GenAI unpacked: Beyond Basics

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Microsoft Regional Director,

Most Valuable Professional: AI

AGENDA

- Tokens
- Embeddings
- Vector DBs
- RAG
- Function Calling
- Semantic Kernel

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TOKENS

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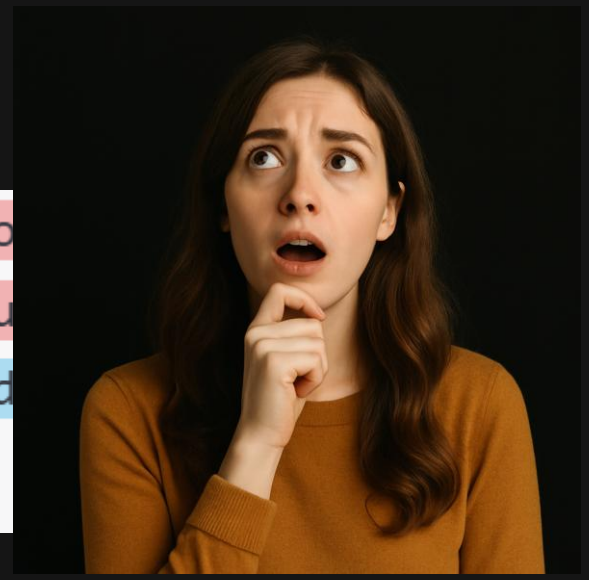
What are Tokens?

- 1 token ~= 4 chars in English
- 1 token ~= ¾ words
- 100 tokens ~= 75 words
- Byte Pare Encoding (Gage,1994): Wikipedia
- What are tokens and how to count them?
- Token Pricing: Pricing (openai.com)

```
OpenAI's large language models process text using tokens, which are co
 sequences of characters found in a set of text. The models learn to u
 the statistical relationships between these tokens, and excel at prod
 next token in a sequence of tokens.
```



