

# Applying open-source LLMs in Social and Behavioral Sciences @ GSERM 2025

Dirk Wulff & Zak Hussain



MAX PLANCK INSTITUTE  
FOR HUMAN DEVELOPMENT

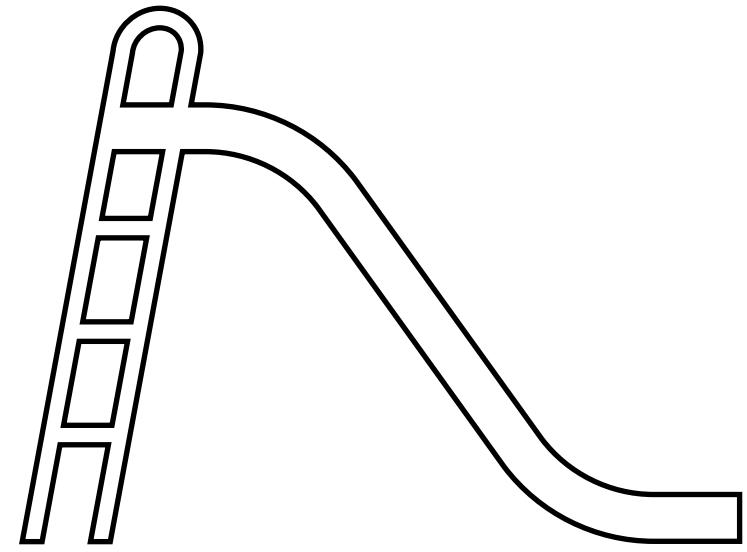


# Goals

Familiarize you with the workings and applications of open-source LLMs and how to implement them using the Hugging Face ecosystem

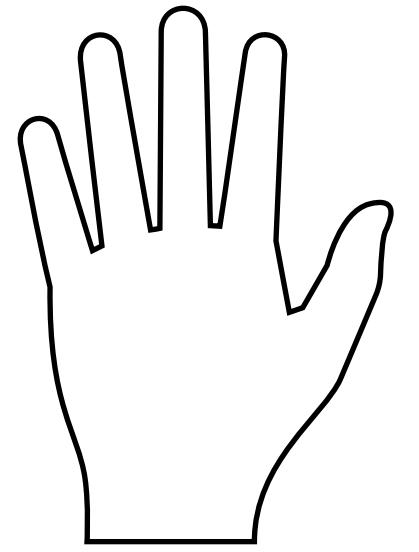


# Components



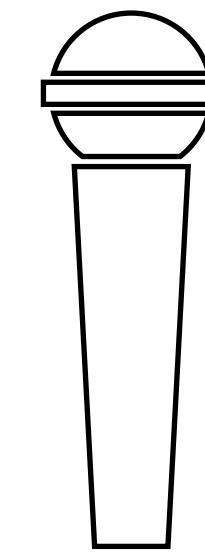
## Slide-based introductions

Introduces core concepts and code



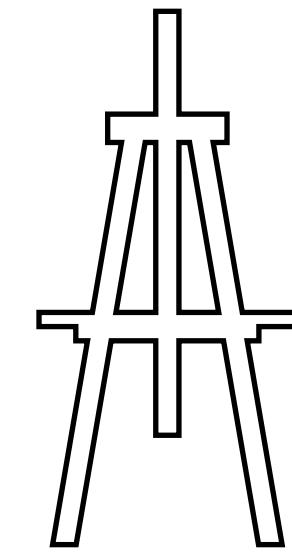
## Hands-on exercises

Work through ready-made notebooks to carry out analyses step-by-step



## Discussions

Discuss and reflect on applications of LLMs

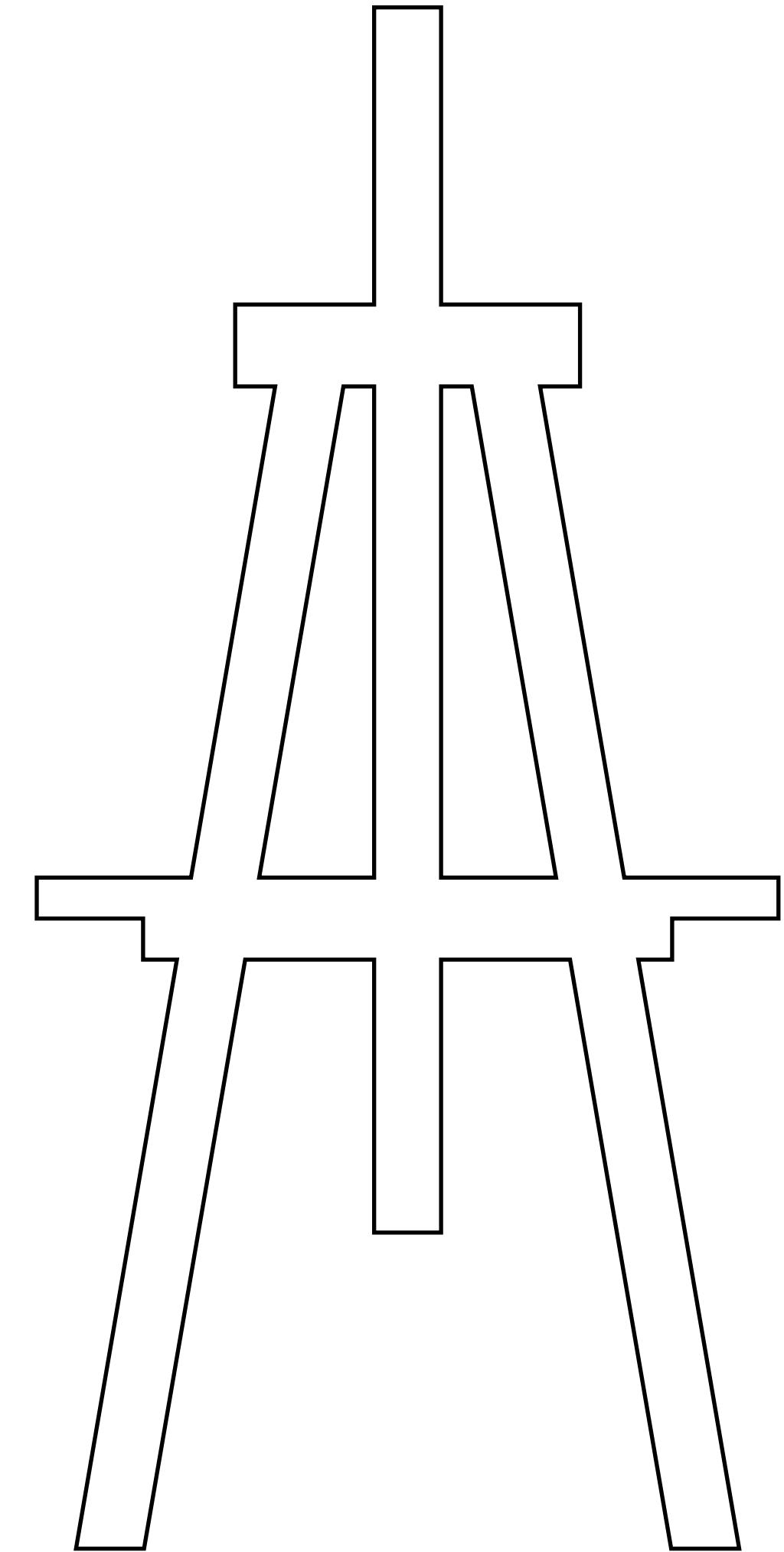


## Project sketching

Sketch and pitch an LLM project of your own

# Project

- † Any project using LLMs
- † Needs to be motivated (i.e., why is it interesting?)
- † Can be based on the exercises, but must go beyond (i.e., different data, different models, etc.)
- † Is presented at the end (max. 3 slides and 4 minutes)
- † Carried out after the event and documented in a two-page research article **submitted by Feb 23**



# Software stack



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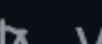
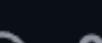
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 LLM4BeSci\_StGallen2025  Watch 0  Fork 0  Star 1  main   
 1 Branch   
 0 Tags Go to file  Add file  Code 

## About

This course introduces the use of open-source large language models (LLMs) from the Hugging Face ecosystem for research in the behavioral and social sciences.

 Readme View license Activity 1 star 0 watching 0 forks Report repository

## Releases

No releases published

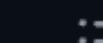
[Create a new release](#)

## Packages

No packages published

[Publish your first package](#)

 Zak-Hussain	update instructions	08087dc · 19 hours ago	 34 Commits
 day_1	task numbering change	3 days ago	
 day_2	task numbering change	3 days ago	
 day_3	update results	3 days ago	
 day_4	update instructions	19 hours ago	
 day_5	fix task ref	3 days ago	
 .gitignore	Initial commit	2 weeks ago	
 LICENSE.txt	add LICENSE.txt	2 weeks ago	
 README.md	own copy	3 days ago	
 notes.txt	add notes	4 days ago	

 README	 License	 
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# LLM4BeSci at GSERM, St. Gallen

# Schedule

<b>Day 1</b>	<b>Day 2</b>	<b>Day 3</b>	<b>Day 4</b>	<b>Day 5</b>
<i>Morning</i>	<i>Morning</i>	<i>Morning</i>	<i>Morning</i>	<i>Morning</i>
Welcome and intro to large language models	Intro to feature extraction and embedding models	Intro to classification and regression	Intro to token and text generation	Additional applications of LLMs for qualitative data analysis
<i>Afternoon</i>	<i>Afternoon</i>	<i>Afternoon</i>	<i>Afternoon</i>	<i>Afternoon</i>
Applying the Hugging Face ecosystem for open-source large language models	Applying large language models to predict the relationships between survey items and questionnaires in personality psychology	Applying large language models to evaluate and classify texts in political science	Applying large language models to predict the relationships between survey items and questionnaires in personality psychology	Project pitches

# Today

09:15 am - 09:45 am	Welcome & Intro
09:45 am - 10:45 am	Talk: Intro to LLMs
10:45 am - 11:00 am	Break
11:00 am - 12:00 pm	Exercise: Identify LLM applications in small groups
12:00 pm - 01:00 pm	Lunch
01:00 pm - 01:45 pm	Talk: A gentle intro to Hugging Face and Python
01:45 pm - 02:00 pm	Setup Colab
02:00 pm - 02:15 pm	Break
02:15 pm - 02:45 pm	Exercise: Run pipelines
02:45 pm - 03:15 pm	Walkthrough
03:15 pm - 04:00 pm	Consulting



1. Where are you from, what is your background, and what do you do?
2. What motivates you to learn more about LLMs?
3. R or Python or \_\_ ?
4. How much experiences do you have with programming and machine learning?

