

# SQL – Indexes

---

Carla Teixeira Lopes

Bases de Dados

Mestrado Integrado em Engenharia Informática e Computação, FEUP

Based on Jennifer Widom slides

# Indexes

---

Primary mechanism to get improved performance on a database

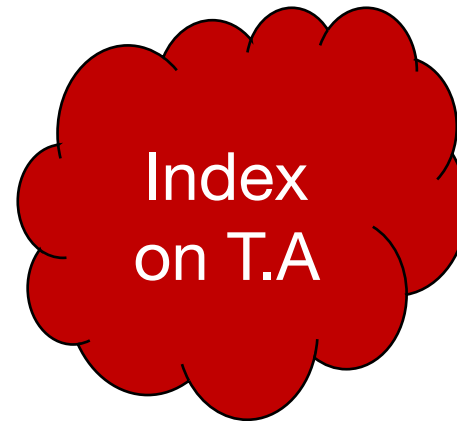
Persistent data structure, stored in database

Many interesting implementation issues

But we are focusing on user/application perspective

# Functionality

---



T

	A	B	C
1	cat	2	...
2	dog	5	...
3	cow	1	...
4	dog	9	...
5	cat	2	...
6	cat	8	...
7	cow	6	...
	...	...	...

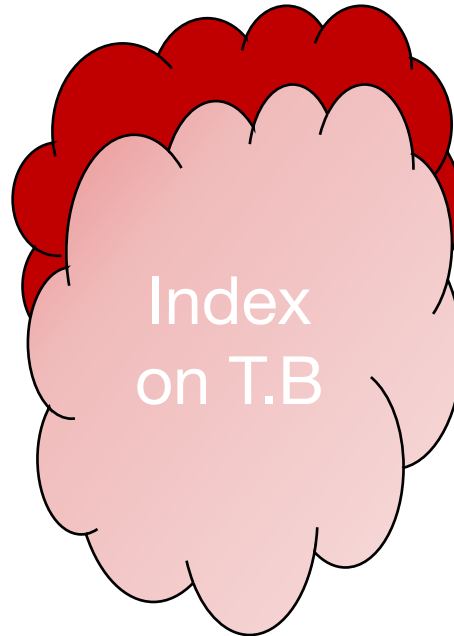
If we want tuples with T.A = 'cow',  
DBMS doesn't need to scan the entire  
table

Users don't access indexes

Indexes are used underneath by the  
query execution engine

# Functionality

---



Useful for queries involving T.B like:

$T.B = 2$

$T.B < 6$

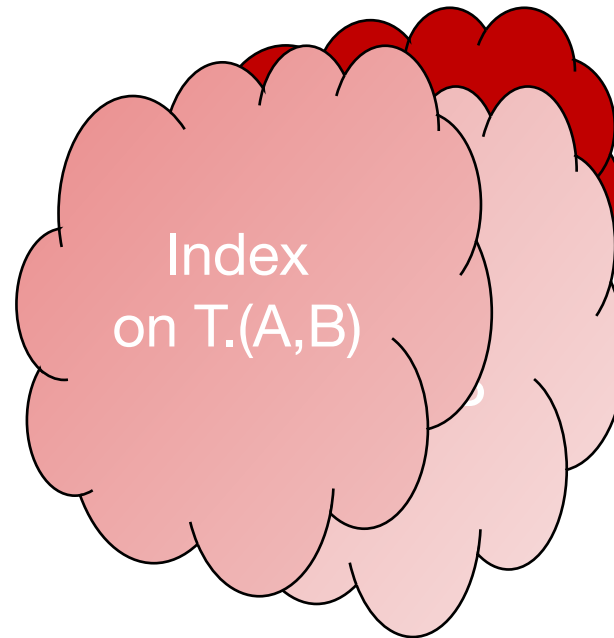
$4 < T.B \leq 8$

T

	A	B	C
1	cat	2	...
2	dog	5	...
3	cow	1	...
4	dog	9	...
5	cat	2	...
6	cat	8	...
7	cow	6	...
	...	...	...

# Functionality

---



**T**

	<b>A</b>	<b>B</b>	<b>C</b>
1	cat	2	...
2	dog	5	...
3	cow	1	...
4	dog	9	...
5	cat	2	...
6	cat	8	...
7	cow	6	...
	...	...	...

