



Google Developer Groups  
Malta

# Build with AI

## AI and Maltese Law

# Simon Agius Muscat



- 10+ years of writing software
- Senior Software Engineer at Hotjar
- Reading for a Master's Degree in AI @ UoM
- [www.simonam.dev](http://www.simonam.dev)



# Today's talk

- A little bit technical
- A little bit legal
- A little bit philosophical

# Today's talk

- Similar to a cooking show



# Today's talk

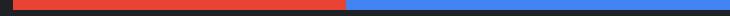
- Recorded (FAST!) Demos from my Home Computer
- Live (SLOW!) Demos on my Laptop





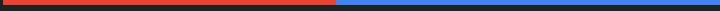
**Can we manage to build a  
Maltese AI Lawyer?**

# Why?



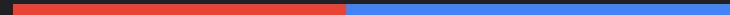
# Why?

## A minor fascination with Lawyers and Law



# Software Engineers

# Lawyers

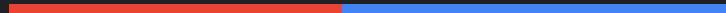


# Software Engineers

Code

# Lawyers

Contracts



# Software Engineers

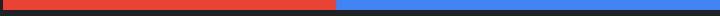
# Lawyers

Code

Executed by a Computer

Contracts

Enforced by a Court



# Software Engineers

Code

Executed by a Computer

# Lawyers

Contracts

Enforced by a Court

Highly subjective craft



# Software Engineers

Code

Executed by a Computer

# Lawyers

Contracts

Enforced by a Court

Highly subjective craft

Half or more of the work is the people involved

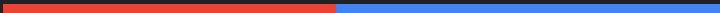
**Why?**  
**Why not? :)**



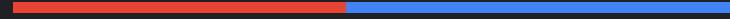
**The aim of today is to ask  
the question...**



**The aim of today is to ask  
the question...**

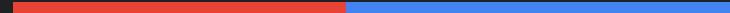
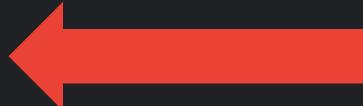


# What do we need?



- The laws of Malta
  - Put them into a format  
than an LLM (Large  
Language Model) can  
query
  - An LLM
- 

- The laws of Malta
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Language Model) can  
query
- An LLM



# The Laws of Malta

<https://legislation.mt/>



The screenshot shows the homepage of the Legislation Malta website. The header features the title 'LEGIZLAZZJONI MALTA' with a flag icon, followed by 'Lijjiet konsolidati' and 'Pubblikazzjonijiet'. A search bar and a 'Filtra malajr' button are also present. The top right includes links for 'Tittixja avanzaata', 'FAQs', 'Ikkuntattnana', 'eCourts', 'Sign up/in', and the British and Maltese flags.

The main content area has several sections:

- L-AHHAR AGGORNAMENTI**: A section showing recent updates with a link to 'Sign in to view your followed laws!'. It lists various academic programs offered by the University of Malta.
  - Ordinamenti ghall-Grad ta' Master of Arts in Ageing and Dementia Studies M.A. - taht il-patrocini tal-Fakultà għal-Tishħiħ tas-Socjetà CONVERGE
  - Ordinamenti ghall-Grad ta' Bachelor of Engineering (Honours) - B.Eng. (Hons) - taht il-patrocini tal-Fakultà tal-Inġierinja
  - Ordinamenti ghall-Grad ta' Master of Arts in International Hospitality and Tourism Experience Management - M.A. - taht il-patrocini tal-Fakultà tal-Ekonomija, il-Management u -Accountancy
  - Ordinamenti ghall-Grad ta' Master of Arts in Financial Services taht il-patrocini tal-Fakultà tal-Ligu
  - Ordinamenti għad-Diploma in Baroque Architecture taht il-patrocini tal-Fakultà tal-Ambjent Mibni
- FAQs**: A section with a list of frequently asked questions:
  - X'tip ta' legizlazzjoni issib f'din il-website?
  - Nista issib legizlazzjoni għidha fug il-website?
  - Kemm huwa aggħorn il-kontenut konsolidat ta' din il-website?
  - Uri iktar...
- GWDI BIL-VIDJO**: A blue button at the bottom left.

Below the main content are four images: an open book with floating letters, a hand signing a document, a magnifying glass over a document, and a close-up of a keyboard with a blue 'Europe' key.

At the bottom, a cookie consent banner reads: 'This website uses cookies to improve your browsing experience. By continuing to use this website you are giving consent to cookies being used.' with 'Accept' and 'Decline' buttons.

# The Laws of Malta

The screenshot shows the 'Consolidated laws' page on the Legislation Malta website. A red arrow points from the 'Followed Laws' section on the left to the 'Constitution' entry in the main table. Another red arrow points from the 'View' column of the Constitution entry to the three document icons in that column.

Chapter	Title	View
SLM	Statute Law Revision Act, 2021	
Constitution	Constitution of Malta	
Cap. 1	Ecclesiastical Courts (Constitution and Jurisdiction) Law	
Cap. 2(R)	Sanctuary (Abolition) Law <small>Repealed by Act II of 2015</small>	
Cap. 3	Marriage Legacies Law	
Cap. 5	Promises of Marriage Law	
Cap. 6(R)	Ecclesiastical Offices or Benefices (Appointment by Foreign Power) Ordinance <small>Repealed by Act II of 2015</small>	
Cap. 7(R)	Coal (Sale) Ordinance <small>Repealed by Act II of 2015</small>	
Cap. 8(R)	Cereals (Sale) Ordinance <small>Repealed by Act II of 2015</small>	
Cap. 9	Criminal Code	
Cap. 10	Code of Police Laws	
Cap. 11	Acts of Parliament (Application) (Powers of Court of Magistrates) Ordinance	
Cap. 12	Code of Organization and Civil Procedure	

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Accept

# The Laws of Malta

<https://legislation.mt/eli/const/eng>

LEGISLATION MALTA

Advanced search FAQs Contact us eCourts Sign up/in 🇮🇪 🇬🇧

Timeline BETA

Consolidated 2021-05-28/05/2021  
Related Acts XIX & Act XXVI of 2021  
Timeline BETA 2021 Jul Oct Jan Apr Jul Oct Jan Apr Jul Oct Jan 2022

11/11/2022  
Act XVI of 2022  
02/02/2024  
Act III of 2024

CONSTITUTION OF MALTA 1

CONSTITUTION OF MALTA  
ARRANGEMENT OF ARTICLES

CHAPTER I  
The Republic of Malta

*Article*

1. The Republic and its Territories.
2. Religion.
3. National Flag.
4. National Anthem.
5. Language.
6. Constitution to be supreme law.

CHAPTER II  
Declaration of Principles

7. Right to work.
8. Promotion of culture, etc.
9. Safeguarding of landscape and historical and artistic patrimony.
10. Compulsory and free primary education.
11. Education of interests.

In Force

Type: Chapter  
Title: Constitution of Malta  
ELI Link: eli/const  
Keywords:  
+ Constitution  
+ Malta  
Language: English Maltese  
Format: PDF

Follow

Ontology Index Related

Status In Force  
Date first in force 1964-09-21  
Date of publication 2024-02-02



# The Laws of Malta

<https://legislation.mt/en/>

The image is a composite of two parts. On the left, there is a screenshot of the Legislation Malta website. The header reads "LEGISLATION MALTA". Below it, a navigation bar includes links for "eServices", "eCourts", "Sign up/in", and flags for "Malta" and "English". A search bar shows the date "03/02/2024". The main content area displays a timeline for "Consolidated Act 2021" dated "28/05/2021". It lists "Related Acts" such as "XIX & Act XXVI of 2021". A "Timeline BETA" section shows a timeline from "2021" to "Oct 2024" with markers for "pr", "Jul", and "Oct". On the right, a close-up photograph shows a person's finger pressing the "F12" key on a dark-colored computer keyboard.

# The Laws of Malta

<https://legislation.mt/eli/const/eng>



A screenshot of the Constitution of Malta document. The title 'CONSTITUTION OF MALTA' is at the top. Below it is 'CHAPTER I' and 'The Republic of Malta'. An 'Article' section lists: 1. The Republic and its Territories, 2. Religion, 3. National Flag, 4. National Anthem, 5. Language, and 6. Constitution to be supreme law. 'CHAPTER II' follows with 'Declaration of Principles' and items 7 through 11. Item 7: Right to work, 8: Promotion of culture, etc., 9: Safeguarding of landscape and historical and artistic patrimony, 10: Compulsory and free primary education, and 11: Educational interest.

