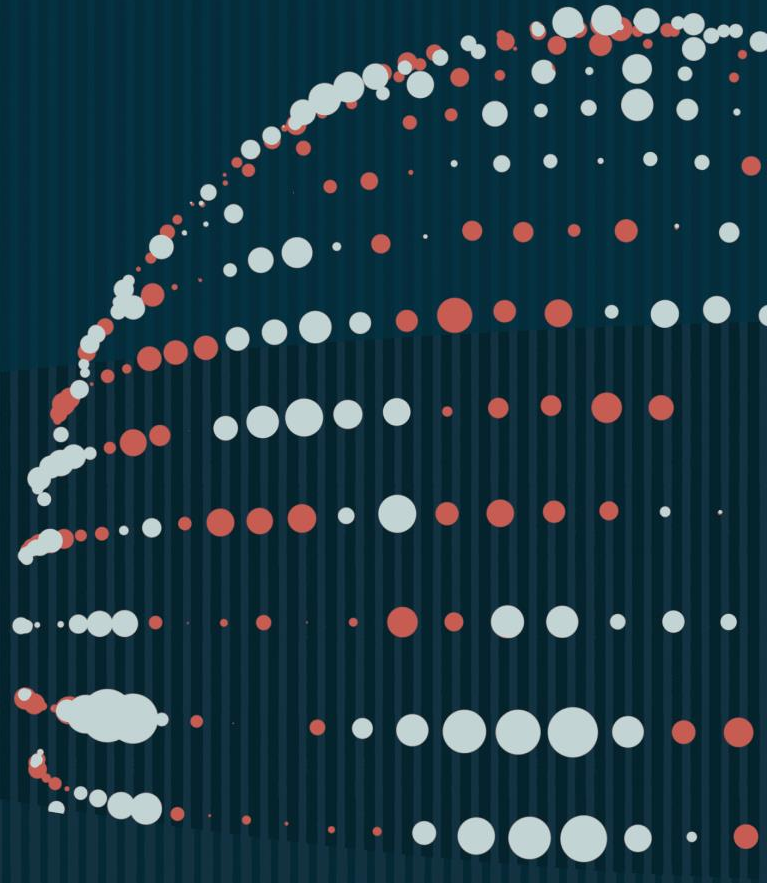
ORACLE
DatabaseWorld
at CloudWorld

Oracle Database In-Memory: Getting Started and Best Practices (LRN3329)



Andy Rivenes
Product Manager, Oracle

Jim Czuprynski
Chief StoryTeller, Zero Defect Computing, Inc.

About Us

Product Manager:
Andy Rivenes, Oracle

- Oracle Product Manager for Database In-Memory
- Oracle database professional for a very long time
- Database In-Memory blog: https://blogs.oracle.com/in-memory
- X - @TheInMemoryGuy
- linkedin.com/in/andy-rivenes

DBA:
Jim Czuprynski, Zero Defect Computing

ORACLE ACE Director

ORACLE Certified Professional

Oracle DBA: **20+** Years

Trained **+2000** DBAs as Oracle University Instructor

APEX / ML / AI Enthusiast

LinkedIn: linkedin.com/in/jczuprynski

Mastodon: techfieldday.net/deck/@jimthewhyguy

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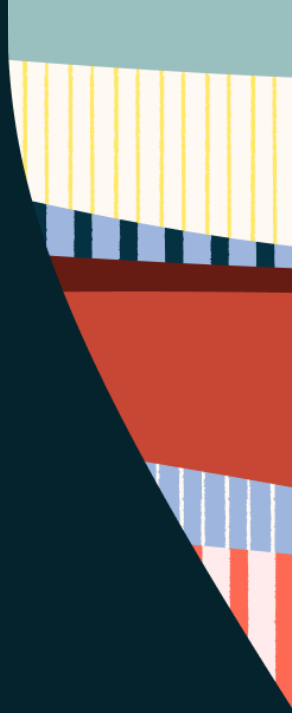
Database In-Memory: A Primer



Operational analytics with Database In-Memory

10x faster reporting

- In-memory aggregation populates report outlines during fast scan operations
- Run ad-hoc reports from in-memory with summarized data from external tables

Real-time analytics

- Get immediate answers without data transformation wait time
- Improve agility with faster data insight, visibility and business intelligence

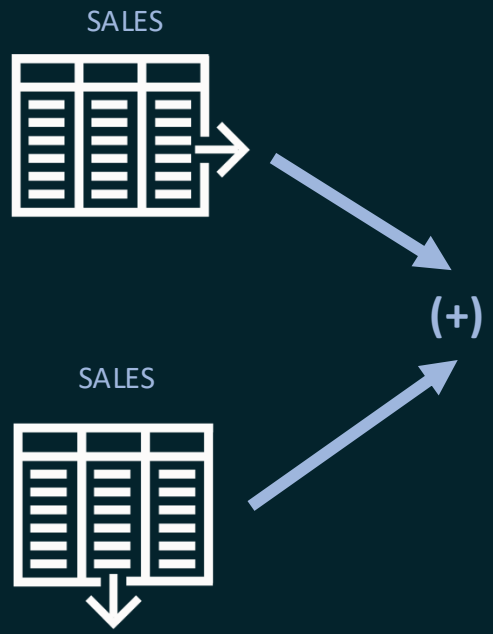
Improved efficiency

- Eliminates analytics reporting indexes and associated storage consumption
- Simplifies management
- Reduces CPU and I/O consumption for queries
- No more separate ODS and staging layer

Analytic and OLTP Formats

What's your favorite data format?

