

LLMs meet Knowledge Graphs

Exploring RDF graphs using Neuro-Symbolic AI

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TU/e Built Environment Coding Café

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Alex who?

BSc Architecture

MSc Construction Management
& Engineering

PhD Semantic Web Technologies
& Digital Twins

Postdoc FireBIM & AM2PM

Learning CS one bug at a time 🤪



Why

Providing digitization of the built environment that ...

- ... helps us to understand buildings better
- ... helps buildings to understand buildings better
- ... helps buildings to understand us better
- ... helps us to understand ourselves better?

Information in the Built Environment is **messy**.

It is **crazy** to ask architects and engineers to understand all this, let alone combine it with other information.

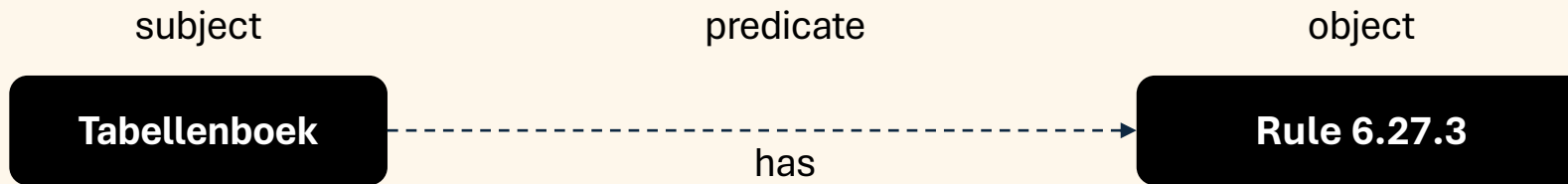
We take the position of an architect that wants to explore **fire safety regulations** using natural language.

Today

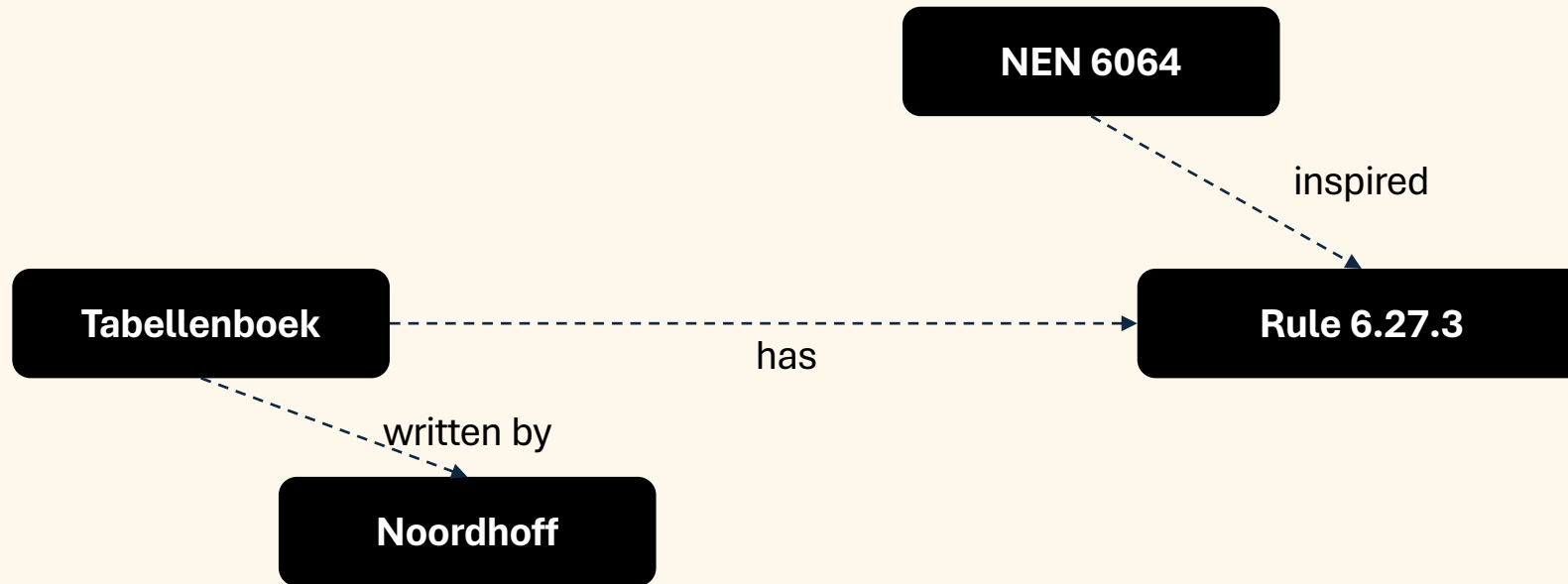
1. Knowledge graphs (RDF)
2. Ontologies (OWL)
3. Graphs meet LLMs
4. GraphRAG reasoning

