MONASH University

MONASH
INFORMATION
TECHNOLOGY

# SQL Intermediate

FIT9132

GROUP OF EIGHT AUSTRALIA

# Aggregate Functions

- COUNT, MAX, MIN, SUM, AVG
- Example:

```
SELECT max(mark)
FROM enrolment;
```

```
SELECT min(mark)
FROM enrolment;
```

```
SELECT avg(mark)
FROM enrolment;
```

```
SELECT count(stu_nbr)
FROM enrolment
WHERE mark >= 50;
```

| | STU_NBR | UNIT_CODE | ENROL_YEAR | ENROL_SEMESTER | MARK | GRADE |
|---|---|---|---|---|---|---|
| 1 | 11111111 | FIT1001 | 2012 | 1 | 78 | D |
| 2 | 11111111 | FIT1002 | 2013 | 1 | (null) | (null) |
| 3 | 11111111 | FIT1004 | 2013 | 1 | (null) | (null) |
| 4 | 11111112 | FIT1001 | 2012 | 1 | 35 | N |
| 5 | 11111112 | FIT1001 | 2013 | 1 | (null) | (null) |
| 6 | 11111113 | FIT1001 | 2012 | 2 | 65 | C |
| 7 | 11111113 | FIT1004 | 2013 | 1 | (null) | (null) |
| 8 | 11111114 | FIT1004 | 2013 | 1 | (null) | (null) |

## Q1. What will be displayed by the following SQL statement?

```
SELECT count(*), count(mark)
FROM enrolment;
```

A. 8, 8

B. 8, 3

C. 3, 3

D. 3, 8

| | STU_NBR | UNIT_CODE | ENROL_YEAR | ENROL_SEMESTER | MARK | GRADE |
|---|---|---|---|---|---|---|
| 1 | 11111111 | FIT1001 | 2012 | 1 | 78 | D |
| 2 | 11111111 | FIT1002 | 2013 | 1 | (null) | (null) |
| 3 | 11111111 | FIT1004 | 2013 | 1 | (null) | (null) |
| 4 | 11111112 | FIT1001 | 2012 | 1 | 35 | N |
| 5 | 11111112 | FIT1001 | 2013 | 1 | (null) | (null) |
| 6 | 11111113 | FIT1001 | 2012 | 2 | 65 | C |
| 7 | 11111113 | FIT1004 | 2013 | 1 | (null) | (null) |
| 8 | 11111114 | FIT1004 | 2013 | 1 | (null) | (null) |

## Q2. What will be displayed by the following SQL statement?

```
SELECT count(*), count(stu_nbr), count(distinct stu_nbr)
FROM enrolment;
```

