Retrieval to Reasoning: RAG & AI Agents on Azure Databricks

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AGENDA

Retrieval to Reasoning: RAG & AI Agents on Azure Databricks
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02 | Context Aware RAG on Azure databricks
03 | Agentic RAG
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Who Am I ….

Professional

- Software Designer in HP
- 12+ years IT experience
- AWS Solutions Architect
- Data Engineer

  &
- AI Enthusiast

Personal

- Punnagai Foundation
- Certified Yoga Trainer
- Blogs

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Who Am I ….

Professional

- Senior Software Engineer at ATMECSAI
- AI researcher & developer
- Embedded and Cloud based full stack AI development

Personal

- Badminton Player
- Mandala Artist

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Evolution – From Retrieval to Reasoning

Evolution – From Retrieval to Reasoning

What are LLMs?

- Large Language Models (e.g., GPT-4, BERT) are deep learning models trained on vast amounts of text data.
- They generate human-like text based on input queries or prompts.

Key Characteristics of LLMs:

- Powerful in understanding and generating text.
- Context-dependent: rely on pre-trained knowledge, limited to training data.

Limitations:

- Static, unable to access real-time or updated information.
- Responses are limited to what the model has learned during training.

What is Retrieval-Augmented Generation (RAG)

RAG: A Hybrid AI Model

- Combines the power of LLMs with real-time information retrieval.

Two Components:

- **Retrieval**: Dynamically fetches relevant data from external sources (e.g., databases, APIs).
- **Generation**: LLM refines and generates context-aware responses using the retrieved data.

Why RAG Matters?

Limitations of Traditional LLMs

- Static and limited knowledge
- Prone to hallucinations (inaccurate responses)
- Lacks real-time context awareness

How RAG Enhances LLMs

- Integrates external and real-time data
- Reduces hallucinations by grounding responses in facts
- Delivers accurate, up-to-date insights
- Improves relevance and precision by incorporating context-specific knowledge

Enhancing LLMs with Context-Aware Data

Static LLMs vs. Dynamic Knowledge

- LLMs alone are limited by the data they were trained on, lacking the ability to adapt to real-world, real-time situations.

Benefits of RAG:

- **Accuracy**: By retrieving relevant information from up-to-date sources, RAG ensures responses are grounded in reality.
- **Context-Awareness**: Improves understanding of context and generates more precise and relevant responses.
- **Adaptability**: Handles a wide range of topics with ease by accessing external knowledge on demand.

Context-Aware RAG on Azure Databricks

Key Components:

- **Retriever:** Searches knowledge bases (Vector DBs, SQL, Delta Lake)
- **Generator (LLM):** Uses retrieved data for contextual responses
- **Feedback Loop:** Ensures accuracy & relevanceState Machine

Data Sources: Azure Blob, Delta Lake, SQL

Vector DBs: Weaviate, FAISS, ChromaDB

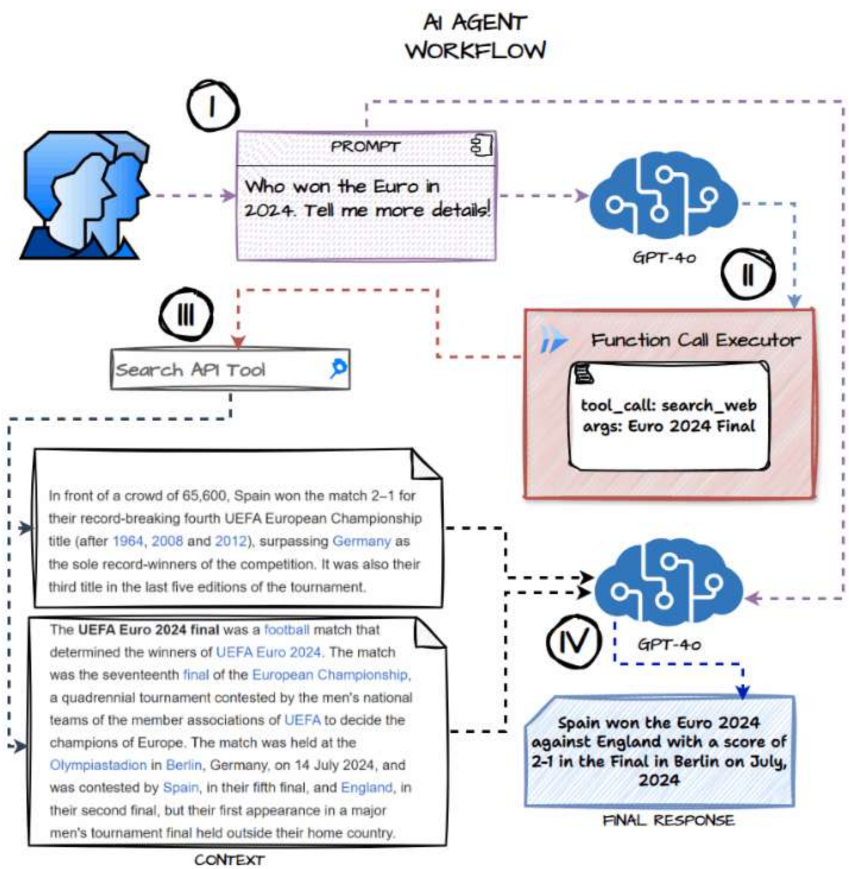
LLMs: OpenAI, MosaicML, Azure OpenAI

Databricks Runtime: Spark, MLFlow, AI Agents

AGENTIC RAG

Agentic RAG: AI That Thinks and Acts

- **LLMs + Reasoning + Automation** → More than just text generation
- **Context-aware AI agents** that retrieve, analyze, and take action
- Refine responses with contextual reasoning
- Automate decision-making workflows