**In Force**

Type: Chapter  
Title: Constitution of Malta  
ELI Link: eli/const  
Keywords:  
+ Constitution  
+ Malta  
Language: English  
Maltese  
Format: PDF

**Ontology In...** Relations

Status  
Date first in force  
1964-09-21  
Date of publication  
2024-02-02

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Accept

A screenshot of a browser developer tools window, specifically the Network tab. It shows a request for a PDF file: 'GET https://legislation.mt/getpdf/65ccb60b8a3fa714e81f30c2.pdf?is2... pdf 584.18... 582... 0c2'. The response status is '200 OK'. The response headers include: Access-Control-Allow-Origin: https://legislation.mt/, Cache-Control: private, no-cache, Content-Length: 582893, Content-Security-Policy: default-src 'self' https://stats.doubleclick.net https://region1.analytics.google.com https://www.google-analytics.com/script/src 'self' unsafe-inline 'unsafe-eval https://www.google-analytics.com https://cdnrs.cloudflare.com https://www.google.com/ecagtchabai https://astatic.com https://use.fontawesome.com https://www.googleapismanager.com/style/src 'self' unsafe-inline https://fonts.googleapis.com https://cdn.cloudflare.com https://use.fontawesome.com/frame-src 'self' https://www.youtube.com https://www.google.com https://astatic.com https://use.fontawesome.com https://www.google.com https://use.fontawesome.com/frame-ancestors 'self' https://use.fontawesome.com https://www.googleapismanager.com/img-src 'self' data: blob https://www.googleapis.com https://www.googleapismanager.com/font-src 'self' data: https://use.fontawesome.com https://astatic.com https://use.fontawesome.com https://astatic.com', Content-Type: application/pdf, Date: Sat, 04 May 2024 20:55:23 GMT, Strict-Transport-Security: max-age=31536000, X-Content-Type-Options: nosniff, X-Content-Type-Options: nosniff, X-Frame-Options: SAMEORIGIN, X-XSS-Protection: 1;mode=block, X-XSS-Protection: 1;mode=block. The request headers are also listed.

# The Laws of Malta

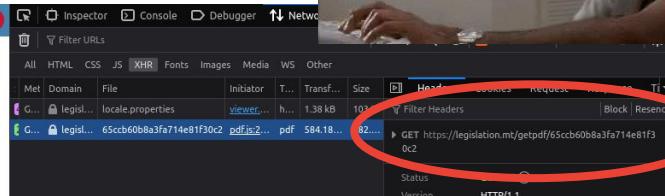
<https://legislation.mt/eli/const/eng>

The screenshot shows the Legislation Malta website. At the top, there's a navigation bar with links for Advanced search, FAQs, Contact us, eCourts, Sign up/in, and a language switcher. Below the navigation is a timeline diagram showing the evolution of the Constitution of Malta from 'Act XXVI of 2021' to 'Act III of 2024'. The main content area displays the 'CONSTITUTION OF MALTA' with 'CHAPTER I' and 'CHAPTER II'. The sidebar on the right provides detailed information about the document, including its status as 'In Force', type as 'Chapter', title as 'Constitution of Malta', and ELI link as 'eli/const'. It also lists keywords such as '+ Constitution', '+ Malta', and '+ English', and specifies the language as English and the format as PDF. A cookie consent banner at the bottom states: 'This website uses cookies to improve your browsing experience. By continuing to use this website you are giving consent to cookies being used.'

The screenshot shows a browser developer tools Network tab. A specific request for a PDF file is highlighted with a red circle. The request URL is https://legislation.mt/getpdf/65ccb60b8a3fa714e81f30c2.pdf. The response headers section is expanded, showing various headers including Content-Type: application/pdf, Date: Sat, 04 May 2024 20:55:23 GMT, and Strict-Transport-Security: max-age=31536000.

# The Laws of Malta

<https://legislation.mt/eli/const/eng>



▶ GET <https://legislation.mt/getpdf/65ccb60b8a3fa714e81f3>

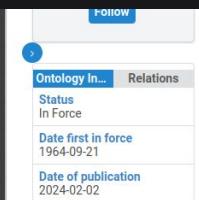
0c2

1. The Republic and its Territories.
2. Religion.
3. National Flag.
4. National Anthem.
5. Language.
6. Constitution to be supreme law.

## CHAPTER II

### Declaration of Principles

7. Right to work.
8. Promotion of culture, etc.
9. Safeguarding of landscape and historical and artistic patrimony.
10. Compulsory and free primary education.
11. Educational interest.



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m/ https://astatic.com https://usefontawesome.com ht  
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ntawesome.com https://astatic.com  
Content-Type: application/pdf  
Date: Sat, 04 May 2024 20:55:23 GMT  
Strict-Transport-Security: max-age=31536000  
X-Content-Type-Options: nosniff  
X-Content-Type-Options: nosniff  
X-Frame-Options: SAMEORIGIN  
X-XSS-Protection: 1;mode=block  
X-XSS-Protection: 1;mode=block

Request Headers (782 B) Raw

Accept: \*/\*  
Accept-Encoding: gzip, deflate, br  
Accept-Language: en-US,en;q=0.5  
Cache-Control: no-cache  
Connection: keep-alive  
Cookie: PDRMID=47.3.315723232307

# The Laws of Malta

The screenshot shows the Legislation Malta website interface. At the top, there's a navigation bar with links for Advanced search, FAQs, Contact us, eCourts, Sign up/in, and a language switcher. Below the navigation is a search bar with a placeholder 'Quick search'.

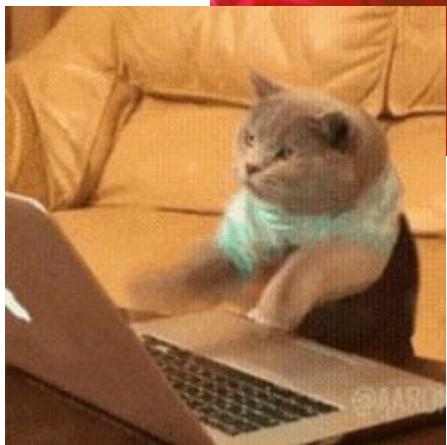
The main content area is titled 'Consolidated laws' and shows a message: 'Last consolidated on 25th April 2024'. It includes a search bar with fields for 'Cap. or S.L. number' and 'Search in Title...', and a 'Search' button.

A large red circle highlights the 'ID: "6022595dbc8272018c0f2ceb"' for the Constitution object. Below it, the 'ChapterText' and 'ChapterTitle' are shown as 'Constitution' and 'Constitution of Malta' respectively. The 'URL' is listed as 'eli/const/eng'. The 'HasChildren: true' status indicates it has sub-entities.

On the right side, a developer tools Network tab is open, showing a JSON response for the 'legisl... LegislationPartial' request. The response contains 25 records, with the first item highlighted by a red circle. This item corresponds to the Constitution object, showing its ID, ChapterText ('Constitution'), ChapterTitle ('Constitution of Malta'), URL ('eli/const/eng'), and HasChildren status.

At the bottom left, a cookie consent banner states: 'This website uses cookies to improve your browsing experience. By continuing to use this website you are giving consent to cookies being used.' There are 'Accept' and 'Decline' buttons. The bottom right corner shows the page number '27'.

## The Laws of Malta



# The Laws of Malta

eli-In-1981-99-eng.pdf 51.7% Q ≡ ×

B 428

L.N. 99 of 1981

**MEDICAL AND KINDRED PROFESSIONS ORDINANCE  
(CAP. 51)**

**Drugs (Control) (Amendment) (No. 2) Regulations, 1981**

IN exercise of the powers conferred by section 35A of the Medical and Kindred Professions Ordinance, the Minister of Health and Environment, on the advice of the Council of Health, has made the following regulations:—

Citation:  
L.N. 31 of 1976

Amends  
Second  
Schedule to the  
principal  
regulations.

1. These regulations may be cited as the Drugs (Control) (Amendment) (No. 2) Regulations, 1981, and shall be read and construed as one with the Drugs (Control) Regulations, 1976, hereinafter referred to as "the principal regulations".

2. Immediately after the item "BARBITAL" in the Second Schedule to the principal regulations there shall be inserted the following item:—

"BENZPHETAMINE (+)-N-Benzyl-N-dimethylphenethylamine".

Suppliment

L.N. 7 of 2012

**MERCHANT SHIPPING ACT  
(CAP. 234)**

**Merchant Shipping (Minimum Wage) (Amendment)  
Regulations, 2012**

IN exercise of the powers conferred by articles 122C and 374 of the Merchant Shipping Act, the Minister for Infrastructure, Transport and Communications, has made the following regulations:

1. The title of these regulations is the Merchant Shipping (Minimum Wage) (Amendment) Regulations, 2012.



- The laws of Malta
- Put them into a format  
than an LLM (Large  
Language Model) can  
query
- An LLM ←



LLM

Large Language Model



How can I help you today?

**Suggest fun activities**  
to help me make friends in a new city

**Create a recipe**  
using ingredients from my kitchen

**Help me study**  
vocabulary for an exam

**Tell me a fun fact**  
about the Roman Empire

Message ChatGPT



ChatGPT can make mistakes. Consider checking important information.

# Closed Source

vs

# Open Source



# Closed Source



How can I help you today?

Suggest fun activities

to help me make friends in a new city

Help me study

vocabulary for an exam

Create a recipe

using ingredients from my kitchen

Tell me a fun fact

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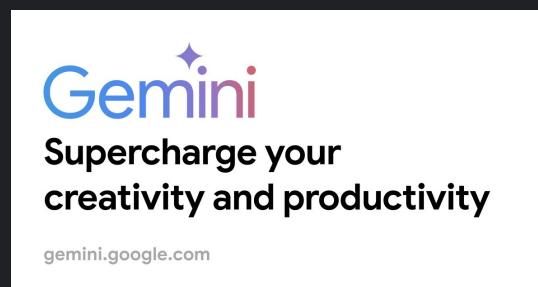
Message ChatGPT



ChatGPT can make mistakes. Consider checking important information.



