LLM Powered Applications

Evolution of Human-Computer Interaction

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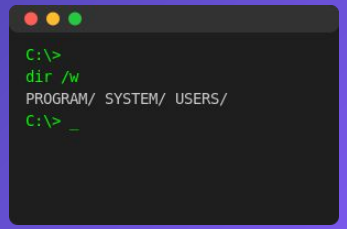
The Journey of Human-Computer Interface

Command Line Era

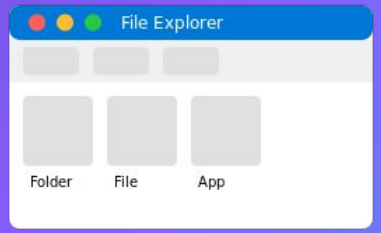
1960s-1980s



- Text-based interaction
- Expert users
- Precise control

Graphical UI Era

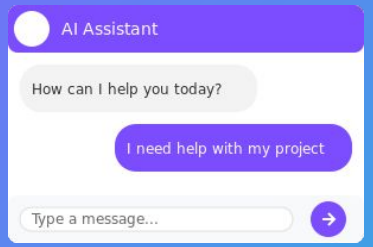
1980s-2020s



- Visual metaphors
- Mass adoption
- WIMP paradigm

LLM Interface Era

2020s+

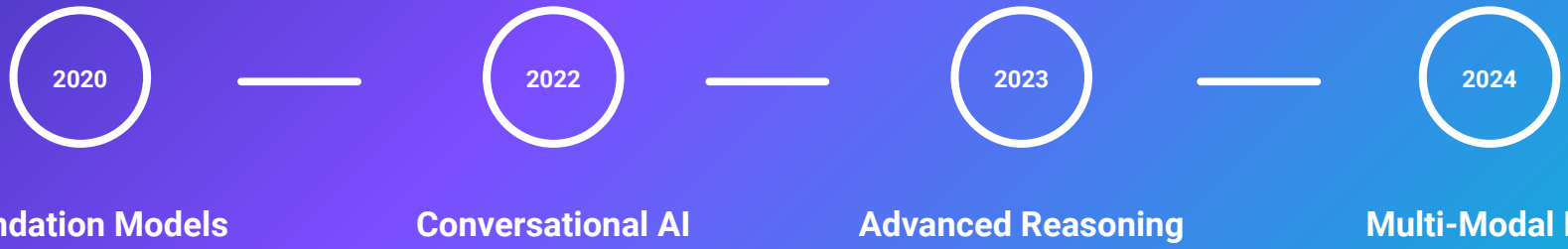


- Natural language
- Context-aware
- Adaptive interaction

State of LLM 2024

Current LLM capabilities:

- Multi-modal understanding (text, images, audio)
- Advanced reasoning and problem solving
- Tool use and API integration



Prompting fundamentals

Basic Prompting

Input:

Translate to Spanish:
Hello, how are you?

Output:

Hola, ¿cómo estás?

Chain of Thought

Input:

Solve: If John has 5 apples and gives 2 to Mary, how many left?

Output:

Let's solve step by step:
1. Initial: 5 apples
2. Given away: 2
3. Result: 5 - 2 = 3

Few-Shot Learning

Input:

Example 1:
Input: Happy → Joyful

Example 2:
Input: Sad → Unhappy

Now do:
Input: Angry →

Output: Furious

Advanced Prompting Techniques

Function Calling

```
{
  "name": "get_weather",
  "description": "Get weather information for a location",
  "parameters": { "type": "object", "properties": {
    "location": { "type": "string", "description": "City" }
  },
  "required": ["location"]
 }
}
```

System Prompts

```
{
  "role": "system",
  "content": "You are a SQL expert. Always validate queries for security and performance. Check for: - SQL injection vulnerabilities - Proper indexing - Query optimization - Table permissions"
}
```

Context Window Management

System Context
Role and Rules

Prior Messages
Conversation History

Current Query
User's Request

Memory
Key Information

Building Blocks of LLM Applications

Orchestrators Deep Dive

Key Features

- **Prompt Management**
- **Chain Composition**
- **Memory Management**
- **Error Handling**
- **Tool Integration**
- **Caching & Optimization**

Implementation

```
from langchain import LLMChain
from llama_index import VectorStoreIndex

# define chain components
chain = LLMChain(
  llm=ChatOpenAI(),
  prompt=PromptTemplate(),
  memory=ConversationMemory()
)

# error handling
try:
  response = chain.run(
    input="query"
  )
```

Common patterns

Sequential Chain
Chain of operations where output of one feeds into next

Router Chain
Directs queries to specific chains based on content

Agent Chain
Dynamic tool selection and execution based on task

Building Blocks of LLM Applications

RAG Deep Dive

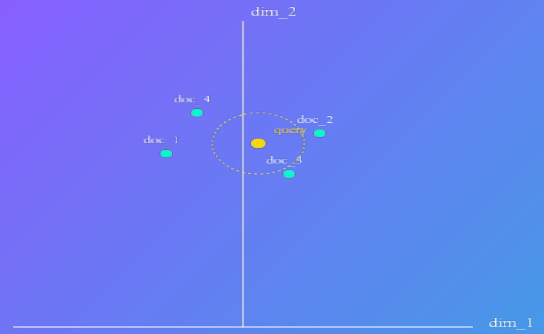
Text to Embeddings

"The quick brown fox jumps"

↓

[0.12, 0.45, -0.23, 0.89, ...]