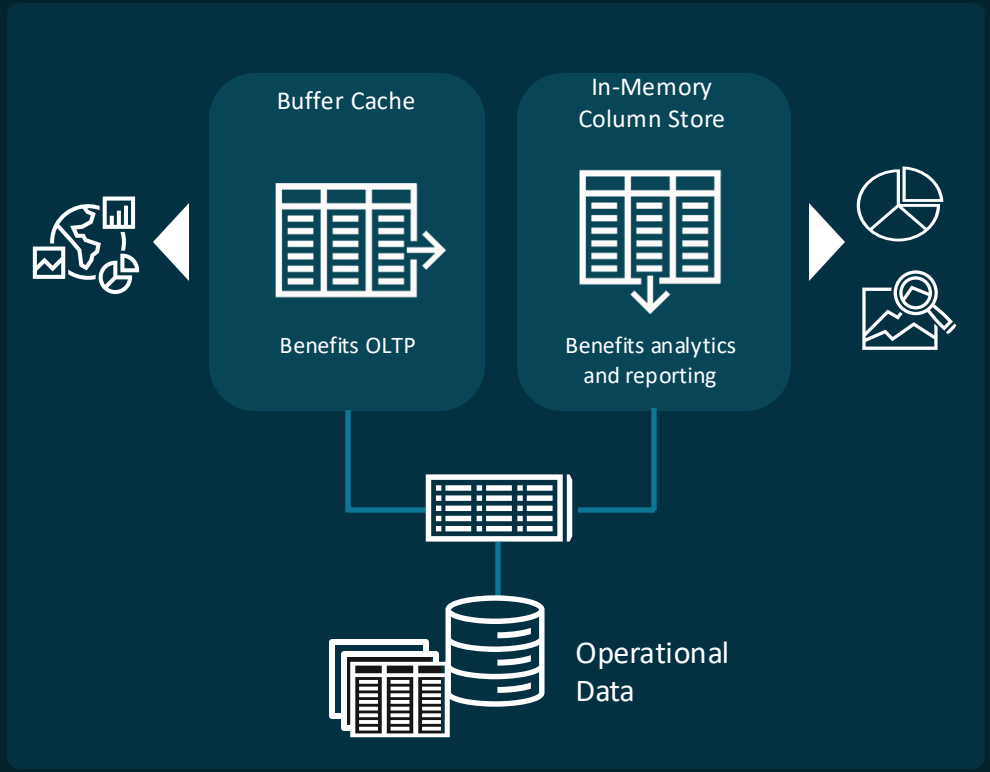
Row Format
Fast for OLTP!
Slower for Analytics



Column Format
Fast for Analytics!
REALLY slow for OLTP!

Dual Format
Best for both Fast Analytics and fast OLTP (No need for Analytic indexes)

Breakthrough: Dual Format Database



- BOTH row and column formats for same table
- Simultaneously active and transactionally consistent
- Analytics & reporting use new in-memory Column format
- OLTP uses proven row format
- No application changes required

Database In-Memory: Simple to Implement

1. Configure Memory Capacity

   ```
   inmemory_size = XXX GB
   ```

2. Configure tables or partitions to be in memory

   ```
   alter table | partition  …  inmemory;
   ```

3. Later, drop analytic indexes to speed up OLTP

Oracle Database In-Memory runs everywhere

Database In-Memory is an option for Oracle Database Enterprise Edition (EE)

Cloud

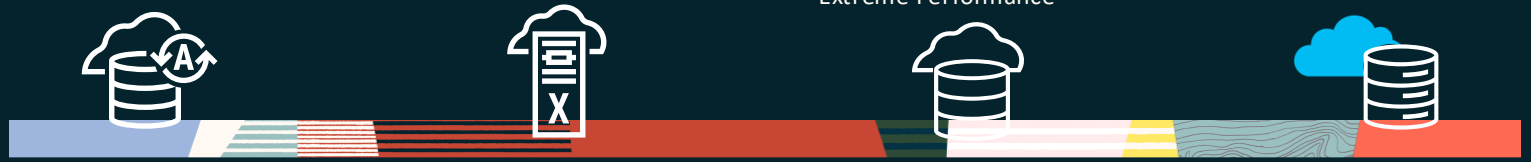
Autonomous Database

Exadata Database Service

Base Database Service

Extreme Performance

Oracle Database@Azure



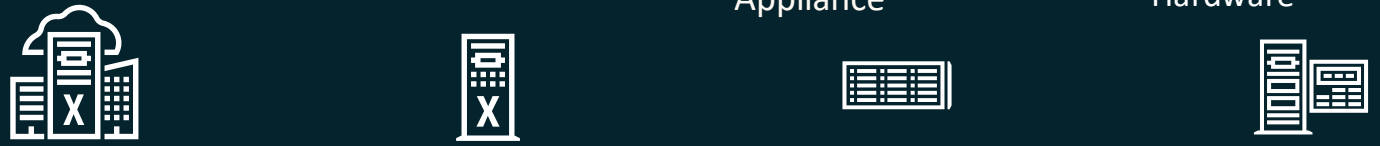
On-Prem

Cloud@Customer

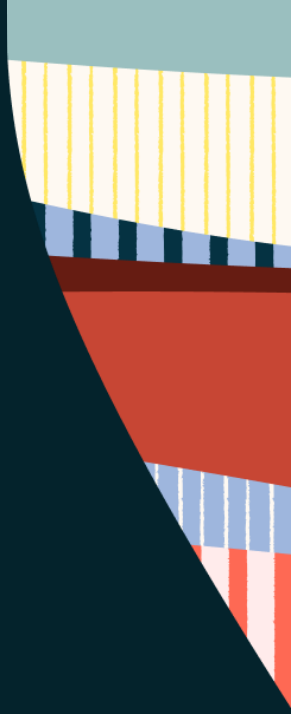
Oracle Exadata

Oracle Database Appliance

Commodity Hardware



Database In-Memory: New Features



Oracle 23ai is the sum of…

21c + 23ai

All the features from Oracle 21c Innovation Release

300+ New Features and Enhancements

Key focus areas:
JSON, Graph, Microservices, Developer Productivity

Database In-Memory Innovations

12.1

- Pure In-Memory column format
- Scan & Filter on compressed data
- Fast joins
- Data pruning via storage indexes
- SIMD vector processing
- In-Memory Aggregation

12.2

- Join Groups
- In-Memory Expressions
- JSON/OSON support
- Massive capacity - In-Memory on Exadata flash
- Auto population policies
- Fast-Start
- Active Data Guard

18c

- Automatic In-Memory
- In-Memory Dynamic Scans
- In-Memory External tables
- In-Memory Optimized Arithmetic
- Memoptimized Rowstore – Fast Lookup

