How Large Language Models Can Improve Your Search Project

Search Solutions 2023

Alessandro Benedetti, Director @ Sease

21/11/2023

www.sease.io

- Headquarter in London/distributed
- Open-source Enthusiasts
- Apache Lucene/Solr experts
- Elasticsearch/OpenSearch experts
- Community Contributors
- Active Researchers
- **Hot Trends** : Neural Search,
  Natural Language Processing
  Learning To Rank,
  Document Similarity,
  Search Quality Evaluation,
  Relevance Tuning

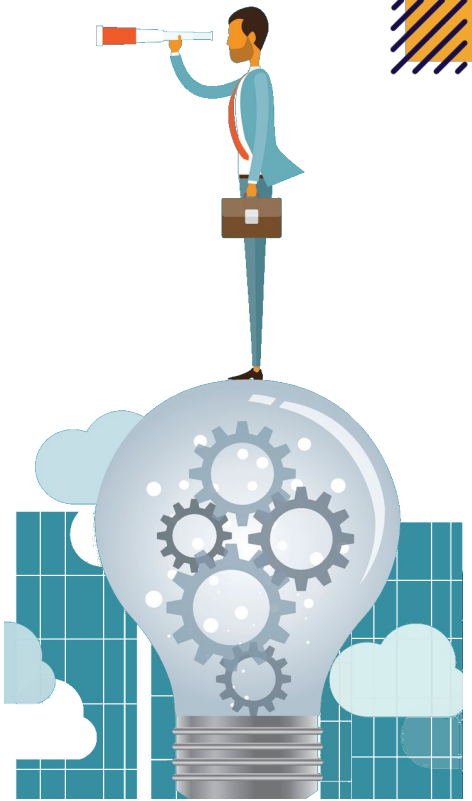
WHO AM I ?

ALESSANDRO BENEDETTI

- Born in Tarquinia (ancient Etruscan city in Italy)
- R&D Software Engineer
- Director
- Master degree in Computer Science
- PC member for ECIR, SIGIR and Desires
- Apache Lucene/Solr PMC member/committer
- Elasticsearch/OpenSearch expert
- Semantic search, NLP, Machine Learning technologies passionate
- Beach Volleyball player and Snowboarder

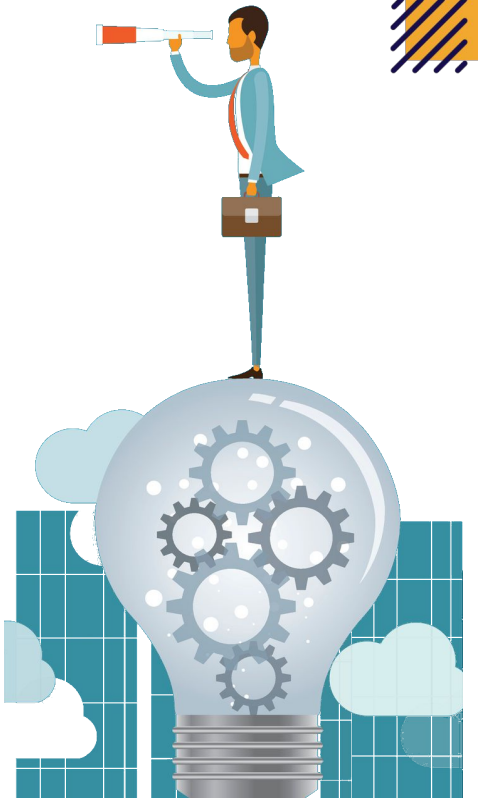
AGENDA 1/2

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



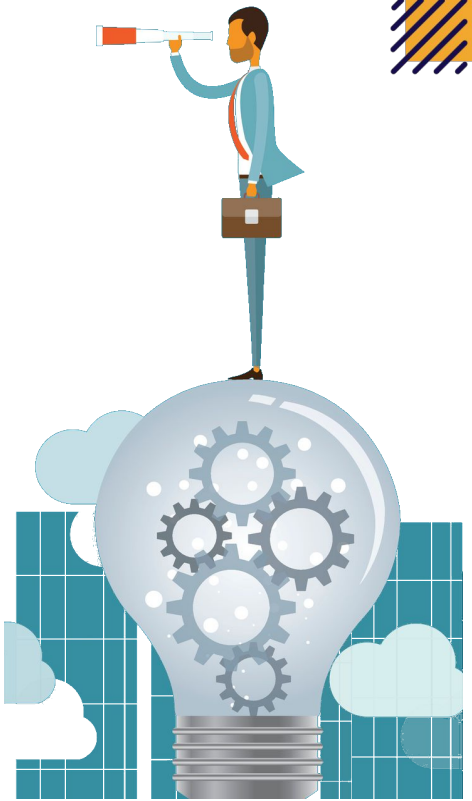
AGENDA 2/2

- Popular Open Source search engines and LLMs
- Rabbit Holes
- Future Works

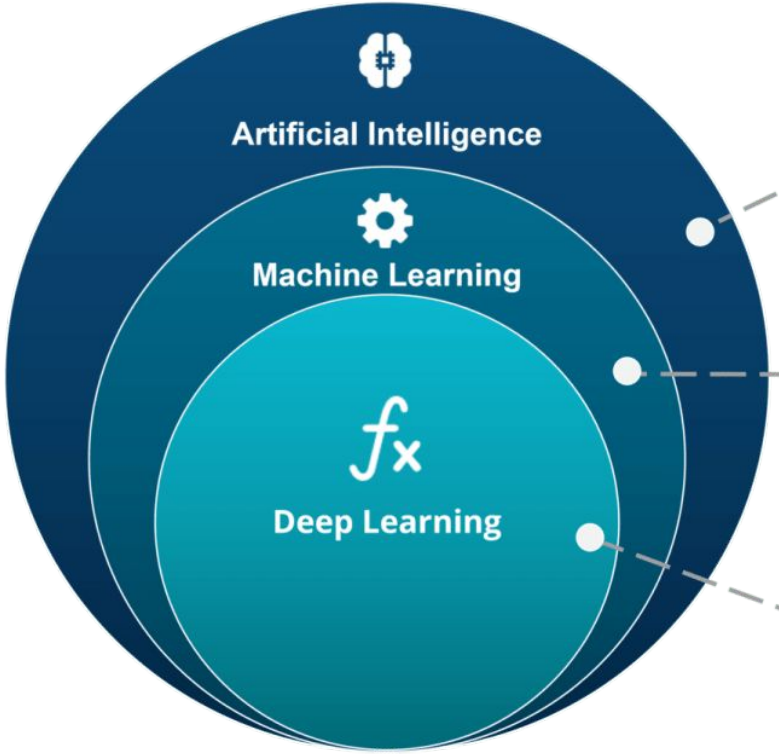


AGENDA 1/2

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



AI, Machine learning and Deep Learning



ARTIFICIAL INTELLIGENCE
A technique which enables machines to mimic human behaviour

MACHINE LEARNING
Subset of AI technique which use statistical methods to enable machines to improve with experience

DEEP LEARNING
Subset of ML which make the computation of multi-layer neural network feasible

GENERATIVE AI

- Text
- Code
- Images
- Video
- Music
- …

WHAT IS A LARGE LANGUAGE MODEL?

- Transformers
- Next-token-prediction and masked-language-modeling
- estimate the likelihood of each possible word (in its vocabulary) given the previous sequence
- learn the statistical structure of language
- pre-trained on huge quantities of text

Next-token-prediction

The model is given a sequence of words with the goal of predicting the next word.

Example:
Hannah is a ____

Hannah is a *sister*
Hannah is a *friend*
Hannah is a *marketer*
Hannah is a *comedian*

Masked-language-modeling

The model is given a sequence of words with the goal of predicting a 'masked' word in the middle.

Example
Jacob [mask] reading

Jacob *fears* reading
Jacob *loves* reading
Jacob *enjoys* reading
Jacob *hates* reading

https://towardsdatascience.com/how-chatgpt-works-the-models-behind-the-bot-1ce5fca96286

FINE-TUNED FOR...

- **Following Instructions**
- Sentence similarity
- Summarizing text
- Creating content
- Translating content
- Classifying/categorizing content
- Rewriting content
- Annotating images
- Synthesizing text to speech
- Correcting spelling
- Detecting fraud
- Generating code
- Doing sentiment analysis
- …

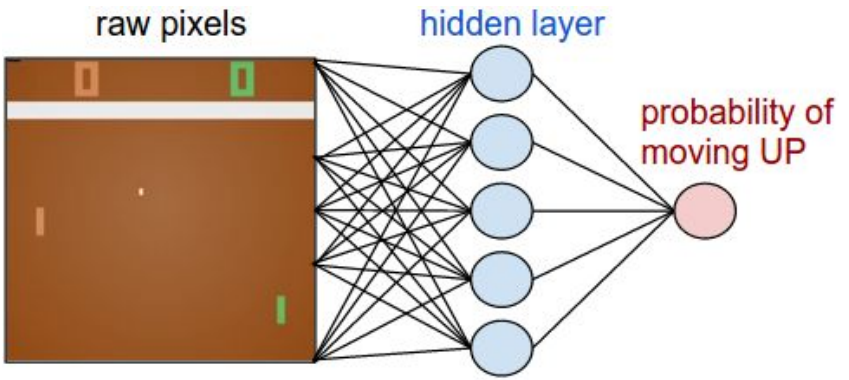
Instruct Model: what is it?

