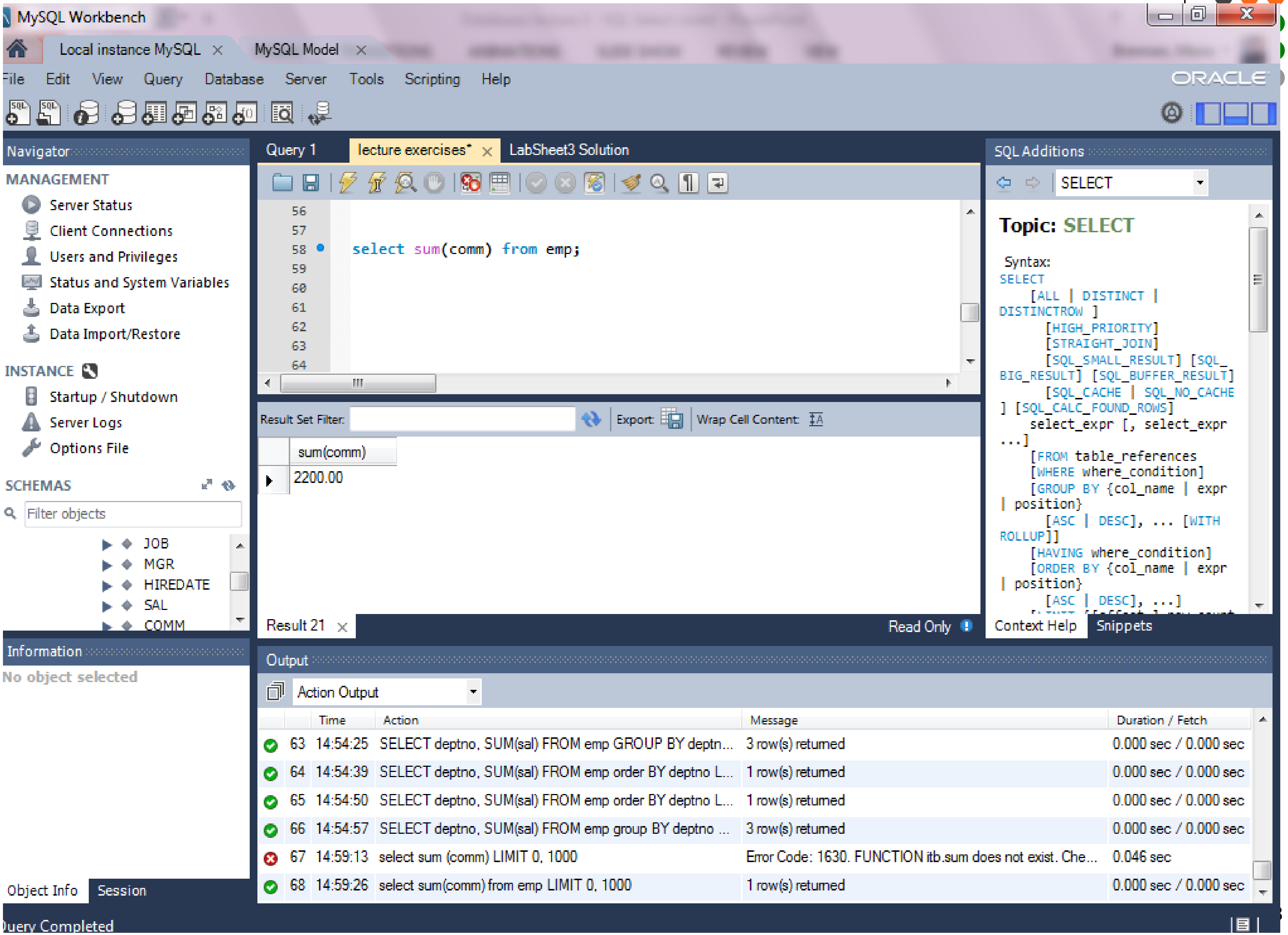
```
Table dept
==========
DEPTNO, DNAME, LOC
----------
```

Query Completed

Exercise (Group Functions)

- Calculate the total amount paid out in commission.
- How many employees have a salary greater than £1500?
- What is the average salary?
- What is the average salary rounded to the nearest whole number?
- How many distinct salary amounts are there?

Calculate the total amount paid out in commission



```sql
select sum(comm) from emp;
```

sum(comm)
2200.00

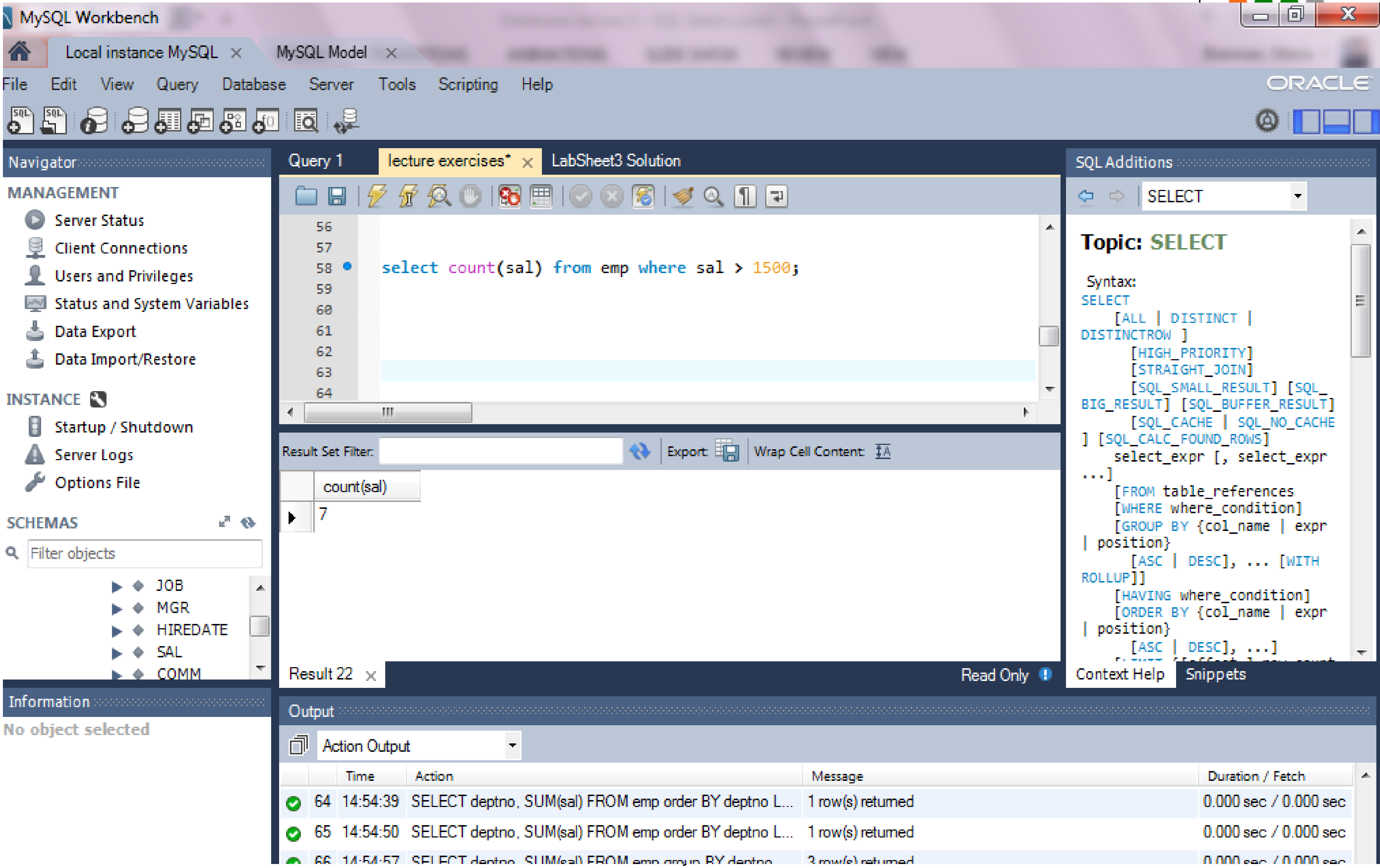
Topic: SELECT

Syntax:

```
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
```

```
    Time      Action                                             Message                                              Duration / Fetch
63  14:54:25  SELECT deptno, SUM(sal) FROM emp GROUP BY deptn...  3 row(s) returned                                    0.000 sec / 0.000 sec
64  14:54:39  SELECT deptno, SUM(sal) FROM emp order BY deptno L...  1 row(s) returned                                  0.000 sec / 0.000 sec
65  14:54:50  SELECT deptno, SUM(sal) FROM emp order BY deptno L...  1 row(s) returned                                  0.000 sec / 0.000 sec
66  14:54:57  SELECT deptno, SUM(sal) FROM emp group BY deptno ...  3 row(s) returned                                   0.000 sec / 0.000 sec
67  14:59:13  select sum (comm) LIMIT 0, 1000                    Error Code: 1630. FUNCTION itb.sum does not exist. Che...  0.046 sec
68  14:59:26  select sum(comm) from emp LIMIT 0, 1000            1 row(s) returned                                    0.000 sec / 0.000 sec
```

How many employees have a salary greater than £1500?



```
select count(sal) from emp where sal > 1500;
```

count(sal)
7

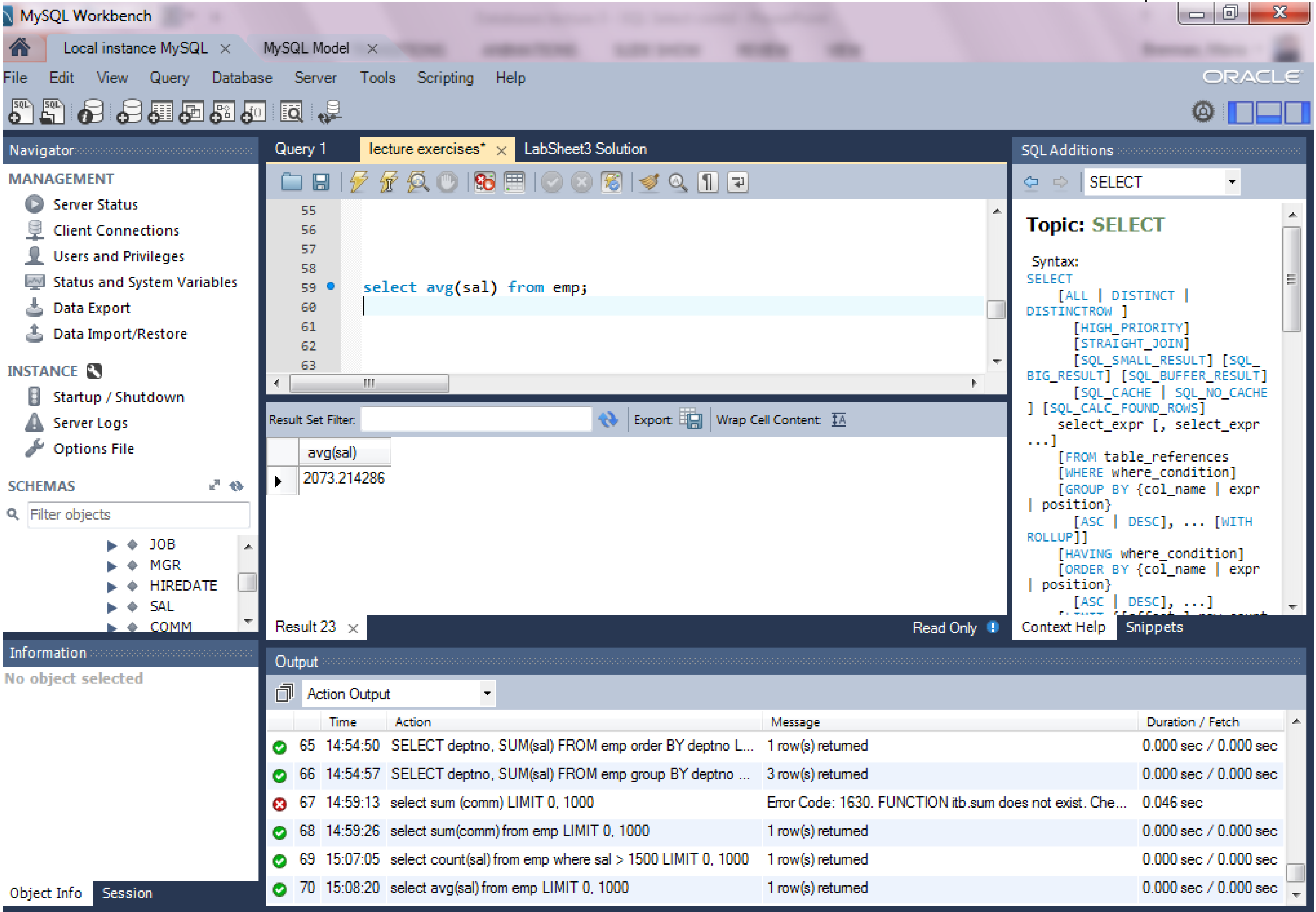
Topic: SELECT

Syntax:

```
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
```

```
     Time      Action                                        Message              Duration / Fetch
64   14:54:39  SELECT deptno, SUM(sal) FROM emp order BY deptno L...   1 row(s) returned    0.000 sec / 0.000 sec
65   14:54:50  SELECT deptno, SUM(sal) FROM emp order BY deptno L...   1 row(s) returned    0.000 sec / 0.000 sec
66   14:54:57  SELECT deptno, SUM(sal) FROM emp group BY deptno ...    3 row(s) returned    0.000 sec / 0.000 sec
```

