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Oracle Database 23ai

運用 AI 的強大能力提升企業資料價值和應用系統功能 (Rev. C)

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Oracle Database Vision

With Generative AI (LLM)

Make modern apps and analytics
easy to **generate** and run
for all use cases at any scale

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使用稱為 'AI Vector' 的新資料型態來搜尋非結構化的資料

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Vector 是用來表示圖像、文件、影片...的語意內容

Vector 是一串的數字，稱做 dimension 來擷取資料的重要 ‘特徵’

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AI Vector Search

Oracle 獨特的地方

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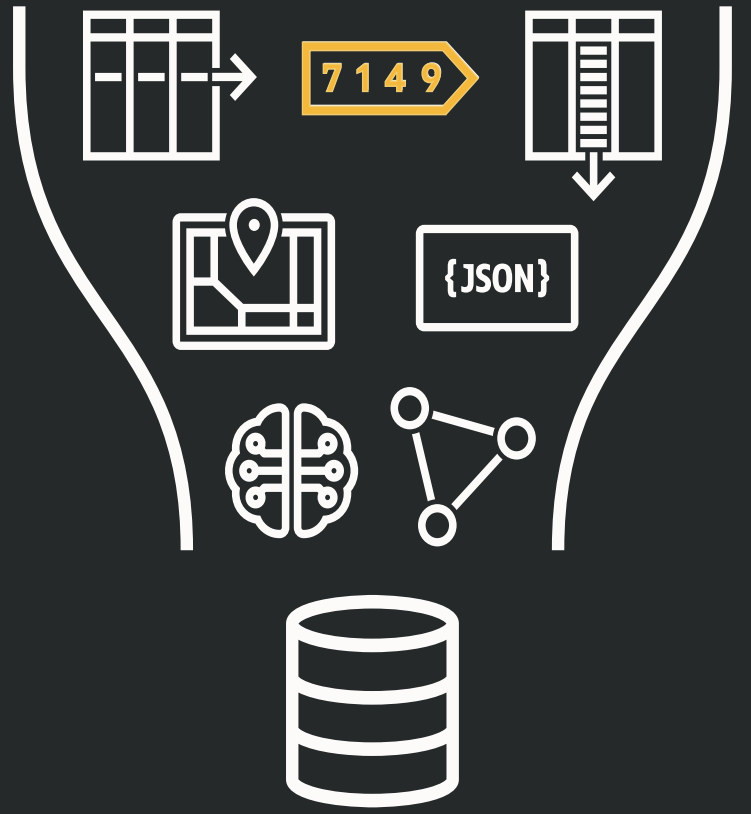
Oracle AI Vector Search

Oracle Database 23^{ai} 具備 AI Vector Search 功能

著重在簡化使用及易於理解

- 新的 VECTOR data type 存放 vector embedding
- 新的 SQL 語法及功能實現方便使用的 similarity search
- 新的 Approximate search indexes 套件著重在高效能及品質



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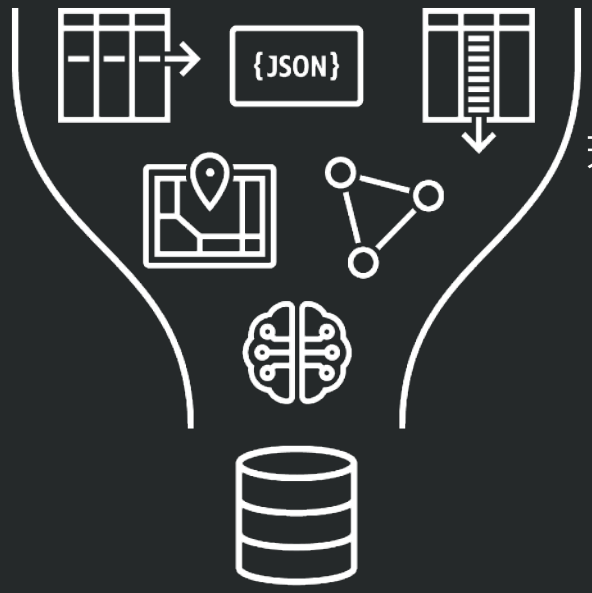
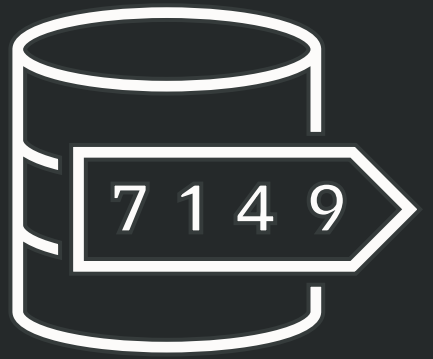
搜尋商務及語意資料的組合需要這兩種資料型態能同時被查詢



商務資料庫

若使用獨立的 Vector 資料庫，必須持續將商務資料傳送至 Vector 資料庫

商務資料



Vector 資料庫

造成資料的不一致、增加複雜度、資安風險提高

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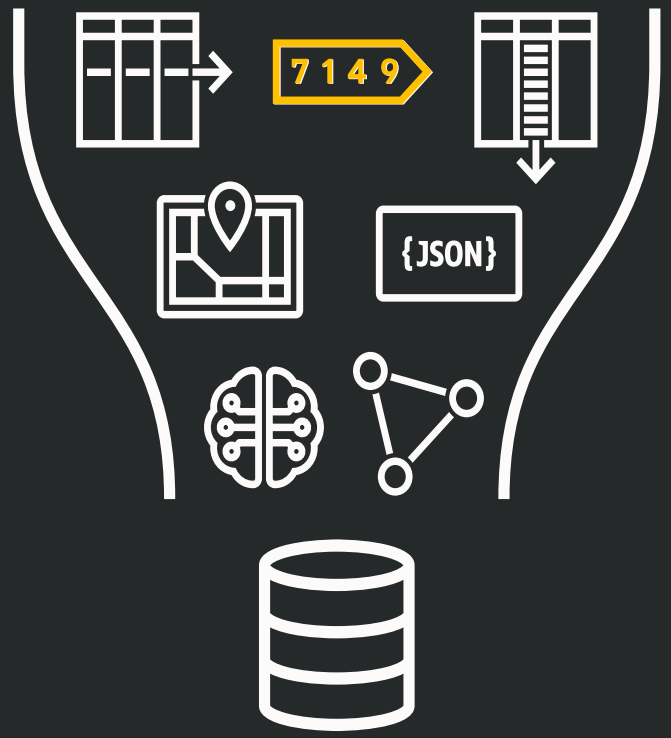

融合式資料庫
(Converged Database)

最好的解決方案是將 vector search 功能加入商務資料庫

- 無需移動或同步資料，也不用管理不同的資料庫系統
- 結合企業既有的結構化資料，實際強化應用程式功能

23ai

Oracle 資料庫

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Vector Datatype

Oracle Database 23^{ai} 新增資料型態

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Vector Datatype

新的資料型態

VECTOR

```
CREATE TABLE my_images (
      id number,
      image BLOB,
      img_vec VECTOR(768, FLOAT32));
```

Optional
維度數

Optional
數值格式

也可以簡單指定

VECTOR

```
CREATE TABLE my_images (
      id number,
      image BLOB,
      img_vec VECTOR);
```

為何這很有用處？

Embedding 模型技術與日俱新，但 schema 可以維持不變

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Vector Operators

主要的 vector 運算是找出這些 vector 有多‘相似’

```
VECTOR_DISTANCE(VECTOR1, VECTOR2, <distance metric>)
```

不同的 embedding 模型可以使用不同的 ‘距離’ 度量方式，例如：Euclidean, cosine similarity, dot product… 等等，但基本概念是一樣的：

實體的 vector ‘距離’ 越短，則實體的相似度就越高

以下為例：越相似的實體，它們的 vector 彼此 ‘距離’ 就越短

VECTOR_DISTANCE(<老虎 Vec>, <獅子 Vec>) < VECTOR_DISTANCE(<老虎 Vec>, <蘋果 Vec>)

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Vector Index

快速，概括的搜尋 - 平衡效能與精準度的拉扯

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Vector Indexing

將查詢的 vector 與 table 內的每一個 vector 計算 '距離' 來找到 Top-K 吻合會是 100% 精確，但，會很慢 (耗時)

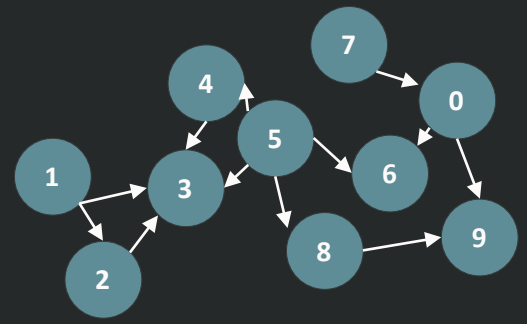
New vector indexes trade-off search accuracy for speed

- Vectors are clustered/connected based on similarity for accuracy
- Greedy search techniques limit accuracy for speed

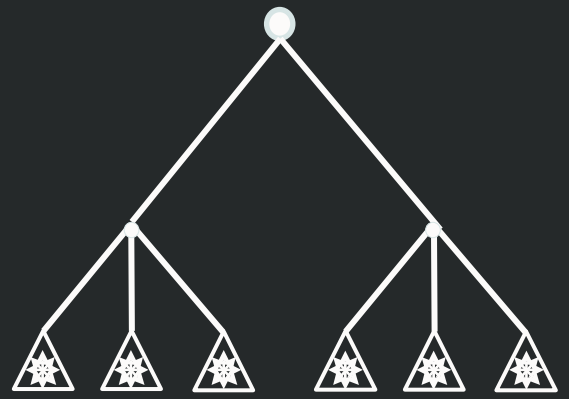
Vector indexes

- Neighbor Graph Vector Index – Graph-based index where vertices represent vectors and edges between vertices represent *similarity*
  - **In-Memory only** index - highly efficient for both accuracy and speed
- Neighbor Partition Vector Index – Partition-based index with vectors clustered into table partitions based on *similarity*
  Efficient scale-out index, with fast and seamless transactional support

Graph Vector Index
(e.g. **HNSW** Index)



Partition Vector Index
(e.g. **IVF_FLAT** index)



