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Balancing Act to improve RDF Query Performance in Oracle Database

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Agenda

- RDF Query processing Issues
- RDF Order-By and Filter Processing
- RDF In-Memory Processing
- RDF In-Memory Virtual Columns
- Conclusion

Oracle RDF

- RDF_LINK$ table (triples)
  - normalized
  - subject, predicate, object IDs
- RDF_VALUE$ table (ID to value mapping)
  - value, type, etc.
- Issues
  - frequent joins with RDF_VALUE$ table to present results, process filters and order-by queries
  - complete de-normalization incurs large storage requirements
  - self-joins: large intermediate join results

Oracle RDF Filters and Order-By Processing

- SPARQL order-by semantics
  - order: no values, blank nodes, IRIs, literals
  - case statement: value type, numeric value, date value, string value
  - ORDER BY CASE WHEN (V4.VALUE_TYPE IS NULL) THEN 0

    WHEN (V4.VALUE_TYPE IN ('BLN','BN')) THEN 1

    WHEN (V4.VALUE_TYPE IN ('URI','UR')) THEN 2

    WHEN (V4.VALUE_TYPE IN ('PL', 'PLL', 'CPLL', 'PL@', 'PLL@', 'CPLL@', 'TL', 'TLL', 'CTLL', 'LIT'))

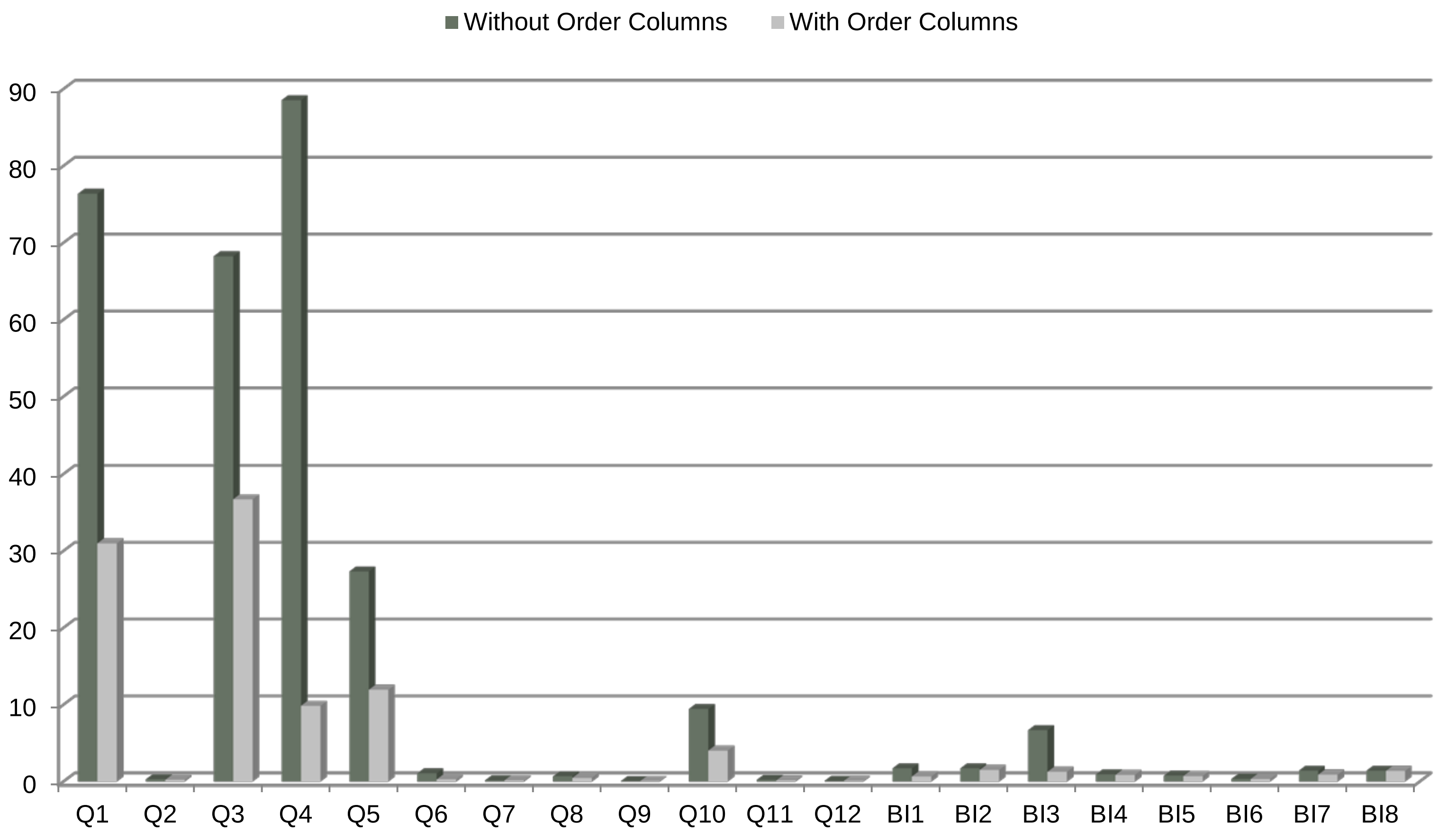
    THEN (CASE WHEN (V4.LANGUAGE_TYPE IS NOT NULL) THEN 5

    ……..

