

SQL – Data Manipulation Language

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Bases de Dados

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Based on Jennifer Widom slides

Group-by versus subqueries

```
SELECT cName, count(*) AS cnt  
FROM Apply  
GROUP BY cName;
```

↳ fazer sem Group By

→ para cada cName distinto

```
SELECT DISTINCT cName,  
    (SELECT count(*)  
     FROM Apply A2  
     WHERE A2.cName = A1.cName) AS cnt  
FROM Apply A1;
```

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

cName	cnt
Berkeley	3
Cornell	6
MIT	4
Stanford	6

→ quantas tuplas com o mesmo cName

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

Group-by versus subqueries

SELECT cName

FROM Apply

GROUP BY cName

HAVING count(*) < 5;

→ No need for DISTINCT: automatically from GROUP BY

SELECT DISTINCT cName

FROM Apply A1

WHERE 5 > (SELECT count(*) FROM Apply A2 WHERE A2.cName = A1.cName);

→ Referência cruzada

→ Não é preciso DISTINCT, porque o GROUP BY já elimina os duplicados

Passava para o where

cName
Berkeley
MIT

Every *group by* and *having* query can be written without using those clauses

Group-by versus subqueries

College(<u>cName</u> , state, enr)
Student(<u>sID</u> , sName, GPA, sizeHS)
Apply(<u>sID</u> , <u>cName</u> , <u>major</u> , decision)

```
SELECT cName
FROM Apply
GROUP BY cName
HAVING count(*) < 5;
```



+ EFICIENTE

This is SQL by an expert

```
SELECT DISTINCT cName
FROM Apply A1
WHERE 5 > (SELECT count(*)
FROM Apply A2
WHERE A2.cName = A1.cName);
```



- EFICIENTE

This is SQL by a novice

Which way is more efficient?

How many times do we do a SFW query in each case? → Número de
With GROUP BY can be much more efficient!

{ select ...
from ...
where ...

Aggregation summary

SELECT	S	→	attributes a_1, \dots, a_k and/or aggregates over other attributes
FROM	R_1, \dots, R_n		
WHERE	C_1	→	any condition on the attributes in R_1, \dots, R_n
GROUP BY	a_1, \dots, a_k		
HAVING	C_2	→	any condition on the aggregate expressions

Evaluation steps

1. Evaluate FROM-WHERE: apply condition C_1 on the attributes in R_1, \dots, R_n
2. GROUP BY the attributes a_1, \dots, a_k
3. Apply condition C_2 to each group
4. Compute aggregates in S and return the result

Agenda

Introduction

The JOIN family of operators

Basic SQL Statement

Aggregation

Table Variables and Set Operators

Null values

Subqueries in WHERE clauses

Data Modification statements

Subqueries in FROM and SELECT clauses

NULL values

Unless specified otherwise, any value in an attribute can take on the special value NULL

NULL usually means that the value is undefined or unknown or not applicable

We will see what happens when we have NULL values and we run queries over the database

NULL values for numerical operations

NULL -> NULL

If $x = \text{NULL}$ then

$4 \cdot (3 - x) / 7$ is NULL

NULL values for Boolean operations

Conditions are evaluated using a three value logic:
TRUE, FALSE, UNKNOWN

If $x = \text{NULL}$ then $x = \text{'Joe'}$ is UNKNOWN

Considering TRUE is 1.0, UNKNOWN is 0.5 and FALSE is 0.0

$$\underline{C1 \text{ AND } C2 = \min(C1, C2)}$$

$$\underline{C1 \text{ OR } C2 = \max(C1, C2)}$$

$$\underline{\text{NOT } C1 = 1 - C1}$$

Rule in SQL: include only tuples that yield TRUE (1.0)

A first query with NULL values

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

SELECT sID, sName, GPA

FROM Student

WHERE GPA > 3.5;



sID	sName	GPA
123	Amy	3.9
234	Bob	3.6
456	Doris	3.9
678	Fay	3.8
987	Helen	3.7
876	Irene	3.9
654	Amy	3.9

2 additional students

Student

sID	sName	GPA	HS
123	Amy	3.9	1000
234	Bob	3.6	1500
345	Craig	3.5	500
456	Doris	3.9	1000
567	Edward	2.9	2000
678	Fay	3.8	200
789	Gary	3.4	800
987	Helen	3.7	800
876	Irene	3.9	400
765	Jay	2.9	1500
654	Amy	3.9	1000
543	Craig	3.4	2000
432	Kevin	NULL	1500
321	Lori	NULL	2500

A second query with NULL values

```
SELECT sID, sName, GPA
FROM Student
WHERE GPA <= 3.5;
```

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

<u>sID</u>	sName	GPA
345	Craig	3.5
567	Edward	2.9
789	Gary	3.4
765	Jay	2.9
543	Craig	3.4

A third query with NULL values

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

```
SELECT sID, sName, GPA
FROM Student
WHERE GPA > 3.5 OR GPA <= 3.5;
```