Useful for queries involving T.A and T.B  
like:

T.A = 'cat' AND T.B > 5

T.A < 'd' AND T.B = 1

# Utility

---

Index = difference between full table scans and immediate location of tuples

Orders of magnitude performance difference

## Underlying data structures

Balanced trees (B trees, B+ trees)

For equalities or inequalities conditions

Operations running time tend to be logarithmic

Hash tables

Only for equality conditions

Operations running time is more or less constant

## Where should indexes be created?

---

```
Select sName  
From Student  
Where sID = 18942
```

Many DBMS's build indexes automatically on PRIMARY KEY (and sometimes UNIQUE) attributes

# Where should indexes be created?

---

```
Select sID  
From Student  
Where sName = 'Mary' and GPA>3.9
```

Index on sName

Hash or tree-based

Index on GPA

Tree-based

Index on (sName, GPA)



# Where should indexes be created?

---

```
Select sName, cName  
From Student, Apply  
Where Student.sID = Apply.sID
```

More attributes →  
Query planning &  
optimization

## Index on Apply.sID

Scans Student relation and, for each student, finds the matching SID in the Apply relation

## Index on Student.sID

Scans Apply relation and, for each student, finds the matching SID in the Student relation

## Index on (Student.sID, Apply.sID)

# Downside of Indexes

---

## Extra space

Marginal downside

## Index creation

Medium downside

## Index maintenance

Can offset benefits

# Picking which indexes to create

---

Benefit of an index depends on:

Size of table (and possibly layout)

Data distributions

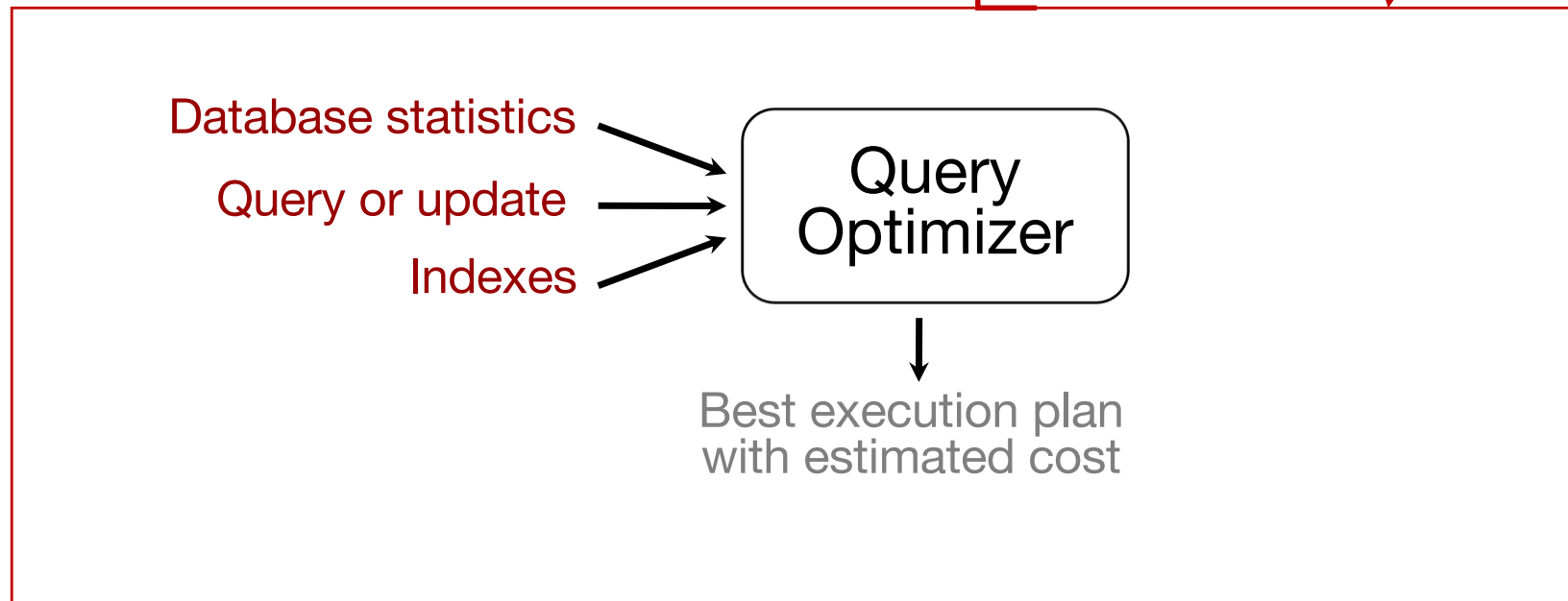
Query vs. update load

# “Physical design advisors”

---

Input: database (statistics) and workload

Output: recommended indexes



Selects indexes whose  
benefits outweigh  
drawbacks

# SQL Syntax

---

Create Index IndexName on T(A)

Create Index IndexName on T(A1,A2,...,An)

Create Unique Index IndexName on T(A)

Drop Index IndexName

# Kahoot time!

---

Any doubts?

# Readings

---

Jeffrey Ullman, Jennifer Widom, A first course in  
Database Systems 3<sup>rd</sup> Edition

Section 8.3 – Indexes in SQL

Section 8.4 – Selection of Indexes