# Intro LLMs

Dirk Wulff & Zak Hussain

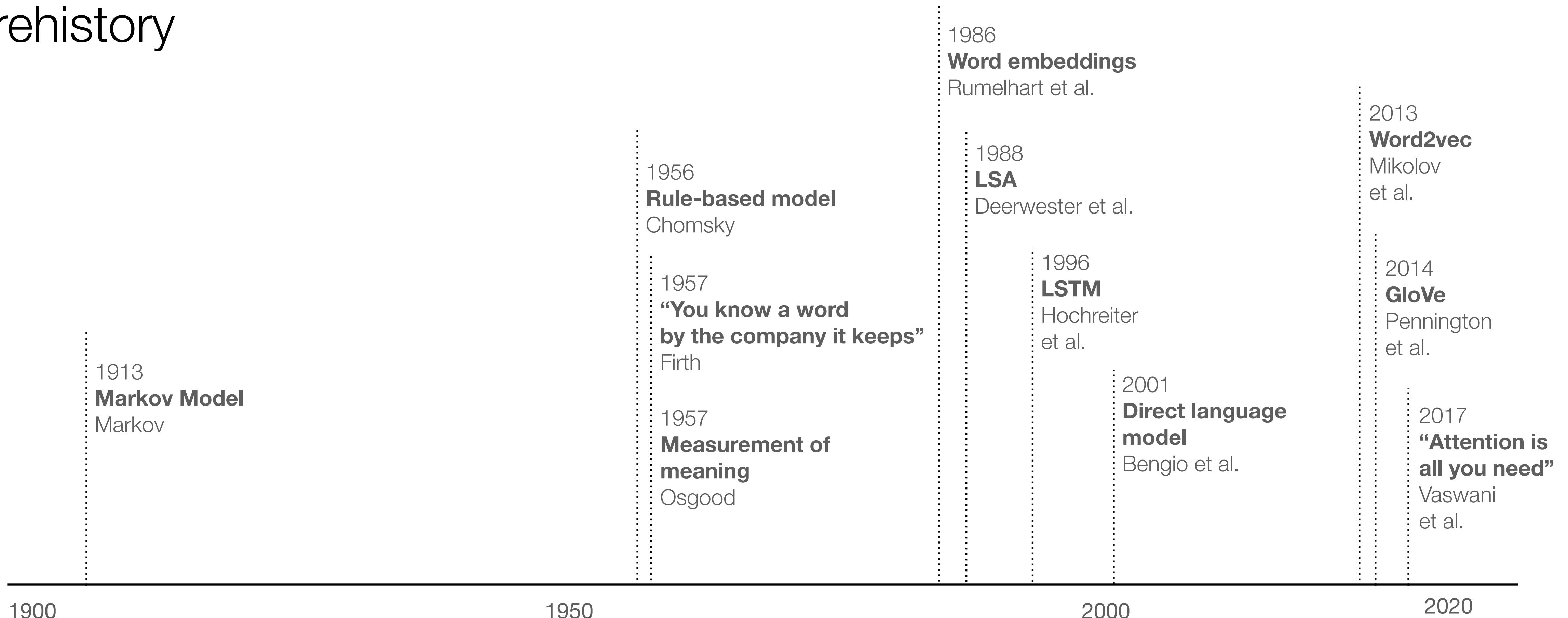


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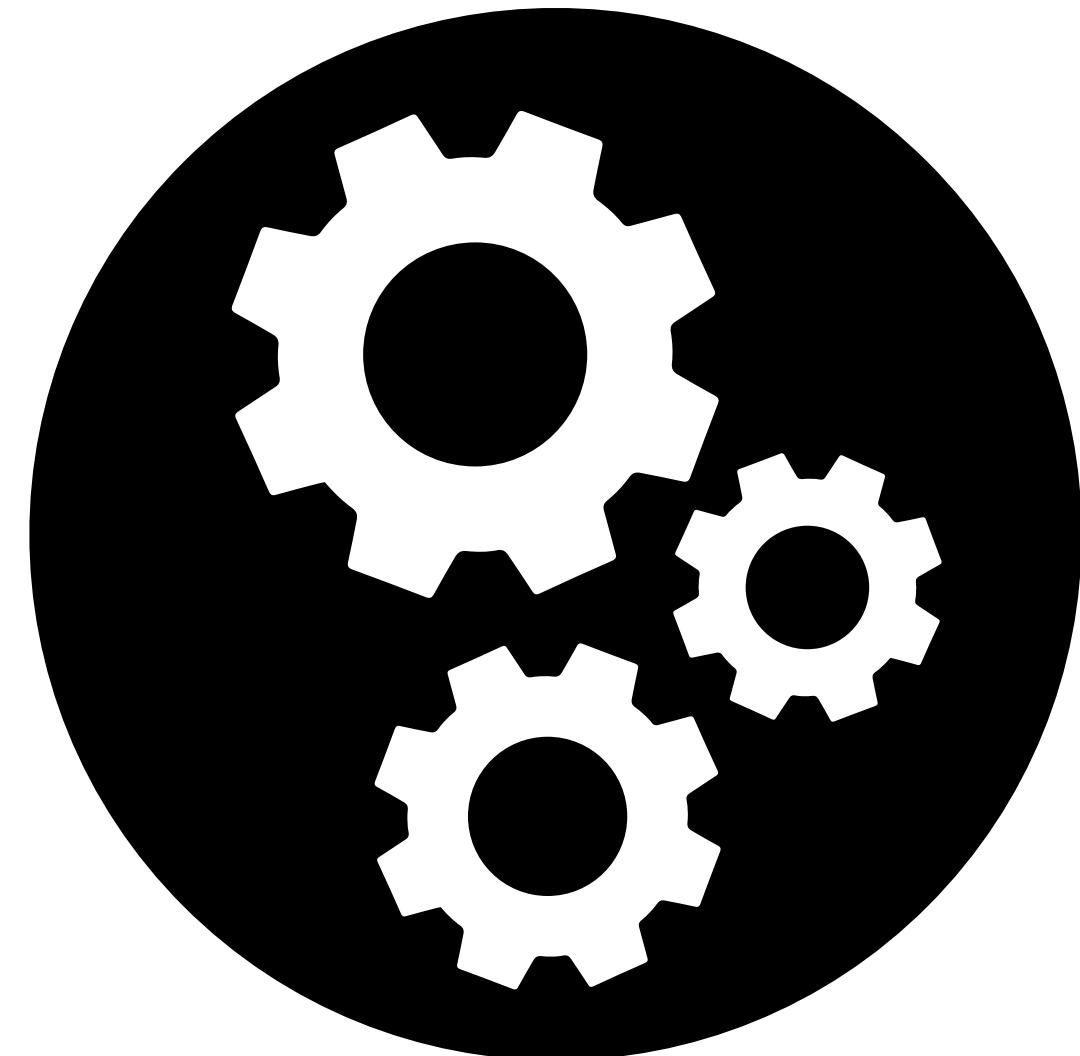
# Language models