19c

- Performance
- External Tables: Hive & HDFS
- Memoptimized Rowstore – Fast Ingest
- Stability Release

21c

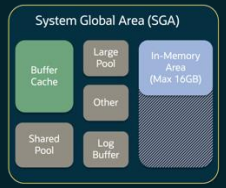
- Self Managing In-Memory
- In-Memory Spatial Analytics
- In-Memory Text Analytics
- External Table Enhancements
- Hybrid Scans
- In-Memory Vectorization - Hash Joins
- JSON Data Type
- Base Level Feature

23ai

- Auto-Sizing Column Store
- Auto-Enabling Features
- Hybrid Exadata Scans
- RAC support Join Group Aware Hash Join
- In-Memory Vectorization – Multi-level joins and Aggregation
- In-Memory Columnar JSON
- Selective In-Memory Columns
- Native In-Memory Advisor

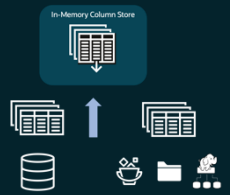
New in 21c for Database In-Memory

Base Level Feature

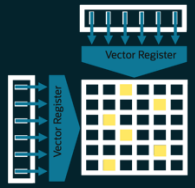


Cell Memory Only

Enhanced External Table Support

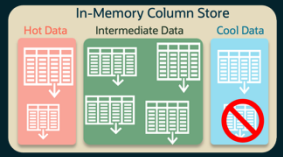


In-Memory Vectorized Joins

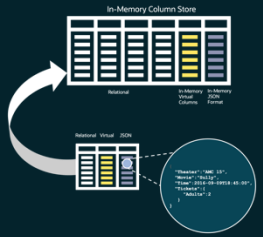


In-Memory Hybrid Scans

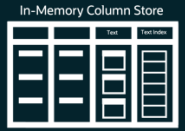
AIM Fully Automatic



In-Memory JSON Data Type



In-Memory Full Text Columns

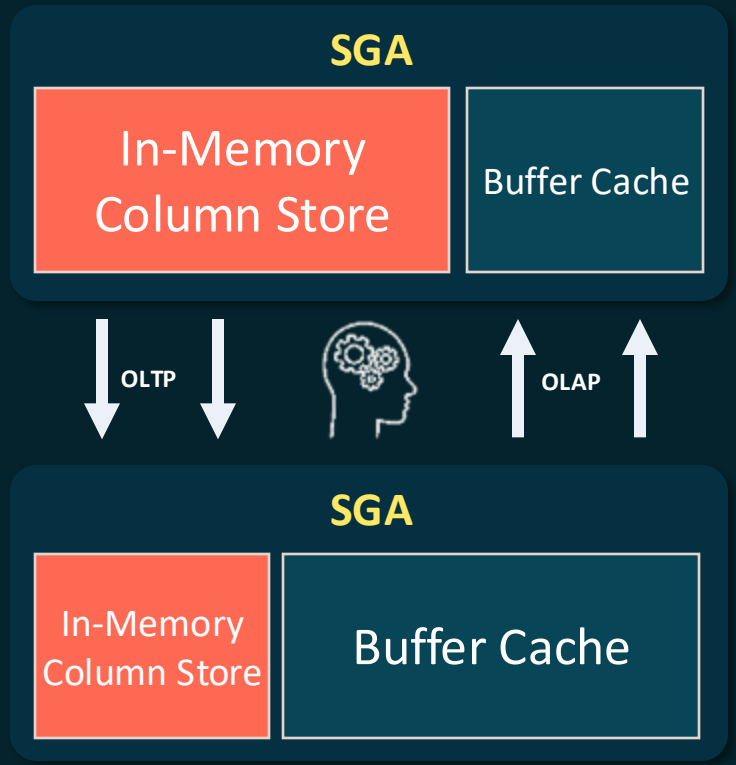


In-Memory Spatial

Automatic In-Memory Sizing

Automatic Sizing of the In-Memory Column Store

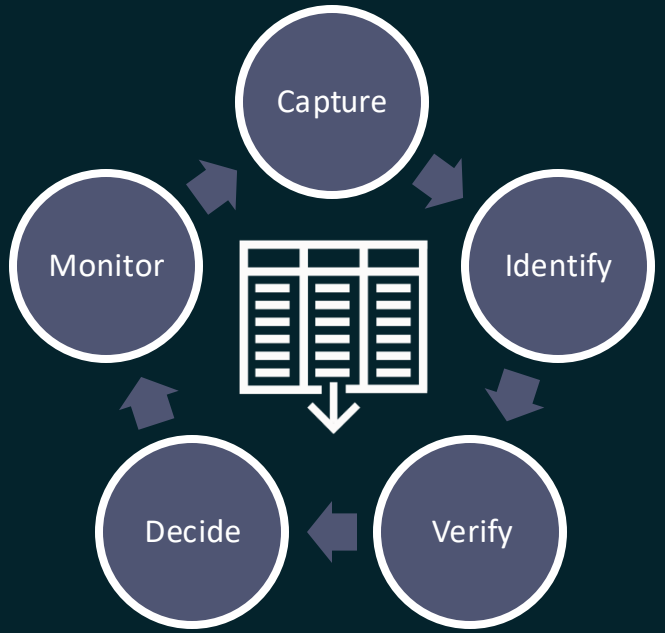
- Auto-size column store to factor in different workload types sharing resources at the same time
  - Shrink column store and increase buffer cache if DML intensive workload predicted.
  - Grow column store and shrink buffer cache if OLAP intensive workload predicted
- Works with Automatic In-Memory (AIM)
  - Requires AIM level HIGH or MEDIUM
  - ASMM to be enabled (i.e. SGA_TARGET)
  - VECTOR_MEMORY_SIZE not specified or set to 0
- The INMEMORY_SIZE parameter sets the minimum IM column store size
- Works in conjunction with In-Memory Hybrid Exadata Scans to ensure that partially populated objects can be accessed both in the IM column store and IM columnar format in Exadata Smart Flash Cache (i.e. cell memory)