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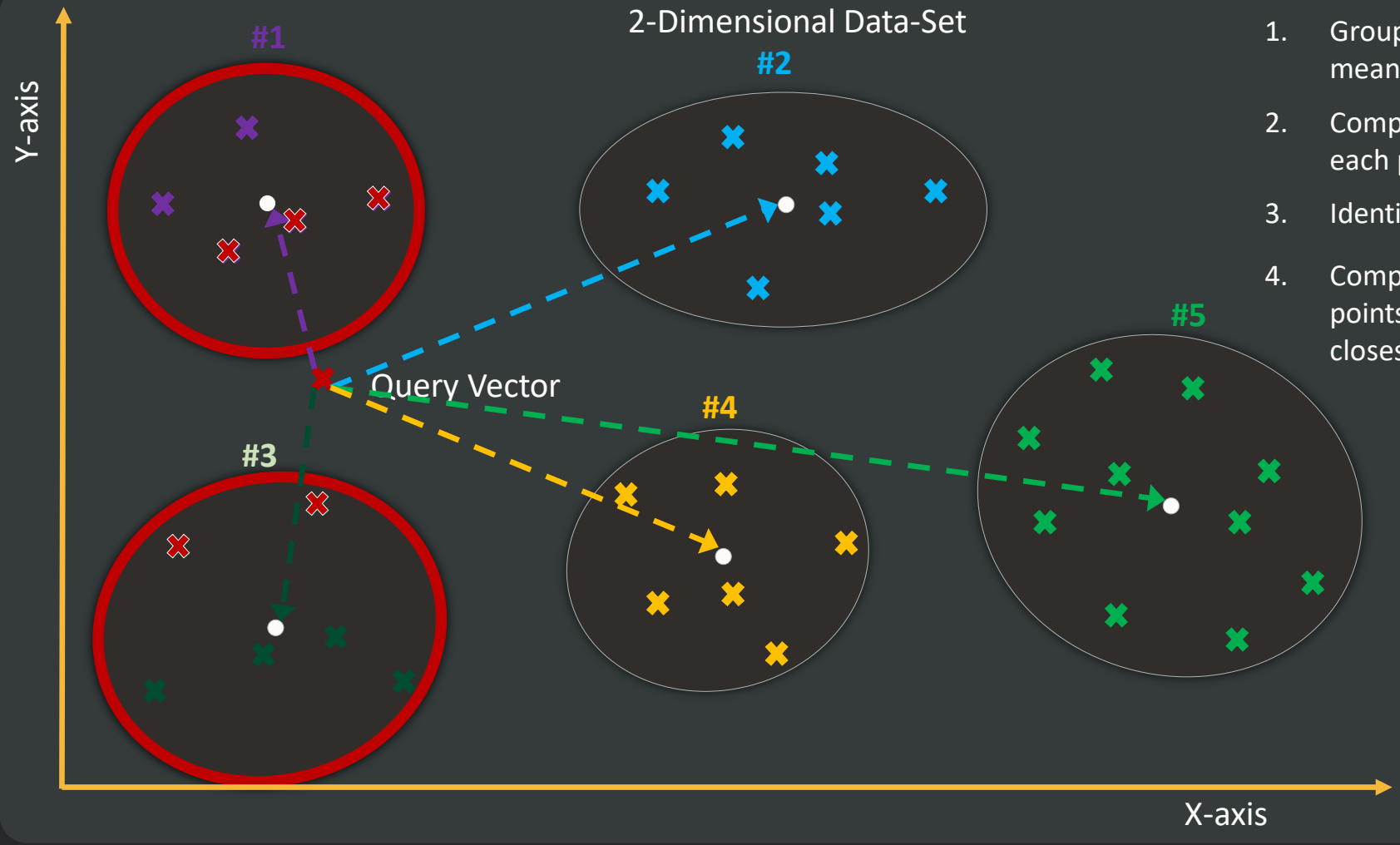
Neighbor Partition Vector Index – Search



1. Group vectors into partitions using OML's K-means clustering algo. (K = 5)
2. Compute distance from query vector to each partition's centroids
3. Identify the 2 nearest partitions
4. Compute distance from query vector to all points in Cluster #1 and #3 to find Top 5 closest matches (shown in red)

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產生 Vector Index 的 SQL 語法

Basic index creation syntax:

```
CREATE VECTOR INDEX photo_idx ON Customer(photo_vector)
ORGANIZATION [INMEMORY NEIGHBOR GRAPH | NEIGHBOR PARTITIONS]
DISTANCE EUCLIDEAN | COSINE_SIMILARITY | HAMMING ...
```

Choosing the ORGANIZATION for an index is simple:

- If the index data will fit in-memory, it is best to use INMEMORY NEIGHBOR GRAPH
- Else use NEIGHBOR PARTITIONS

The DISTANCE function clause is optional (the default is Euclidean)

The distance function should be chosen based on the embedding model used to generate the vectors.

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應用探討：疾病管制署傳染病問答集

資料來源：https://data.cdc.gov.tw/dataset/disease-qa/resource/600debb5-4564-441c-b69a-43a85a564ac8

FAQ 問題：'被動物咬傷時，該怎麼辦？'

FAQ 回答：

'一旦被動物咬傷時，請遵循「記、沖、送、觀」四字訣： 1. 記：保持冷靜，牢記動物特徵 2. 沖：用大量肥皂、清水沖洗15分鐘，並以優碘消毒傷口 3. 送：儘速送醫評估是否要接種疫苗 4. 觀：儘可能將咬人動物繫留觀察10天。若動物兇性大發，不要冒險捕捉'

但，民眾可能直接問：'被野狗咬到怎麼辦？'；外籍人士相同問題可能問：'被野狗咬到怎么办？' (簡體中文)、'What to do if bitten by a wild dog?' (英文)、'野犬に噛まれた場合はどうすればいいですか？' (日文) 或 'Bị chó hoang cắn phải làm sao?' (越南文)

傳統 Chatbot 挑戰：

1. 關鍵字比對往往找不到最相似的問題 (及回答)
2. 要支援多語系，就需準備多語系的問答集

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應用探討：疾病管制署傳染病問答集

將 FAQ 問題與民眾問題透過多語系 LLM embedding 模型產生 Vector

FAQ 問題：

'被動物咬傷時，該怎麼辦？'

'瘧疾會有什麼症狀？'

'B型肝炎傳染途徑為何？'

…

民眾問題：

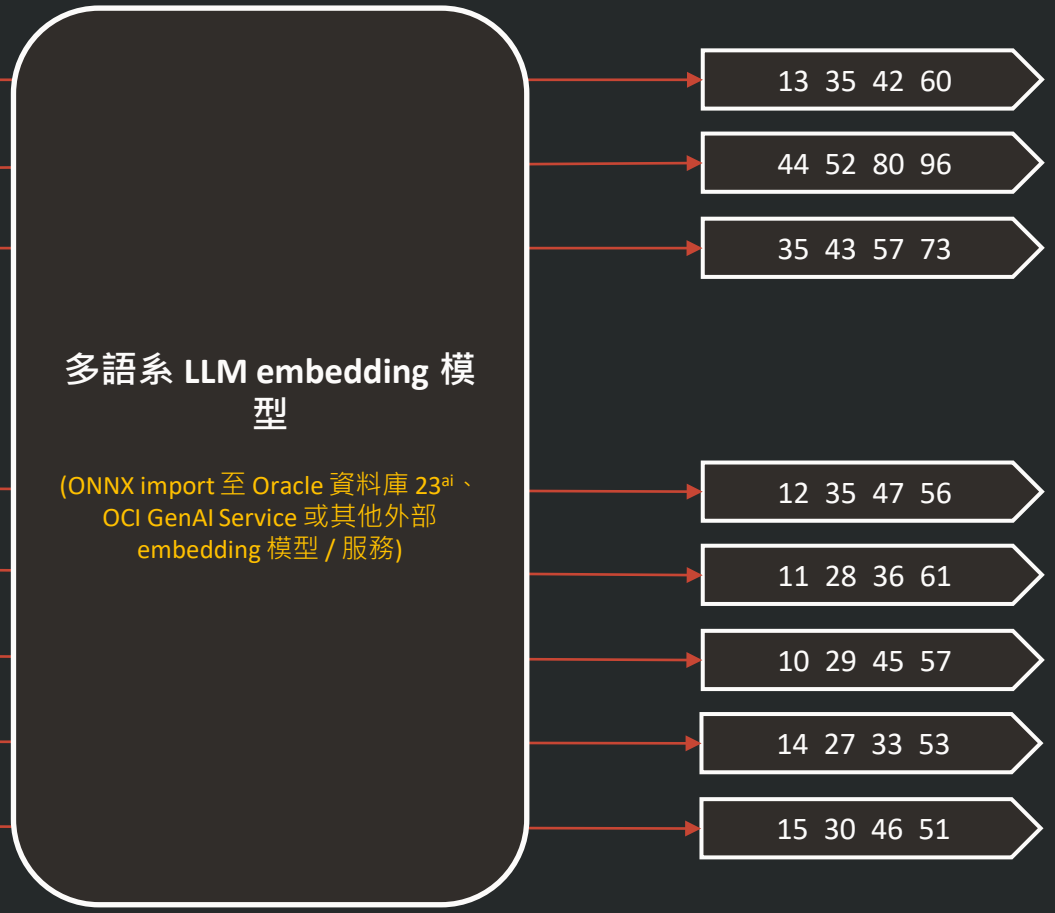
'被野狗咬到怎麼辦？'

'被野狗咬到怎么办？'

'What to do if bitten by a wild dog?'

'野犬に噛まれた場合はどうすればいいですか？'

'Bị chó hoang cắn phải làm sao?'



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將民眾問題的 Vector 與 FAQ 問題的 Vector 計算數學上的 ‘距離’

‘被野狗咬到怎麼辦？‘

12 35 47 56

'被動物咬傷時，該怎麼辦？’

13 35 42 60

Distance (Euclidean Norm)

$= SQRT((12 - 13)^2 + (35 - 35)^2 + (47 - 42)^2 + (56 - 60)^2)$

有許多基於數學的‘距離’計算公式

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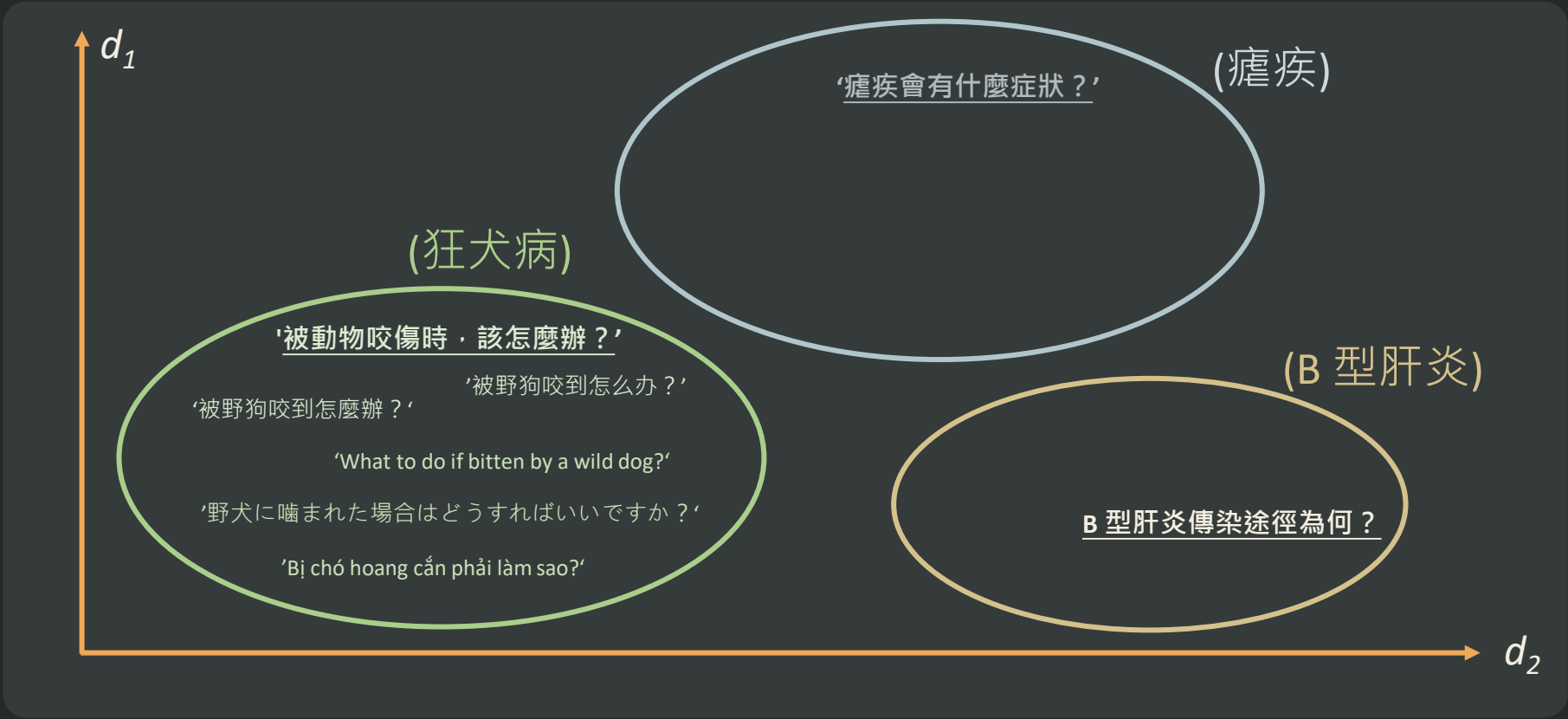
Vector 的 ’距離’ 越近，表示其 (各語系的) ‘語意’ 越接近



