Exploring the latest in MySQL & HeatWave: from Mundane to the Exotic

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Nov 18, 2025

Safe harbor statement

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MySQL™

One of the world's most popular open-source database

#1
DB for developers

1B+
Installations worldwide

190M+
Downloads/year on mysql.com

30 yr
Proven technology

LAMP
Linux Apache MySQL PHP, Pearl, Python

M → MySQL

aws

Innovative organizations across all industries run MySQL

Social

E-Commerce

SaaS

Finance

Manufacturing

Modern Data Platform Requirements

Structured Data


Medical Records


Orders


Forms


Invoices

Unstructured Data


Phone


Social

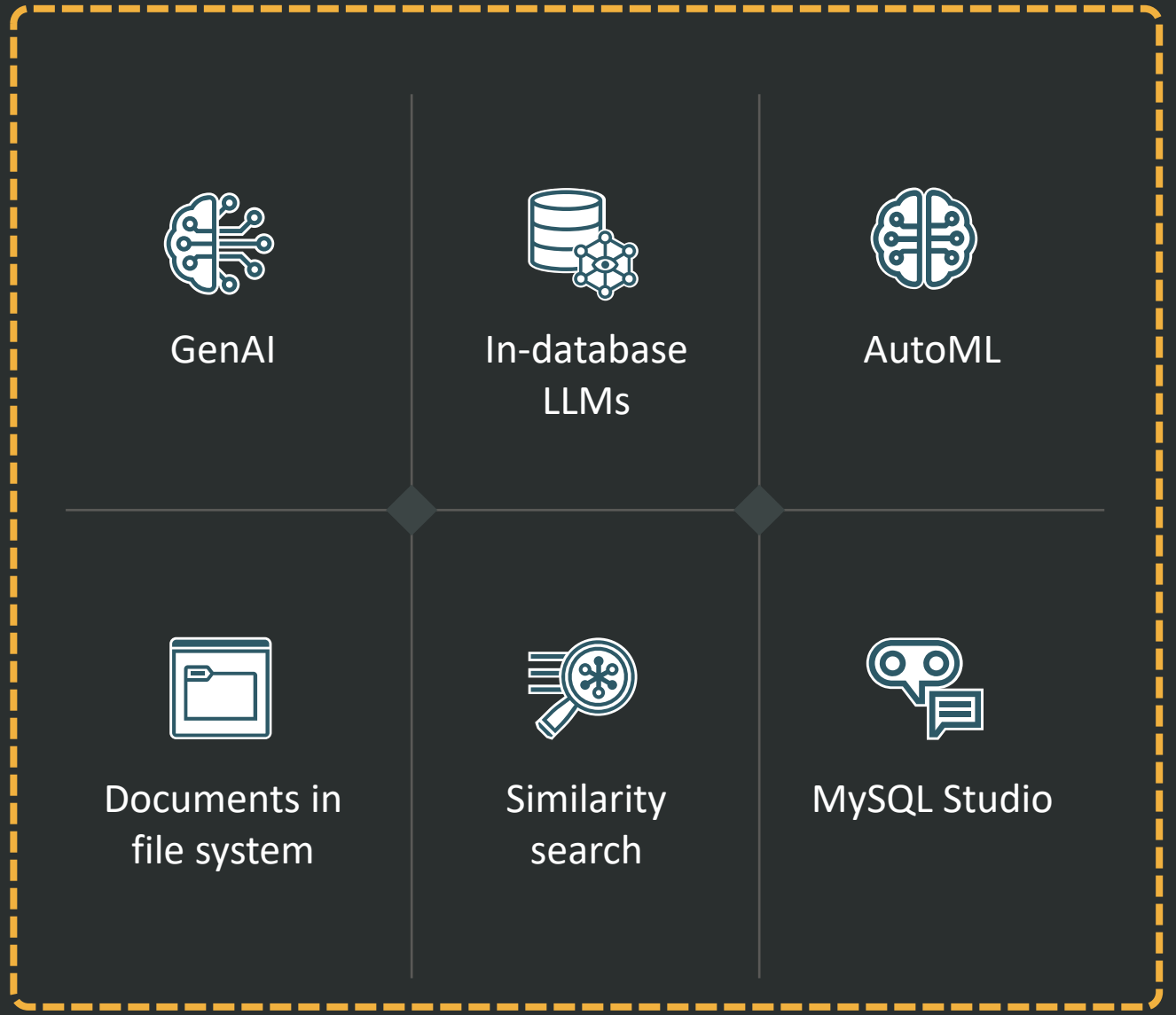

Natural language interfaces


Personalized recommendations

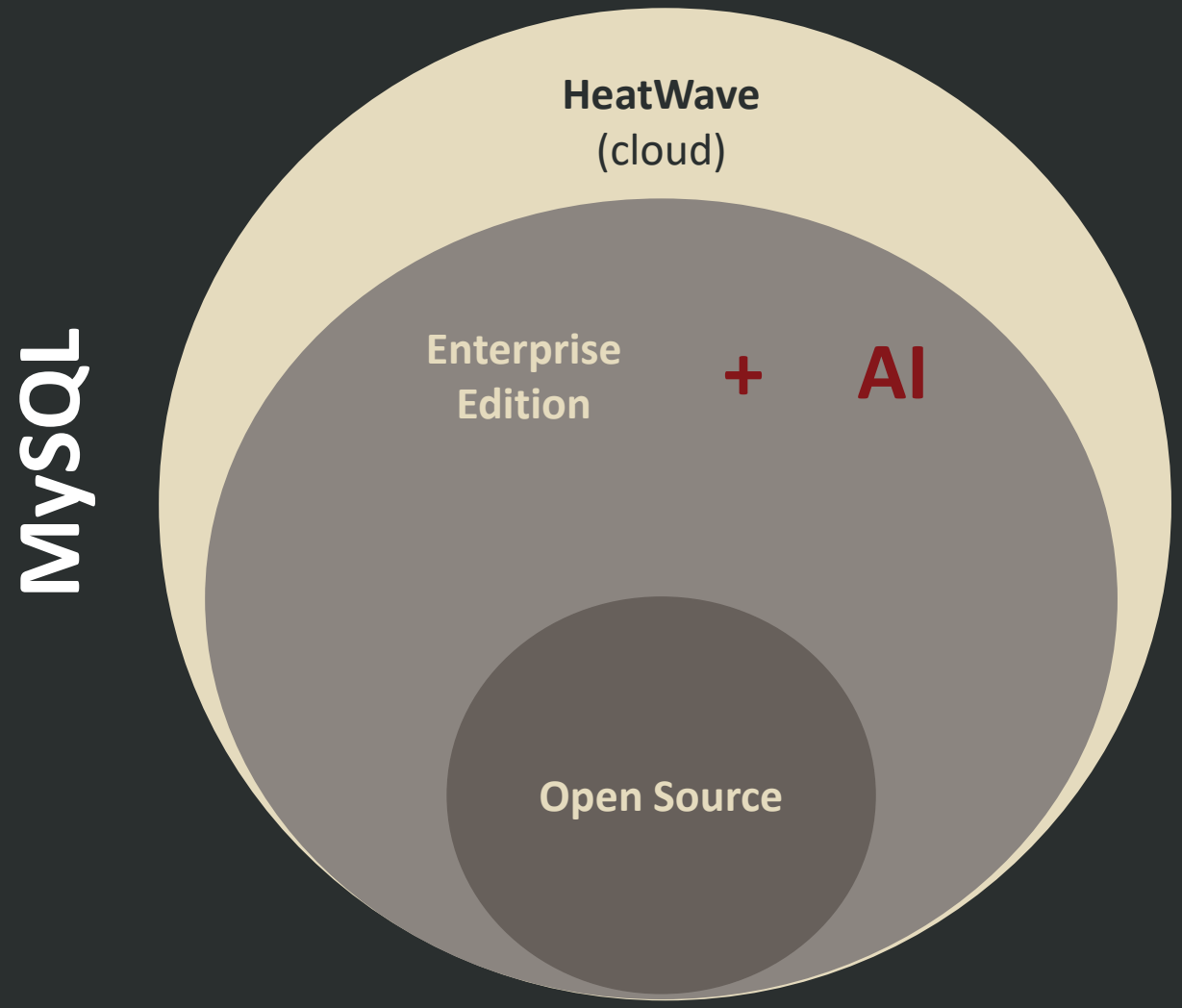
Flexibility of platform

MySQL AI

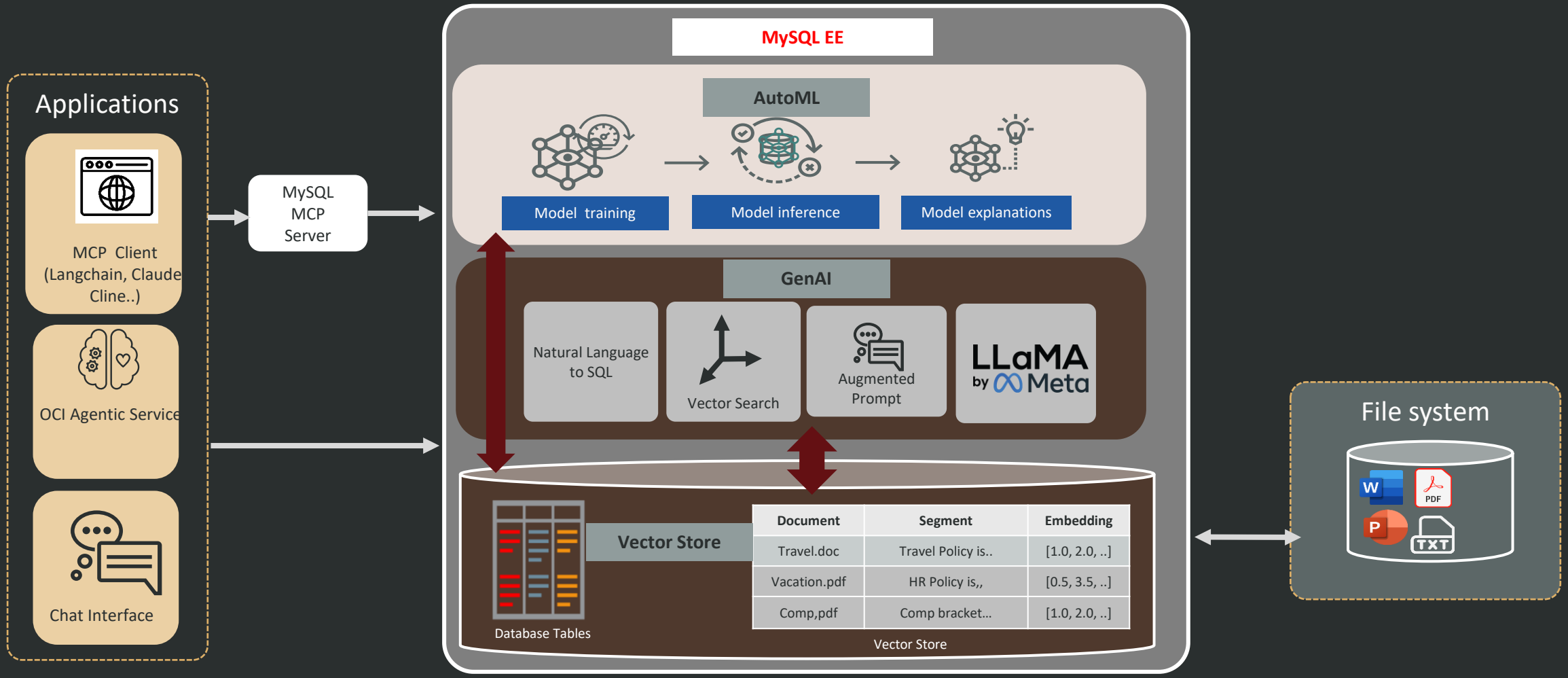
Redefining Built-In Intelligence



Tiered MySQL functionality



MySQL AI

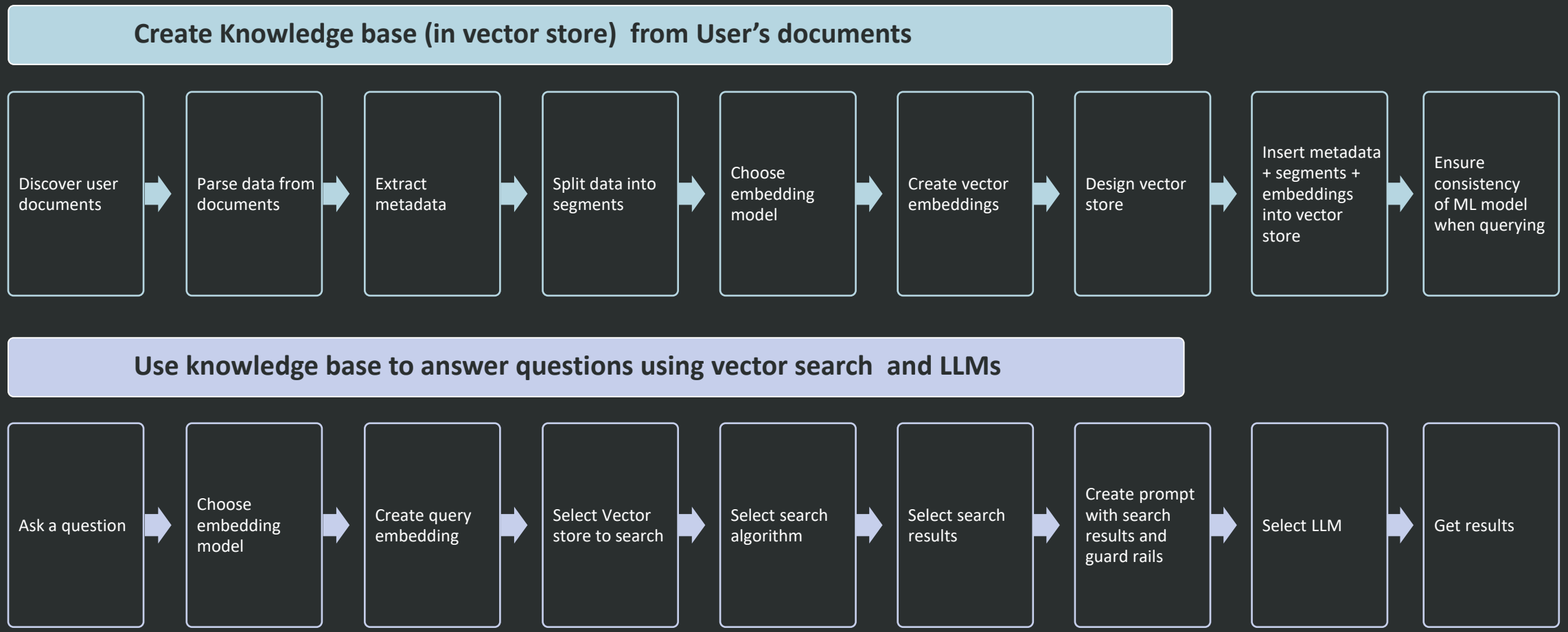

Applications
MCP Client (Langchain, Claude Cline..)
OCI Agentic Service
Chat Interface