DEMO

- Tokenizer
- Creating tokens in C#

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EMBEDDINGS

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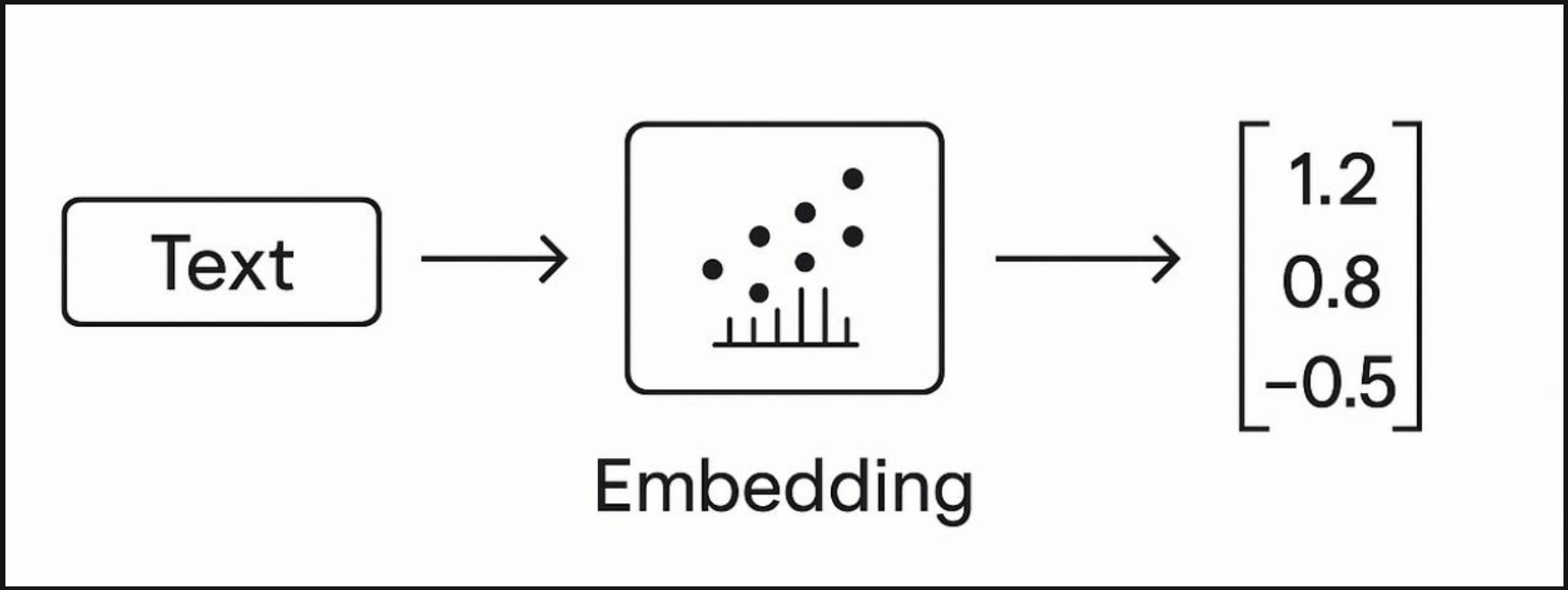
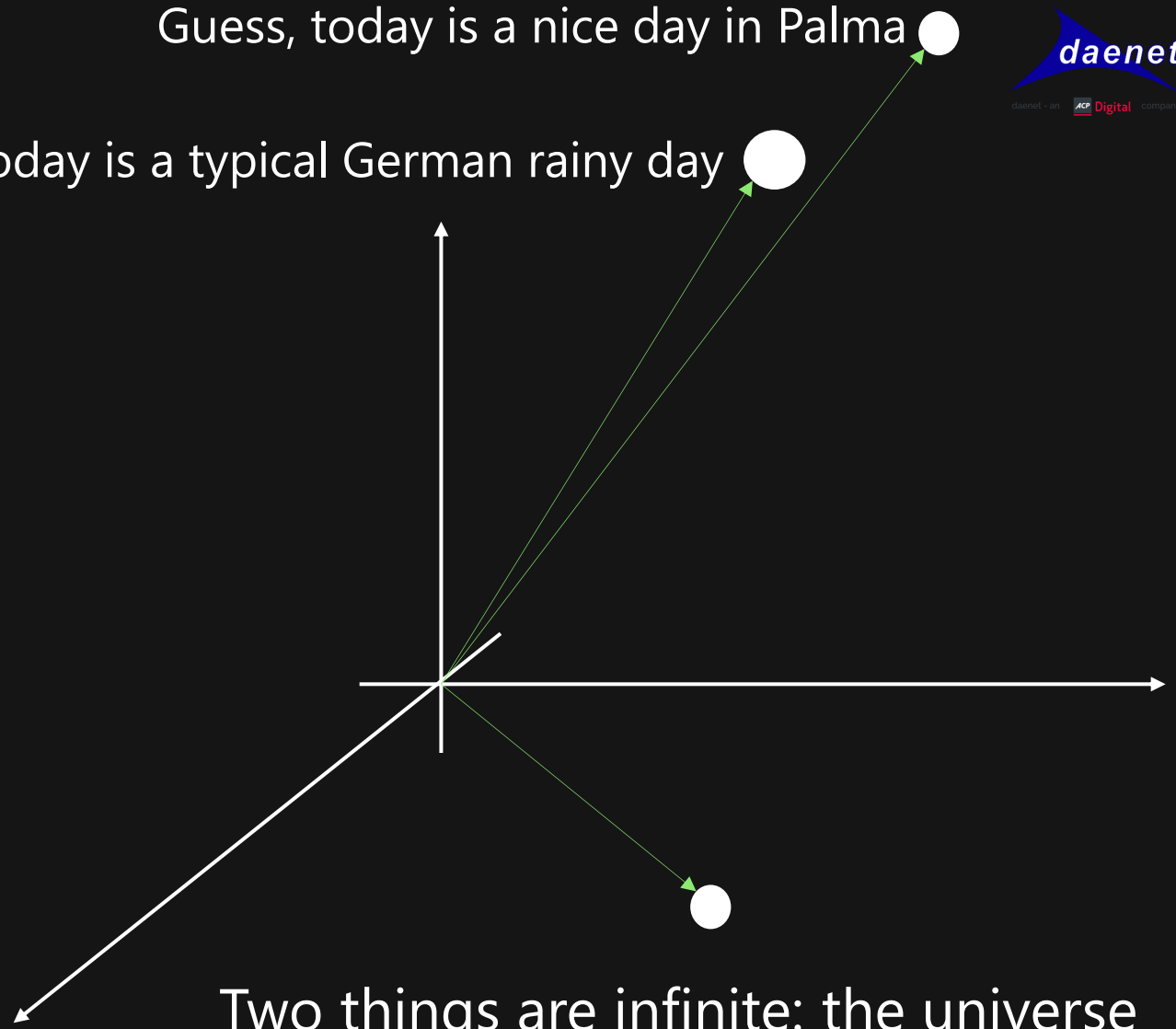
Embeddings