# Closed Source



# Open Source



# Open Source



LLAMA 2



# Open Source



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<https://ollama.com/>

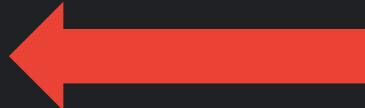
# Ollama

**DEMO: Let's run Google Gemma locally!**





- The laws of Malta
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query
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01

# Introduction to RAG

Retrieval Augmented Generation

## Typical usage of LLMs

LLMs are phenomenal for knowledge generation and reasoning. They are pre-trained on large amounts of **publicly available data**.



# But.... The Grounding Problem (aka Hallucinations)

LLMs can only understand the information

- That they were trained on
- That they are explicitly given in the prompt

They will often assume that the premise of a prompt is true.

LLMs don't have the capability to ask for more information and potentially need some outside input.

## Prompt

What is langchain?

## Response

LangChain is a blockchain-based platform that allows users to create, share, and learn languages. It is a decentralized platform that is not controlled by any single entity. This means that users have complete control over their data and content. LangChain is also a secure platform, as all data is encrypted and stored on the blockchain. This makes it very difficult for hackers to access or steal data.

# Don't be this person...

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**Canada**

• This article is more than 2 months old

## Canada lawyer under fire for submitting fake cases created by AI chatbot

**Chong Ke, from Vancouver, under investigation after allegedly using ChatGPT to cite case law - but those cases did not exist**

 Generative AI refers to a class of artificial intelligence (AI) models that can create or generate new data, such as images, text, or music, that is similar to the data it was trained on. Generative models learn to recognize patterns and relationships in the input data and then use this knowledge to generate new data that is similar to the training data but is not identical.

There are many different types of generative AI models, including Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), and autoregressive models. VAEs learn a probabilistic model of the input data and then generate new data samples by sampling from this model. GANs consist of two neural networks: a generator that creates new data samples and a discriminator that works to distinguish between real data and generated data. Autoregressive models learn a probability distribution over the data and then sample from it to generate new data.

The judge found Ke took steps to correct her errors. Photograph: Michael Dwyer/AP

# The Guardian

<https://www.theguardian.com/world/2024/feb/29/canada-lawyer-chatgpt-fake-cases-ai>

### Most viewed

**Live** London mayor election result due as Labour takes Liverpool and South Yorkshire - live

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Three bodies found in northern Mexico where Perth brothers went missing

India opposition social media chief arrested over doctored video

'When I became a meme it was humiliating and hurtful': Dua Lipa on pop, psychedelics and proving her haters wrong

**"Citing fake cases in court filings and other materials handed up to the court is an abuse of process and is tantamount to making a false statement to the court," wrote Justice David Masuhara. "Unchecked, it can lead to a miscarriage of justice."**

44

# What kind of hallucinations about Maltese Law can we find?

## Prompt (Google Gemma 7B 4 bit)

Summarise L.N. 203 of 2021 PUBLIC HEALTH ACT CAP 465 of Maltese legislation

## Response

## Summary of Legal Notice 203 of 2021 (Public Health Act)

### \*\*Purpose:\*\*

The Legal Notice empowers the Superintendent of Public Health to issue regulations related to the management of COVID-19 and other infectious diseases.

### \*\*Key Provisions:\*\*

\* \*\*Restrictions:\*\* The Superintendent can impose restrictions on:

- \* Gatherings
- \* Events
- \* Businesses
- \* Travel
- \* Public spaces

\* \*\*Mandatory Measures:\*\*

\* Wearing of face masks in designated places

## Prompt (OpenAI GPT3.5 via ChatGPT)

Summarise L.N. 203 of 2021 PUBLIC HEALTH ACT CAP 465 of Maltese legislation

## Response



You

Summarise L.N. 203 of 2021 PUBLIC HEALTH ACT CAP 465 of Maltese legislation



ChatGPT

L.N. 203 of 2021 amends the Public Health Act CAP 465 in Malta. This legislation deals with various aspects of public health, including regulations related to communicable diseases, sanitation, and health inspections. The specific amendments introduced by L.N. 203 of 2021 would need to be reviewed directly from the legal text for an accurate summary of the changes.

## What kind of hallucinations about Maltese Law can we find?

**DEMO:** Let's give a legal document to the LLM and see if it uses it to ground itself!



# Retrieval Augmented Generation (RAG)

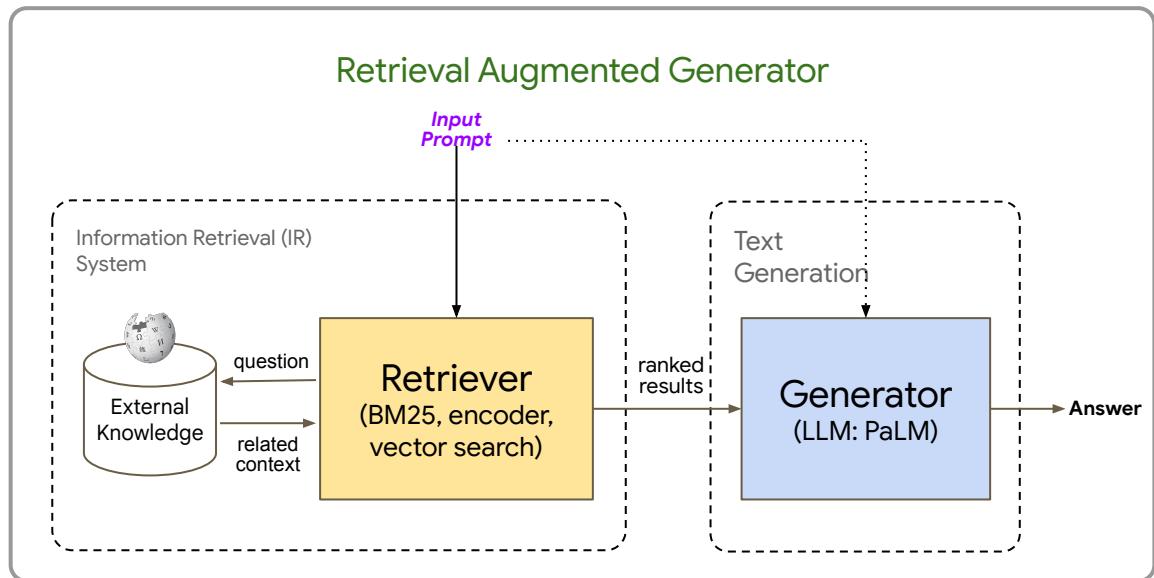
‘Grounding’ on user data

## The Problem:

- LLMs do not know your business’s proprietary or domain specific data
- LLMs do not have real-time information
- LLMs find it challenging to provide accurate citations from their parametric knowledge

## The Solution:

Feed the LLM \*relevant\* context in real-time, by using an information retrieval system



## Modified Prompt

You are an intelligent assistant helping the users with their questions on {{company | research papers | ...}}. Strictly Use ONLY the following pieces of context to answer the question at the end. Think step-by-step and then answer.

Do not try to make up an answer:

- If the answer to the question cannot be determined from the context alone, say "I cannot determine the answer to that."
- If the context is empty, just say "I do not know the answer to that."

CONTEXT:

**{{retrieved\_information}}**

QUESTION:

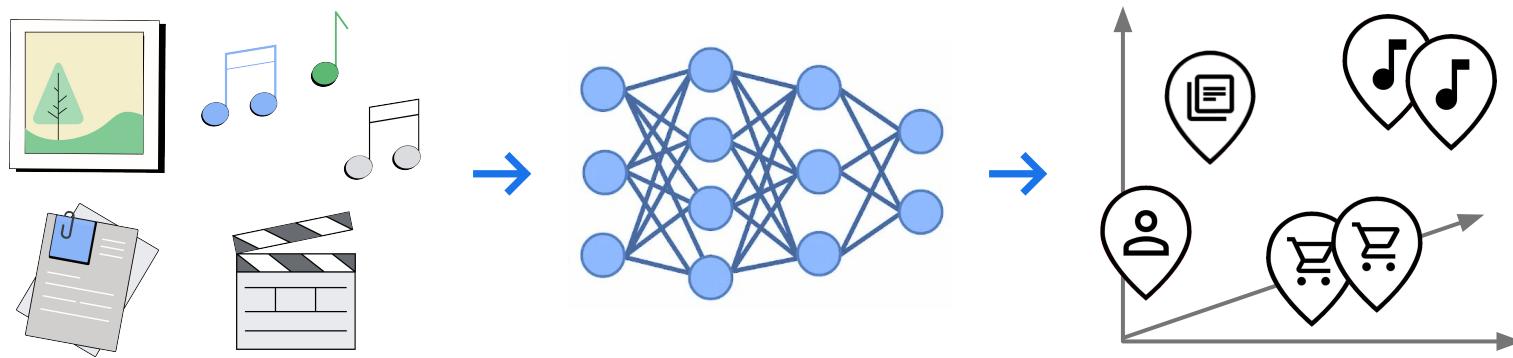
**{{question}}**

Helpful Answer:

# Benefits of RAG-based workflows / applications

- **Factuality & Grounding:** Provides context, and accuracy grounded in evidence to generative AI, beyond what the LLM can provide.
- **Better context:** Can contain data that's more contextual than the data in a generalized LLM.
- **Fresher data:** Access to information which could be more recent than the data used to train the LLM.
- **Quicker updates to data:** Data in the RAG can be continually updated without incurring significant costs.
- **Cheaper:** Relatively cheaper than fine-tuning and quicker to implement
- **Governance:** Control LLM response based on who is accessing, by implementing access control and entitlements.