A. 8, 8, 4

B. 8, 8, 8

C. 8, 4, 8

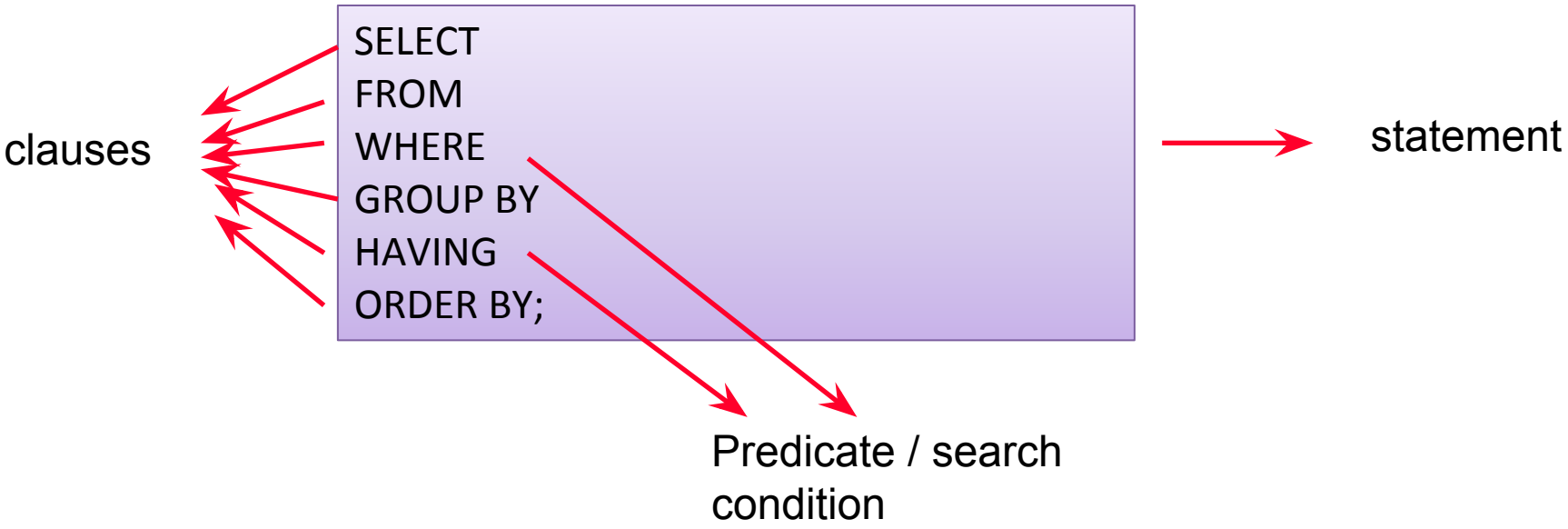
D. 8, 4, 4

| | STU_NBR | UNIT_CODE | ENROL_YEAR | ENROL_SEMESTER | MARK | GRADE |
|---|---|---|---|---|---|---|
| 1 | 11111111 | FIT1001 | 2012 | 1 | 78 | D |
| 2 | 11111111 | FIT1002 | 2013 | 1 | (null) | (null) |
| 3 | 11111111 | FIT1004 | 2013 | 1 | (null) | (null) |
| 4 | 11111112 | FIT1001 | 2012 | 1 | 35 | N |
| 5 | 11111112 | FIT1001 | 2013 | 1 | (null) | (null) |
| 6 | 11111113 | FIT1001 | 2012 | 2 | 65 | C |
| 7 | 11111113 | FIT1004 | 2013 | 1 | (null) | (null) |
| 8 | 11111114 | FIT1004 | 2013 | 1 | (null) | (null) |

**Q3. We want to calculate the average mark of the 8 rows in the above table. What SQL statement should we use?**
**Note: We want to calculate (78+35+65)/8=22.25**

A. SELECT avg(mark) FROM enrolment;
B. SELECT sum(mark)/count(mark) FROM enrolment;
C. SELECT sum(mark)/count(*) FROM enrolment;
D. SELECT avg(NVL(mark,0)) FROM enrolment;
E. None of the above.
F. More than one option is correct.

# Anatomy of an SQL Statement - Revisited



# GROUP BY

- If a GROUP BY clause is used with aggregate function, the DBMS will apply the aggregate function to the different groups defined in the clause rather than all rows.

```
SELECT avg(mark)
FROM enrolment;
```

```
SELECT unit_code, avg(mark)
FROM enrolment
GROUP BY unit_code;
```

# What output is produced?

| Unit_code | Mark | Studid | Year |
|---|---|---|---|
| FIT2094 | 80 | 111 | 2016 |
| FIT2094 | 20 | 111 | 2015 |
| FIT2004 | 100 | 111 | 2016 |
| FIT2004 | 40 | 222 | 2015 |
| FIT2004 | 40 | 333 | 2015 |

```
SELECT avg(mark)
FROM enrolmentA;
```

```
SELECT unit_code, avg(mark)
FROM enrolmentA
GROUP BY unit_code;
```

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code;
```

# What output is produced?

| Unit_code | Mark | Studid | Year |
|---|---|---|---|
| FIT2094 | 80 | 111 | 2016 |
| FIT2094 | 20 | 111 | 2015 |
| FIT2004 | 100 | 111 | 2016 |
| FIT2004 | 40 | 222 | 2015 |
| FIT2004 | 40 | 333 | 2015 |

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code, year;
```