MySQL MCP Server
MySQL EE
AutoML
Model training
Model inference
Model explanations
GenAI
Natural Language to SQL
Vector Search
Augmented Prompt
LLaMA by Meta
Database Tables
Vector Store
Document
Segment
Embedding
Travel.doc
Travel Policy is..
[1.0, 2.0, ..]
Vacation.pdf
HR Policy is,,
[0.5, 3.5, ..]
Comp,pdf
Comp bracket...
[1.0, 2.0, ..]
Vector Store
File system
W
PDF
P
TXT

Why it Matters

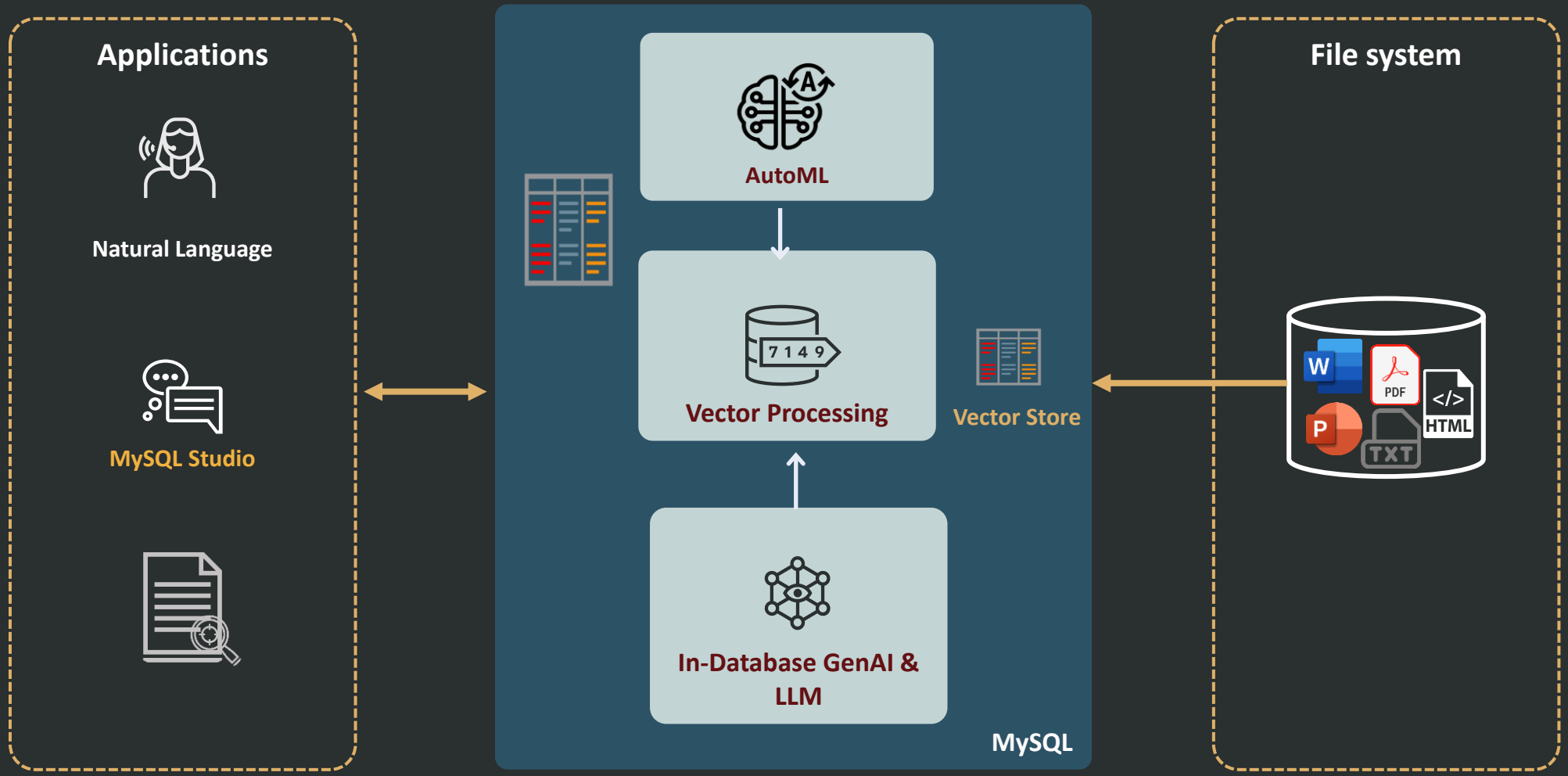
- AI/ML available on premise, runs on existing hardware (CPUs)
- Content can be on the local **file system**
- Query documents
- Highly secure

Building GenAI apps – a multi-step process

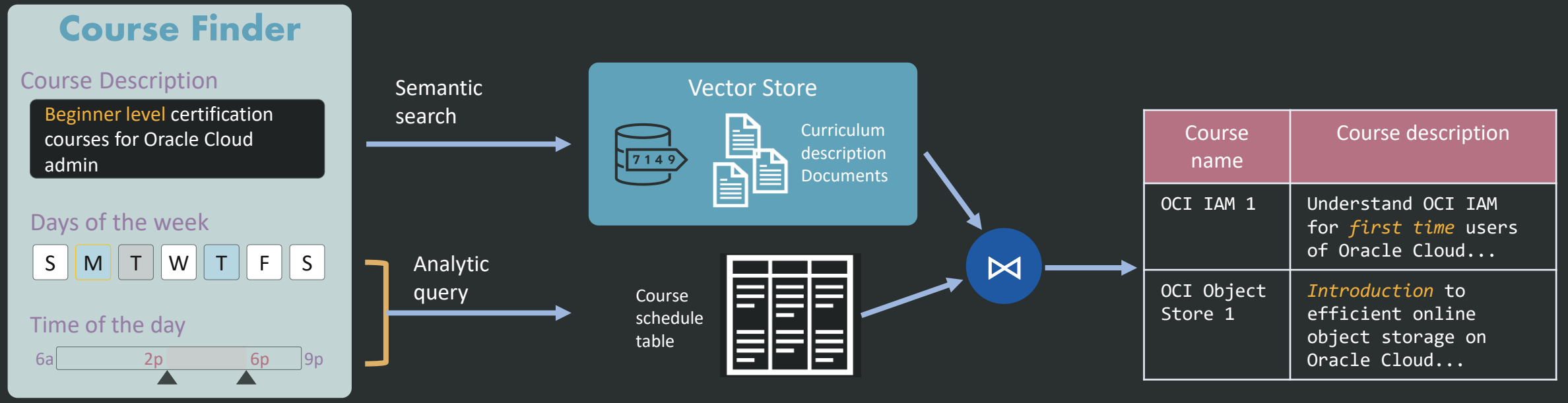
Single step with MySQL AI



MySQL AI can create vectors from documents on a file system



Combining queries with semantic search across documents



AutoML

Predictive analytics

Machine Learning horizontal use cases

Most enterprises have…

Customers

- Segmentation
- Loyalty
- Lifetime value
- Retention/churn
- Acquisition
- Lead generation and prioritization
- Factors of best customers
- Invoice anomaly detection
- Fraud detection