## Prehistory

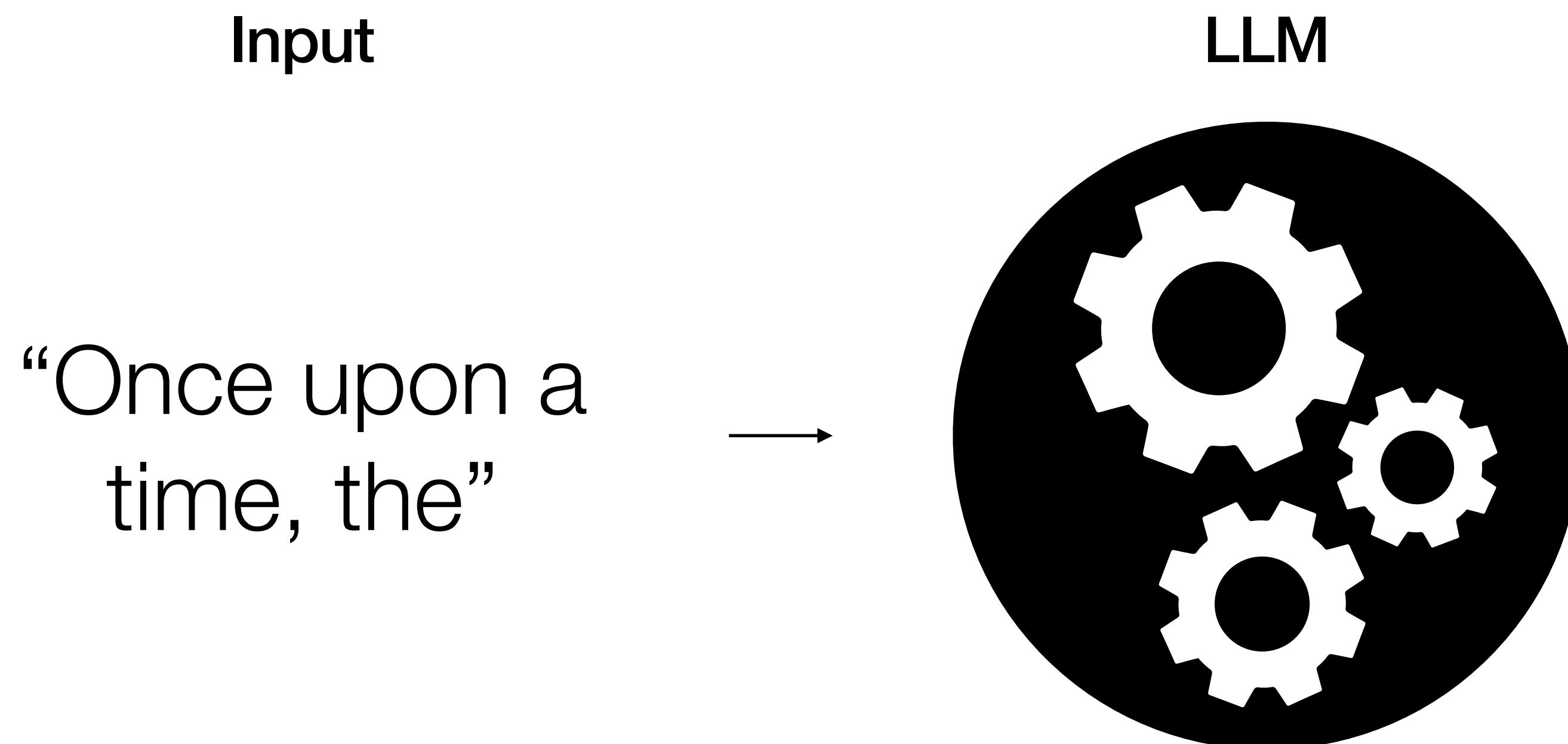


# LLMs as mechanisms

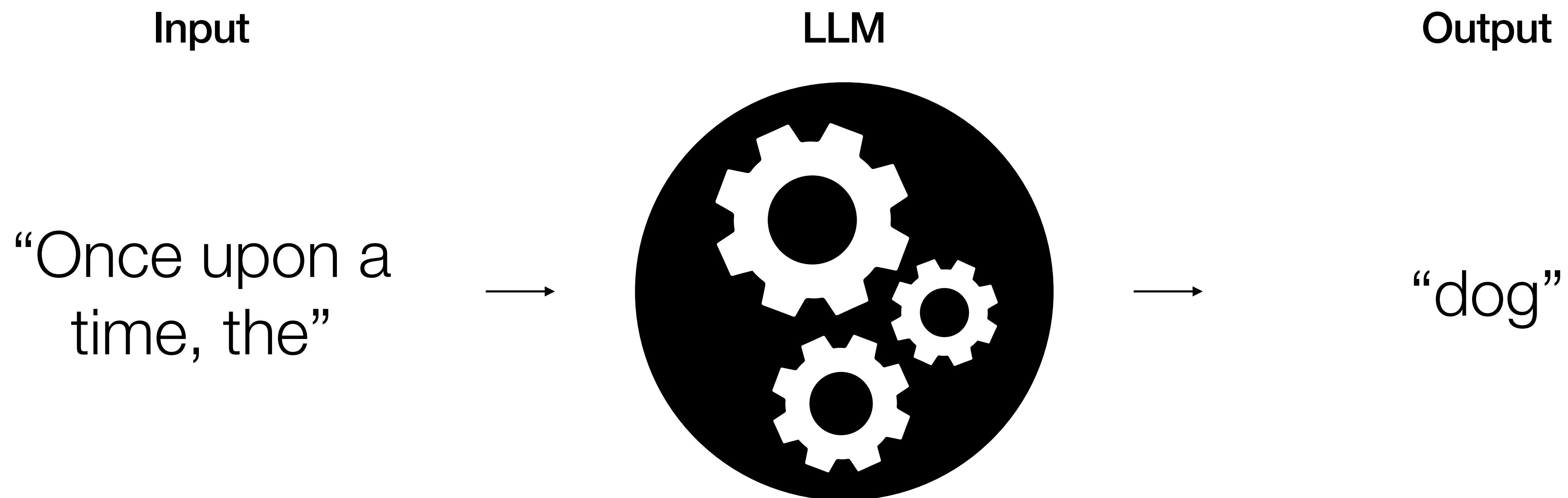
LLM



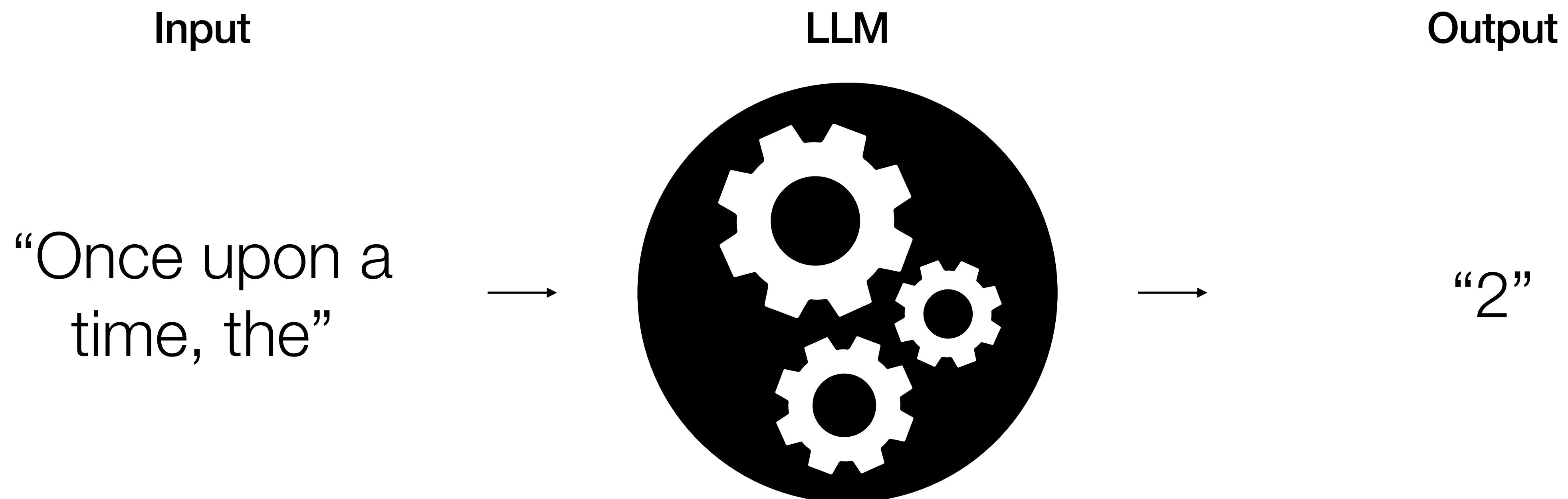
# LLMs as mechanisms



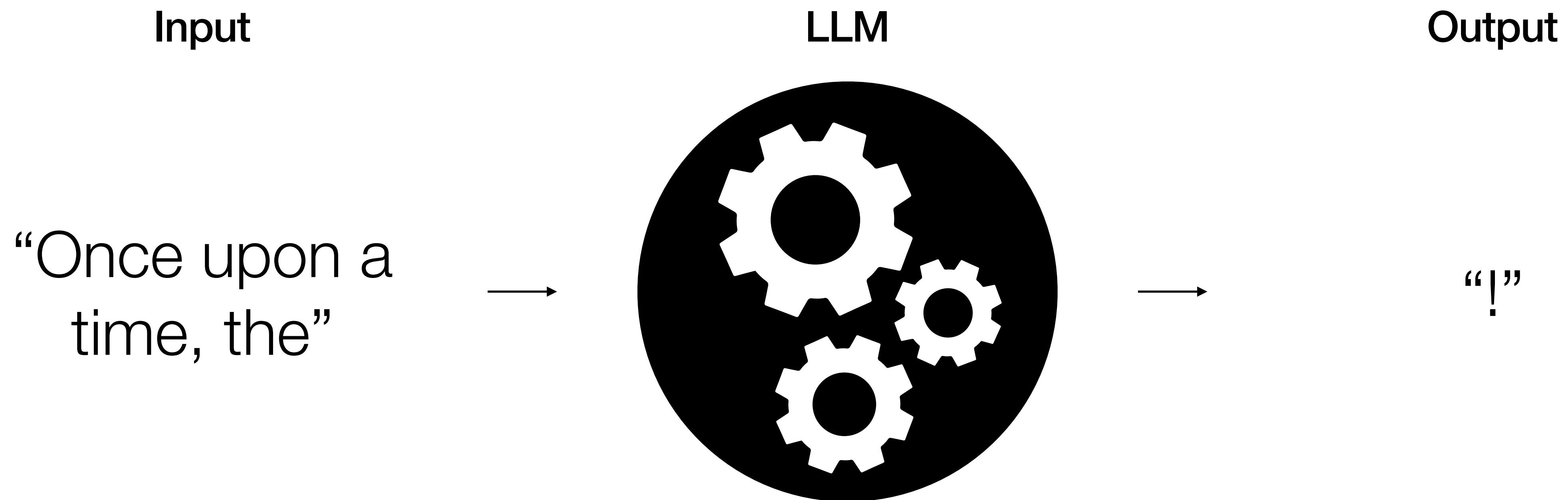
# LLMs as mechanisms



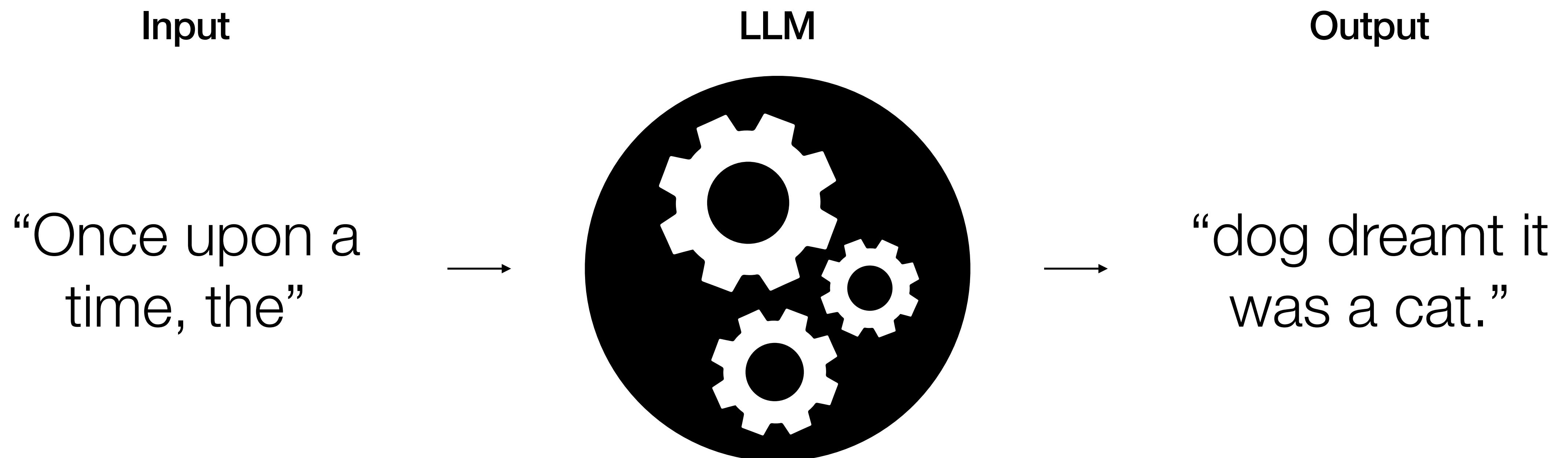
# LLMs as mechanisms



# LLMs as mechanisms



# LLMs as mechanisms



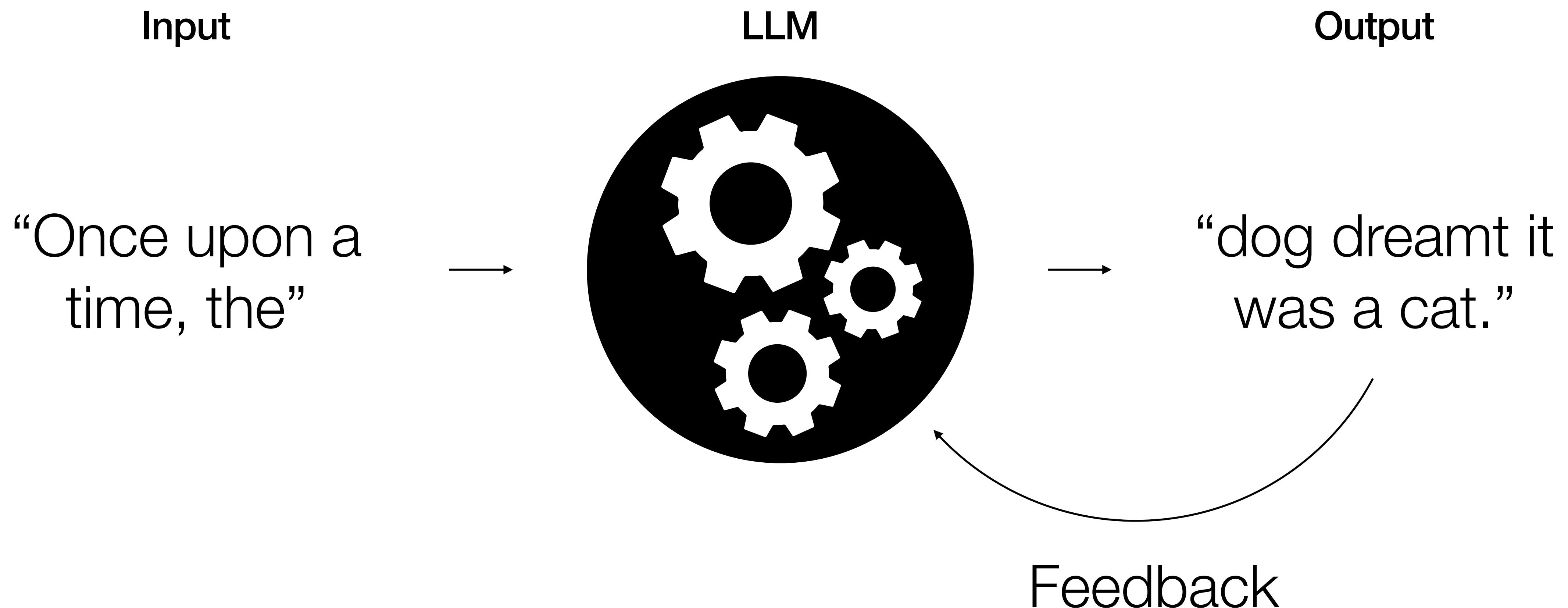
Once upon a time, the



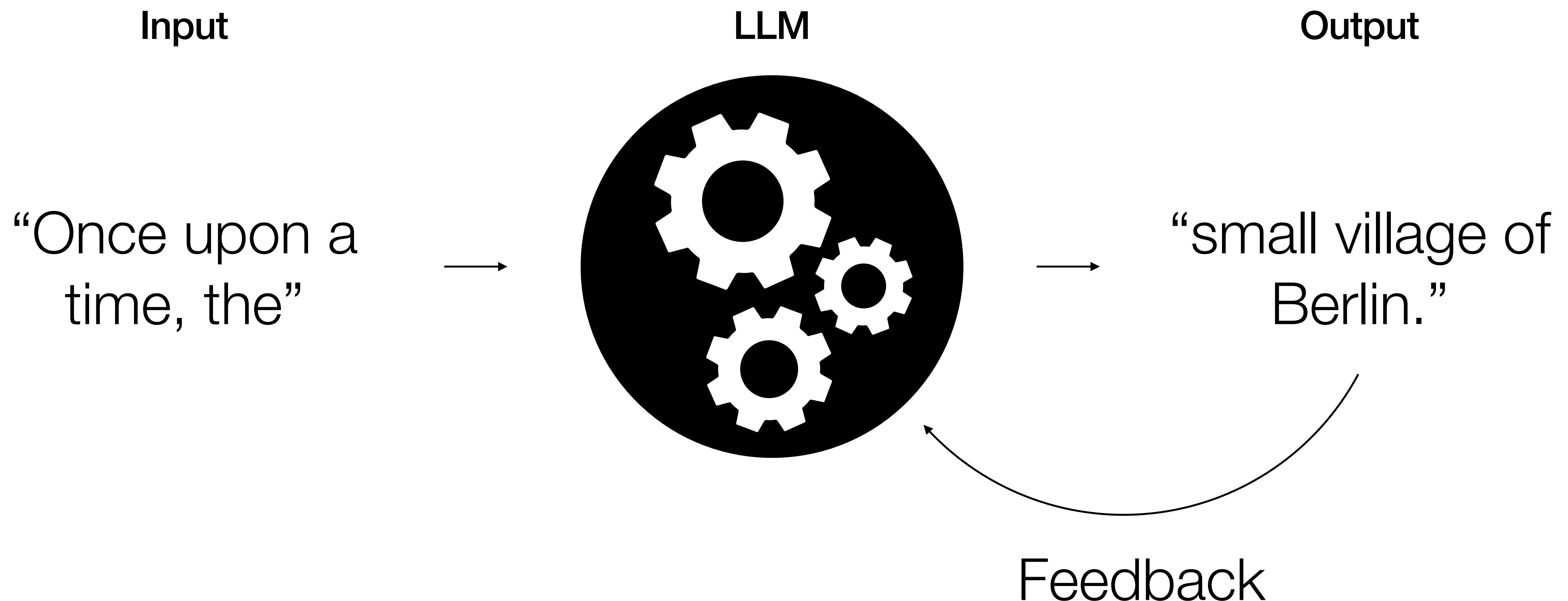
Once upon a time, the small village of Elmswood was nestled in a lush valley surrounded by towering mountains. The villagers lived peacefully, their days marked by the rhythms of nature and the changing seasons. However, everything changed when a mysterious old man arrived, carrying with him a locked chest that was said to contain a secret capable of altering the course of history. Intrigued by the stranger and his enigmatic treasure, the people of Elmswood soon found themselves on the brink of an adventure that would bind them together in ways they could never have imagined.



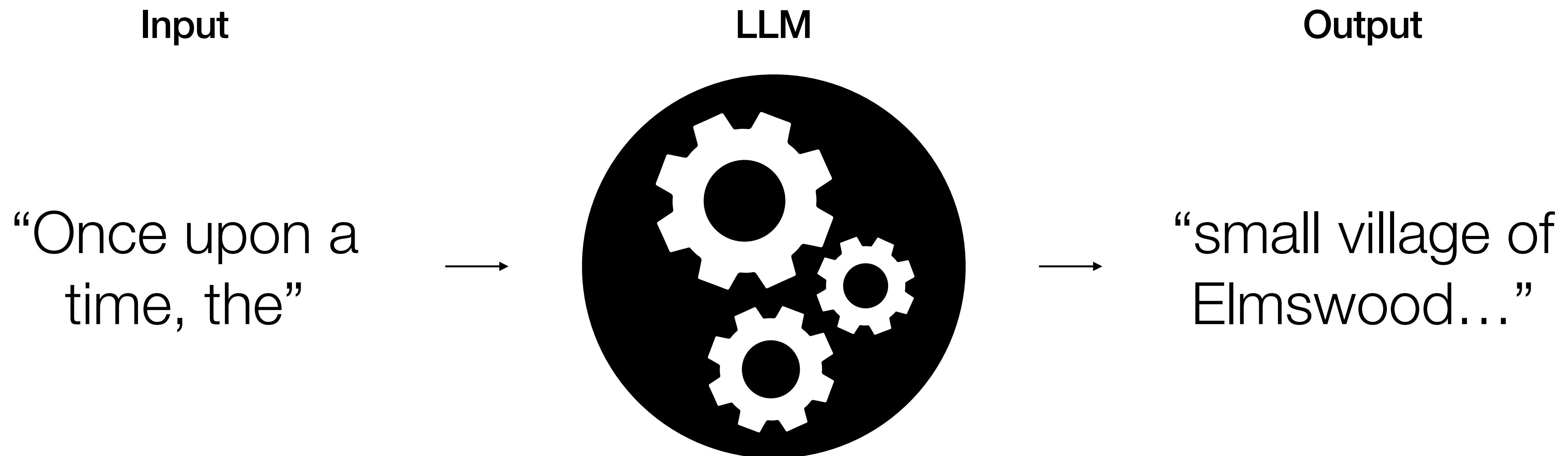
# LLMs as **trained** mechanisms



# LLMs as **trained** mechanisms



# LLMs as **trained** mechanisms



Phi-3-mini-4K-Instruct and Phi-3-mini-128K-Instruct were trained over 7 days on 3.3T tokens using 512 H100-80G GPUs for each model. They followed advanced fine-tuning techniques to align with human preferences and safety standards.

The pre-training process followed two distinct and consecutive stages:

- In the first stage, the models were primarily exposed to a vast collection of web sources. This data helped the models develop general knowledge and language comprehension.
- In the second stage, the models were fine-tuned with a more rigorously selected subset of web data from the first phase, combined with additional synthetic data, to improve their logical reasoning and specialized abilities.