# HAVING clause

- It is used to put a condition or conditions on the groups defined by GROUP BY clause.

```
SELECT unit_code, count(*)
FROM enrolment
GROUP BY unit_code
HAVING count(*) > 2;
```

# What output is produced?

| Unit_code | Mark | Studid | Year |
|---|---|---|---|
| FIT2094 | 80 | 111 | 2016 |
| FIT2094 | 20 | 111 | 2015 |
| FIT2004 | 100 | 111 | 2016 |
| FIT2004 | 40 | 222 | 2015 |
| FIT2004 | 40 | 333 | 2015 |

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code
HAVING count(*) > 2;
```

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
GROUP BY unit_code
HAVING avg(mark) > 55;
```

# HAVING and WHERE clauses

```
SELECT unit_code, count(*)
FROM enrolment
WHERE mark IS NULL
GROUP BY unit_code
HAVING count(*) > 1;
```

- The WHERE clause is applied to ALL rows in the table.
- The HAVING clause is applied to the groups defined by the GROUP BY clause.
- The order of operations performed is FROM, WHERE, GROUP BY, HAVING and then ORDER BY.
- On the above example, the logic of the process will be:
  - All rows where mark is NULL are retrieved. (due to the WHERE clause)
  - The retrieved rows then are grouped into different unit_code.
  - If the number of rows in a group is greater than 1, the unit_code and the total is displayed. (due to the HAVING clause)

# What output is produced?

| Unit_code | Mark | Studid | Year |
|---|---|---|---|
| FIT2094 | 80 | 111 | 2016 |
| FIT2094 | 20 | 111 | 2015 |
| FIT2004 | 100 | 111 | 2016 |
| FIT2004 | 40 | 222 | 2015 |
| FIT2004 | 40 | 333 | 2015 |

```
SELECT unit_code, avg(mark), count(*)
FROM enrolmentA
WHERE year = 2015
GROUP BY unit_code
HAVING avg(mark) > 30
ORDER BY avg(mark) DESC;
```

| Unit_code | Mark | Studid | Year |
|---|---|---|---|
| FIT2094 | 80 | 111 | 2016 |
| FIT2094 | 20 | 111 | 2015 |
| FIT2004 | 100 | 111 | 2016 |
| FIT2004 | 40 | 222 | 2015 |
| FIT2004 | 40 | 333 | 2015 |

**Q4. What is the output for:**

```
SELECT unit_code, avg(mark), studid
FROM enrolmentA
GROUP BY unit_code
HAVING avg(mark) > 55;
```

A. FIT2094, 50, 111
B. FIT2004, 60, 111
C. FIT2004, 60, 111, 222, 333
D. FIT2004, 100, 111
E. Will print three rows
F. Error

```
SELECT stu_lname, stu_fname, avg(mark)
FROM enrolment e JOIN student s
        ON s.stu_nbr = e.stu_nbr
GROUP BY s.stu_nbr;
```

The above SQL generates error message "ORA-00979: not a GROUP BY expression
00979. 00000 - " not a GROUP BY expression"

**Why and how to fix this?**

- Why? Because the grouping is based on the stu_nbr, whereas the display is based on stu_lname and stu_fname. The two groups may not have the same members.
- How to fix this?
  - Include the stu_lname,stu_fname as part of the GROUP BY condition.
- Attributes that are used in the SELECT, HAVING and ORDER BY must be included in the GROUP BY clause.

# Subqueries

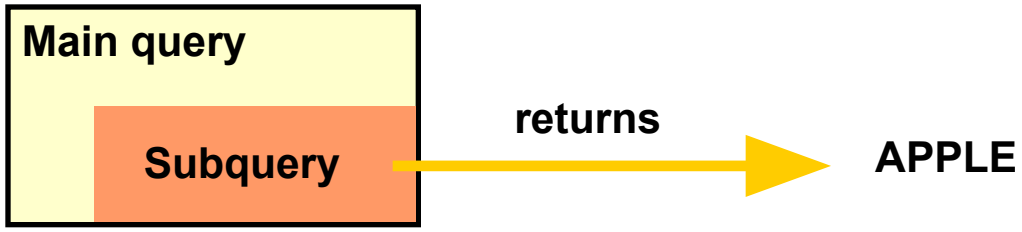
- Query within a query.