Automatic Enablement of In-Memory Features

New In 23ai

- In Oracle Database 23ai AIM has been enhanced to add the ability to automatically:
  - Optimized Arithmetic
  - Bloom filter optimization (cached hash values)
  - Stored using vector optimization
  - Join Group
- Requires INMEMORY_AUTOMATIC_LEVEL be set to HIGH
- Column store cannot be under memory pressure
- Reduces manual effort required to leverage key performance features
- Enhanced workload analysis to better account for mixed workload environments
  - DML overhead with In-Memory (for example, fetching invalid rows in column store from buffer cache) is factored into analysis
- No application changes required



New Database Embedded In-Memory Advisor

New In 23ai

- Previous version
  - Standalone package that had to be installed in the database
  - Analyzed existing database workload using AWR/ASH data to determine benefit that Database In-Memory might provide
  - Generated an HTML report with estimates for overall benefit, benefit for top SQL statements and objects based on an in-memor size
- New in 23ai, the In-Memory Advisor is now a package in Oracle Database
- Relies on Heat Map data for analysis
  - Heat Map is now available as part of Oracle Database Enterprise Edition (no separate license required)
- Composed of two tools:
  - A new Eligibility tool to quickly identify databases where Database In-Memory would NOT be useful – **also available in 19c (19.20 RU)**
  - A Comprehensive Analysis tool based on a specified workload timeframe that produces an object benefit analysis

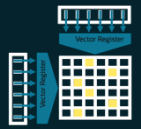
For more details, see this AskTom broadcast:
https://asktom.oracle.com/ords/r/tech/catalog/session-landing-page?p2_event_id=248374559603062421988130559058680421 2&session=600488868058289

Additional Database In-Memory Enhancements

Hybrid Exadata Scans

A table scan of a partially populated table will use the In-Memory Column Store

The remaining non-populated data can be accessed from Cell Memory Columnar Cache via an Exadata Smart Scan



In-Memory Vectorized Joins

Support for single and multi-level joins and aggregations

- Multi-level Joins
- Multiple join keys
- Semi and Outer Joins
- Fully grouping and aggregation

In-Memory Global Dictionaries

- Works with Join Groups
- Creates common dictionary values at population
- Speeds up in-memory hash joins by eliminating decompression and column value hashing overhead

In-Memory Columnar JSON

Supported in Exadata CELLMEMORY

JSON operators supported by Exadata Smart Scans

Extracts 'Path/Value' pairs from JSON docs and materializes them as columns

Automatic In-Memory Performance Features

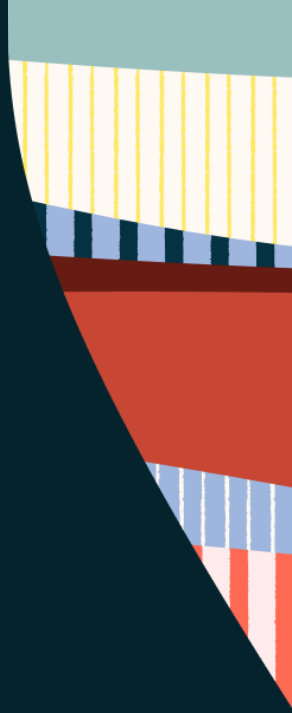
Optimized Arithmetic uses an optimized NUMBER format for faster arithmetic calculations using SIMD vector operations

Join Groups eliminate the overhead of decompressing and then hashing column values in the IMCS

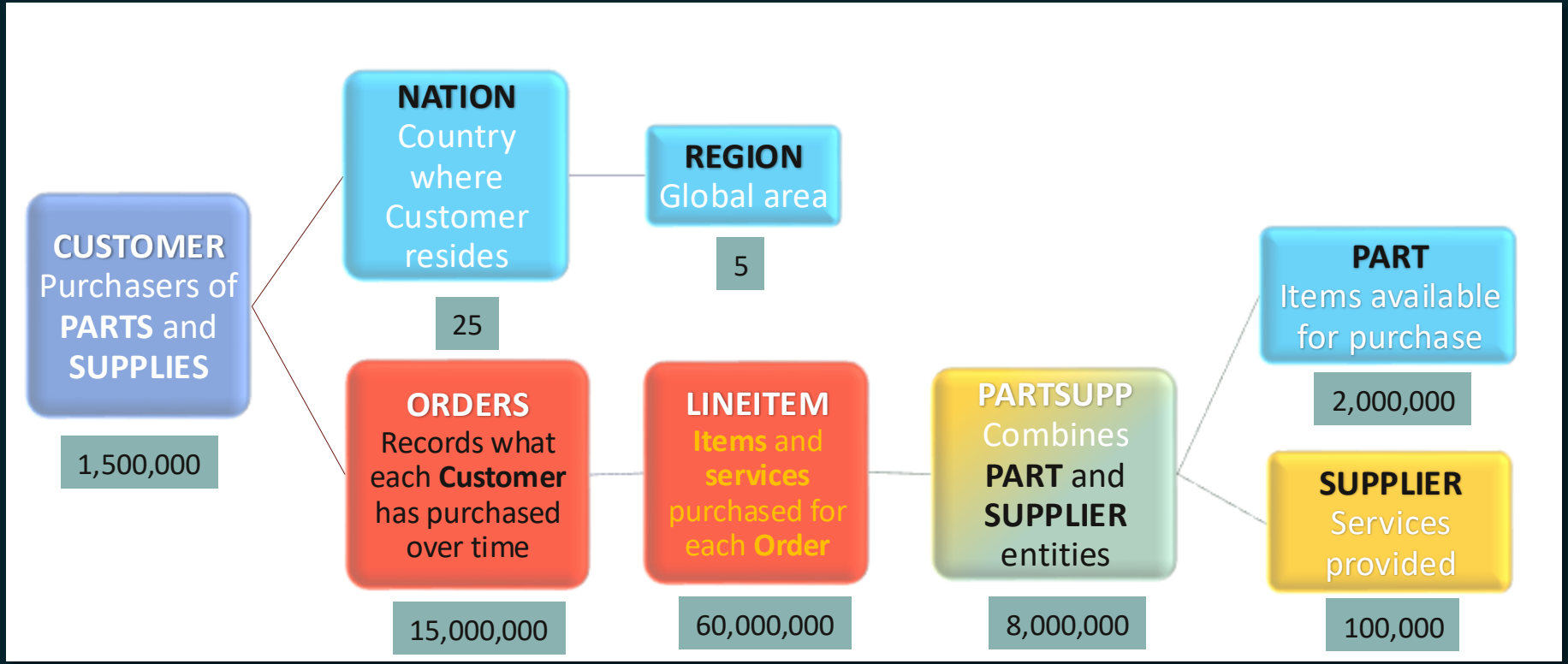
Vector Optimization for NUMBER columns enables a binary format that enhances SIMD operations

