Column-Oriented Databases Lab

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Do I Really Need a Column-Oriented Database?

LAB DISCUSSION

Do I Really Need a Column-Oriented DB?

- Traditional (row-oriented) databases provide means for improving performance in front of read-only queries
  - Vertical partitioning (improves useful read ratio)
    - Each table split in a set of two-columned partitions (key, attribute)
  - Use index-only query plans (no table access)
    - Create a collection of indexes that cover all columns used in a query
  - Use a collection of materialized views such that there is a view with the exact columns needed to answer the query

Tuning for Read-Only Queries

- *Objective: Refresh the main tuning techniques for read-only queries*
- *Tasks:*
  1. *(5') With a teammate apply (and understand) the following tuning to the database and query shown below*
     1. *Vertical partitioning*
     2. *Index-only query answering*
     3. *Materialized views*
  2. *(10') Discuss (under what circumstances) which is best or, in other words, what access plan would result for each strategy*
  3. *(5') Think tank*

Query:

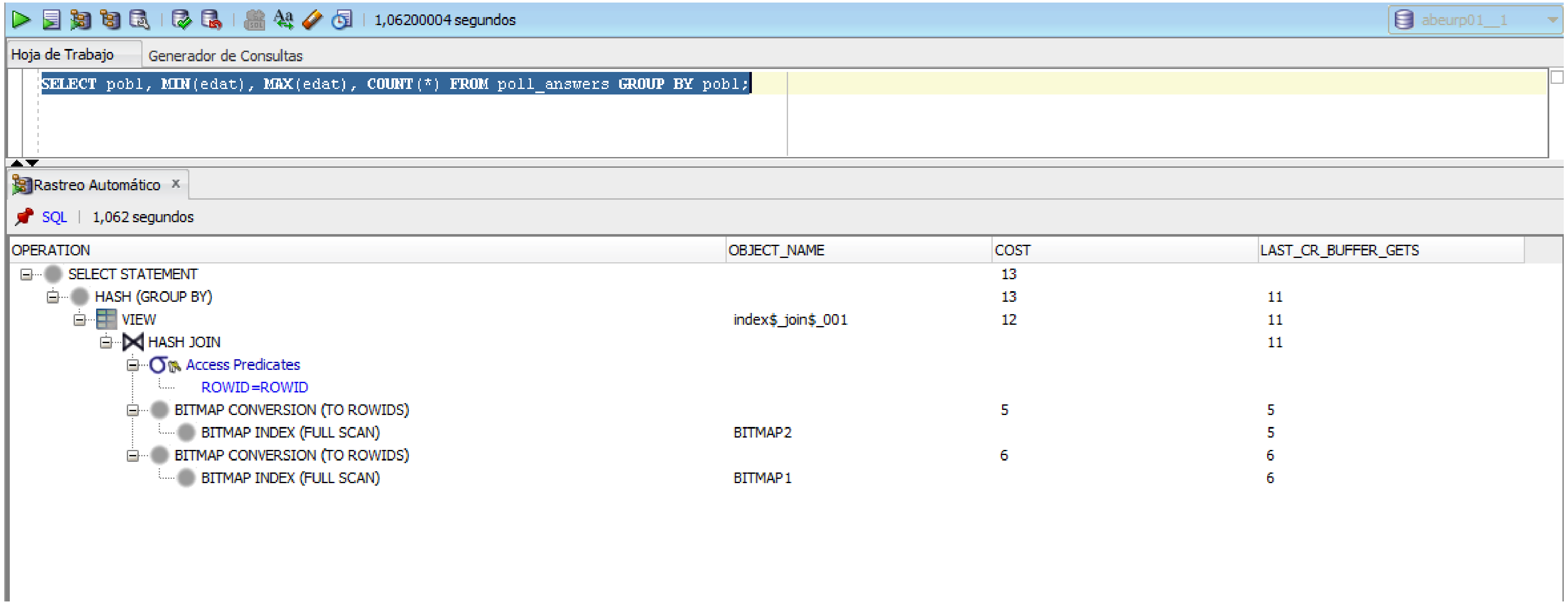
```
SELECT llibreId, SUM(numUnitats) FROM compres c, llibre l
WHERE c.llibreId = l.llibreId AND editorial = 'RBA'
GROUP BY llibreId
```