What is the average salary?



```
select avg(sal) from emp;
```

avg(sal)
2073.214286

Topic: SELECT

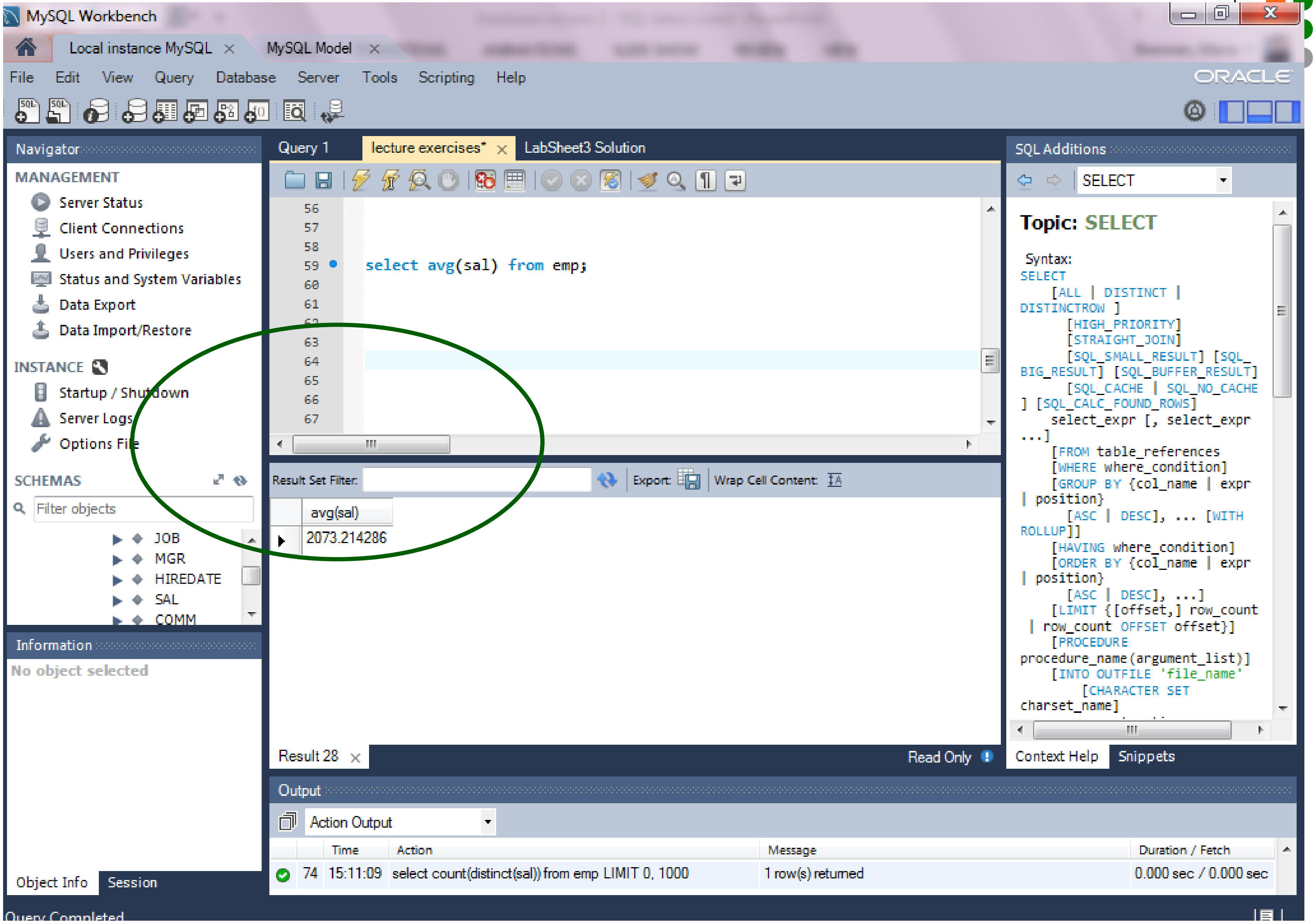
Syntax:

```
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
```

		Time	Action	Message	Duration / Fetch
✓	65	14:54:50	SELECT deptno, SUM(sal) FROM emp order BY deptno L...	1 row(s) returned	0.000 sec / 0.000 sec
✓	66	14:54:57	SELECT deptno, SUM(sal) FROM emp group BY deptno ...	3 row(s) returned	0.000 sec / 0.000 sec
✗	67	14:59:13	select sum (comm) LIMIT 0, 1000	Error Code: 1630. FUNCTION itb.sum does not exist. Che...	0.046 sec
✓	68	14:59:26	select sum(comm) from emp LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec
✓	69	15:07:05	select count(sal) from emp where sal > 1500 LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec
✓	70	15:08:20	select avg(sal) from emp LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec

What is the average salary rounded to the nearest whole number?

step by step example…



```
select avg(sal) from emp;
```

avg(sal)
2073.214286

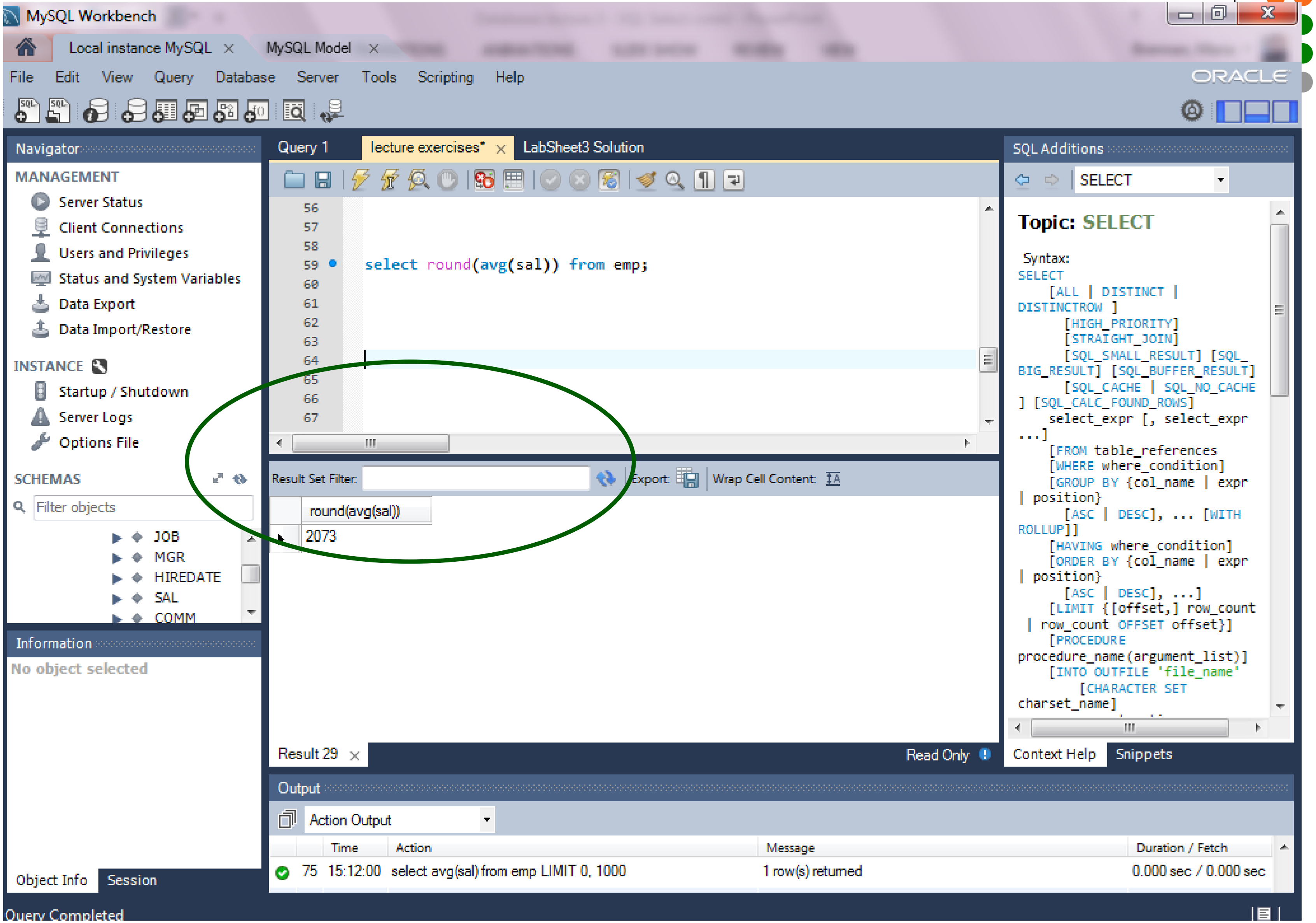
Topic: SELECT

Syntax:

```
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
    [LIMIT {[offset,] row_count
 | row_count OFFSET offset}]
    [PROCEDURE
procedure_name(argument_list)]
    [INTO OUTFILE 'file_name'
        [CHARACTER SET
charset_name]
```

		Time	Action	Message	Duration / Fetch
✓	74	15:11:09	select count(distinct(sal)) from emp LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec

To the nearest whole number – rounding up, round()



```sql
select round(avg(sal)) from emp;
```

```
round(avg(sal))
2073
```

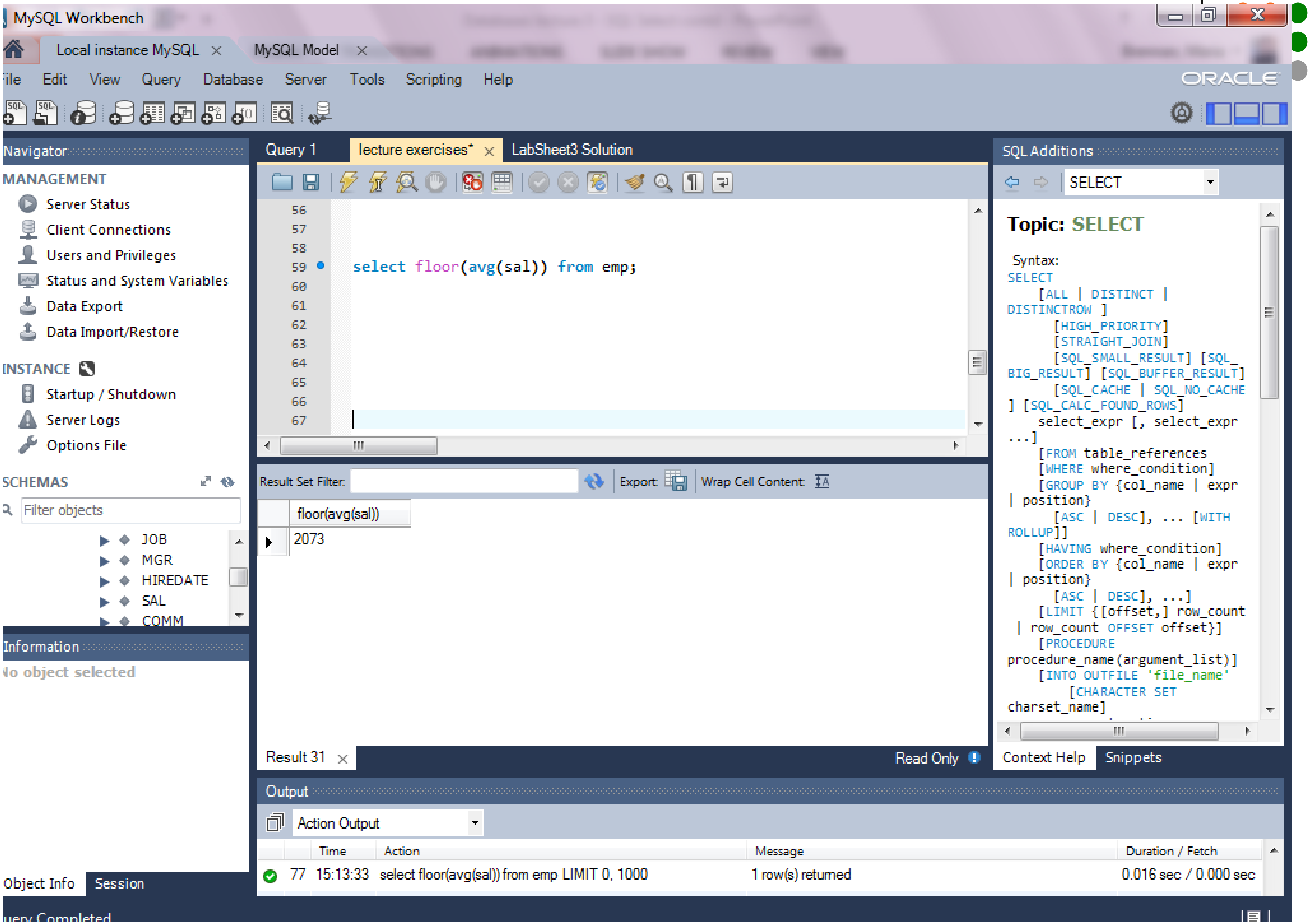
Topic: SELECT

```
Syntax:
SELECT
      [ALL | DISTINCT |
DISTINCTROW ]
        [HIGH_PRIORITY]
        [STRAIGHT_JOIN]
        [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
        [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
      select_expr [, select_expr
...]
      [FROM table_references
      [WHERE where_condition]
      [GROUP BY {col_name | expr
| position}
        [ASC | DESC], ... [WITH
ROLLUP]]
      [HAVING where_condition]
      [ORDER BY {col_name | expr
| position}
        [ASC | DESC], ...]
      [LIMIT {[offset,] row_count
 | row_count OFFSET offset}]
      [PROCEDURE
procedure_name(argument_list)]
      [INTO OUTFILE 'file_name'
          [CHARACTER SET
charset_name]
```

```
    Time      Action                                  Message            Duration / Fetch
✓ 75  15:12:00  select avg(sal) from emp LIMIT 0, 1000  1 row(s) returned  0.000 sec / 0.000 sec
```

