Database

SQL

Simple Queries

Recap

Quizzes

Quiz #1

Question

Assume a relation R(A,B) with

- domain of A being { x, y, z }
- domain of B being { 1, 2, 3, 4 }

Which row in the table on the right **violate** the definition of relation R mathematically?

$A_1, A_2, \dots, A_n$

$R \subseteq A_1 \times A_2 \times \dots \times A_n$

#	A	B
1	x	4
2	z	4
3	null	2
4	null	3
5	y	1
6	y	null
7	null	null
8	x	4
9	x	x
10	z	1

Recap

Quizzes

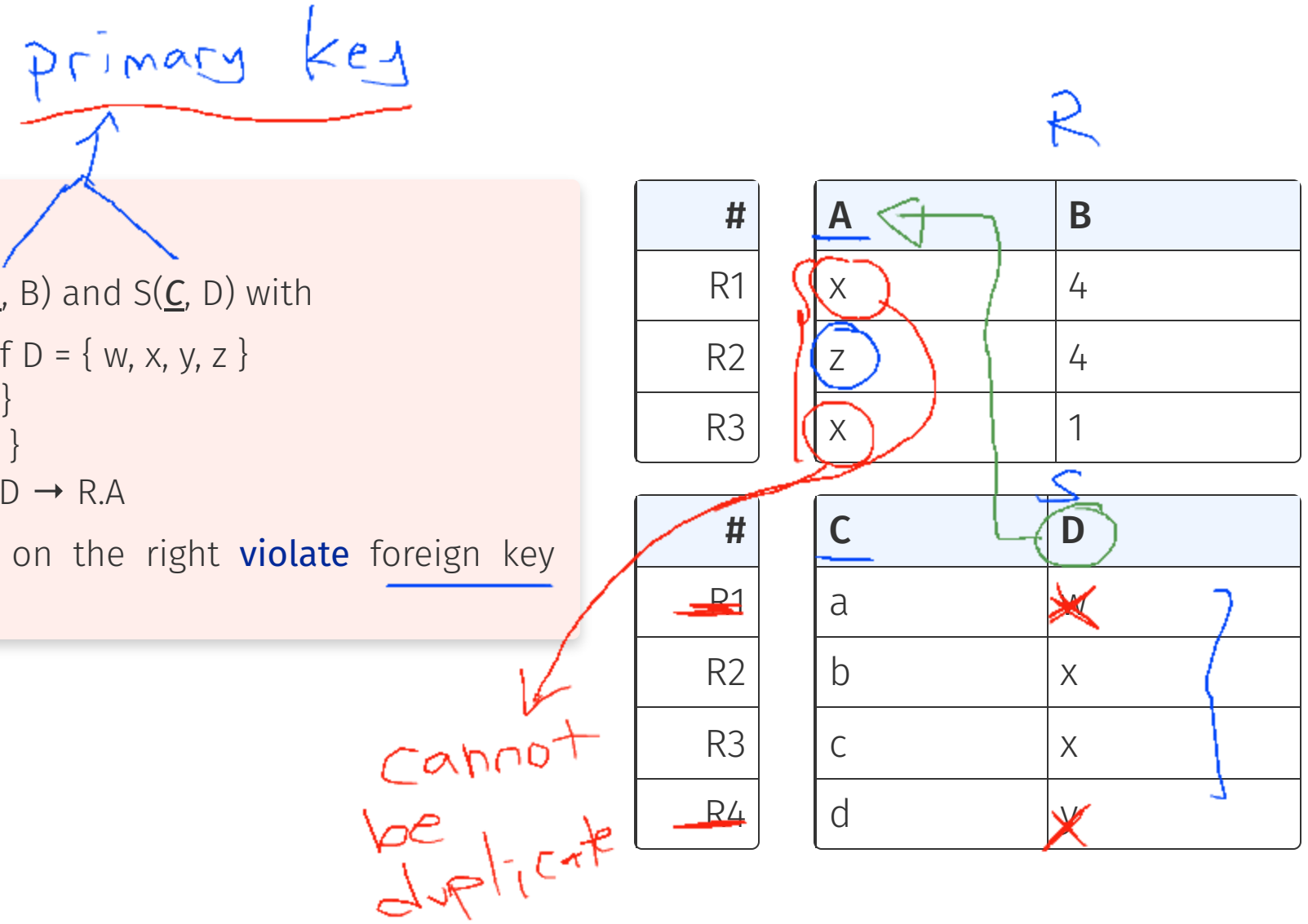
Quiz #2

Question

Assume the two tables R(<u>A</u>, B) and S(<u>C</u>, D) with

- domain of A = domain of D = { w, x, y, z }
- domain of B = { 1, 2, 3, 4 }
- domain of C = { a, b, c, d }
- foreign key constraint S.D → R.A

Which row in the tables on the right **violate** foreign key constraints?



#	A	B
R1	x	4
R2	z	4
R3	x	1

#	C	D
~~R1~~	a	~~w~~