- Making a vector from text



Embedding Models



Two things are infinite: the universe and human stupidity; and I'm not sure about the universe.

Similarity Between Multidimensional Vectors

- Dot Product

$$A \cdot B = a_1 \cdot b_1 + a_2 \cdot b_2 + \ldots + a_n \cdot b_n$$

- The Norm

$$\|\mathbf{A}\| = \sqrt{a_1^2 + a_2^2 + \ldots + a_n^2}$$

- Cosine Similarity

$$\mathbf{A} \cdot \mathbf{B} = \|\mathbf{A}\| \|\mathbf{B}\| \cos(\theta)$$

When to use Embeddings?

- Semantic Search
- Classification
- Clustering
- Recommendations
- . . .

DEMO

- Consuming Embedding Model with HTTP/Post
- Creating Embeddings in C#

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VECTOR DATABASES

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Vector DBs

- SqlServer 2025 Native Vector Search
- Quadrant
- CosmosDB
- …

SqlServer 2025 Native Vector Search

- SqlServer 2025 Native Vector Search
  - In Azure
  - On-Prem
- SQL Server Native Vector Search for .NET Developers

```
CREATE TABLE test.Vectors
(
    [Id] INT IDENTITY(1,1) NOT NULL,
    [Text] NVARCHAR(MAX) NULL,
    [VectorShort] VECTOR(3)  NULL,
    [Vector] VECTOR(1536)  NULL
);
```

DEMO

- SQL Server Native Vector Search

  SQL Server Native Vector

```
DECLARE @v1 VECTOR(2) = '[1,1]';
DECLARE @v2 VECTOR(2) = '[-1,-1]';

SELECT
    VECTOR_DISTANCE('euclidean', @v1, @v2) AS euclidean,
    VECTOR_DISTANCE('cosine', @v1, @v2) AS cosine,
    VECTOR_DISTANCE('dot', @v1, @v2) AS negative_dot_product;
```

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COMPLETION MODELS

How does all this work?