Query Completed

To the nearest whole number – rounding down, floor()



```
select floor(avg(sal)) from emp;
```

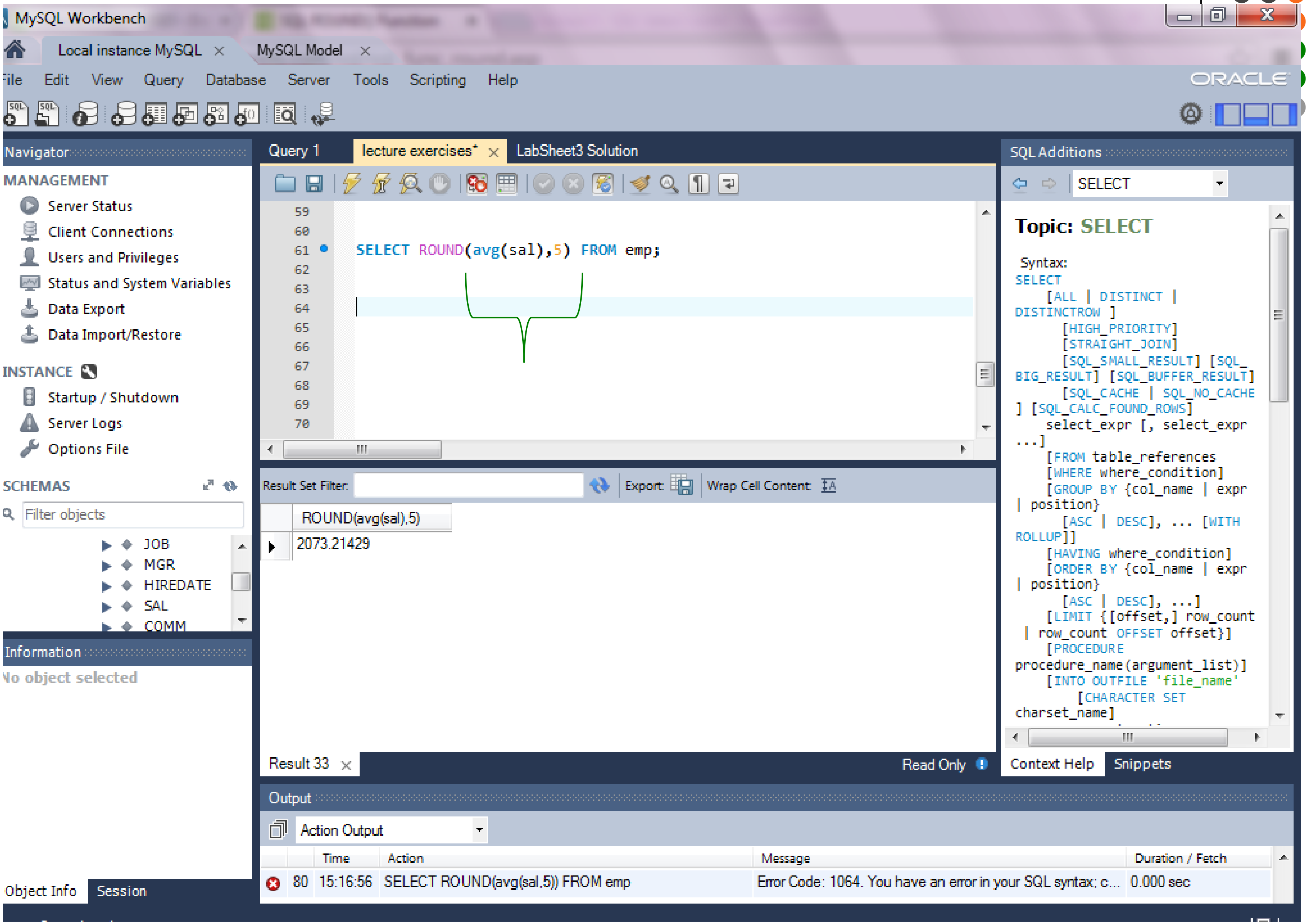
	floor(avg(sal))
▶	2073

Topic: SELECT

```
Syntax:
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
    [LIMIT {[offset,] row_count
 | row_count OFFSET offset}]
    [PROCEDURE
procedure_name(argument_list)]
    [INTO OUTFILE 'file_name'
        [CHARACTER SET
charset_name]
```

		Time	Action	Message	Duration / Fetch
✓	77	15:13:33	select floor(avg(sal)) from emp LIMIT 0, 1000	1 row(s) returned	0.016 sec / 0.000 sec

To 5 decimal places…



```
SELECT ROUND(avg(sal),5) FROM emp;
```

ROUND(avg(sal),5)
2073.21429

Topic: SELECT

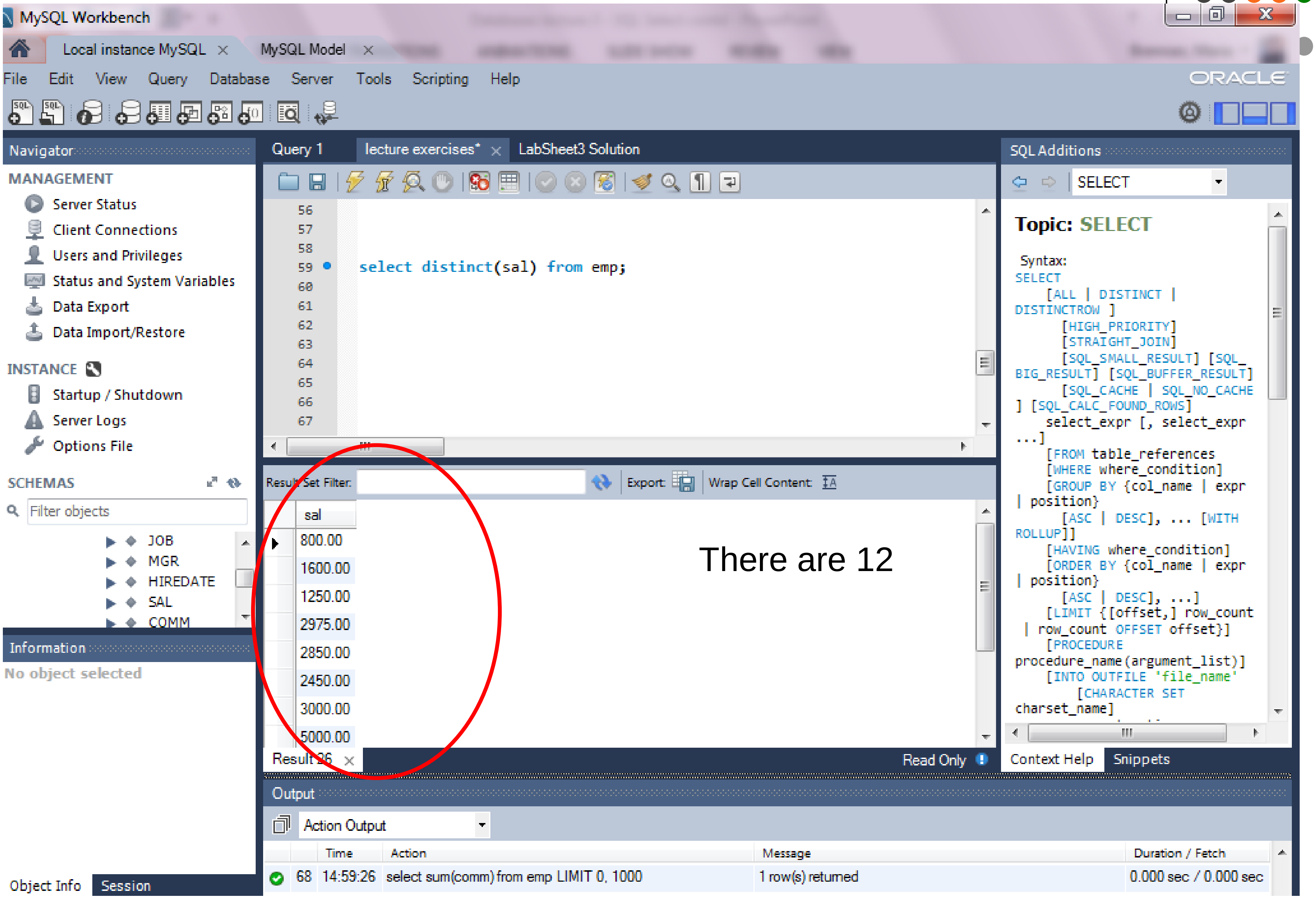
Syntax:

```
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
    [LIMIT {[offset,] row_count
 | row_count OFFSET offset}]
    [PROCEDURE
procedure_name(argument_list)]
    [INTO OUTFILE 'file_name'
        [CHARACTER SET
charset_name]
```

	Time	Action	Message	Duration / Fetch
80	15:16:56	SELECT ROUND(avg(sal,5)) FROM emp	Error Code: 1064. You have an error in your SQL syntax; c...	0.000 sec

G. Gray 2010

How many distinct salary amounts are there?



```
select distinct(sal) from emp;
```

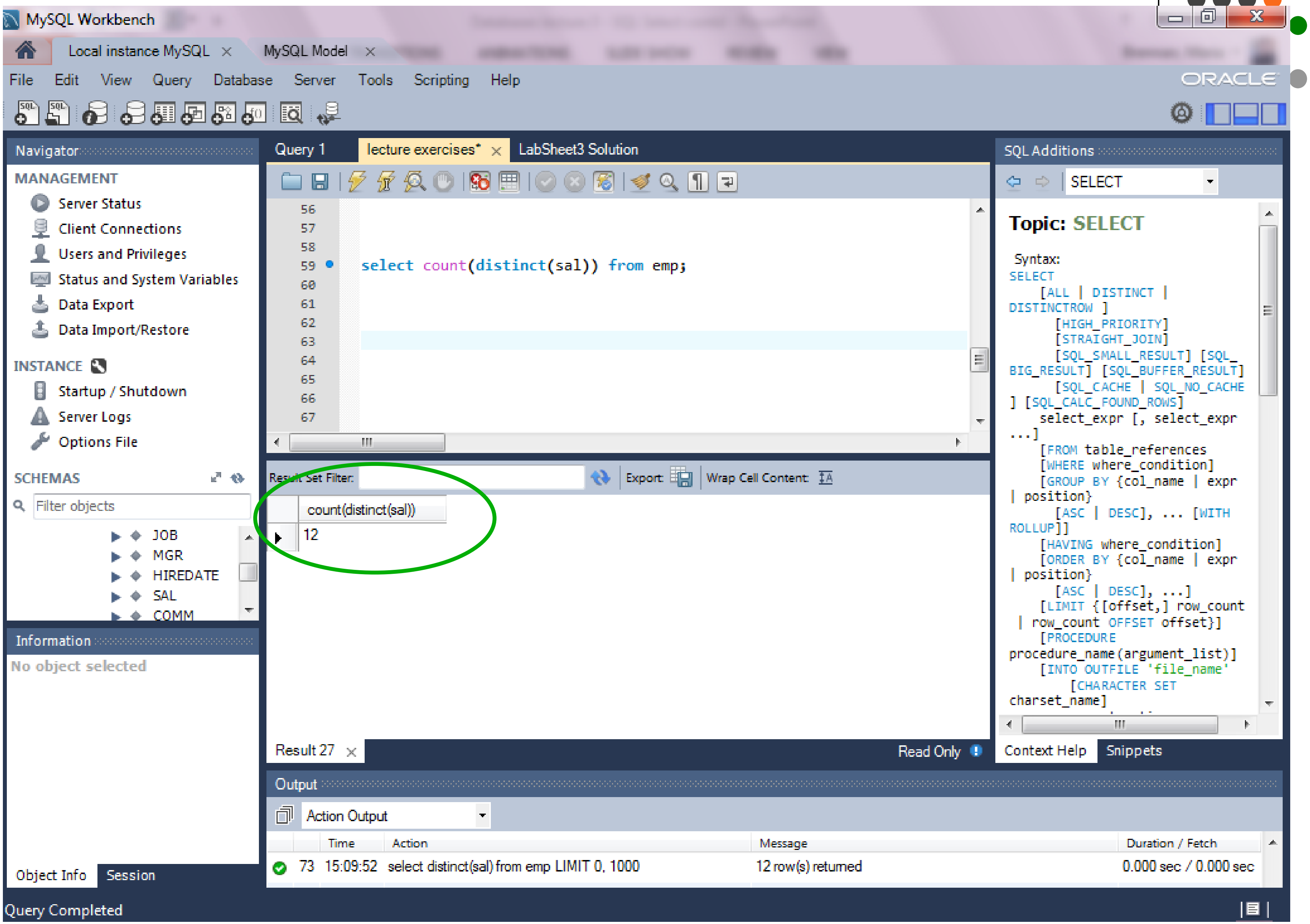
sal
800.00
1600.00
1250.00
2975.00
2850.00
2450.00
3000.00
5000.00

There are 12

Topic: SELECT

```
Syntax:
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
    [LIMIT {[offset,] row_count
 | row_count OFFSET offset}]
    [PROCEDURE
procedure_name(argument_list)]
    [INTO OUTFILE 'file_name'
        [CHARACTER SET
charset_name]
```

	Time	Action	Message	Duration / Fetch
68	14:59:26	select sum(comm) from emp LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec



```
select count(distinct(sal)) from emp;
```

count(distinct(sal))
12

	Time	Action	Message	Duration / Fetch
73	15:09:52	select distinct(sal) from emp LIMIT 0, 1000	12 row(s) returned	0.000 sec / 0.000 sec