<https://github.com/AlexDonkers/ISBECodingCafe/>

Module 1 Knowledge graphs



Module 1 Knowledge graphs



Module 1 Knowledge graphs



Module 1 Knowledge graphs



Module 1 Knowledge graphs



<https://www.noordhoff.nl#Tabellenboek> > **nh:Tabellenboek**

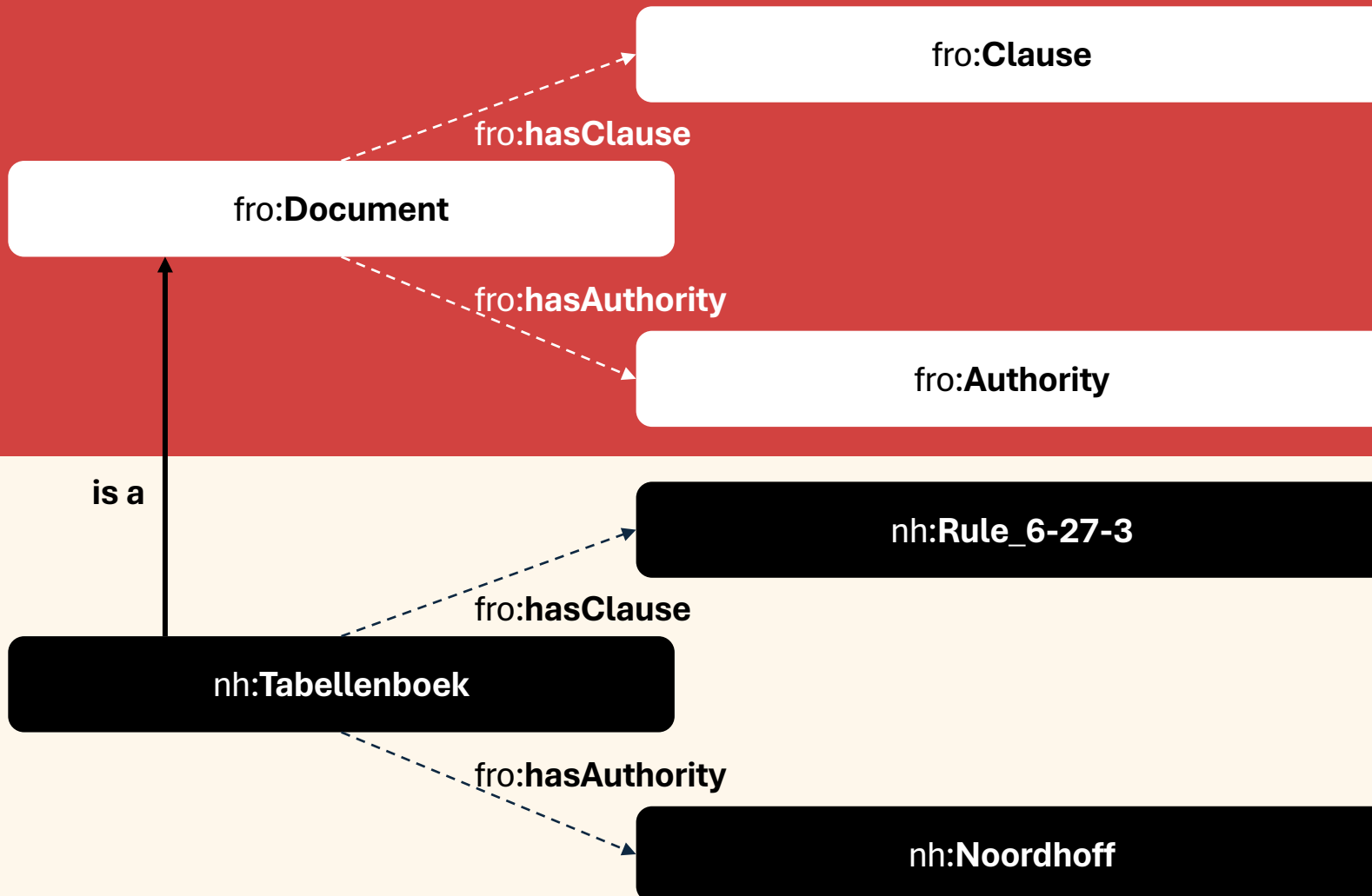
Module 1 Knowledge graphs

```
@prefix nh:      <https://www.noordhoff.nl#>
@prefix fro:     <https://www.firebim.org/ontologies/fro#>

nh:Tabellenboek
    fro:has              nh:Rule_6-27-3 ;
    fro:writtenBy        nh:Noordhoff .

nh:Rule_6-27-3
    fro:hasText          "Tweezijdige wapening van kolommen voor C25 – B500" .
```