Tautology

→ Os nulos não são incluídos

Even with a tautology, we might not get all the data

<u>sID</u>	sName	GPA
123	Amy	3.9
234	Bob	3.6
345	Craig	3.5
456	Doris	3.9
567	Edward	2.9
678	Fay	3.8
789	Gary	3.4
987	Helen	3.7
876	Irene	3.9
765	Jay	2.9
654	Amy	3.9
543	Craig	3.4

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

A fourth query with NULL values

To make this query return all the students

```
SELECT sID, sName, GPA
```

```
FROM Student
```

```
WHERE GPA > 3.5 OR GPA <= 3.5 OR  
GPA IS NULL;
```

Can test for NULL explicitly

} attribute IS NULL

} attribute IS NOT NULL

sID	sName	GPA
123	Amy	3.9
234	Bob	3.6
345	Craig	3.5
456	Doris	3.9
567	Edward	2.9
678	Fay	3.8
789	Gary	3.4
987	Helen	3.7
876	Irene	3.9
765	Jay	2.9
654	Amy	3.9
543	Craig	3.4
432	Kevin	
321	Lori	

A fifth query with NULL values

```
SELECT sID, sName, GPA, HS  
FROM Student  
WHERE GPA > 3.5 OR HS < 1600;
```

Although Kevin has a NULL GPA, he
is retrieved because it has a HS<1600

sID	sName	GPA	HS
123	Amy	3.9	1000
234	Bob	3.6	1500
345	Craig	3.5	500
456	Doris	3.9	1000
678	Fay	3.8	200
789	Gary	3.4	800
987	Helen	3.7	800
876	Irene	3.9	400
765	Jay	2.9	1500
654	Amy	3.9	1000
432	Kevin		1500

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

NULL values and aggregate functions

SELECT distinct GPA
FROM Student;

GPA
NULL
2.9
3.4
3.5
3.6
3.7
3.8
3.9

8 tuples

SELECT count(distinct GPA)
FROM Student;

count(distinct GPA)
7

→ Não são contabilizados
os nulos

When counting (the distinct)
values, NULLs are not included

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

NULL values

When using a database with NULL values

Be careful when writing queries

Understand how the NULL values are going to influence the result

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Operators

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Subqueries in WHERE clauses

Data Modification statements

Subqueries in FROM and
SELECT clauses

Inserting new data

Insert Into **Table** (A_1, A_2, \dots, A_n)

Values (v_1, v_2, \dots, v_n)

↳ só é necessário, se esta lista não for completa

→ If we provide values for all attributes, we may omit the list of attributes.

Insert Into **Table**

Select-Statement →

Same schema as the table

↳ ir buscar dados a outras tabelas

Inserting new data

Insert Into College

→ Não se adiciona os nomes dos atributos, pois inserimos todos os valores

Values ('Carnegie Mellon', 'PA', 11500);

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

College

cName	state	enr
Stanford	CA	15000
Berkeley	CA	36000
MIT	MA	10000
Cornell	NY	21000
Carnegie Mellon	PA	11500

Inserting new data

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

Have all students who didn't apply anywhere apply to CS at Carnegie Mellon

Todos os
estudantes
que
não se
candidataram
a lado nenhum

```
SELECT *  
FROM Student  
WHERE sID not in (select sID FROM Apply);
```

sID	sName	GPA	HS
456	Doris	3.9	1000
567	Edward	2.9	2000
789	Gary	3.4	800
654	Amy	3.9	1000

```
INSERT INTO Apply
```

Acrescentar
valores
em apply

```
SELECT sID, 'Carnegie Mellon', 'CS', NULL  
FROM Student  
WHERE sID not in (select sID FROM Apply);
```

com estes
valores

Apply

sID	cName	major	dec
...
543	MIT	CS	N
456	Carnegie Mellon	CS	NULL
567	Carnegie Mellon	CS	NULL
789	Carnegie Mellon	CS	NULL
654	Carnegie Mellon	CS	NULL

Resultado

Inserting new data

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

Admit to Carnegie Mellon EE all students who were turned down in EE elsewhere

*1. Selecionar todos os que se candidataram a EE
noutro sítio qualquer e decision='N'*

SELECT *

FROM Student

WHERE sID in (select sID FROM Apply WHERE major='EE' AND decision='N' AND cName<>'Carnegie Mellon');

sID	sName	GPA	HS
123	Amy	3.9	1000
345	Craig	3.5	500

Apply

sID	cName	major	dec
...
654	Carnegie Mellon	CS	NULL
123	Carnegie Mellon	EE	Y
345	Carnegie Mellon	EE	Y

INSERT INTO Apply

SELECT sID, 'Carnegie Mellon', 'EE', 'Y'

FROM Student

WHERE sID in (select sID FROM Apply WHERE major='EE' AND decision='N' AND cName<>'Carnegie Mellon');

*Inserir
muitos
valores*

Deleting existing data



Delete From **Table**
Where **Condition**

Condition can be complicated

Can include subqueries and aggregation over other tables

Deleting existing data

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

Delete all students who applied to more than two different majors

SELECT sID

FROM Apply

GROUP BY sID

HAVING count(distinct major) > 2;

DELETE FROM Student

WHERE sID in (

SELECT sID FROM Apply GROUP BY sID

HAVING count(distinct major) > 2);