Vector Database



RAG Pipeline

Query → Embedding → Vector Search → Context → LLM

Building Blocks of LLM Applications

ETL Systems for LLM Applications

Extract

- PDFs, Docs
- Websites, HTML
- Databases
- APIs

Transform

- Text Cleaning
- Chunking
- Metadata Extraction
- Embeddings

Load

- Vector Stores
- Document Stores
- Metadata DB
- Cache Layer

Processing Pipeline

Building Blocks of LLM Applications

LLM Monitoring Systems

Tracking

- Latency
- Token Usage
- Error Rates
- Cost Analytics

Prompt Analysis

- Effectiveness
- Response Quality
- Chain Steps
- Context Usage

LLM System Runtime

User Feedback

- Ratings
- Corrections
- Preferences
- Usage Patterns

System Updates

- Prompt Refinement
- RAG Optimization
- Chain Tuning
- Model Selection

Continuous Improvement Loop: Monitor → Analyze → Collect Feedback → Implement → Validate

Building Blocks of LLM Applications

LLM Testing Strategies

Testing Types

Semantic Similarity
Compare response meaning

Factual Accuracy
Verify information

Format Validation
Check output structure

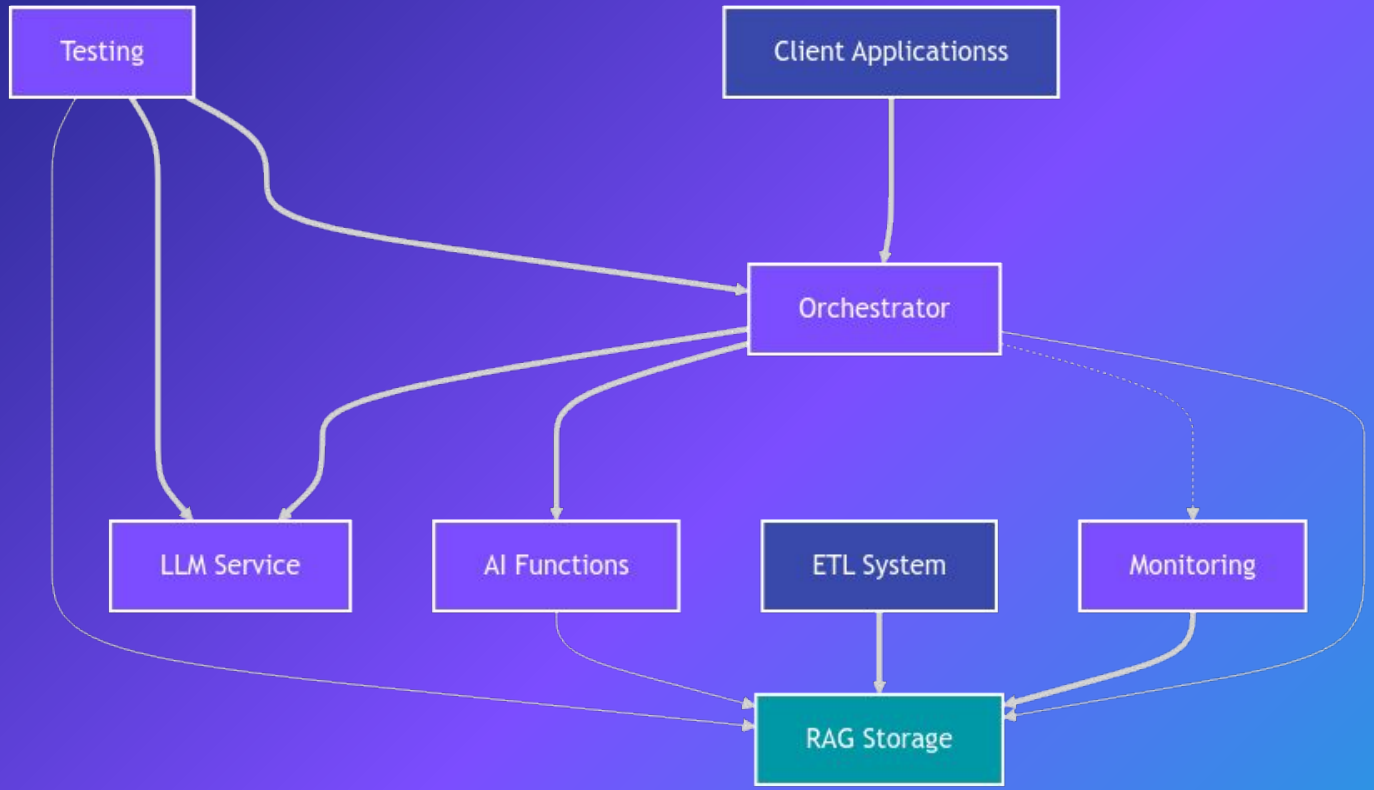
Response Time
Performance metrics

Tests Examples

```
test_input = "What is the capital of France?"
test_context = "Paris is the capital and largest city of France."
expected_output = "Paris is the capital of France."

# 1. Semantic Similarity - Compare response meaning
semantic_test = SemanticSimilarityMetric(threshold=0.8).measure(
    actual=llm_chain.run(test_input),
    expected=expected_output
).score > 0.8

# 2. Factual Accuracy - Check for hallucinations
factual_test = HallucinationMetric(threshold=0.3).measure(
    context=test_context,
    response=llm_chain.run(test_input)
).score < 0.3

# 3. Format Validation - Verify JSON structure
format_test = ResponseFormatMetric(
    json_schema={"type": "object", "required": ["answer", "confidence"]}
).validate(response=json.dumps({"answer": "Paris", "confidence": 0.95}))

# 4. Response Time - Check performance
latency_test = LatencyMetric(threshold_seconds=2.0).measure(
    lambda: llm_chain.run(test_input)
).score < 2.0
```

Building Blocks of LLM Applications

Modern LLM Application Architecture



core components
external systems
storage systems
direct calls
data pulls
data pushes

knezevic.dev/llm-diagram-full

Thank you!