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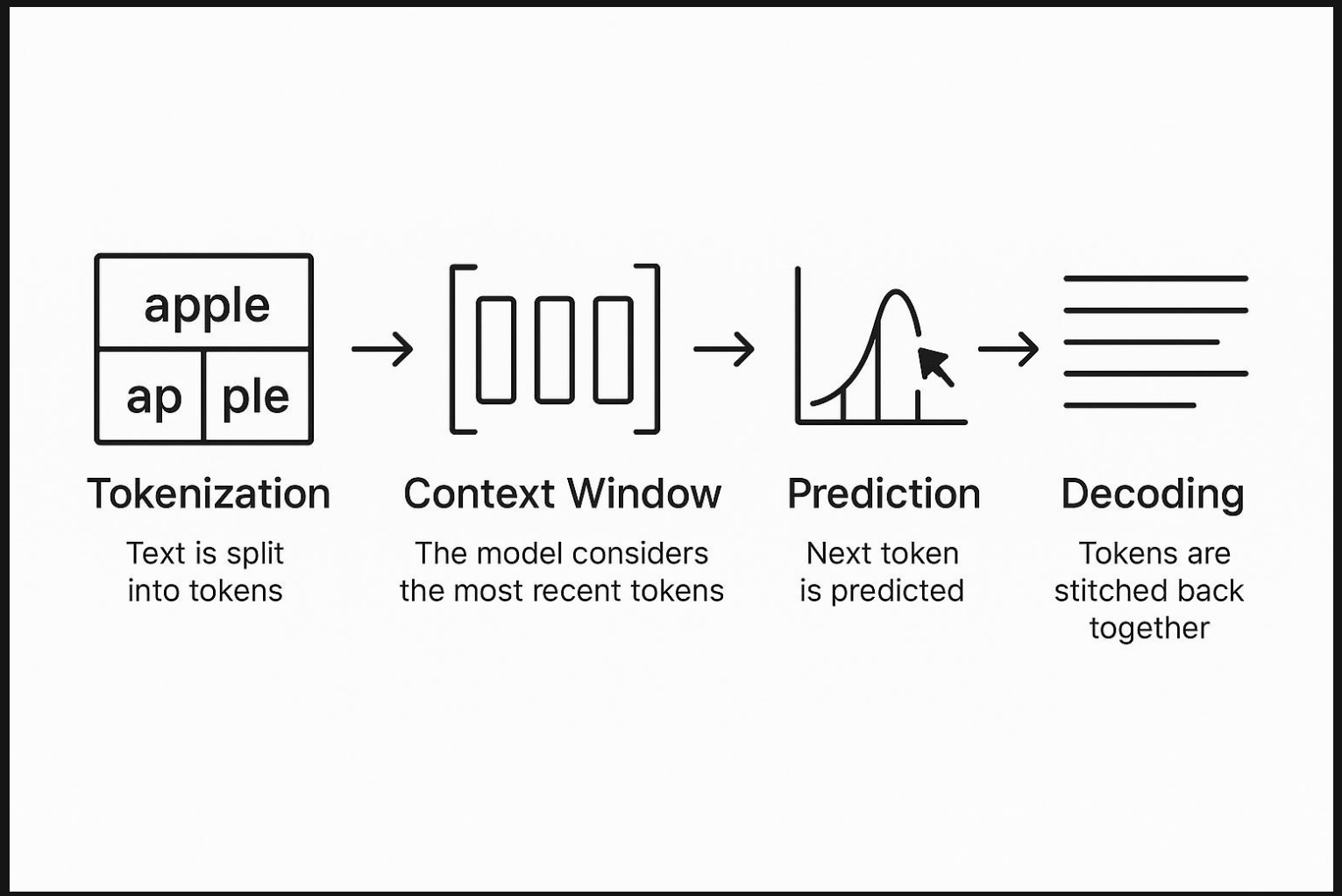
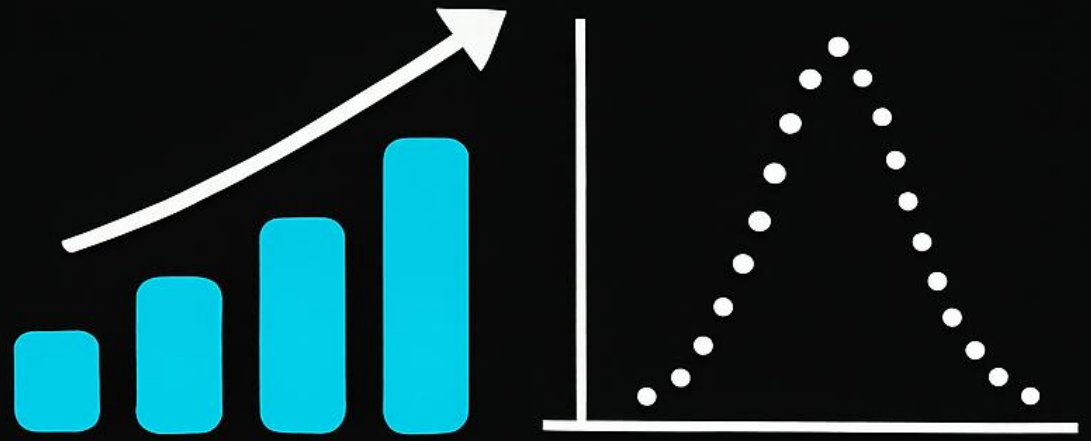
Completion Models

Text Completion Flow



DEMO

- C# Application
- Using OpenAI nuget package
- Executing ChatCompletions
- Presenting Probabilities