"Find all students whose mark is higher than the average mark of all enrolled students"

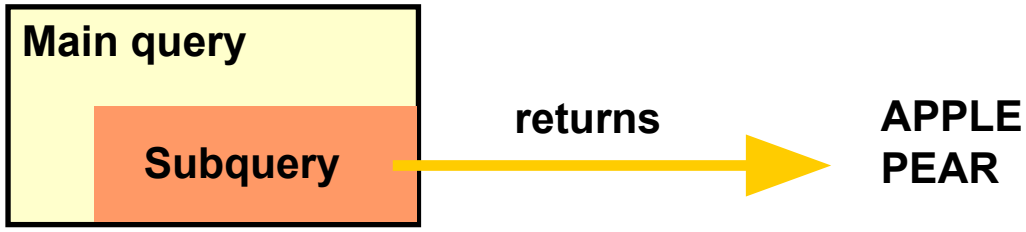
```
SELECT *
FROM enrolment
WHERE mark > (SELECT avg (mark)
                    FROM enrolment );
```

# Types of Subqueries

**Single-value**




**Multiple-row subquery (a list of values – many rows, one column)**




**Multiple-column subquery (many rows, many columns)**

## Q5. What will be returned by the *inner query*?

```
SELECT *
FROM enrolment
WHERE mark > (SELECT avg(mark)
              FROM enrolment
              GROUP BY unit_code);
```

A. A value (a single column, single row).
B. A list of values.
C. Multiple columns, multiple rows.
D. None of the above.

## Q6. What will be returned by the *inner query*?

```
SELECT unit_code, stu_lname, stu_fname, mark
FROM  enrolment e join student s
          on e.stu_nbr = s.stu_nbr
WHERE (unit_code, mark) IN (SELECT unit_code, max(mark)
                            FROM enrolment
                            GROUP BY unit_code);
```

A. A value (a single column, single row).
B. A list of values.
C. Multiple columns, multiple rows.
D. None of the above.

# Comparison Operators for Subquery

- Operator for single value comparison.
  =, <, >
- Operator for multiple rows or a list comparison.
  - –equality
    - IN
  - –inequality
    - •ALL, ANY combined with <, >

| | STU_NBR | UNIT_CODE | ENROL_YEAR | ENROL_SEMESTER | MARK | GRADE |
|---|---|---|---|---|---|---|
| 1 | 11111111 | FIT1001 | 2012 | 1 | 78 | D |
| 2 | 11111111 | FIT1002 | 2013 | 1 | 80 | HD |
| 3 | 11111111 | FIT1004 | 2013 | 1 | 85 | HD |
| 4 | 11111112 | FIT1001 | 2012 | 1 | 35 | N |
| 5 | 11111112 | FIT1001 | 2013 | 1 | 50 | P |
| 6 | 11111113 | FIT1001 | 2012 | 2 | 65 | C |
| 7 | 11111113 | FIT1004 | 2013 | 1 | 89 | HD |
| 8 | 11111114 | FIT1004 | 2013 | 1 | 50 | P |

## Q7. Which row(s) in ENROL2 table will be retrieved by the following SQL statement?

```
SELECT * FROM enrol2
WHERE mark IN (SELECT max(mark)
                FROM enrol2
                GROUP BY unit_code);
```

A. 1, 2, 7
B. 7
C. 2,3,7

| | STU_NBR | UNIT_CODE | ENROL_YEAR | ENROL_SEMESTER | MARK | GRADE |
|---|---|---|---|---|---|---|
| 1 | 11111111 | FIT1001 | 2012 | 1 | 78 | D |
| 2 | 11111111 | FIT1002 | 2013 | 1 | 80 | HD |
| 3 | 11111111 | FIT1004 | 2013 | 1 | 85 | HD |
| 4 | 11111112 | FIT1001 | 2012 | 1 | 35 | N |
| 5 | 11111112 | FIT1001 | 2013 | 1 | 50 | P |
| 6 | 11111113 | FIT1001 | 2012 | 2 | 65 | C |
| 7 | 11111113 | FIT1004 | 2013 | 1 | 89 | HD |
| 8 | 11111114 | FIT1004 | 2013 | 1 | 50 | P |