Source: Dipanjan Sarkar

Types Of AI Agent

Name of the agent	Key Characteristics	Examples	Best For
Fixed Automation: The Digital Assembly Line	No intelligence, predictable behavior, limited scope	RPA, email autoresponders, basic scripts	Repetitive tasks, structured data, no need for adaptability
LLM-Enhanced: Smarter, but Not Einstein	Context-aware, rule-constrained, stateless	Email filters, content moderation, support ticket routing	Flexible tasks, high-volume/low-stakes, cost-sensitive scenarios
ReAct: Reasoning Meets Action	Multi-step workflows, dynamic planning, basic problem-solving	Travel planners, AI dungeon masters, project planning tools	Strategic planning, multi-stage queries, dynamic adjustments
ReAct + RAG: Grounded Intelligence	External knowledge access, low hallucinations, real-time data	Legal research tools, medical assistants, technical support	High-stakes decisions, domain-specific tasks, real-time knowledge needs
Tool-Enhanced: The Multi-Taskers	Multi-tool integration, dynamic execution, high automation	Code generation tools, data analysis bots	Complex workflows requiring multiple tools and APIs
Self-Reflecting: The Philosophers	Meta-cognition, explainability, self-improvement	Self-evaluating systems, QA agents	Tasks requiring accountability and improvement

ReAct RAG –Reasoning +Action+ knowledge

Feature	Description
Intelligence	Employs a RAG workflow, combining LLMs with external knowledge sources (databases, APIs, documentation) for enhanced context and accuracy.
Behavior	Uses ReAct-style reasoning to break down tasks, dynamically retrieving information as needed. Grounded in real-time or domain-specific knowledge.
Scope	Designed for scenarios requiring high accuracy and relevance, minimizing hallucinations.
Best Use Cases	High-stakes decision-making, domain-specific applications, tasks with dynamic knowledge needs (e.g., real-time updates).
Examples	Legal research tools, medical assistants referencing clinical studies, technical troubleshooting agents.

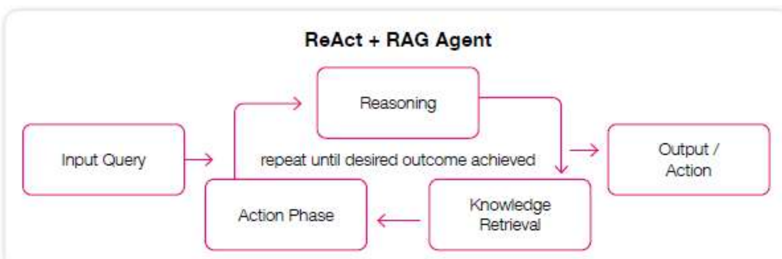
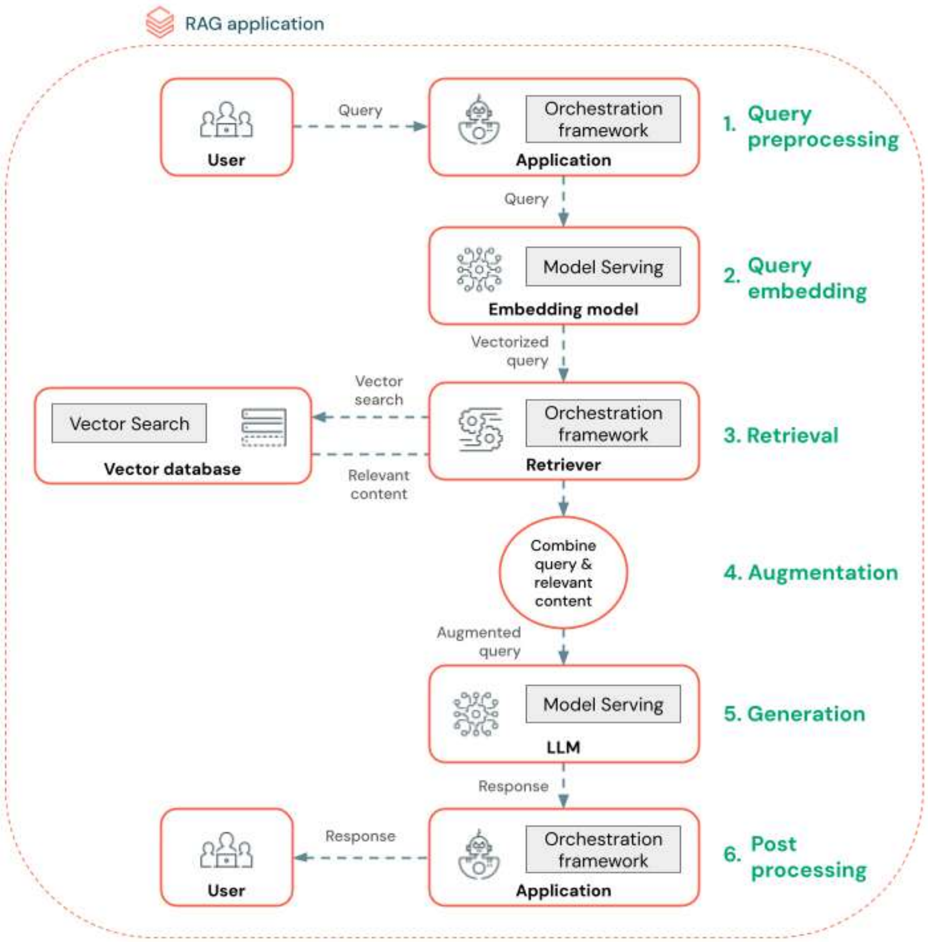