A Scientific look under the hub

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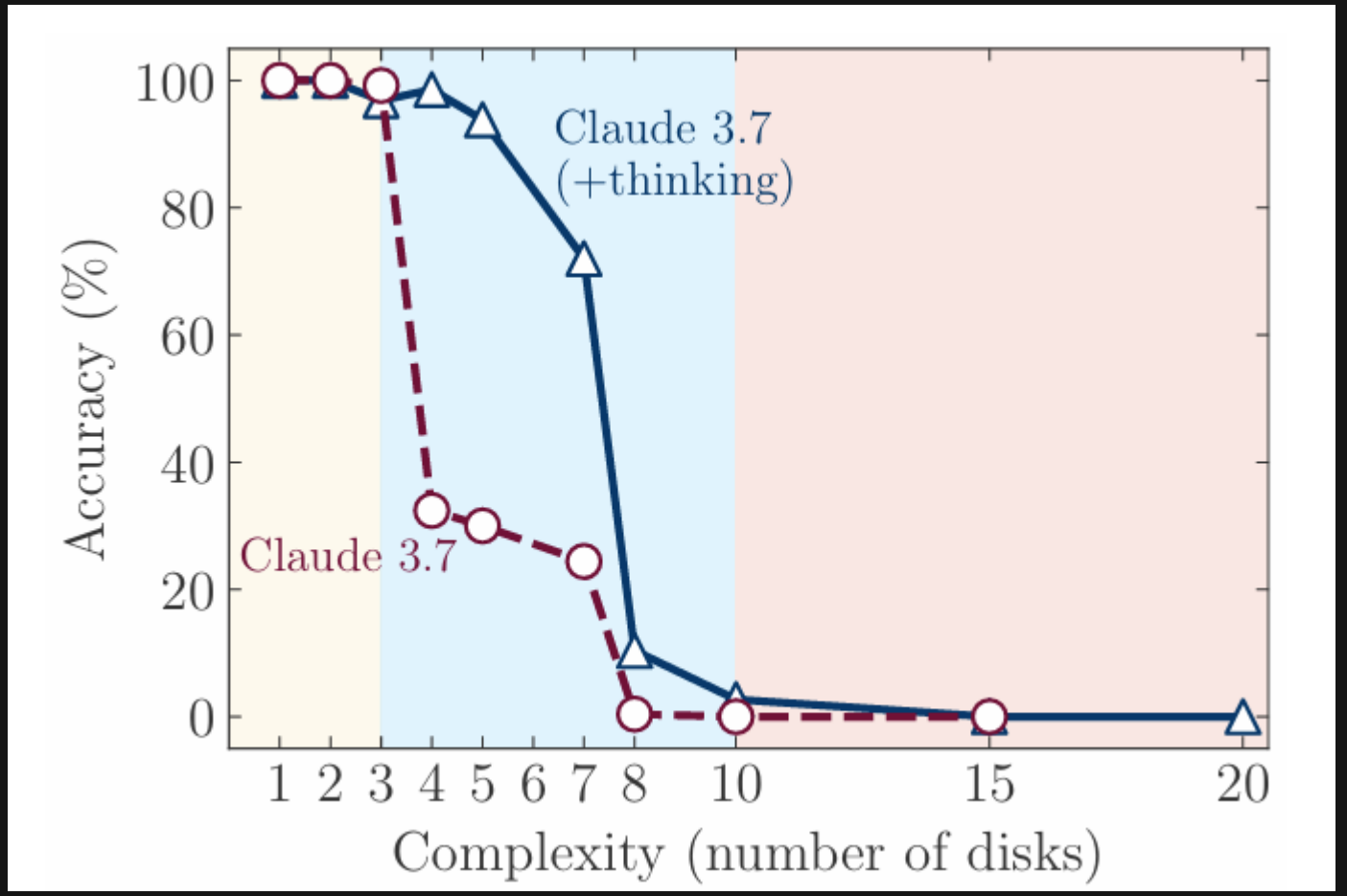
Model Performance and Illusion of Tinking

