RETRIEVAL AUGMENTED GENERATION (RAG)

Workshop

December 2024

Jason Haley

Questions for you

- Do you know what Retrieval Augmented Generation (RAG) is?
- Have you used a RAG application yet?
  - BTW: ChatGPT does a good job with RAG these days
- How about built one?
- How many people have used Azure SQL?

Phases of LLM Usage

01

General use and awareness

02

Combining LLM with external data and APIs

03

Agents or multi-step workflows with LLMs and other sources

04

Tools that provide actual business value

Using LLMs in an Application

Chatbot – Simple back and forth messaging between system and user

RAG – Chat with your own data ←**This is what we will explore**

Copilot – Assistants that work with you to complete tasks

Agents – Minimal human intervention to follow out instructions and perform tasks autonomously

Other ways LLMs are used:
Data generation, summarization, classification, writing drafts, and many more!

Retrieval Augmented Generation Pattern

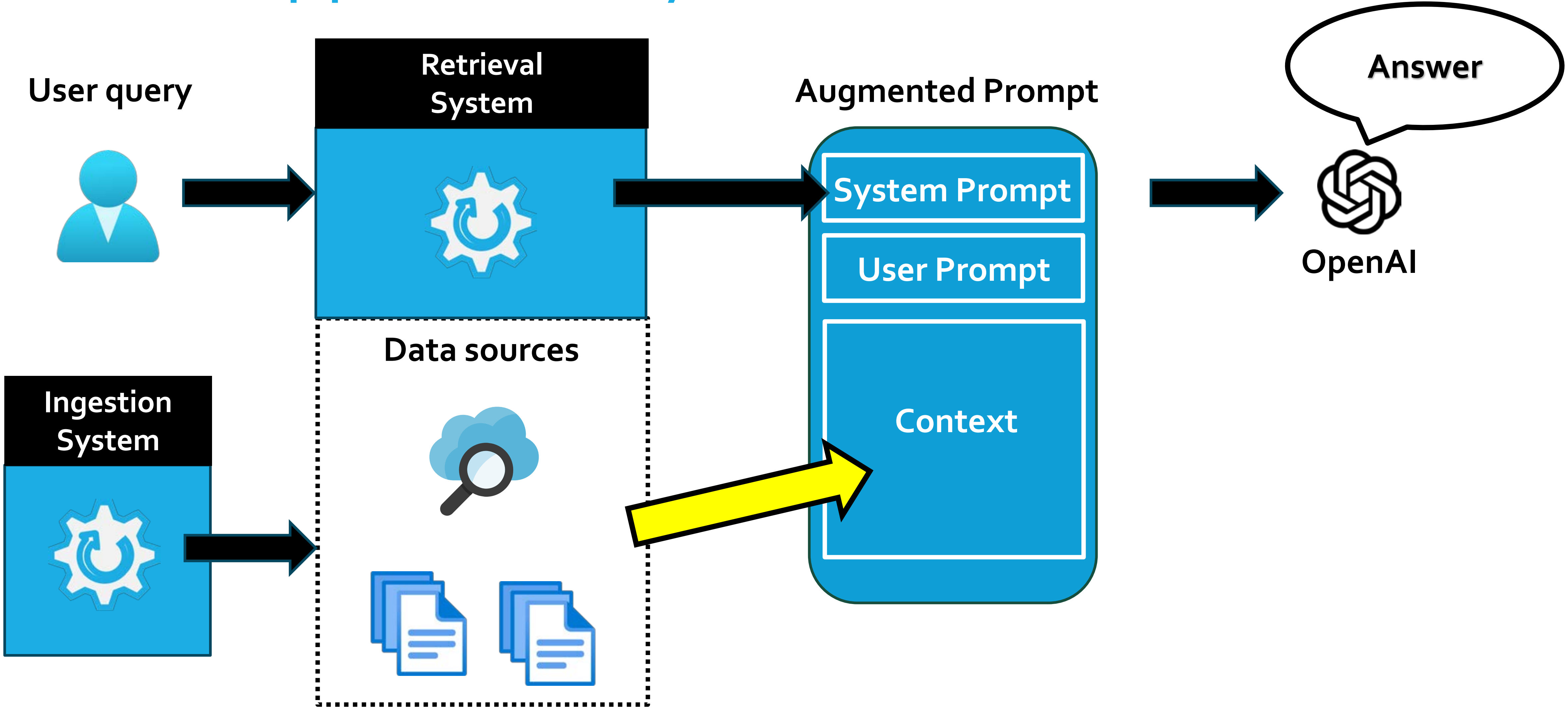
3 Steps

- Do a search in your retrieval system
- Augment the prompt with search results
- Pass to LLM

Use Cases for RAG

- Customer support and help desks
- Legal Document Analysis
- Healthcare Information Systems
- Education and e-Learning
- Enterprise Knowledge Management
- Research Assistance
- Content Generation
- Many more …

RAG Application System Flow



Retrieval System

Pre-step of searching your data sources before calling LLM

Goal is to provide knowledge for LLM to use

Searching Types

Keyword

Semantic or Similarity

Hybrid (with reranking)

LAB 3: RAG WITH WEB SEARCH

Ingestion/Indexing System

- Data quality is directly related to how useful your system will be
- Are you starting with structured or unstructured data?
    - Structured – content is already in a database (relational, document db, graph db)
    - Unstructured – data is not organized, such as documents
- How will the data be updated?
- What metadata will be helpful in searching?