Database:

Compres(llibreId^{FK}, date, preu, numUnitats)
Llibre(llibreId, autor, any, editorial, ISBN)

Bottlenecks in Row-Oriented DBs

- *Objective: Identify the bottlenecks remaining in a row-oriented database after tuning it with bitmaps and materialized views*
- *Tasks:*
  1. *(5') Understand the access plan below and identify what operations are taking more computation time*
  2. *(5') Discussion*



```sql
SELECT pobl, MIN(edat), MAX(edat), COUNT(*) FROM poll_answers GROUP BY pobl;
```

1,062 segundos

```
OPERATION                                   OBJECT_NAME        COST    LAST_CR_BUFFER_GETS
SELECT STATEMENT                                               13
  HASH (GROUP BY)                                              13      11
    VIEW                                    index$_join$_001   12      11
      HASH JOIN                                                        11
        Access Predicates
          ROWID=ROWID
        BITMAP CONVERSION (TO ROWIDS)                          5       5
          BITMAP INDEX (FULL SCAN)          BITMAP2                    5
        BITMAP CONVERSION (TO ROWIDS)                          6       6
          BITMAP INDEX (FULL SCAN)          BITMAP1                    6
```

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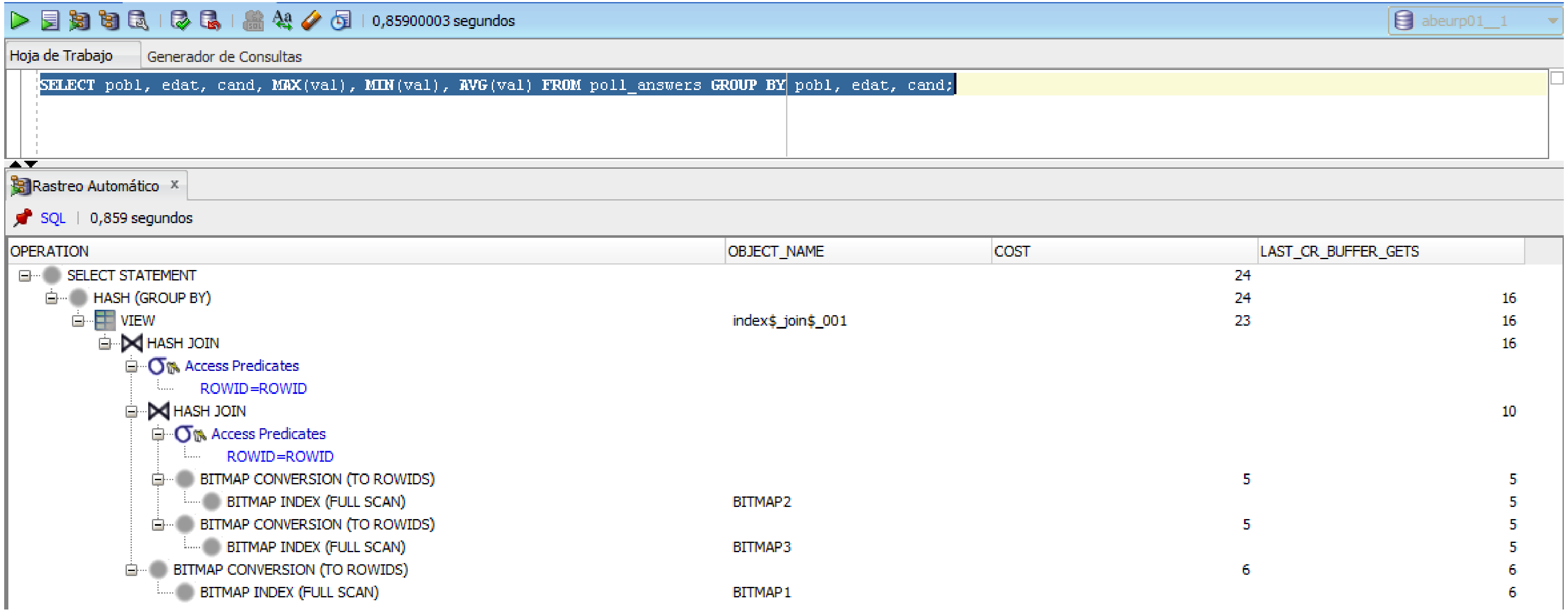

```
SELECT pobl, edat, cand, MAX(val), MIN(val), AVG(val) FROM poll_answers GROUP BY pobl, edat, cand;
```