R2	b	x
R3	c	x
~~R4~~	d	~~y~~

Case Study

Game Store

Requirement

Game Store Requirement

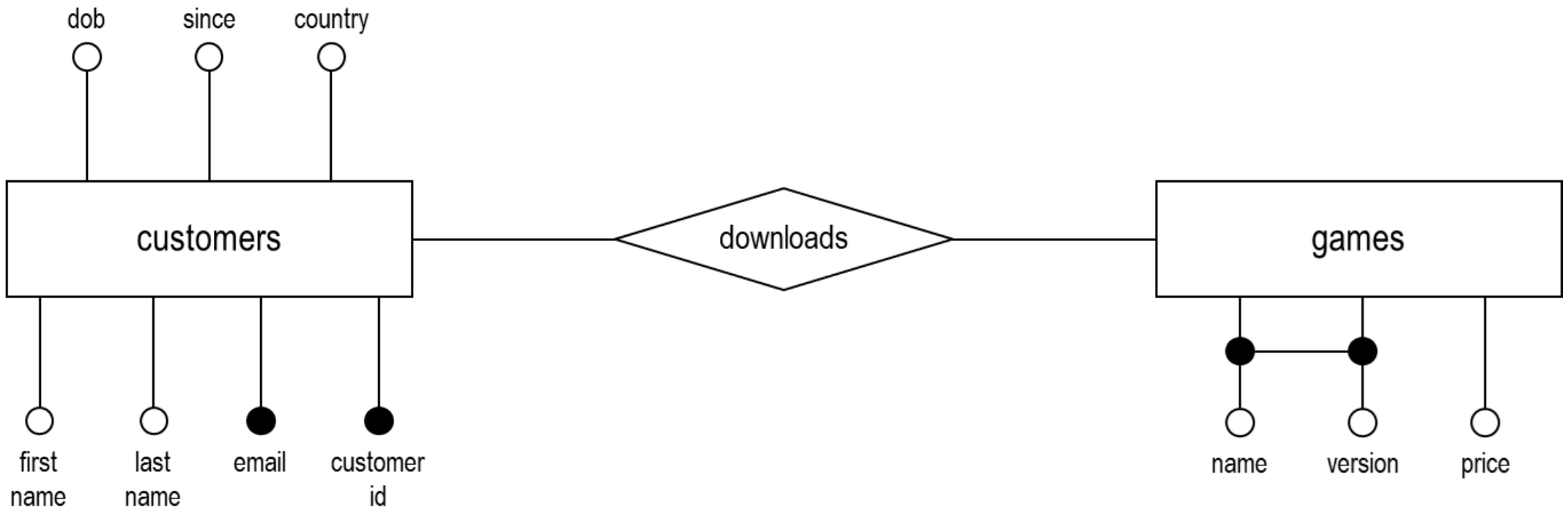
Our company, **Apasaja Pte Ltd**, has been commissioned to develop an application to manage the data of an online app store. We want to store several items of information about our customers such as their first name, last name, date of birth, e-mail, date and country of registration to our online sales service and the customer identifier that they have chosen.

We also want to manage the list of our products, games, their name, their version, and their price. The price is fixed for each version of each game. Finally, our customers buy and download games. We record which version of which game each customer has downloaded. It is not essential to keep the download date for this application.