LiveBench



ml-site.cdn-apple.com/papers/the-illusion-of-thinking.pdf

RAG

Retrieval Augmented Generation

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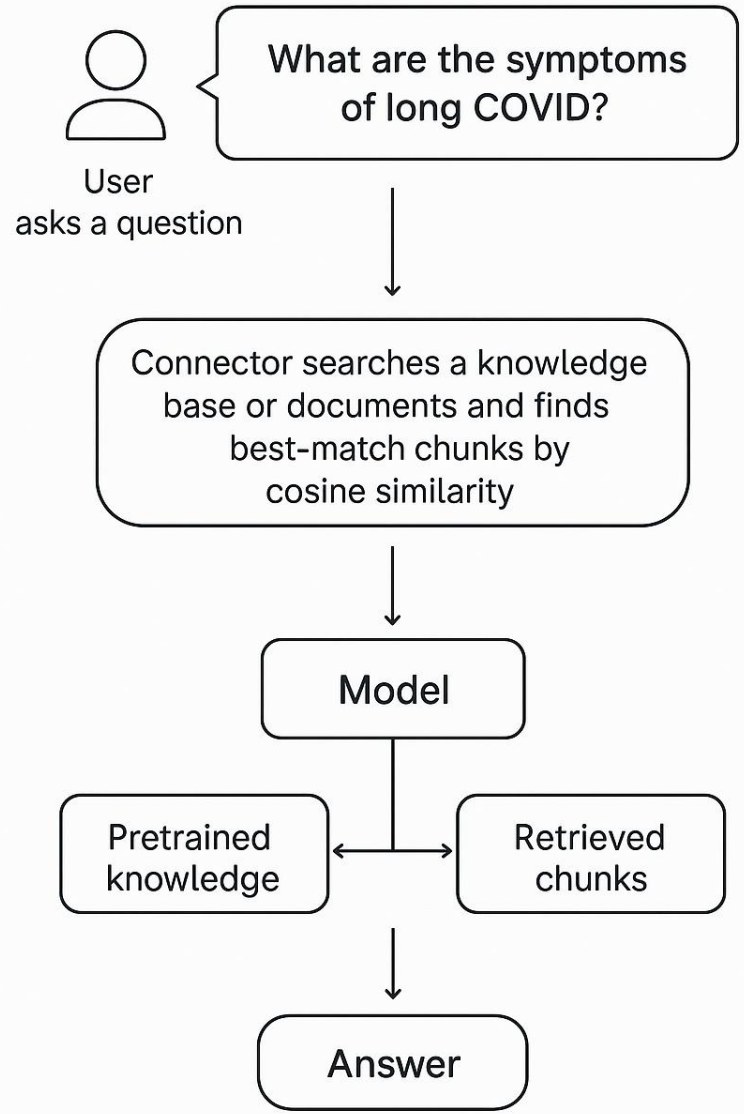
RAG
Retrieval-Augmented Generation

- Extending the model knowledge
- Combines information retrieval with text generation

https://arxiv.org/abs/2005.11401



DEMO (c#)

- Creating chunks
- Creating embeddings
- InMemory Vector DB
- Calculating Similarity