Module 2 Ontologies



Ontology
= Abstract representation
of concepts

Data
= Real-world phenomena
or 'things'

Module 2 Ontologies

```
@prefix fbr-nl: <http://www.firebim.org/regulations/nl#>
@prefix fro: <https://www.firebim.org/ontologies/fro#>
@prefix fbo: <https://www.firebim.org/ontologies/fbo#>
```

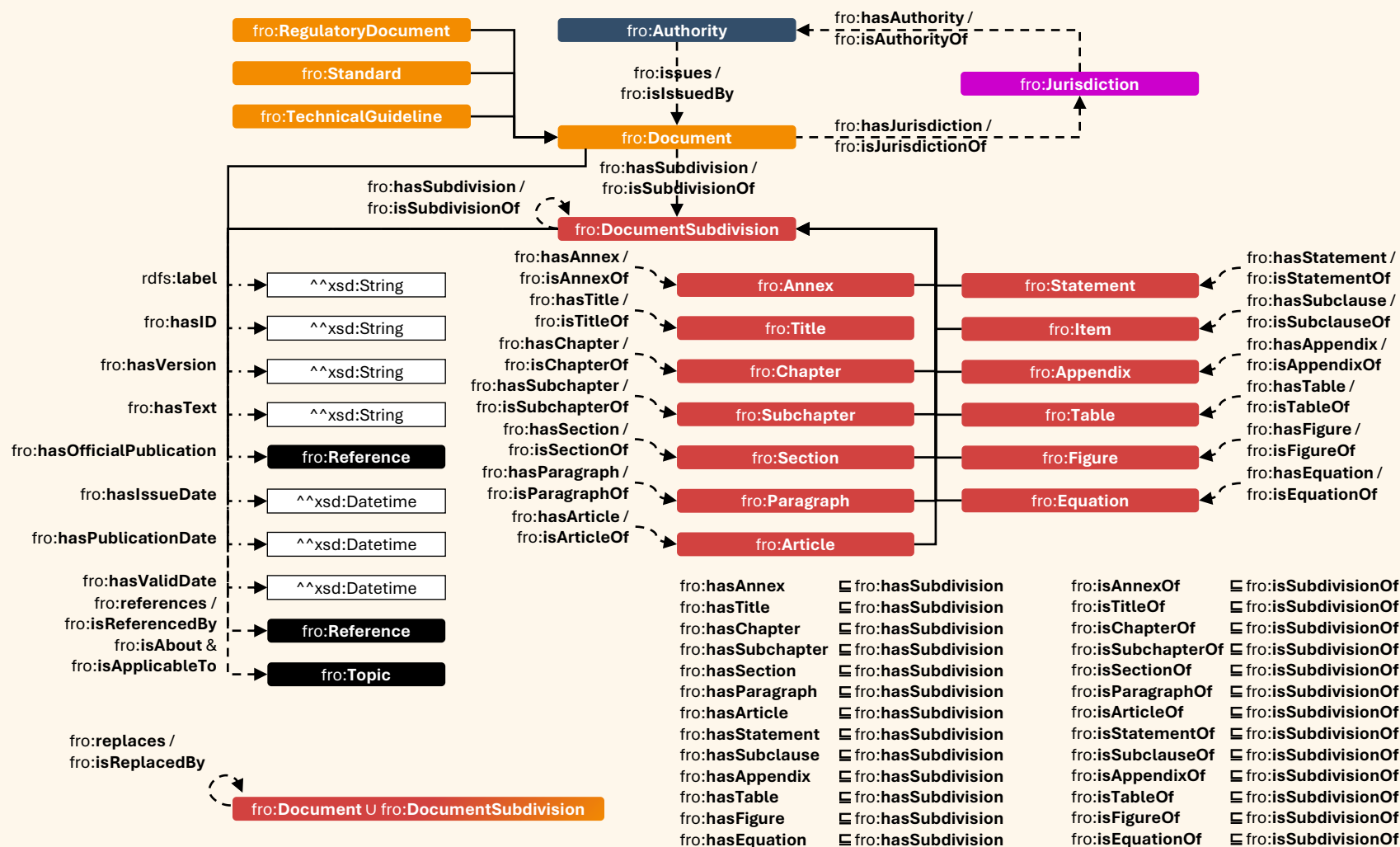
fbr-nl:Clause_3.46

 rdf:type fro:Clause ;

 fro:hasText "De volgens NEN 6075 bepaalde weerstand tegen rookdoorgang van een
 subbrandcompartiment naar een besloten ruimte in het
 brandcompartiment is ten minste 20 minuten."@nl .

 fro:isAbout fbo:FireCompartment

Module 2 Ontologies



Module 3 Graphs meet LLMs

Until now, we discussed **symbolic** AI.