Fig 1.5: Workflow of a ReAct + RAG agent

Source:https://www.galileo.ai/ebook-mastering-agents

AI Agents & RAG – Working Together



Source:https://www.galileo.ai/ebook-mastering-agents

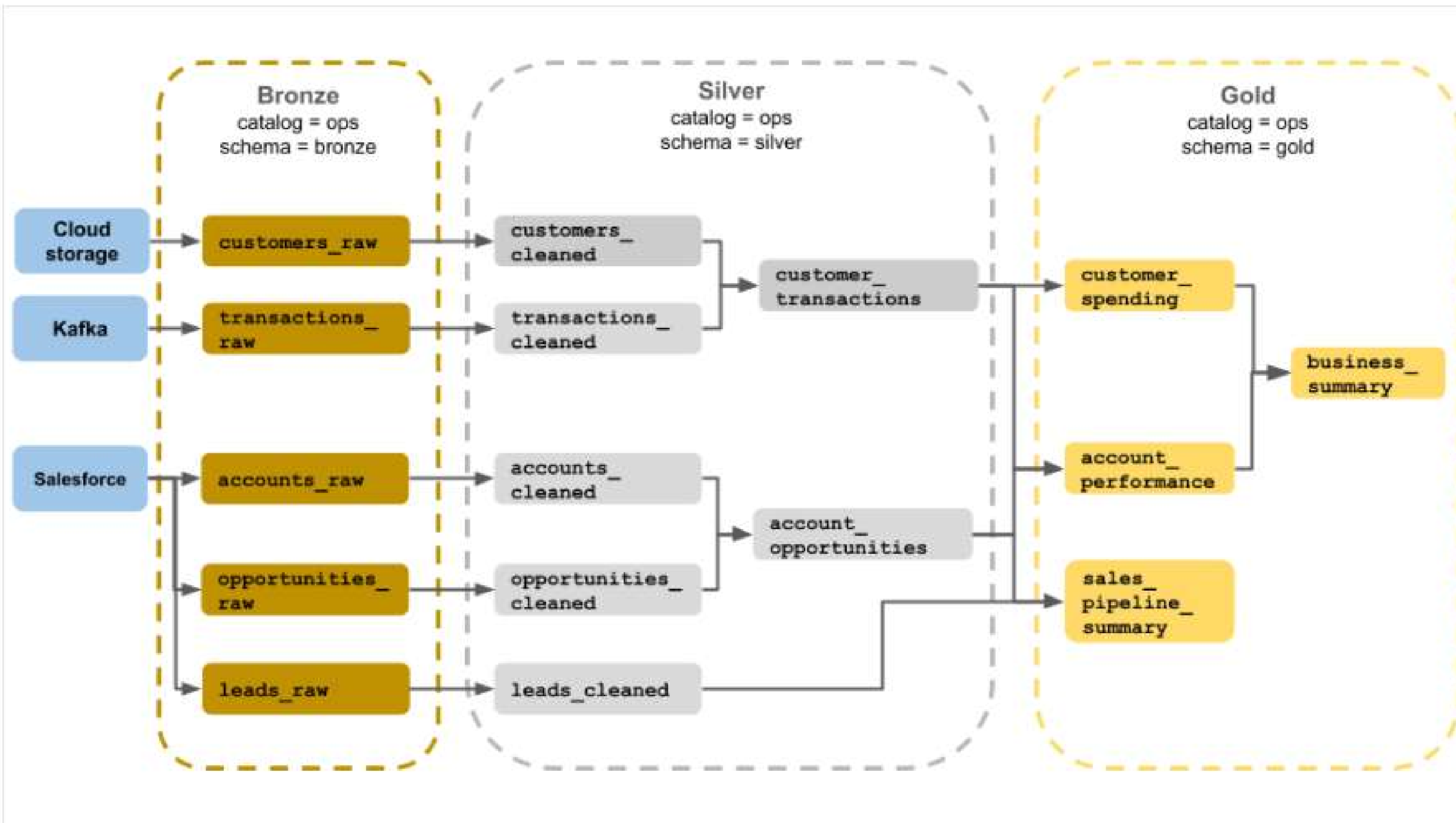
1. **Query Preprocessing** – The user query is formatted, templated, or keyword-extracted for vector search.
2. **Query Vectorization** – Model Serving converts the query into embeddings, aligning with the indexed data.
3. **Retrieval Phase** – A vector similarity search fetches and ranks the most relevant data chunks
4. **Prompt Augmentation** - Retrieved chunks are merged with the query to enhance context before LLM processing.
5. **LLM Generation** – The LLM generates a response using the enriched prompt
6. **Post-processing** – The output is refined with business logic, citations, or formatting adjustments.