Bloom filter optimization for statements that can most benefit by storing cached hash values for more efficient join processing

Demo:
23*ai* Automatic In-Memory (AIM) Performance Features



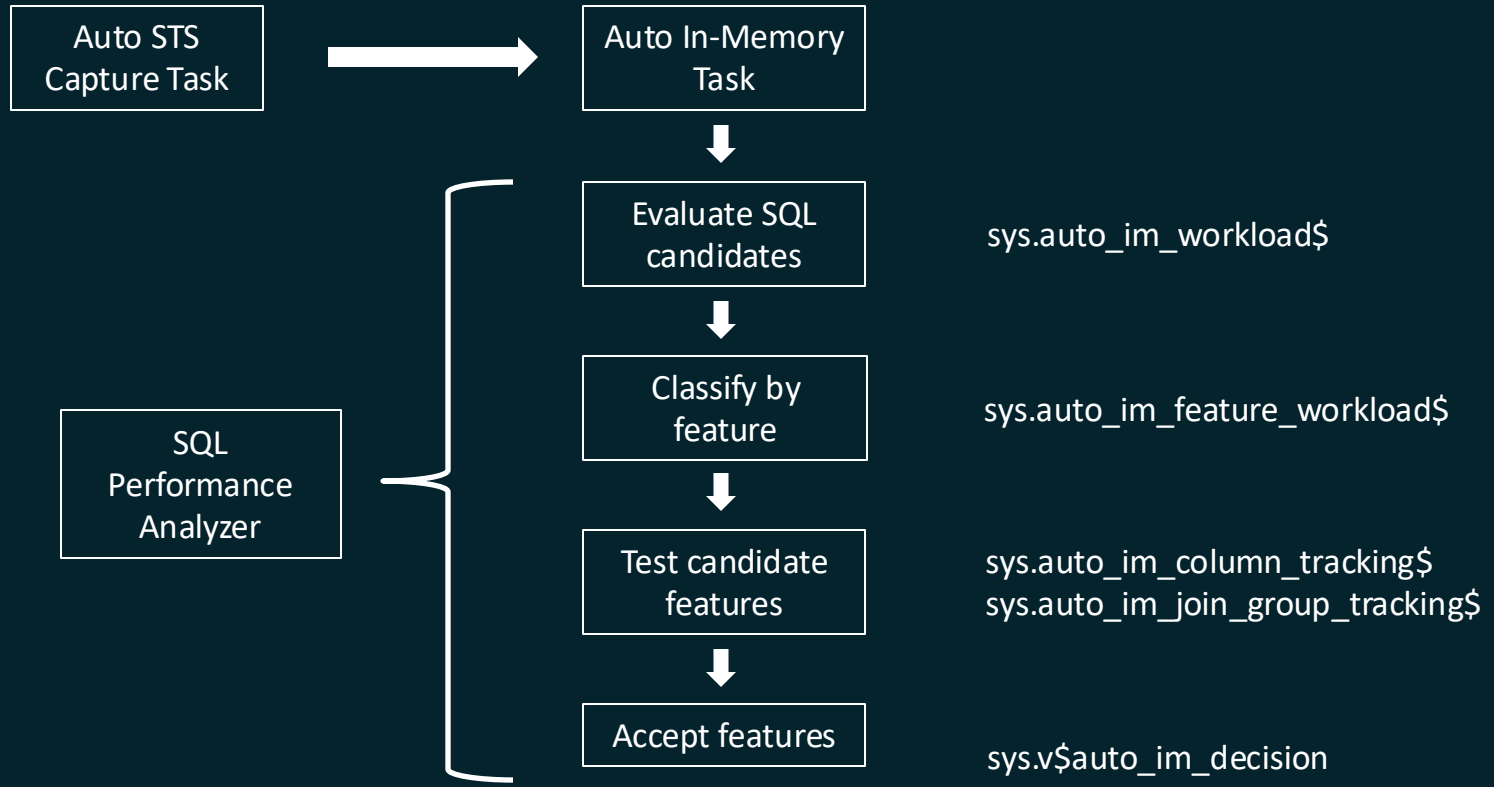
TPC-H: The Perfect Schema for Demonstrating In-Memory Features in 23ai