- **G**enerative **P**re-training **T**ransformer
- **product** capable of generating text in a wide range of styles and for different purposes responding to a prompt
- (based on) generative AI Large Language Models
- e.g **InstructGPT, GPT 4…**

most of our explanations come from here

Deep Reinforcement Learning

- Input status -> vector
- **Policy network:** A **probability** for the actions is estimated by a policy (**neural network**)
- An **action** is **sampled** from the probability distribution
- the action is performed on the **real system**
- the **reward** is observed
- **Policy Gradients:** the reward is back-propagated to the policy(to affect next probability estimations)



Reinforcement Learning from Human Feedback

1. *Supervised fine-tuning step*

   a **pre-trained language** model is **fine-tuned** on a relatively **small human-curated dataset**, to **learn a supervised policy** (the SFT model) that **generates text** from a **prompt**

2. *Reward estimation step*

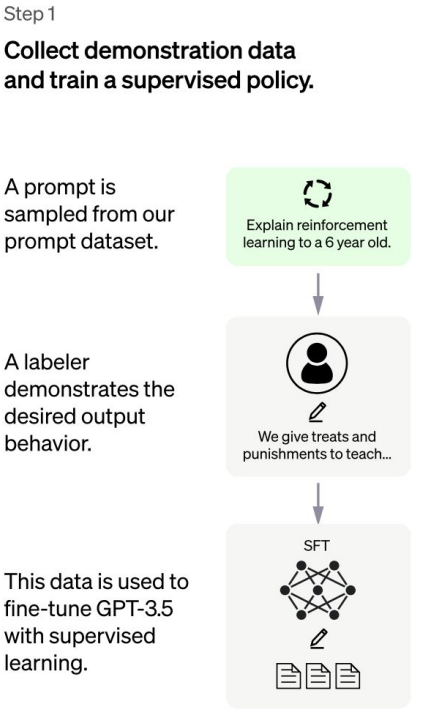
   a **pre-trained language** model is **fine-tuned** on a relatively **large human-curated dataset**, to **learn a reward function** that **generates a rating** from a **prompt** and a **response**

3. *Proximal Policy Optimization (PPO) step*: the **reward model** is used to **fine-tune** the SFT model. The outcome of this step is the final model (that can be iteratively improved).

- **2-3 are iteratively repeated**

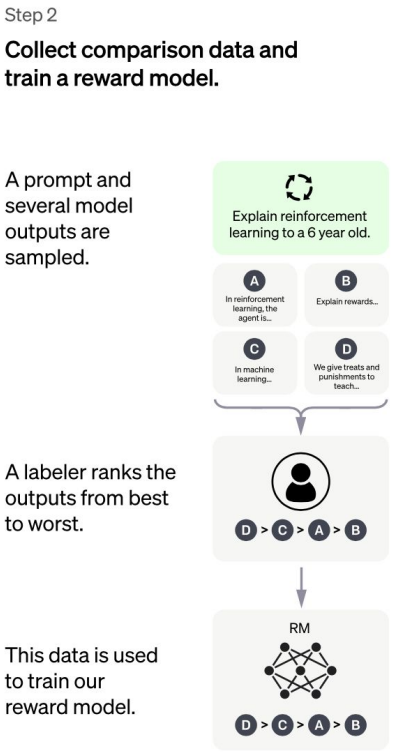
Supervised Fine-Tuning (SFT) Model

- training sample **<prompt, text> -> human-curated**
  - directly from Human labellers
  - from GPT3 clients
  - 10-15.000 'ish samples
- starting from GPT-3.5 series.
  - Presumably the baseline model used is the latest one **text-davinci-003**, a GPT-3 model which was fine-tuned mostly on programming code.
- **expensive** -> scale this up is not a solution to improve the model



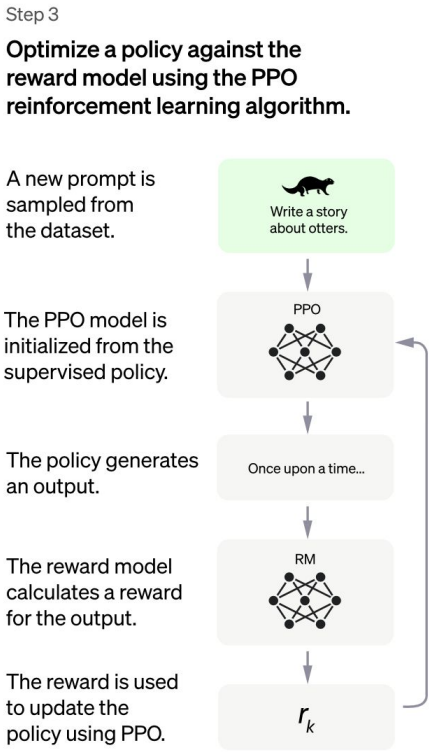
Reward model

- **Scope**: fine-tune a model that estimates a score for <prompt, text> pair
- A list of **prompts** is selected and the SFT model generates **multiple outputs** (4…9) for each prompt.
- **Training Set**: Humans rank the outputs. The size of this dataset is approximately 10 times bigger than the dataset used for the SFT model.
- The fine-tuned model takes as input a few of the SFT model outputs and ranks them in order of preference. (Learning to Rank, sounds familiar?)
- **easier** for humans **to rate**, rather than write text
- the reward function can be further updated with users' feedback



Fine-tuning the SFT model via Proximal Policy Optimization (PPO)

- PPO is a **reinforcement learning** algorithm.
- **"on-policy"**
  PPO is continuously adapting the current policy according to the **actions** that the agent is taking(sampling) and the **rewards** it is receiving
- PPO uses a trust region optimization method -> it **constrains the change** in the policy to be within a certain distance of the previous policy in order to ensure **stability**



Fine-tuning the SFT model via Proximal Policy Optimization (PPO)

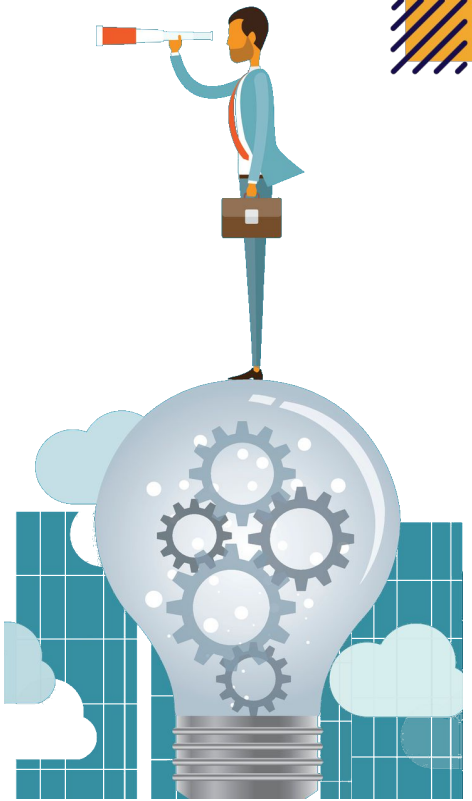
- PPO **policy** is **initialized** from the **SFT model**
- **value function** is initialized from the **reward model**.
- The environment presents a **random prompt** and expects a **response**
- Given the prompt and response, it produces a reward
- policy get updated and the episode ends.
- During the fine-tuning many episodes happen

Problems...

- Biases in generated text
- Incredibly expensive to pre-train (GPUs)
- High operating costs
- Low explainability
- Difficulty troubleshoot due to complexity
- Vulnerability to malicious prompts that could break the system

AGENDA 1/2

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



OPEN SOURCE ?