Implementing RAG Pipelines & Agents on Azure Databricks

AZURE DATABRICKS

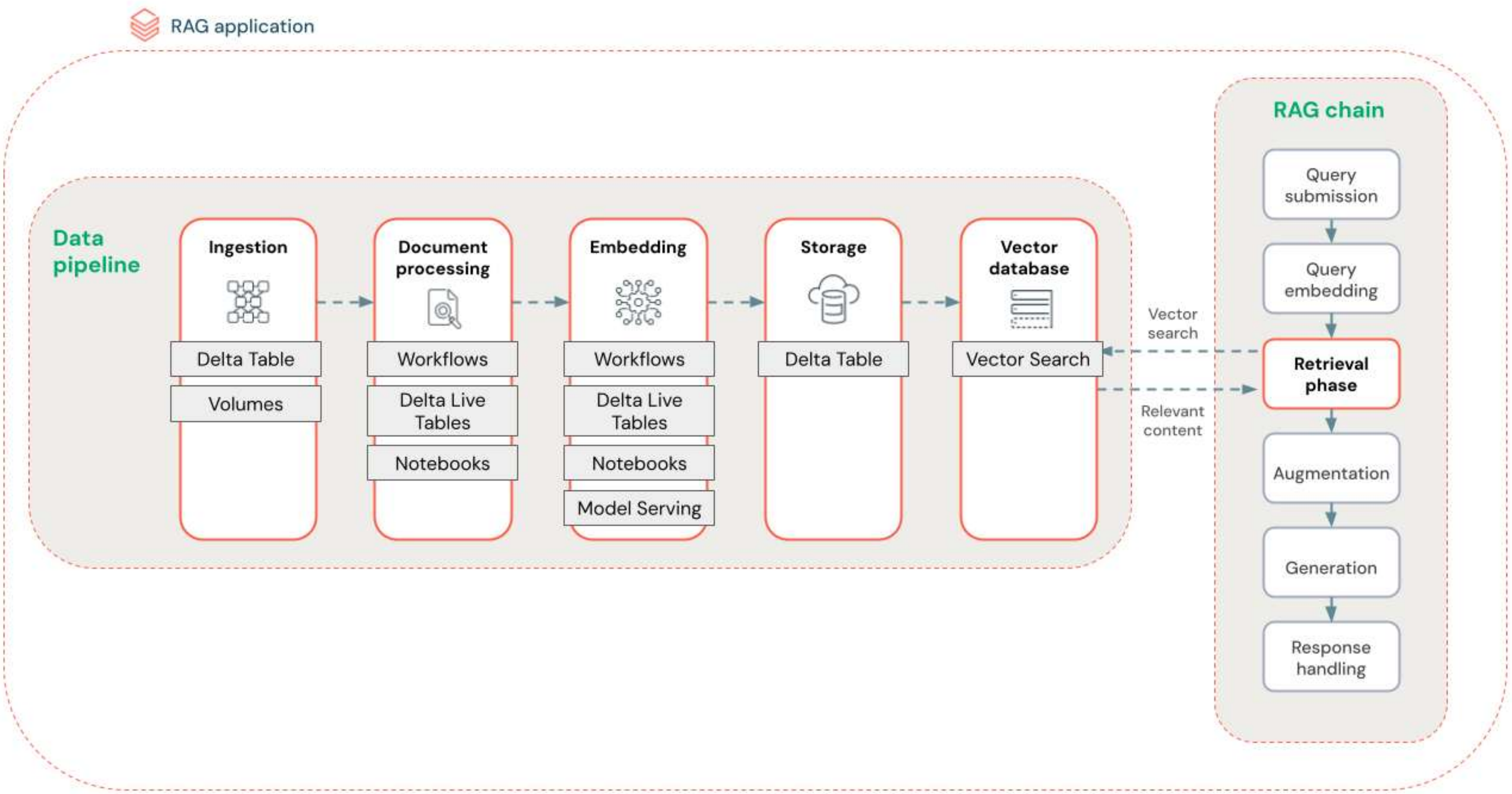
- Unified, **open analytics platform** for data, AI, and ML for data-driven decision-making
- Built on **Apache Spark**, optimized for Azure and integrated with cloud storage and security
- Uses **Data Lakehouse + AI** for optimized performance
- Supports ETL, ML, BI, & Generative AI.
- **Data Governance & Security** – Manage access and compliance effortlessly with Unity Catalog for secure data control.
- **Streaming & Real-time Analytics** – Process live data streams with Structured Streaming for instant insights and automation.