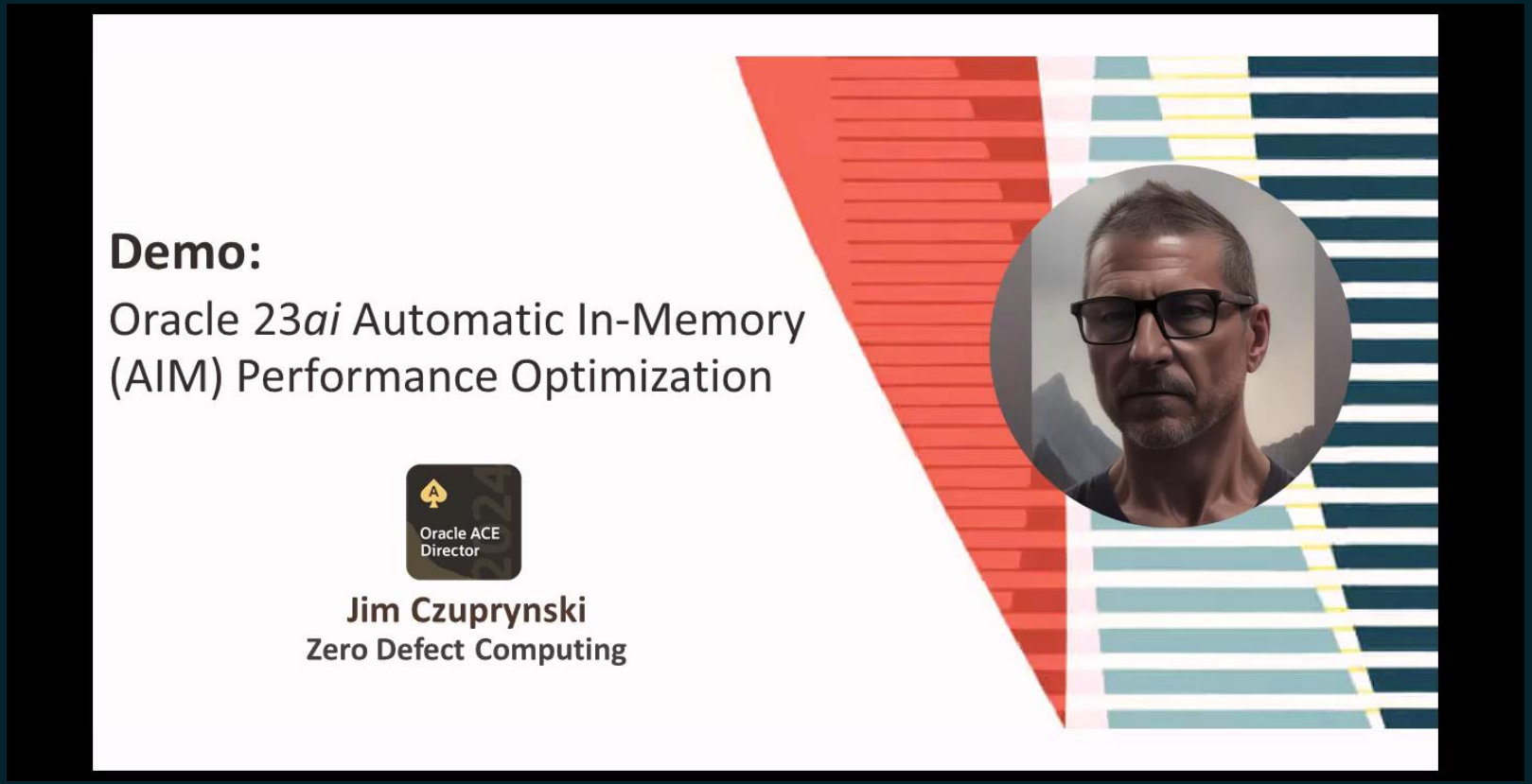
Demo: Testing Environment and Methodology

- Database environment: 23*ai* Enterprise Edition with 32GB available memory
- Swingbench 2.7.1470 used to create 10GB TPC-H schema
  - ORDERS and LINEITEM tables partitioned on appropriate DATE columns
  - This allows specific partitions to be pulled into IMCS as needed as TPCH query workload executes for different date ranges
- SGA_TARGET: **24G**
- INMEMORY_SIZE: **12G** (large enough to fit all TPC-H database objects into IMCS)
- INMEMORY_AUTOMATIC_LEVEL: **HIGH**
  - This enables Automatic In-Memory to select precisely which objects should be populated into, retained in, or evicted from the IMCS

AIM Performance Feature Processing



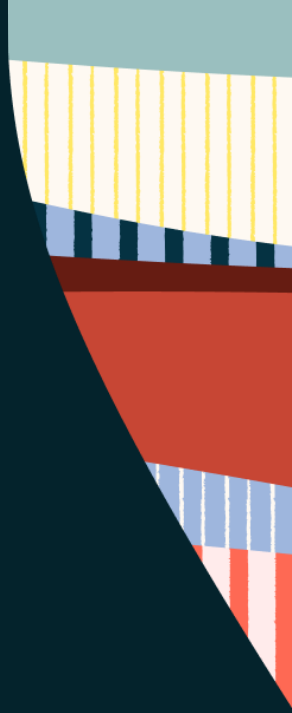
AIM: Intelligent IMCS Population and Automatic SQL Optimization



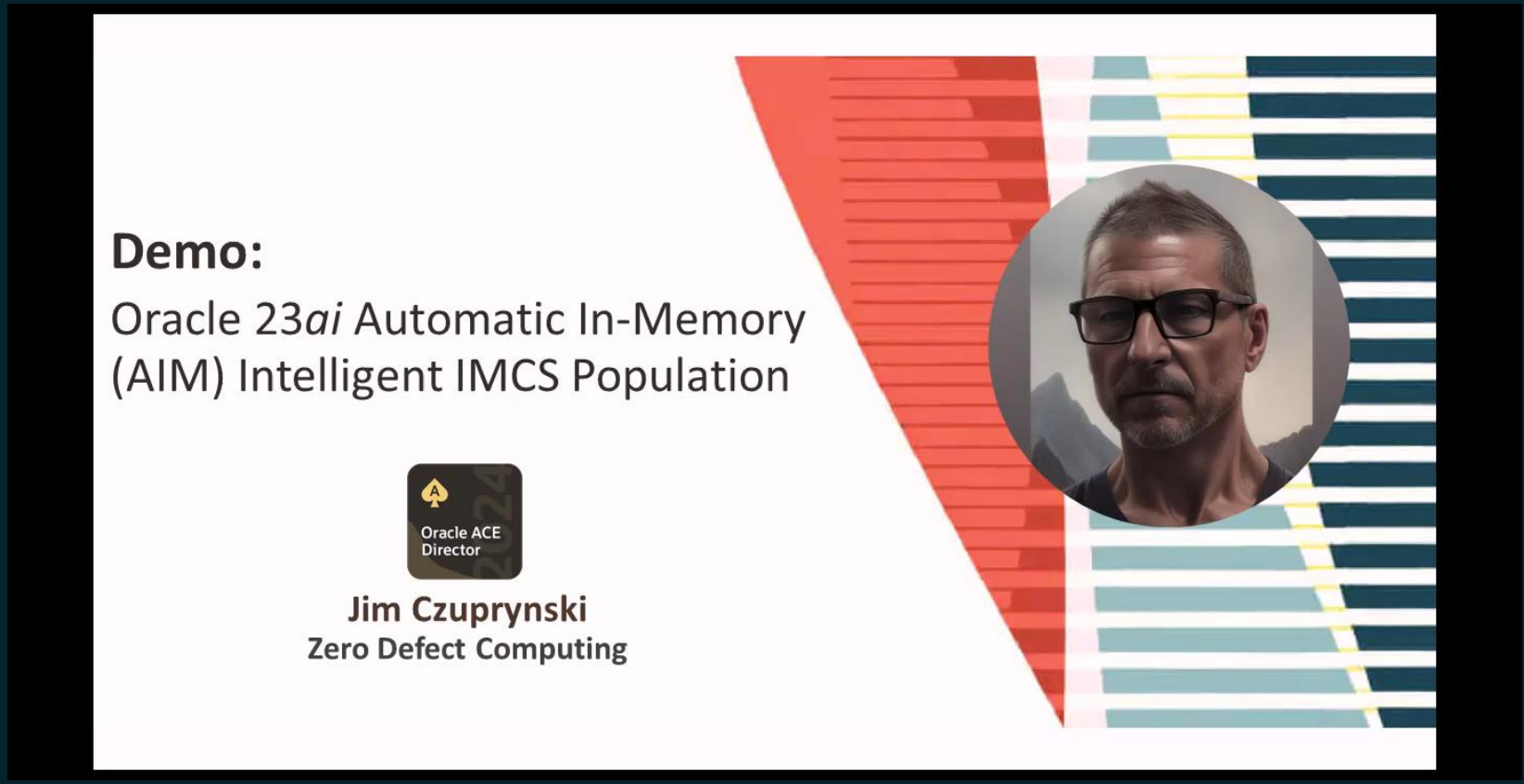
Looking Under the Hood: AIM SQL Performance Optimization Views