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Function Calling

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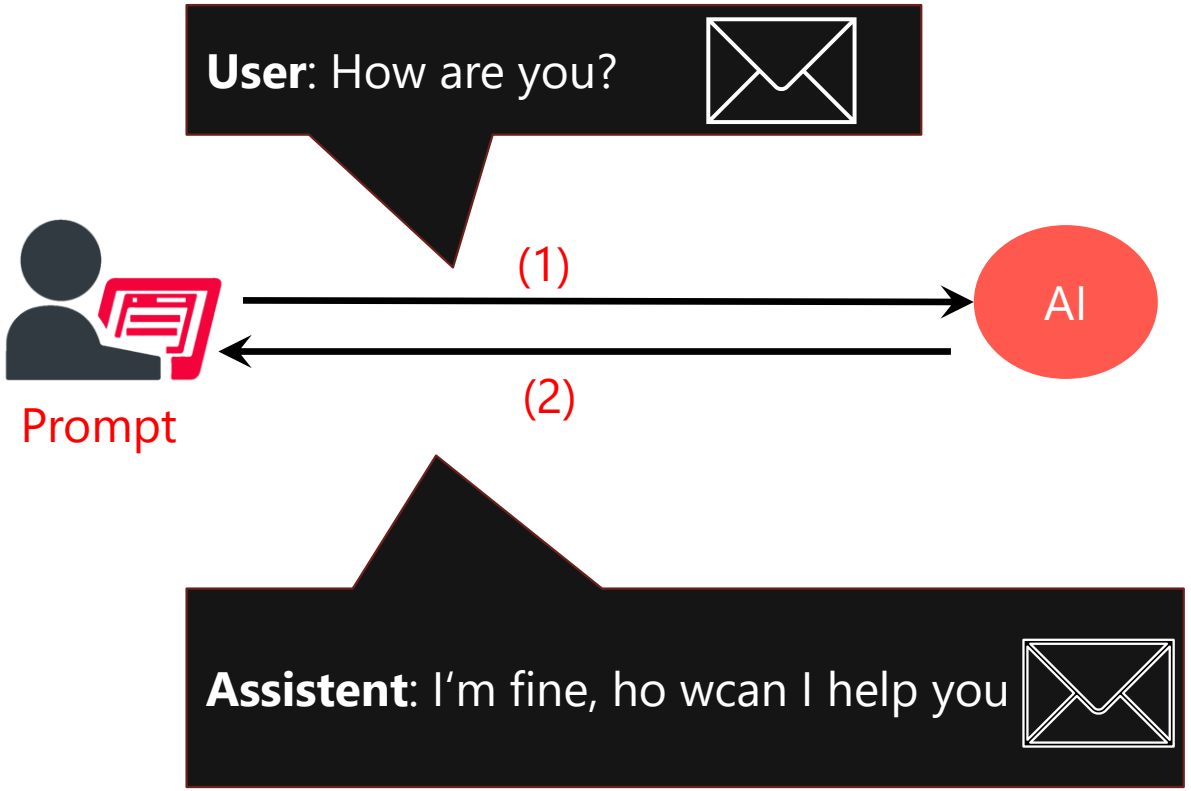
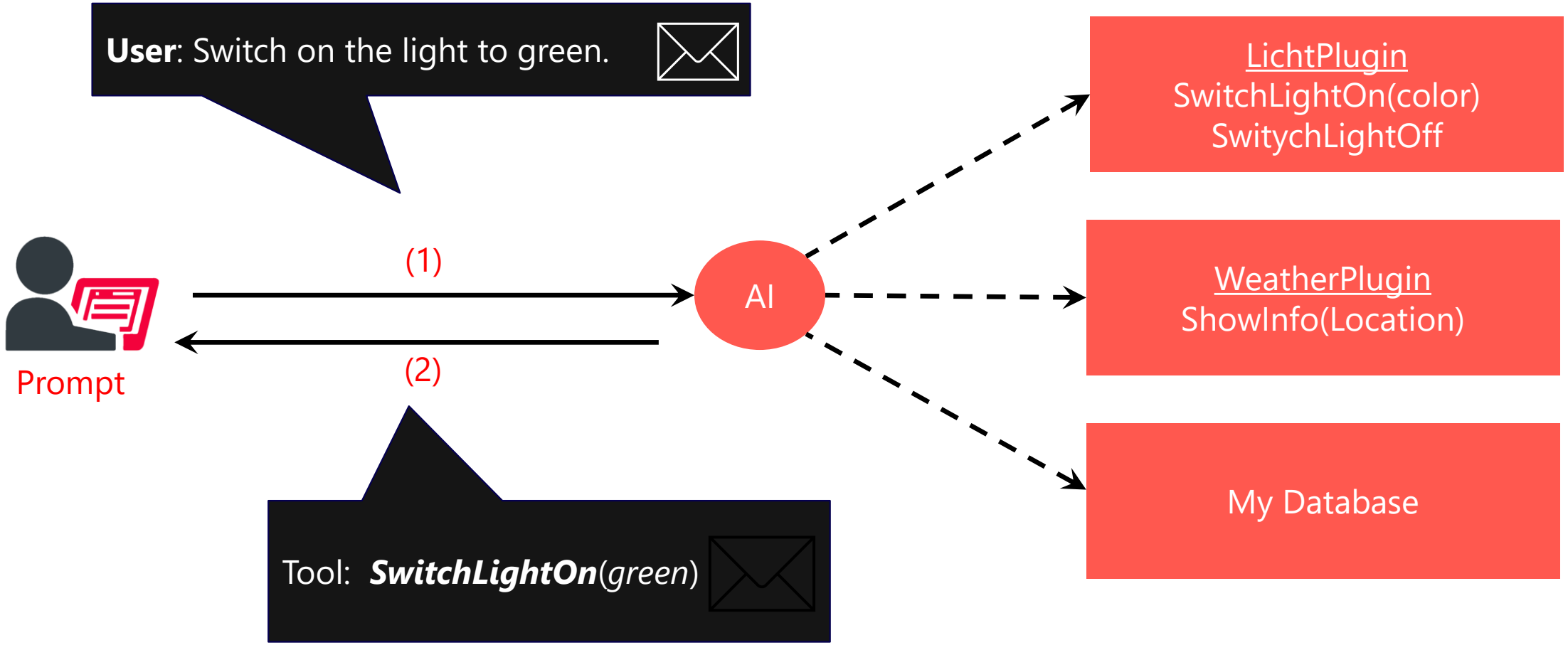
Chat Model Interaction