Medallion Architecture



Source:https://learn.microsoft.com/en-us/azure/databricks/lakehouse/medallion

RAG DATA Pipeline



Source: https://www.databricks.com/glossary/retrieval-augmented-generation-rag

Real-time Use Cases & Best Practices

Implementing RAG in Databricks

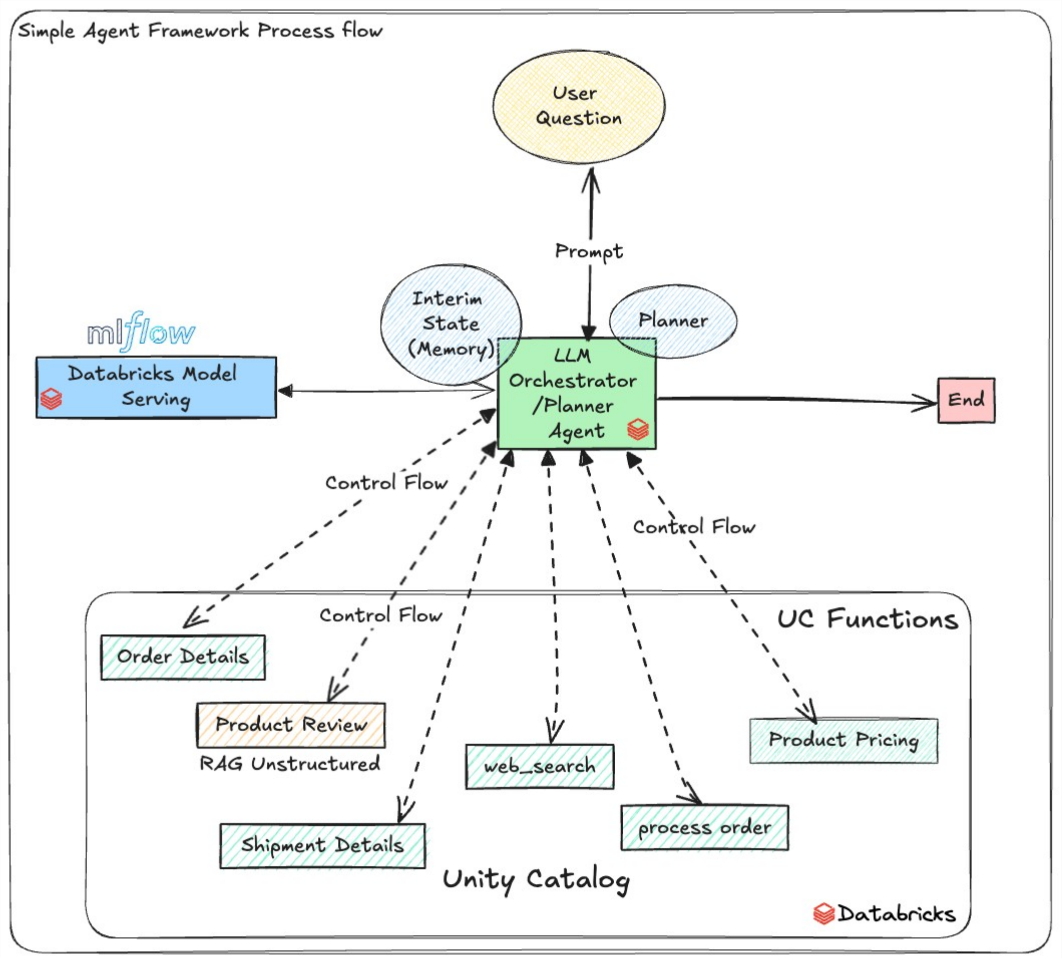
1.Ingest & Prepare Data: Store in Delta Lake or Azure Blob

2.Generate Embeddings: Use FAISS/ChromaDB for vector indexing

3.Retrieve Relevant Context: Query vector DB for relevant documents

4.Generate Responses: Pass retrieved data to LLM

5.Agent Execution: Automate insights & decision-making

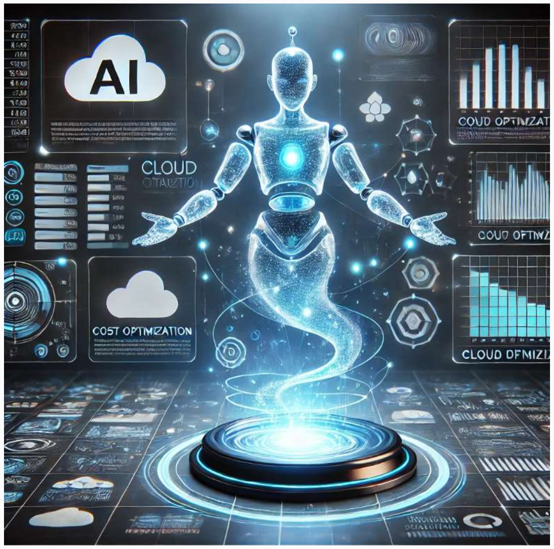


Source:https://www.databricks.com/blog/announcing-mosaic-ai-agent-framework-and-agent-evaluation

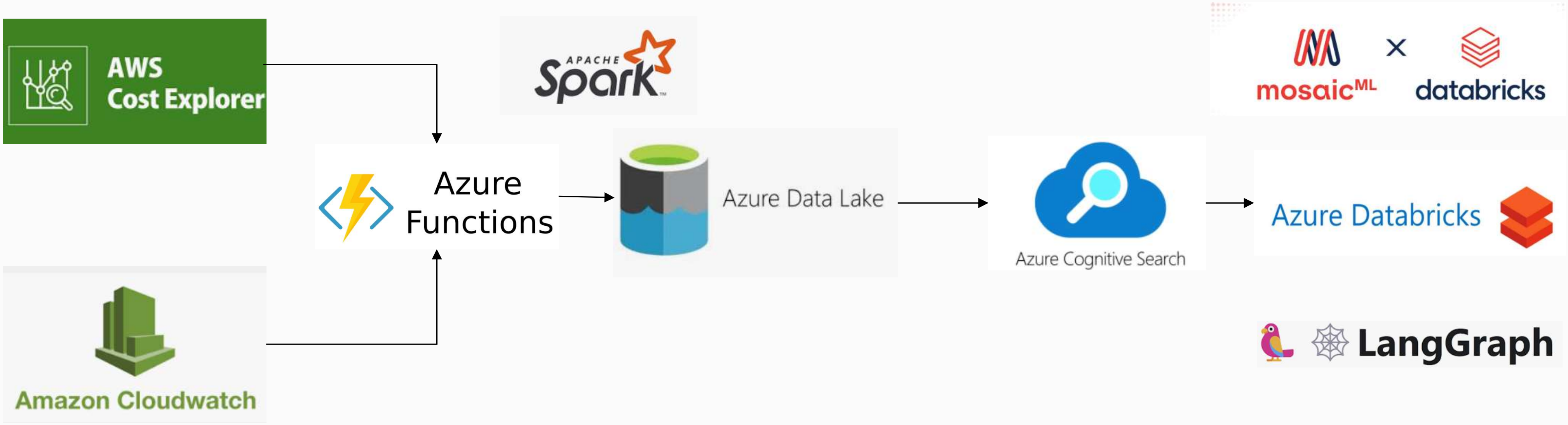
FinOps Genie in Action

Use Case:

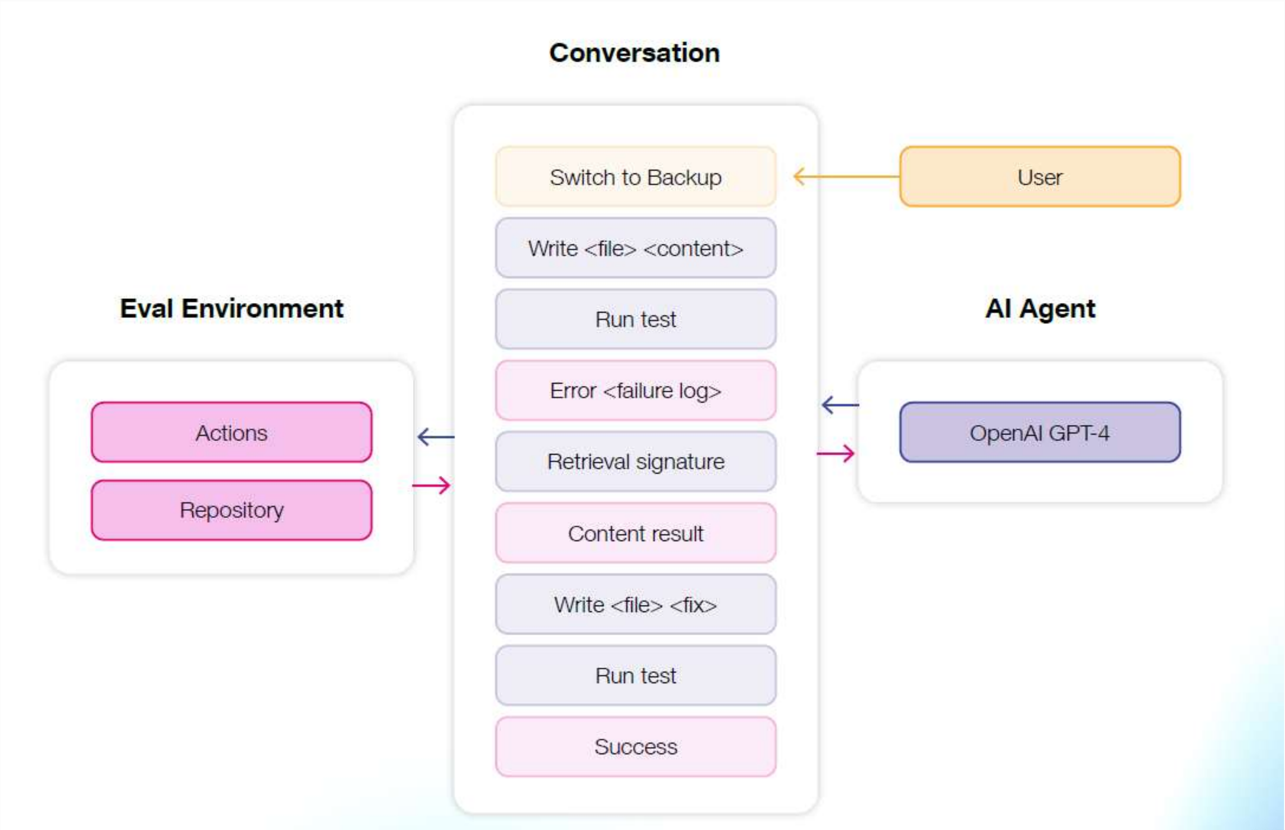
- AWS Cost Analysis & Optimization using RAG-based LLM Agent
- Ingest AWS cost data into Databricks
- Retrieve relevant insights using RAG
- AI Agent suggests cost-saving strategies