# Embeddings



**Data ( $10^4 \sim 10^6$  dims)**

**DL models**

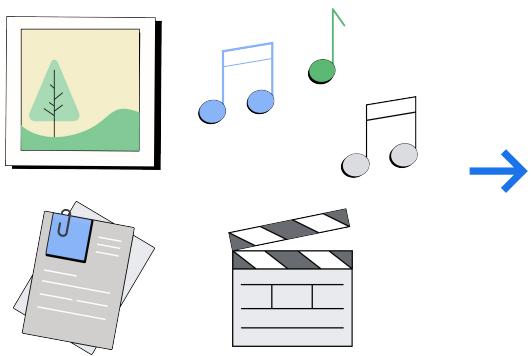
**Embs ( $10^2 \sim 10^4$  dims)**

"An **embedding** is a relatively low-dimensional vector into which you can translate high-dimensional vectors. Ideally, an embedding captures some of the semantics of the input by placing **semantically similar inputs close together** in the embedding space."

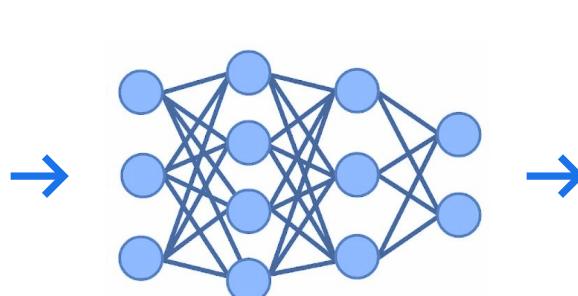
[Meet AI's multitool: Vector embeddings](#)

From: [Google Machine Learning Crash Course](#)

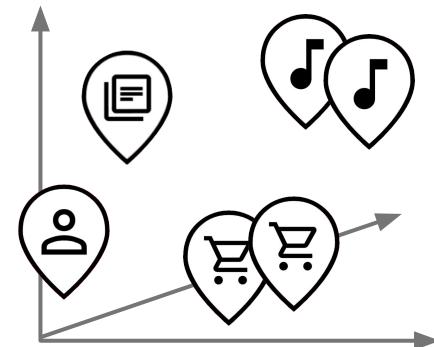
## Embeddings



**Data ( $10^4 \sim 10^6$  dims)**

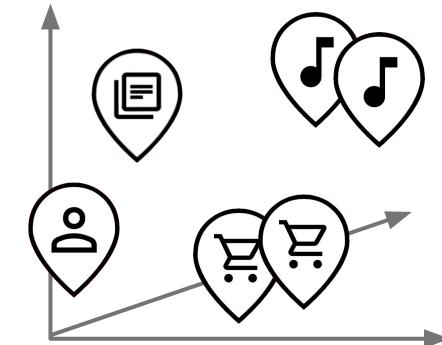
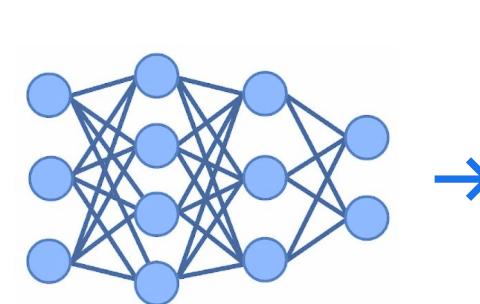
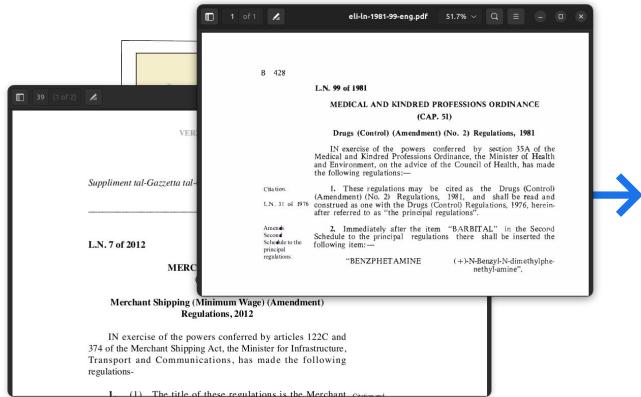


**DL models**



**Embs ( $10^2 \sim 10^4$  dims)**

# Embeddings from Law Documents

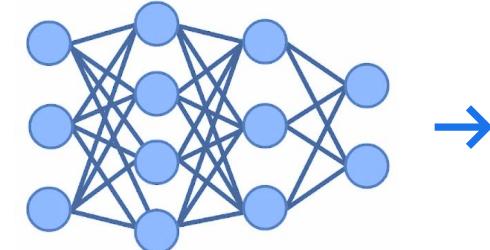
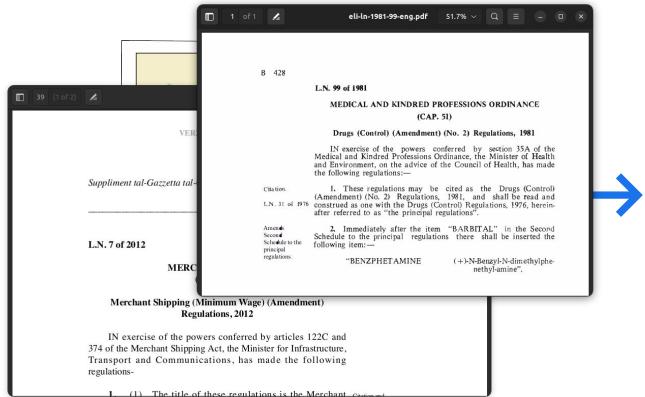


Data ( $10^4 \sim 10^6$  dims)

DL models

Embs ( $10^2 \sim 10^4$  dims)

# Embeddings from Law Documents



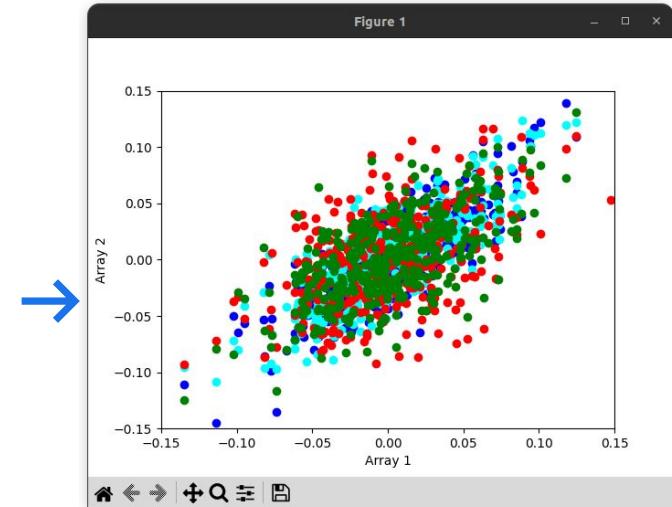
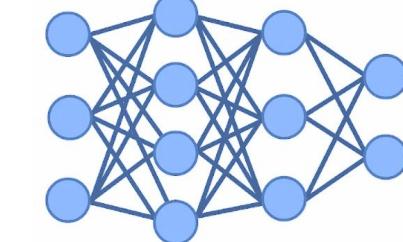
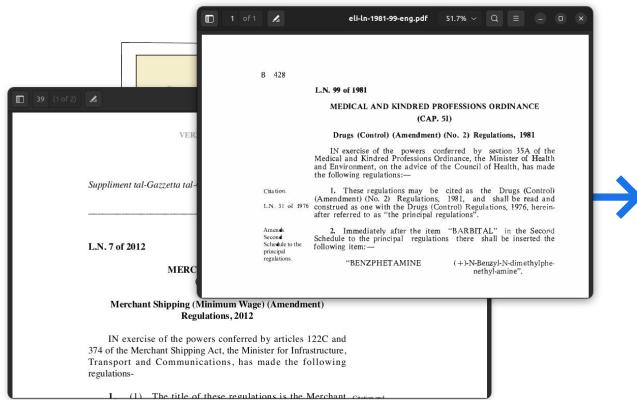
Data ( $10^4 \sim 10^6$  dims)

DL models

-0.0248113963752985,  
0.014038640074431896,  
-0.0363677553832531,  
0.005548791028559208,  
0.03860688582062721,  
0.020979879423975945,  
0.025668920949101448,  
0.028817223384976387,  
-0.0016689413459971547,  
0.0052922870963811874,  
0.01692878268659115,  
-0.08155131340026855,  
0.01830998621881008,  
-0.0014124816516414285,  
0.012671221978962421,  
-0.032539252191782,  
-0.000628573470748961,  
-0.08237277716398239,  
-0.012060565873980522,  
0.019501671195030212,  
0.012089765630662441,  
0.05592379719018936,