文字與影像運作是相同的

‘語意’ 相似度要比 ’詞彙‘ 相似度更真實貼近人的認知

民眾問題可以使用許多不同的詞彙，但只要 ‘語意’ 與 FAQ 的問題接近，就可以提供相對的回答

一組 FAQ 可以支援多語系 (可以把回答翻譯成問題的語系再顯示)

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Demo

Oracle Database 23^{ai} 使用 AI Vector Search (文字與圖像 embedding)

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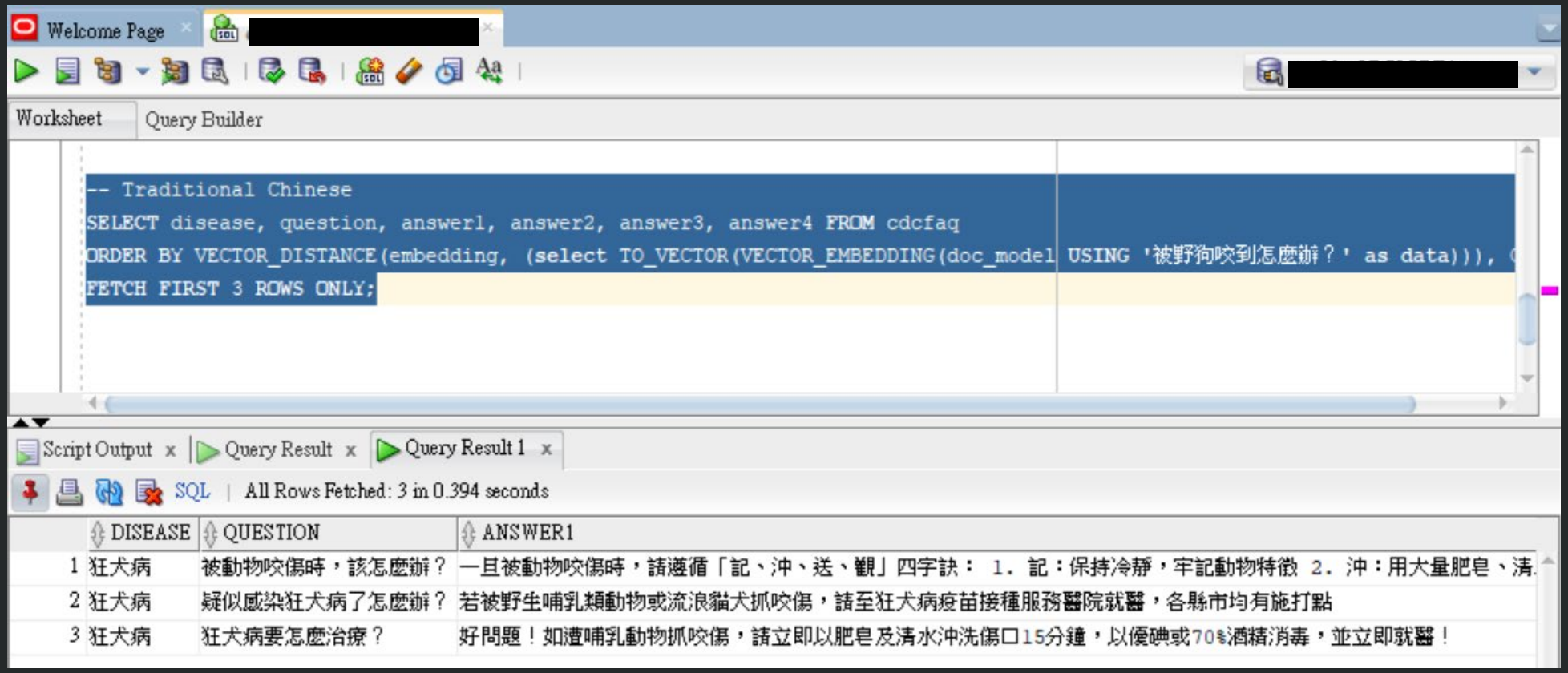
應用探討：疾病管制署傳染病問答集

實際運作範例

```
-- Traditional Chinese
SELECT disease, question, answer1, answer2, answer3, answer4 FROM cdcfaq
ORDER BY VECTOR_DISTANCE(embedding, (select TO_VECTOR(VECTOR_EMBEDDING(doc_model USING '被野狗咬到怎麼辦？' as data))), COSINE)
FETCH FIRST 3 ROWS ONLY;
```



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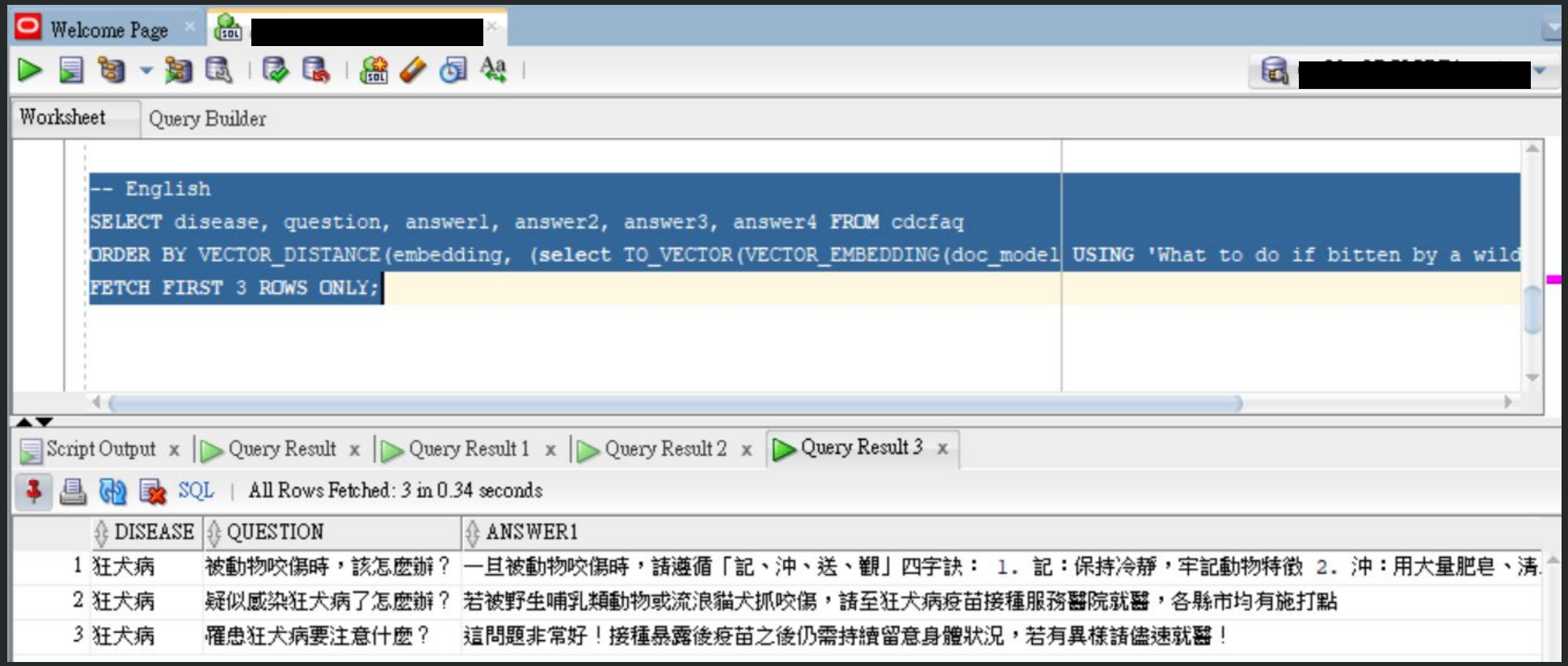
應用探討：疾病管制署傳染病問答集

實際運作範例 - 多語系 (英文)

```
-- English
SELECT disease, question, answer1, answer2, answer3, answer4 FROM cdcfaq
ORDER BY VECTOR_DISTANCE(embedding, (select TO_VECTOR(VECTOR_EMBEDDING(doc_model USING 'What to do if bitten by a wild dog?' as data))), COSINE)
FETCH FIRST 3 ROWS ONLY;
```



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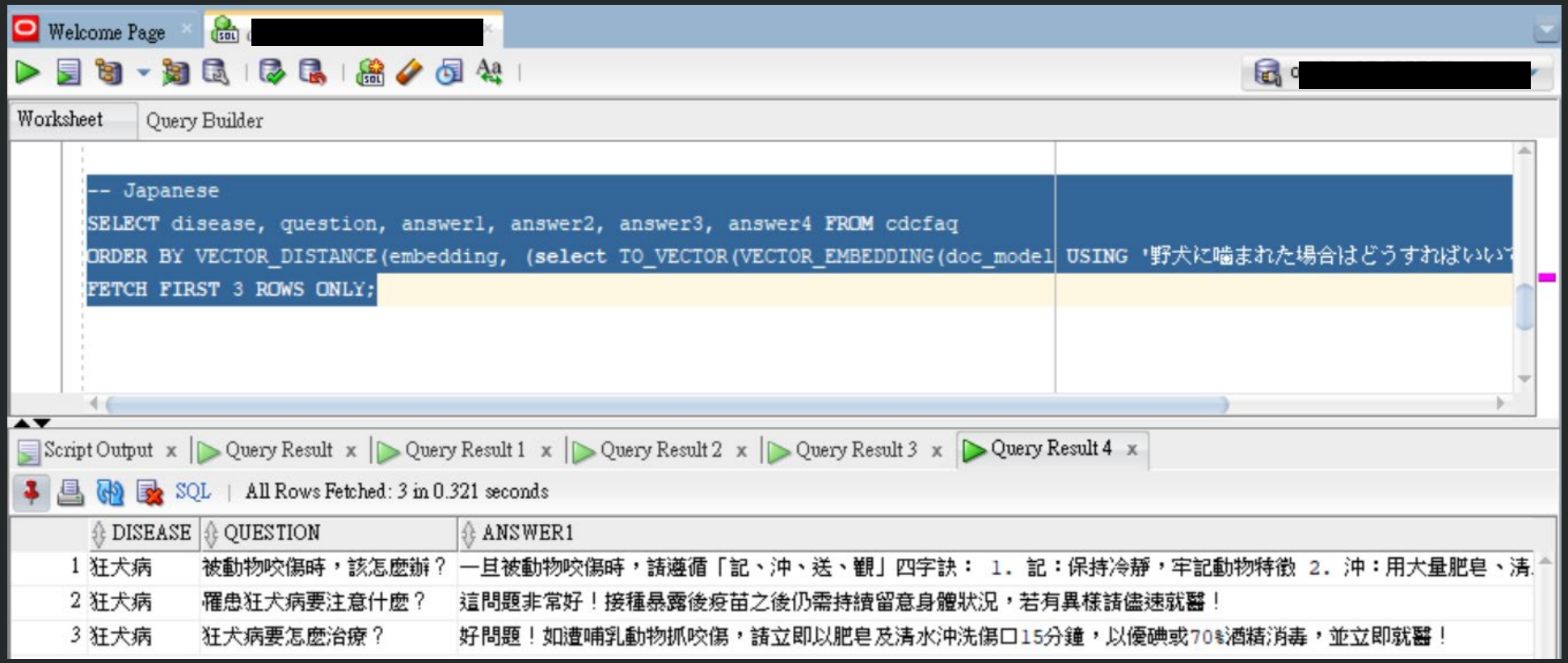
應用探討：疾病管制署傳染病問答集