Products

- Next best offer
- Cross-sell
- Upsell
- Product bundling
- Demand forecasting
- Inventory forecasting
- Revenue prediction

Equipment

- Predictive maintenance
- Root cause analysis
- Demand forecasting
- Usage and sensor anomaly detection
- Failure risk assessment

Financials

- Financial forecasting
- Credit risk assessment
- Cash flow prediction
- Fraud prevention
- Resource allocation
- Payment prediction

MySQL AI AutoML

From data to insights with built-in self-service data tools

Model

Easily create models with AutoML

Training

Deploy

Integrate ML models into apps via REST or SQL

Explanation

Gain Insight

Guided discovery of hidden patterns and anomalies

Inference

AutoML use cases

Address business problems that impact customers, products, operations, and employees

Anomaly Detection

Detect anomalies in sensor readings
Predict network outages

Classification

Defective part identification
Financial fraud detection

Churn prediction
Classify warranty claims

Predict when failure will occur
IoT digital twin failure prediction

Predict air pollution
Return on advertising spend prediction
Utilization demand forecasting

Identify similar users

Loan default prediction

Demand forecasting

Timeseries Forecasting

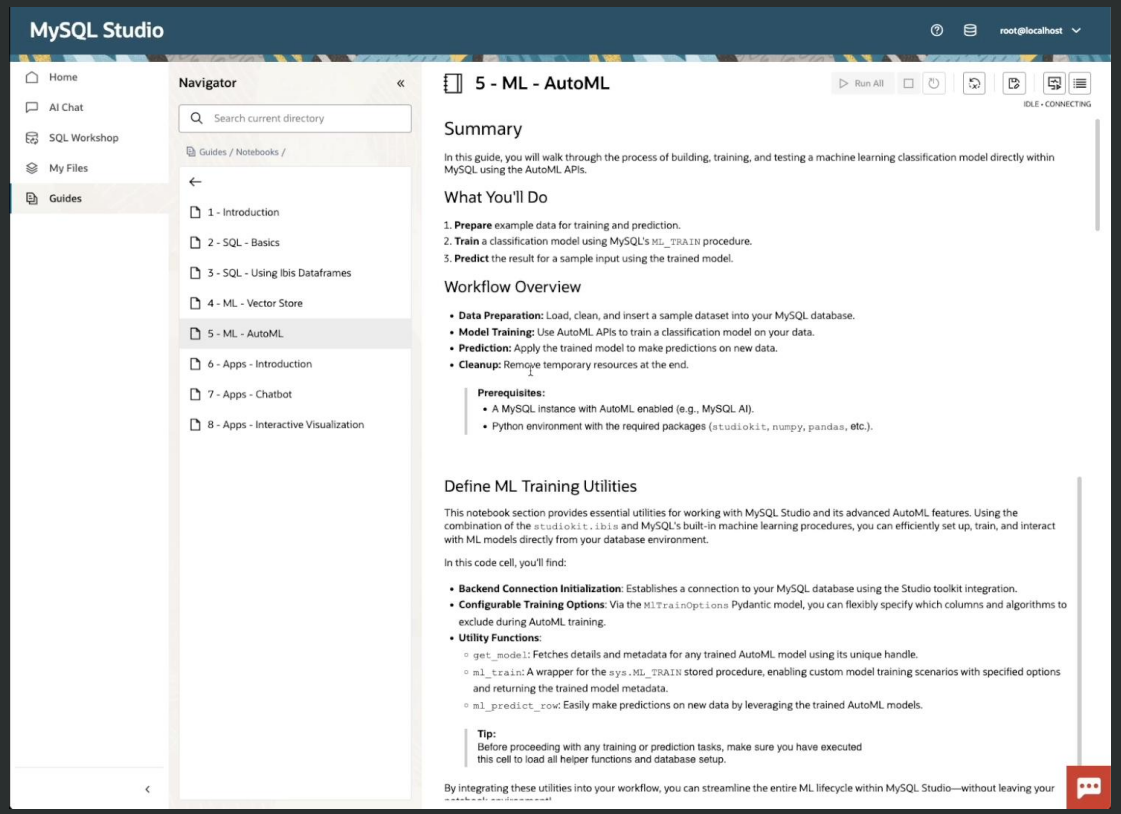
Recommend content to viewers
Suggest substitute products
Recommend new products

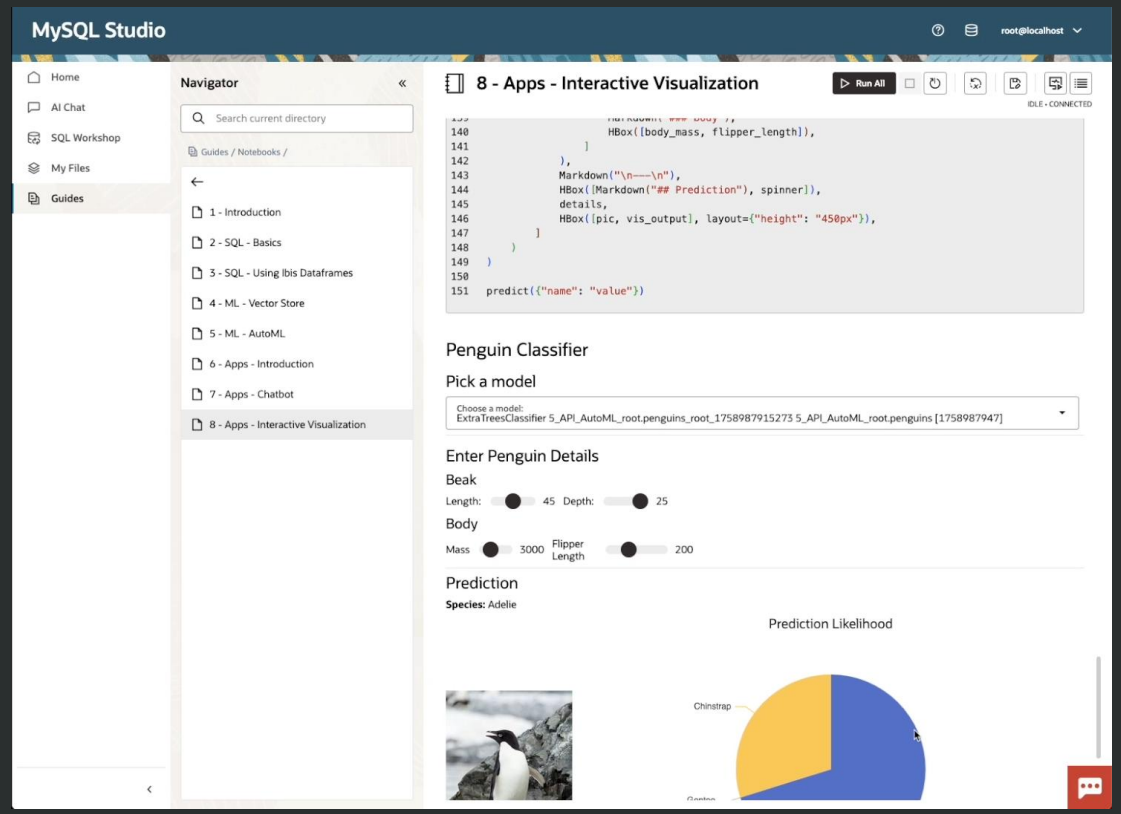
Predict delays
Loan amount prediction
Yield prediction