Blue  
Red  
Gre

# Embeddings from Law Documents



Data ( $10^4 \sim 10^6$  dims)

DL models

Embs ( $10^2 \sim 10^4$  dims)

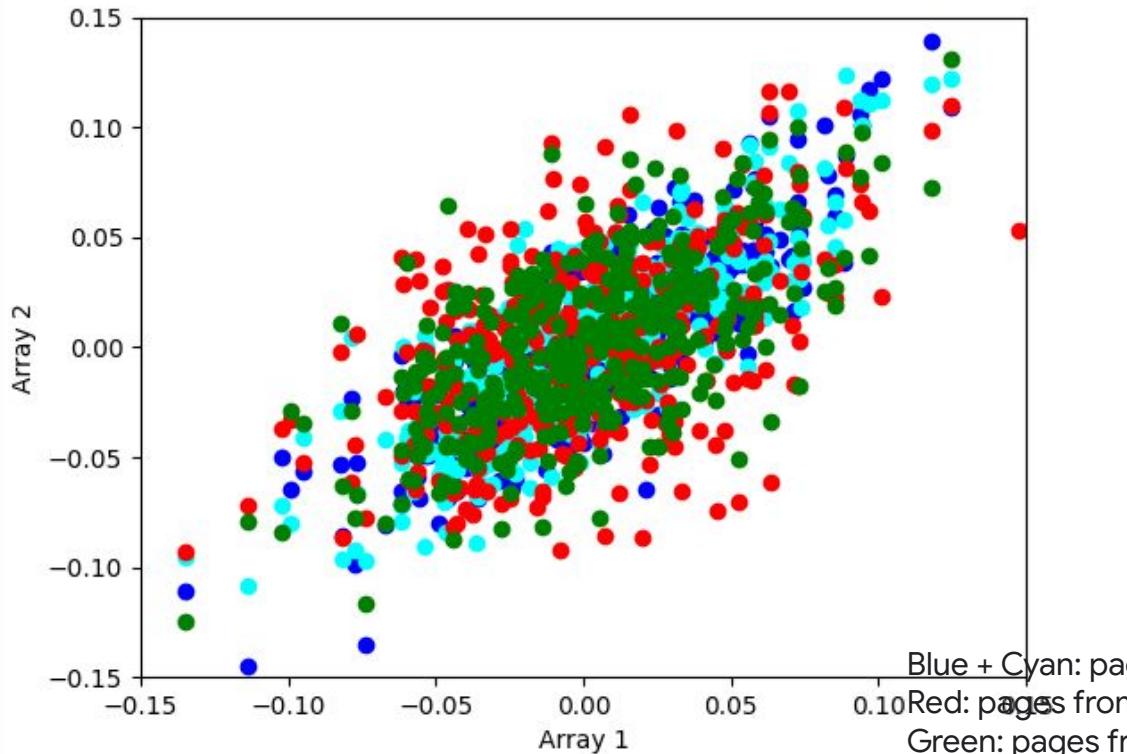
Blue + Cyan: pages from LN 2021 203  
Red: pages from SL 605  
Green: pages from SL 662

Figure 1

## Embedding



## Data (1)

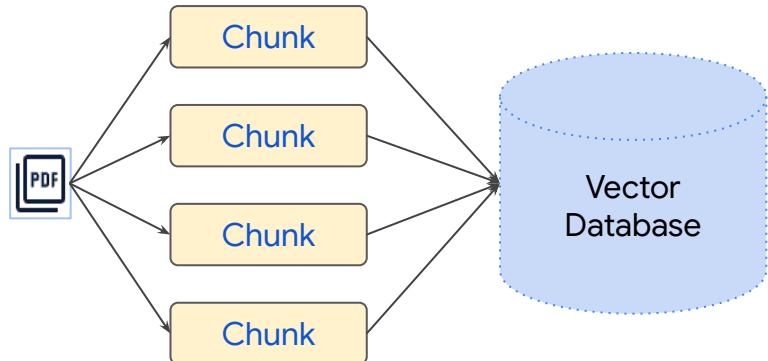


$10^2 \sim 10^4$  dims)

Blue + Cyan: pages from LN 2021 203  
Red: pages from SL 605  
Green: pages from SL 662

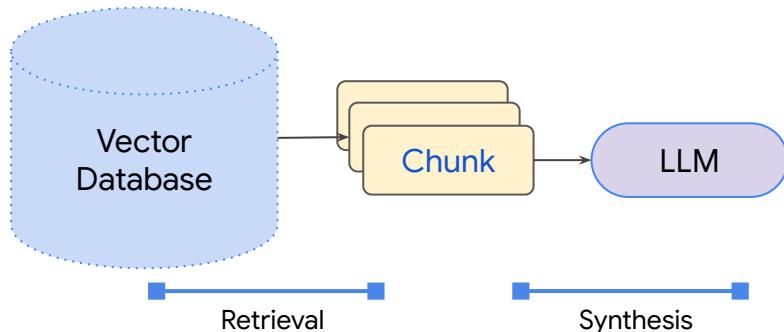


# RAG workflow for building a QA System



## Data Ingestion / Parsing

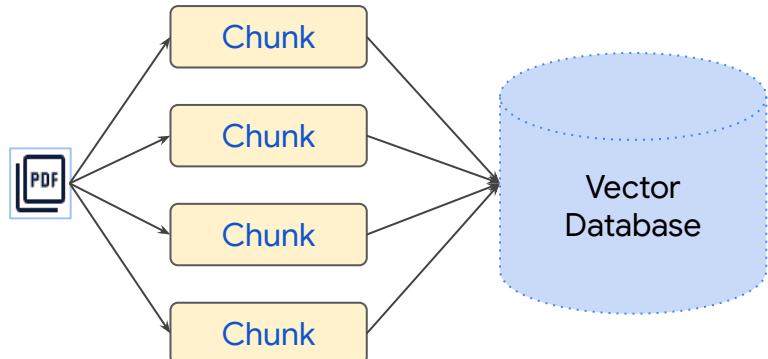
- Split up document(s) into even chunks.
- Each chunk is a piece of raw text.
- Generate embedding for each chunk
- Store each chunk into a vector database



## Querying

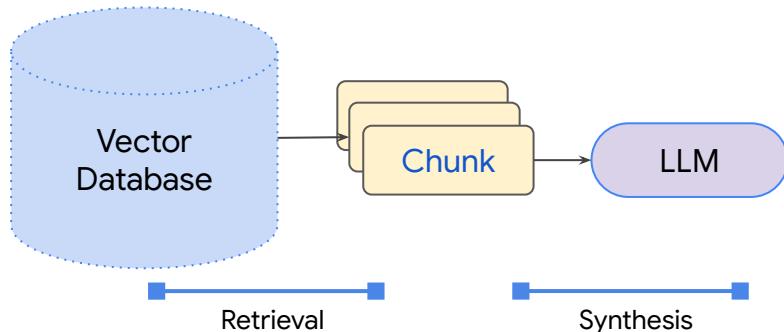
- Generate embedding for query
- Find top-k most similar chunks from vector database
- Plug into LLM response synthesis

# RAG workflow for building a QA System



## Data Ingestion / Parsing

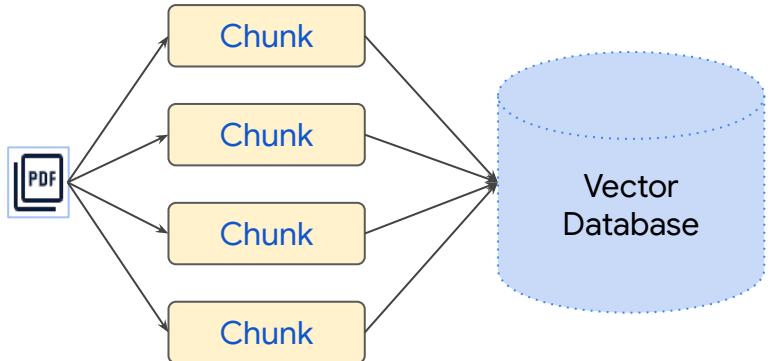
- Split up document(s) into even chunks.
- Each chunk is a piece of raw text.
- Generate embedding for each chunk
- Store each chunk into a vector database



## Querying

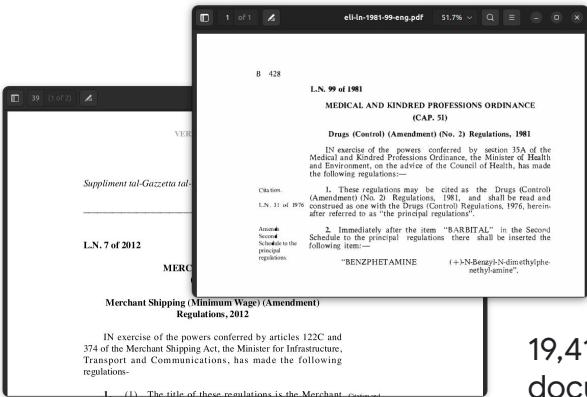
- Generate embedding for query
- Find top-k most similar chunks from vector database
- Plug into LLM response synthesis