Oracle RDF Filters and Order-By Processing

  - literal type - numeric: TO_NUMBER( )
  - literal type - date/time: TO_TIMESTAMP_TZ ( ), DECODE( )
  - use function calls to generate SQL for order-by
  - case statements executed for every row at runtime
  - same problem for filters
- Solution
  - materialize value type and values in RDF_VALUE$ table
  - stored as ORDER_TYPE, ORDER_NUM, ORDER_DATE
  - filled in at load time
  - generate SQL: ORDER BY order_type, order_num, order_date, value_name
  - filter clause: WHERE order_num < to_number(89)

Oracle RDF Order-By and Filter Performance using BSBM Benchmark Queries (in secs)

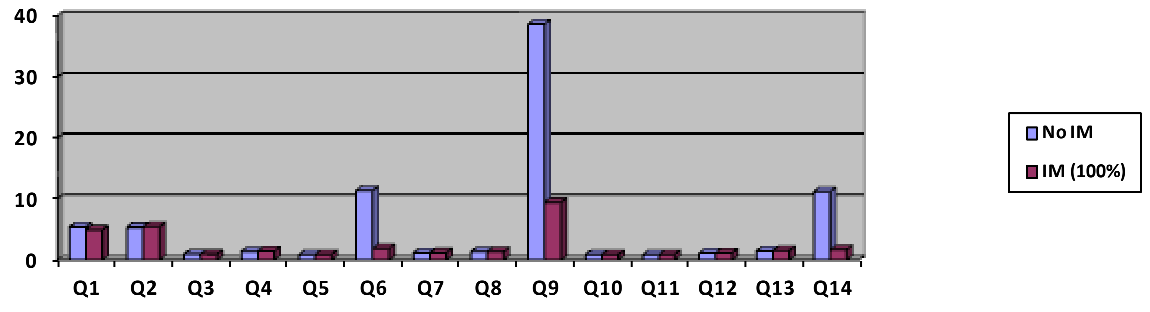


Oracle RDF In-Memory Processing

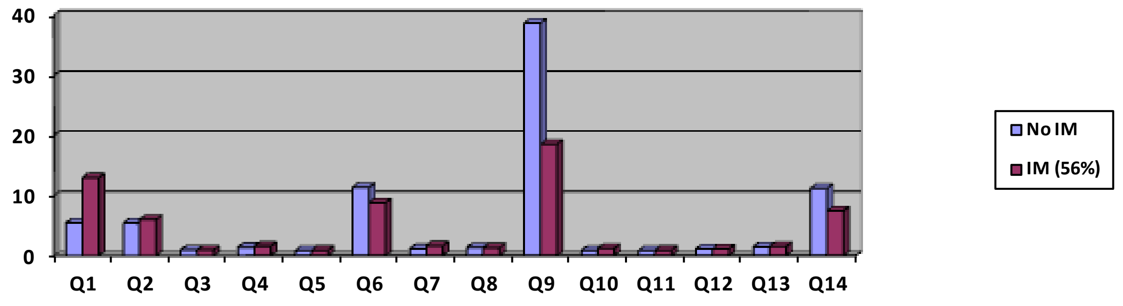
- Utilize Oracle IMC
  - load frequently accessed columns in memory
    - RDF_LINK$ table: subject, predicate, object IDs
    - RDF_VALUE$: id, value
  - fast full scan of the table: good for hash join
- Experiment
  - 32GB memory, 2TB disk space
  - LUBM benchmark queries (8,763,829 rows including entailment)
  - varying the size of the memory: 6G(100%), 4G(56%), 2G(27%), 1G(12%)