After these 2 stages, the models underwent additional training, which included supervised instruction fine-tuning and preference tuning, to enhance their stability and security.

The training dataset, made of 3.3 trillion tokens, is a meticulously curated mix of quality-filtered public documents, select educational materials, code, and newly generated synthetic data generated by LLMs. Specifically, the team filtered the web data to encompass the appropriate degree of knowledge and retained a greater number of web pages that may enhance the models' reasoning abilities. Instead of indiscriminately feeding vast amounts of data into the training model, the emphasis was placed on enhancing its reasoning capabilities, rather than one that merely has a vast repository of information.



# Phi-3

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# **LLM training = Pretraining + Fine-tuning**

Trillions of tokens

Millions of power  
consumption

Uses masked/next token  
prediction

Hand-selected/crafted texts

Quality input-output pairs  
Human feedback

# Masked/next token prediction

"Once upon a time" is a [stock phrase](#) used to introduce a narrative of past events, typically in [fairy tales](#) and folk tales. It has been used in some form since at least 1380 (according to the [Oxford English Dictionary](#)) in [storytelling](#) in the [English language](#) and has started many narratives since 1600. These stories sometimes end with "and they all lived [happily ever after](#)", or, originally, "happily until their deaths".

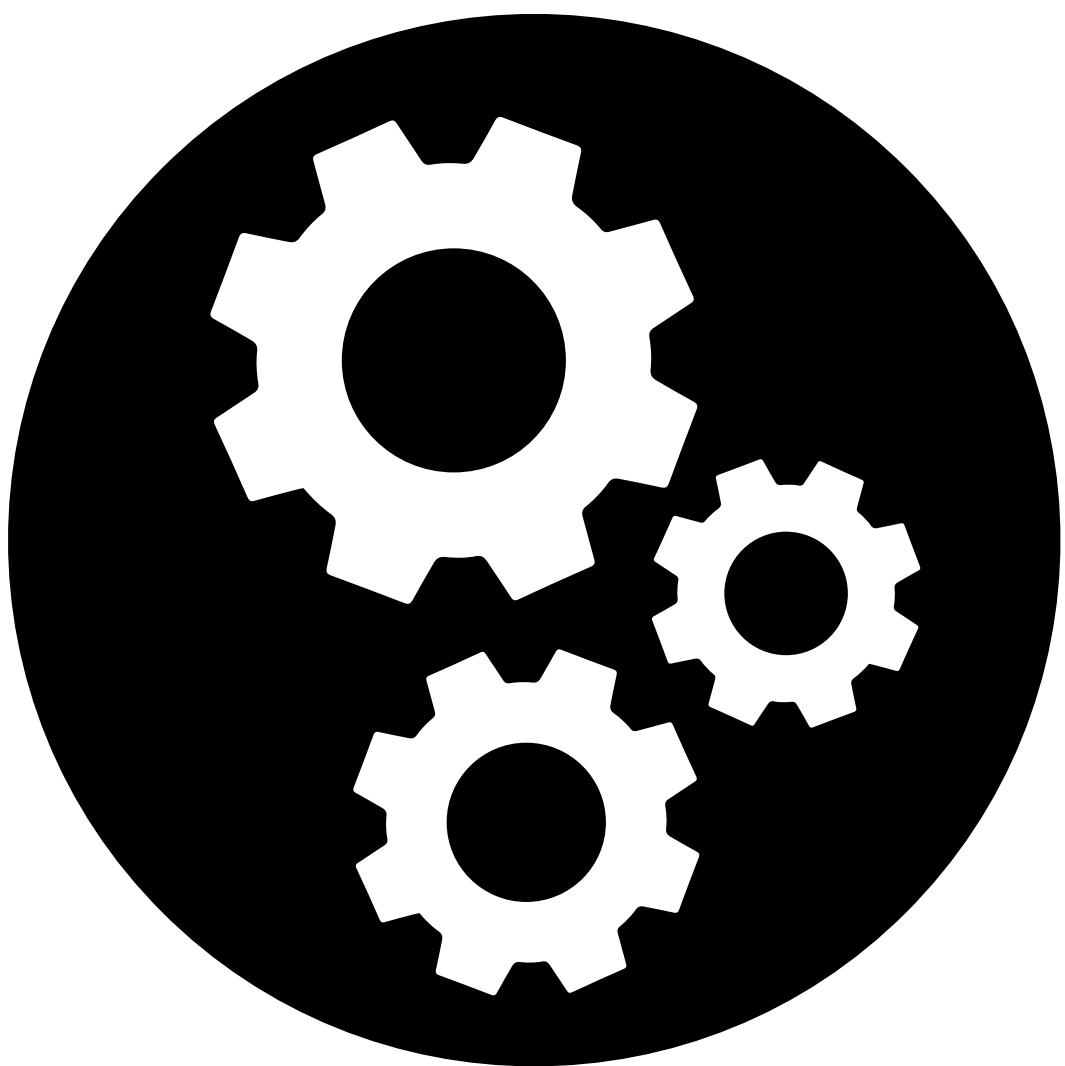
The phrase is common in [fairy tales](#) for younger children. It was used in the original translations of the stories of [Charles Perrault](#) as a translation for the [French](#) "*il était une fois*", of [Hans Christian Andersen](#) as a translation for the [Danish](#) "*der var engang*" (literally "there was once"), the [Brothers Grimm](#) as a translation for the [German](#) "*es war einmal*" (literally "it was once") and [Joseph Jacobs](#) in [English](#) translations and fairy tales.