# RAG workflow for building a QA System



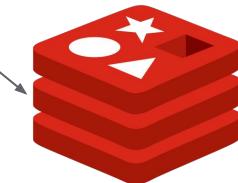
## Data Ingestion / Parsing

- Split up document(s) into even chunks.
- Each chunk is a piece of raw text.
- Generate embedding for each chunk
- Store each chunk into a vector database



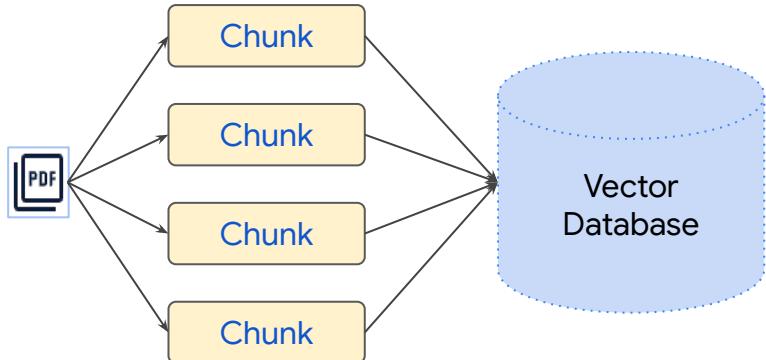
19,419  
documents

<https://huggingface.co/BAAI/bge-small-en-v1.5>



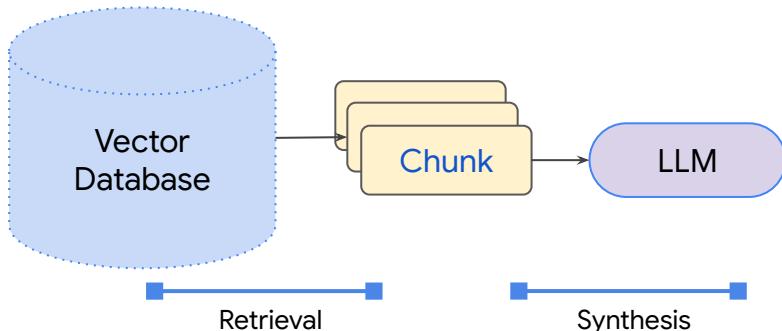
redis

# RAG workflow for building a QA System



## Data Ingestion / Parsing

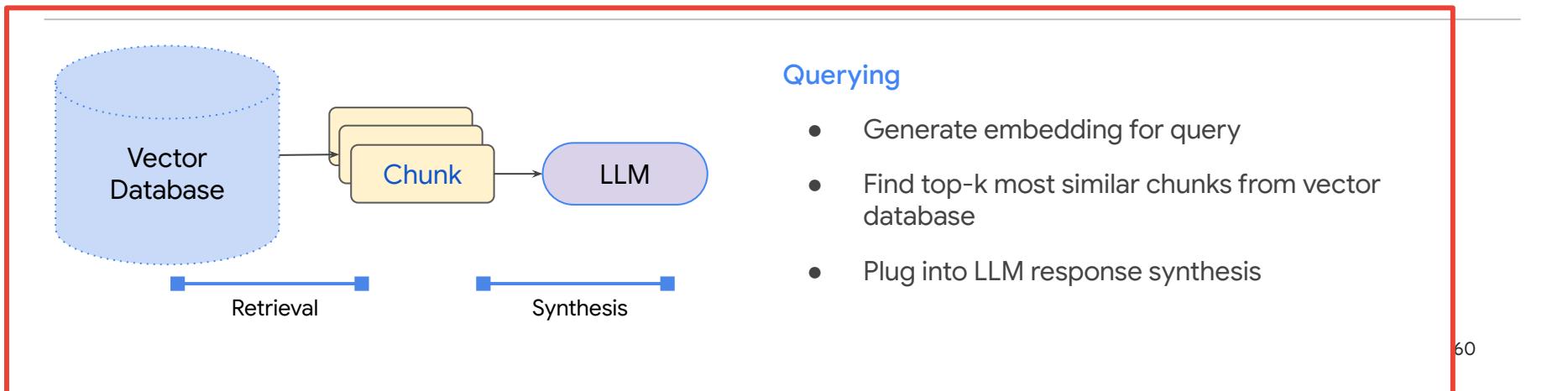
- Split up document(s) into even chunks.
- Each chunk is a piece of raw text.
- Generate embedding for each chunk
- Store each chunk into a vector database



## Querying

- Generate embedding for query
- Find top-k most similar chunks from vector database
- Plug into LLM response synthesis

# RAG workflow for building a QA System





- The laws of Malta
- Put them into a format  
than an LLM (Large  
Language Model) can  
query
- An LLM



# What kind of hallucinations about Maltese Law can we find?

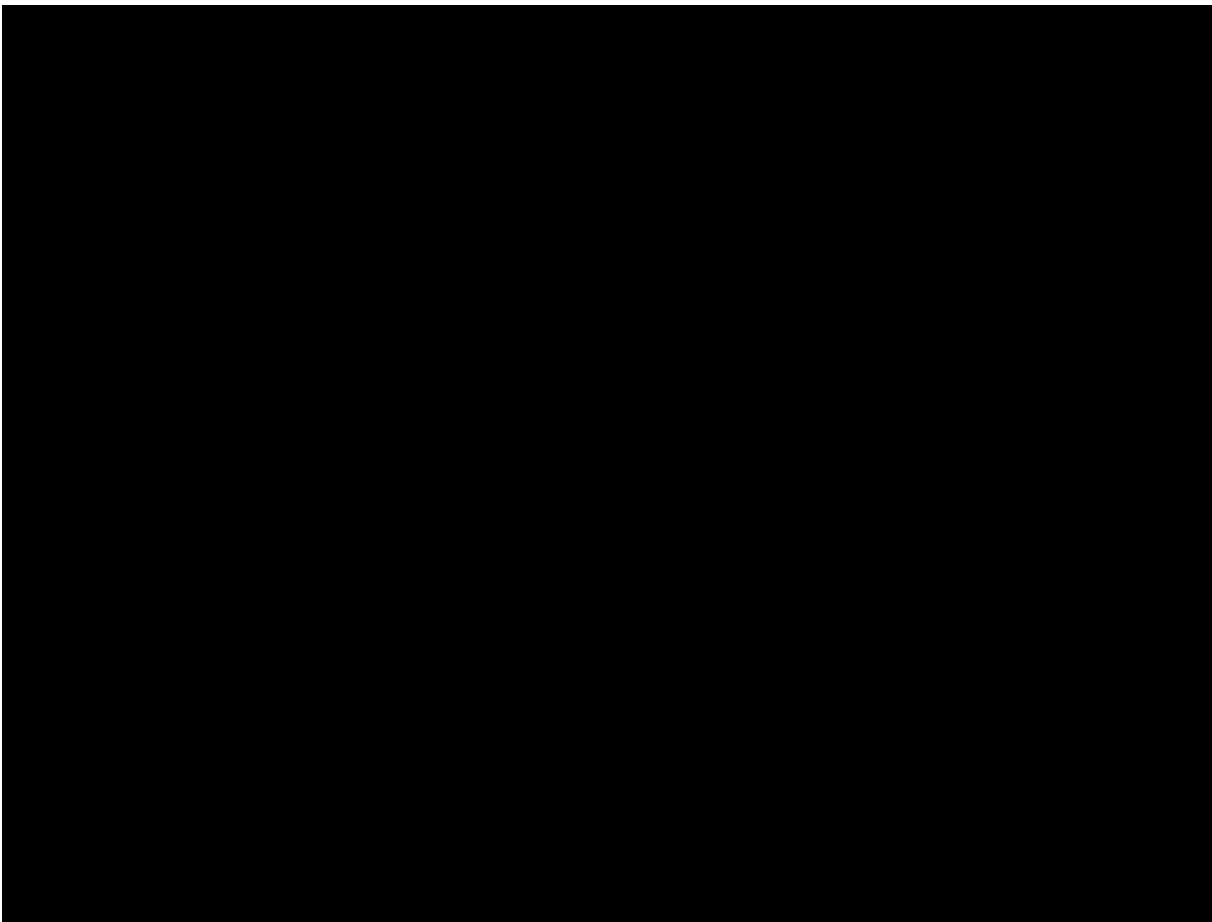


**DEMO:** Let's give ALL the legal documents to the LLM and see if it uses them to ground itself!

## Prompts

- What laws exist around fireworks in Malta?
- Is it legal to play loud music outside in Malta?
- Can I park on a double yellow line in Malta?
- Can I open a shop on a public holiday till 11pm in Malta?
- Can I drive on the left side of the road in Malta?
- Can I drive on the right side of the road in Malta?

**Prompts: What laws exist around fireworks in Malta?**



# Prompts: What laws exist around fireworks in Malta?

EXPLOSIVES

[CAP. 33. 1]

## CHAPTER 33

### EXPLOSIVES ORDINANCE

To amend and consolidate the laws relating to explosives.

15th July, 1904

ORDINANCE XII of 1904, as amended by Ordinances IV of 1920 and XL of 1940; Acts XXXV of 1949 and XXVII of 1955; Ordinances XVIII of 1960, XVII of 1961 and XXV of 1962; Legal Notices 4 of 1963 and 46 of 1965; Acts LVIII of 1974, XXII of 1976, XI of 1977, XLIX of 1981, XIII of 1983, VIII of 1990 and III of 2002; Legal Notice 407 of 2007; and Acts VIII of 2008, XX of 2012, IX of 2018 and XVII and XXI of 2020 and XVI of 2022 and XXXV of 2023.