Apagar aqueles que estão aqui

+2 mestras dos

já não
a parecem

sID
345
876

Student

sID	sName	GPA	HS
123	Amy	3.9	1000
234	Bob	3.6	1500
456	Doris	3.9	1000
567	Edward	2.9	2000
678	Fay	3.8	200
789	Gary	3.4	800
987	Helen	3.7	800
765	Jay	2.9	1500
654	Amy	3.9	1000
543	Craig	3.4	2000

Deleting existing data

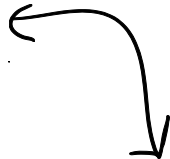
College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

Delete those students also from Apply → Tabela Apply está sempre a ser alterada

```
DELETE FROM Apply  
WHERE sID in (  
    SELECT sID FROM Apply GROUP BY sID  
    HAVING count(distinct major) > 2);
```



Not all database systems allow deletion commands where the subquery includes the same relation that you're deleting from

In systems that don't allow, a temporary table would have to be created

Deleting existing data

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

Delete colleges with no CS applicants

As que não
têm candida-
turas a
'CS'

```
SELECT *  
FROM College  
WHERE cName not in  
(SELECT cName from Apply where major='CS');
```

cName	state	enr
Cornell	NY	21000

Delete

```
DELETE FROM College  
WHERE cName not in  
(SELECT cName from Apply where major='CS');
```

cName	state	enr
Stanford	CA	15000
Berkeley	CA	36000
MIT	MA	10000
Carnegie Mellon	PA	11500

College

Updating existing data

Update **Table**

Set **Attr** = **Expression**

Where **Condition** → sem where, aplica a todos

Atributo = Expressão

Update **Table**

Set **$A_1 = Expr_1, A_2 = Expr_2, \dots, A_n = Expr_n$** → Lista

Where **Condition** → quais os tuplos em que acontece

Conditions and expressions can include subqueries and queries over other tables or the same table

Updating existing data

College(cName, state, enr)
Student(sID, sName, GPA, sizeHS)
Apply(sID, cName, major, decision)

Accept applicants to Carnegie Mellon with GPA<3.6 but turn them into economics majors

```
SELECT *  
FROM Apply  
WHERE cName = 'Carnegie Mellon' and sID in  
(SELECT sID from Student where GPA<3.6);
```

sID	cName	major	dec
567	Carnegie Mellon	CS	
789	Carnegie Mellon	CS	

```
UPDATE Apply  
SET decision = 'Y', major='economics'  
WHERE cName = 'Carnegie Mellon' and sID in  
(SELECT sID from Student where GPA<3.6);
```

Apply

sID	cName	major	dec
...
654	Carnegie Mellon	CS	NULL
123	Carnegie Mellon	EE	Y
567	Carnegie Mellon	economics	Y
789	Carnegie Mellon	economics	Y

Via alterar em
567-789

Updating existing data

Turn the highest GPA EE applicant into a CSE applicant

↳ mudar o major

SELECT *

FROM Apply

WHERE major='EE' AND sID in

(select sID from Student where GPA>=all

(select GPA from Student where sID in

(select sID from Apply where major='EE')));

← só os que têm 'EE'

← máximo

sID	cName	major	dec
123	Stanford	EE	N
123	Cornell	EE	Y
123	Carnegie Mellon	EE	Y

→ GPA dos estudantes

→ Estudantes de EE

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

Updating existing data

Turn the highest GPA EE applicant into a CSE applicant

UPDATE Apply

SET major = 'CSE'

WHERE major='EE' AND sID in

(select sID from Student where GPA>=all

(select GPA from Student where sID in

(select sID from Apply where major='EE')));

sID	cName	major	dec
...
789	Carnegie Mellon	economics	Y
123	Stanford	CSE	N
123	Cornell	CSE	Y
123	Carnegie Mellon	CSE	Y

Apply

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

Updating existing data

College(cName, state, enr)

Student(sID, sName, GPA, sizeHS)

Apply(sID, cName, major, decision)

Give every student the highest GPA and the smallest high school in the database

UPDATE Apply

Sub-queries
no
SET

SET GPA = (select max(GPA) from Student),
HS = (select min(sizeHS) from Student);

In the SET command, the right-hand side of the equals can itself be a subquery

Student

sID	sName	GPA	HS
123	Amy	3.9	200
234	Bob	3.9	200
456	Doris	3.9	200
567	Edward	3.9	200
678	Fay	3.9	200
789	Gary	3.9	200
987	Helen	3.9	200
765	Jay	3.9	200
654	Amy	3.9	200
543	Craig	3.9	200

Summary

SQL is a rich programming language that handles the way data is processed declaratively

Kahoot time!

Any doubts?

Readings

Jeffrey Ullman, Jennifer Widom, A first course in Database Systems 3rd Edition

Section 6.1 – Simple Queries in SQL

Section 6.2 – Queries Involving More Than One Relation

Section 6.3 - Subqueries

Section 6.4 – Full-Relation Operations

Section 6.5 – Database Modifications

Philip Greenspun, SQL for Web Nerds,
<http://philip.greenspun.com/sql/>