實際運作範例 - 多語系 (日文)

```
-- Japanese
SELECT disease, question, answer1, answer2, answer3, answer4 FROM cdcfaq
ORDER BY VECTOR_DISTANCE(embedding, (select TO_VECTOR(VECTOR_EMBEDDING(doc_model USING '野犬に噛まれた場合はどうすればいいですか？'as data))), COSINE)
FETCH FIRST 3 ROWS ONLY;
```



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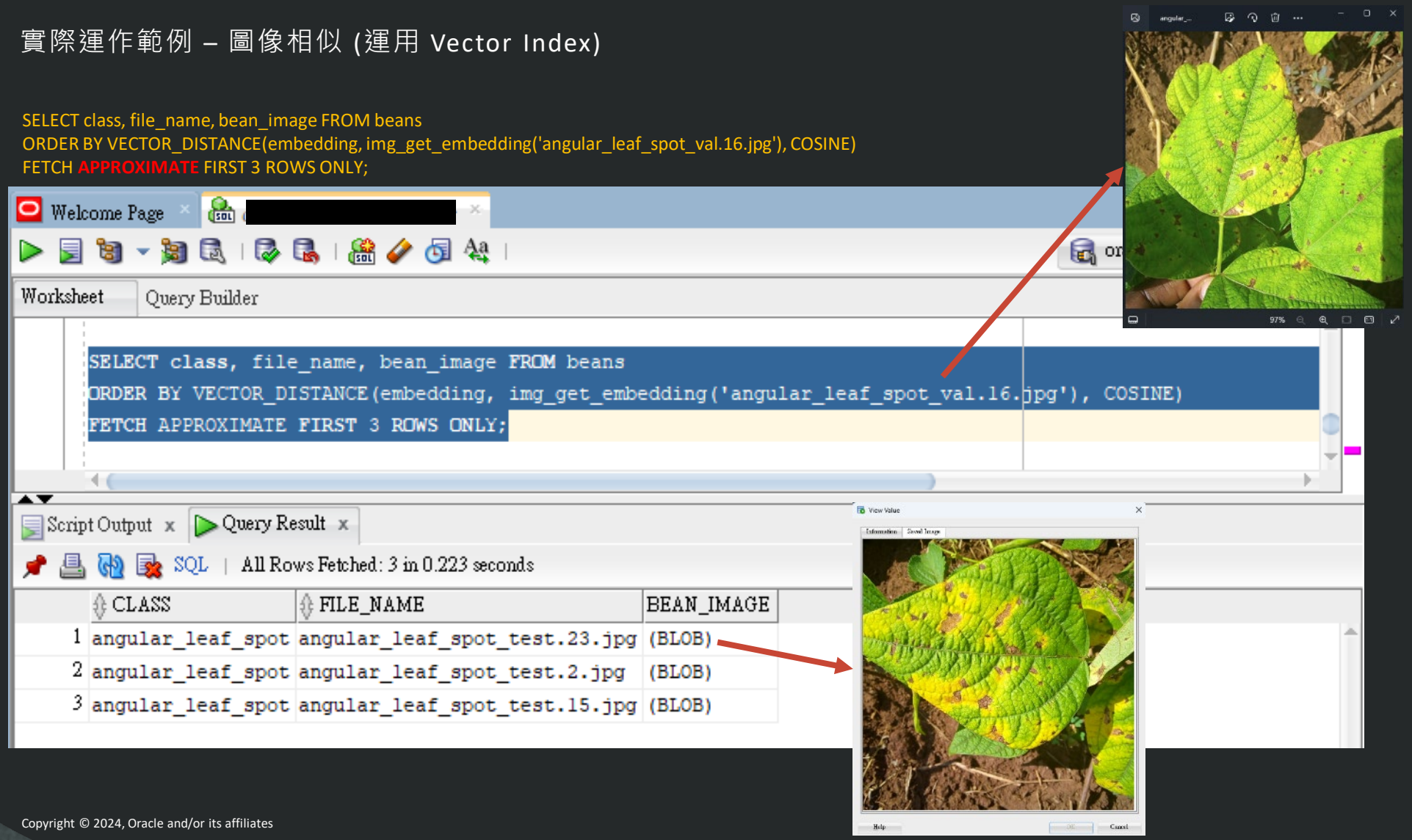
應用探討：豆類葉片損傷分類 (資料來源：https://huggingface.co/datasets/beans)

實際運作範例 – 圖像相似 (運用 Vector Index)

```
SELECT class, file_name, bean_image FROM beans
ORDER BY VECTOR_DISTANCE(embedding, img_get_embedding('angular_leaf_spot_val.16.jpg'), COSINE)
FETCH APPROXIMATE FIRST 3 ROWS ONLY;
```



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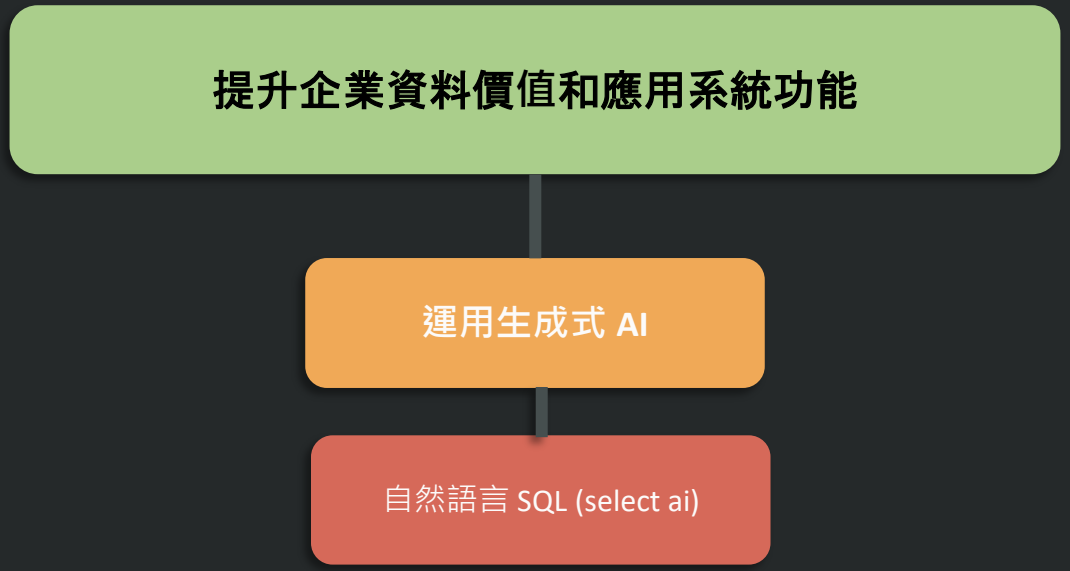
Oracle Database 23ai



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開發人員運用生成式 AI 可以使用自然語言來產生 SQL 查詢指令

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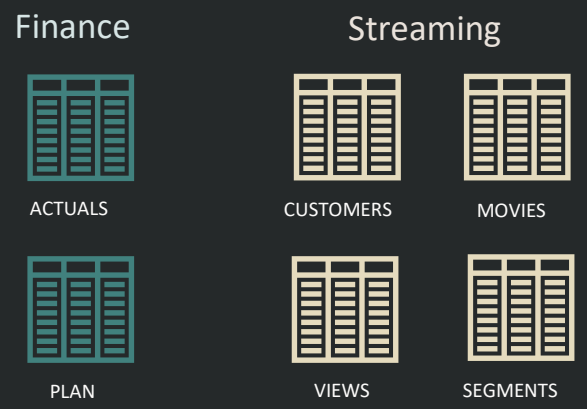
設定資料來進行自然語言查詢是很容易的

依據實際業務需求設定一個或數個 Select AI Profile

1 選擇 LLM 來支援自然語言產生資料庫查詢指令

- OCI Generative AI
- OpenAI
- Cohere
- Azure OpenAI

2 指定處理程序相關的 schema、table 及/或 view



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設定資料來進行自然語言查詢是很容易的

依據實際業務需求設定一個或數個 Select AI Profiles

1. 選擇 LLM 來支援自然語言產生資料庫查詢指令

2. 指定處理程序相關的 schema、table 及/或 view

簡單的 PLSQL API 產生 AI profile:

```
dbms_cloud_ai.create_profile(
 profile_name => 'GenAI_nl_processing',
 attributes =>
   '{ "provider“ : "oci",
     "credential_name" : "GENAI_CRED",
     "object_list": [
        {"owner" : "GENAI" , "name" :  "dept"},
        {"owner" : "GENAI" , "name" :  "emp"},
        {"owner" : "GENAI" , "name" :  "bonus"},
        {"owner" : "GENAI" , "name" :  "salgrade" }],
     "comments" : true
   }'
);
```


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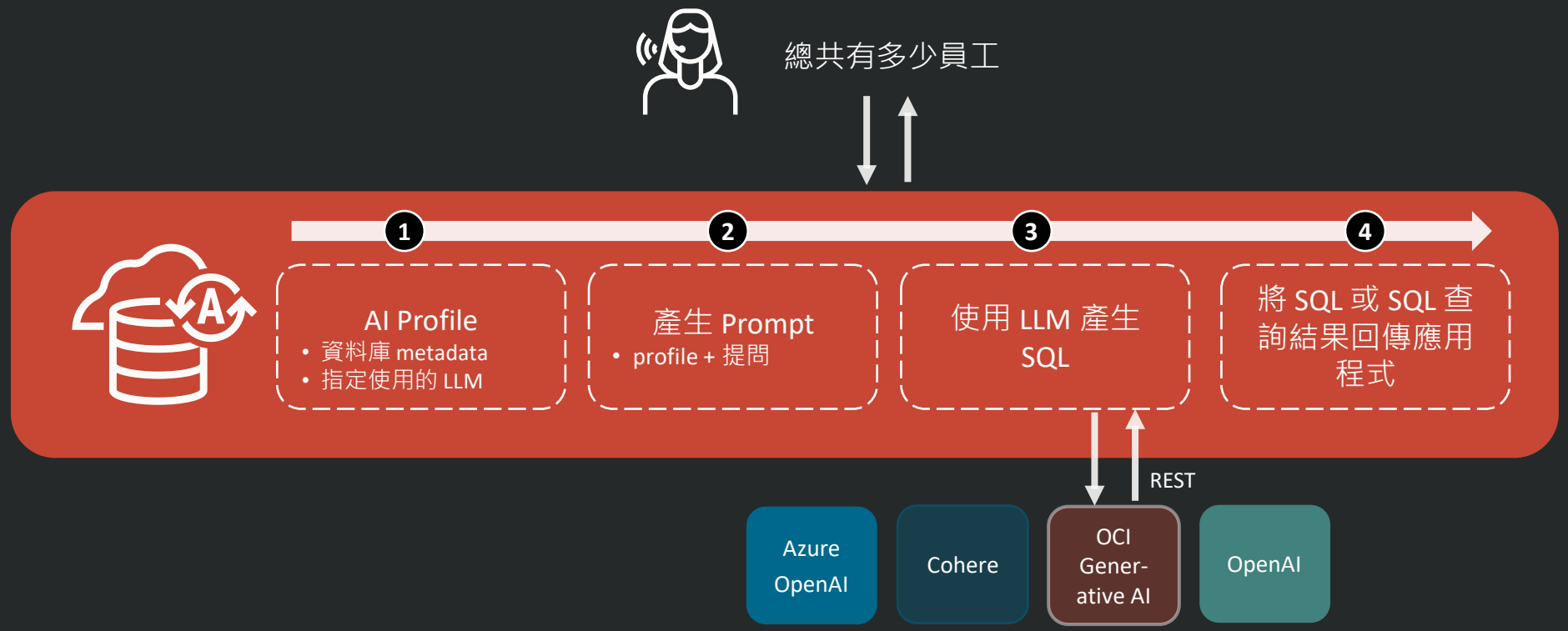
SQL 查詢指令產生的處理流程