Case Study

Design

Entity-Relationship Diagram



Single Table

Basic

Simple Queries

SELECT-FROM-WHERE

A **simple** SQL query includes `SELECT` clause that indicates the **columns** to be output, a `FROM` clause that indicates the **table(s)** to be queried, and possibly a `WHERE` clause that indicates a possible **condition** on the records to be printed.

Code

```
SELECT first_name, last_name
FROM customers
WHERE country = 'Singapore';
```

Table

first_name	last_name
"Deborah"	"Ruiz"
"Tammy"	"Lee"
"Walter"	"Leong"
...	

Single Table

Basic

Wildcards

Asterisk

The **asterisk** *(i.e., * symbol)* is a shorthand indicating that **all the column names**, in order of the `CREATE TABLE` declaration, should be considered in the `SELECT` clause.

Full Listing

```
SELECT first_name, last_name,
       email, dob, since,
       customerid, country
FROM customers;
```

Using Wildcard

```
SELECT *
FROM customers;
```

Single Table

Duplicate

Ordering

Projection

Selecting a **subset of the columns** *(i.e., projection)* of a table may result in **duplicate** rows even if the original table has a primary key. This can be made clearer if we order the result *(i.e., on the right)*. Always use `ASC` and `DESC` for **good practice**.

No Ordering

```
SELECT name, version
FROM downloads;
```

ORDER BY

```
SELECT name, version
FROM downloads
ORDER BY name, version;
```

Note

By default, order in `ASC` and not `DESC`.

Single Table

Duplicate

Ordering

Unordered

If we only **order partially** *(i.e., not using all columns)*, the columns not mentioned are in **no particular order**. In particular, we **should not rely on specific ordering** as it should work for any data.

Partial Ordering

```
SELECT name, version
FROM downloads
ORDER BY name ASC;
```

Note

We only order by `name`. As such, `version` may appear in any order.

Single Table

Duplicate

Ordering

Unmentioned

We can order the result according to a **column that is not printed**. But this may **interfere** with other constructs. Only use this when you are sure that it will work.

Partial Ordering

```
SELECT name, version
FROM games
ORDER BY price ASC;
```

Note

`price` is used in `ORDER BY` but not present in the `SELECT` clause.

Single Table

Duplicate

Distinct

Deduplication

The keyword `DISTINCT` eliminates eventual **duplicates** in the result of the query. It requests that the results contains **distinct rows** *(it does not apply to columns individually)*.

DISTINCT

```
SELECT DISTINCT name, version
FROM downloads
```

Note

The query with `DISTINCT` displays **422** records. The query without `DISTINCT` displays **4214** records.

It often gives a sorted result but this is **not guaranteed**.

Single Table

Duplicate

Composition

Combining Constructs

You can **combine** different constructs **but not always**. Not all combinations make sense. Both `DISTINCT` and `ORDER BY` conceptually involve sorting and `ORDER BY` is applied before `DISTINCT`. SQL does not know which row to remove.

Compatible

```
SELECT DISTINCT name
FROM games
ORDER BY name ASC;
```

Incompatible

```
SELECT DISTINCT name, version
FROM games
ORDER BY price ASC;
```

Error

`price` does not appear in `DISTINCT`.