Recommender System

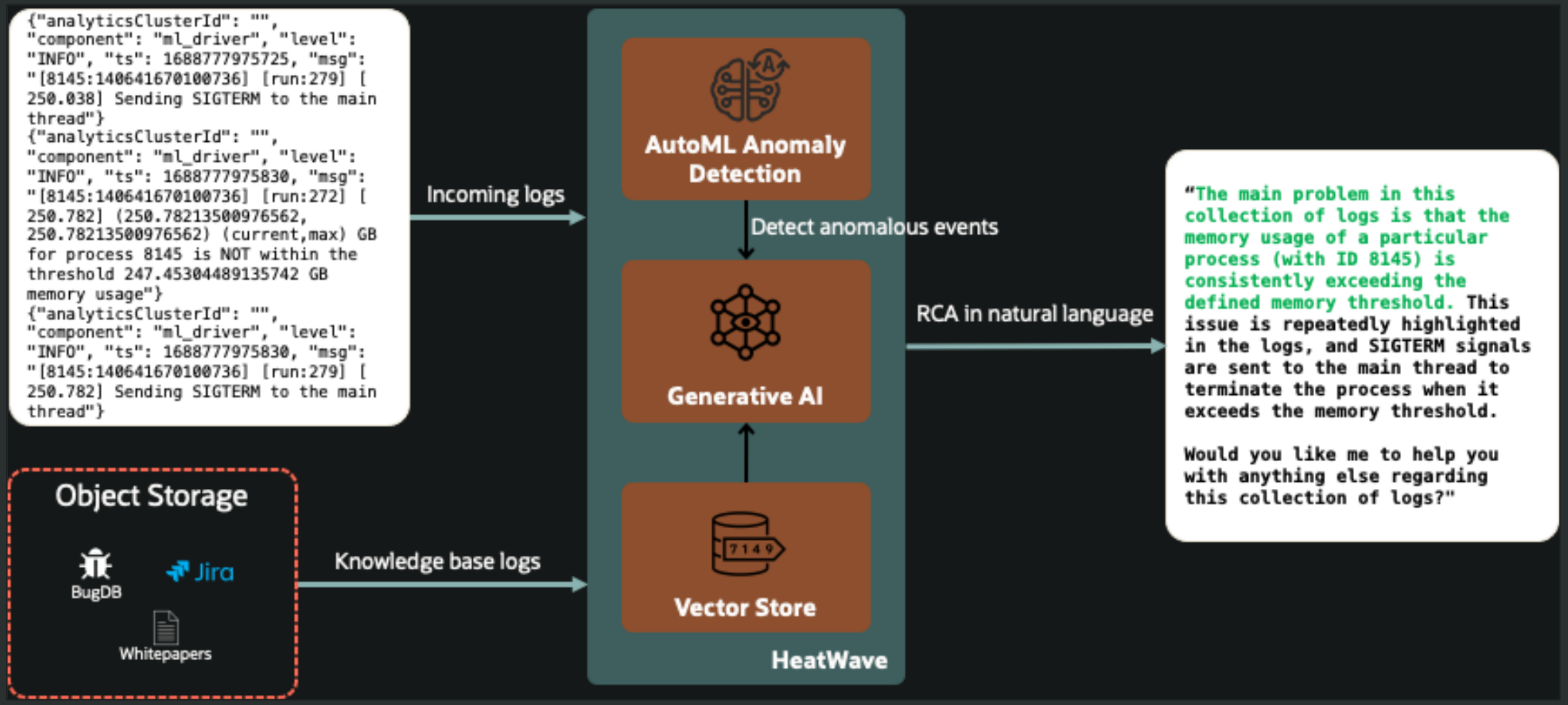
Regression

AutoML and Python Notebooks in MySQL Studio



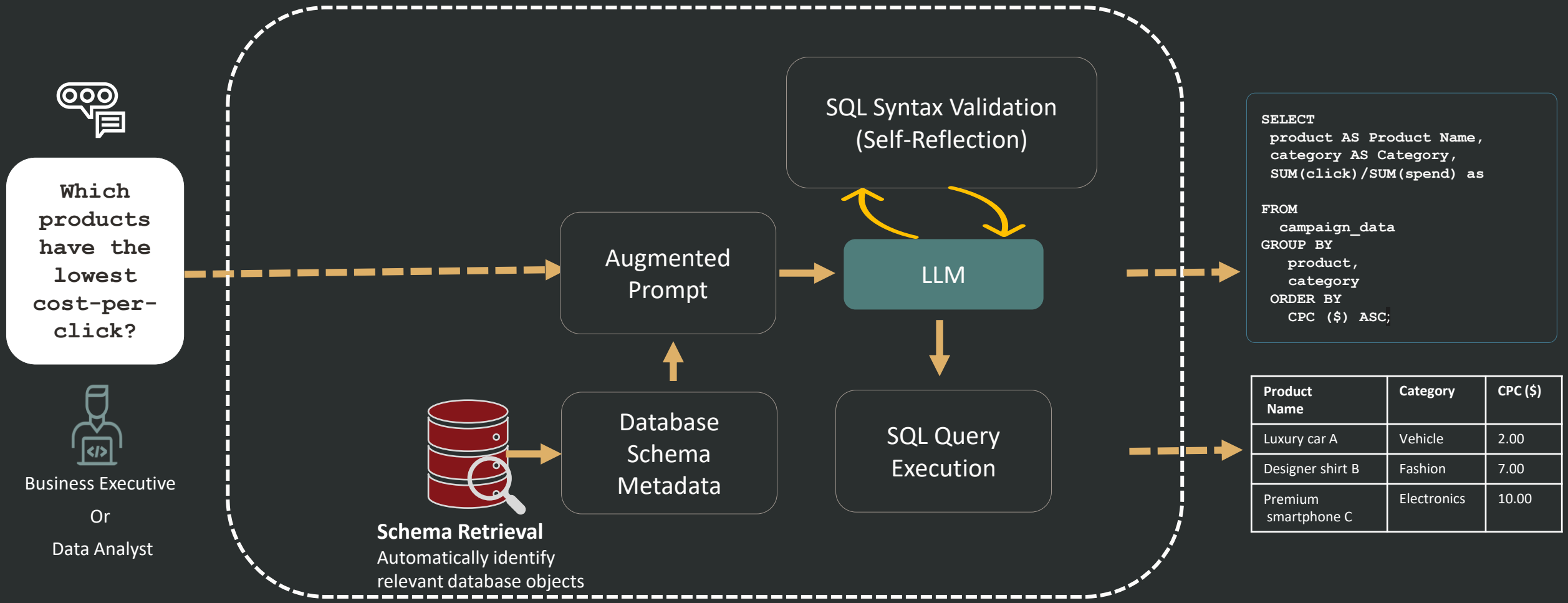


AutoML-GenAI Synergy : Predictive maintenance



Query in Natural Language

NL2SQL: Interact with your database in natural language



Product Name	Category	CPC ($)
Luxury car A	Vehicle	2.00
Designer shirt B	Fashion	7.00
Premium smartphone C	Electronics	10.00

Vector Operations

Vector data type, Vector distance functions

- `VECTOR_DISTANCE(vector, vector, distance_metric)`
- `STRING_TO_VECTOR(string)`
- `VECTOT_TO_STRING(vector)`

Suppported distance metrics

- Cosine
- Dot product
- Euclidean
- Manhattan

Vector processing is parallelized and in-memory

A vector index is also supported

Use existing tools: MySQL Shell, VS code to query structured and unstructured content

```
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Type '\help' or '\?' for help; '\quit' to exit.
Creating a session to 'root@localhost'
Fetching global names for auto-completion... Press ^C to stop.
Your MySQL connection id is 2058
Server version: 9.4.2-ai MySQL Enterprise - AI
No default schema selected; type \use <schema> to set one.
 MySQL  localhost:3306 ssl  SQL > CALL sys.NL_SQL("List five airlines that have the highest number of airplanes along with the total airplanes they have.", @output, NULL);
+-----------------------------------------------------------------------------------------------------------------------------------------------------------+
| Executing generated SQL statement...                                                                                                                      |
+-----------------------------------------------------------------------------------------------------------------------------------------------------------+
| SELECT `airline_id`, COUNT(`airplane_id`) AS `total_airplanes` FROM `airportdb`.`airplane` GROUP BY `airline_id` ORDER BY `total_airplanes` DESC LIMIT 5 |
+-----------------------------------------------------------------------------------------------------------------------------------------------------------+
1 row in set (5.1490 sec)

+------------+-----------------+
| airline_id | total_airplanes |
+------------+-----------------+
|         73 |              90 |
|         45 |              89 |
|         81 |              89 |
|         24 |              89 |
|         94 |              89 |
+------------+-----------------+
5 rows in set (5.1490 sec)

Query OK, 0 rows affected (5.1490 sec)
 MySQL  localhost:3306 ssl  SQL >
```
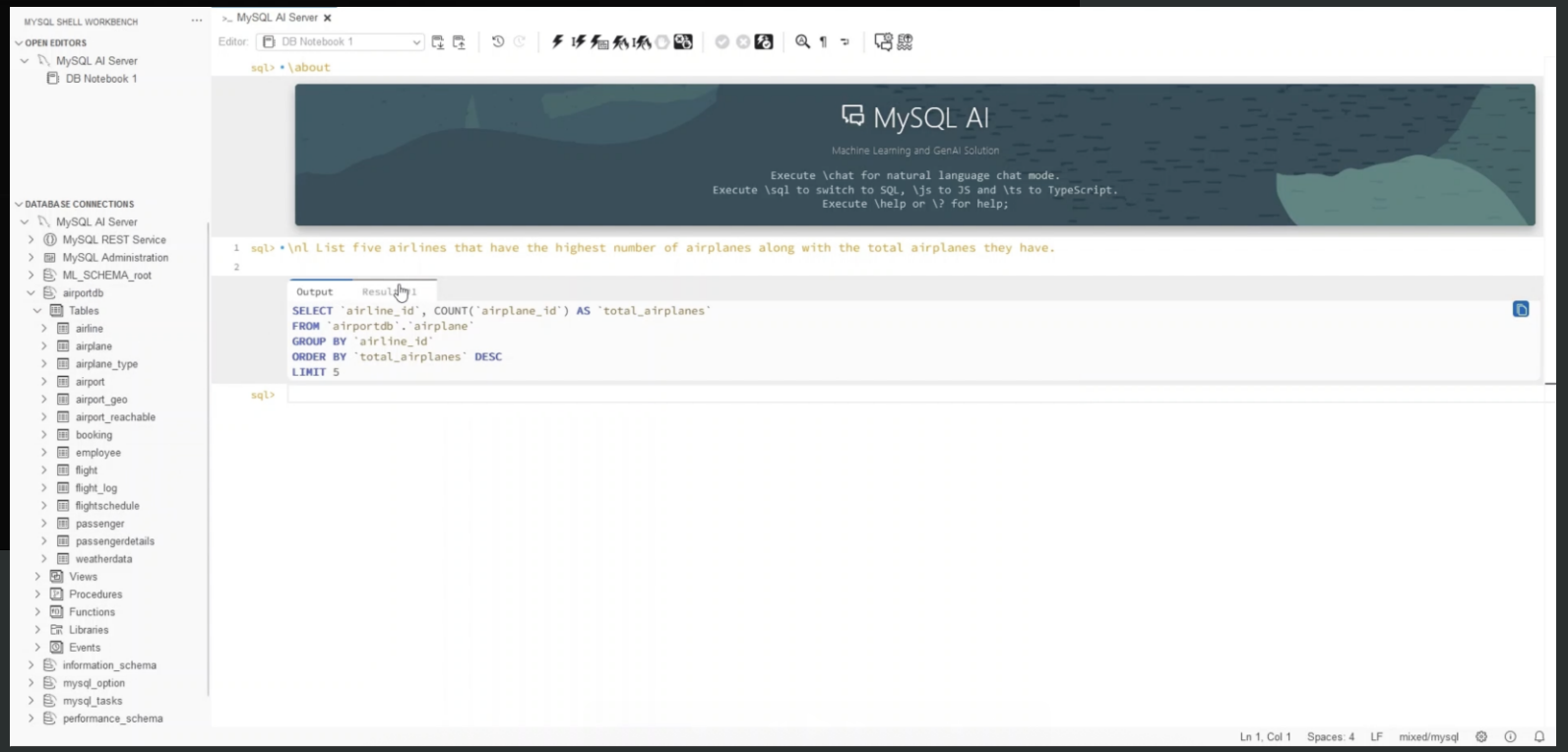



Seamless migration to MySQL HeatWave

- No change to application, lower cost, better performance
- Analytics support – best price performance in industry
- Query from object store
- OCI Gen AI Services
  - Grok, Open AI, Gemini, Meta LLMs
- Enhanced OLTP capabilities – e.g. Autopilot
- Choice of cloud – OCI, AWS, Azure

Vector Index for similarity search

Complementary to full scan search for better performance and high accuracy

High Performance

- Fast parallel index creation
- ~100x compared to full table scan

Adaptive Accuracy

- Full scan when query recall is low
- Dynamic runtime sampling for query recall estimation