- **Architecture**
- **Datasets**
  - pre-training
  - fine-tuning
- **Code**
  - pre-training
  - fine-tuning
  - inference
  - …

OPEN SOURCE ?

https://arxiv.org/abs/2307.05532

Opening up ChatGPT: Tracking openness, transparency, and accountability in instruction-tuned text generators

Authors: Andreas Liesenfeld, Alianda Lopez, Mark Dingemanse

CUI '23: Proceedings of the 5th International Conference on Conversational User Interfaces
July 2023

Project	Availability						Documentation					Access methods	
(maker, bases, URL)	Open code	LLM data	LLM weights	RLHF data	RLHF weights	License	Code	Architecture	Preprint	Paper	Data sheet	Package	API
chatGPT	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	~
OpenAI	LLM base: GPT3.5, GPT4			RLHF base: Instruct-GPT								https://chat.openai.com	
StableVicuna-13B	✓	✓	~	~	~	~	~	✓	✓	✗	✗	~	✗
CarperAI	LLM base: LLaMA			RLHF base: oasst1, anthropic								https://huggingface.co/CarperAI/stable-vicuna-13b-delta	
text-generation-webu	✓	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗
oobabooga	LLM base: various			RLHF base: various								https://github.com/Akegarasu/ChatGLM-webui	
MPT-7B-Instruct	✓	✗	✓	~	✗	✓	✓	~	✗	✗	✗	✓	✗
MosaicML	LLM base: MosaicML			RLHF base: dolly, anthropic								https://github.com/mosaicml/llm-foundry#mpt	
Falcon-40B-Instruct	✓	~	✓	~	✓	✓	~	~	~	✗	~	~	✗
TII	LLM base: Falcon 40B			RLHF base: Baize (synthetic)								https://huggingface.co/tiiuae/falcon-40b-instruct	
minChatGPT	✓	✓	✓	~	✗	✓	✓	~	✗	✗	✗	✗	✓
ethanyanjiali	LLM base: GPT2			RLHF base: anthropic								https://github.com/ethanyanjiali/minChatGPT	
trlx	✓	✓	✓	~	✗	✓	✓	~	✗	✗	✗	~	✓
carperai	LLM base: various (pythia, flan, OPT)			RLHF base: various								https://github.com/carperai/trlx	
stanford_alpaca	✓	✓	~	~	✗	~	✓	✓	✗	✗	~	✗	✗
Tatsu labs	LLM base: LLaMA			RLHF base: Self-Instruct (synthetic)								https://github.com/tatsu-lab/stanford_alpaca	
Cerebras-GPT-111M	✓	✓	✓	✓	✗	✓	✓	✓	~	✗	✗	✗	✗

False claims?

- **Llama**
  - **Fully Open Source?**
  - doesn't actually use an OSI approved license - **Check the license**
  - OSI-approved licenses may fall short of certain needs of AI models
  - not sharing training data
  - not sharing training code
- Not only LLAMA

https://spectrum.ieee.org/open-source-llm-not-open

FINE-TUNE OPEN SOURCE LLMs?

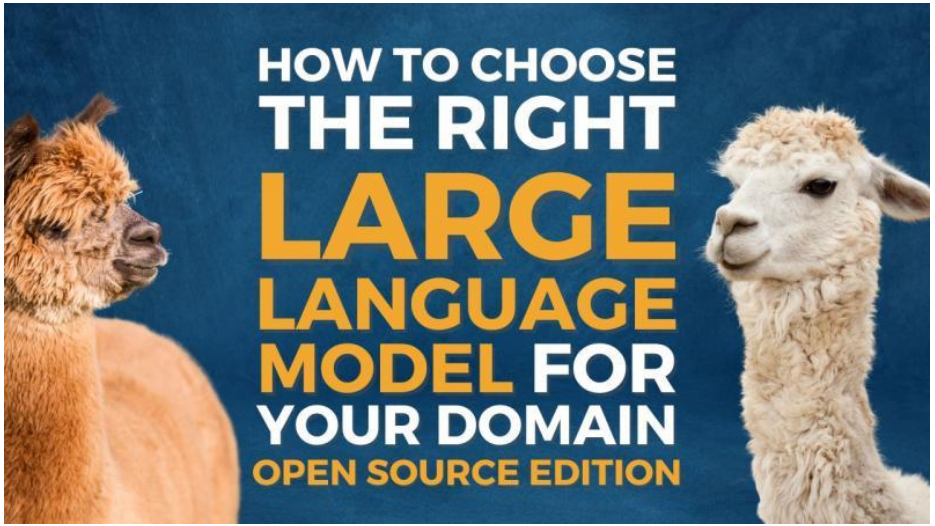
Looking to fine-tune your open source LLM? Try LoRA.

Microsoft offers the open sourced LoRA (Low-Rank Adaptation of Large Language Models) project on GitHub:

- LoRA is a training method that uses a mathematical trick to decompose large metrics into smaller ones. This leads to fewer parameters and more storage efficiency, resulting in quicker processing time.
- Techniques like LoRA can help you deploy LLMs to many customers, since it only requires saving small matrices.
- Other techniques for fine-tuning LLMs include hard tuning, soft tuning, and prefix tuning.

OPEN SOURCE Large Language Models

https://sease.io/2023/06/how-to-choose-the-right-large-language-model-for-your-domain-open-source-edition.html



- **Generalists**
  - MPT-Series
  - Falcon-Series
  - Bloom
  - T5
  - Mistral
  - LLaMA 2
    - alpaca
    - vicuna

… many others!

OPEN SOURCE Large Language Models

- **Fundamental Biomedicine Science**
  - MoLFormer - Chemical molecules
  - Nucleotide Transformer - DNA sequences
  - Evolutionary Scale Modeling - Proteins
- **Biomedical - Clinical Healthcare Support**
  - BioGPT
  - BioMedLM (previously known as PubMedGPT)
  - GatorTron
- **Finance**
  - FinBERT
- **Legal**
  - LEGAL-BERT

Repositories

#1. Awesome-LLM - general list with corresponding papers, tutorials

Pre-training / Instruction Tuning / Alignment

https://github.com/Hannibal046/Awesome-LLM

#2. Awesome-LLM-Large-Language-Models-Notes

https://github.com/kyaiooiayk/Awesome-LLM-Large-Language-Models-Notes

#3. awesome-decentralized-llm (effectively "open source" with "commercial license"?

Collection of LLM resources that can be used to build products you can "own" or to perform reproducible research.

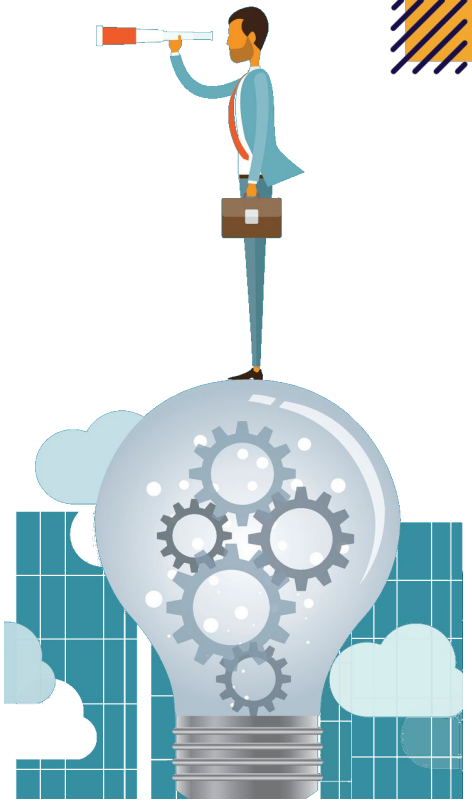
https://github.com/imaurer/awesome-decentralized-llm

HuggingFace's Open LLM Leaderboard

https://huggingface.co/spaces/HuggingFaceH4/open_llm_leaderboard

AGENDA 1/2

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



Selecting the best LLM

Selecting the best

What is the best LLM to use with your Business Content?

1. A list of Awesome LLM's to select the best for your business.

2. What best represents your Search use case? Product Search or News Search or?

3. Select top 3 LLMs ask: Use LLM out-of-box? LLM requires Fine-Tuning? Feature Engineering?

Selecting the best LLM

What can I use?

What best represents your Business Search Use Case?

Product Search? Or News Search? or Research Paper Search?

1. **In regards to an Open LLM, can I legally use it for my commercial business?**
   Real world **Open LLM** examples: **Dolly, DALL-E, Falcon**.

2. **Using a list of Open LLM's that I can legally use, was it pre-trained on similar content?**
   Real world **Content** examples: Product Search (Kaggle Walmart?), Legal (LexisNexis) or ?

3. **Using a list of Open LLM's that are highly relevant to my business content and use case**
   Do I have a version fine-tuned for my task (sentence similarity, instruct, summarization, etc?

4. **Given these questions as a starting point and list of Awesome Github Resources, ask you team:**
   Can we use the LLM out-of-box? Will the LLM requires Fine-Tuning? Any additional Feature Engineering?

Exercise: Mistral

Starting point

https://huggingface.co/mistralai/Mistral-7B-Instruct-v0.1

1. In regards to an Open LLM, can I legally use it for my commercial business?

Apache 2.0.