#### ARRANGEMENT OF ORDINANCE

	Short Title and Interpretation	Articles
Part I	Explosives	1-2
Part II	Penal Provisions	3-26
Part III	General Provisions	27-34
	Transitory Provisions	35-49
		50

METROLOGY

[CAP. 454. 1]

## CHAPTER 454

### METROLOGY ACT

To repeal and replace the Weights and Measures Ordinance.

15th September, 2006

ACT XXV of 2002, as amended by Act XV of 2006; Legal Notices 427 of 2007, 110 of 2010 and 190 of 2020; and Act VI of 2011 and XXI of 2020.

#### PART I

##### Preliminary

- The short title of this Act is the Metrology Act.

Short title.  
Amended by:  
XV. 2006.19.

- In this Act unless the context otherwise requires -

Interpretation.  
Amended by:  
XV. 2006.20;  
VI. 2011.163.  
Cap. 510.

"Authority" means the Malta Competition and Consumer Affairs Authority as established by the Malta Competition and Consumer Affairs Authority Act;

"calibration" refers to all the operations for the purpose of determining the values of errors of a measuring instrument;

"container" means a container in which goods are exposed

## Prompts: Is it legal to play loud music outside in Malta?

```
(mal) → maltese-ai-lawyer-experiment git:(main) python3 lawyer.py
2024-05-06 00:33:13.183 Starting LLM...
2024-05-06 00:33:13.183 Loading embedding model...
2024-05-06 00:33:13.189 Load pretrained SentenceTransformer: BAAI/bge-small-en-v1.5
^[[R
^[[home/simon/miniconda3/envs/mal/lib/python3.12/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
  warnings.warn(
/home/simon/miniconda3/envs/mal/lib/python3.12/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
  warnings.warn(
  warnings.warn(
  warnings.warn(
2024-05-06 00:33:16.106 2 prompts are loaded, with the keys: ['query', 'text']
2024-05-06 00:33:16.107 Connecting to redis...
2024-05-06 00:33:16.107 Creating Vector Store...
00:33:16 revliva.Index.Index Index already exists, not overwriting.
2024-05-06 00:33:16.109 Index already exists, not overwriting.
2024-05-06 00:33:16.109 Loading Index...
2024-05-06 00:33:16.259 Starting chat engine...
===== Entering Chat REPL =====
Type "exit" to exit.

Human: ■

0[                               ] Tasks: 175, 766 thr: 1 running
1[                               ] Load average: 0.41 0.19 0.13
2[                               ] Uptime: 11:31:28
3[                               ]
4[                               ]
5[                               ]
6[                               ]
7[                               ]
Mem[████████████████████████████████████████████████████████████████] 5.56G/31.2G
Swap[                               ]

Device 0 [NVIDIA GeForce GTX 1080 Ti] PCIE GEN 3@16x RX: 0.000 KiB/s TX: 0.000 KiB/s
GPU 1569MHz MEM 5005MHz TEMP 48°C FAN 0% POW 65 / 275 W
GPU[          0%] MEM[████████████████████████████████████████████████████████████████] 6.862Gi/11.000Gi

100 GPU %  
75 GPU mem%  
50  
25  
0

100 GPU %  
75 GPU mem%  
50  
25  
0

PID USER PRI NI VIRT RES SHR S CPU% MEM% TIME+ Command
26966 simon -6 0 1978M 29440 20608 S 2.0 0.1 0:29.88 /usr/bin/pulseaudio --daemonize=no --log=err
1232 simon 9 -1 1978M 29440 20608 S 1.3 0.1 9:26.35 /usr/bin/pulseaudio --daemonize=no --log=err
19175 simon 20 0 15040 5888 3840 R 1.3 0.0 2:27.80 htop
F1Help F2Setup F3Search F4Filter F5Tree F6SortBy F7Nice F8Nice F9Kill F10Quit F11Save Config
F12Python3
[0] BgPython3*
```

# Prompts: Can I park on a double yellow line in Malta?

(mal) → maltese-ai-lawyer-experiment gtt:(main) python3 lawyer.py  
2024-05-06 00:36:03,822 Starting LLM...  
2024-05-06 00:36:03,822 Loading embedding model...  
2024-05-06 00:36:03,822 Load pretrained SentenceTransformer: BAAI/bge-small-en-v1.5  
/home/simon/miniconda3/envs/ma1/lib/python3.12/site-packages/huggingface\_hub/file\_download.py:1132: FutureWarning: 'resume\_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force\_download=True'.  
 warnings.warn(  
'/home/simon/miniconda3/envs/ma1/lib/python3.12/site-packages/huggingface\_hub/file\_download.py:1132: FutureWarning: 'resume\_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use "force\_download=True".  
 warnings.warn(  
2024-05-06 00:36:06,795 2 prompts are loaded, with the keys: ['query', 'text']  
2024-05-06 00:36:06,796 Connecting to redis...  
2024-05-06 00:36:06,796 Creating Vector Store...  
2024-05-06 00:36:06,796 Index already exists, not overwriting.  
2024-05-06 00:36:06,798 Index already exists, not overwriting.  
2024-05-06 00:36:06,798 Loading Index...  
2024-05-06 00:36:06,952 Starting chat engine...  
==== Entering Chat REPL ====  
Type "exit" to exit.

Human: [REDACTED]

(base) → maltese-ai-lawyer-experiment gtt:(main) ollama run gemma:7b  
>>> Send a message (/? for help)

Device 0 [NVIDIA GeForce GTX 1080 Ti] PCIe GEN 3@16x RX: 0.000 Kib/s TX: 0.000 Kib/s  
GPU 1569MHz MEM 5005MHz TEMP 47°C FAN 0% POM 65 / 275 W  
GPU[  
 6%] MEM[  
 75 6.862Gi/11.000Gi]  
GPU 0 %  
GPU mem%  
100 75 50 25 0  
Mem[  
 5.57G/31.2G  
Swap[

PID	USER	DEV	TYPE	GPU	GPU MEM	CPU	HOST MEM	Command
28921	simon	0	Compute	0%	6428MB	57%	0%	826MB /tmp/ollama3663282917/runners/cuda v11/ollama
1232	simon	9 -11	1978M	29440 20608 S	2.0 0.1	9:22.47	/usr/bin/pulseaudio --daemonize=no --log	
19175	simon	20	0	15040 3688 3840 R	1.3 0.0	2:29.79	htop	
26960	simon	-6	0	1978M 29440 20608 S	1.3 0.1	0:31.97	/usr/bin/pulseaudio --daemonize=no --log	

F1Help F2Setup F3Search F4Filter F5Free F6SortbyF7Nice F8Nice F9Kill F10Quit  
F12Save Config  
[0] 0:python3\*

## Prompts: Can I open a shop on a public holiday till 11pm in Malta?

```
(mal) → maltese-ai-lawyer-experiment git:(main) python3 lawyer.py
2024-05-06 00:37:16.424 Starting LLM...
2024-05-06 00:37:16.424 Loading embedding model...
2024-05-06 00:37:16.430 Load pretrained SentenceTransformer: BAAI/bge-small-en-v1.5
/hom/simon/miniconda3/envs/mal/lib/python3.12/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
    warnings.warn(
/hom/simon/miniconda3/envs/mal/lib/python3.12/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
    warnings.warn(
2024-05-06 00:37:19.417 2 prompts are loaded, with the keys: ['query', 'text']
2024-05-06 00:37:19.418 Connecting to redis...
2024-05-06 00:37:19.418 Creating Vector Store...
00:37:19 [re]tsv, Index, index      Index already exists, not overwriting.
2024-05-06 00:37:19.424 Index already exists, not overwriting.
2024-05-06 00:37:19.424 Loading index...
2024-05-06 00:37:19.572 Starting chat engine...
===== Entering Chat REPL =====
Type "exit" to exit.

Human: |
```

# Prompts: Can I drive on the left side of the road in Malta?

The screenshot shows a Linux desktop environment with two terminal windows and several system monitoring tools.

**Terminal 1 (Left):**

```
(mal) → maltese-at-lawyer-experiment git:(main) python3 lawyer.py
2024-05-06 00:38:48,295 Starting LLM...
2024-05-06 00:38:48,296 Loading embedding model...
2024-05-06 00:38:48,302 Load pretrained SentenceTransformer: BAAI/bge-small-en-v1.5
/home/simon/miniconda3/envs/mal/lib/python3.12/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
  warnings.warn(
/home/simon/miniconda3/envs/mal/lib/python3.12/site-packages/huggingface_hub/file_download.py:1132: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
  warnings.warn(
2024-05-06 00:38:51,520 2 prompts are loaded, with the keys: ['query', 'text']
2024-05-06 00:38:51,539 Connecting to redis...
2024-05-06 00:38:51,539 Creating Vector Store...
2024-05-06 00:38:51,541 Index already exists, not overwriting.
2024-05-06 00:38:51,541 Index already exists, not overwriting.
2024-05-06 00:38:51,691 Starting chat engine...
===== Entering Chat REPL =====
Type "exit" to exit.

Human: [REDACTED]
```

**Terminal 2 (Right):**

```
(base) → maltese-at-lawyer-experiment git:(math) ollama run gemma:7b
>>> Send a message (/? for help)
```

**System Monitoring:**

- CPU Usage:** Shows CPU usage for Device 0 (NVIDIA GeForce GTX 1080 Ti) with a graph from 0% to 100% GPU %.
- Memory Usage:** Shows GPU memory usage from 0% to 100% MEM [%].
- Task Manager:** Shows system tasks with columns: PID, USER, PRI, NI, VIRT, RES, SHB, S, CPU%, MEM%, TIME+, Command. Tasks include pulseaudio, httpd, and gnome-shell.
- Filesystem:** Shows disk usage with columns: PID, USER, DEV, TYPE, GPU, GPU MEM, CPU, HOST MEM, Command. It lists processes like ollama, python3, and browser instances.