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Demo

Oracle Autonomous Database 自然語言 SQL (select ai)

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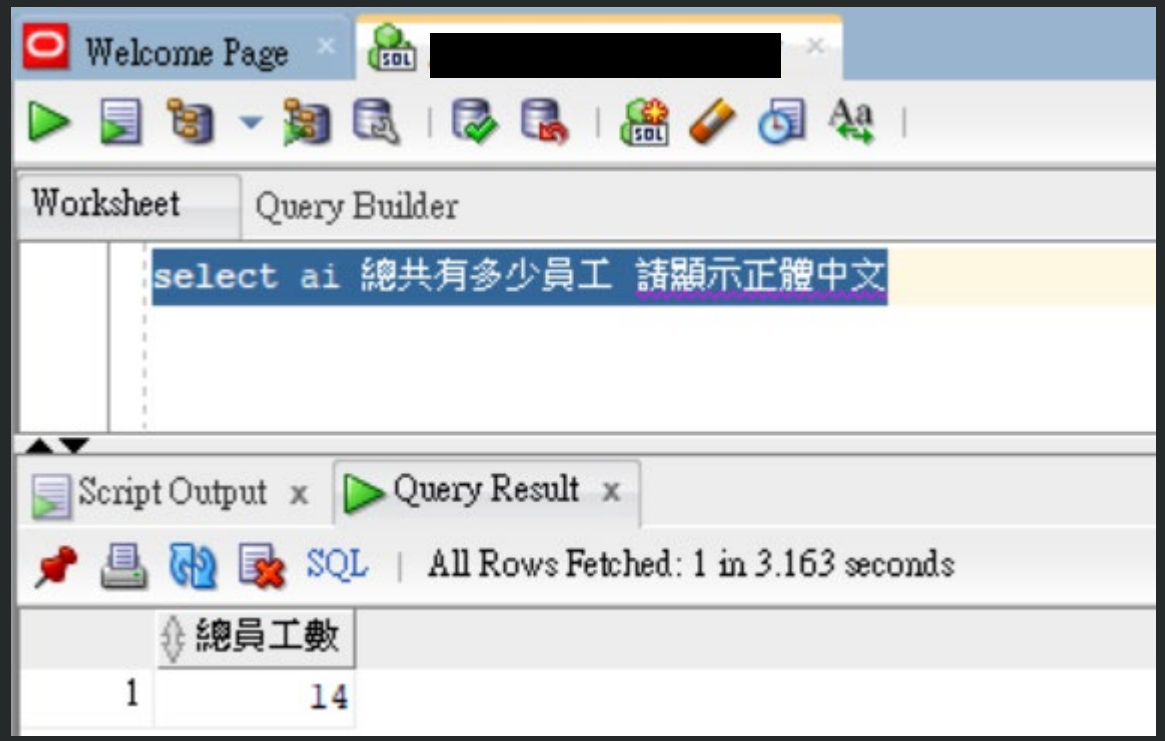
Oracle Autonomous Database 自然語言 SQL

實際運作範例

```
-- EXECUTE (default)
select ai 總共有多少員工 請顯示正體中文
```



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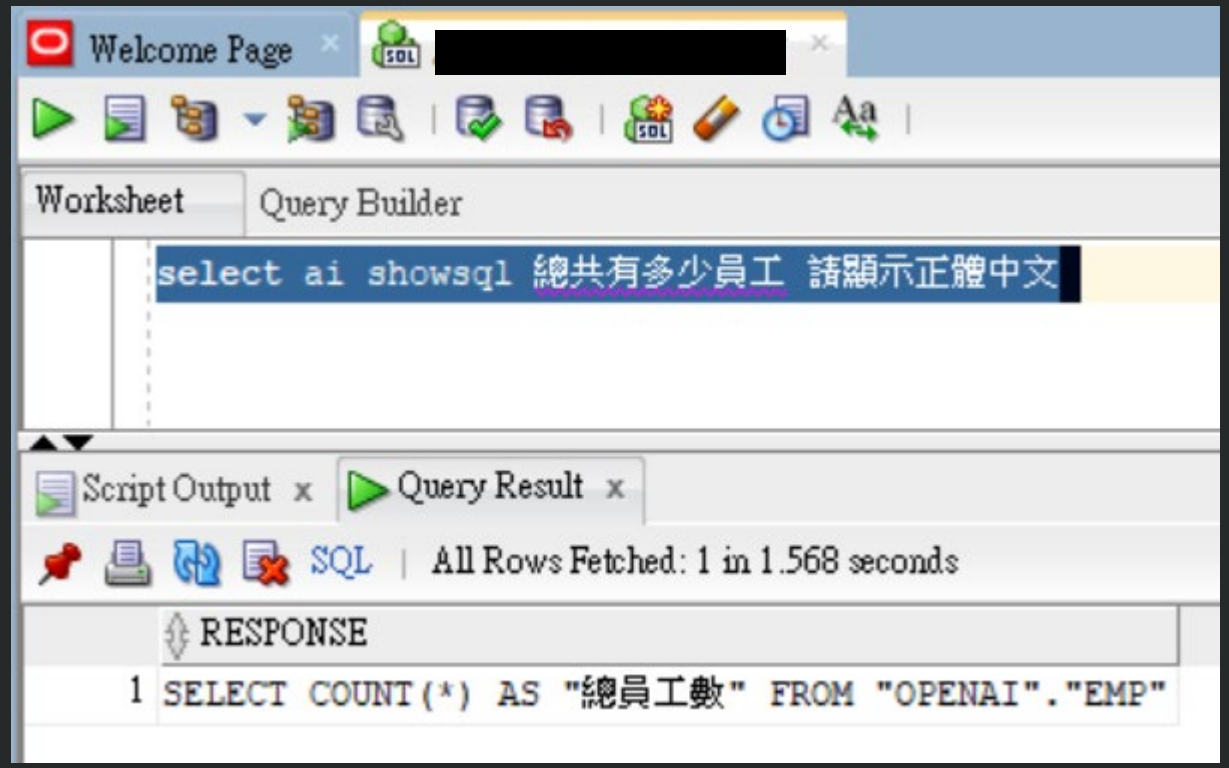
Oracle Autonomous Database 自然語言 SQL

實際運作範例

```
-- SHOWSQL
select ai showsql 總共有多少員工 請顯示正體中文
```



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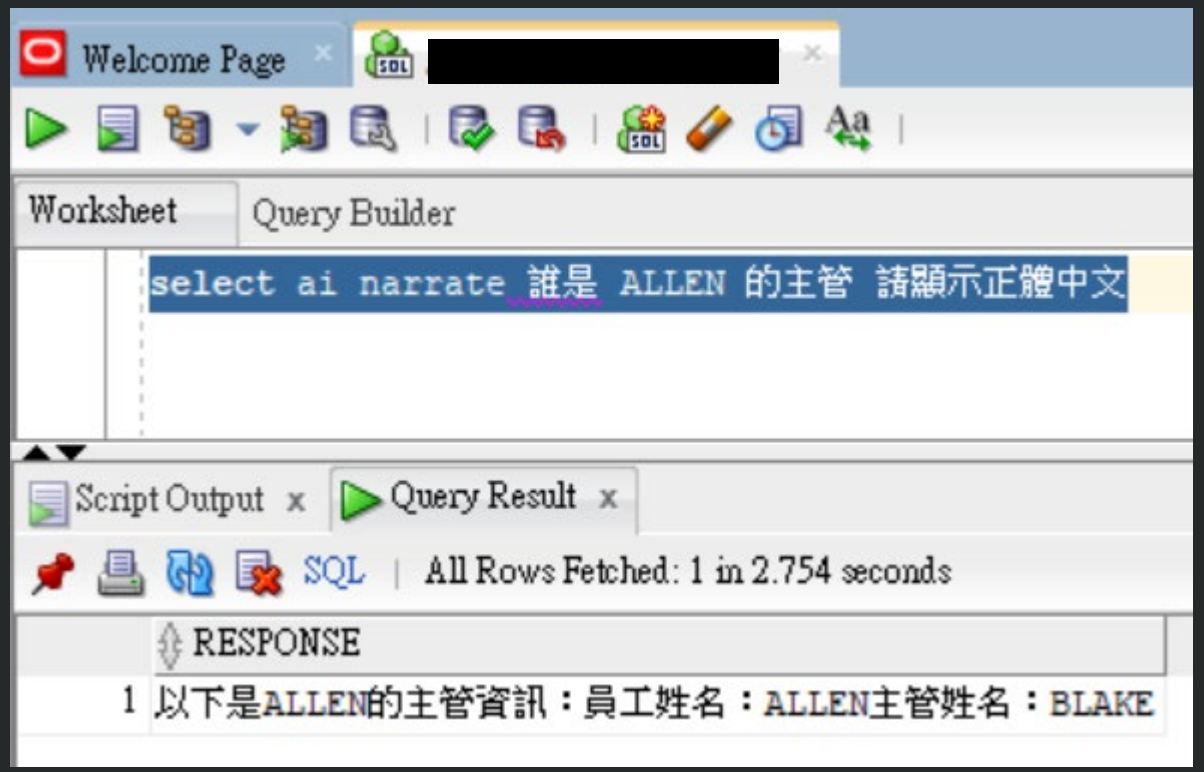
Oracle Autonomous Database 自然語言 SQL