2. Using a list of Open LLM's that I can legally use, was it pre-trained on similar content?

paper -> variety of publicly available conversation datasets , on instruction datasets publicly available on the Hugging Face repository. No proprietary data or training tricks were utilized

3. Using a list of Open LLM's that are highly relevant to my business content and use case

instruction based

Exercise: Falcon 180B

Starting point

https://huggingface.co/tiiuae/falcon-180B

1. In regards to an Open LLM, can I legally use it for my commercial business?

https://huggingface.co/spaces/tiiuae/falcon-180b-license/blob/main/LICENSE.txt

2. Using a list of Open LLM's that I can legally use, was it pre-trained on similar content?

Falcon-180B was trained on 3,500B tokens of RefinedWeb, a high-quality filtered and deduplicated web dataset which we enhanced with curated corpora. Significant components from our curated copora were inspired by The Pile (Gao et al., 2020).

3. Using a list of Open LLM's that are highly relevant to my business content and use case

instruction based fine tuned available

Exercise: Falcon 7B

Starting point

https://huggingface.co/tiiuae/falcon-7b

1. In regards to an Open LLM, can I legally use it for my commercial business?

Apache 2.0

2. Using a list of Open LLM's that I can legally use, was it pre-trained on similar content?

Falcon-7B was trained on 1,500B tokens of RefinedWeb, a high-quality filtered and deduplicated web dataset which we enhanced with curated corpora. Significant components from our curated copora were inspired by The Pile (Gao et al., 2020).

3. Using a list of Open LLM's that are highly relevant to my business content and use case

instruction based fine tuned available

ARENA

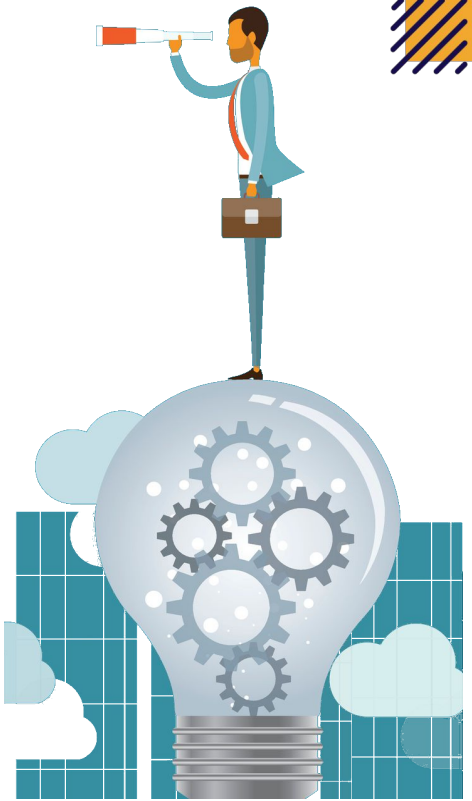
Compare Large Language Models

https://chat.lmsys.org/?arena

- Select Model A/ Model B
- Run Prompt in parallel
- give your vote

AGENDA 1/2

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



Interact with a Large Language Model

To encode From text to vectors (or in general to enrich your data):

- On premise
  - own both the services and servers
- In the cloud
  - just use your favourite cloud provider and host your own services
- As a service
  - https://huggingface.co/inference-endpoints
  - https://aws.amazon.com/sagemaker/
  - https://azure.microsoft.com/en-gb/products/machine-learning
  - …

Interact with a Large Language Model

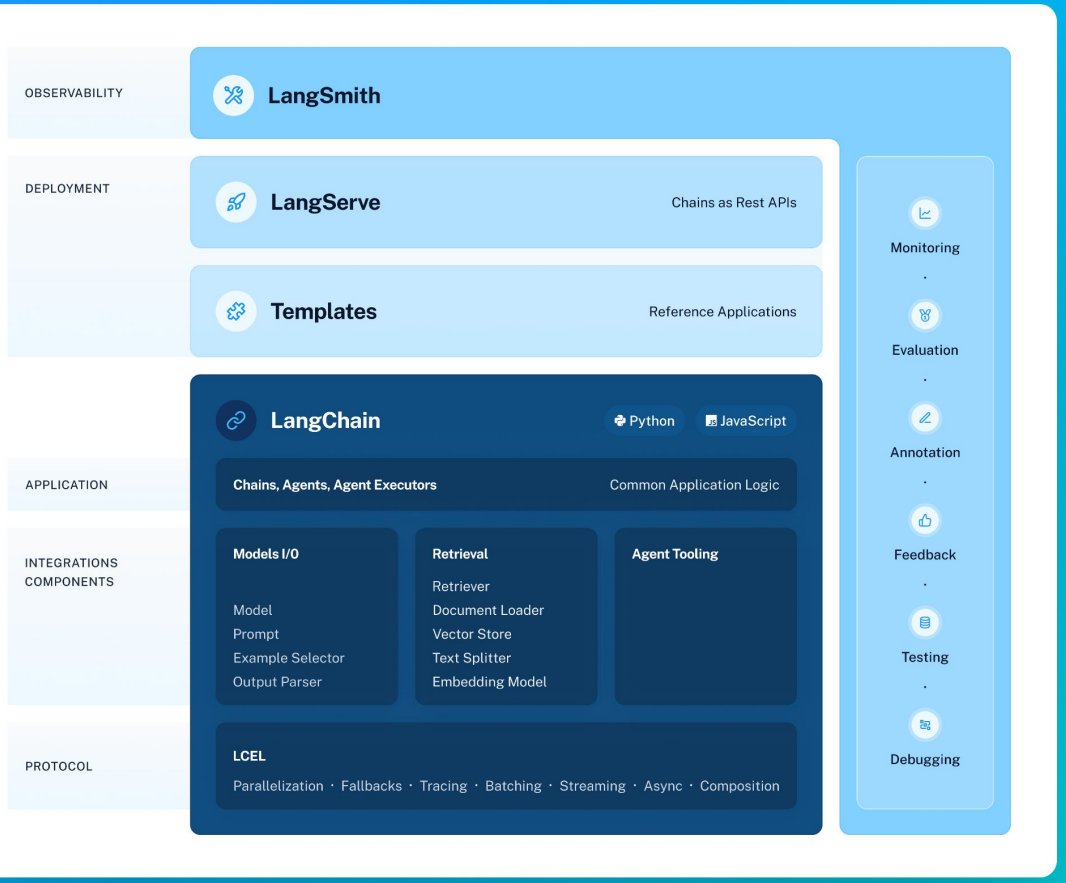
LangChain is a framework for developing applications powered by language models

https://www.langchain.com /

This framework consists of several parts.

- https://github.com/langchain-ai/langchain - **MIT license**
- **LangChain Libraries**: The Python and JavaScript libraries. Contains interfaces and integrations for a myriad of components, a basic run time for combining these components into chains and agents, and off-the-shelf implementations of chains and agents.
- LangChain Templates: A collection of easily deployable reference architectures for a wide variety of tasks.
- LangServe: A library for deploying LangChain chains as a REST API.
- LangSmith: A developer platform that lets you debug, test, evaluate, and monitor chains built on any LLM framework and seamlessly integrates with LangChain.

LANGCHAIN



Sease

LANGSTREAM

Build event-based applications

Use the power of streaming to connect to LLMs

https://langstream.ai/ /

- https://github.com/LangStream/langstream - Apache 2.0 license
- **Easy Development to Production -** Develop and test robust Gen AI apps right on your laptop. When you're ready, deploy to a production environment powered by Kubernetes and Kafka—all through a single CLI command.
- **Event-Driven Architecture -** LangStream is engineered event-driven computing by a team with decades of experience. Build reactive, scalable, and fault-tolerant Gen AI applications with ease.
- **Configurable Agents -** Out of the box, LangStream offers configuration-driven agents designed for various tasks—be it AI chat completions, text processing, or working with vector databases. If they don't meet your unique needs, craft your own agents in Python.
- **Up-to-Date Libraries -** The LangStream runtime is always stocked with the latest Gen AI libraries like LangChain and LlamaIndex, so you're never left behind.

HAYSTACK

Interact with a Large Language Model

Haystack is the open source Python framework by deepset for building custom apps with large language models
https://haystack.deepset.ai/ /

- https://github.com/deepset-ai/haystack - Apache 2.0 license
- Use the latest LLMs: hosted models by OpenAI or Cohere, open-source LLMs, or other pre-trained models
- All tooling in one place: preprocessing, pipelines, agents & tools, prompts, evaluation and finetuning
- Choose your favorite database: Elasticsearch, OpenSearch, Weaviate, Pinecone, Qdrant, Milvus and more
- Scale to millions of documents: use Haystack's proven retrieval architecture

HAYSTACK

- Effortless deployment of models from Hugging Face or other providers into your NLP pipeline
- Create dynamic templates for LLM prompting
- Cleaning and preprocessing functions for various formats and sources
- Seamless integrations with your preferred document store (including many popular vector databases like Faiss, Pinecone, Qdrant, or Weaviate): keep your NLP-driven apps up-to-date with Haystack's indexing pipelines that help you prepare and maintain your data
- The free annotation tool for a faster and more structured annotation process
- Tooling for fine-tuning a pre-trained language model
- Specialized evaluation pipelines that use different metrics to evaluate the entire system or its individual components
- Haystack's REST API to deploy your final system so that you can query it with a user-facing interface

Arena

We preferred **Haystack** to develop our neural highlighter plugin because it proved to be quite intuitive for supporting bert-like models.