In *More English Fairy Tales*, Joseph Jacobs notes that:

"The opening formulae are varied enough, but none of them has much play of fancy. 'Once upon a time and a very good time it was, though it wasn't in my time nor in your time nor in any one else's time.' is effective enough for a fairy epoch, and is common, according to Mayhew (*London Labour*, III), among tramps."<sup>[1]</sup>

[https://en.wikipedia.org/wiki/Once\\_upon\\_a\\_time](https://en.wikipedia.org/wiki/Once_upon_a_time)

LLM



# Masked/next token prediction

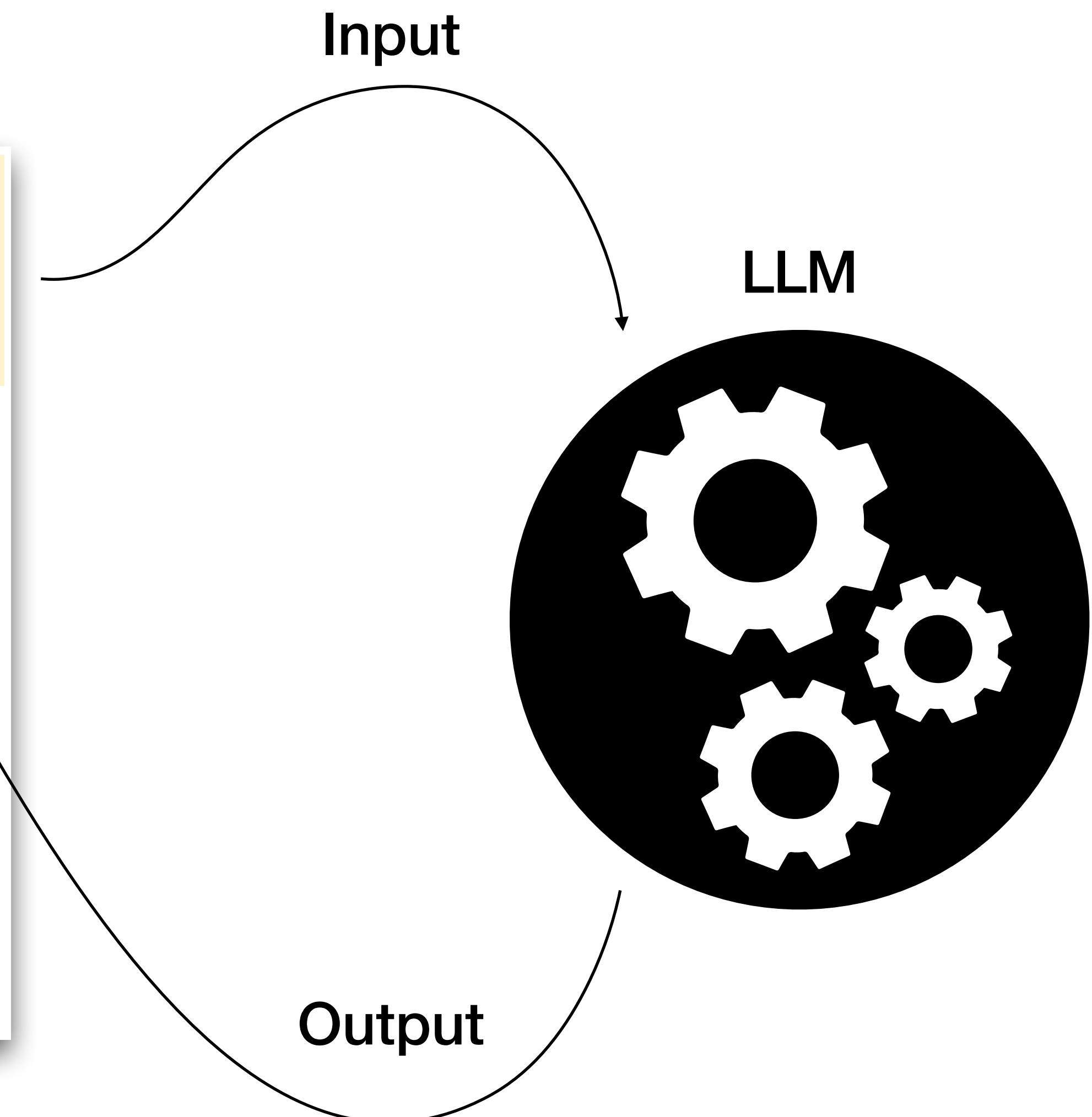