實際運作範例

```
-- NARRATE
select ai narrate 誰是 ALLEN 的主管 請顯示正體中文
```



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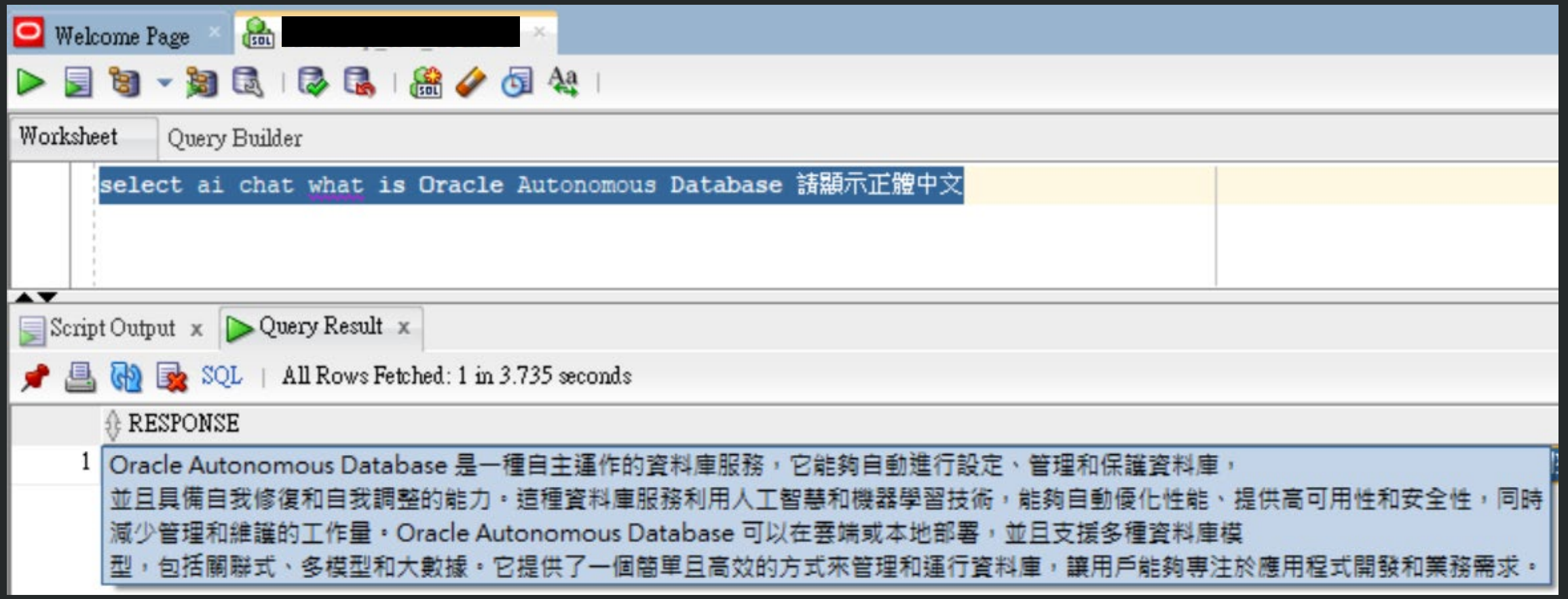
Oracle Autonomous Database 自然語言 SQL

實際運作範例

-- CHAT
select ai chat what is Oracle Autonomous Database 請顯示正體中文



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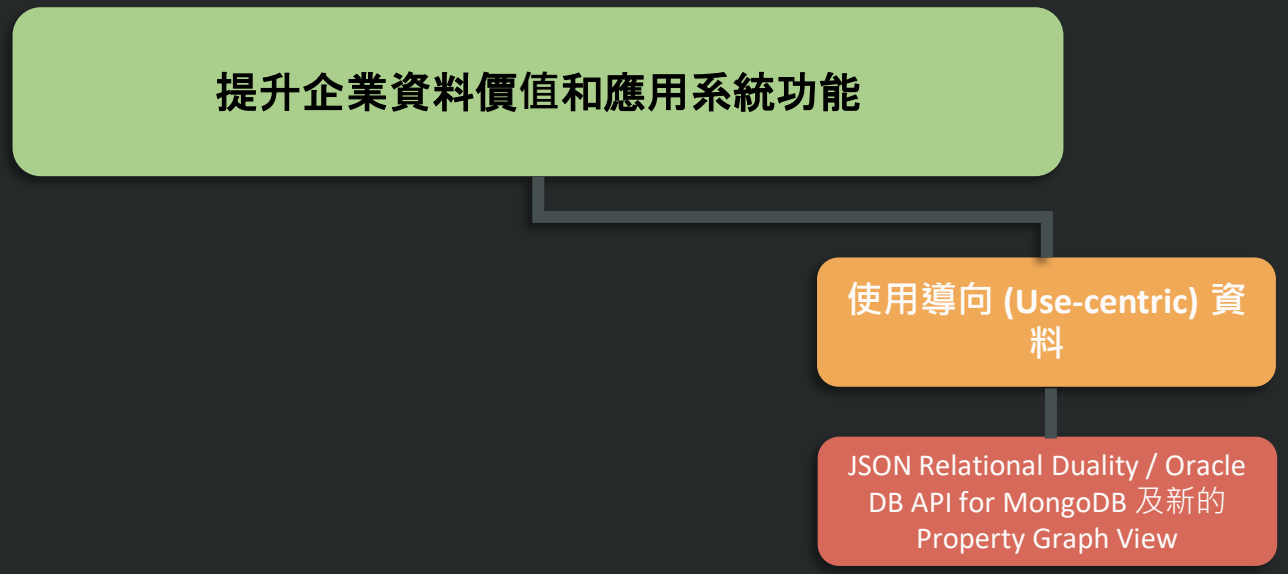
Oracle Database 23ai



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理念上，我們都想要 JSON 的所有好處加上關連式資料的所有好處

關聯式

- Use Case Flexibility
- Queryability
- Consistency
- Space Efficiency

加

JSON

- Easy mapping to language types
- Agile schema-less development
- Hierarchical data format
- Standard interchange format

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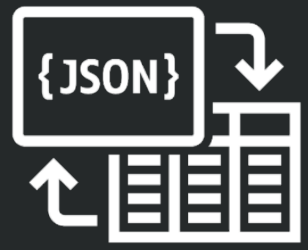
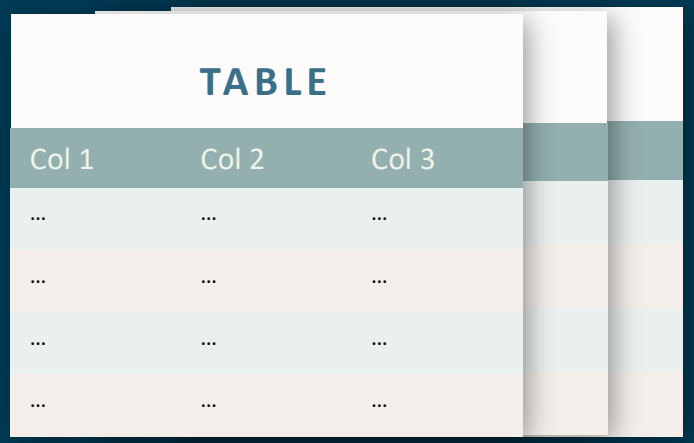
JSON Document Relational Duality



資料以 **row 儲存**在 table 來提供關聯式及 SQL 存取的好處

Rows can include JSON columns to store data whose schema is dynamic or evolving

儲存格式



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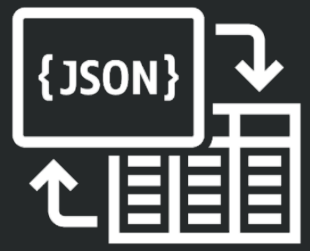
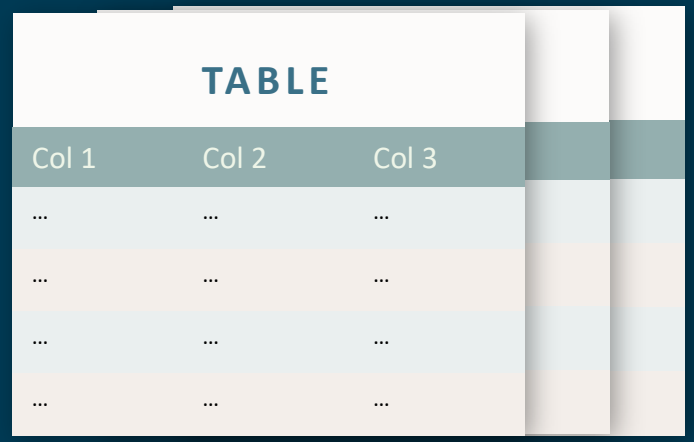
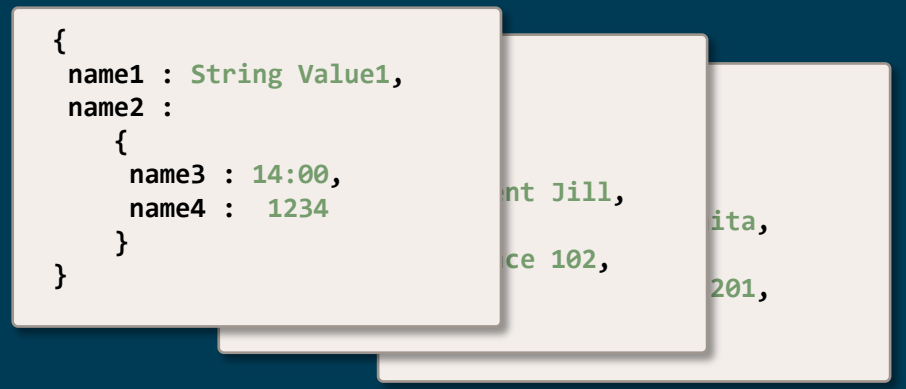
JSON Document Relational Duality



結構化資料**可以 JSON 文件格式讀寫**，
讓應用程式的文件處理變得簡易

儲存格式





GET/PUT Doc

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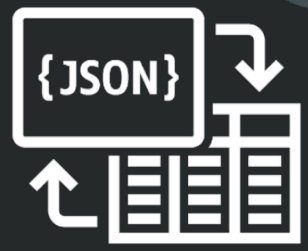
定義一個 JSON Relational Duality View



JSON Duality Views declare the recipe for assembling normalized rows into a JSON document

```
CREATE JSON DUALITY VIEW student_schedule
AS student
{
   name       : sname
   student_id : stuid
   schedule   : student_courses
   {
      course
      {
         time
         course    : cname
         course_id : cid
         room
         teacher @unnest
         {
            teacher : tname
         }
      }
   }
};
```

The structure of the view mirrors the structure of the desired JSON object

STUDENT SCHEDULE FOR: JILL

```
{
 name:       Jill,
 student_id: S3245,
 schedule:
 [  {
        time:    14:00,
        course:  Math 101,
        room:    A102,
        teacher: Adam
    },
    …
 ]
}
```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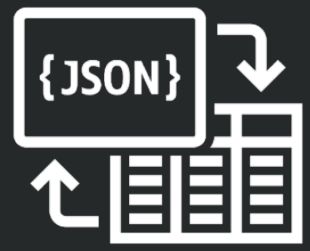
開發人員享有非常簡易的方便性