It was a quick investigation but its documentation was straight away useful to build a quick prototype for our use case.

The perception on **LangChain** was it was more oriented to remote inference services(such as OpenAI ones)

Arena

LangChain, while feature-rich, presents a **steeper learning curve** compared to the more **straightforward Haystack**. While LangChain is being harnessed for comprehensive enterprise chat applications, Haystack is often the choice for lighter tasks or swift prototypes.

https://www.stork.ai/blog/langchain-vs-haystack-a-comparative-insight

Arena

Both **LangChain** and **Haystack** are LLM orchestration frameworks, so the mission is pretty much the same.

LangChain offers many integrations with LLM providers and vector DBs, it has a huge community and popularity, it's good for quick prototypes but difficult to customise, because of the many layers of abstraction, releases happen frequently (with many breaking changes).

Haystack has less integration but an active community.

The focus is on modularity and easily customisable pipelines.

Very stable, production ready (used by Nvidia, Netflix…).

The project was born for RAG, so there's good support for search engines and rankers.

Stefano Fiorucci · 1st

Contributing to Haystack, the LLM Framework 🏗️ | NLP...

San Giustino

6K followers

Talks about #llm, #nlp, #python, #opensource, and #largelanguagemodels

Arena

Aspect	LangChain	Haystack
Website	LangChain	Haystack
Cost & Model	Open source with value-added services for enterprises	Open source supporting deepset's products
Funding	$10 MM	$45.2 MM (deepset)
Integrations & Tools	Abundant, e.g., AWS Lambda, APIFY	Limited but customizable
Community Support	Very Good	Adequate
Complexity	High, with extensive object-oriented concepts	More intuitive and user-friendly
Workflow	Uses Chains and Agents for routing	Uses Nodes and Agents for task management
Data Tools	Comprehensive set of tools	Slightly fewer tools with basic features
Memory Retention	Multiple options for conversation history	Limited options with REDIS integration
Output Parsers	Highly flexible response structuring	Basic parsing with regex patterns
Debugging	Proprietary framework, LangSmith (beta)	Standard IDE debugging
Additional Features	Asynchronous support, autonomous agents	OCR support, Rasa integration
Observations	Some tools may crash on invalid queries	Handles invalid queries more gracefully

Qease

Arena

Features	LangChain Support	Haystack Support
LLM Support	OpenAI, Cohere, AI21, HuggingFace, etc	OpenAI, Cohere, AI21, HuggingFace, etc
Prompt Templates and Engineering	PromptTemplates, Custom templates, Prompt Serialization, Selectors, Partial Prompts	PromptNode, PromptTemplates
Process orchestration	Chains	Pipelines & Ready-made pipelines
Data Fetching & Preprocessing	Document Loader, Text Splitting, Embeddings, CombineDocuments Chains	Document Loader, Text Splitting, Embeddings, CombineDocuments Chains
Document Stores	Chroma, FAISS, Elastic Search, Milvus, Pinecone, Qdrant, and Weaviate	Elasticsearch, FAISS, In Memory, Milvus, OpenSearch, Pinecone, SQL and Weaviate
Information Retrieval (Semantic Search & Question Answering)	Fetching Data & Augmenting	Reader, Retriever, Ranker, and QuestionGenerator
Deployment	No REST API	REST API
Agents & Memory	Agents to perform actions Memory classes	Working on adding Agents to components.
GPU	DeepInfra Integration	Enables GPU Acceleration
Other features	Generic utilities e.g Python REPL, Web search API, Requests library, SearxNG Search API, etc. Evaluation	Generative Pseudo Labelling, Evaluation
Use Cases	Completion, Summarization, Question-Answering, Conversational AI, Data Augmented Generation	Completion, Summarization, Semantic Search, Question-Answering, Conversational AI, Data Augmented Generation, Annotation

Sease

Arena - Langstream

- Better support for event-based ingestion and vectorization
  - compatible with Kafka connect as data source
  - compatible with Apache Camel as data source
- Micro-batching and write on vector DB out of the box
- Support for many libraries (LlamaIndex, NTLK)
- No code - already available agents
- Code - internally using LangChain

Exercise - LANGCHAIN

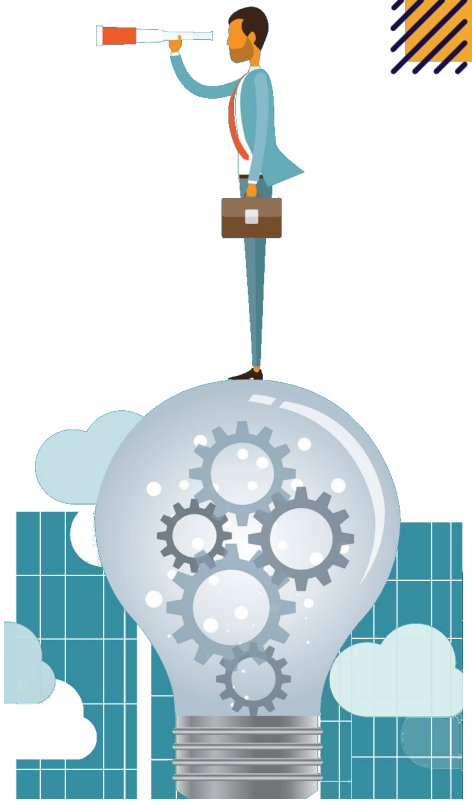
Exercise

https://github.com/SeaseLtd/LLM-in-search

From Natural Language to an element in a taxonomy

AGENDA 1/2

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



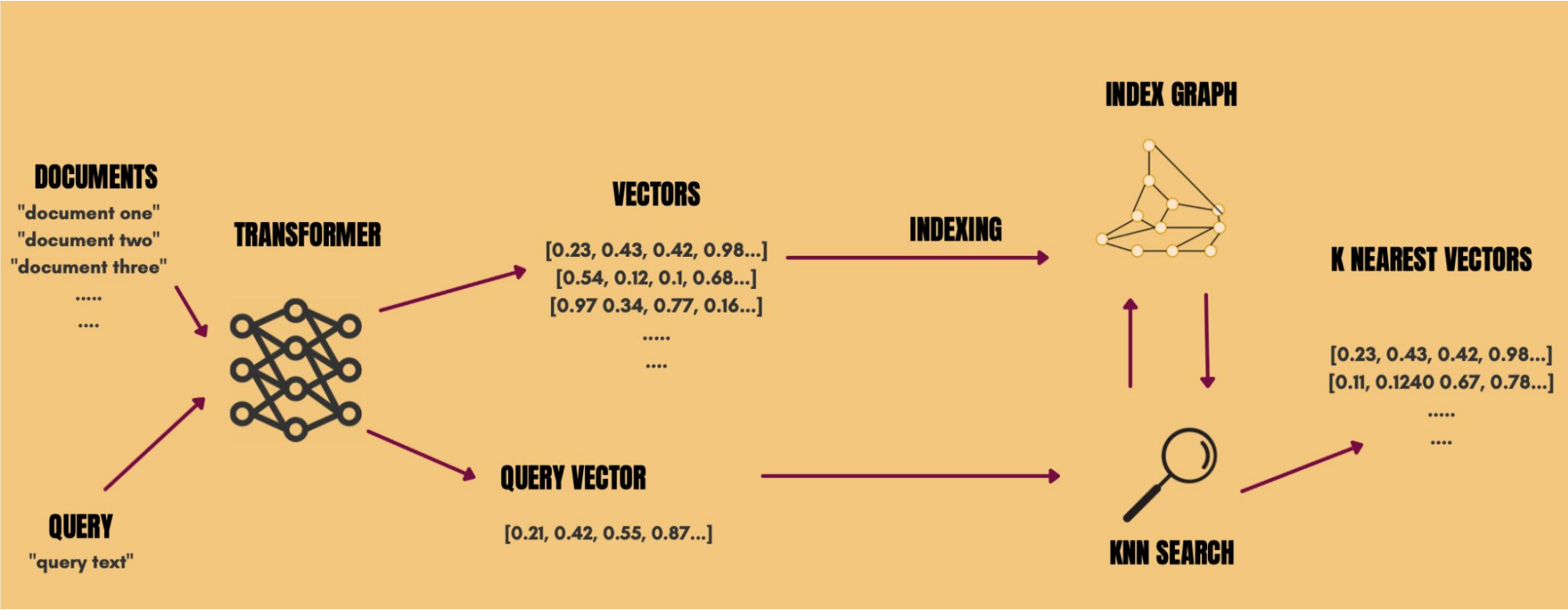
Ways of Adding Large Language Models to Search

Why?