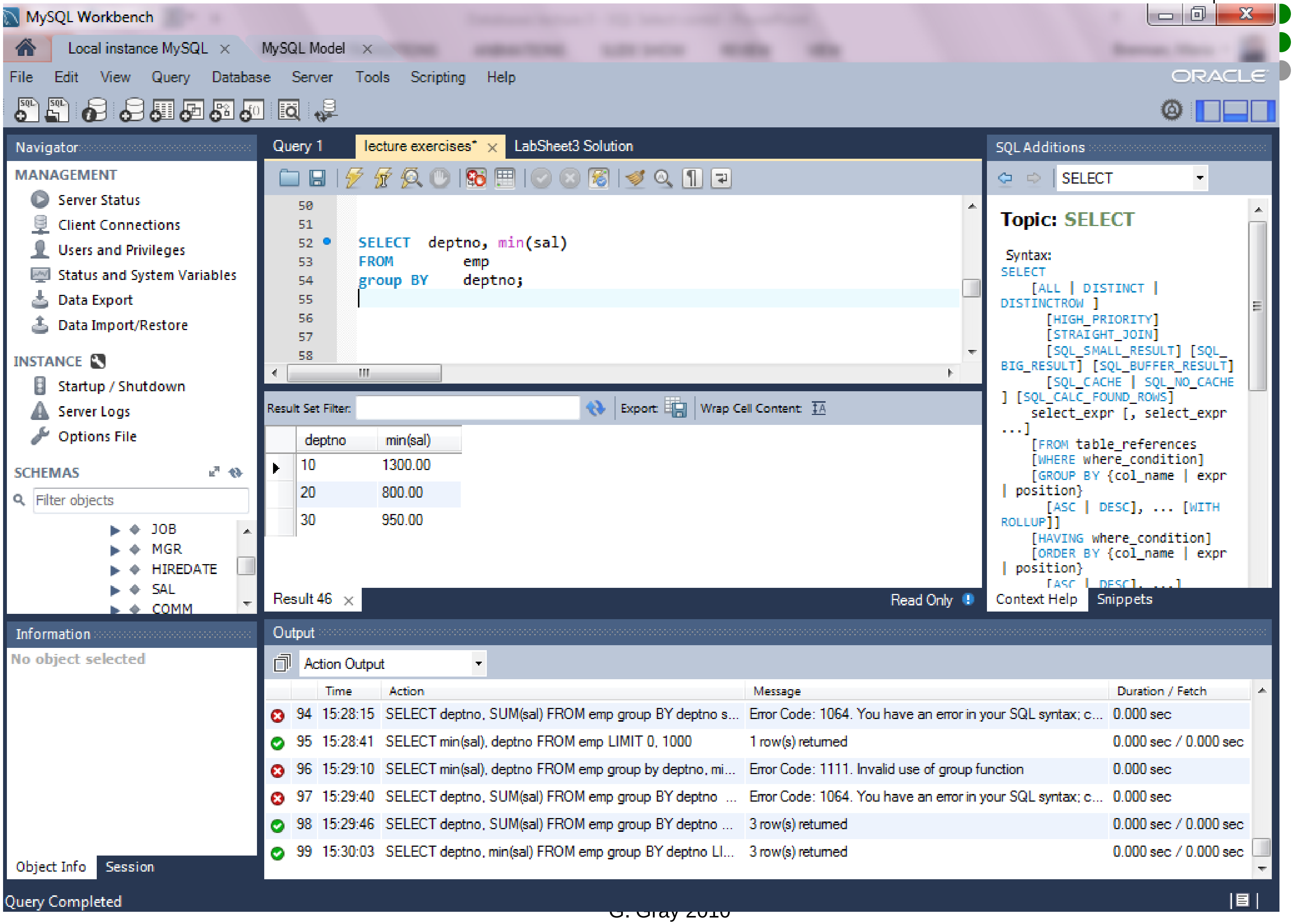
Topic: SELECT

```
Syntax:
SELECT
    [ALL | DISTINCT | DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr ...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr | position}
      [ASC | DESC], ... [WITH ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr | position}
      [ASC | DESC], ...]
    [LIMIT {[offset,] row_count | row_count OFFSET offset}]
    [PROCEDURE procedure_name(argument_list)]
    [INTO OUTFILE 'file_name'
        [CHARACTER SET charset_name]
```

Exercise (GROUP BY)

- What is the minimum salary in each department?
- Grouping employees by the manager they report to, what is the maximum salary paid in each group?

What is the minimum salary in each department?



```
SELECT  deptno, min(sal)
FROM       emp
group BY     deptno;
```

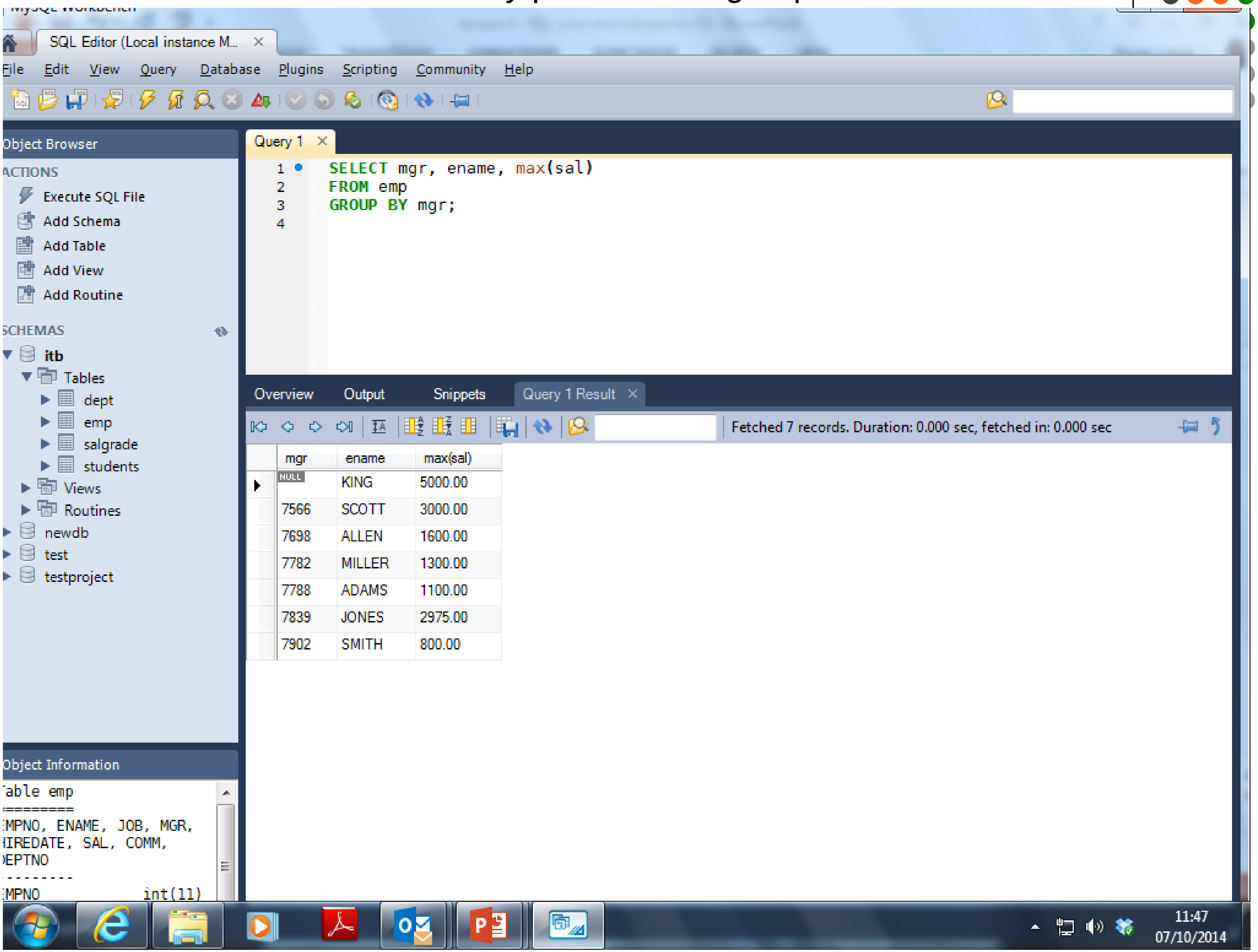
deptno	min(sal)
10	1300.00
20	800.00
30	950.00

```
Topic: SELECT

 Syntax:
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
```

	Time	Action	Message	Duration / Fetch
94	15:28:15	SELECT deptno, SUM(sal) FROM emp group BY deptno s...	Error Code: 1064. You have an error in your SQL syntax; c...	0.000 sec
95	15:28:41	SELECT min(sal), deptno FROM emp LIMIT 0, 1000	1 row(s) returned	0.000 sec / 0.000 sec
96	15:29:10	SELECT min(sal), deptno FROM emp group by deptno, mi...	Error Code: 1111. Invalid use of group function	0.000 sec
97	15:29:40	SELECT deptno, SUM(sal) FROM emp group BY deptno ...	Error Code: 1064. You have an error in your SQL syntax; c...	0.000 sec
98	15:29:46	SELECT deptno, SUM(sal) FROM emp group BY deptno ...	3 row(s) returned	0.000 sec / 0.000 sec
99	15:30:03	SELECT deptno, min(sal) FROM emp group BY deptno LI...	3 row(s) returned	0.000 sec / 0.000 sec

Grouping employees by the manager they report to, what is the maximum salary paid in each group?



```
SELECT mgr, ename, max(sal)
FROM emp
GROUP BY mgr;
```

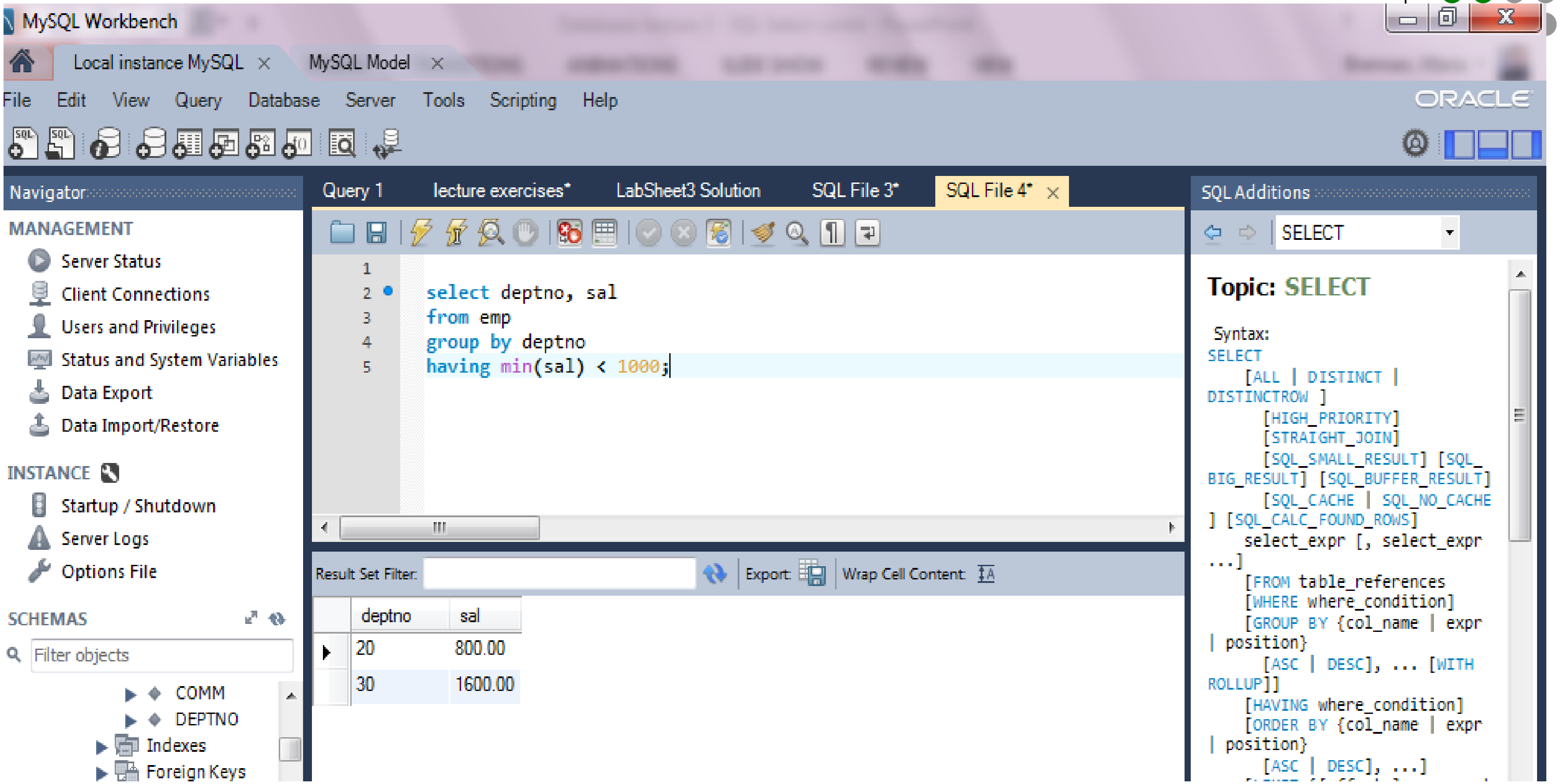
Fetched 7 records. Duration: 0.000 sec, fetched in: 0.000 sec

mgr	ename	max(sal)
NULL	KING	5000.00
7566	SCOTT	3000.00
7698	ALLEN	1600.00
7782	MILLER	1300.00
7788	ADAMS	1100.00
7839	JONES	2975.00
7902	SMITH	800.00

```
Table emp
=========
EMPNO, ENAME, JOB, MGR,
HIREDATE, SAL, COMM,
DEPTNO
---------
EMPNO              int(11)
```