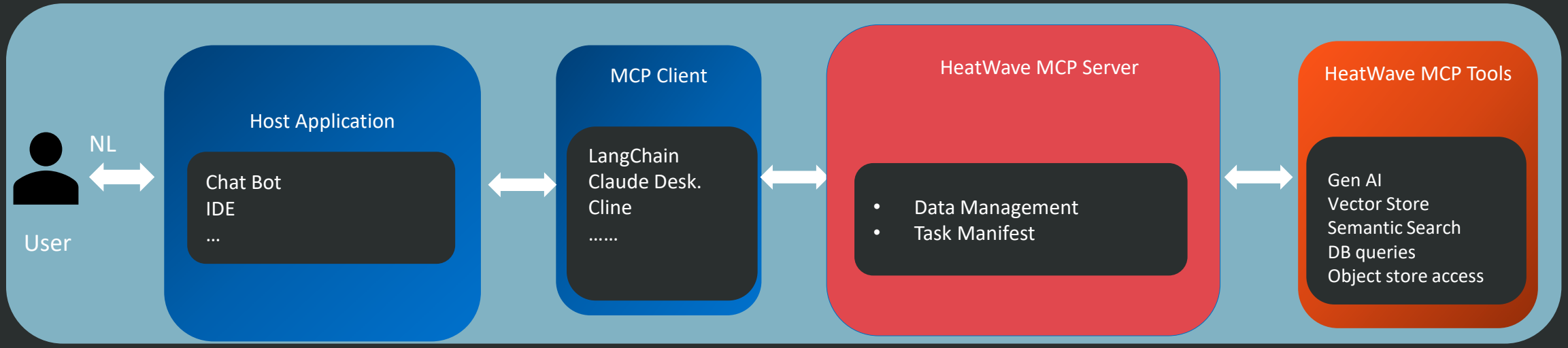
Automatic Index management

- Monitors similarity search queries
- Builds and refreshes Vector Indexes automatically

Model Context Protocol (MCP) for MySQL HeatWave

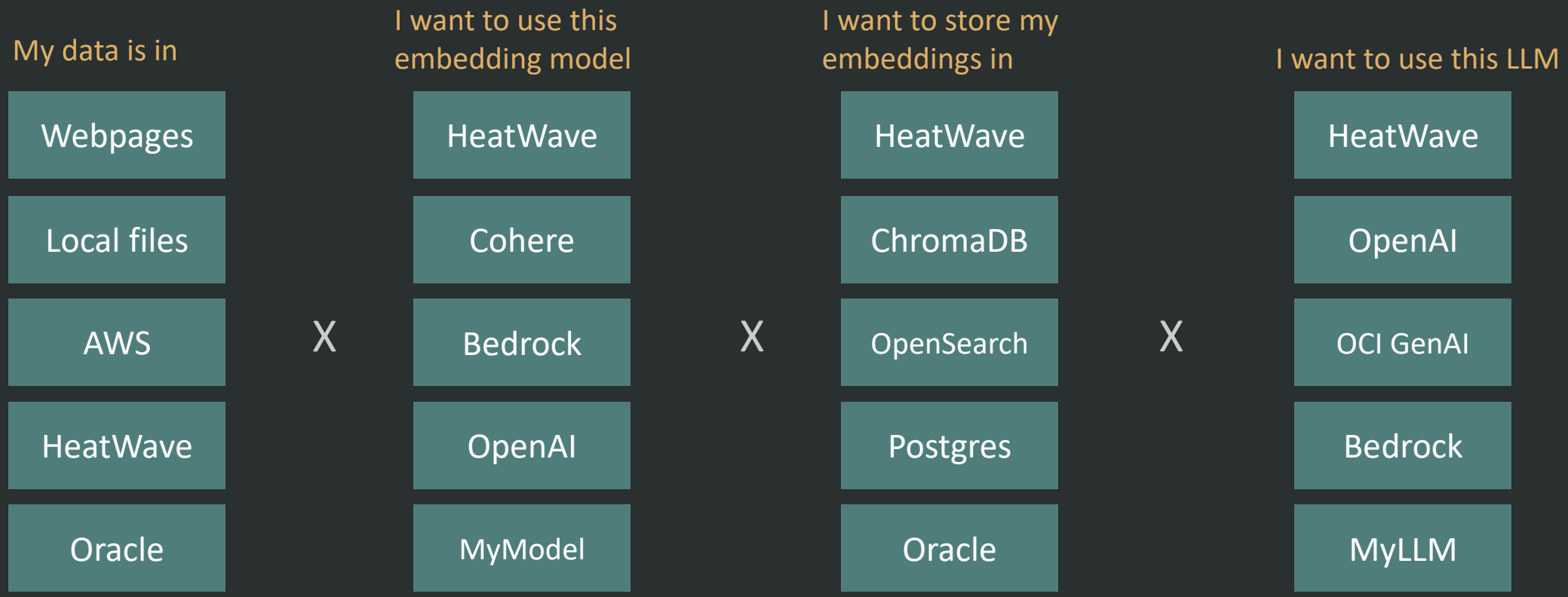
A single interface to interact with MySQL HeatWave GenAI capabilities

- Develop applications on MySQL HeatWave with GenAI assistance
- Build use-case and industry-specific tools using the provided MySQL HeatWave tools as examples
- MCP client orchestrates the usage of MySQL Heatwave capabilities using a LLM
- For more details: https://github.com/oracle/mcp



MySQL HeatWave Python SDK

Simplify GenAI and AutoML development by integrating with popular frameworks



100s of document loaders at https://python.langchain.com/docs/integrations/document_loaders/

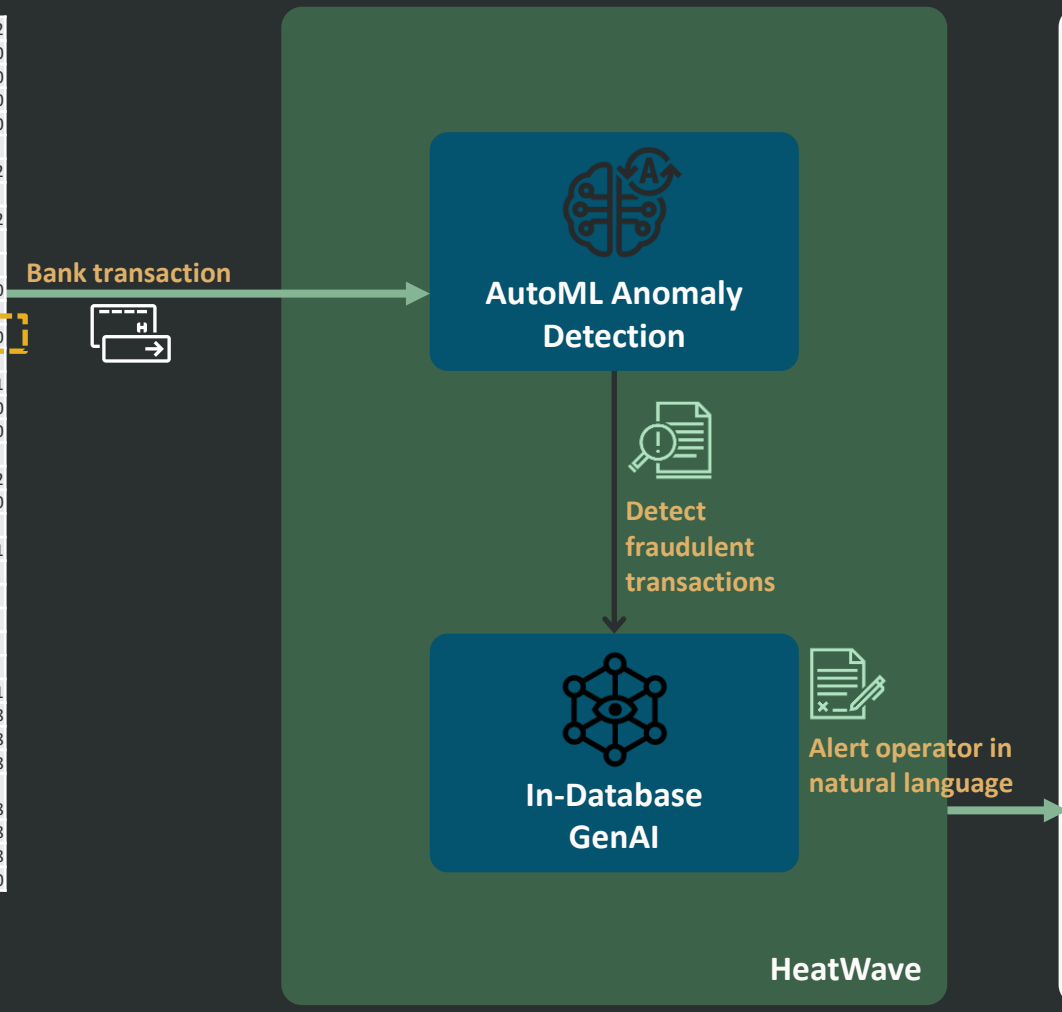
100s of models at https://python.langchain.com/docs/integrations/text_embedding/

100s of vector stores at https://python.langchain.com/docs/integrations/vectorstores/

100s of LLM providers at https://python.langchain.com/docs/integrations/llms/

Financial fraud detection with AutoML + GenAI

DAT_TXN	3/31/12
COD_CC_BRN_TXN	160
COD_USERNO	0
CTR_BATCH_NO	0
REF_SYS_TR_AUD_NO	0
REF_SUB_SEQ_NO	
COD_ACCT_NO	1601000010862
TXT_TXN_DESC	Balance brought forward
DAT_VALUE	3/31/12
REF_CHQ_NO	
COD_DRCR	C
COD_TXN_MNEMONIC	5010
COD_TXN_LITERAL	PBC
AMT_TXN	0
FLG_PASBKUPD	N
RAT_CCY	1
COD_MSG_TYP	200
COD_PROC	251000
CTR_UPDAT_SRLNO	
DAT_POST	3/31/12
AMT_TXN_TCY	0
COD_TXN_CCY	
RAT_CONV_TCLCY	1
COD_SC	
COD_AUTH_ID	
REF_CARD_NO	
REF_TXN_NO	
REF_USR_NO	
TXT_ADDL_INFO	1
DAT_TS_TXN_INIT	2015/02/18 15:38:58
DAT_TS_SENT_FOR_AUTH	2015/02/18 15:38:58
DAT_TS_AUTH	2015/02/18 15:38:58
DAT_TS_SUB_FOR_PROCESSING	2015/02/18 15:38:58
DAT_TS_SENT_TO_HOST	2015/02/18 15:38:58
DAT_TS_HOST_PROCESSING	2015/02/18 15:38:58
COD_ENTITY_VPD	240