Oracle RDF In-Memory Query Times (in sec) for LUBM Benchmark Queries

- 100% : 4x – 6x gain

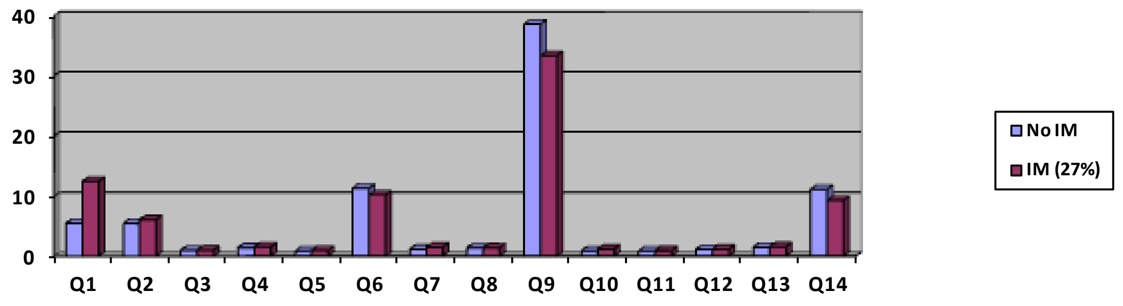


- 56%

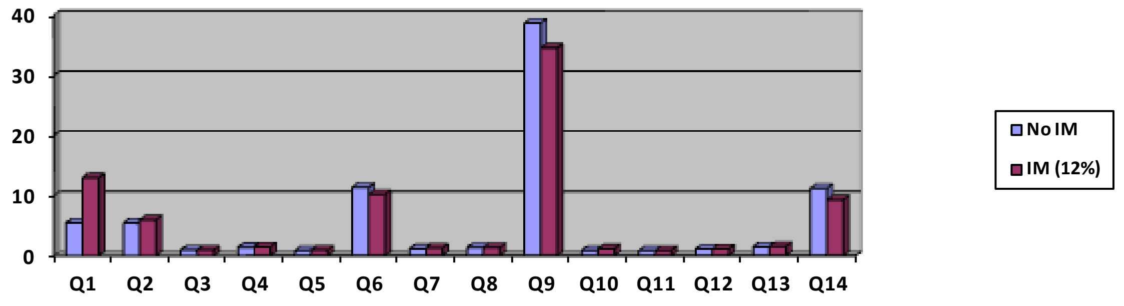


Oracle RDF In-Memory Query Times (in sec) for LUBM Benchmark Queries

- 27%

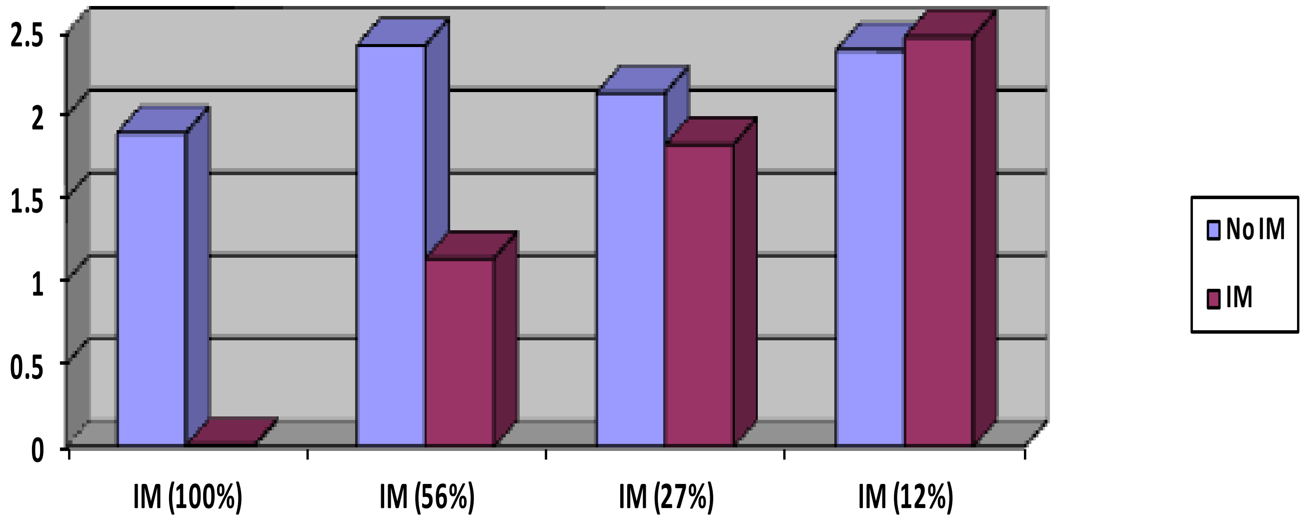


- 12%



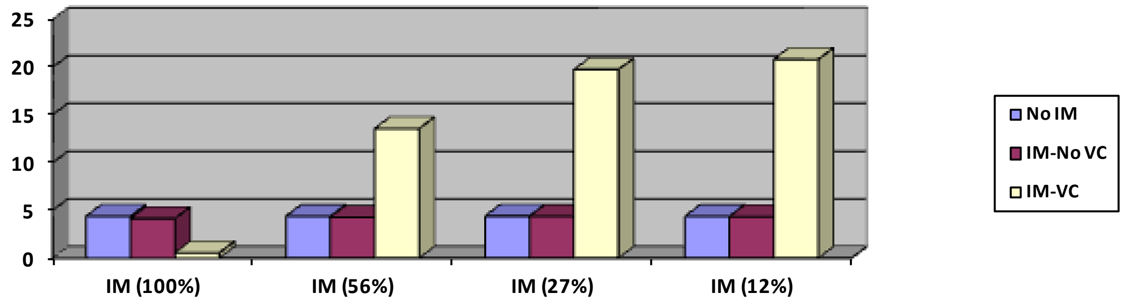
Oracle RDF In-Memory Full Scan Performance (in sec)