Exercise (HAVING)

- Which department(s) have a minimum salary less than 1000?



```sql
select deptno, sal
from emp
group by deptno
having min(sal) < 1000;
```

deptno	sal
20	800.00
30	1600.00

Topic: SELECT

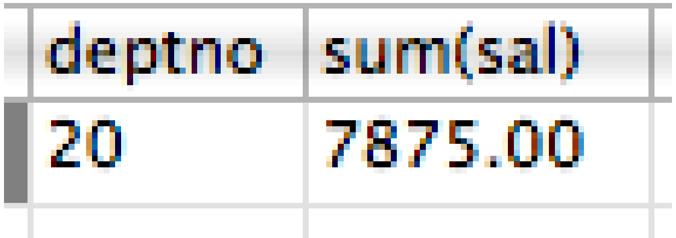
Syntax:

```
SELECT
    [ALL | DISTINCT |
DISTINCTROW ]
      [HIGH_PRIORITY]
      [STRAIGHT_JOIN]
      [SQL_SMALL_RESULT] [SQL_
BIG_RESULT] [SQL_BUFFER_RESULT]
      [SQL_CACHE | SQL_NO_CACHE
] [SQL_CALC_FOUND_ROWS]
    select_expr [, select_expr
...]
    [FROM table_references
    [WHERE where_condition]
    [GROUP BY {col_name | expr
| position}
      [ASC | DESC], ... [WITH
ROLLUP]]
    [HAVING where_condition]
    [ORDER BY {col_name | expr
| position}
      [ASC | DESC], ...]
```

Putting it all together

- For all employees with ‘S’ in their name, show the total salary by department, provided that total is more than 2000. Show highest value first.

```
SELECT deptno, sum(sal)
FROM emp
WHERE ename LIKE "%S%"
GROUP BY deptno
HAVING sum(sal) > 2000
ORDER BY sum(sal) DESC;
```



deptno	sum(sal)
20	7875.00

Another example with different tables . . . .. .

- For all non-Dublin based customers, show the total spent by each customer for all customers that spent more than £10,000. Show highest spenders first

```
SELECT customer_id, sum(order_total)
FROM order
WHERE customer_county NOT LIKE ‘Dublin%’
GROUP BY customer_id
HAVING sum(order_total) > 10,000
ORDER BY sum(order_total) DESC;
```

Order Table:

Order_ number	**Customer _id**	**Customer_c ounty**	**Order_ total**
001	46	Dublin	600
002	48	Cork	13,000
003	45	Limerick	7,000
004	46	Dublin	12,000
005	45	Limerick	5,000
006	50	Cavan	500
007	50	Cavan	2,000

Query result:

Customer_ID	**Sum(Order_total)**
48	13,000
45	12,000

Note the order of the clauses!!

```
SELECT columnlist
FROM tablename
WHERE condition
GROUP BY
HAVING group condition
ORDER BY           ;
```

Objective for this lecture:

Continue with SQL Select clause

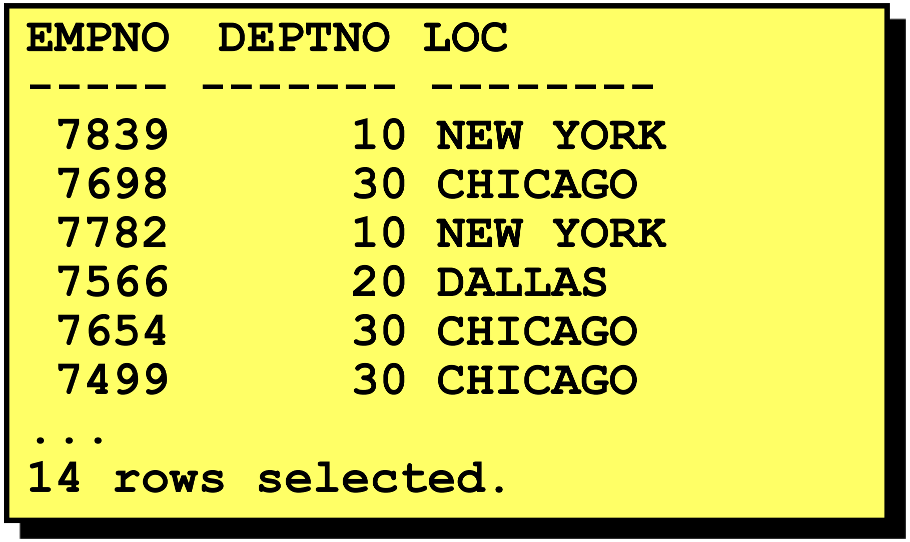
- **Join**two or more tables together to answer a query
- **Sub-queries**

Section 1

Joining tables together

Joining tables

- **JOINS** is obtaining data from multiple tables
- Where does the following data come from?



```
EMPNO  DEPTNO LOC
----- ------- ---------
 7839      10 NEW YORK
 7698      30 CHICAGO
 7782      10 NEW YORK
 7566      20 DALLAS
 7654      30 CHICAGO
 7499      30 CHICAGO
...
14 rows selected.
```

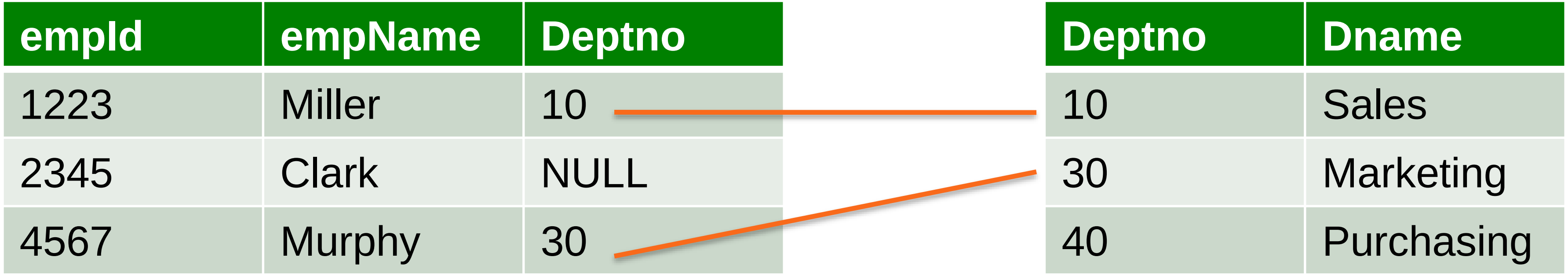
JOIN

- A JOIN operation **combines two or more tables** generating **one result set** from the information stored in such tables

- One column needs to be the same in each table, usually a **foreign key**, which is the column used to JOIN the two tables.

- Six JOIN keywords:
  - INNER JOIN
  - LEFT OUTER JOIN
  - RIGHT OUTER JOIN
  - FULL OUTER JOIN
  - NON-EQUI JOIN
  - CROSS JOIN (CARTESIAN PRODUCT)

Types of Joins



empId	empName	Deptno
1223	Miller	10
2345	Clark	NULL
4567	Murphy	30

Deptno	Dname
10	Sales
30	Marketing
40	Purchasing

- **Inner Join**: only show rows that are linked across both tables

  Two rows returned:

Miller	Sales
Murphy	Marketing

- **Left outer join**: show all rows from the first table, and only rows that match in the second table.
  - Three rows returned:

Miller	Sales
Clark	NULL
Murphy	Marketing

Types of Joins

empId	empName	Deptno
1223	Miller	10
2345	Clark	NULL
4567	Murphy	30

Deptno	Dname
10	Sales
30	Marketing
40	Purchasing

- **Right outer join**: show all rows from the Second table, and only rows that match in the First table.

Three rows returned:

Miller	Sales
Murphy	Marketing
NULL	Purchasing

- **FULL outer join**: show all rows from both tables.

Four rows returned:

Miller	Sales
Clark	NULL

Types of join

- A cross join is generally the result you get when you have made a mistake! It links ALL rows in one table with ALL rows in the other table as follows:

Four rows returned:

Miller	Sales
Miller	Marketing
Miller	Purchasing
Clark	Sales
Clark	Marketing
Clark	Purchasing
Murphy	Sales
Murphy	Marketing
Murphy	Purchasing

Non-equi joins will be explained in a later slide

EXAMPLE: INNER JOIN

```
SELECT emp.empno, dept.deptno, dept.loc
FROM emp INNER JOIN dept
ON emp.deptno = dept.deptno;
```

- Rows in one table can be joined to rows in another table according to common values existing in corresponding tables, **usually primary and foreign keys.**
- **The FROM clause specifies the tables to use and the type of JOIN**
- **INNER JOIN returns all common rows in two or more tables**
- ON clause – specifies what columns to use to finding matching rows
- The column name is prefixed by the table name if the same column name appears in more than one table
- You can have other conditions in the query, such as a WHERE clause, e.g. WHERE dept.deptno>30

Using aliases for table names

Rather than including the full table name in front of column names, you can give each table an alias in the FROM clause, and use the alias in all other clauses. For example:

```
SELECT  emp.empno, dept.deptno, dept.loc
FROM emp INNER JOIN dept
ON          emp.deptno = dept.deptno;
```

is the same as

```
SELECT e.empno, d.deptno, d.loc
FROM emp e INNER JOIN dept d
ON  e.deptno = d.deptno;
```

Cross Join(Cartesian Product)

Warning:

If no join condition is included, or if it is invalid, the DBMS joins every row in the first table with every row in the second table - this is called a **Cartesian product.**

emp

emp_id	**deptno**
001	10
002	10
003	20
004	30

dept

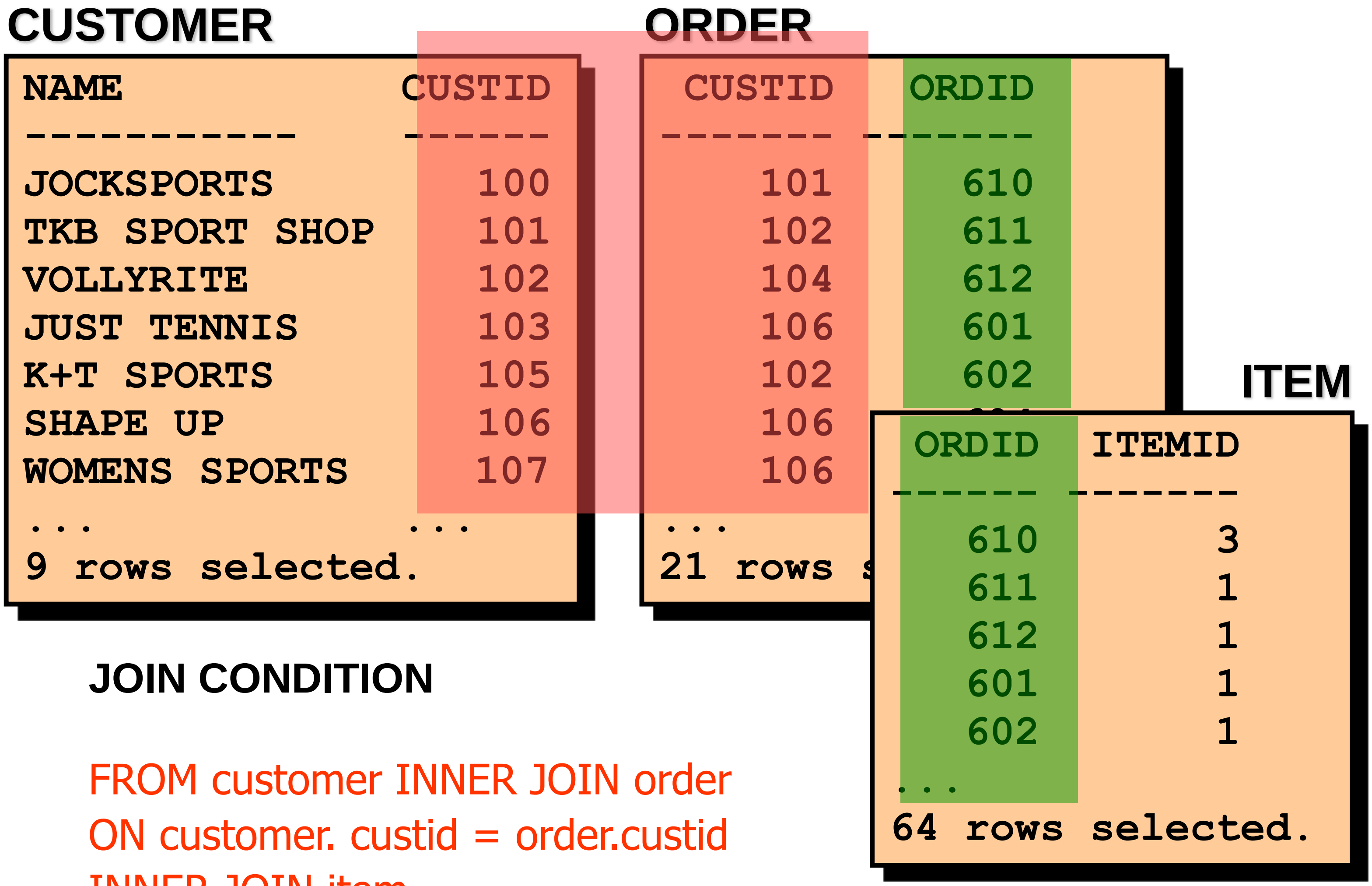
deptno	**dept_name**
10	sales
20	purchasing
30	finance