Single Table

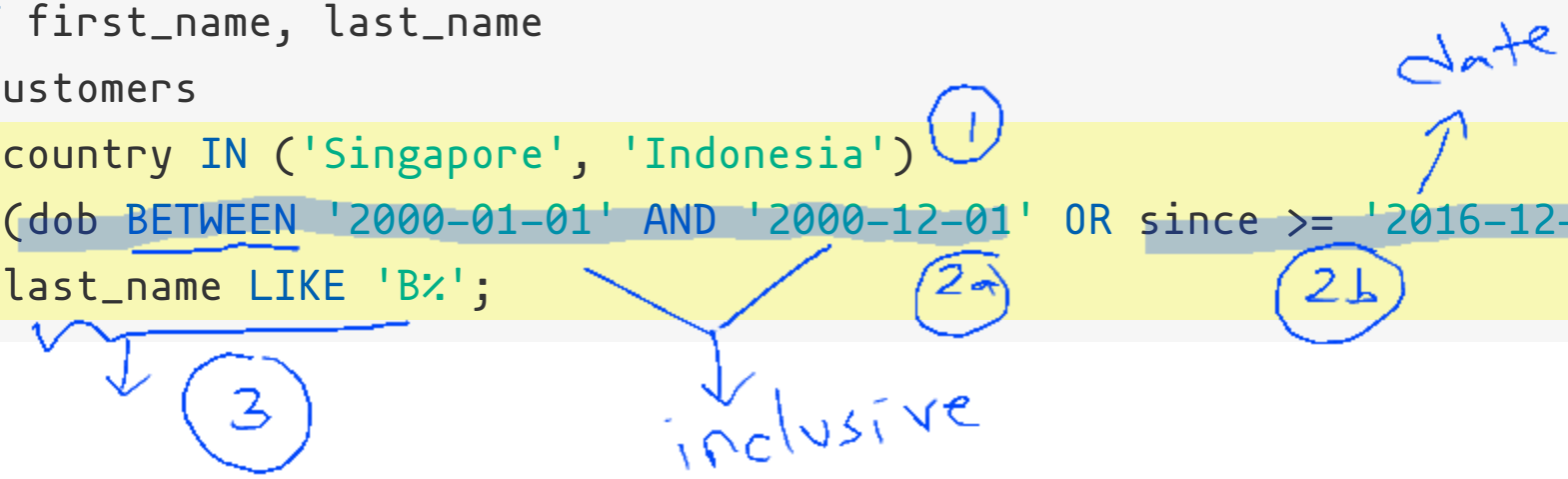
Operation

Condition

WHERE Clause

The `WHERE` clause is used to **filter rows** on a **Boolean** condition. The Boolean condition uses Boolean operators such as `AND`, `OR`, and `NOT` as well as various **comparison** operators such as `>`, `<`, `>=`, `<=`, `<>`, `IN`, `LIKE`, and `BETWEEN .. AND`.

```sql
SELECT first_name, last_name
FROM customers
WHERE country IN ('Singapore', 'Indonesia')
  AND (dob BETWEEN '2000-01-01' AND '2000-12-01' OR since >= '2016-12-01')
  AND last_name LIKE 'B%';
```



*See: **BETWEEN .. AND** and **LIKE** documentations.

Single Table

Operation

Operators

Operators in PostgreSQL

Arithmetic and other functions can be used in `SELECT` and `WHERE` clauses *(as well as in the `ORDER BY`, `GROUP BY`, and `HAVING` clauses)*.
The operator AS is a **renaming** operator.

In SELECT Clause

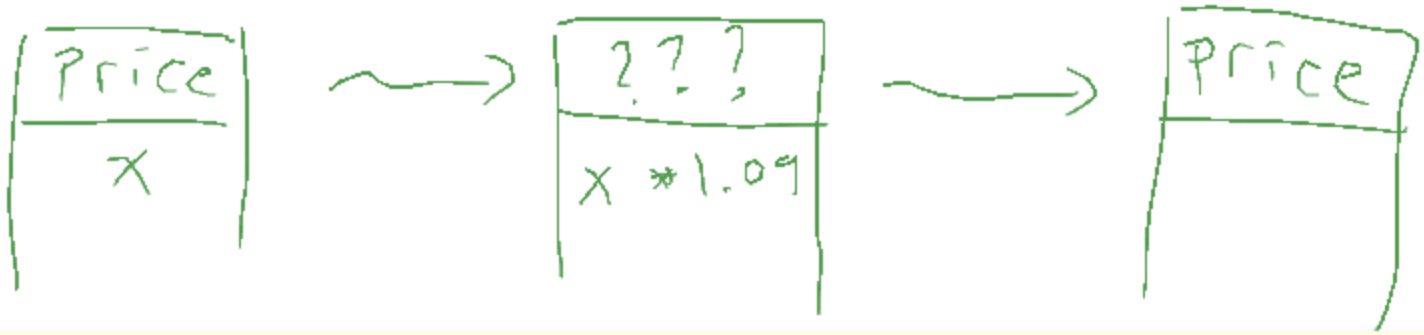
```sql
SELECT DISTINCT price * 1.09 AS gst   -- add GST of 9%
FROM games
ORDER BY gst ASC;
```

*More info on operators.