OPERATION	OBJECT_NAME	COST	LAST_CR_BUFFER_GETS
SELECT STATEMENT		24	
HASH (GROUP BY)		24	16
VIEW	index$_join$_001	23	16
HASH JOIN			16
Access Predicates			
ROWID=ROWID			
HASH JOIN			10
Access Predicates			
ROWID=ROWID			
BITMAP CONVERSION (TO ROWIDS)		5	5
BITMAP INDEX (FULL SCAN)	BITMAP2		5
BITMAP CONVERSION (TO ROWIDS)		5	5
BITMAP INDEX (FULL SCAN)	BITMAP3		5
BITMAP CONVERSION (TO ROWIDS)		6	6
BITMAP INDEX (FULL SCAN)	BITMAP1		6

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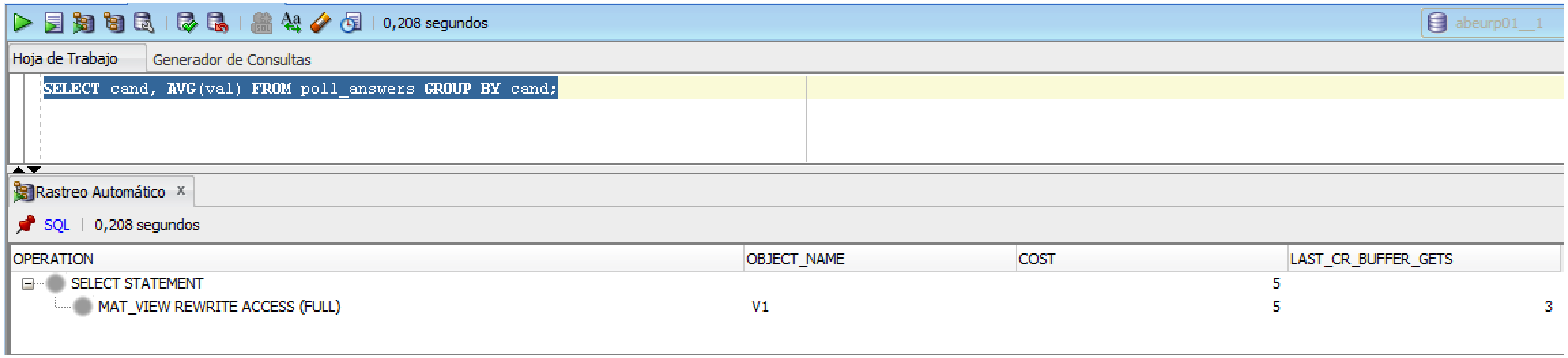
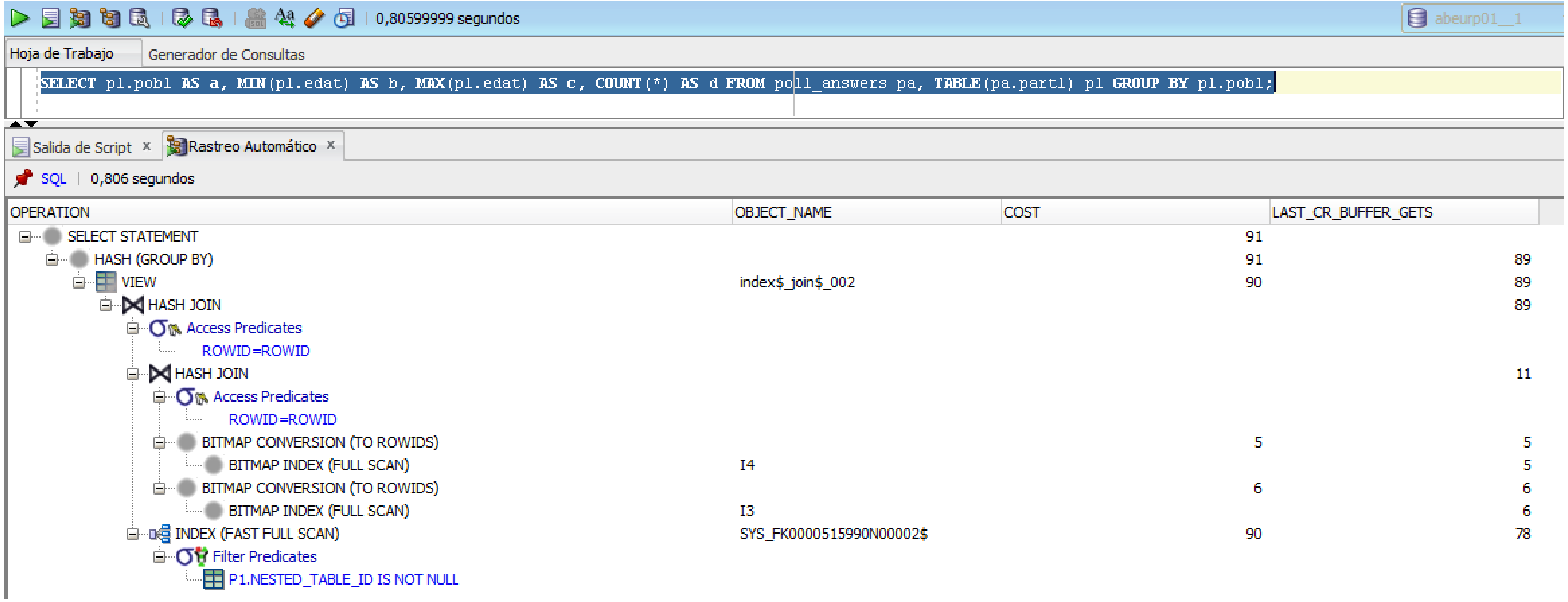


```sql
SELECT cand, AVG(val) FROM poll_answers GROUP BY cand;
```