- Fetching 3 IDs from RDF_LINK$ table
- 100% - 190x gain



Oracle RDF In-Memory Virtual Columns

- In-memory complete de-normalization without incurring disk storage requirements
  - define virtual columns in RDF_LINK$ table for values, types, etc. : VALUE_NAME_S, VALUE_NAME_P, VALUE_NAME_O, etc.
  - useful for fully populated data in memory: virtual model



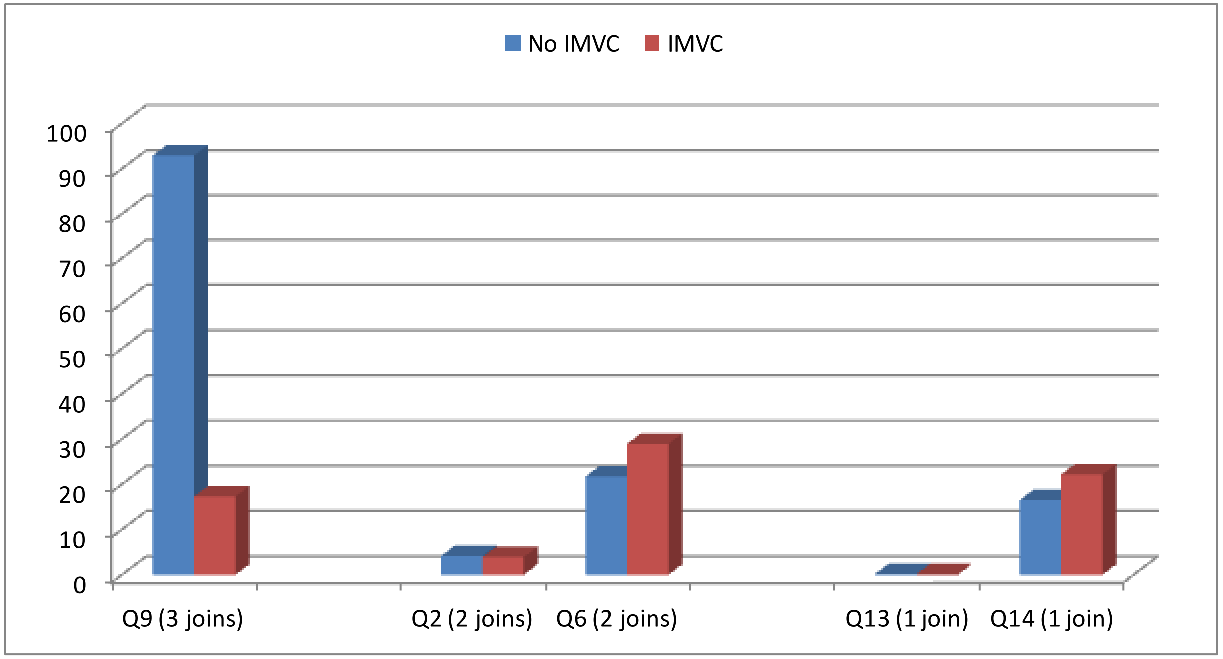
Virtual column in-memory performance (in min) –fetching 3 IDs & 3 VCs

Oracle RDF In-Memory Virtual Columns

- remove joins with RDF_VALUE$ table
- queries are processed on RDF_LINK$ table only
- compression, smart scans (in-memory storage index), dictionary code for values, SIMD vector processing

Oracle RDF In-memory Virtual Column Performance using LUBM Benchmark Queries (in secs)

- Up to 8x gain



- As the number of joins increases, a bigger gain is achievable

Oracle RDF In-Memory Virtual Columns

- Can apply to data mart/data warehousing star/ snowflake schema
  - remove joins with dimension tables
- Can apply to any applications where joined tables have one-to-one mapping on their join keys

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Conclusion

- Significant performance improvement
  - use order columns in place of complex logic in the query for RDF filter and order-by processing
  - improve hash joins by in-memory processing of frequently accessed columns
  - remove costly joins using in-memory virtual columns by complete de-normalization for fully populated data

Your Questions

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