NESTED QUERIES

AGGREGATE RESULTS IN WHERE

Account

Num	Branch	CustID	Balance
111	London	1	1330.00
222	London	2	1756.00
333	Edinburgh	1	450.00

QN: Accounts w/ a higher balance than the avg. of all accounts

(✓)

```
SELECT  A.number
FROM    Account A
WHERE   A. balance  >
    (SELECT AVG (A1.balance)
     FROM   Account A1);
```

This query will give a table w/ one column and one row → A table w/ a single value.

Num
111
222

(✗)

```
SELECT   A.number
FROM     Account A
WHERE    A. balance  >
    AVG ( SELECT  A1.balance
          FROM    Account A1);
```

Aggregate fns can only be used in SELECT and HAVING!

GENERAL SYNTAX

```
SELECT  ...
FROM    ...
WHERE   term  op  (subquery);
```

↳ Allowed as long as subquery returns a single value

```
SELECT  ...
FROM    ...
WHERE  (term1, ..., termn)  op  ( subquery );
```

(subquery) op (subquery) is also allowed as long as both subqueries

↳ Allowed as long as subquery returns a single row w/ n columns

The WHERE clause revisited

term := attribute | value

comparison :=

- (term, . . . , term) **op** (term, . . . , term)
  with **op** ∈ {=, <>, <, > <=, >=}
- term **IS** [**NOT**] **NULL**
- (term, . . . , term) **op ANY** (query)
- (term, . . . , term) **op ALL** (query)
- (term, . . . , term) [**NOT**] **IN** (query)
- **EXISTS** (query)

condition :=

- comparison
- condition **AND** condition
- condition **OR** condition
- **NOT** condition

Comparisons between tuples

(1,2,3) < (1,2,4) true

(1,2,3) < (1,2,3) false

(1,3,1) < (1,4,3) true

(1,2,3) <= (1,2,3) true

$$(A_1, \dots A_n) = (B_1, \dots, B_n) \iff A_1 = B_1 \wedge \dots \wedge A_n = B_n$$

$$(A_1, \dots A_n) <> (B_1, \dots, B_n) \iff A_1 \neq B_1 \vee \dots \vee A_n \neq B_n$$

$(A_1, A_2, A_3) < (B_1, B_2, B_3)$ (generalizes to n elements)

$$\iff$$

$$A_1 < B_1 \vee \Big(A_1 = B_1 \wedge (A_2 < B_2 \vee (A_2 = B_2 \wedge A_3 < B_3))\Big)$$

$(A_1, A_2, A_3) <= (B_1, B_2, B_3)$ (generalizes to n elements)

$$\iff$$

$$A_1 < B_1 \vee \Big(A_1 = B_1 \wedge (A_2 < B_2 \vee (A_2 = B_2 \wedge A_3 \leq B_3))\Big)$$

$$\iff$$

$$\big((A_1, A_2, A_3) < (B_1, B_2, B_3)\big) \vee \big((A_1, A_2, A_3) = (B_1, B_2, B_3)\big)$$

ANY

→ (term, ..., term) op ANY (query)

→ True if there exists a row $\bar{r}$ in the results of query such that (term, ..., term) op $\bar{r}$ is true

→ 3 < ANY ({1, 2, 3}) – FALSE

3 < ANY ({2, 3, 4}) – TRUE

$\exists x : x \in \{2,3,4\} \wedge (3 < x)$

3 < ANY ({}) – FALSE

No element in the empty set

ALL

→ (term, ..., term) op ALL (query)

→ True if for all rows $\bar{r}$ in the results of query such that (term, ..., term) op $\bar{r}$ is true

→ 3 < ALL ({5, 4, 6}) – TRUE

3 < ALL ({4, 3, 5}) – FALSE

↳ $\forall x : x \in \{4,3,5\} \rightarrow (3 < x)$

3 < ALL ({}) – TRUE

↳ $\forall x : \underbrace{x \in \emptyset}_{\text{False}} \rightarrow (3 < x)$

i.e. Customer : ID, Name, City
Account : Num, Branch, CustID, Balance

→ QN: ID of customers from London who own an account

```
SELECT  C.id
FROM    customer C
WHERE   C.city = 'London'
        AND  C.id = ANY (SELECT A.custid
                         FROM Account A);
```

→ QN: Customers living in cities w/o a branch

```
SELECT  *
FROM    Customer C
WHERE   C.city <> ALL (SELECT A.branch
                       FROM Account A);
```