Single Table

Operation

Operators



Operators in PostgreSQL

Arithmetic and other functions can be used in `SELECT` and `WHERE` clauses *(as well as in the `ORDER BY`, `GROUP BY`, and `HAVING` clauses)*.
The operator `||` is a **concatenation** operator.

In WHERE Clauses

```sql
SELECT
  name || ' ' || version AS game,
  ROUND(price * 1.09, 2) AS price
FROM games
WHERE price * 0.09 >= 0.3;
```

```sql
SELECT
  name || ' ' || version AS game,
  price
FROM games
WHERE price * 0.09 < 0.3;
```

*We perform operations on `price` and rename the result as `price` again.

Single Table

Operation

Operators

Case Analysis

We can do this but not preferrable.
`CASE-WHEN-THEN-ELSE` is like `if-else`. We perform the **first** condtion that is **satisfied** with checking done from **top to bottom**.

```
SELECT name || ' ' || version,
  CASE
    WHEN price * 0.09 >= 0.3 THEN ROUND(price * 1.09, 2)
    ELSE price
  END AS price
FROM games;
```

*The syntax of operations and functions can be specific to DBMS, see PostgreSQL documentation.

Logic and NULL

Reasoning

Differences?

```
SELECT first_name, last_name FROM customers
WHERE (country = 'Singapore' OR country = 'Indonesia')
AND ((dob >= '2000-01-01' AND dob <= '2000-12-01') OR since >= '2016-12-01')
AND last_name LIKE 'B%';
```

```
SELECT first_name, last_name FROM customers
WHERE country IN ('Indonesia', 'Singapore')
AND last_name LIKE 'B%'
AND (since >= '2016-12-01' OR NOT (dob < '2000-01-01' OR dob > '2000-12-01'));
```

```
SELECT first_name, last_name FROM customers
WHERE (country = 'Singapore' OR country = 'Indonesia')
AND (dob BETWEEN '2000-01-01' AND '2000-12-01' OR since >= '2016-12-01')
AND last_name LIKE 'B%';
```

Logic and NULL

De Morgan's Law

Equivalence

Negation of Conjunction/Disjunction

$\neg(A \wedge B) \equiv \neg A \vee \neg B$ $\neg(A \vee B) \equiv \neg A \wedge \neg B$ Wikipedia

```sql
SELECT name FROM games
WHERE (version = '1.0' OR version = '1.1');
```

```sql
SELECT name FROM games
WHERE version IN ('1.0', '1.1');
```

```sql
SELECT name FROM games
WHERE NOT (version <> '1.0' AND version <> '1.1');
```

Logic and NULL

Boolean

Truth Table

WHERE Clause

"`SELECT FROM WHERE <condition>`" returns results when the `<condition>` is True *(later on, you will see that it does not return result when the `<condition>` is False or `NULL`).*

P	Q	P AND Q	P OR Q	NOT P
True	True	True	True	False
True	False	False	True	False
False	True	False	True	True
False	False	False	False	True

Logic and NULL

Boolean

NULL Value

Meaning of NULL

Every **domain** has the additional value: the **NULL** value. In SQL it generally *(but not always)* has the meaning of "***unknown***".

Examples

- "`something = NULL`" is unknown *(even if "`something`" is `NULL`)*.
- "`something <> NULL`" is unknown *(even if "`something`" is `NULL`)*.
- "`something > NULL`" is unknown.
- "`something < NULL`" is unknown.

  etc

- "`10 + NULL`" is null.
- "`0 * NULL`" is null!

Logic and NULL

Boolean

NULL Value

```
CREATE TABLE example (
  column1 VARCHAR(32),
  column2 NUMERIC
);
```

```
INSERT INTO example VALUES
  ('abc', 1),
  ('def', NULL),
  ('ghi', NULL);
```

```
SELECT *
FROM example;
```

column1	column2
"abc"	1
"def"	
"ghi"	

Logic and NULL

Boolean

NULL Value

```
SELECT column1, column2
FROM example
WHERE column2 > 0;
```

column1	column2
"abc"	1

```
SELECT column1, column2
FROM example
WHERE column2 <= 0;
```

column1	column2

Note

`NULL <= 0` and `NULL > 0` evaluates to `NULL`.