Implementing RAG & AI Agents in Databricks



Automated AI Agent driven Development



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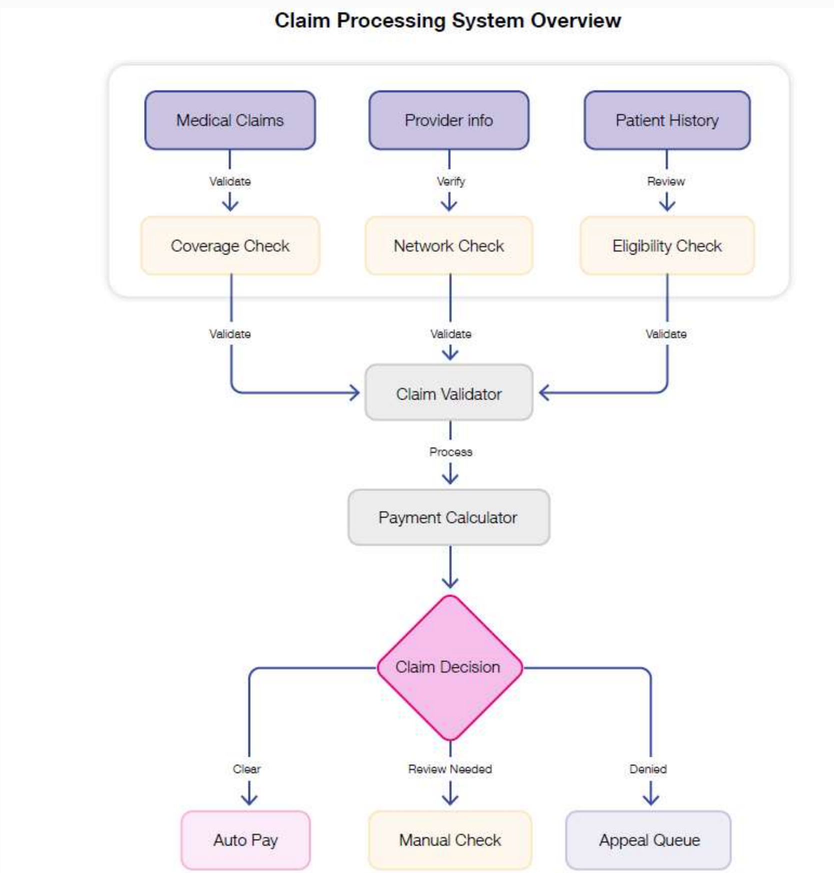
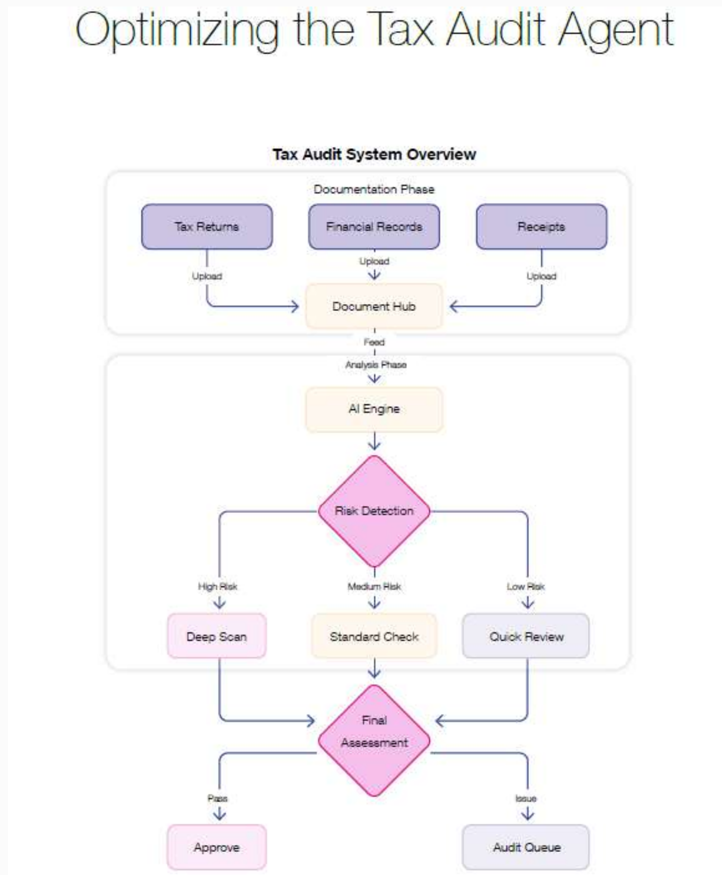
AI Agents Usecases : Claim Processing





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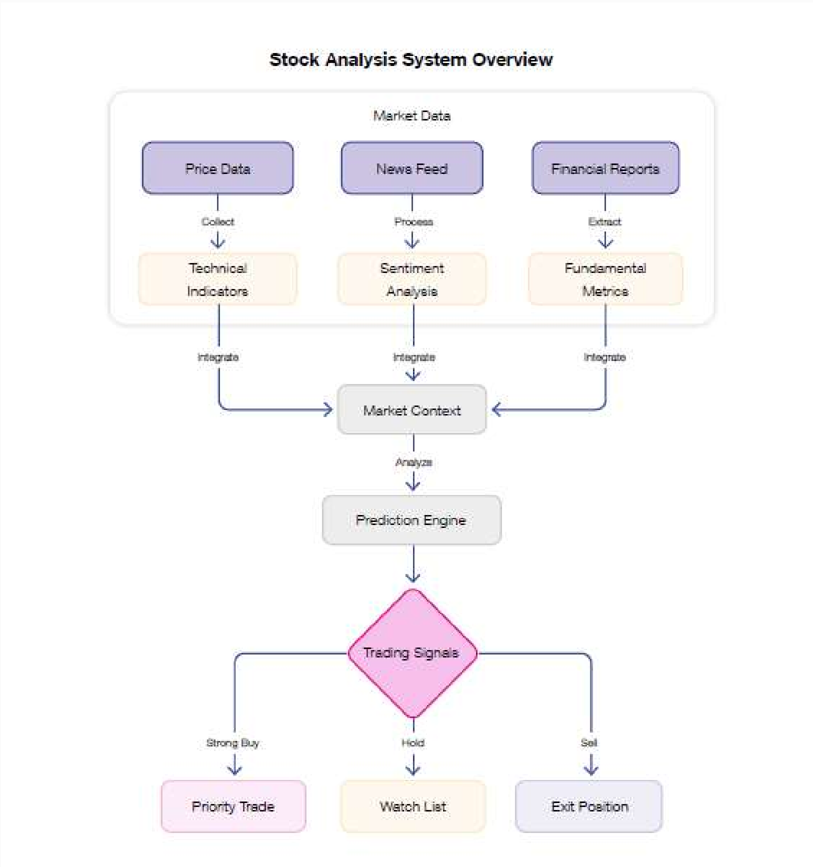
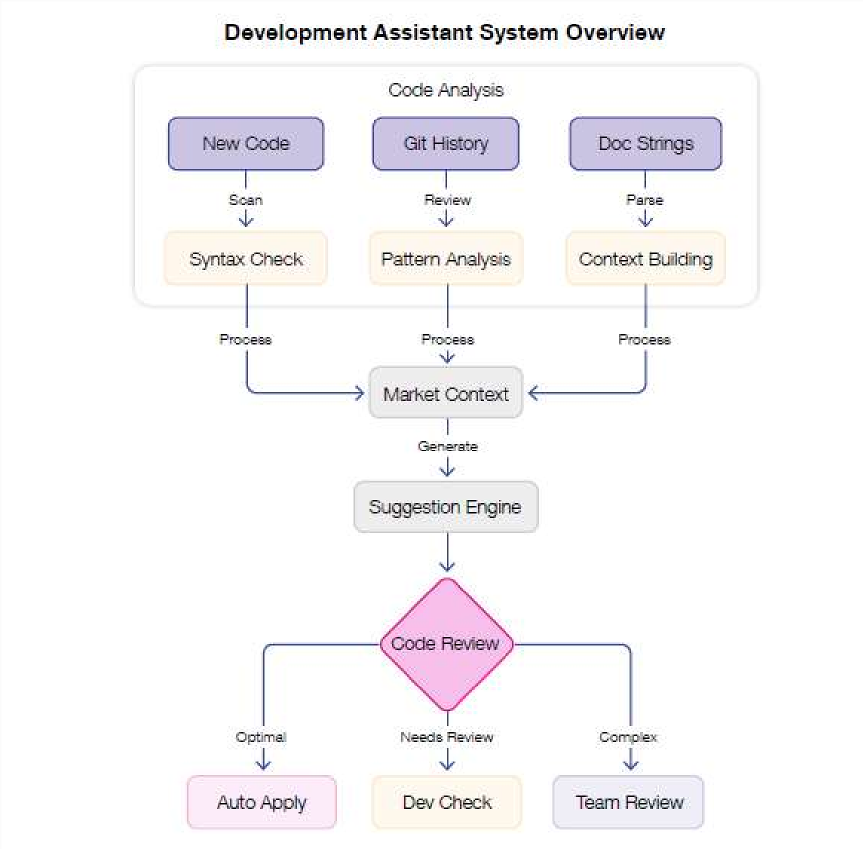
AI Agents Usecases :Stock Analysis