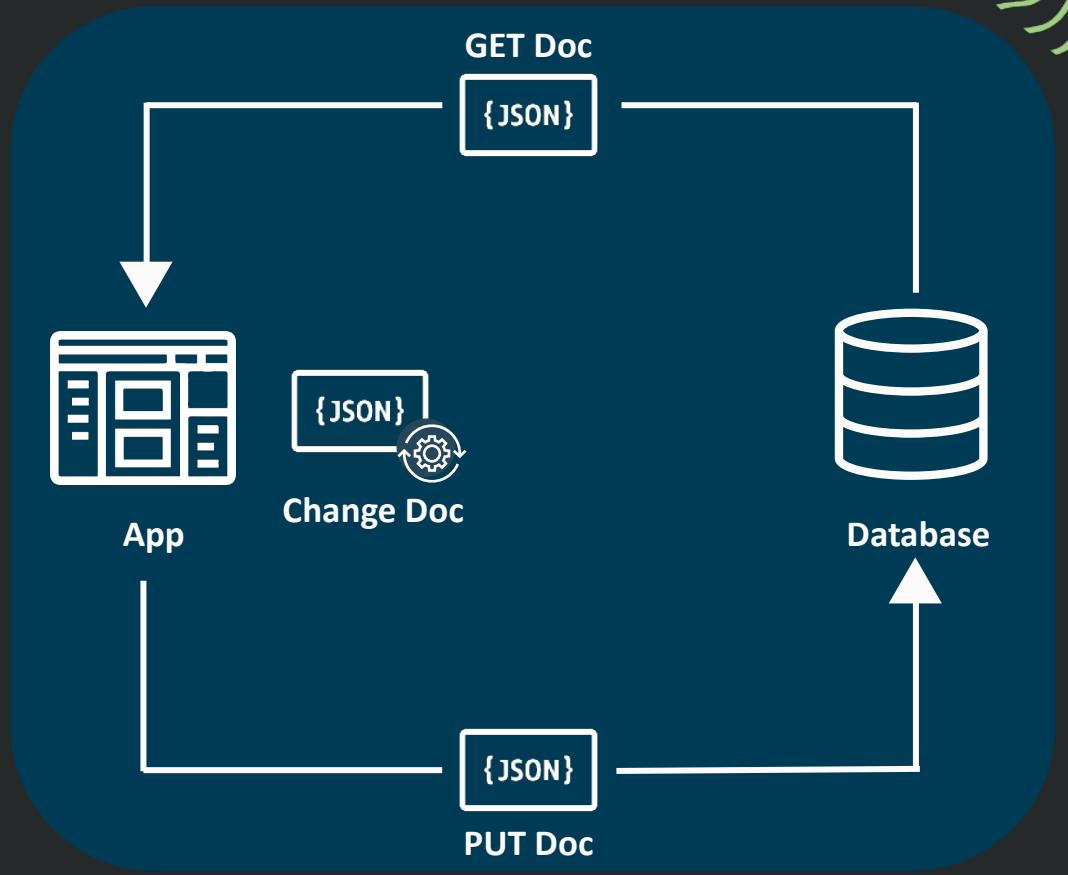


JSON Duality Views 透過 REST 很容易存取:

- 從 View GET 一個文件
- 對文件做需要的更改
- PUT 文件回到 View

資料庫自動偵測新文件的更動並更新相關的 table 欄位

- 所有共享相同資料的 duality views 立刻反應這個更新
- 不產生資料複製，也就不會產生資料不一致的問題
- 實際資料需符合資料庫的資料格式 – 實現 JSON schema




```
GET school.edu/student_schedule?q={student:Jill}
```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去除 JSON 與關聯式資料世界的鴻溝

一種資料兩種面向

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"With Oracle Database 23c Free—Developer Release, developers get early access to new app dev features highlighted by **JSON Relational Duality, This release finally gives developers an opportunity to try out a feature that unifies and synchronizes the documents and relational worlds. It enables developers and data engineers to access formats for each use case without worrying about data structure, data mapping, data consistency or performance tuning.** They can now also run graph analytics on top of both relational and JSON data. Oracle's JSON Relational Duality, a truly revolutionary solution, is perhaps one of the most important innovations in information science in 20 years."

Carl Olofson

Research Vice President, Data Management Software

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Oracle API for MongoDB

連接 MongoDB 用戶端驅動及工具至 Oracle 資料庫

MongoDB 開發人員繼續使用相同的技術、工具及 framework

易於遷移 MongoDB 至 Oracle 資料庫

MongoDB 不具備 tables 而是儲存 JSON 文件的 collection

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MongoDB API for Oracle Database

在 Oracle 資料庫執行 MongoDB workload

MongoDB API 於以下環境支援

Oracle Autonomous Database, 整合至管理服務

Oracle Database 21^{c}/23^{ai} 透過使用者管理的 Oracle REST Data Services (ORDS)

無縫進行開發及移轉 MongoDB 應用程式

MongoDB 開發人員繼續使用相同的技術、工具及 framework

- MongoDB 的 collection 由 Oracle 資料庫 table 的 JSON 文件 table 通透支持

結合 SQL 及 Oracle 資料庫與 JSON collection 成為一個整合的體系

- 可以同時查詢 JSON 與其他資料型態，例如：關聯式資料、XML、spatial…
- 可使用 Oracle 資料庫強大的分析能力及機器學習功能
- 也可以將關聯式資料、報表、查詢解果展現為 MongoDB 的 collection

讓 MongoDB 可以連接任何企業級資料庫應用程式

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MongoDB API for Oracle Database

相容程度

一般應用程式無需或只需極小部分的改動原始碼

將 MongoDB connection 改成 Oracle 資料庫的 connection

透過 Oracle 資料庫對 transaction 的支援，MongoDB 應用程式也具備 transaction 確保能力

Limitations for applications:

MongoDB API 使用 Oracle 資料庫的 authentication 及 authorization

- 運用 Oracle 資料庫的企業級資安機制支援 MongoDB collection
- 整合所有資料庫應用程式的使用者管理

Indexes 必須透過 SQL 產生 (21^c)

- db.createIndex() from MongoAPI does not create an index

```
SQL> create index lastidx on
     employee (json_value(data, '$.job'  error on error));
```

- **Addressed in Oracle Database 23^{ai}**

Aggregation pipeline 尚未支援 (21^c)

- **Addressed in Oracle Database 23^{ai}**

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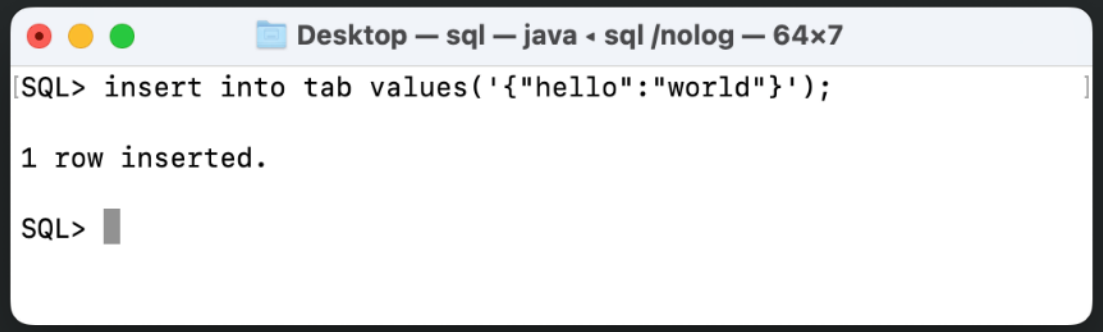
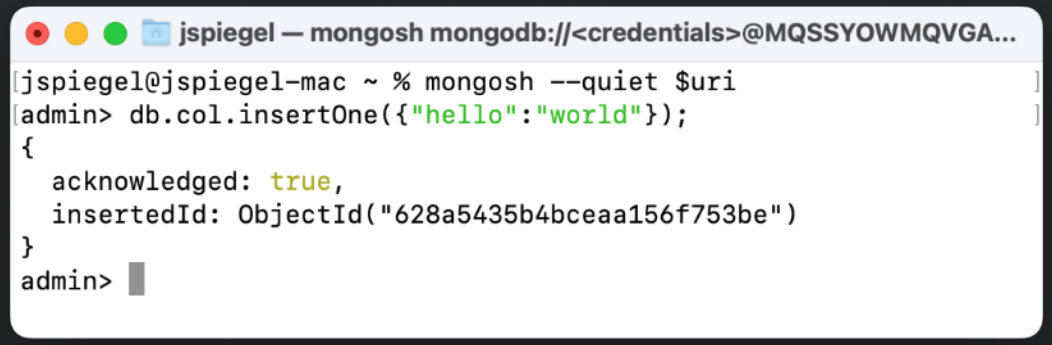
MongoDB API for Oracle Database

JSON 資料庫連接

Option 1
使用 Oracle 用戶端及工具
JDBC, node-oracledb, sqlcl, etc.



Option 2
使用 Mongo 用戶端及工具
mongo-java-driver, node-mongodb, mongosh, etc.



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MongoDB API for Oracle Database

MongoDB API

database credentials

mongodb://**admin:MyPassword**@

hostname identifies database

g0a51db2590de87-demo.adb-dev.eu-frankfurt-1.oraclecloudapps.com:27017/

Mongo database ==
Oracle schema

TLS/SSL required

admin?**authMechanism=PLAIN**&**authSource=$external**&**ssl=true**&...

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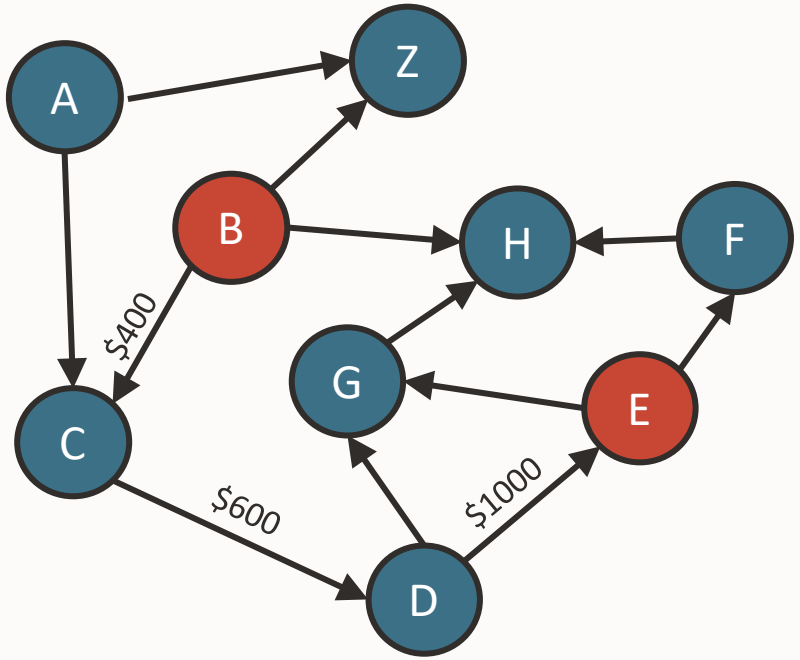
New Property Graph Views in Oracle Database 23ai

declare intent to treat data as vertices or edges in a graph

For example, to discover indirect money movements from bank account 'B' to bank account 'E'



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Defining a property graph view is simple

Just declare the tables whose rows represent vertices or edges in the graph

```
CREATE PROPERTY GRAPH bank_graph
       VERTEX TABLES (
         bank_accounts as accounts
         PROPERTIES (id, balance))
       EDGE TABLES  (
         bank_transfers
         SOURCE KEY      (from_acc) REFERENCES ACCOUNTS(ID)
         DESTINATION KEY (to_acc)   REFERENCES ACCOUNTS(ID)
         PROPERTIES (amount, to_acc))
;
```

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Querying the view is simple

This query finds money flows from account ‘B’ to account ‘E’

```
SELECT graph.path
FROM   GRAPH_TABLE (
       bank_graph
        MATCH (v1)-[e is BANK_TRANSFERS]->{1,3} (v2)
         WHERE  v1.id = 'B'
         AND    v2.id = 'E'
        COLUMNS LISTAGG(e.to_acc, ',') AS path)
       ) graph
;
```

The database understands the intent and generates the code to get it by walking the graph

Writing the same query using relational SQL requires 12 joins and 3 unions

New SQL standard for property graphs

SQL:2023 includes SQL syntax for property graphs (defined by the ISO standard ISO/IEC 9075-16). Oracle Database 23^{ai} implements this new syntax so that graph operations can be executed using SQL. Before Oracle Database 23^{ai} , graph operations were enabled by the Property Graph Query Language (PGQL). Along with PGQL, Oracle Database 23^{ai} supports the new SQL syntax for property graphs.