Logic and NULL

ISNULL IS NULL

IS NOT NULL

Boolean

NULL Value

```
SELECT column1,
  column2 * 0 AS newcolumn2
FROM example;
```

column1	newcolumn2
"abc"	0
"def"	
"ghi"	

```
SELECT column1, column2
FROM example
WHERE column2 <> NULL;
```

column1	column2

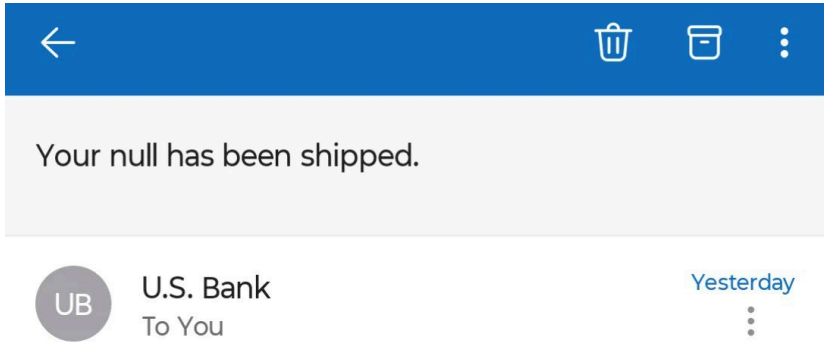
Note

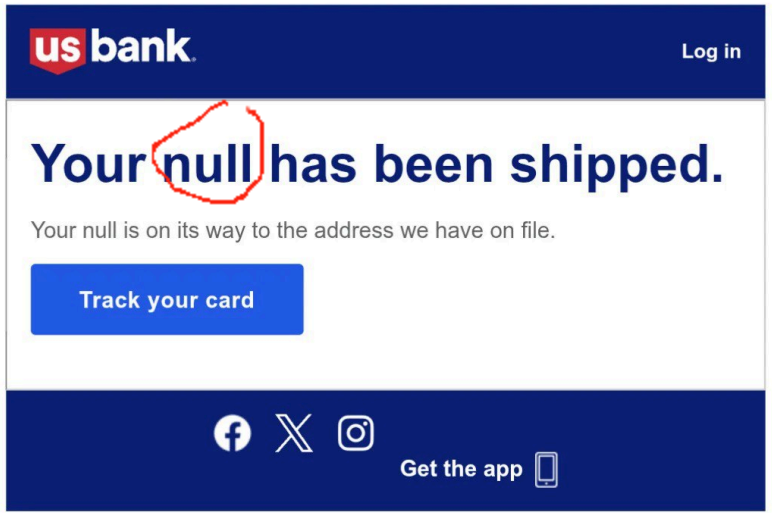
`NULL <> NULL` evaluates to `NULL`.

Logic and NULL

Boolean

NULL Value





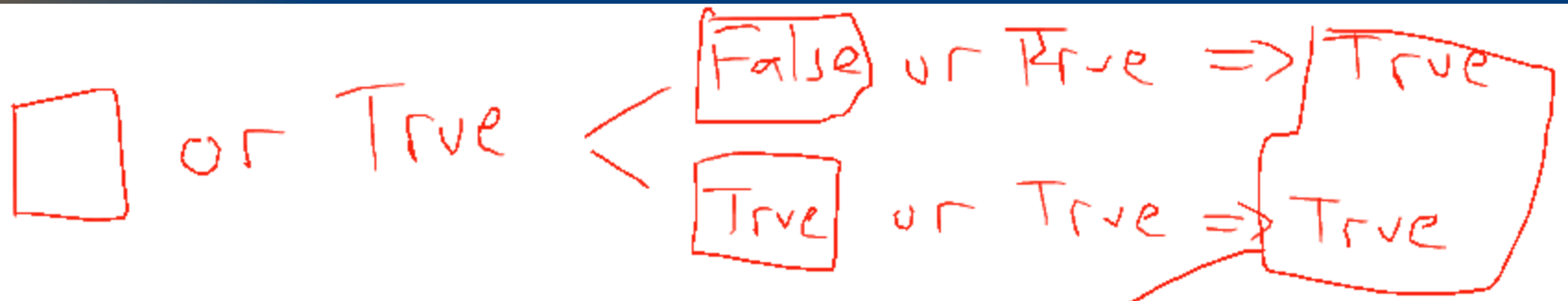
Dear MR Adi Yoga Sidi Prabawa null,

Thank you for registering Singtel OnePass.