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RAG & AI Agents in Enterprise

- **Financial Services:** Risk analysis & fraud detection
- **Cloud Cost Optimization:** AI-powered cost-saving recommendations
- **Customer Support AI:** Context-aware chatbot interactions
- **Healthcare AI:** Clinical data retrieval & summarization

Databricks, Fabric & Synapse: UseCases

Comparison: Databricks vs. Fabric vs. Synapse

Feature	Azure Databricks 🟠	Microsoft Fabric 🔵	Azure Synapse Analytics 🟢
Core Focus	AI, ML, Data Engineering & Analytics	Unified Data & AI Platform	Data Warehousing & Big Data Analytics
Architecture	Open Lakehouse (Delta Lake)	SaaS-based Lakehouse	SQL Data Warehouse & Data Lake
Best For	Big Data, ML, AI, Real-time Streaming	End-to-end Data & AI (BI, AI, Governance)	BI, SQL Analytics, ETL
Compute Engine	Apache Spark, Photon	Power BI, Spark	SQL Pools, Apache Spark
Data Processing	Batch, Streaming, ML, AI	Low-code/no-code, AI-powered automation	SQL-based ETL, Data Pipelines
Storage	Delta Lake (open format)	OneLake (Fabric's data lake)	Azure Data Lake Storage (ADLS)
Governance	Unity Catalog (fine-grained access)	Microsoft Purview	Role-based Access Control (RBAC)
BI & Reporting	Connects to Power BI	Deep Power BI integration	Power BI & SQL Reporting
Use Cases	AI/ML, Real-time Analytics, Data Science	Business Intelligence, AI Automation, Governance	Data Warehousing, Structured Data Analytics

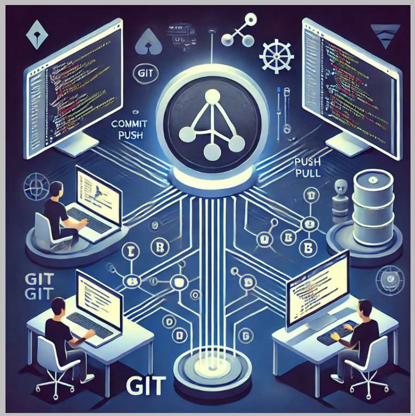
Best Practices for Scalable RAG & AI Agents

- **Optimize Retrieval Efficiency:** Hybrid search (semantic + keyword)
- **Fine-tune models** for domain-specific knowledge using Azure OpenAI, MosaicML, or Databricks Foundation Models.
- **Implement Cohere Reranking** for improved relevance in retrieval results.
- **Optimize embedding model selection** (e.g., OpenAI's ada-002, Cohere embeddings).
- **Reduce Hallucinations:** Reinforcement learning for feedback loops
- **Scalability Considerations:** Deploy RAG with Databricks & Azure AI
- Implement **AI Agent Evaluation Framework** to measure response accuracy and quality.

Future of RAG & AI Agents

- **Memory-augmented Agents** (Retain past interactions)
- **Autonomous AI Decision-Making** (Self-improving models)
- **Advanced Multi-Agent Systems** (Collaboration between AI agents)

ANY QUESTIONS…



https://github.com/hemsush/GlobalAIBootcamp2025Talk