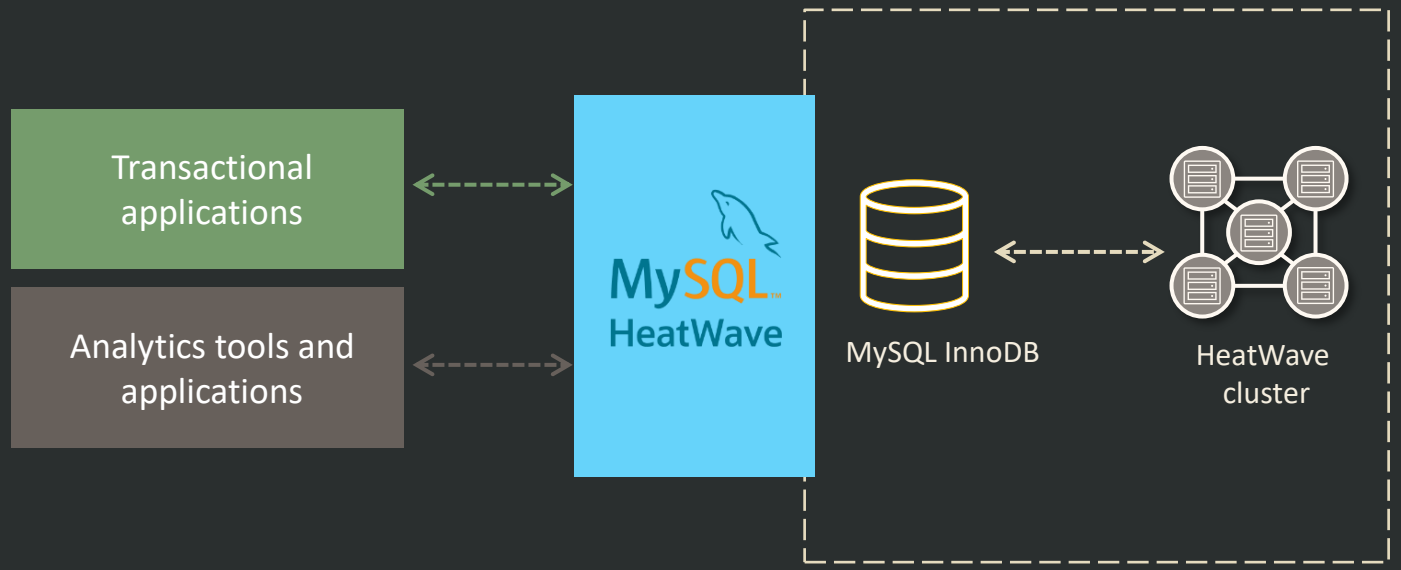


The provided bank transaction information indicates that on March 31, 2012, a balance was brought forward from the previous accounting period to the current one. The account number associated with this transaction is 1601000010862, and the amount of the transaction is zero. The flag indicating whether the transaction has been successfully processed is set to N, which means that the transaction was not successful….

There are several suspicious aspects of this transaction that require further investigation. Firstly, the fact that the amount of the transaction is zero raises questions about the purpose and validity of the transaction. Secondly, the flag indicating that the transaction was not successful suggests that there may have been an issue with the processing or authorization of the transaction.

MySQL HeatWave Analytics

HeatWave Analytics - MySQL mixed workloads



One service for OTLP & OLAP

No ETL duplication

Unmatched performance, at a fraction of the cost

Real-time analytics

Improved security

Applications work without changes (including BI tools such as Tableau, QuickSight, OAC)

Industry’s best performance & price-performance

TPC-H 4TB

	MySQL HeatWave	AWS Aurora MySQL	Amazon Redshift	Google BigQuery	Snowflake on AWS
Cluster size	128 HeatWave capacity units	Db.r5.24xlarge	2x ra3.4xlarge	400 slots	Medium (4)
Query total time	339 sec	130 hours	4,189 sec	4,328 sec	3,183 sec
Cost	$22,594	$67,843	$37,696	$81,600	US$70,080
Query price-perf	$0.24	$987.9	$4.91	$10.99	$6.94
HeatWave price-perf advantage		**4145x**	**20x**	**46x**	**29x**

Benchmark queries are derived from the TPC-H benchmark but results are not comparable to published TPC-H benchmark results since these do not comply with the TPC-H specifications.

MySQL vs MySQL HeatWave functionality

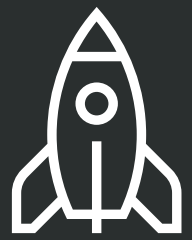
Features	MySQL CE	MySQL HeatWave
HeatWave in-memory engine	N	**Y**
OLAP functions	N	**Y, Cube, HLL, Grouping Set, Qualify Table sample**
Auto-refresh Materialized View	N	**Y**
Result caching	N	**Y**
In-memory temp table	Only for small data set	**Y**
Process data outside of MySQL	N	**Y**

HeatWave Materialized Views refresh automatically

Improve performance, simplify complex queries

Automatic refresh

- Always fresh data
- Ideal for real-time dashboard and analytics



Faster queries

- Precomputed query results for complex queries
- Faster time-to-insights

Higher scalability

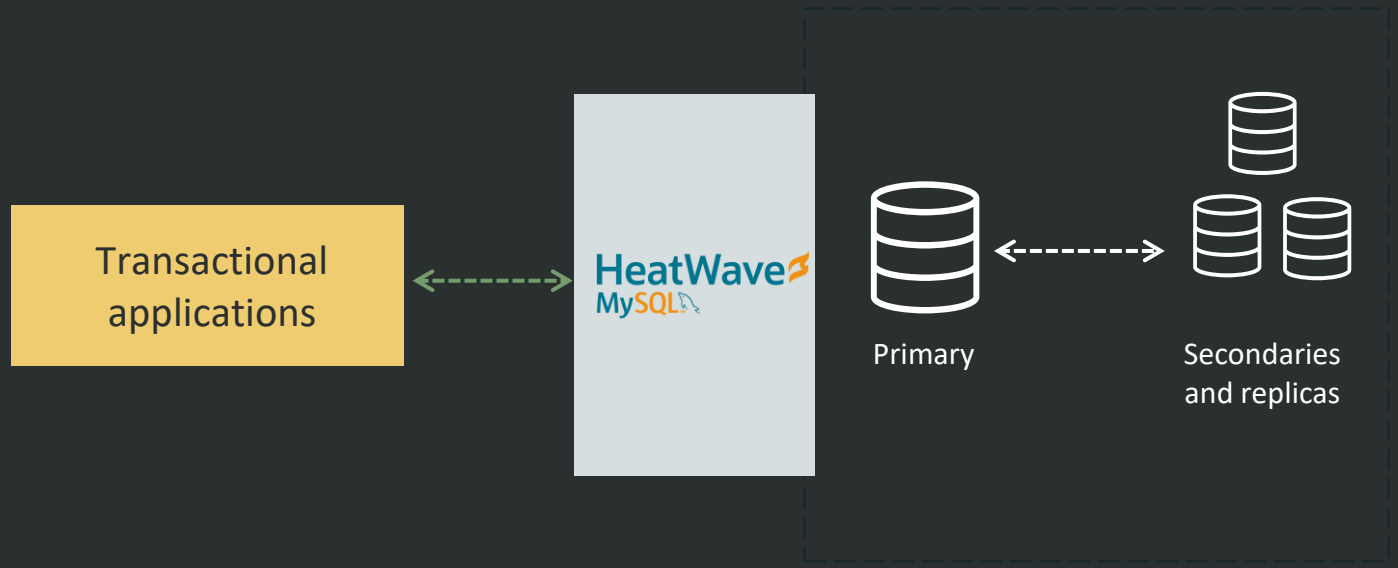
- Reduce computation and resource loads
- Improves read scalability

Secure

- Same MySQL privilege system
- Build data marts with access isolation

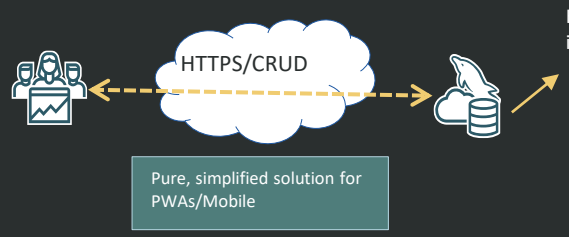
OLTP Enhancements

MySQL HeatWave for OLTP

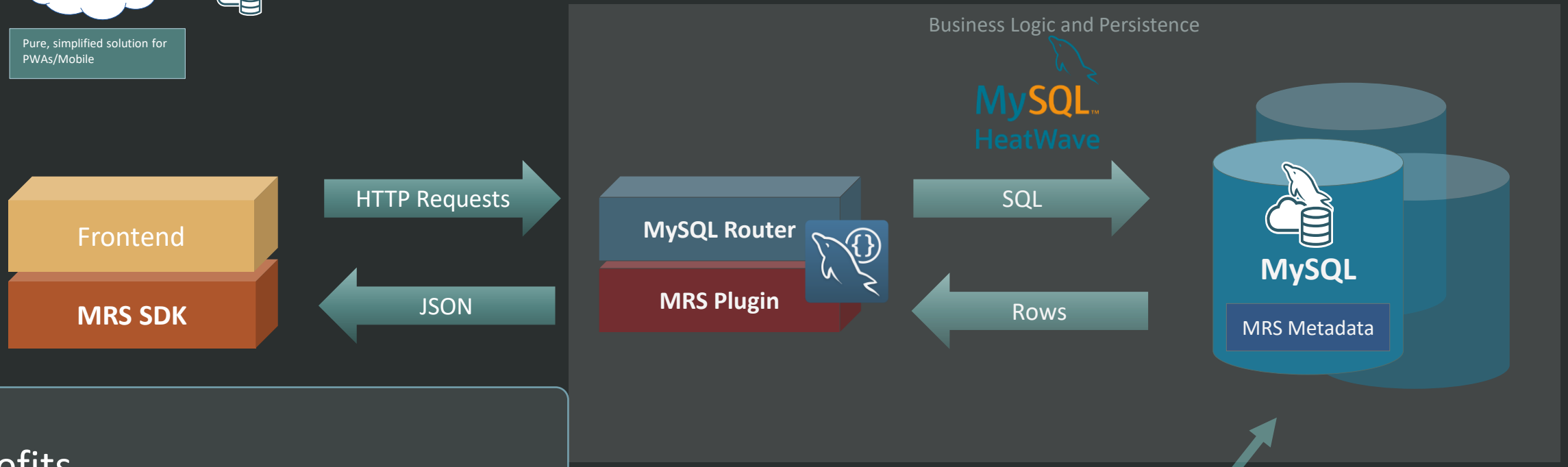


- Optimized for high-performance
- Highly-available & scalable
- Low failover latency
- Unbeatable price
- Enterprise Edition and Premier Support included
- Cloud only new features

REST Service in MySQL HeatWave



HTTPS/CRUD fitting well into modern architecture



Benefits

- Out-of-the-Box REST for MySQL Features
- Simplifies App/PWAs/Mobile Development
- Removes need for middle-ware

WebAssembly

Compile Rust, C, and C++ to WebAssembly run them right where your data lives.