Logic and NULL

Boolean

Three Valued



P	Q	P AND Q	P OR Q	NOT P
True	True	True	True	False
True	False	False	True	False
True	**Unknown**	**Unknown**	True	False
False	True	False	True	True
False	False	False	False	True
False	**Unknown**	False	**Unknown**	True
Unknown	True	**Unknown**	True	**Unknown**
Unknown	False	False	**Unknown**	**Unknown**
Unknown	**Unknown**	**Unknown**	**Unknown**	**Unknown**

Logic and NULL

Operations

NULL Operators

Operators Involving NULL Values

- `IS NULL` and `IS NOT NULL` checks for `NULL` values.
  "`NULL IS NULL`" is True.
  "`1 IS NULL`" is False.
  "`NULL IS NOT NULL`" is False.
  "`1 IS NOT NULL`" is True.
- `COALESCE(x1, x2, x3, ...)` returns the first non-`NULL` *(from left-to-right)* of its argument.
  "`COALESCE(NULL, 1, NULL, 2)`" is `1`.
  "`COALESCE(NULL, NULL, NULL)`" is `NULL`.

Logic and NULL

Operations

NULL Operators

```
SELECT column1, column2,
  COALESCE(column2, 0) AS col2
FROM example
WHERE column2 = NULL;
```

column1	column2	col2

Note

`NULL = NULL` evaluates to `NULL`.

```
SELECT column1, column2,
  COALESCE(column2, 0) AS col2
FROM example
WHERE column2 IS NULL;
```

column1	column2	col2
"def"		0
"ghi"		0

Logic and NULL

Operations

NULL Operators

```
SELECT column1, column2,
  (
    CASE WHEN column2 is NULL THEN 0
    ELSE column2 END
  ) AS col2
FROM example;
```

column1	column2	col2
"abc"	1	1
"def"		0
"ghi"		0

Note

We need not use `COALESCE` but `CASE-WHEN` is harder to read in general.

Logic and NULL

Operations

Counting

Counting with NULL

"`COUNT(*)`" counts `NULL` values.
"`COUNT(att)`", "`AVG(att)`", "`MAX(att)`", "`MIN(att)`" eliminate `NULL` values.

```sql
SELECT COUNT(*) AS ctx
FROM example;
```

ctx
3

```sql
SELECT COUNT(column2) AS ctx
FROM example;
```

ctx
1

Logic and NULL

Dear MR Adi Yoga Sidi Prabawa null,

Thank you for registering Singtel OnePass.

Multiple Table

Cross Product

Syntax

Cartesian Product

Cartesian product of tables is the table containing **all the columns** and all **possible combinations of the rows** of the three tables. The comma in the `FROM` clause is a **convenient shorthand** for the keyword `CROSS JOIN`.

Comma

```
SELECT *
FROM customers, downloads, games;
```

1000 x 4214 x 430

Note

Number of **columns** is the **sum** of columns. Number of **rows** is the **product** of rows.