Embeddings

Represent semantically similar items

- Vectors (arrays) of numbers
- Common distance metrics
  - Cosine Similarity
  - Euclidean Distance
  - Dot Product

Types

- Word embeddings
- Sentence or document embeddings
- Image embeddings
- Audio and video embeddings
- Knowledge graph embeddings

Hugging Face Leaderboard: https://huggingface.co/spaces/mteb/leaderboard

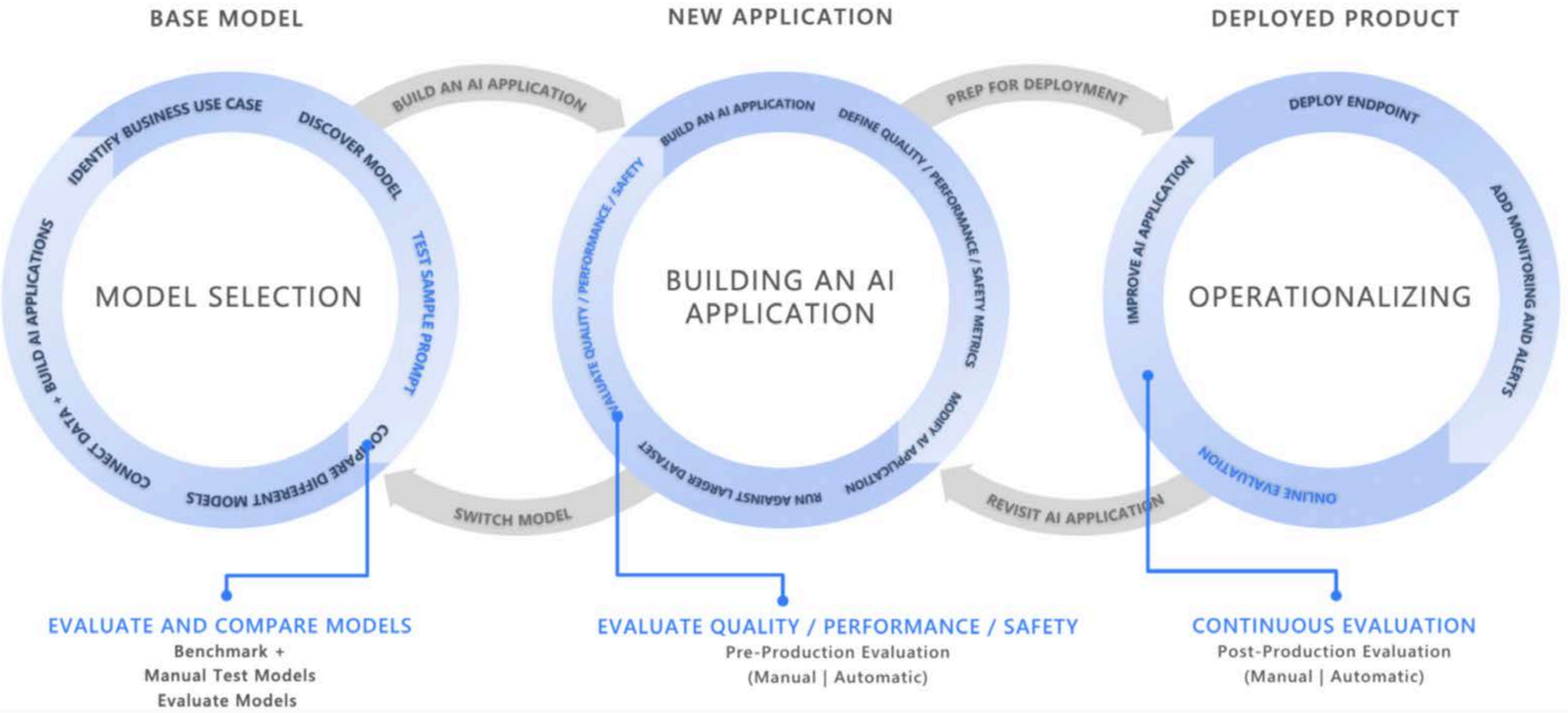
Vector Databases

- Azure SQL (public preview)
- Azure AI Search
- Cosmos DB
- Pinecone
- Chroma
- Qdrant
- Many others…

Chunking and Its Challenges

- Process of breaking something up into smaller parts (ie. files or text)
- Keep mind: Embeddings encode a meaning for a given chunk of text
- What does that mean for blocks of text?
  - Character count
    - Overlap (10 – 20 %)
  - Paragraphs
  - Pages
  - Other
- What about tables of text?
- What about images or charts?