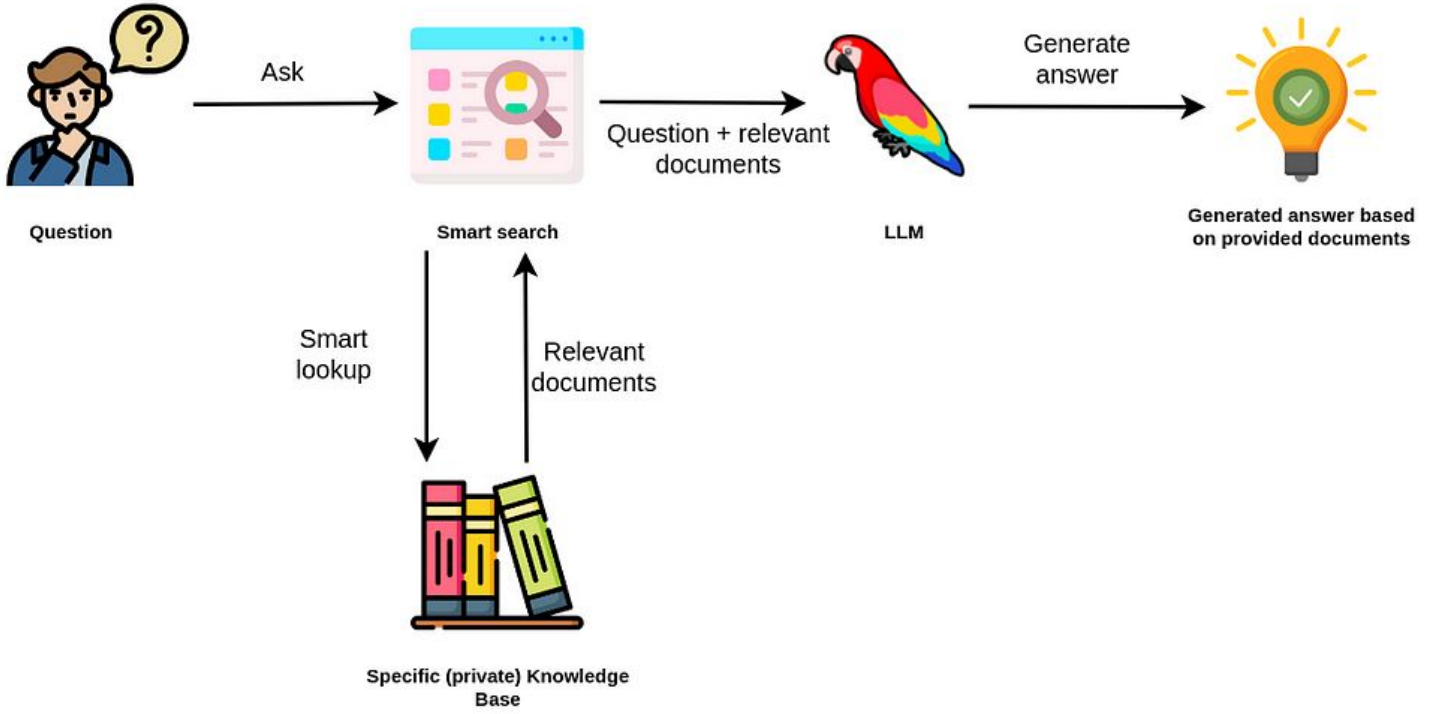
Why add LLM's (Large Language Models) to your Search Platform?

1. Query Expansion (Generative/Extractive)
2. Retrieval Augmented Generation
3. Dense Retrieval Neural/Vector-based search

Dense Retrieval (neural/vector-based search)



Retrieval Augmented Generation



https://neo4j.com/developer-blog/fine-tuning-retrieval-augmented-generation/

Query/Document Expansion

What were the sulfur oxide emissions in Australia in 2013

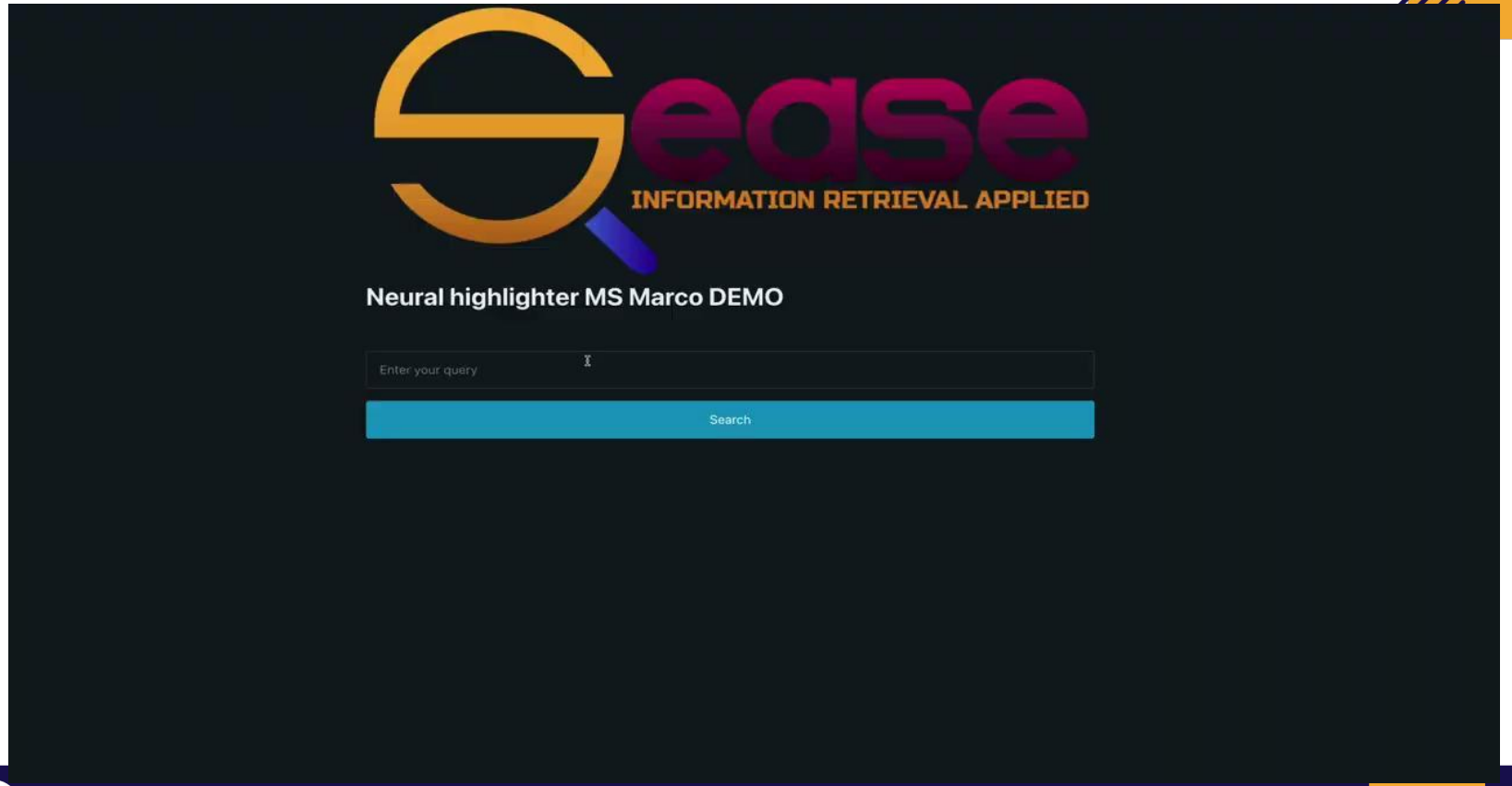
GPT Generative answer is:
```
['Sulfur dioxide emissions', 'Air pollution', 'Environmental impact', 'Fossil fuel combustion', 'Acid rain']
```

GPT Extractive answer is:
```
{'srQMgwl_en_ss': ['1|Environment#ENV#|Air and climate#ENV_AC#'], 'dimensions_en_ss': ['Time period', 'Reference area', 'Pollutant', 'Country']}
```