## Q8. Which row/s in ENROL2 will be retrieved by the following SQL statement?

| UCODE | ROUND(AVG(MARK)) |
|---|---|
| FIT1001 | 57 |
| FIT1002 | 80 |
| FIT1004 | 75 |

```
SELECT * FROM enrol2
WHERE mark > ANY (SELECT avg(mark)
                  FROM enrol2
                  GROUP BY unit_code);
```

A. 1,2,3,6,7

B. 2,3,7

C. 3,7

D. No rows will be returned

| | STU_NBR | UNIT_CODE | ENROL_YEAR | ENROL_SEMESTER | MARK | GRADE |
|---|---|---|---|---|---|---|
| 1 | 11111111 | FIT1001 | 2012 | 1 | 78 | D |
| 2 | 11111111 | FIT1002 | 2013 | 1 | 80 | HD |
| 3 | 11111111 | FIT1004 | 2013 | 1 | 85 | HD |
| 4 | 11111112 | FIT1001 | 2012 | 1 | 35 | N |
| 5 | 11111112 | FIT1001 | 2013 | 1 | 50 | P |
| 6 | 11111113 | FIT1001 | 2012 | 2 | 65 | C |
| 7 | 11111113 | FIT1004 | 2013 | 1 | 89 | HD |
| 8 | 11111114 | FIT1004 | 2013 | 1 | 50 | P |

## Q9. Which row/s in ENROL2 will be retrieved by the following SQL statement?

| UCODE | ROUND(AVG(MARK)) |
|---|---|
| FIT1001 | 57 |
| FIT1002 | 80 |
| FIT1004 | 75 |

```
SELECT * FROM enrol2
WHERE mark > ALL (SELECT avg(mark)
                  FROM enrol2
                      GROUP BY unit_code);
```

A. 1,2,3,6,7

B. 2,3,7

C. 3,7

D. No rows will be returned

**Q10. Find all students whose mark in any enrolled unit is lower than 'Wendy Wheat's lowest mark of all units she is enrolled.**

**What would be a possible inner query statement for the above query?**

A.
```
SELECT min(mark)
    FROM enrol2
    WHERE stu_lname='Wheat' AND stu_fname='Wendy';
```

B.
```
SELECT min(mark)
    FROM enrol2 e JOIN student s   on e.studid = s.studid
    WHERE stu_lname='Wheat' AND stu_fname='Wendy';
```