CROSS JOIN

```
SELECT *
FROM customers
  CROSS JOIN downloads
  CROSS JOIN games;
```

1,812,020,000

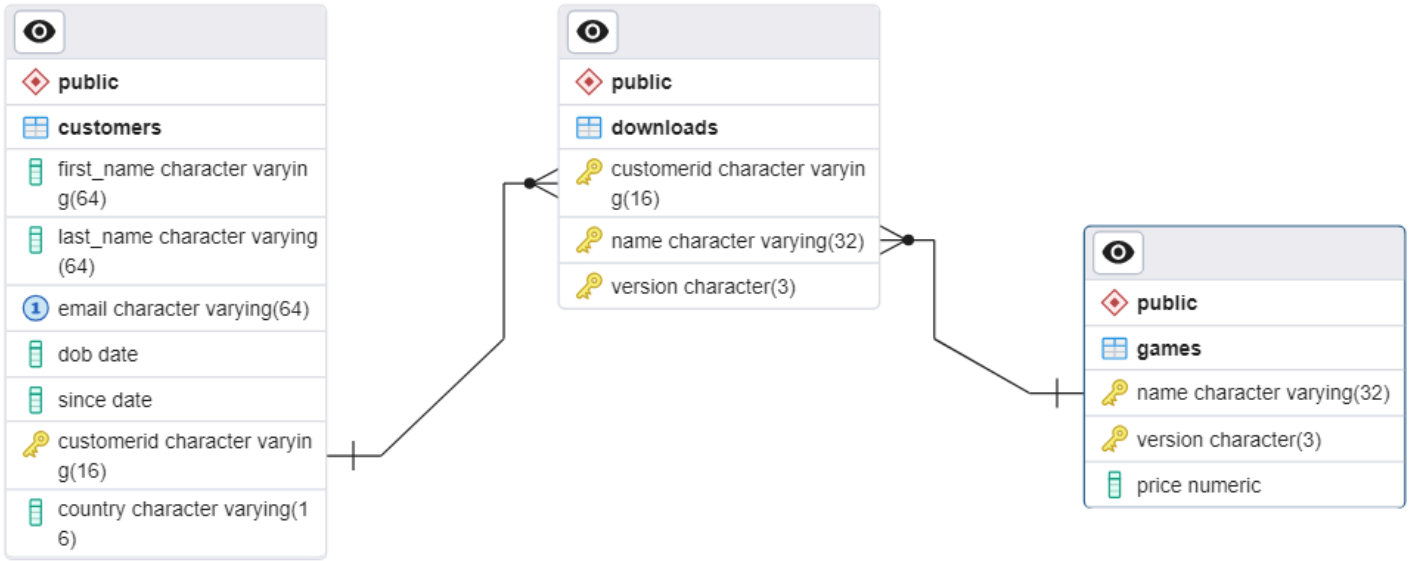
Multiple Table

Primary/Foreign

Joining Tables

When to Join

We should join the tables according to their **primary** and **foreign keys** to make sense of the data. In particular, we add conditions that **referencing attributes** be **equal** to **referenced attributes** in the `WHERE` clause.



Note

This is a graphical representation of **logical schema** called **logical diagram** and not ER diagram.

Multiple Table

Primary/Foreign

Meaningful Join

Conditional Join

To be more precise, we add the condition that **foreign key columns** are **equal** to the corresponding **primary key columns**. The condition below meaningfully corresponds to the "**customers who download a game**".

Code

```
SELECT *
FROM customers c, downloads d, games g
WHERE d.customerid = c.customerid
  AND d.name = g.name
  AND d.version = g.version;
```

Note

It is required from now on in this course to systematicaly define **table variables** for each table in the `FROM` clause and to use the **dot** notation to avoid ambiguity even when there is none.

Multiple Table

Primary/Foreign

Meaningful Join

Conditional Join

To be more precise, we add the condition that **foreign key columns** are **equal** to the corresponding **primary key columns**. The condition below meaningfully corresponds to the "**customers who download a game**".

Code

```
SELECT *
FROM customers, downloads, games
WHERE customerid = customerid
  AND name = name
  AND version = version;
```

Error

Without **table variables**, the system cannot understand which column is which.

In this case, we have two tables containing the same attribute `name` and `version`.

Multiple Table

Understanding

Reading Query

Question

Consider the query below. What does this query find *(in "everyday" English)*?

```
SELECT c.email, g.version
FROM customers c, downloads d, games g
WHERE c.customerid = d.customerid
  AND g.name = d.name
  AND g.version = d.version
  AND c.country = 'Indonesia'
  AND g.name = 'Fixflex';
```

Print all the customers from Indonesia who has downloaded any version of the game named Fixflex

```
postgres=# exit
Press any key to continue . . .
```