



Indexes =

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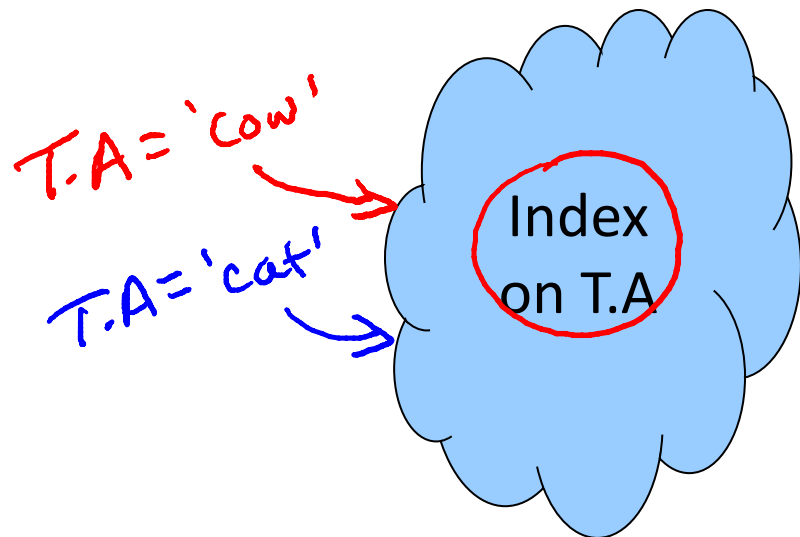
*Indices*

# 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

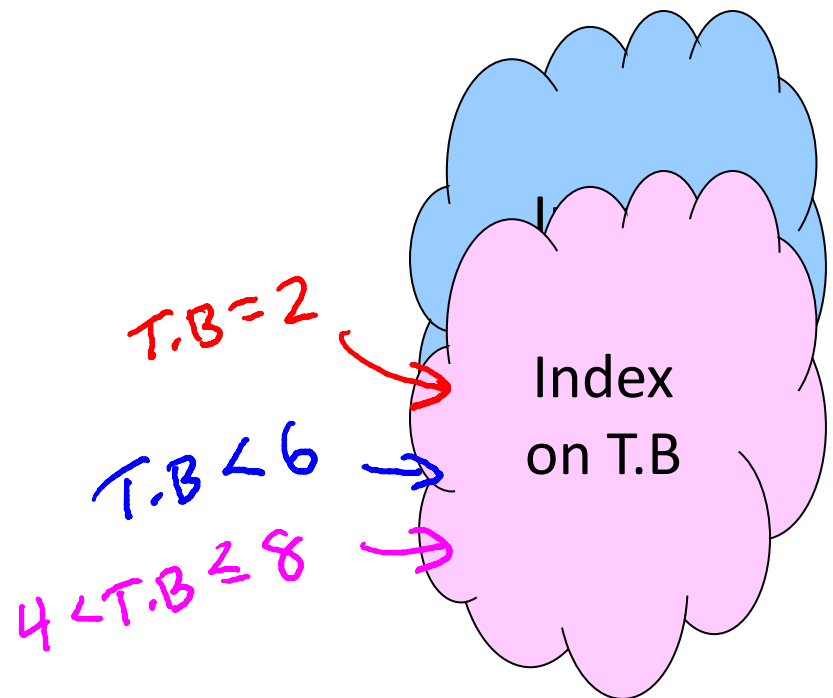
## Functionality



**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	...
	...	...	...

## Functionality



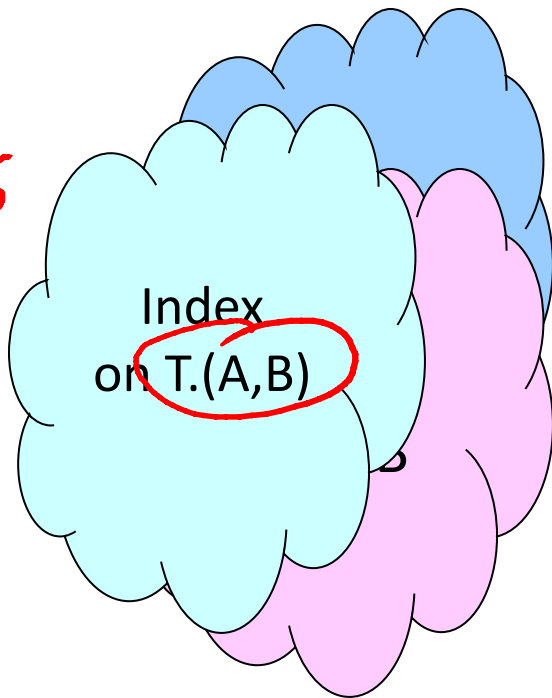
**T**

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

# Functionality

$T.A = 'cat'$   
and  $T.B > 5$

$T.A < 'd'$   
and  $T.B = 1$



**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	...
	...	...	...

# 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)

- Hash tables

$$A = v$$

→ constant ✓

$$A = v \quad v_1 \leq A \leq v_2$$
$$A < v$$

→ logarithmic ✓

```
Select sName  
From Student  
where SID = 18942
```

*Index on SID*

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

```
Select SID  
From Student  
where sName = 'Mary' And GPA > 3.9
```

Index on sName  $\leftarrow$  hash or tree  
Index on GPA  $\leftarrow$  tree-based  
" (sName, GPA)



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

Index ——— Index

Query planning & optimization



## Downsides of Indexes

- 1) Extra space – marginal
- 2) Index creation – medium
- 3) 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

*Benefits outweigh drawbacks*

- Database statistics

- Query or update

- Indexes

Query  
Optimizer

Best execution plan  
with estimated cost

## 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

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