SELECT emp_id, dept_name
FROM emp INNER JOIN dept
would give:

query result:

emp_id	**dept_name**
001	10
001	20
001	30
002	10
002	20
002	30
003	10
003	20
003	30

Joining more than two tables



CUSTOMER

```
NAME               CUSTID
-----------        -------
JOCKSPORTS             100
TKB SPORT SHOP         101
VOLLYRITE              102
JUST TENNIS            103
K+T SPORTS             105
SHAPE UP               106
WOMENS SPORTS          107
...                ...
9 rows selected.
```

ORDER

```
  CUSTID    ORDID
-------- -------
     101     610
     102     611
     104     612
     106     601
     102     602
     106
     106
...
21 rows s
```

ITEM

```
 ORDID    ITEMID
------ -------
   610        3
   611        1
   612        1
   601        1
   602        1
...
64 rows selected.
```

JOIN CONDITION

FROM customer INNER JOIN order
ON customer. custid = order.custid
INNER JOIN item
ON order.ordid = item.ordid;

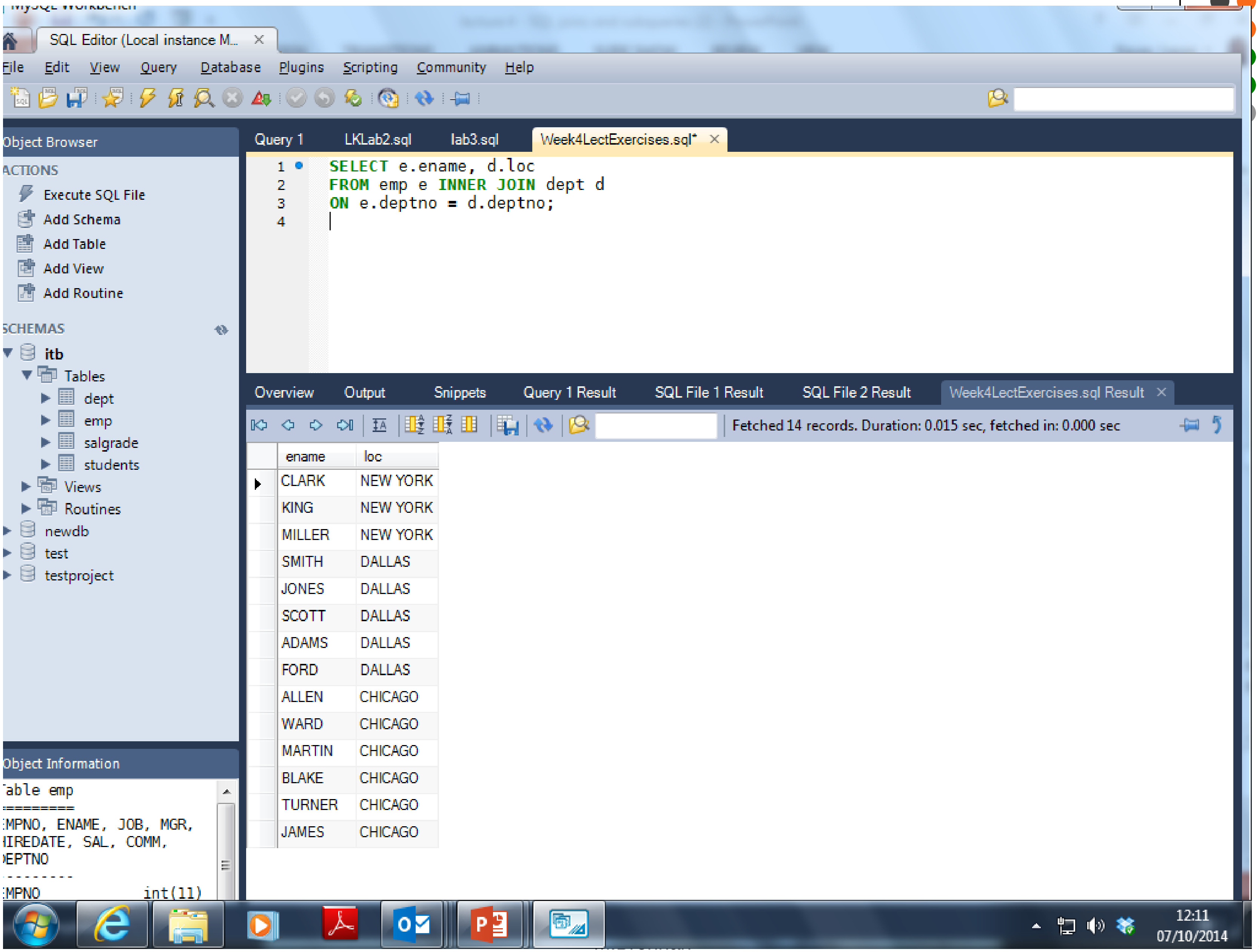
- Note: When joining ‘n’ tables, there should be at least ‘n-1’ join conditions.

- If you have 4 tables then you must have at least 3 conditions

Exercises

- List the name and location for each employee
- List the name and location for each employee in Chicago
- Give the employee name and department name for each CLERK.

List the name and location for each employee



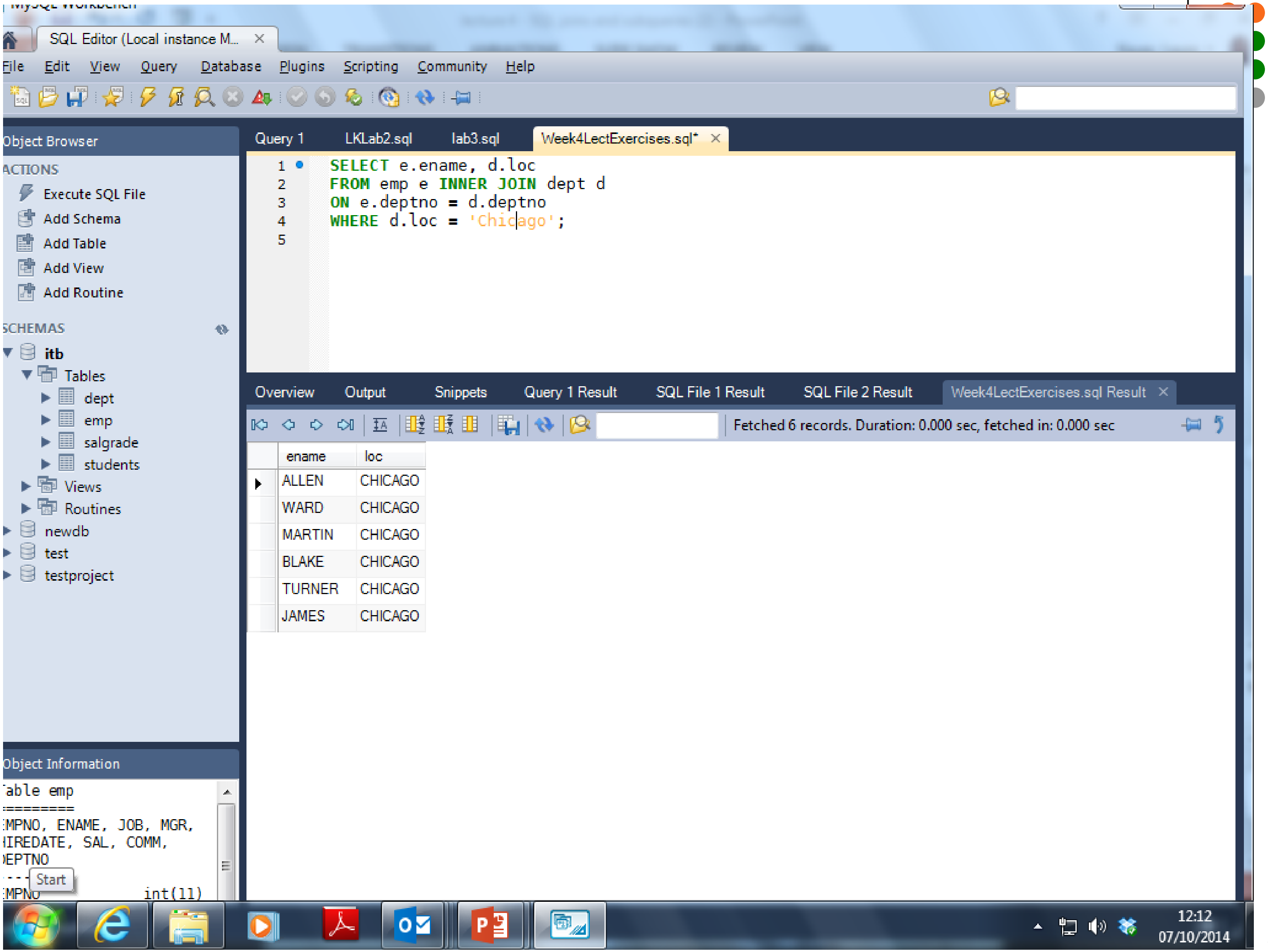
```sql
SELECT e.ename, d.loc
FROM emp e INNER JOIN dept d
ON e.deptno = d.deptno;
```

Fetched 14 records. Duration: 0.015 sec, fetched in: 0.000 sec

ename	loc
CLARK	NEW YORK
KING	NEW YORK
MILLER	NEW YORK
SMITH	DALLAS
JONES	DALLAS
SCOTT	DALLAS
ADAMS	DALLAS
FORD	DALLAS
ALLEN	CHICAGO
WARD	CHICAGO
MARTIN	CHICAGO
BLAKE	CHICAGO
TURNER	CHICAGO
JAMES	CHICAGO

```
able emp
=========
MPNO, ENAME, JOB, MGR,
IREDATE, SAL, COMM,
EPTNO
--------
MPNO              int(11)
```

List the name and location for each employee in Chicago



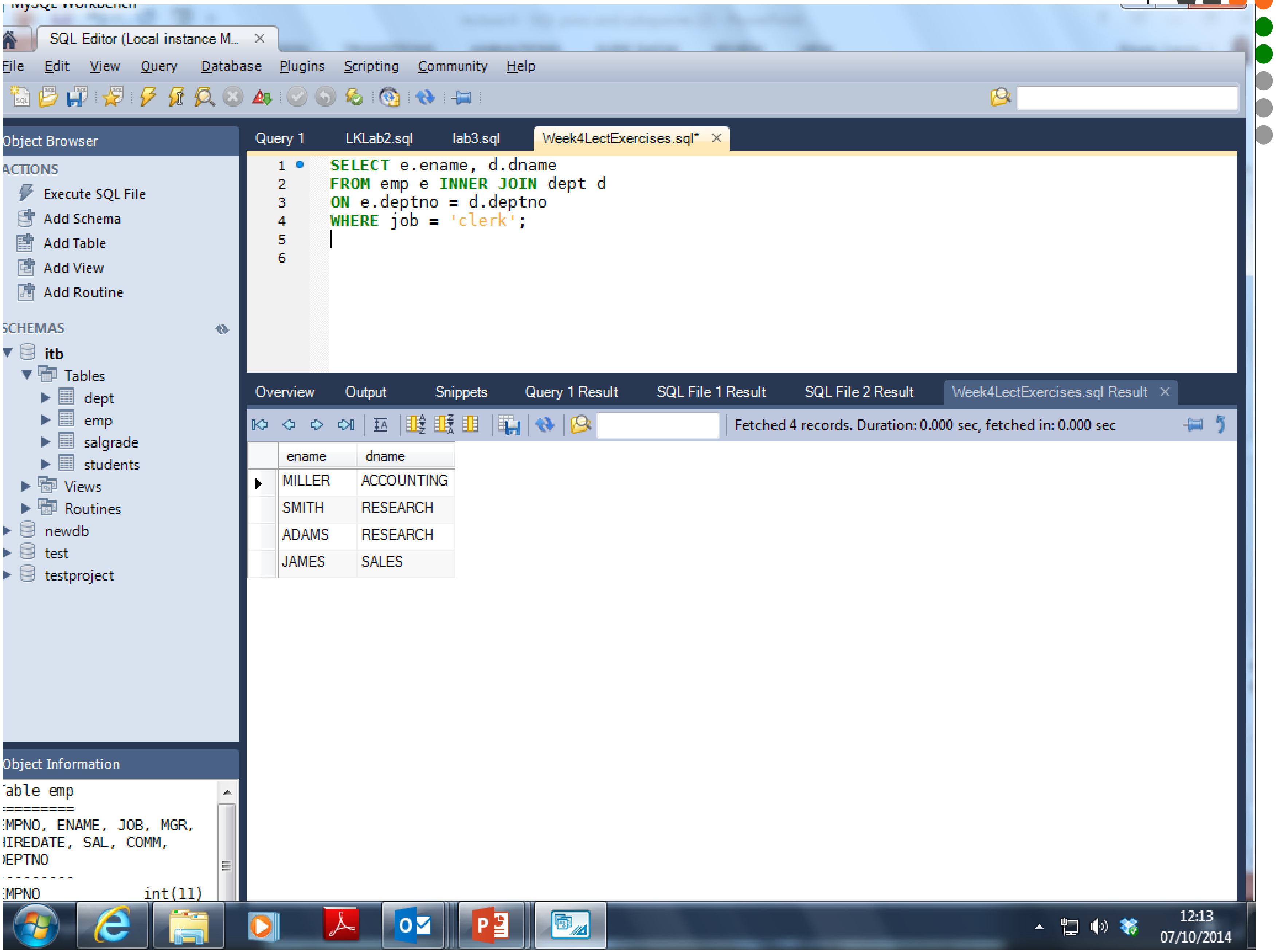
```sql
SELECT e.ename, d.loc
FROM emp e INNER JOIN dept d
ON e.deptno = d.deptno
WHERE d.loc = 'Chicago';
```