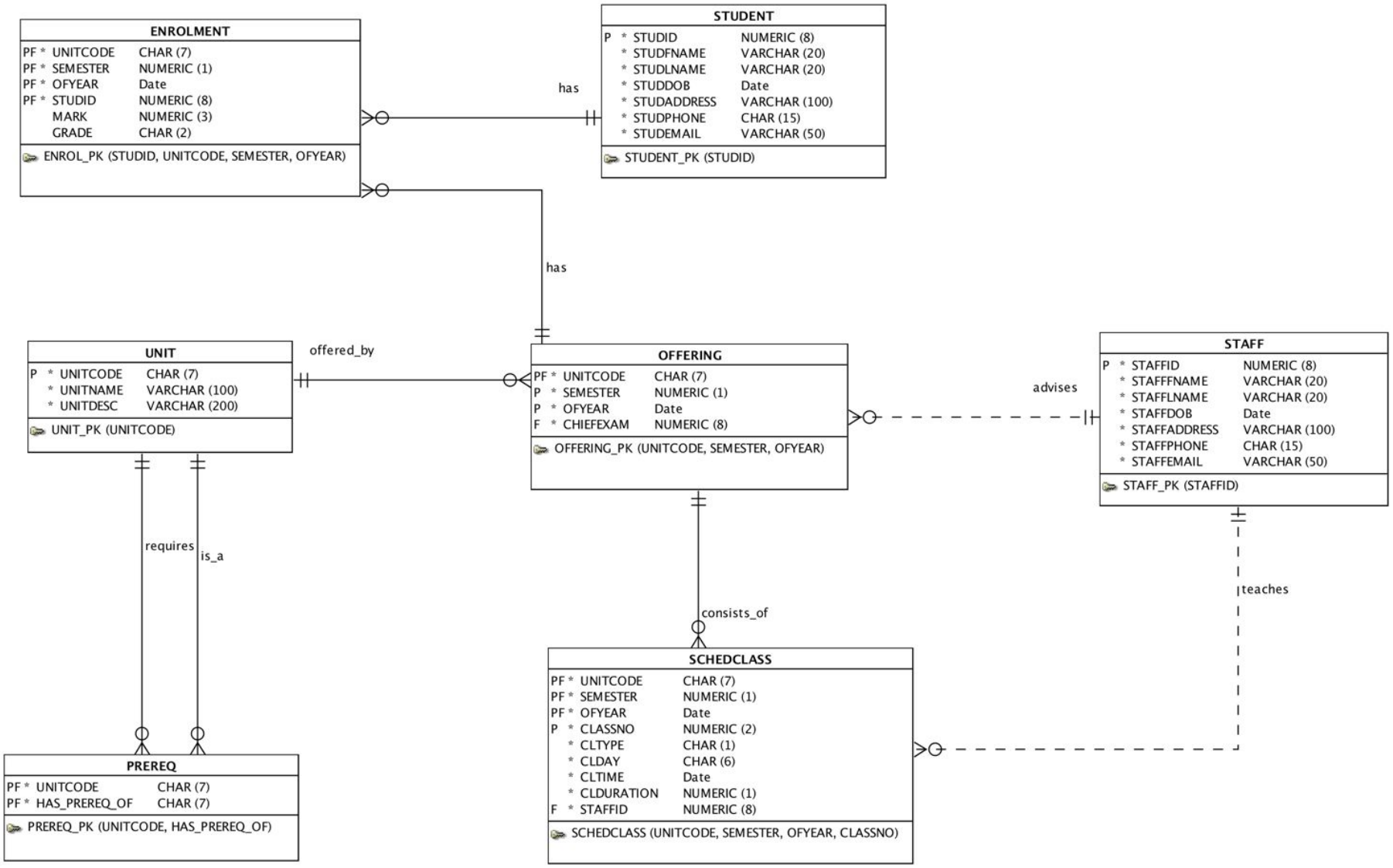
C.
```
SELECT min(mark) FROM enrol2;
```

D.
```
SELECT mark
    FROM enrol2 e JOIN student s on e.studid = s.studid
    WHERE stu_lname='Wheat' AND stu_fname='Wendy';
```

# Summary

- Aggregate Functions
  - –count, min, max, avg, sum
- GROUP BY and HAVING clauses.
- Subquery
  - –Inner vs outer query
  - –comparison operators (IN, ANY, ALL)

# Practice




Uni data model

Q1. Display the number of enrolments with a mark assigned, and the average mark for all enrolments

Q2. Select the highest mark ever in any unit

Q3. Select the highest mark ever for each unit (show the unit code only)

Q4. For each student (show the id only), select the highest mark he/she ever received

Q5. For each unit, print unit code, unit name and the highest mark ever in that unit. Print the results in descending order of highest marks.

Q6. For each offering of a unit with marks show the unit code, unitname, offering details and and average mark

Q7. For each student that is enrolled in at least 3 different units, print his/her name and average mark. Also, display the number of units he/she is enrolled in.

Q8. For each unit, count the total number of HDs

Q9. For each unit, print the total number of HDs, Ds, and Cs. The output should contain three columns named unitcode, grade_type, num where grade_type is HD, D or C and num is the number of students that obtained the grade.

Q10. For each unit, print the student ids of the students who obtained maximum marks in that unit