View	Purpose
V$SGA_RESIZE_OPS	Shows the most recent SGA resize operations
V$IM_SEGMENTS	Identifies which database objects are present in the IMCS
V$INMEMORY_AREA	Shows IMCS used vs. total memory allocation
V$AUTO_IM_FEATURES	Shows which IMCS features will be optimized by AIM
V$AUTO_IM_DECISION	Details on database object columns being evaluated for AIM
DBA_INMEMORY_AIMTASKS DBA_INMEMORY_AIMTASKDETAILS	Lists which AIM tasks are active at summary and detail levels
AUTO_IM_TASK_STATE	Describes current state of AIM automatic task
AUTO_IM_WORKLOAD$	Candidate SQL statements acting upon objects in IMCS
AUTO_IM_FEATURE_WORKLOAD$	SQL statements being evaluated for AIM SQL Optimization
AUTO_IM_COLUMN_TRACKING$	Database table columns being evaluated for AIM features
AUTO_IM_JOIN_GROUP_TRACKING$	Database table columns being evaluated for Join Groups

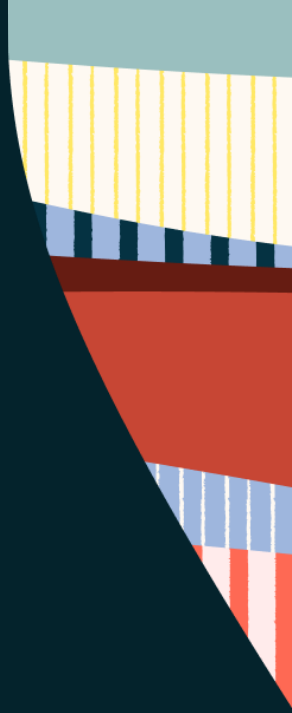
Demo:
23*ai* Automatic In-Memory (AIM)
IMCS Automated Population



Demo: IMCS Automated Population



Where Can You Get More Information?



Learn More

Database In-Memory Blog

Database In-Memory Hands-on-Lab

Database In-Memory Documentation

Guidelines and Tools

Help is available …

Actions

- Validate that use cases fit Database In-Memory benefits
- Use the In-Memory Advisor to verify benefit
- Don't "just try it out", use the guidelines to avoid re-inventing the wheel
- Use the latest Oracle Database release and the latest RU to benefit from the latest innovations and fixes

These guidelines can help…

DBIM technical briefs to help customers get started …

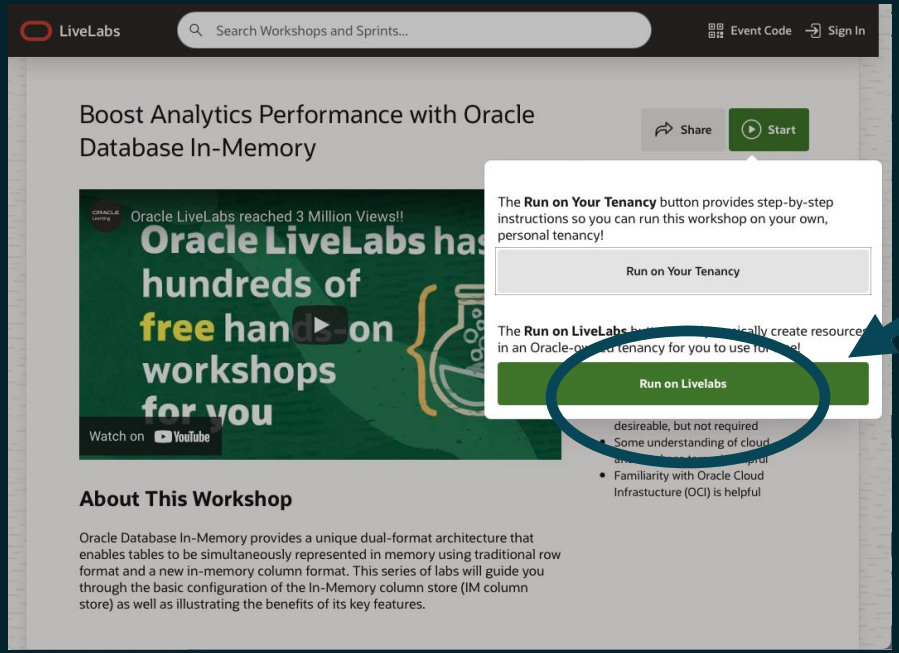
Quick Start (one pager) (see here)