Generate synonyms, reformulations…

Select expansion terms from taxonomies

Explainability - Highlighting



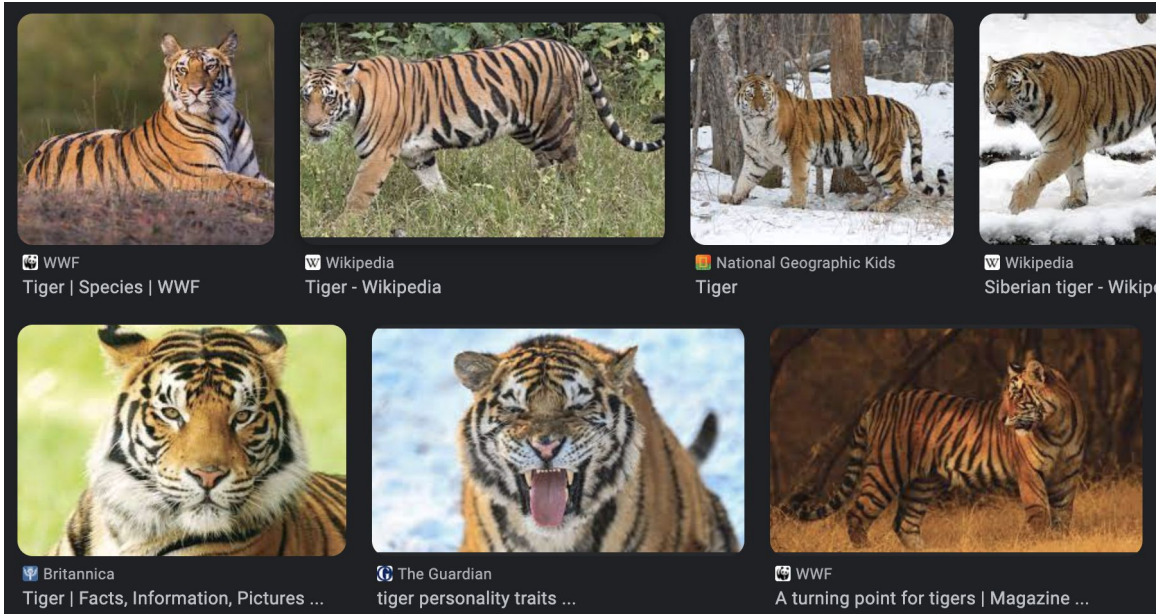
Natural Language Query Parsing

What were the sulfur oxide emissions in Australia in 2013

```
{
    "filters": {
        "Country": "0|Australia#AUS#",
        "Pollutant": "0|Sulphur Oxides#SOX#",
        "Variable": "0|Total man-made emissions#TOT#",
        "Year": "2013"
    }
}
```

Multi-modal search

black striped orange big cat



Multi-language search

QUERY:

Stato di conservazione della tigre [it]

Tiger / Conservation status

Endangered

Population decreasing

The tiger is listed as Endangered on the IUCN Red List. As of 2023, the global wild tiger population is estimated to number 5,574 individuals, with most populations living in small isolated pockets.

Wikipedia
https://en.wikipedia.org › wiki › Tiger

Tiger - Wikipedia

People also search for

Lion
Vulnerable (Population decreasing)

Cheetah
Vulnerable (Population decreasing)

Sumatran tiger
Critically Endangered (Population decreasing)

Feedback • Sources include: Encyclopedia of Life

Scholarly articles for **tiger conservation status**

… tigris sumatrae): A review of **conservation status** - Wibisono - Cited by 77

Tiger

Animal

The tiger is the largest living cat species and a member of the genus Panthera. It is most recognisable for its dark vertical stripes on orange fur with a white underside. An apex predator, it primarily preys on ungulates, such as deer and wild boar. Wikipedia

Conservation status: Endangered (Population decreasing) Encyclopedia of Life

Speed: 49 – 65 km/h (In Short Bursts)

Lifespan: 10 – 15 years (In the wild)

Scientific name: Panthera tigris

Mass: 90 – 310 kg (Male, Adult), 65 – 170 kg (Female, Adult)

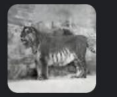
Eats: Wild boar, Sambar deer

Lower classifications View 5+ more

Bengal tiger

Siberian Tiger

Sumatran tiger



Caspian tiger

Deciding on how to measure success. (KPI's)

Measure Success

How do you know you have improved your Business Seaarch with LLM's?

1. Search + LLMs KPI's:
   Operational
   Search Session
   Improve Search-driven Business Metrics.

2. What KPI's specific to LLMs?
   What Data metrics?
   Combine Metric for Business?

3. Focus on limited KPI's that impact business.
   Track customers onsite Behaviors for positive or negative trends.

Deciding on how to measure success. (KPI's)

PURPOSE (Measure Success)

Search + LLMs KPIs, select those that improve Search-driven Business Metrics.
What KPI's are specific to LLM's. What Data to collect or Combine Metrics?
Focus on Impactful KPI's. Track onsite Searcher Behaviors for +/- Trends.

Prior to adding LLM's to your Business Search platform:

ensure a baseline of KPI's & Data for comparisons

Monitor for lift (positive) and sink (negative),

Monitor for Trends, short & long-term.

Track delta of Conversion Rate

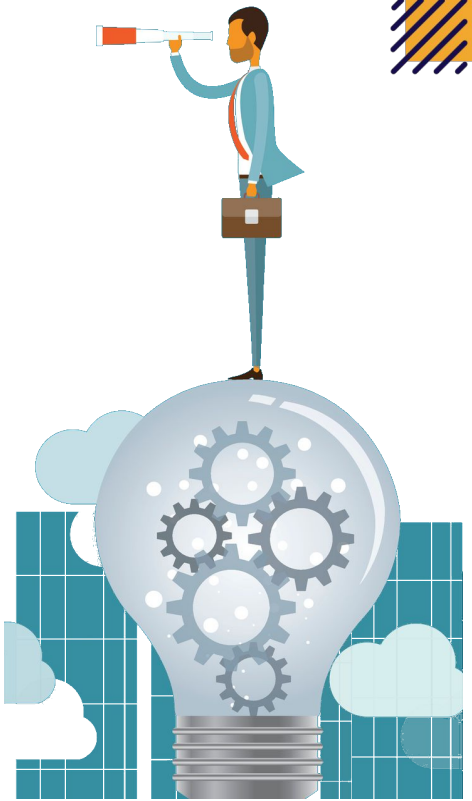
Track delta of Life-Time Value

Track Engagement combined with renewals & conversion.

Search is the Product and **Search is Data-driven** for **Searcher Satisfaction.**

AGENDA 2/2

- Popular Open Source search engines and LLMs
- Rabbit Holes
- Future Works



Apache Solr 9.4

- **Features**
  - Vector Based Search(KNN)
    - pre-filtering
    - as a Learning To Rank feature
  - Hybrid Search
  - Neural Highlighter (commercial)

JIRA ISSUES

https://issues.apache.org/jira/browse/SOLR-15880?jql=labels%20%3D%20vector-based-search

Elasticsearch 8.11

- **Features**
  - Vector Based Search(KNN)
    - pre-filtering

-------- Commercial **(Platinum)**

  - Hybrid Search (Reciprocal Rank Fusion)
  - Learned Sparse Encoder
  - Retrieval Augmented Generation (ChatGPT + simple python script)
  - End to End neural search (including ingestion+vectorization)
  - Question Answering
  - Text Classification
  - Text Similarity
  - Dedicated Machine Learning Nodes

elasticsearch

OpenSearch 2.11

- **Features**
  - Vector Based Search(KNN)
    - pre-filtering
  - End to End neural search (including ingestion+vectorization)
    - multi-modal (text/image)
  - Learned Sparse Encoder
  - Connect to Remote Models (ChatGPT, Cohere, etc) - Not possible to use custom LLM
  - Hybrid Search
  - Conversational Search (Conversation Memory + Retrieval Augmented Generation)
    - As of OpenSearch 2.11, the RAG technique has only been tested with OpenAI models and the Anthropic Claude model on Amazon Bedrock.

OpenSearch

Vespa

- **Features**
  - Vector Based Search(KNN)
    - pre-filtering
  - End to End neural search (including ingestion+vectorization)
  - Hybrid Search (Reciprocal Rank Fusion)

vespa

OPEN SOURCE VECTOR DATA BASES

- **Milvus**
  - Vector Based Search
- **Weaviate**
  - Vector Based Search
  - Generative Search
  - Weaviate modules
- **Qdrant**
  - Vector Based Search
  - Quaterion (fine-tuning framework)

LANGSTREAM - RAG in Apache Solr

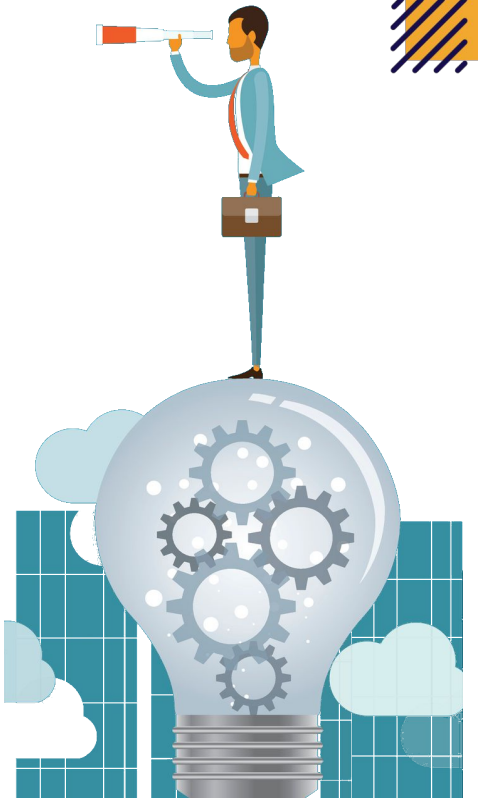
Exercise

https://github.com/LangStream/langstream/tree/main/examples/applications/query-solr

- brew install LangStream/langstream/langstream
- docker run --rm -p 8983:8983 --rm solr:9.3.0 -c
- export OPEN_AI_ACCESS_KEY=<your-openai-api-key>
- export SOLR_HOST=host.docker.internal
- langstream -v docker run test -app /Users/sease/PythonProjects/SearchSolutions/2023/langstream/examples/applications/query-solr -s examples/secrets/secrets.yaml

AGENDA 2/2

- Popular Open Source search engines and LLMs
- Rabbit Holes
- Future Works



RABBIT HOLES

PURPOSE

identify critical decisions and avoid wasting much time and resources
Do NOT go down that Rabbit Hole: Danger, Will Robinson, Danger!