Fetched 6 records. Duration: 0.000 sec, fetched in: 0.000 sec

ename	loc
ALLEN	CHICAGO
WARD	CHICAGO
MARTIN	CHICAGO
BLAKE	CHICAGO
TURNER	CHICAGO
JAMES	CHICAGO

```
able emp
=========
MPNO, ENAME, JOB, MGR,
IREDATE, SAL, COMM,
EPTNO
---
MPNO                int(11)
```

Give the employee name and department name for each CLERK.



```sql
SELECT e.ename, d.dname
FROM emp e INNER JOIN dept d
ON e.deptno = d.deptno
WHERE job = 'clerk';
```

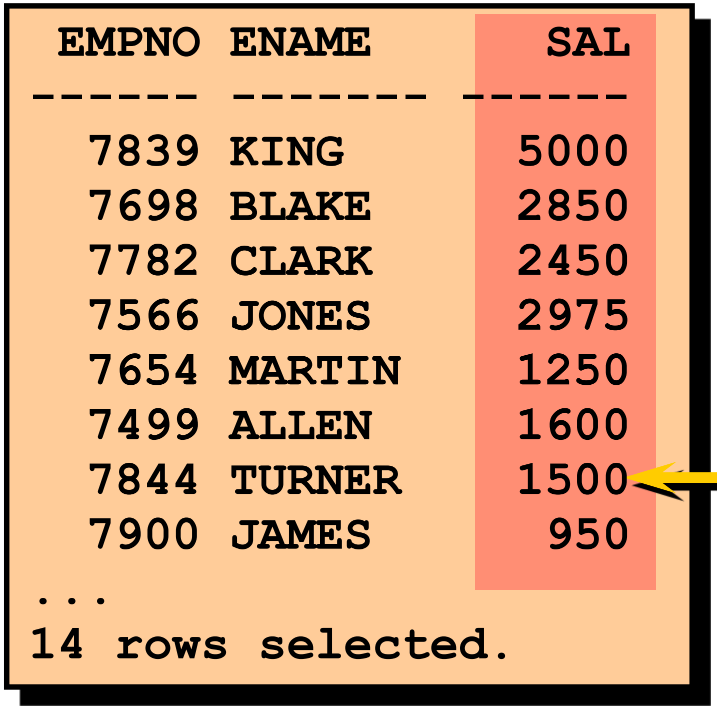
Fetched 4 records. Duration: 0.000 sec, fetched in: 0.000 sec

ename	dname
MILLER	ACCOUNTING
SMITH	RESEARCH
ADAMS	RESEARCH
JAMES	SALES

```
able emp
=========
MPNO, ENAME, JOB, MGR,
IREDATE, SAL, COMM,
EPTNO
--------
MPNO            int(11)
```

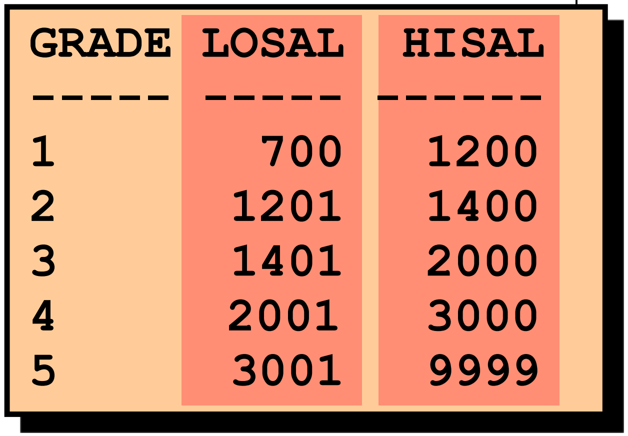
Non-equijoin – using a comparison operator other than =

EMP



```
 EMPNO ENAME        SAL
------ -------- -------
  7839 KING        5000
  7698 BLAKE       2850
  7782 CLARK       2450
  7566 JONES       2975
  7654 MARTIN      1250
  7499 ALLEN       1600
  7844 TURNER      1500
  7900 JAMES        950
...
14 rows selected.
```

SALGRADE

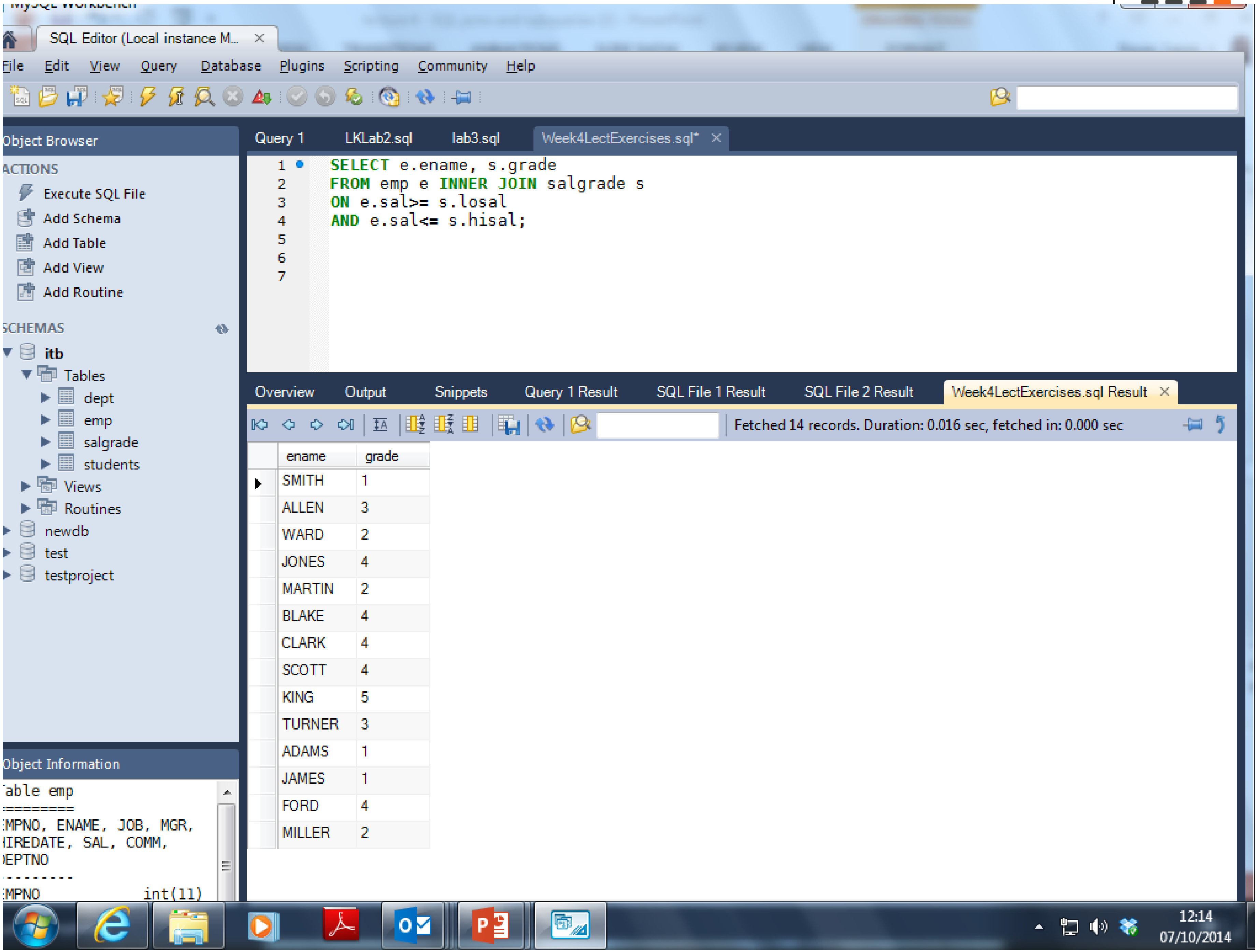


```
GRADE LOSAL  HISAL
----- ----- ------
1       700   1200
2      1201   1400
3      1401   2000
4      2001   3000
5      3001   9999
```

“salary in the EMP table is between low salary and high salary in the SALGRADE table”

```
SELECT e.ename, s.grade
FROM emp e INNER JOIN salgrade s
ON e.sal>= s.losal
AND e.sal<= s.hisal;
```

What would you expect the output to be ?



```sql
SELECT e.ename, s.grade
FROM emp e INNER JOIN salgrade s
ON e.sal>= s.losal
AND e.sal<= s.hisal;
```

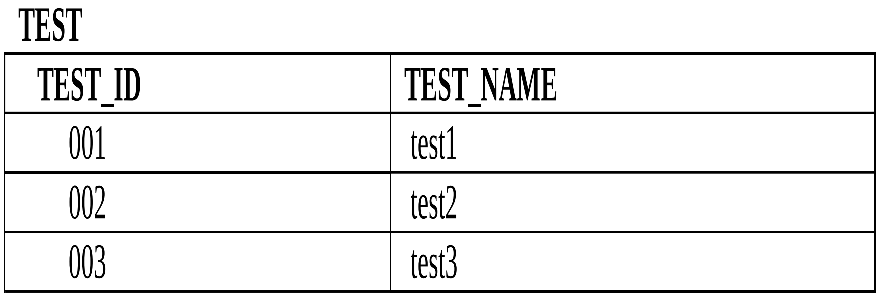
Fetched 14 records. Duration: 0.016 sec, fetched in: 0.000 sec

ename	grade
SMITH	1
ALLEN	3
WARD	2
JONES	4
MARTIN	2
BLAKE	4
CLARK	4
SCOTT	4
KING	5
TURNER	3
ADAMS	1
JAMES	1
FORD	4
MILLER	2

```
able emp
=========
MPNO, ENAME, JOB, MGR,
IREDATE, SAL, COMM,
EPTNO
--------
MPNO             int(11)
```

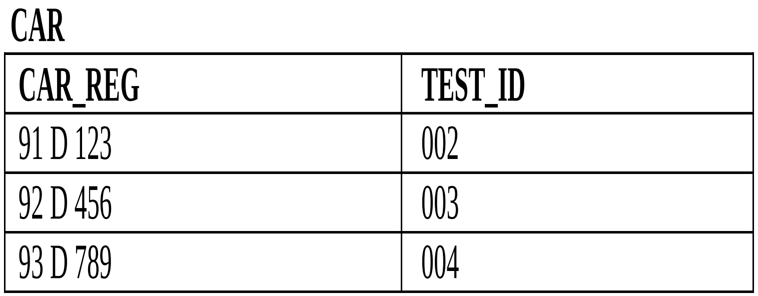
Examples of Outer Joins

The following examples are based on these two tables:



TEST

TEST_ID	TEST_NAME
001	test1
002	test2
003	test3



CAR

CAR_REG	TEST_ID
91 D 123	002
92 D 456	003
93 D 789	004

Test 1	Wheel Change
Test 2	Clutch Replace
Test 3	Oil Change

Right Outer Join

- Returns **all matching rows in both tables** and also rows in the right table that don’t have a corresponding row in the left table
- In the result set, the rows that don’t have a corresponding row in the left table contain a NULL value in all columns of the left table
- RIGHT OUTER JOIN is equivalent to RIGHT JOIN, so either can be used

```
SELECT t.test_name, c.car_reg
FROM test t RIGHT OUTER JOIN car c
ON t.test_id = c.test_id;
```

Remember the aliases

Giving

TEST_NAME	CAR_REG
test2	91 D 123
test3	92 D 456
NULL	93 D 789

All the rows in the right table are returned and only the matching values in the left

- All cars are listed
- Cars that don’t have a corresponding row in the left table contain a NULL value

- these cars have not been tested

❖ Keyword OUTER is optional

LEFT OUTER JOIN

- Returns all matched rows and rows from the **left table that don’t have a corresponding row in the right table**
- The unmatched rows of the result set have NULL values in the columns of the right table.
- A LEFT OUTER join can be turned into a RIGHT INNER JOIN if the order of the tables is changed (the right table becomes the left and vice versa).
- LEFT OUTER JOIN is equivalent to LEFT JOIN, so either can be used

Left Outer Join

```
SELECT t.test_id, t.test_name, c.car_reg
FROM test t LEFT OUTER JOIN car c
ON t.test_id = c.test_id;
```

Giving

Test

Test_id	test_name	car_reg
001	test 1	NULL
002	test 2	91D123
003	test 3	92D456

- All tests are listed but all cars are not, as they have not been tested

FULL OUTER JOIN

- Returns **all rows** that **match the JOIN condition**
- Rows from the left table that don’t have a corresponding row in the right table.

- These rows have NULL values in the columns of the right table

- Rows from the right table that don’t have corresponding row in the left table.

- These rows have NULL values in the columns of the left table.