Quick Start Guide (see here)

Implementation Guidelines (see here)

Boost Analytics Performance with Oracle Database In-Memory

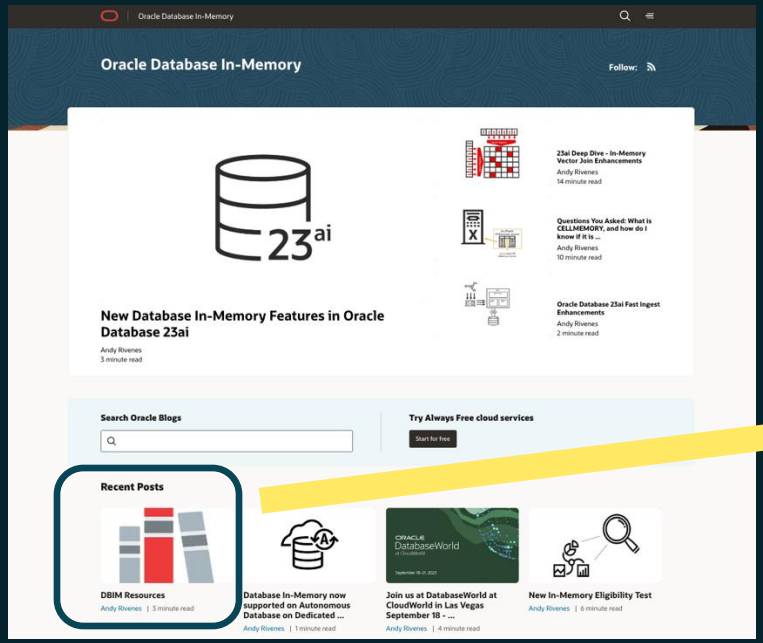
http://bit.ly/golivelabs

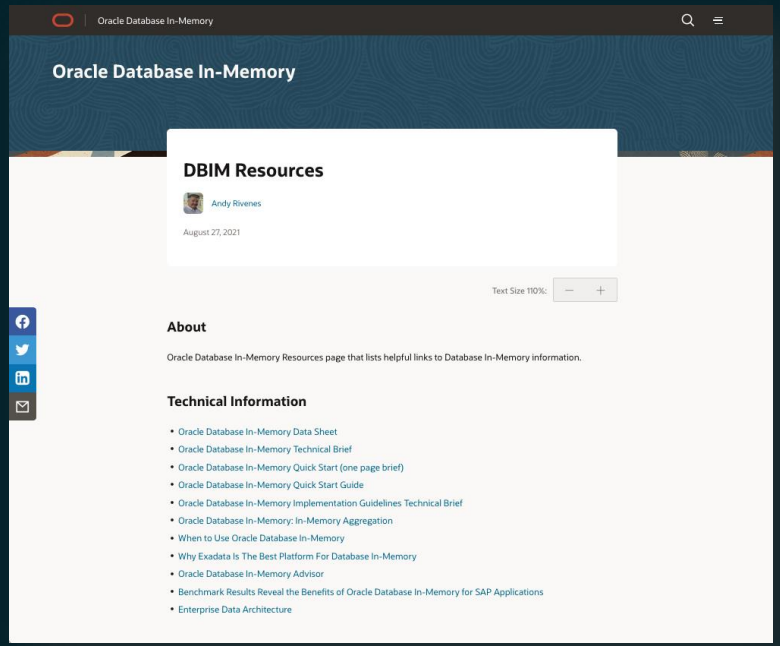


Free Tenancy Reservation

No requirement to sign up for the Cloud!

blogs.oracle.com/in-memory/dbim-resources





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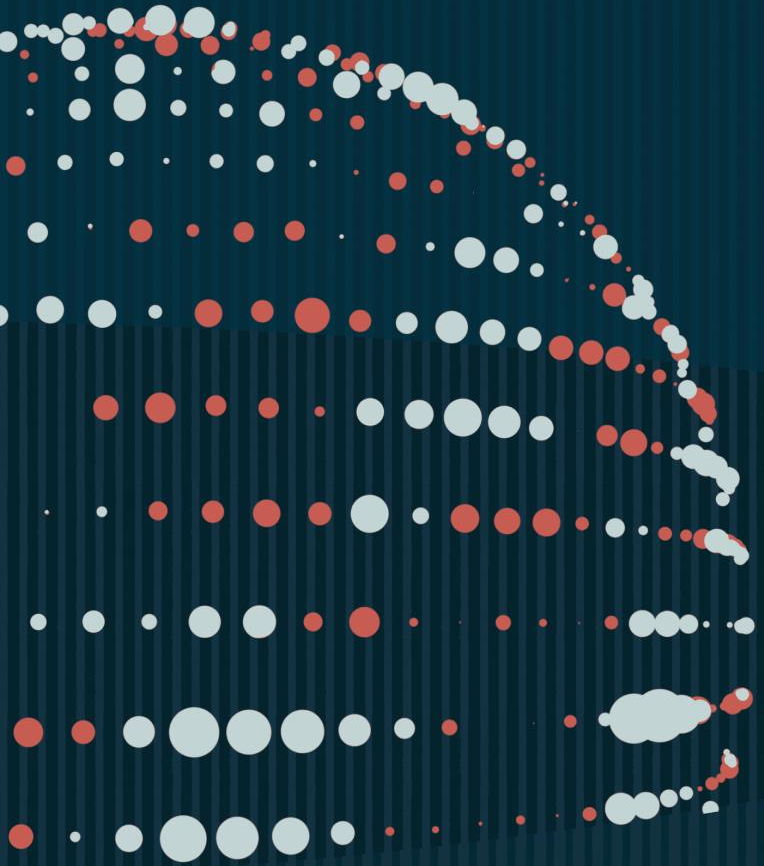

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Thank You

Please fill out your evaluations for session

LRN3329