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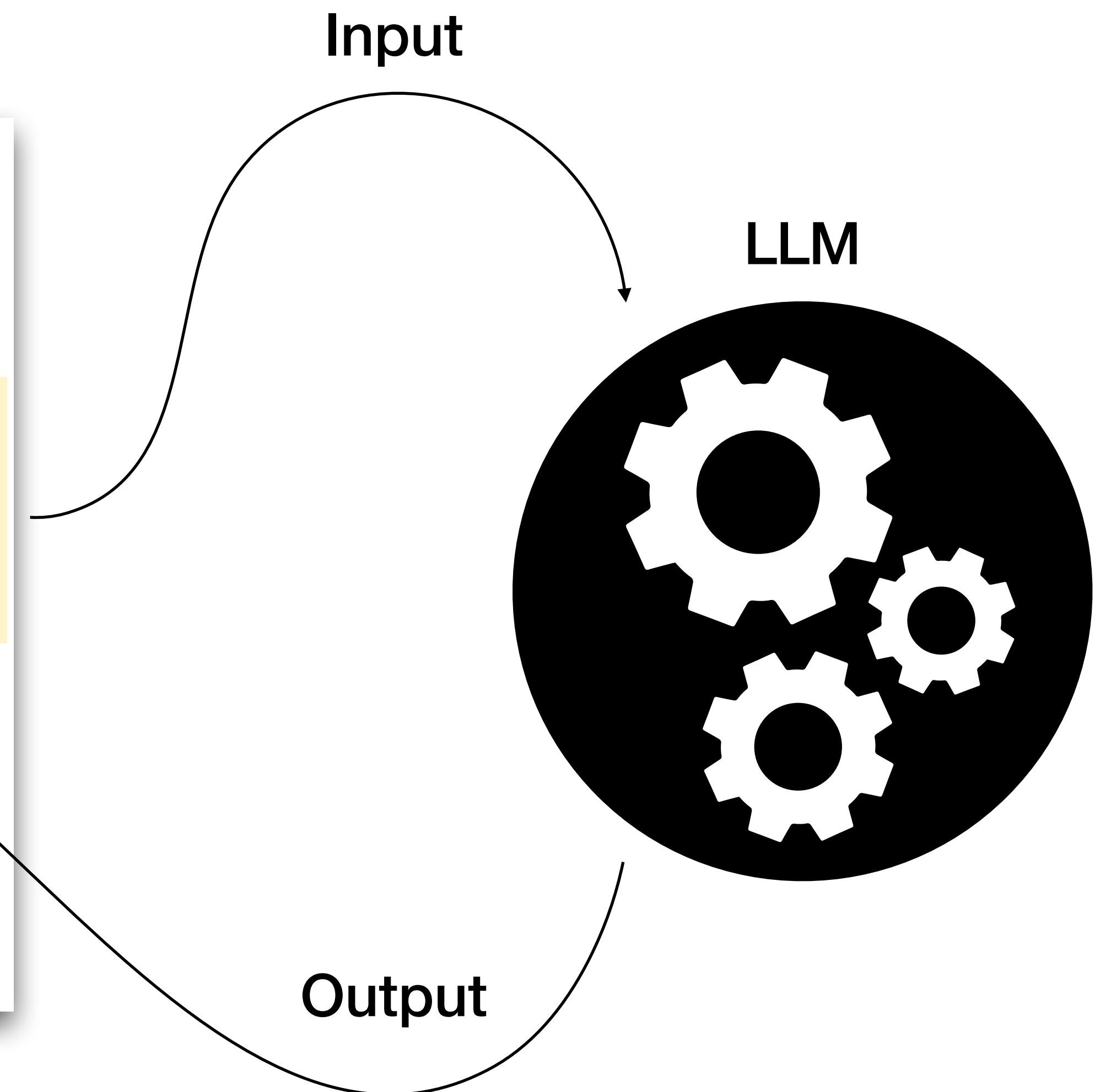
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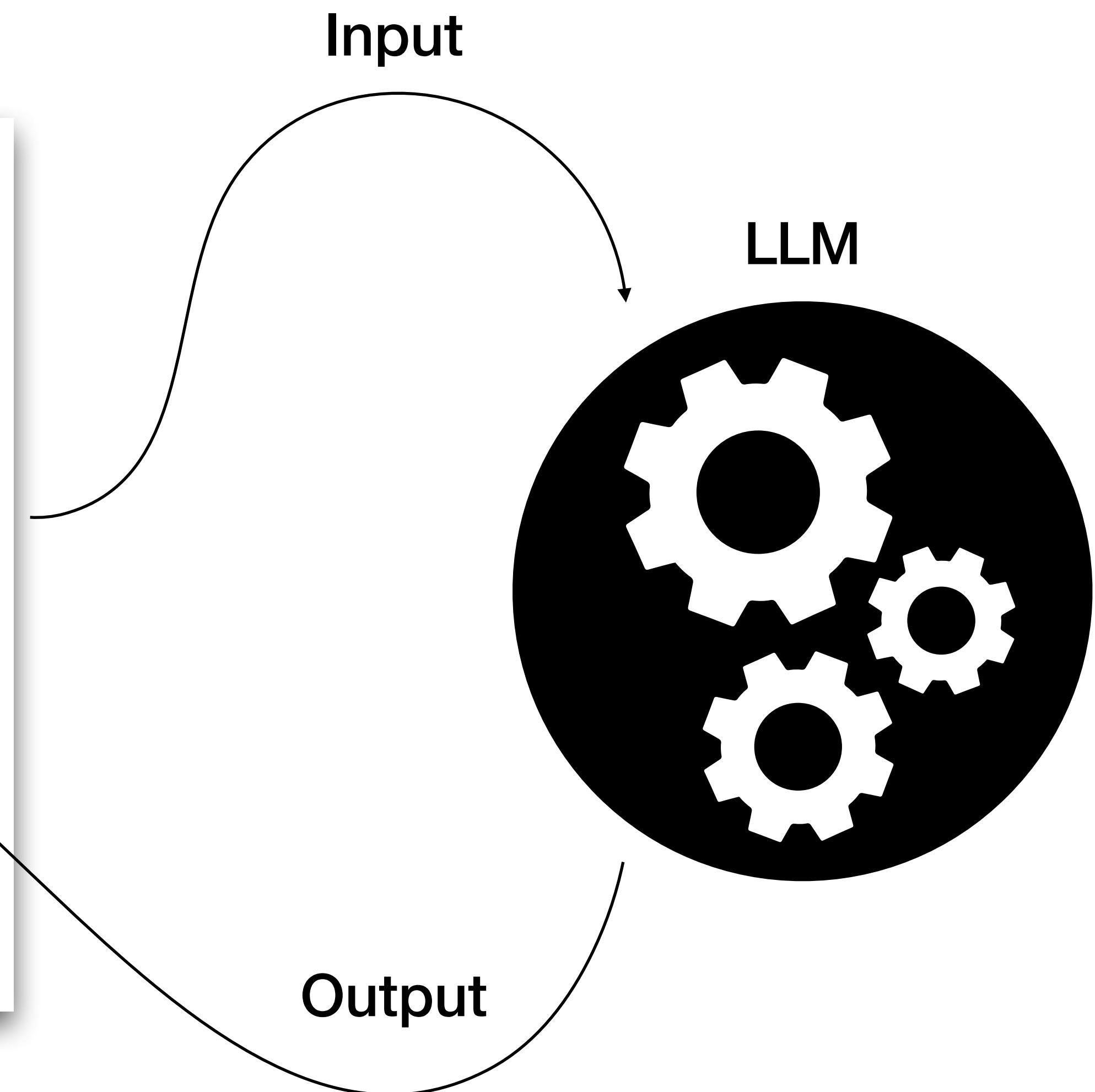
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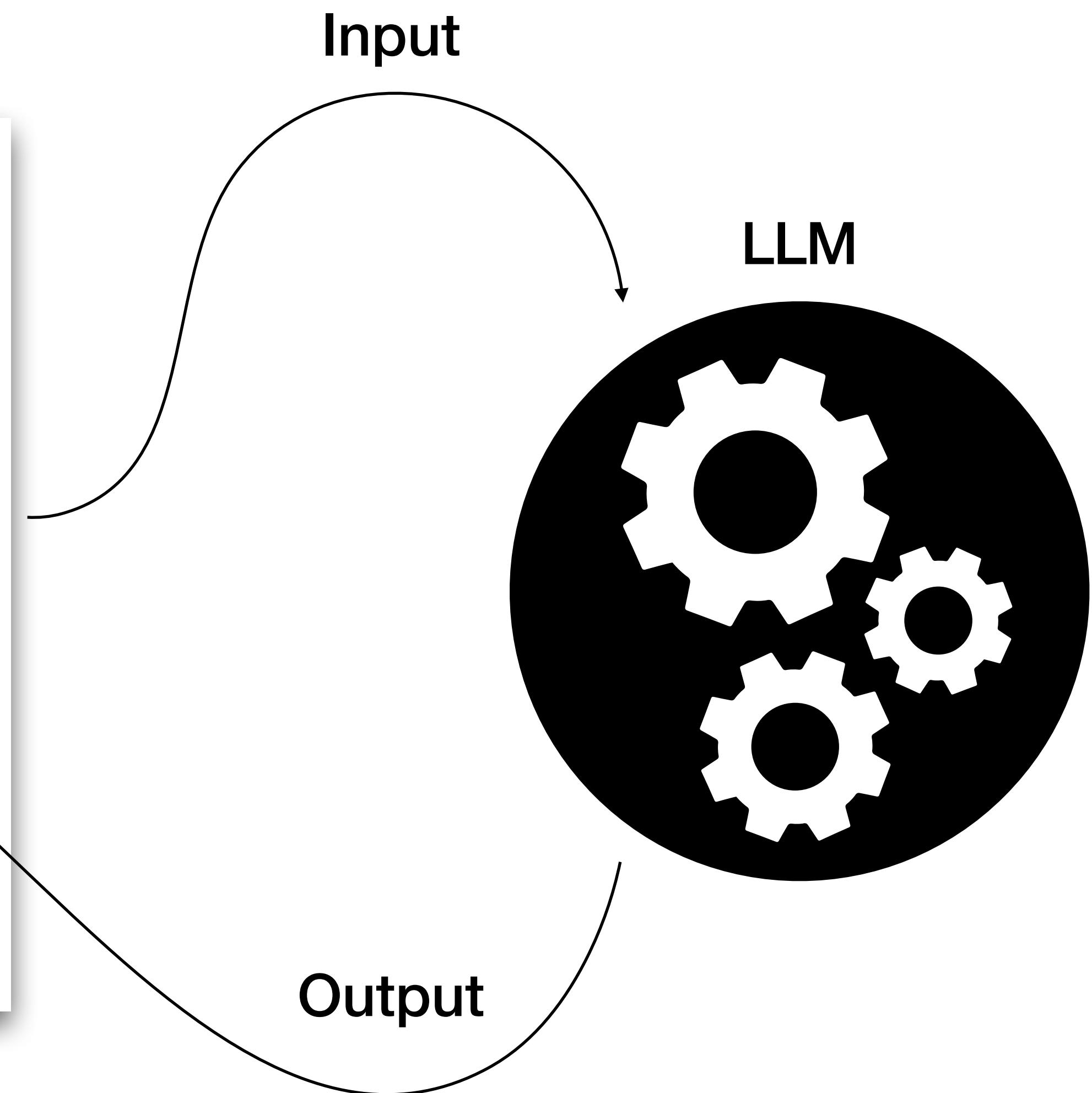
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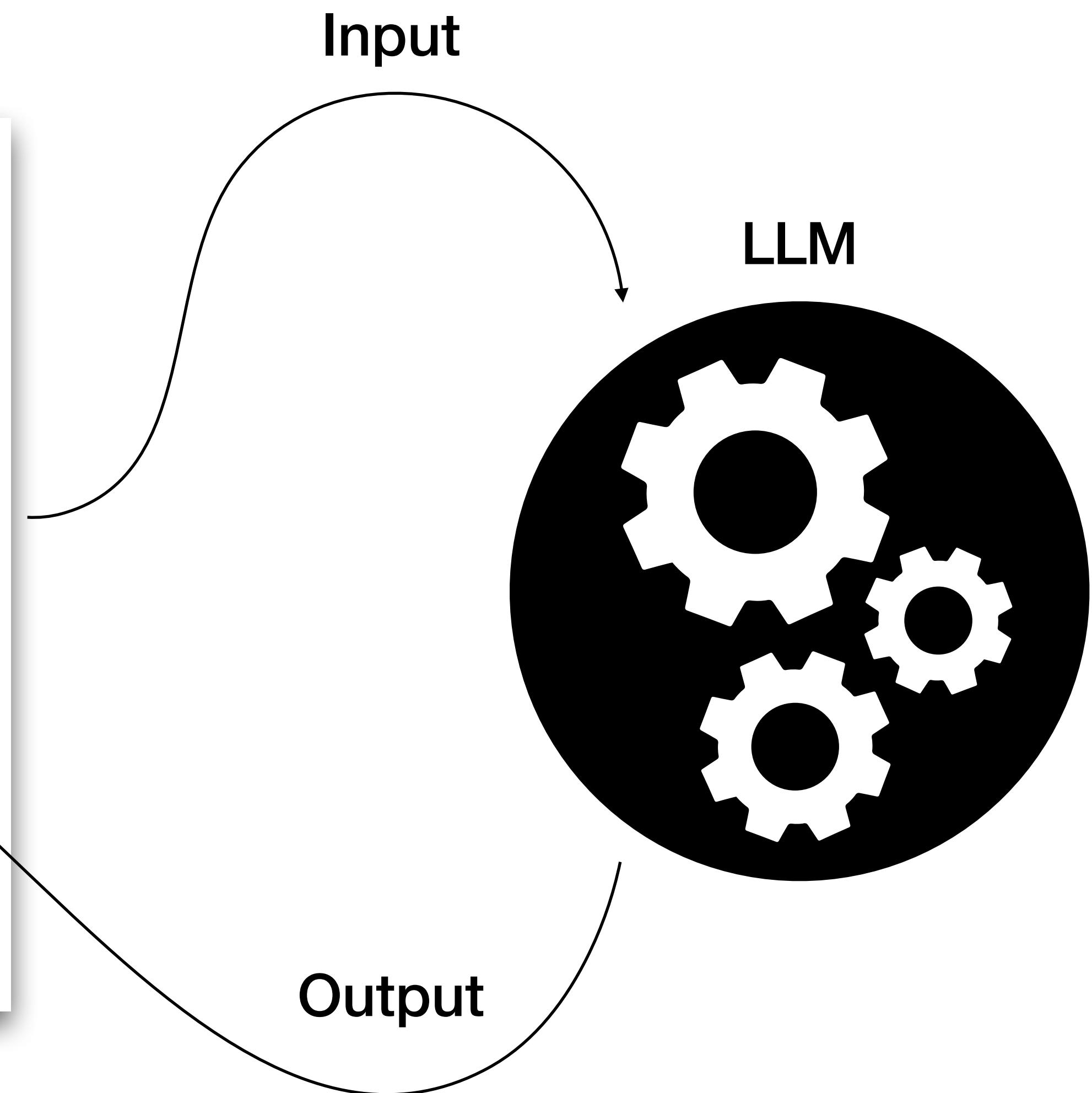
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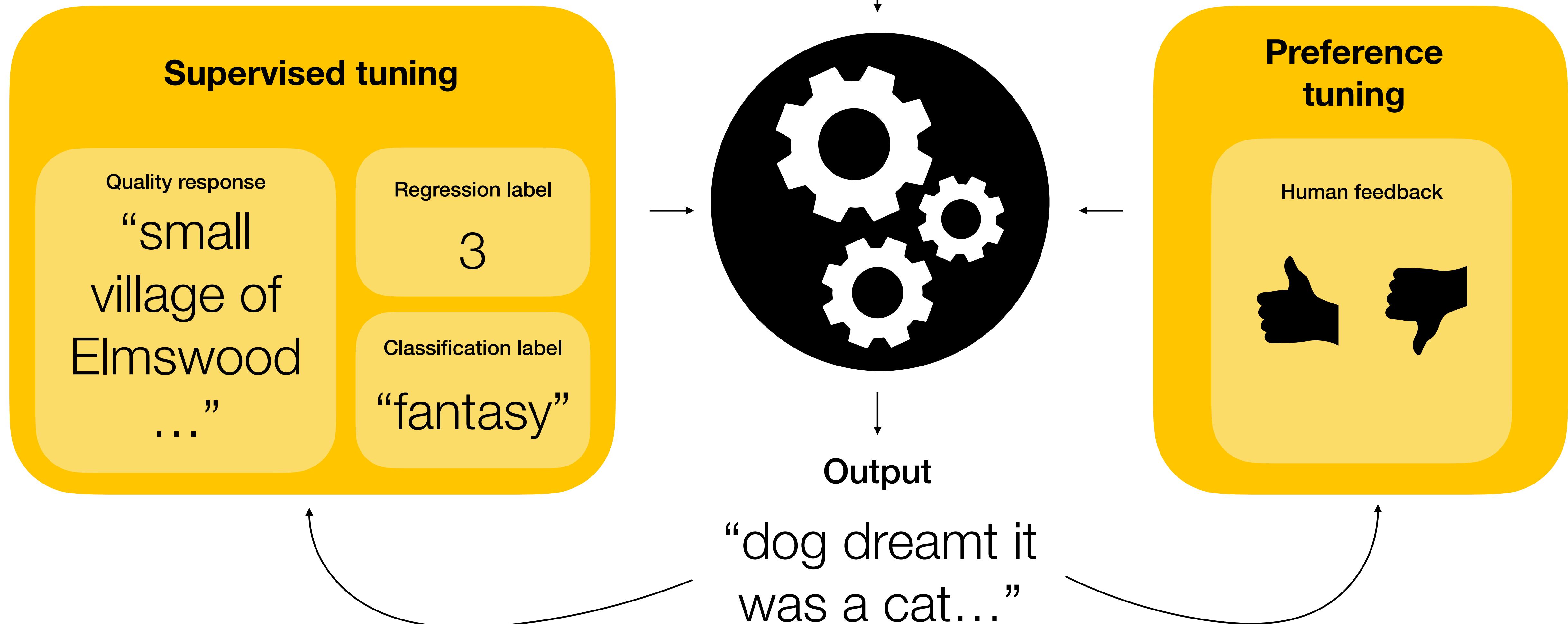
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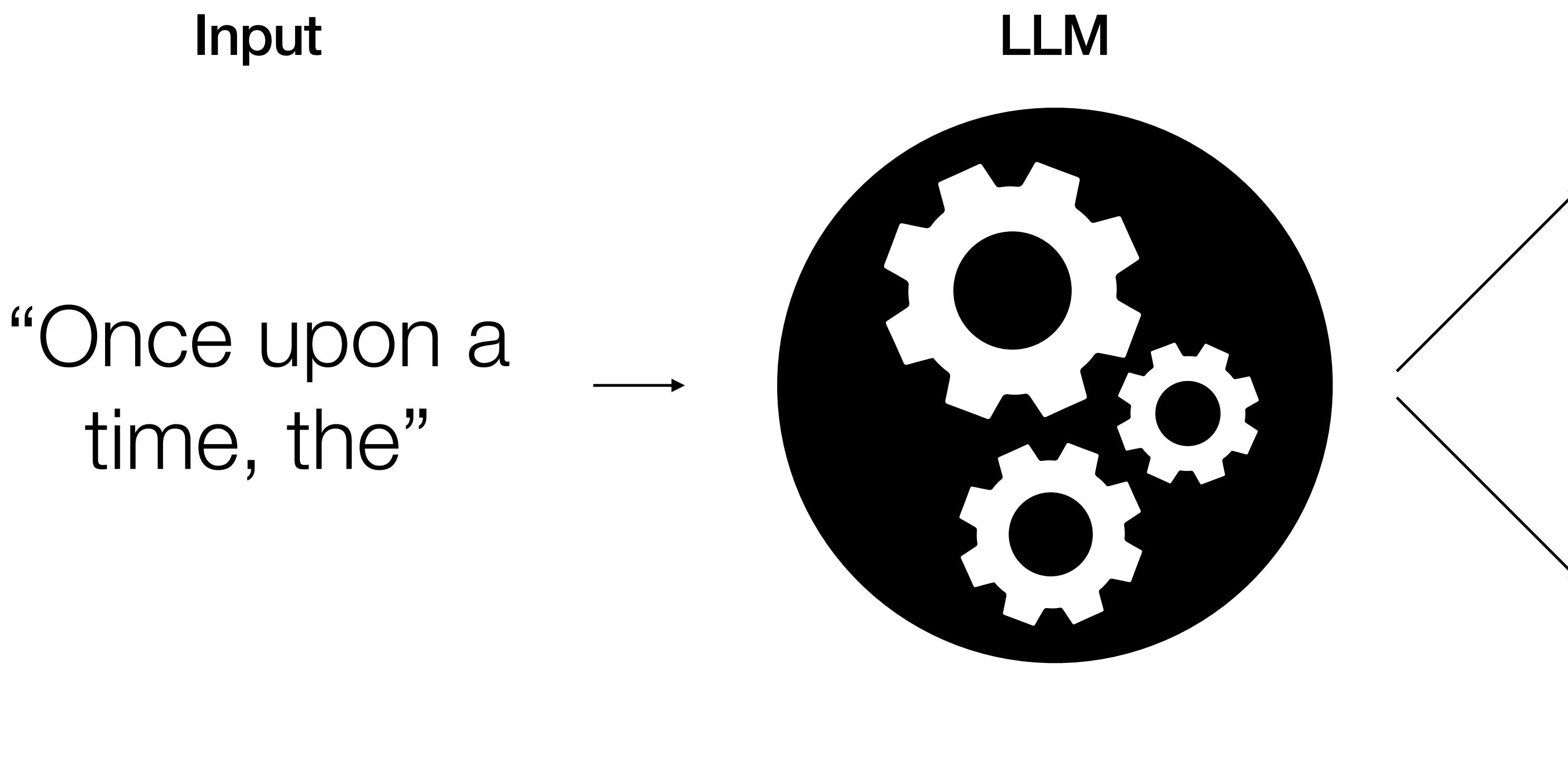
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# Fine-tuning