- FULL OUTER JOIN is equivalent to FULL JOIN, so either can be used

Full Outer Join

- List all tests and all cars

```
SELECT t.test_id, t.test_name, c.car_reg
FROM test t FULL OUTER JOIN car c
ON t.test_id = c.test_id;
```

```
test_id   test_name        car_reg
-------   ----------       ----------
002       test 2            91D123
003       test 3           92D456
NULL      NULL             93D789
001       test 1            NULL
```

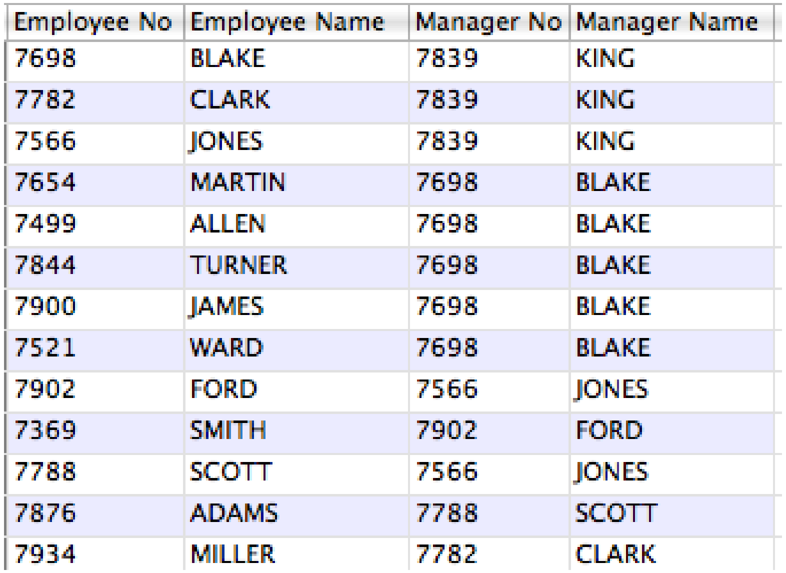
Joining a table to itself – **need to use aliases**

A different alias for each column

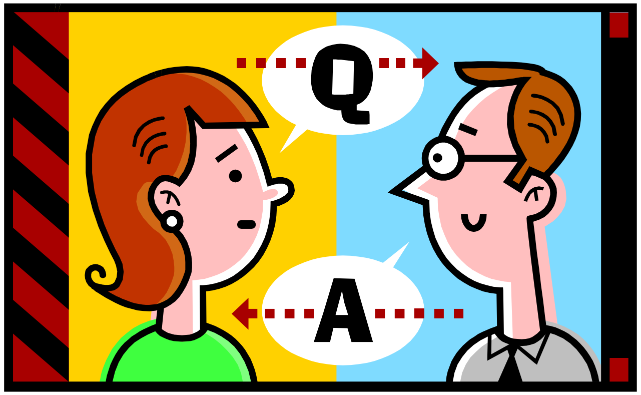
Find the name of the each employee’s manager

```
SELECT e1.empno as ‘Employee No’,
   e1.ename as ‘Employee Name’,
         e2.empno as ’ManagerNo’,
           e2.ename as ‘Manager Name’
FROM emp e1
  INNER JOIN emp e2
  ON e1.mgr = e2.empno;
```

Result:



Employee No	Employee Name	Manager No	Manager Name
7698	BLAKE	7839	KING
7782	CLARK	7839	KING
7566	JONES	7839	KING
7654	MARTIN	7698	BLAKE
7499	ALLEN	7698	BLAKE
7844	TURNER	7698	BLAKE
7900	JAMES	7698	BLAKE
7521	WARD	7698	BLAKE
7902	FORD	7566	JONES
7369	SMITH	7902	FORD
7788	SCOTT	7566	JONES
7876	ADAMS	7788	SCOTT
7934	MILLER	7782	CLARK


Q
A

Exercises (lectureExercise10.sql)- In-class

- List all employees working in ‘Dallas’
- Give a unique list of jobs of people based in ‘Chicago’
- List all employees on grade 3
- For all **4** locations, show the employees working in that location.

Section 2

Sub-Queries

Sub-Queries

- A Sub-Query is a **query** (i.e. a select statement) **nested within another SQL statement**.
- For Select statements, you can place a subquery in a
  - WHERE clause
  - HAVING clause
  - FROM clause
- You can also use subqueries in
  - CREATE statements
  - UPDATE statements
  - INSERT statements

Sub-query Example

- List all employees whose salary is greater than Jones salary.
- To answer this, you need to know
  - Jones salary - **one** query
  - employees with a salary greater than Jones salary - **second** query

```
SELECT ename
FROM emp
WHERE sal> (SELECT sal
               FROM emp
               WHERE ename=‘Jones’);
```

Exercise

- Who is earning more than the average salary?
- Who is earning more than Clark?
- How many people are earning more than Clark?

Points on Subqueries

- A subquery is **always enclosed in brackets**
- When using the following comparison operators, the sub query must return only ONE value
    - =, >, >=, <, <=, <>

- For subqueries that return more than one ROW, use the following operators
    - IN, ANY, ALL
- For subqueries that return more than one COLUMN, list all columns in the WHERE clause:

```
      . . .WHERE (prodid, qty) IN (SELECT prodid, qty
                                    FROM . . . )
```

Example - IN

What employees are paid the same as the lowest salary in a department?

```
SELECT ename, sal, deptno
FROM emp
WHERE sal  IN  ( SELECT MIN(sal)
                 FROM emp
                 GROUP BY deptno);
```

What employees are paid the same as the highest salary in a department?

```
SELECT ename, sal, deptno
FROM emp
WHERE sal IN  ( SELECTMAX(sal)
                FROM emp
                GROUP BY deptno);
```

Using ANY and ALL

- Note:
- > ANY means greater than the smallest value in the list
- < ANY means less than the highest value in the list
- > ALL means greater than the highest value in the list
- < ALL means less than the lowest value in the list
- = ANY is the same as in

Example

List employees who’s salary is less than the minimum salary in any department:

```
SELECT ename, sal, deptno
FROM emp
WHERE sal< ANY  ( SELECT MIN(sal)
                   FROM emp
                   GROUP BY deptno);
```

Return a list of three salaries – the minimum salary in each department, i.e. 1300, 800, 950

Less than any of these numbers: 1300, 800, 950
Any value less than 1300 will be less than one of these numbers

Examples

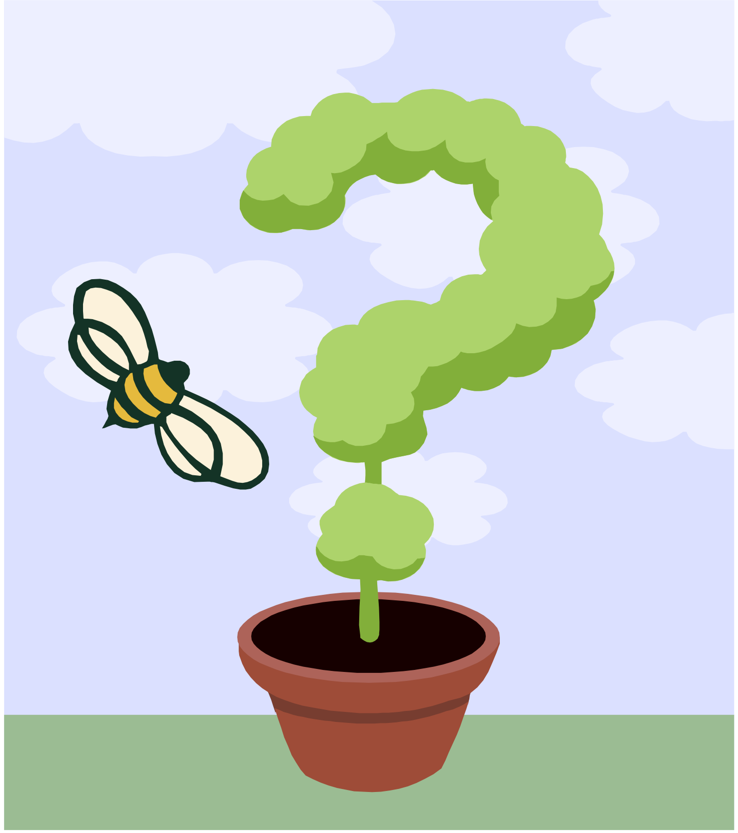
```
SELECT ENAME, SAL, DEPTNO
FROM EMP
WHERE SAL > ALL  ( SELECT MIN(SAL)
                   FROM EMP
                   GROUP BY DEPTNO);
```

Greater than all of these numbers: 1300, 800, 950
Any value greater than 1300 will be greater than all of the numbers in the list

```
SELECT ENAME, SAL, DEPTNO
FROM EMP
WHERE SAL < ALL  ( SELECT MIN(SAL)
                   FROM EMP
                   GROUP BY DEPTNO);
```

Return a list of three salaries – the minimum salary in each department, i.e. 1300, 800, 950

Less than ALL of these numbers: 1300, 800, 950
To be less that each of these numbers, the value must be less than 800.



Exercises - In-class

- What manager has a salary lower than BLAKES
- List all employees working for below the average salary
- List all employees working for below the lowest average salary in a department
- List all employees working for below the highest average salary in a department

SYNTAX SELECT

SELECT [DISTINCT] column_list

FROM table_name [JOIN table name ON column_name COMPARISON OPERATOR column_name]

[WHERE conditional expression]

[GROUP BY group_by_column_list]

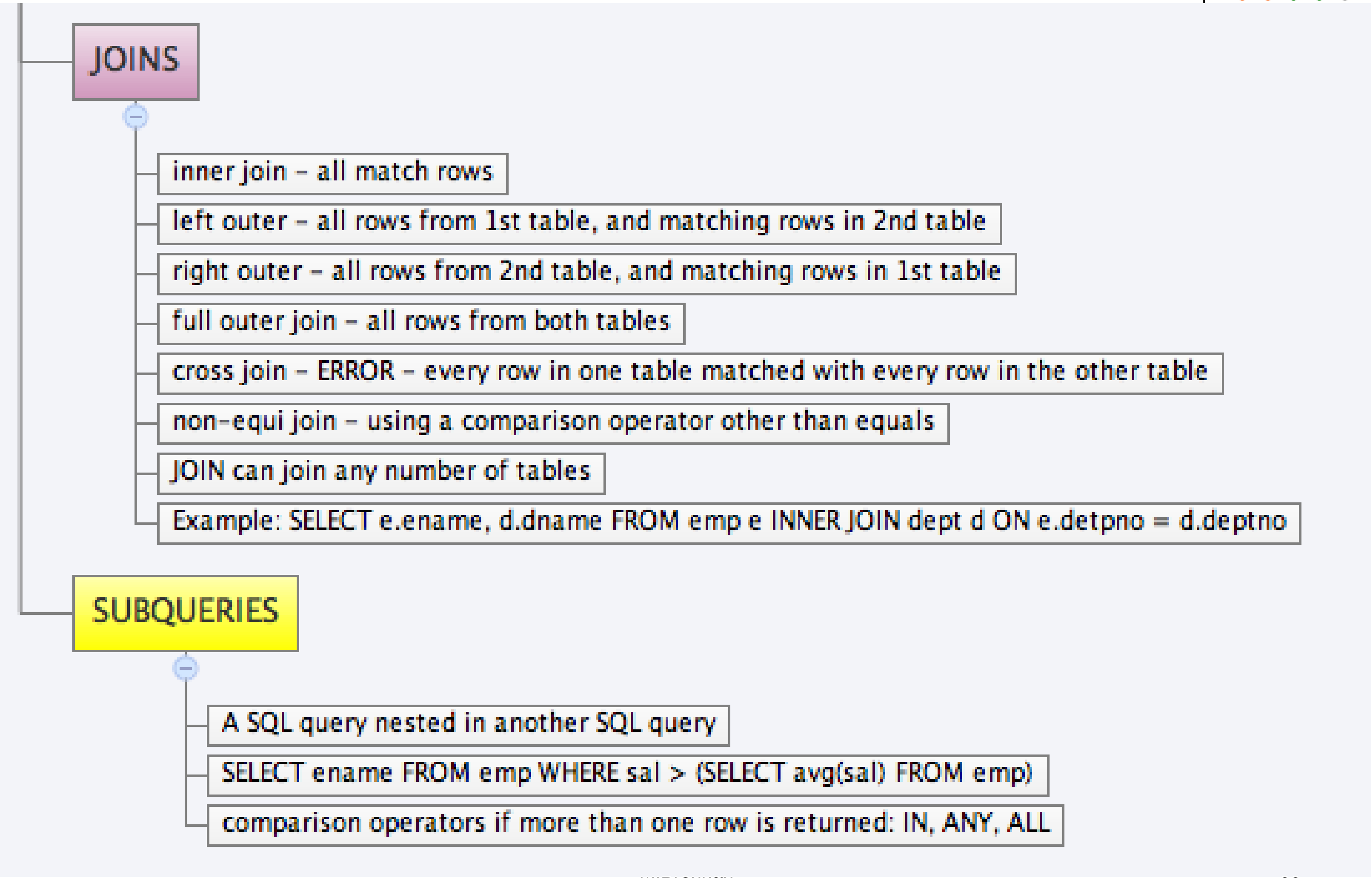
[HAVING conditional expression]

[ORDER BY order_by_column_list]

SQL Statement Processing Order

- SELECT – identifies the **columns** to be displayed
- FROM – identifies the **table**(s) involved
- WHERE – Finds **rows** meeting a stated condition
- GROUP BY –Identifies groups to which a **group function**is to be applied (max, min, avg, sum etc.)
- HAVING – Finds all **groups** meeting a stated conditions
- ORDER BY – **order** in which results are to be displayed

Summary



- JOINS
  - inner join - all match rows
  - left outer - all rows from 1st table, and matching rows in 2nd table
  - right outer - all rows from 2nd table, and matching rows in 1st table
  - full outer join - all rows from both tables
  - cross join - ERROR - every row in one table matched with every row in the other table
  - non-equi join - using a comparison operator other than equals
  - JOIN can join any number of tables
  - Example: SELECT e.ename, d.dname FROM emp e INNER JOIN dept d ON e.detpno = d.deptno
- SUBQUERIES
  - A SQL query nested in another SQL query
  - SELECT ename FROM emp WHERE sal > (SELECT avg(sal) FROM emp)
  - comparison operators if more than one row is returned: IN, ANY, ALL

Course Aims:

This course has **two** aims:

- To provide the student with an understanding of how to model a system using UML.
- To provide the student with an understanding of how to design a relational database for a system.