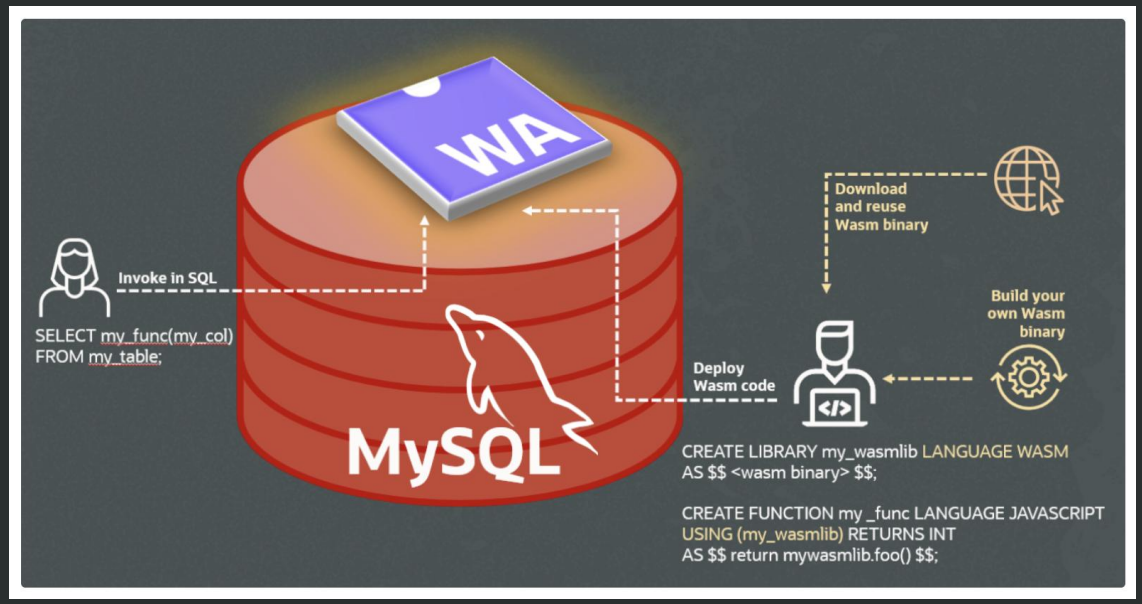
Eliminate Data Movement and Middleware Overhead

Tap Into a Powerful Open-Source Ecosystem

- Reuse open-source WASM libraries or safely integrate your own business-critical code with no vendor lock-in

Enterprise-Grade Speed, Security, and Flexibility

- Execute at near-native speed, isolated by GraalVM no system or network access, fully compliant.



JSON Duality Views

Unifying relational and document models

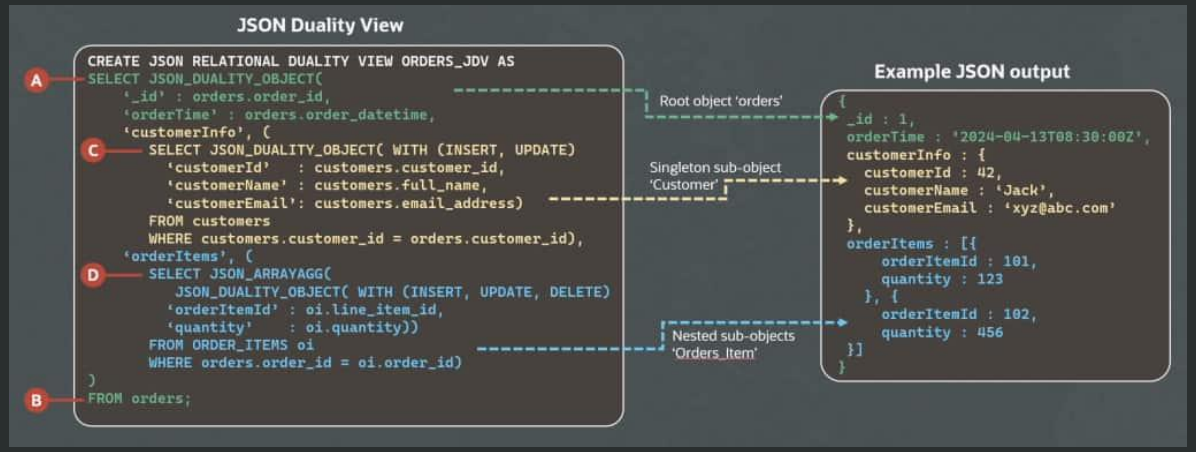
Introduced in the Oracle database

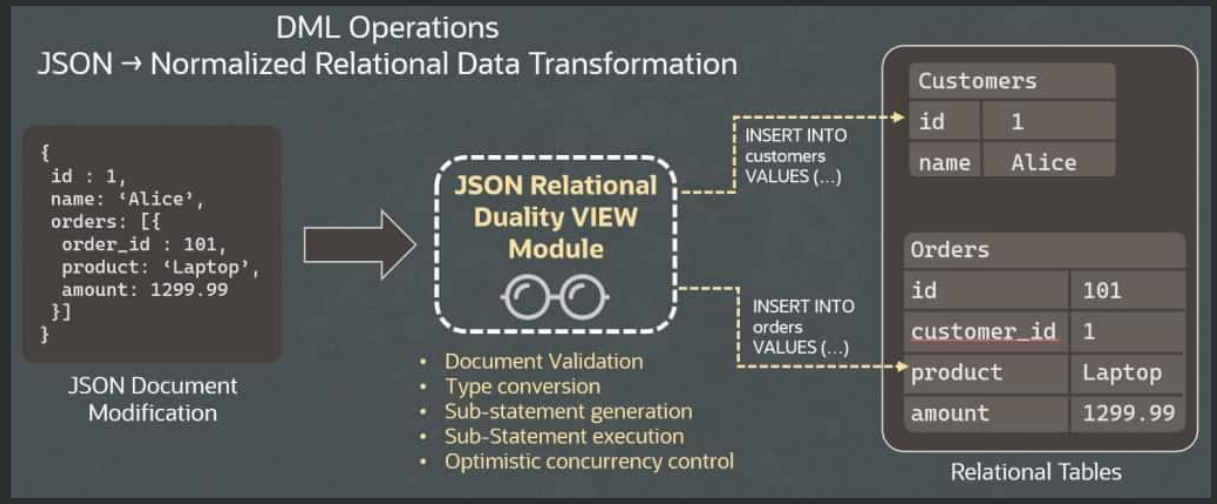
New DDL syntax for creating JSON Duality Views using InnoDB or Lakehouse tables

Query JSON Duality Views using SELECT statements - results are JSON documents

Perform DML operations (INSERT, UPDATE, DELETE) directly on JSON Duality Views using JSON objects

Lockless optimistic concurrent control to prevent conflicting read-write operations performed via state-less (REST) operations





MySQL HeatWave High Availability with automatic failover

99.99% SLA with Zero Data Loss

Near zero-downtime failover

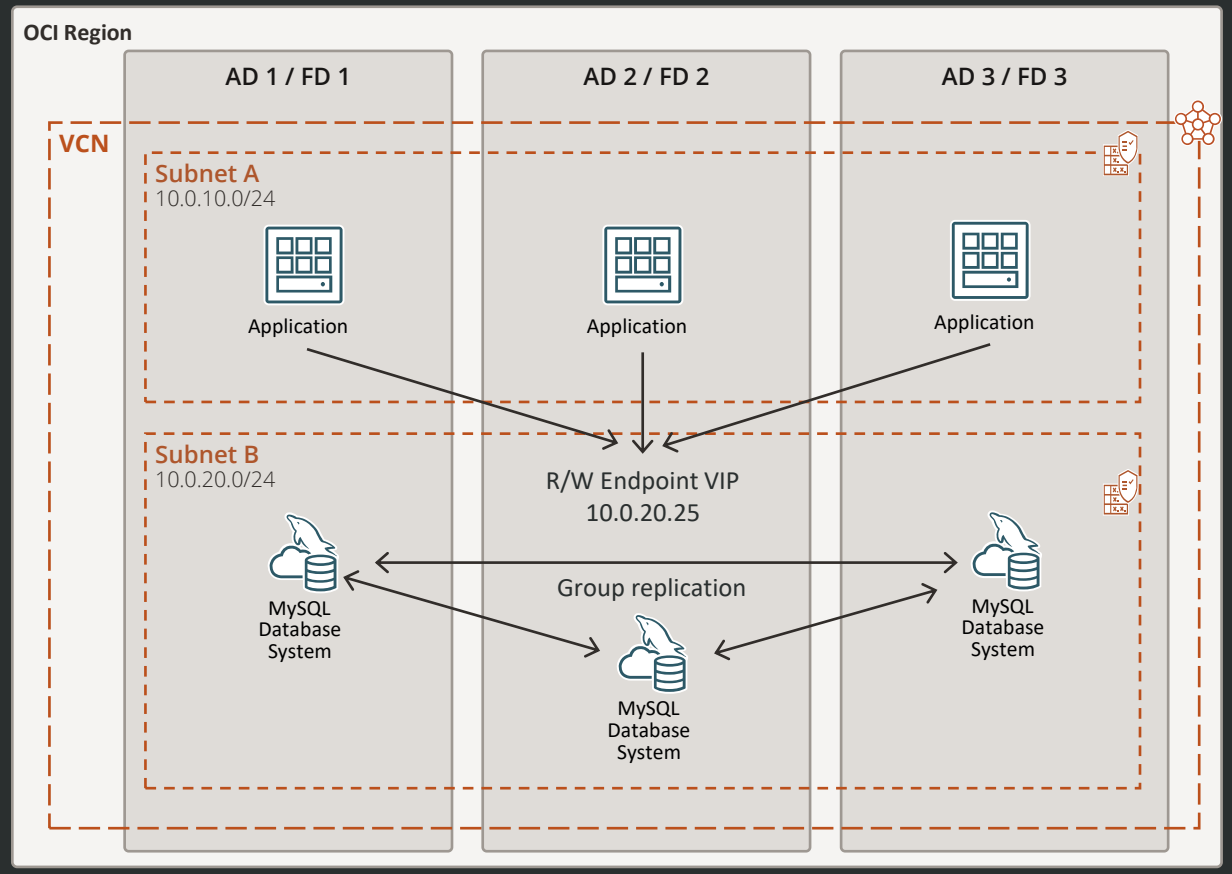
- Planned Upgrade: **~60s → ~2s (Typically)**
- Planned Switchover: **~ 21s → ~0.5s (Typically)**
- Unplanned Failover: **Minutes -> ~20s (Typically)**