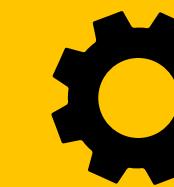


# Two major applications



## Text generation

“small village of  
Elmswood...”



## Feature extraction

-.23, 1.23, .24,  
-.12, .34, .32, ...

# Closed vs. Open

Public use

Performance

Safety

Reproducible

Data secure

Interpretable



Tasks Libraries Datasets Languages Licenses Other

Filter Tasks by name

Multimodal

Audio-Text-to-Text Image-Text-to-Text  
Visual Question Answering Document Question Answering Video-Text-to-Text  
Visual Document Retrieval Any-to-Any

Computer Vision

Depth Estimation Image Classification  
Object Detection Image Segmentation  
Text-to-Image Image-to-Text Image-to-Image  
Image-to-Video Unconditional Image Generation  
Video Classification Text-to-Video  
Zero-Shot Image Classification Mask Generation  
Zero-Shot Object Detection Text-to-3D  
Image-to-3D Image Feature Extraction  
Keypoint Detection

Natural Language Processing

Text Classification Token Classification  
Table Question Answering Question Answering  
Zero-Shot Classification Translation  
Summarization Feature Extraction

Models 1,680,396

Filter by name

Full-text search

↑↓ Sort: Trending

nvidia/parakeet-tdt-0.6b-v2  
Automatic Speech Recognition • Updated 10 days ago • ↓ 72.7k • ❤ 691

ACE-Step/ACE-Step-v1-3.5B  
Text-to-Audio • Updated 1 day ago • ❤ 310

nari-labs/Dia-1.6B  
Text-to-Speech • Updated 5 days ago • ↓ 148k • ⚡ • ❤ 2.04k

Lightricks/LTX-Video  
Text-to-Video • Updated 5 days ago • ↓ 214k • ⚡ • ❤ 1.38k

JetBrains/Mellum-4b-base  
Text Generation • Updated 4 days ago • ↓ 2.81k • ❤ 311

Qwen/Qwen3-235B-A22B  
Text Generation • Updated 10 days ago • ↓ 82.4k • ⚡ • ❤ 764

deepseek-ai/DeepSeek-Prover-V2-671B  
Text Generation • Updated 11 days ago • ↓ 7.38k • ⚡ • ❤ 750

lodestones/Chroma  
Text-to-Image • Updated 1 day ago • ❤ 401

black-forest-labs/FLUX.1-dev  
Text-to-Image • Updated Aug 16, 2024 • ↓ 2.66M • ⚡ • ❤ 10.1k

cognition-ai/Kevin-32B  
Updated 5 days ago • ↓ 342 • ❤ 93

Qwen/Qwen3-30B-A3B  
Text Generation • Updated 11 days ago • ↓ 150k • ⚡ • ❤ 514

microsoft/Phi-4-reasoning-plus  
Text Generation • Updated 3 days ago • ↓ 10.8k • ❤ 240

tencent/HunyuanCustom  
Image-to-Video • Updated 2 days ago • ❤ 77

Tesslate/UIGEN-T2-7B-Q8\_0-GGUF  
Text Generation • Updated 5 days ago • ↓ 2.59k • ❤ 115

