$BF_r \Rightarrow 51200/256 = 200$

$Bf_{ri} \Rightarrow 51200/16$

$$\begin{cases} Dept \Rightarrow Research \Rightarrow 0.55 \\ Gender \Rightarrow female \Rightarrow 0.12 \\ Salary > 300000 \Rightarrow 0.04 \end{cases}$$

## High Selectivity Query

$0.55 (0.12 (0.04 \times 1280000))) \Rightarrow 3380 \longrightarrow \boxed{S_c}$

Research $\Rightarrow$ $0.55 \times 1280000 \Rightarrow 704000. \longrightarrow \boxed{S1}$

female $\Rightarrow$ $0.12 \times 1280000 \Rightarrow 153600 \longrightarrow \boxed{S2}$

Salary > 300000 $\Rightarrow 0.04 \times 1280000 \Rightarrow 51200 \longrightarrow \boxed{S3}$.

### 1) Full Table Scan

$\Rightarrow 6400$ blocks.

### 2) Single Indexing

We use S3 in this case (highest selectivity).

$S3 \Rightarrow 51200$

$S3/Bf_{ri} \Rightarrow 51200/3200 \Rightarrow 16$ blocks

Total I/o cost $\Rightarrow$ Base Table + Index Table

$\Rightarrow 6400 + 16 \Rightarrow 6416$ blocks

### 3) Combining Multiple Indexes

Total Cost $\Rightarrow \left(\frac{S1}{Bf_{ri}}\right) + \left(\frac{S2}{Bf_{ri}}\right) + \left(\frac{S3}{Bf_{ri}}\right)$

$\Rightarrow \left(\frac{704000}{3200}\right) + \left(\frac{153600}{3200}\right) + \left(\frac{51200}{3200}\right)$

$\Rightarrow 220 + 48 + 16$

$\Rightarrow 284.$

Total I/o Cost $\Rightarrow$ Base table + Total index access cost

$\Rightarrow 3380 + 284$

$\Rightarrow 3664$ blocks.

## 4) Dynamic Bitmap Index.

It will be the same as combining multiple indexes.

## 5) Static Bitmap Index

$$\text{Bitmap size} \Rightarrow \frac{r}{B \times 8} \Rightarrow \frac{1280000}{(51200 \times 8)}$$

$$\Rightarrow 4 \text{ blocks.}$$

Research → 4

Female → 4

Salary > 300000 → 4

Total Index Cost ⇒ 4 + 4 + 4 ⇒ 12

Qualifying Rows ⇒ $S_c$ ⇒ 3380

Total I/O Cost ⇒ Base Table + Index cost

$$\Rightarrow 3380 + 12$$

$$\Rightarrow 3392 \text{ blocks.}$$

## 6) Composite Index.

Composite Index size = 16 bytes.

$$\text{Blocking factor for composite index} \Rightarrow \frac{B}{R_i}$$

$$\Rightarrow \frac{51200}{16}$$

$$\Rightarrow 3200$$

Index access cost ⇒ 3380 / 3200

$$\Rightarrow 2 \text{ blocks.}$$

Total I/O cost ⇒ Base Table + Index Table

$$\Rightarrow 3380 + 2$$

$$\Rightarrow 3382$$

## 7) Clustered Index

No of blocks for base $\Rightarrow S3/Bfr$

$\Rightarrow 51200/200$

$\Rightarrow 256$ blocks.

No of blocks for Index $\Rightarrow S3/Bfri$

$\Rightarrow 51200/3200$

$\Rightarrow 16$ blocks

Total $\Rightarrow$ $256 + 16$ $\Rightarrow$ $272$ blocks.

## Low Selectivity Query

Dept $\Rightarrow$ Research $\Rightarrow$ 0.55

Gender $\Rightarrow$ Female $\Rightarrow$ 0.12.

Salary > 50 000 $\Rightarrow$ 0.6

Combined selectivity $\Rightarrow$ $\boxed{Sc} \Rightarrow 0.55(0.12(0.6 \times 1280000)))$

$\Rightarrow$ 50688 rows

| | | | |
|---|---|---|---|
| Research | $\Rightarrow$ 0.55 × 1280 000 $\Rightarrow$ 704000 rows $\Rightarrow$ | $S_1$ |
| Female | $\Rightarrow$ 0.12 × 1280 000 $\Rightarrow$ 153600 rows $\Rightarrow$ | $S_2$ |
| Salary > 50 000 $\Rightarrow$ 0.60 × 1280 000 $\Rightarrow$ 768 000 rows $\Rightarrow$ | $S_3$ |

## 1) Full Table Scan

I/O total cost would be equal to the number of blocks in the base table

i.e $\Rightarrow$ 6400

## 2) Single Indexing

We choose $S_2$ in this case. because of high selectivity.

$$\text{Index Table Cost} \Rightarrow S_2/Bfri$$

$$\Rightarrow 153600/3200$$

$$\Rightarrow 48 \text{ Blocks}$$

$$\text{Total cost} \Rightarrow 6400 + 48$$

$$\boxed{\Rightarrow 6448 \text{ blocks}}$$

## 3) Combining Multiple Indexes

$$\Rightarrow \quad S_1/Bfri \quad + \quad S_2/Bfri \quad + \quad S_3/Bfri$$

$$\Rightarrow \frac{704000}{3200} + \frac{1536000}{3200} + \frac{768000}{3200}$$

$$\Rightarrow 508$$

$$\text{Total cost} \Rightarrow 6400 + 508$$

$$\Rightarrow 6908$$

## 4) Dynamic Bitmap Indexing

Same as combining multiple indexes.

## 5) Static Bitmap Indexing

$$\text{Bitmap size} \Rightarrow r/B \times B$$

$$\Rightarrow \frac{1280000}{5200 \times 8}$$

$$\Rightarrow 4 \text{ Blocks}$$

$$\text{Total Index access cost} \Rightarrow 4 + 4 + 4$$

$$\Rightarrow 12$$

$$\text{Total I/O cost} \Rightarrow 6400 + 12$$

$$\Rightarrow 6412$$

## 6) Composite Index

Blocking Factor for composite index $\Rightarrow B/i$

$$\Rightarrow 51200/16$$

$$\Rightarrow 3200.$$

Index access cost $\Rightarrow \dfrac{50688}{3200}$

$$\rightarrow 16 \text{ blocks}$$

Total cost $\Rightarrow 6400 + 16 \quad \Rightarrow 6416$

## 7) Clustered Index

No of blocks for base table $\Rightarrow s^2/Bfr$

$$\Rightarrow 153600/200$$

$$\Rightarrow 768 \text{ blocks}$$

No of blocks for Index table $\Rightarrow s^2/Bfri$

$$\Rightarrow 153600/3200$$

$$\rightarrow 48 \text{ blocks.}$$

Total cost $\Rightarrow 768 + 48$

$$\Rightarrow 816 \text{ blocks.}$$