Up-to-date Aware Primary Election

- Promotes most up-to-date secondary as new primary during failover
- Prevents failover to lagging or delayed nodes

Automatic Eviction on Resource Exhaustion

- Proactively removes nodes running low on resources
- Prevents cluster-wide resource exhaustion



MySQL HeatWave Disaster Recovery

Integrated with FSDR

Automated cross region backups

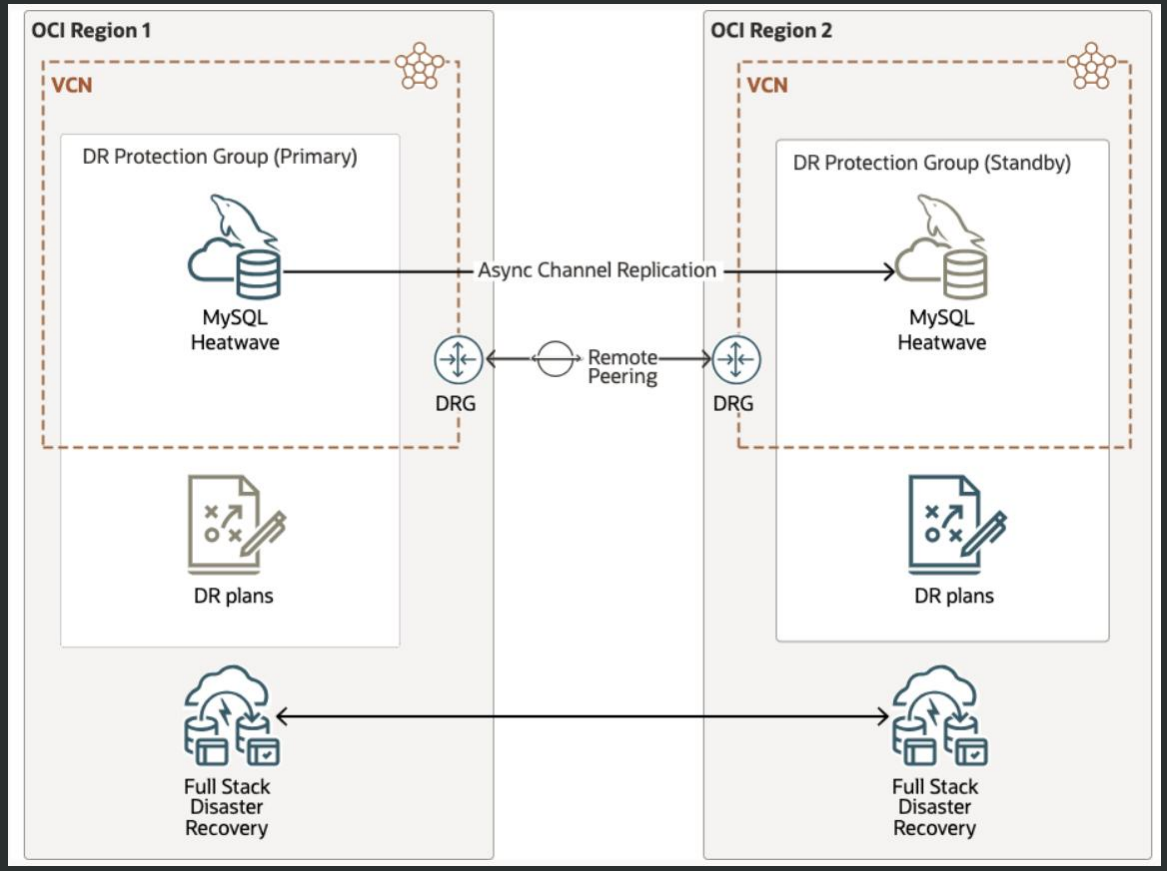
- Recover/create MySQL HeatWave easily cross region

Backup validation

- DR readiness
- Compliance requirements

Automated Disaster Recovery with FSDR

- Rapid DR Runbook Creation for application stacks
- Customizable Recovery
- Seamless DR Validation with automated, non-intrusive DR drills
- Automate recovery steps leveraging Existing Deployments
- Flexible DR Topologies



STORViX supercharges data storage and disaster recovery using OCI and MySQL HeatWave

"Thanks to OCI, we are able to offer a secure, efficient, and flexible cloud extension to our product, AiRE, that represents a clear competitive advantage for both us and our customers. In addition, OKE saved us an impressive amount of setup time, and HeatWave MySQL is simply amazing."

Luca Minoja

Founder, STORViX

Business challenge:

Sweden-based STORViX offers an AI-powered data platform that helps companies manage their data across different systems and locations. To best serve its clients, the company wanted to decrease administrative overhead and gain near-zero RTO and RPO. For greater automation and scalability, the company re-architected the cloud native extension of its product, AiRE, to take advantage of Oracle Container Engine for Kubernetes. Additionally, the firm's original MariaDB instance was upgraded to Oracle MySQL HeatWave.

Results:

- ✓ Can rely on a full managed MySQL Database service
- ✓ 15X faster transaction speeds vs. MariaDB
- ✓ Vast OCI data center coverage helped the company deploy resources in close geographic proximity to customers

Products:

MySQL HeatWave

Read full story here

Migration

MySQL HeatWave Migration Assistant

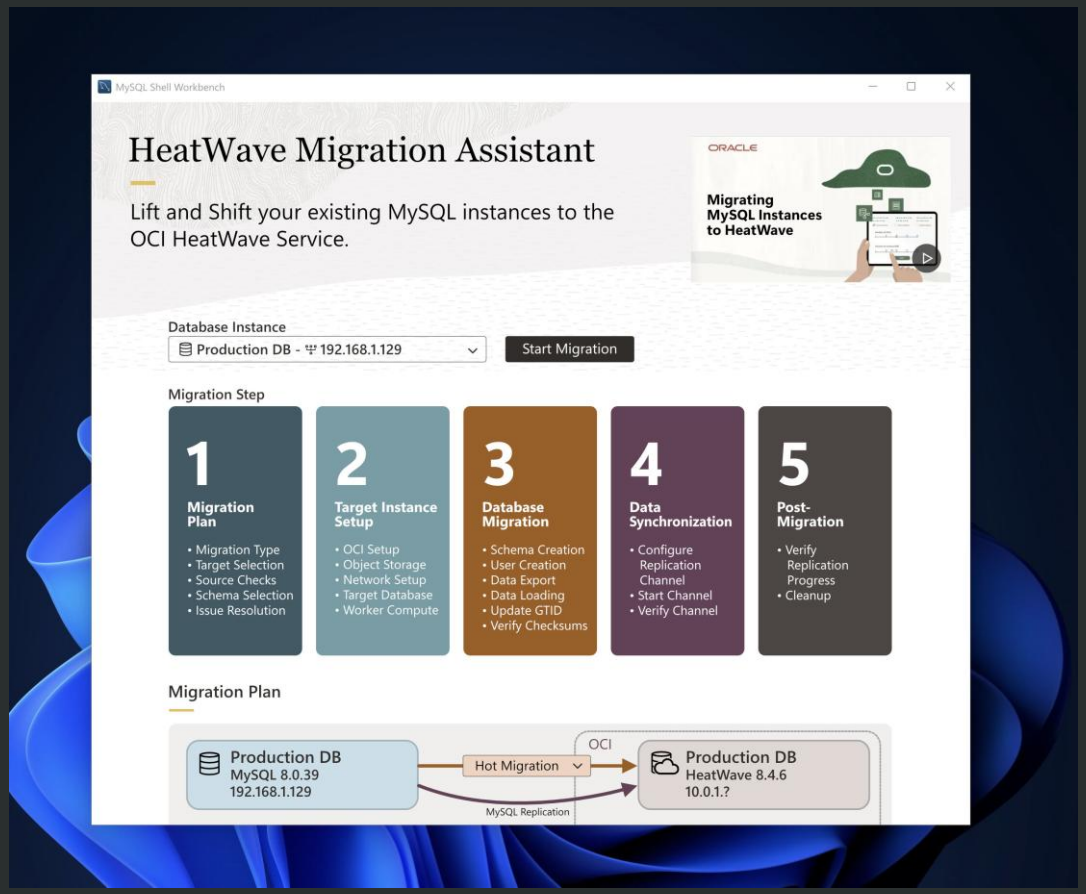
Seamless end-to-end migration from on-premise to OCI

GUI-based migration assistant - Intuitive workflow designed to streamline migrating MySQL workload to MySQL HeatWave

Support all MySQL versions - migration of schema, data, accounts, and sets up inbound replication

Zero downtime migration – minimal impact on live production workloads

Migrate MySQL AI to MySQL HeatWave - Enables organizations to continue their MySQL AI journey in the cloud



MySQL HeatWave

Single platform for OLTP, OLAP, Machine Learning and GenAI

MySQL

- Streamlined, guided workflow for effortless migration
- Lower cost
- Cloud first innovations: NL2SQL, JavaScript, REST

HeatWave Analytics

- PB scale real-time analytics, no ETL
- Query data across files in object store and database
- Industry's best performance and price-performance

HeatWave AI/ML

- Automated, integrated in-db GenAI & ML on all data
- Build applications with open frameworks at no additional cost
- Built-in security, no data movement

Always FREE MySQL HeatWave service in OCI

- Migrate with one click for effortless onboarding
- New innovations: JavaScript, REST
- Real-time analytics, no ETL
- Run queries across files in object store and database
- Unify relational, document, ML, and AI vector search capabilities
- Build new applications with no AI/ML expertise required
- No additional cost for in-database LLMs and ML
- Industry-leading performance and cost-efficiency

Start for free here:
- Oracle Cloud: https://cloud.oracle.com/mysqlaas/db-systems
- Databases → HeatWave MySQL DB Systems

One Always Free DB system free-of-charge in the home region of each commercial tenancy

Deploy MySQL applications anywhere

Managed Service

Self managed	**On premises**	• Run on premise or in Hybrid deployment
Native Service		• All commercial regions, US Gov • Dedicated Region Cloud@Customer • Alloy
Runs inside AWS		• Low latency, no need for data egress • Integrated with AWS Services • Available for over 3 years
Interconnect		• Private Interconnect < 2ms latency • Collaborative Support

5 reasons to choose MySQL HeatWave

1 Best platform for MySQL workloads

The only MySQL EE cloud service. Built, managed & supported by the MySQL team

2 Best performance & price-performance

3rd party published benchmark for best price performance for analytics, ML, vector processing and GenAI

3 Seamless migration from MySQL AI

Build new AI applications with automated, in-database GenAI

4 Built-in GenAI and vector store

Migrate AI application for lower cost and better performance

5 Available in multi-clouds

Available across OCI, AWS, Azure, OCI Alloy, OCI DRCC, and hybrid deployment


ORACLE