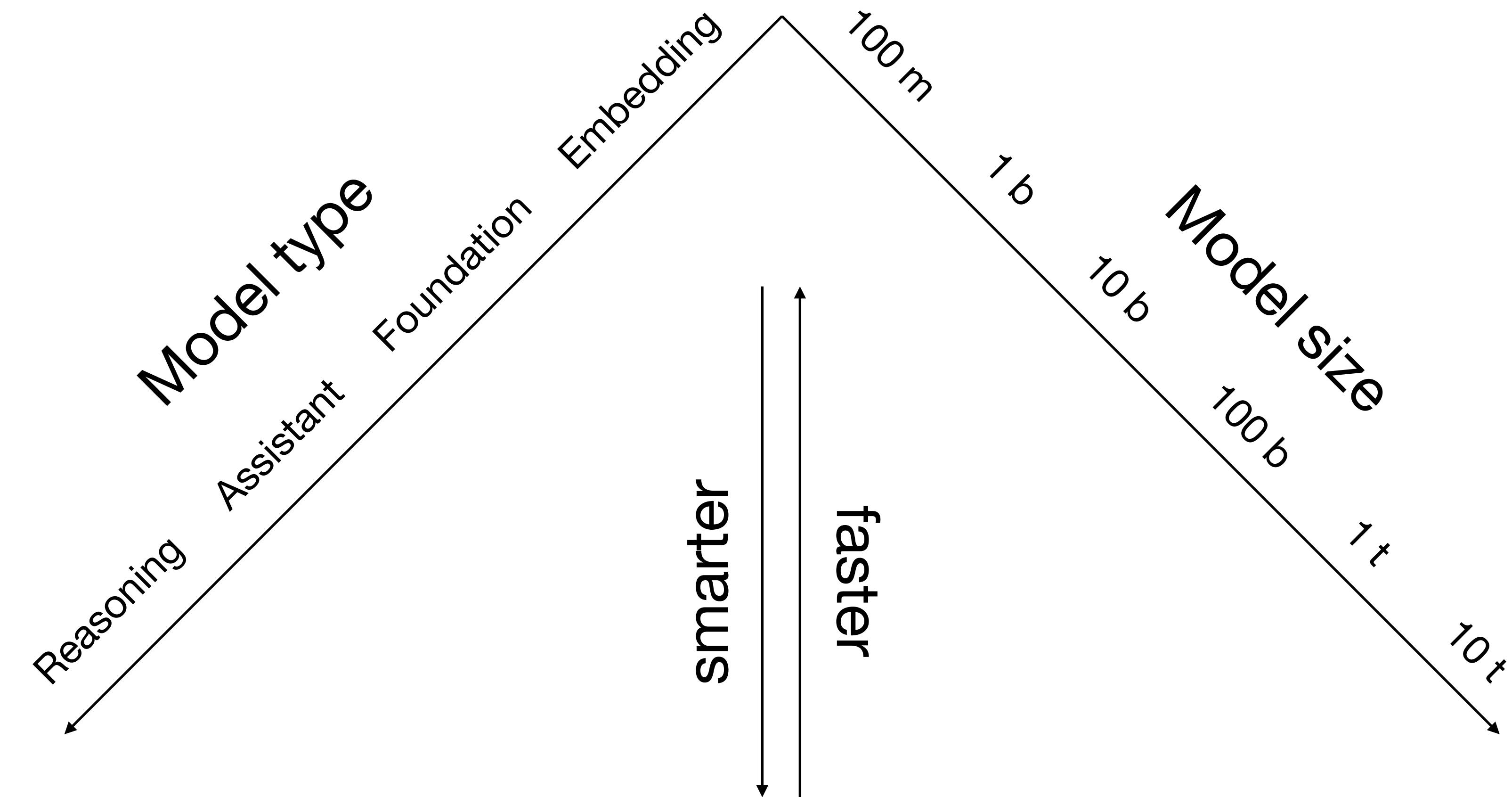
hexgrad/Kokoro-82M  
Text-to-Speech • Updated about 1 month ago • ↓ 1.88M • ⚡ • ❤ 4.27k

fdtn-ai/Foundation-Sec-8B  
Text Generation • Updated 10 days ago • ↓ 21.5k • ❤ 145

ServiceNow-AI/AprielandNemotron-15b-Thinker  
Updated 4 days ago • ↓ 784 • ❤ 66

Qwen/Qwen3-8B  
Text Generation • Updated 12 days ago • ↓ 394k • ❤ 262

# Distinguishing LLMs



Project (maker, bases, URL)	Availability						Documentation						Access		
	Open code	LLM data	LLM weights	RL data	RL weights	License	Code	Architecture	Preprint	Paper	Modelcard	Datasheet	Package	API	
OLMo 7B Instruct Ai2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	~
BLOOMZ bigscience-workshop	✓	✓	✓	✓	~	~	✓	✓	✓	✓	✓	✓	✗	✓	12.0
AmberChat LLM360	✓	✓	✓	✓	✓	✓	~	~	✓	✗	~	~	✗	✓	10.0
Open Assistant LAION-AI	✓	✓	✓	✓	✗	✓	✓	✓	~	✗	✗	✗	✓	✓	9.5
...															
Command R+ Cohere AI	✗	✗	✗	✓	✓	~	✗	✗	✗	✗	~	✗	✗	✗	3.0
LLaMA2 Chat Facebook Research	✗	✗	~	✗	~	✗	✗	~	~	✗	~	✗	✗	✗	3.0
Nanbeige2-Chat Nanbeige LLM lab	✓	✗	✗	✗	✓	~	✗	✗	✗	✗	✗	✗	✗	~	3.0
Llama 3 Instruct Facebook Research	✗	✗	~	✗	~	✗	✗	~	✗	✗	~	✗	✗	~	2.5
Solar 70B Upstage AI	✗	✗	~	✗	~	✗	✗	✗	✗	✗	~	✗	✗	~	2.0
Xwin-LM Xwin-LM	✗	✗	~	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	~	1.0
ChatGPT OpenAI	✗	✗	✗	✗	✗	✗	✗	✗	~	✗	✗	✗	✗	✗	0.5

see also <https://osai-index.eu/the-index>

# LMSYS Chatbot Arena Leaderboard

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LMSYS [Chatbot Arena](#) is a crowdsourced open platform for LLM evals. We've collected over 1,000,000 human pairwise comparisons to rank LLMs with the [Bradley-Terry model](#) and display the model ratings in Elo-scale. You can find more details in our [paper](#).

Arena

Full Leaderboard

Total #models: 99. Total #votes: 1,170,955. Last updated: 2024-05-20.

⚠ NEW! View leaderboard for different categories (e.g., coding, long user query)! This is still in preview and subject to change.

Rank* (UB) ▲	Rank (StyleCtrl) ▲	Model	Arena Score	95% CI ▲	Votes ▲	Organization	License
1	1	<a href="#">Gemini-Exp-1206</a>	1374	+4/-5	20227	Google	Proprietary
1	1	<a href="#">ChatGPT-4o-latest...(2024-11-20)</a>	1365	+4/-3	33383	OpenAI	Proprietary
1	4	<a href="#">Gemini-2.0-Flash-Thinking-Exp-1219</a>	1364	+5/-6	15728	Google	Proprietary
2	4	<a href="#">Gemini-2.0-Flash-Exp</a>	1357	+6/-4	19030	Google	Proprietary
3	1	<a href="#">o1-2024-12-17</a>	1351	+7/-7	7289	OpenAI	Proprietary
6	4	<a href="#">o1-preview</a>	1335	+4/-4	33194	OpenAI	Proprietary
7	7	<a href="#">DeepSeek-V3</a>	1319	+6/-6	10510	DeepSeek	DeepSeek
7	10	<a href="#">Step-2-16K-Exp</a>	1305	+8/-9	3374	StepFun	Proprietary

Overall	Bitext Mining	Classification	Clustering	Pair Classification	Reranking	Retrieval	STS	Summarization	Retrieval w/Instructions
English	Chinese	French	Polish						
<b>Overall MTEB English leaderboard 🎉</b>									
<ul style="list-style-type: none"> <li><b>Metric:</b> Various, refer to task tabs</li> <li><b>Languages:</b> English</li> </ul>									
Rank	Model	Model Size (Million Parameters)	Memory Usage (GB, fp32)	Embedding Dimensions	Max Tokens	Average (56 datasets)	Classification Average (12 datasets)	Clustering Average (11 datasets)	
1	<a href="#">NV-Embed-v1</a>					69.32	87.35	52.8	
2	<a href="#">voyage-large-2-instruct</a>			1024	16000	68.28	81.49	53.35	
3	<a href="#">SFR-Embedding-Mistral</a>	7111	26.49	4096	32768	67.56	78.33	51.67	
4	<a href="#">gte-Qwen1.5-7B-instruct</a>	7099	26.45	4096	32768	67.34	79.6	55.83	
5	<a href="#">voyage-lite-02-instruct</a>	1220	4.54	1024	4000	67.13	79.25	52.42	
6	<a href="#">GritLM-7B</a>	7242	26.98	4096	32768	66.76	79.46	50.61	
7	<a href="#">e5-mistral-7b-instruct</a>	7111	26.49	4096	32768	66.63	78.47	50.26	
8	<a href="#">google-gecko.text-embedding-p</a>	1200	4.47	768	2048	66.31	81.17	47.48	
9	<a href="#">SE_v1</a>					65.66	76.8	47.38	
10	<a href="#">GritLM-8x7B</a>	46703	173.98	4096	32768	65.66	78.53	50.14	

# Models

BERTish

**all-MiniLM-L6-v2**  
**MPNet**  
**MPNet-personality**



Feature extraction  
(fine-tuning)

Open GPTs

**Llama 3.2 3B**



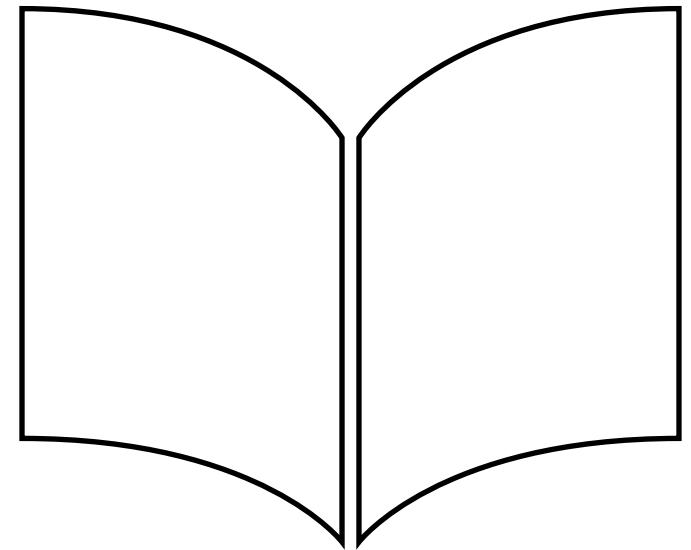
Text-generation  
(in-context learning)

# Applications



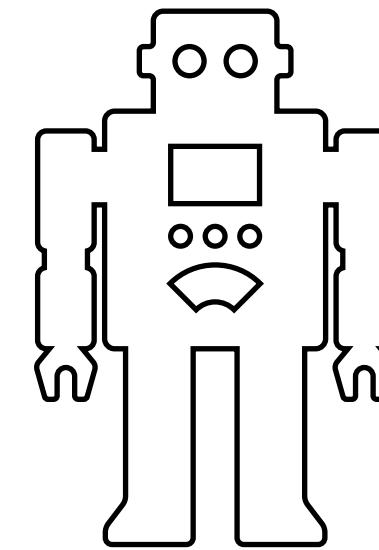
## Personality

Predict the relatedness among survey items and between items and constructs based on **feature extraction**



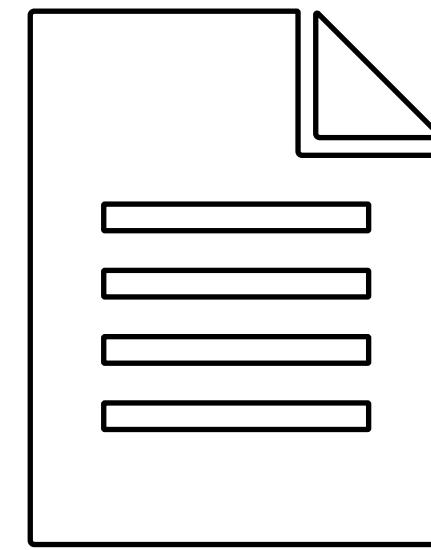
## Media bias

Predict media bias based on headline texts using **text generation** and **fine-tuning**



## Synthetic samples

Generate human-like responses using **text generation** to simulate human participants



## Querying articles

Process articles using **in-context learning** and **text generation** to extract and summarize information

# Discussion

- Gather in small groups (2-3 people)
- Identify applications of LLMs
- Report 1-3 applications



# Quiz



MAX PLANCK INSTITUTE  
FOR HUMAN DEVELOPMENT



# Quiz

How are LLMs trained?

What are the main ways to use LLMs?

What aspects distinguish different LLMs?

How to choose an LLM?