# Prompts: Can I drive on the right side of the road in Malta?

```
Activities Terminal Mej 6 00:39 0:00 99 %
[mal] → maltese-ai-lawyer-experiment git:(main) python3 lawyer.py
2024-05-06 00:39:37,506 Starting LLM...
2024-05-06 00:39:37,507 Loading embedding model...
2024-05-06 00:39:37,513 Load pretrained SentenceTransformer: BAAI/bge-small-en-v1.5
/home/simon/miniconda3/envs/ml/lib/python3.12/site-packages/huggingface_hub/file_download.py:113: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
    warnings.warn(
/home/simon/miniconda3/envs/ml/lib/python3.12/site-packages/huggingface_hub/file_download.py:113: FutureWarning: 'resume_download' is deprecated and will be removed in version 1.0.0. Downloads always resume when possible. If you want to force a new download, use 'force_download=True'.
    warnings.warn(
2024-05-06 00:39:40,260 2 prompts are loaded, with the keys: ['query', 'text']
2024-05-06 00:39:40,261 Connecting to redis...
2024-05-06 00:39:40,261 Creating Vector Store...
00:39:40 [xavivxv].Index.Index Index already exists, not overwriting.
2024-05-06 00:39:40,263 Index already exists, not overwriting.
2024-05-06 00:39:40,263 Loading index...
2024-05-06 00:39:40,417 Starting chat engine...
===== Entering Chat REPL =====
Type "exit" to exit.

Human: Can I drive on the right side of the road in Malta?]

Device 0 [NVIDIA GeForce GTX 1080 Ti] PCIe GEN 3@16X RX: 0.000 KiB/s TX: 0.000 KiB/s
GPU 1569MHz MEM 5005MHz TEMP 50°C FAN 0% PWR 66 / 275 W
GPU[ 0% ] MEM[||||||||||||||||||||||| 6.862Gi/11.000Gi]
GPU % GPU mem%
75
50
25
0

Tasks: 175, 768 thr; 1 running
Load average: 0.23 0.26 0.18
Uptime: 11:38:03

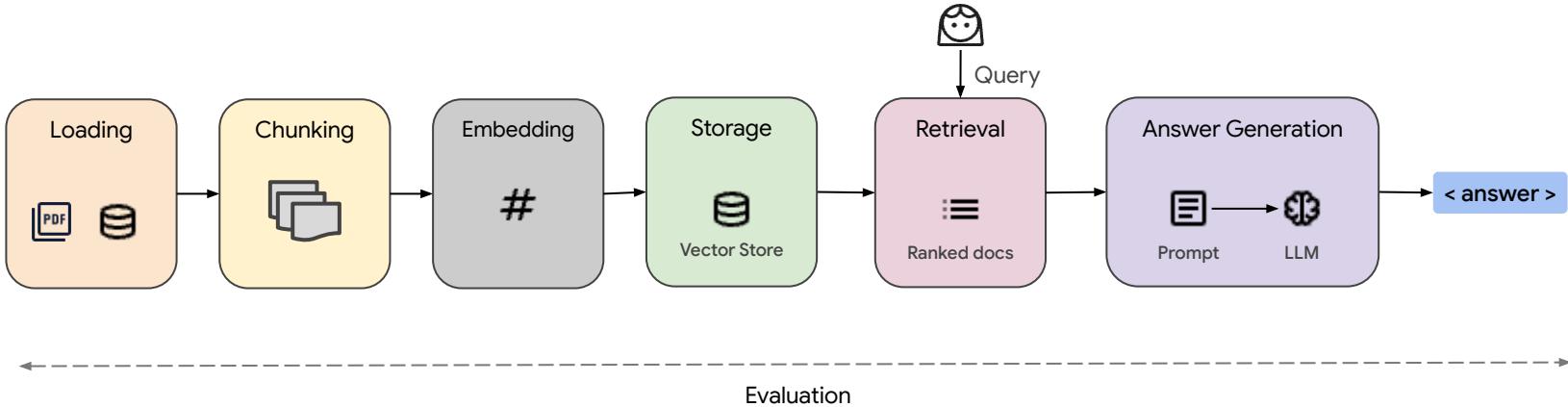
PID USER PRI NI VIRT RES SHR S CPU%MEM TIME+ Command
19175 simon 20 0 15040 5888 3840 R 1.3 0.0 2:32,47 httpd
26966 simon -6 0 1978M 29440 26608 S 1.3 0.1 0:34,64 /usr/bin/pulseaudio --daemonize=no --log
1232 simon 9 -11 1978M 29440 26608 S 0.7 0.1 9:25,14 /usr/bin/pulseaudio --daemonize=no --log
F1Help F2Setup F3Search F4Filter F5Tree F6SortByF7Nice F8Nice +F9Kill F10Quit
[0] 0:python3*
```

## Prompts: Can I drive on the left/right side of the road in Malta?

```
(base) ➔ maltese-ai-lawyer-experiment git:(main) ollama run gemma:7b
>>> Can I drive on the left side of the road in Malta?
No, driving in Malta is on the **right** side of the road.

>>> Can I drive on the right side of the road in Malta?
Yes, you can drive on the right side of the road in Malta. The island follows the European standard
of driving on the right.
```

# Better retrieval == better results





**Did we manage to build a Maltese  
AI Lawyer?**

“

**Did we manage to build a  
Maltese AI Lawyer?**

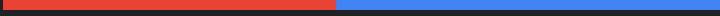
**More like a Maltese Law  
Parrot**



**But this parrot is...**



# But this parrot is...

- **Fast!**
  - **Can converse in natural language**
  - **More correct than not (most of the time)**
  - **Independently verifiable**
- 



Yann LeCun ✅ 🔒  
@ylecun

...

Yes, I do.

LLMs produce their answers with a fixed amount of computation per token.

There is no way for them to devote more (potentially unlimited) time and effort to solving difficult problems. This is very much akin to the human fast and subconscious "System 1" decision process.

True reasoning and planning would allow the system to search for a solution, using a potentially unlimited unlimited time for it. This iterative inference process is more akin to the human deliberate and conscious "System 2".

This is what allows humans and many animals to find new solutions to new problems in new situations.

Some AI systems have planning abilities, namely those that play games or control robots. Game playing AI systems such as AlphaGo, AlphaZero, Libratus (poker), and Cicero (Diplomacy) have planning abilities. These systems are still fairly limited in their planning abilities, compared to animals and humans.

To have more general planning abilities, an AI system would need to possess a \*world model\*, i.e. a subsystem that can predict the consequences of an action sequence: given the state of the world at time  $t$ , and an imagined action I could take, what would be the set of plausible states of the world at time  $t+1$ .

With a world model, a system can plan a sequence of action so as to fulfill an objective.

How to build and train such world models is still a largely unsolved problem.

Even more complex is how to decompose a complex objective into a sequence of sub-objectives. This would enable hierarchical planning, something that humans and many animals can do effortlessly but is still completely out of reach of AI systems.



<https://www.youtube.com/watch?v=vdv8TF8n52Y>

“



“



- Law became more like code?

“



- You could simulate how a judge would react to your legal argument?

“



- You could simulate what arguments the opposing lawyer will use?





# Thank you!

```
>>> write me a note thanking my listeners at a meetup for patiently listening to me give a talk about mal  
... tese law and AI  
## Thank You Note for Meetup Attendees
```

Hi everyone,

I just wanted to express my heartfelt thanks to all of you for attending my talk today about Maltese law and AI. I truly appreciate your patience and engagement as I delved into this fascinating and complex topic.

It was an absolute pleasure to share my insights and engage in thoughtful discussions with you all. Your questions and comments were insightful and helped to enrich the conversation.

I hope that the information I shared was both informative and thought-provoking. I believe that AI has the potential to revolutionize various aspects of our lives, including legal frameworks. It was inspiring to hear your perspectives on how this technology can be ethically and responsibly implemented in Malta.

Thank you for your unwavering attention and for making the meetup such a stimulating and enjoyable experience. I hope you found the event valuable and insightful.

I would love to continue the conversation. Please feel free to reach out to me if you have any further questions or would like to explore this topic in more depth.

Thank you once again for your support and for making this meetup such a success!

Best regards,

[Your Name]



Questions?

[www.simonam.dev](http://www.simonam.dev)