1. Not measuring search metrics offline/online
2. Choosing the wrong technology for your problem
3. Choosing the wrong Large Language Model for your problem

MEASURING SEARCH QUALITY

PROBLEM

How can I measure if I am bringing improvements to my search system?

MEASURING SEARCH QUALITY

RABBIT HOLE

No offline/online search quality evaluation.
The new system is evaluated based on vibe, feelings, subjective opinions etc…
A lot of time and resources can be spent for un-promising solutions.
Promising solutions may be discarded just because of superficial analysis.

MEASURING SEARCH QUALITY

BETTER TO...

Set up an offline and online evaluation system that drives research and development

CHOOSE THE RIGHT TECHNOLOGY

PROBLEM

What technology should I use to implement Large Language Models in search?

- Should I use a traditional search engine that supports also vectors?
- Should I use a dedicated vector search engine?
- What kind of inference service should I use?
- …

CHOOSE THE RIGHT TECHNOLOGY

RABBIT HOLE

A technology is chosen because:

- cool/popular
- already used
- imposed from above

You end up wasting a lot of time and resources trying to make such technology work in your use case.
You accumulate technical debt, team and business discontent.
You end up failing and having to go back and revisit the tech stack and architecture with immense costs.

CHOOSE THE RIGHT TECHNOLOGY

BETTER TO...

Carefully assess the technologic landscape, identify the most promising softwares that satisfy your needs and proceed with a comparison both functional and performance-wise.

The Large Language Model and vector-search domain is going so fast, especially in the open source realm, so this activity is crucial and deserve the right amount of time and attention.

CHOOSE THE RIGHT MODEL

PROBLEM

What model should I use?

CHOOSE THE RIGHT MODEL

RABBIT HOLE

A model is chosen:

- from the shelf
- out of context
- based on popolarity

You end up wasting a lot of time and resources trying to make such model work in your use case.
You use it as it is accumulating team and business discontent.
You spend a lot of time fine-tuning it even if it’s not meant to be.
You end up failing and having to go back and choose a different model.

CHOOSE THE RIGHT MODEL

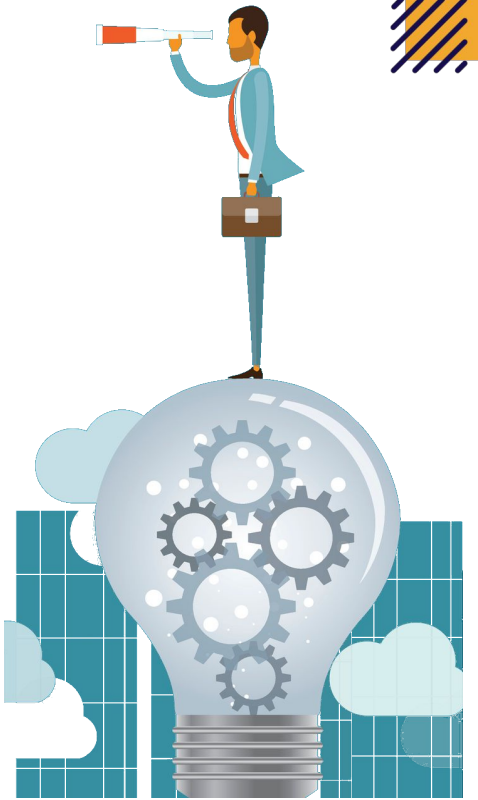
BETTER TO...

Carefully assess the models available, starting from the pre-training:
- you want a domain that is as close as possible to yours

The look for fine-tuned examples, potentially close to your use case.
Iterate and refine if additional fine tuning is necessary.
Investigate the models deeply, understanding the datasets used for both pre-training and fine tuning.
Look at those datasets!
Compare different candidate models on your data.

AGENDA 2/2

- Popular Open Source search engines and LLMs
- Rabbit Holes
- Future Works



Apache Solr Roadmap

- END-TO-END NEURAL SEARCH
- BETTER HYBRID SEARCH
- LARGE LANGUAGE MODEL QUERY REWRITER
- RETRIEVAL AUGMENTED GENERATION
- LUCENE MULTI-VALUED VECTORS

- LANGCHAIN Document Store
- HAYSTACK Document Store

https://sease.io/2023/10/apache-lucene-solr-ai-roadmap-do-you-want-to-make-i
ppen.html

WHAT'S NEXT

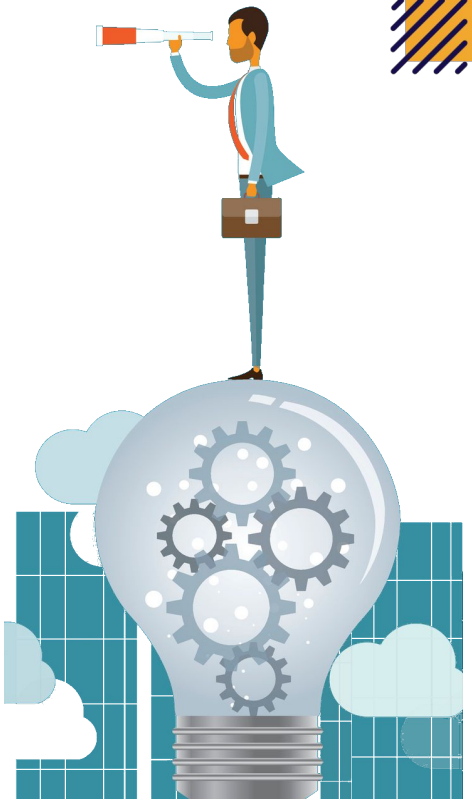
NEED HELP IMPLEMENTING LLMs FOR SEARCH?

Our collaboration with John aim to give our customers comprehensive guidance and implementation capabilities to design and develop LLMs integrations:

- PROJECT/PRODUCT MANAGEMENT
- ENGINEERING DIRECTION AND ARCHITECTING
- DESIGN AND DEVELOPMENT

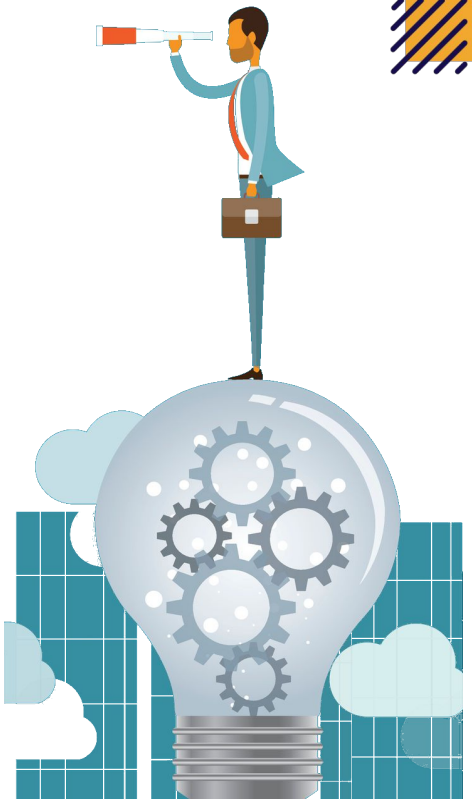
To Wrap it Up

- Introduction to Large Language Models (LLM)
- The Open Source landscape (and repositories) for LLMs
- Selecting the best LLM for your use case
- Open Source frameworks and projects to interact with LLMs
- Ways of adding LLMs to Search



To Wrap it Up

- Popular Open Source search engines and LLMs
- Rabbit Holes
- Future Works



Sease
INFORMATION RETRIEVAL APPLIED

THANK YOU!

SCAN ME

@seaseltd @sease-ltd @seaseltd @sease_ltd