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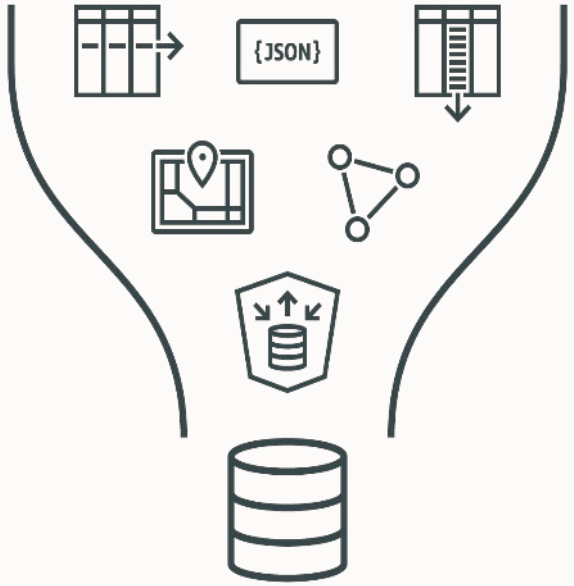
Oracle Converged Database

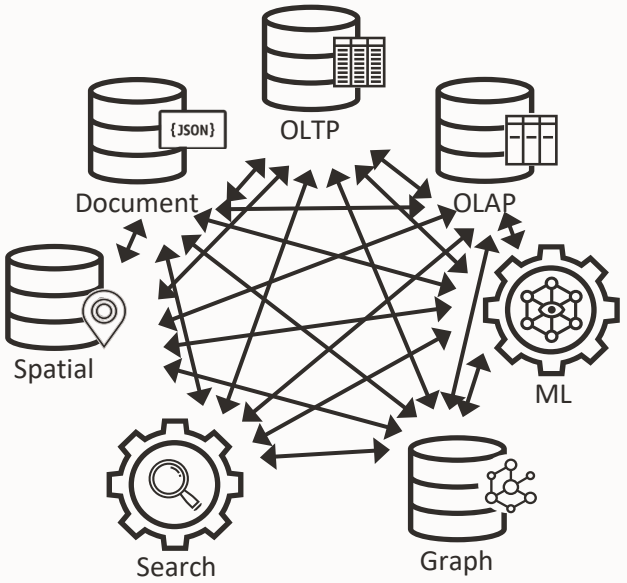
With Oracle Database 23[ai], one part of an app can treat the data as relational, while other parts treat the same data as a document, and others treat it as a graph.

Converged Database Architecture



for **any** data type or workload

Single-purpose databases



for each data type and workload

Multiple security models, languages, skills, licenses, etc

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總結

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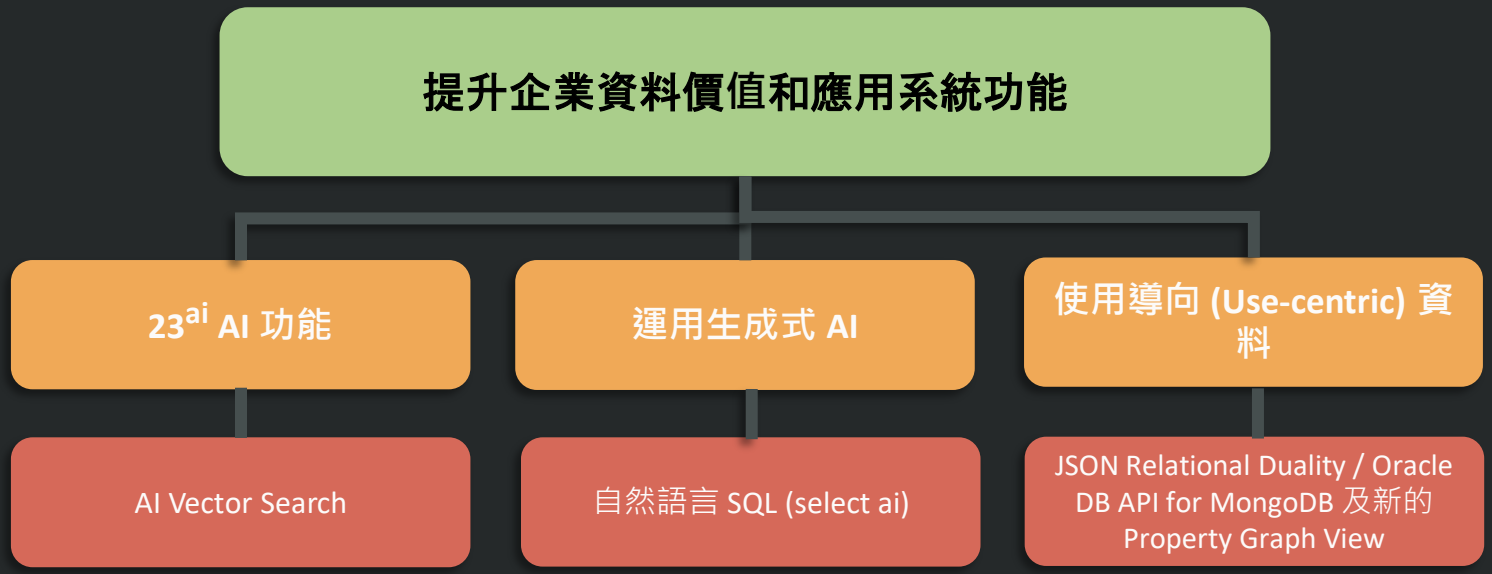
Oracle Database 23ai



可以讓查詢結合 AI Vector 搜尋有關客戶及產品的商務資料

- 結合客戶資料、產品資訊和 AI 搜尋都可以使用簡單的 SQL。
- 單獨整合的解決方案，所有資料都是全面維持一致性。
- 嶄新的 AI Vector Search 活化既有的結構化資料，企業的資料搜尋及分析能力可以大幅提升！

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Oracle Database 23ai

開發人員運用生成式 AI 可以使用自然語言來產生 SQL 查詢語句

- 適用於 Oracle Autonomous Database
- 目前支援的生成式 AI 為 Oracle Cloud Infrastructure GenAI、Azure OpenAI、OpenAI 及 Cohere
- 開發人員可以不需要非常熟悉 SQL；可內嵌至使用自然語言的應用系統來查詢資料庫

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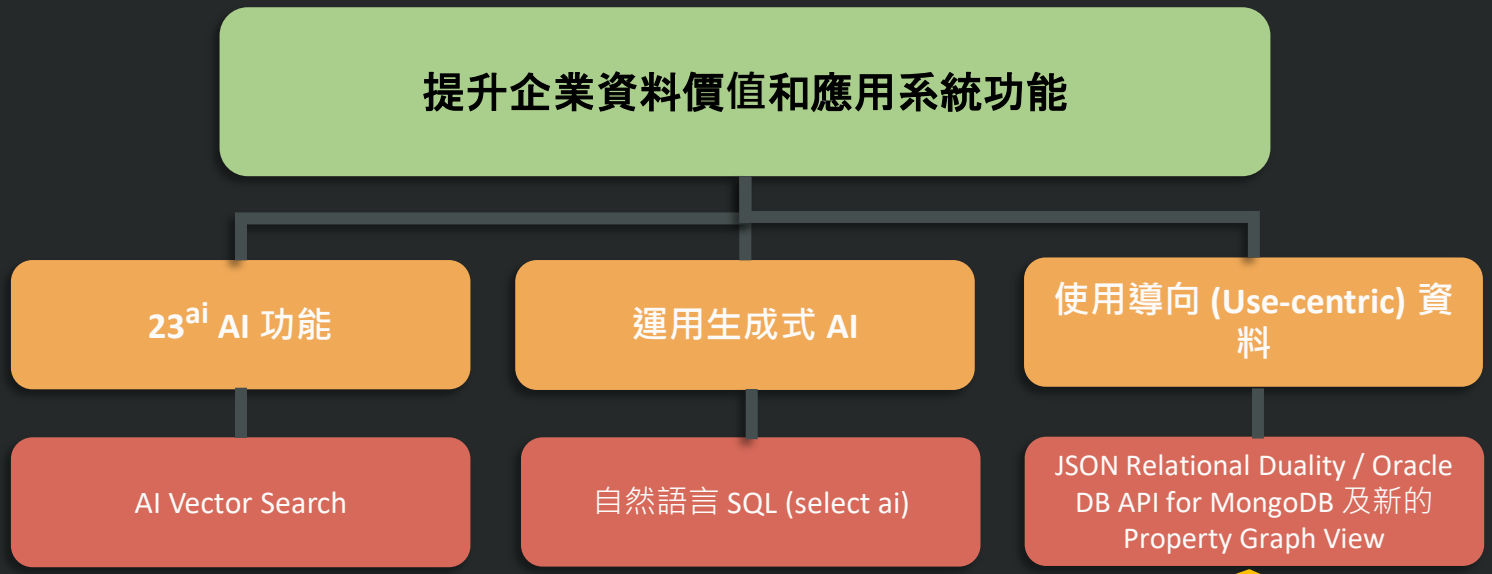
Oracle Database 23ai



讓開發人員宣告使用的資料意涵而不是儲存的格式

- Oracle Database 23ai 的 JSON Relational Duality 可以讓資料以最有效率的結構化存在資料庫，此單一的資料透過宣告方式，無須複製資料 (也就沒有資料破碎或不一致的問題) 即可同時透過 SQL 或 JSON 文件處理來分析或更新資料。
- 搭配 Oracle Database API for MongoDB，既有基於 MongoDB 開發的 JSON 處理應用程式，有機會無縫移轉至 Oracle Database 23ai。
- 新的 Property Graph Views 大幅簡化 Graph 的應用程式開發。

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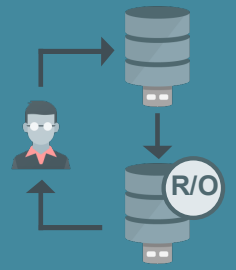
Oracle Database 23ai – The Next Long Term Support Release

Data Use Case Domains

Boolean Datatype

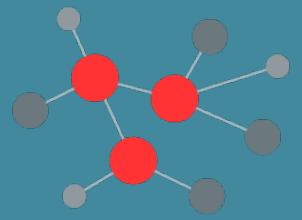
Oracle Database 23ai

Bring AI to your data



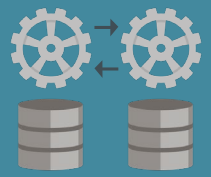
Readable PDB Standby

Property Graphs



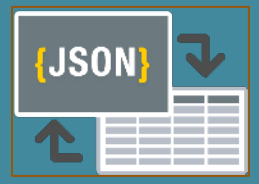
Real-time SQL Plan Management

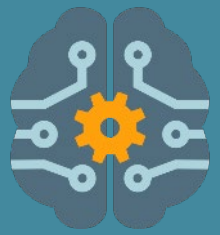
JSON Schema



Microservice Sagas

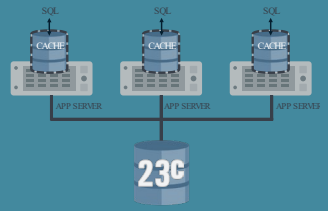
JSON / Relational Duality





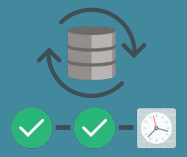
AI Vector Search

True Cache



SQL Firewall

Priority Transactions



Rolling Patching

JS Stored Procedures

Developer Role

Shrink Tablespace

Schema Privileges

Globally Distributed Database

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Oracle Database 23^{ai} is available TODAY

In the Oracle Public Cloud

On-Premises via Oracle Database Free

Coming Soon Everywhere

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Projected Database Release and Support Timeline

- Innovation Release - 2 years of Premier Support, and no Extended Support
- Long Term Release - 5 years of Premier Support, and 3 years of Extended Support
- Always refer to MOS Note: Release Schedule of Current Database Releases (Doc ID 742060.1)

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提問與討論？