ENTERPRISE GENAIOPS LIFECYCLE



EVALUATE AND COMPARE MODELS
Benchmark +
Manual Test Models
Evaluate Models

EVALUATE QUALITY / PERFORMANCE / SAFETY
Pre-Production Evaluation
(Manual | Automatic)

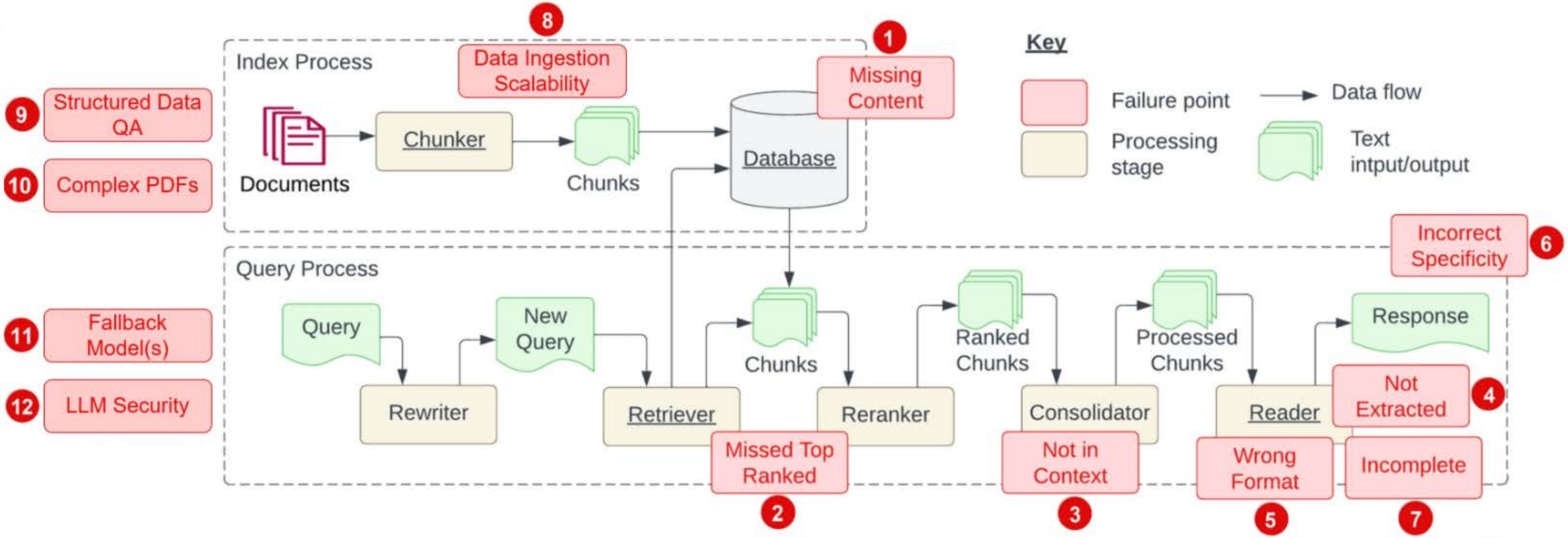
CONTINUOUS EVALUATION
Post-Production Evaluation
(Manual | Automatic)

https://learn.microsoft.com/en-us/azure/ai-studio/concepts/evaluation-approach-gen-ai

Challenges – not all questions are easy

Type	Description	
Yes/No	Answer is Yes or No	Has Lady Gaga ever made a song with Ariana Grande?
Comparative	Compare 2 objects on an attribute	Is Mont Blanc taller than Mount Rainier?
Generic	Simple question	Where was Michael Phelps born?
Intersection	Must fulfill 2 or more conditions	Which movie was directed by Denis Villeneuve and stars Timothee Chalamet?
Ordinal	Based on item in ordered list	Who was the last Ptolemaic ruler of Egypt?
Count	Answer required counting	How many astronauts have been elected to Congress?
Difference	Question with a negation	Which Mario Kart game did Yoshi not appear in?
Superlative	Max/Min of an attribute	Who was the youngest tribute in the Hunger Games?
Multi-hop	Requires 2 or more steps to answer	Who was the quarterback of the team that won Super Bowl 50?

https://github.com/amazon-science/mintaka



Proposed Solutions

1. Clean your data & Better prompting
2. Hyperparameter tuning & Reranking
3. Tweak retrieval strategies & Finetune embeddings
4. Clean your data, prompt compression, & LongContextReorder
5. Better prompting, output parsing, pydantic programs, & OpenAI JSON mode
6. Advanced retrieval strategies
7. Query transformations
8. Parallelizing ingestion pipeline
9. Chain-of-table pack & Mix-self-consistency pack
10. Embedded table retrieval
11. Neutrino router & OpenRouter
12. NeMo Guardrails & Llama Guard

12 RAG Pain Points and Proposed Solutions, Wenqi Glantz https://bit.ly/3CRASHG

LAB 4: RAG WITH PDF

LAB 5: COMBINE WEB AND PDF