# Performance issues

# Indexes

- Indexes are a common way to **enhance database performance**.
  - An index allows the database server to find and retrieve specific rows **much faster** than it could do without an index.
  - But indexes also **add overhead to the database system** as a whole, so they should be used sensibly

# Create index

- CREATE INDEX test1_id_index ON test1 (id);
- CREATE INDEX test1_id_index ON test1 USING btree (id);

- CREATE INDEX test1_id_index ON test1 [USING btree] (id) WHERE <condition>;

➔ Partial index

# Index types in PostgreSQL

- PostgreSQL provides several index types: B-tree, Hash, GiST, SP-GiST, GIN
- Each index type uses a different algorithm that is best suited to different types of queries.

By default, the CREATE INDEX command creates **B-tree** indexes, which **fit the most common situations**

# Index types in PostgreSQL

- B-Tree (default)
  - handle equality and range queries on data that can be sorted into some ordering.
  - Operators: <, ≤, = , ≥, > , LIKE (col LIKE **'foo%'** but not col LIKE '%bar')
  - Sorted output
- Hash index: can only handle simple equality comparisons
- GiST index: for several two-dimensional geometric data types,
  - not a single kind of index, but rather an infrastructure within which many different indexing strategies can be implemented
- GIN index
  - inverted indexes which can handle values that contain more than one key, arrays for example

# Multicolumn index

- CREATE INDEX test2_mm_idx ON test2 (major, minor);

- B-Tree
- GiST index
- GIN index

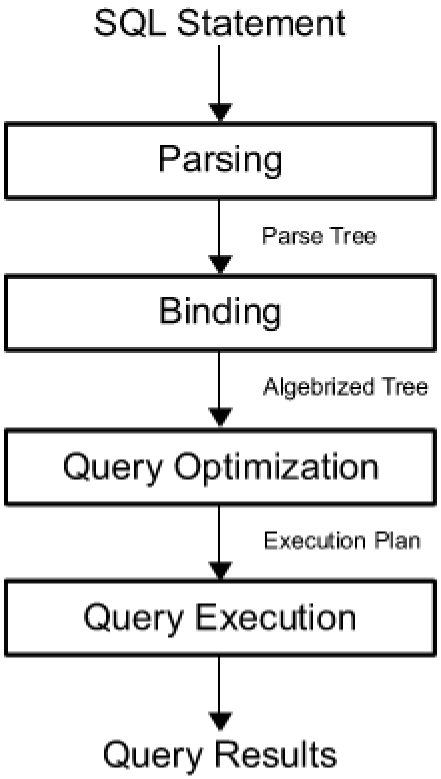
https://www.postgresql.org/docs/10/sql-createindex.html

https://www.postgresql.org/docs/10/indexes.html

# Examining index usage

- EXPLAIN [ ANALYZE ] [ VERBOSE ] *statement*
  - EXPLAIN *statement:* displays the execution plan that the PostgreSQL planner generates for the supplied statement.

    Actually two numbers are shown: the start-up cost before the first row can be returned, and the total cost to return all the rows.
  - **VERBOSE** option: displays additional information regarding the plan (output column list, table and function names, …)



# Examining index usage

- EXPLAIN [ ANALYZE ] [ VERBOSE ] *statement*
  - **ANALYZE** option: causes the statement to be actually executed, not only planned, actual runtime statistics are added to the display
- **Important:** If you wish to use EXPLAIN ANALYZE on an INSERT, UPDATE, DELETE, CREATE TABLE AS, or EXECUTE statement without letting the command affect your data, use this approach:

```
BEGIN;
EXPLAIN ANALYZE ...;
ROLLBACK;
```

# View table indexes

- \d table_name
- Ex.: \d customers

# Tips

- Select fewer columns to improve hash join performance
- Index the *independent* **where** predicates to improve hash join performance

# Tips

- Having a **WHERE / HAVING** clause in your queries does not necessarily means that it is a bad query
- Only retrieve the data you need
  - remove unnecessary columns from SELECT
  - Inner join vs. exists (with subqueries)
  - Select **DISTINCT** : try to avoid if you can
  - **LIKE** operator: the index isn’t used if the pattern starts with % or _

- Limit your results : LIMIT, TOP
- Don’t Make Queries More Complex Than They Need To Be
  - OR / IN / UNION ?
  - OR operator : index is not used except composite index ➔ IN/UNION/OUTER JOIN
  - NOT operator: index is not used => avoid
  - AND vs BETWEEN
  - ANY / ALL: index not used => max , min ,…
  - Isolate columns in Condition : age + 7 < 20 ➔ age < 13

- Limit your results : **LIMIT, TOP**

You can add the LIMIT or TOP clauses to your queries to set a maximum number of rows for the result set.

```
SELECT TOP 3 *
FROM customers;

SELECT  *
FROM customers
LIMIT 3;
```

- Don’t Make Queries More Complex Than They Need To Be
  - OR / IN / UNION ?
  - OR operator : index is not used except composite index ➔ IN/UNION/OUTER JOIN

    ➔ Using a condition with IN or UNION:

```
SELECT * FROM orderlines
WHERE orderid = 1 OR orderid = 5; -- (first cost: 8 - total cost: 4

SELECT * FROM orderlines
WHERE orderid IN (1,5); -- (0.29 - 30)

SELECT * FROM orderlines
WHERE orderid = 1
UNION
SELECT * FROM orderlines
WHERE orderid = 5; -- (30 - 31)
```

- Don’t Make Queries More Complex Than They Need To Be
  - To be careful not to unnecessarily use the UNION operation because you go through the same table multiple times ➔ use a UNION in your query, the execution time will increase.
  - Alternatives to the UNION operation are: reformulating the query in such a way that all conditions are placed in one SELECT instruction, or using an OUTER JOIN instead of UNION.

```sql
SELECT P.* , o.quantity
FROM products p left join orderlines o ON(p.prod_id =
o.prod_id) -- (326 - 2076), ~500ms
WHERE o.orderlineid IS NULL; -- (326 - 2076), 162ms

SELECT * , 0
FROM products
WHERE prod_id not in (select prod_id from orderlines)
UNION
SELECT p.*, quantity
FROM products p join orderlines o ON(p.prod_id = o.prod_id);
-- (17 780 - 19 210) 864 ms
```

- NOT operator: index is not used => avoid

```
select * from customers
where customerid != 5000;

select * from customers
where customerid = 5000;
```

- ANY / ALL: index not used => max , min ,…

- Isolate columns in Condition :

  age + 7 < 20 ➔ age < 13

- No Brute force
  - JOIN clause:
    - Order of tables => biggest table: placed last in join
    - No redundant conditions on joins
  - Having clause:
    - Used only if needed
    - Not to replace WHERE => WHERE help to limit the intermediate number of records

➔ Need smart indexing, smart using

# Luu y: co the them ve

- Geometric type :
  - https://www.postgresql.org/docs/10/datatype-geometric.html
  - https://www.postgresql.org/docs/10/functions-geometry.html
- GiST: https://www.postgresql.org/docs/10/indexes-types.html