OPERATION	OBJECT_NAME	COST	LAST_CR_BUFFER_GETS
SELECT STATEMENT		5	
MAT_VIEW REWRITE ACCESS (FULL)	V1	5	3

Bottlenecks in Row-Oriented DBs

- *Objective: Identify the bottlenecks remaining in a row-oriented database after tuning it with vertical fragmentation*
- *Tasks:*
  1. *(5') Understand the access plan below and identify what operations are taking more computation time*
  2. *(5') Discussion*



```
SELECT pl.pobl AS a, MIN(pl.edat) AS b, MAX(pl.edat) AS c, COUNT(*) AS d FROM poll_answers pa, TABLE(pa.partl) pl GROUP BY pl.pobl;
```

OPERATION	OBJECT_NAME	COST	LAST_CR_BUFFER_GETS
SELECT STATEMENT		91	
HASH (GROUP BY)		91	89
VIEW	index$_join$_002	90	89
HASH JOIN			89
Access Predicates			
ROWID=ROWID			
HASH JOIN			11
Access Predicates			
ROWID=ROWID			
BITMAP CONVERSION (TO ROWIDS)		5	5
BITMAP INDEX (FULL SCAN)	I4		5
BITMAP CONVERSION (TO ROWIDS)		6	6
BITMAP INDEX (FULL SCAN)	I3		6
INDEX (FAST FULL SCAN)	SYS_FK0000515990N00002$	90	78
Filter Predicates			
P1.NESTED_TABLE_ID IS NOT NULL			

Conclusions

- Column-oriented DBs implement specific optimization mechanisms that outperform tuned row-oriented RDBMS (up to **50-75%** of improvement). This is due to:
  - Implement vertical fragmentation in an efficient manner
    - As result, while row-oriented databases need joins to reconstruct the original tuples, column-oriented DBs do not
  - Compression is not as efficiently applied in row-oriented DBs as in column-oriented DBs
    - Ligthweight compression and fixed-size records
  - Row-oriented DBs do not apply specific query processing techniques tailored for columnar databases
    - Vectorized query processing

As such, trying to emulate a column-store in a row-store does not yield good performance results

Bibliography

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