Function Calling



Function Calling

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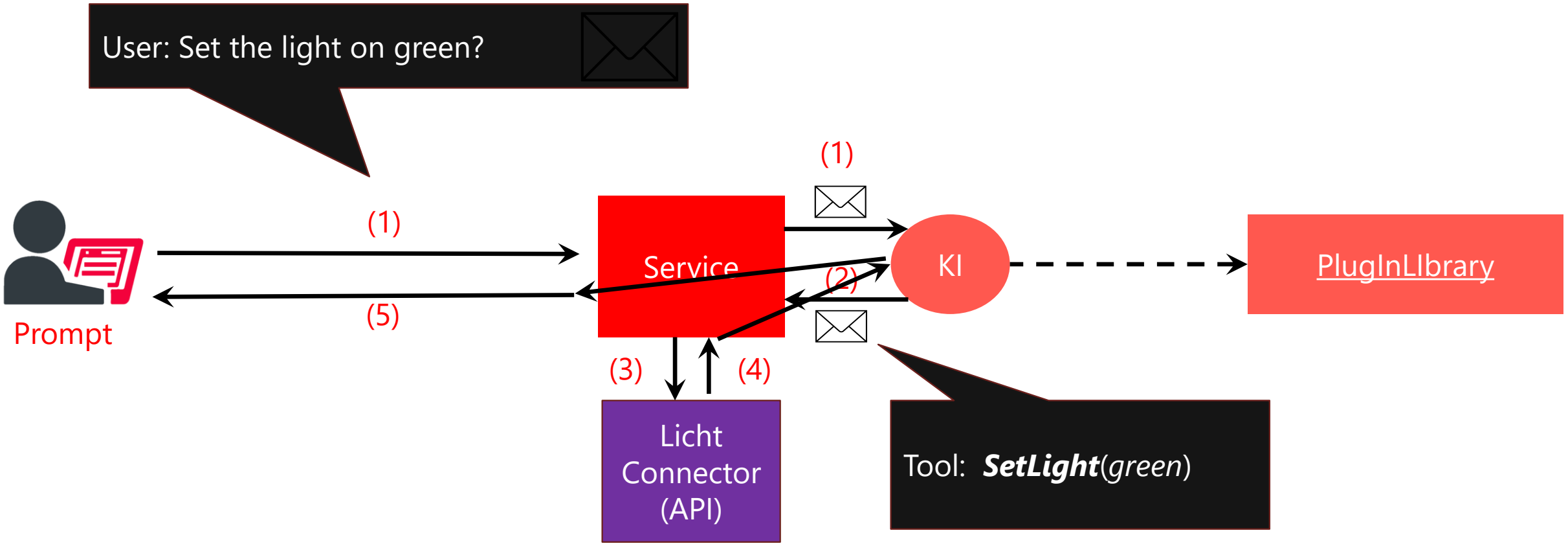
```
{
    "type": "function",
    "function": {
        "name": "get_weather",
        "description": "Retrieves current weather for the given location.",
        "strict": true,
        "parameters": {
            "type": "object",
            "properties": {
                "location": {
                    "type": "string",
                    "description": "City and country e.g. Bogotá, Colombia"
                },
                "units": {
                    "type": ["string", "null"],
                    "enum": ["celsius", "fahrenheit"],
                    "description": "Units the temperature will be returned in."
                }
            },
            "required": ["location", "units"],
            "additionalProperties": false
        }
    }
}
```

Function Calling



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THANK YOU ☺

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