When introducing LLMs, we'll touch the **neural** part of AI.

Symbolic is great, because it is white-box reasoning.

But, creating such symbolic representations is **time-consuming**.

Hey Grok, make an RDF graph of this regulation: https://wetten.overheid.nl/BWBR0041297/2025-07-01#Hoofdstuk3_Afdeling3.2_Paragraaf3.2.11_Artikel3.54

Thought for 29s

```
turtle
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix reg: <http://example.org/regulation#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

reg:Artikel3_54 rdf:type reg:Article ;
  rdfs:label "Artikel 3.54"@nl ;
  reg:title "aansturing artikel: toegankelijkheid" ;
  reg:provision "Een bouwwerk is zodanig dat het voor personen met een handicap toegankelijk is" ;
  reg:appliesTo reg:Tabel3_54 ;
  reg:chapter "Hoofdstuk 3" ;
  reg:division "Afdeling 3.2" ;
  reg:paragraph "Paragraaf 3.2.11" ;
  reg:date "2025-07-01"^^xsd:date .

reg:Tabel3_54 rdf:type reg:Table ;
  rdfs:label "Tabel 3.54"@nl ;
  reg:designates reg:Woonfunctie, reg:Bijeenkomstfunctie, reg:Gezondheidszorgfunctie, reg:Kantoorfunctie, reg:Winkelfunctie .

reg:Woonfunctie rdf:type reg:UsageFunction ;
  rdfs:label "woonfunctie"@nl .

reg:Bijeenkomstfunctie rdf:type reg:UsageFunction ;
  rdfs:label "bijeenkomstfunctie"@nl .

reg:Gezondheidszorgfunctie rdf:type reg:UsageFunction ;
  rdfs:label "gezondheidszorgfunctie"@nl .

reg:Kantoorfunctie rdf:type reg:UsageFunction ;
  rdfs:label "kantoorfunctie"@nl .

reg:Winkelfunctie rdf:type reg:UsageFunction ;
```

How can Grok help?

Auto



Hey Gemini, make an RDF graph of this regulation: https://wetten.overheid.nl/BWBR0041297/2025-07-01#Hoofdstuk3_Afdeling3.2_Paragraaf3.2.11_Artikel3.54



This is the RDF graph for **Artikel 3.54 (tweede vluchtroute)** of the **Besluit bouwwerken leefomgeving (Bbl)**, based on the regulation text.

The graph is modeled in **Turtle** syntax, defining the article, the condition, and the resulting exemption.

RDF Graph (Turtle)

```
Codefragment
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix bbl: <https://wetten.overheid.nl/BWBR0041297/2025-07-01#> .
@prefix reg: <http://example.org/regulation-ontology#> .
@prefix article: <http://example.org/article/> .

# 1. Define the Regulation and General Concepts
reg:LegalArticle rdfs:label "Legal Article" .
reg:Condition rdfs:label "Applicability Condition" .
reg:Exemption rdfs:label "Resulting Exemption" .

bbl:Besluit_Bouwwerken_Leefomgeving
  rdf:type rdfs:Resource ;
  rdfs:label "Besluit bouwwerken leefomgeving" ;
  reg:identifier "BWBR0041297" .

# 2. Define the Subject Article: Artikel 3.54
bbl:Artikel_3_54
  rdf:type reg:LegalArticle ;
```

Vraag het Gemini



Tools

2.5 Flash



Module 3 Graphs meet LLMs

Combining the strengths of symbolic AI and neural AI,
in this case, graphs and LLMs,
is what we call **neuro-symbolic AI**

Module 3 Graphs meet LLMs

More specifically is the development of GraphRAG, or **Graph Retrieval Augmented Generation**

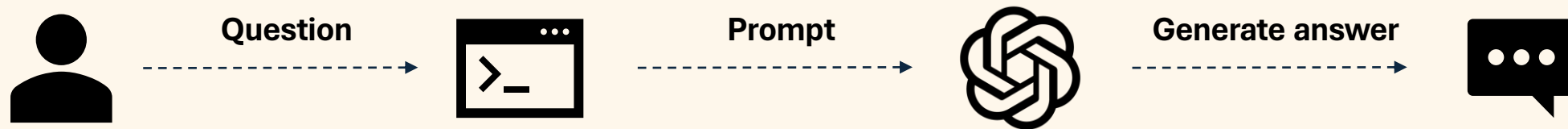
Generation > LLM produces text from internal knowledge

RAG > LLM uses retrieved documents as context to improve answer

GraphRAG > LLM uses knowledge graph to retrieve connected concepts, not just raw text, leverages the graph structure and produces answers that reflect how concepts are connected

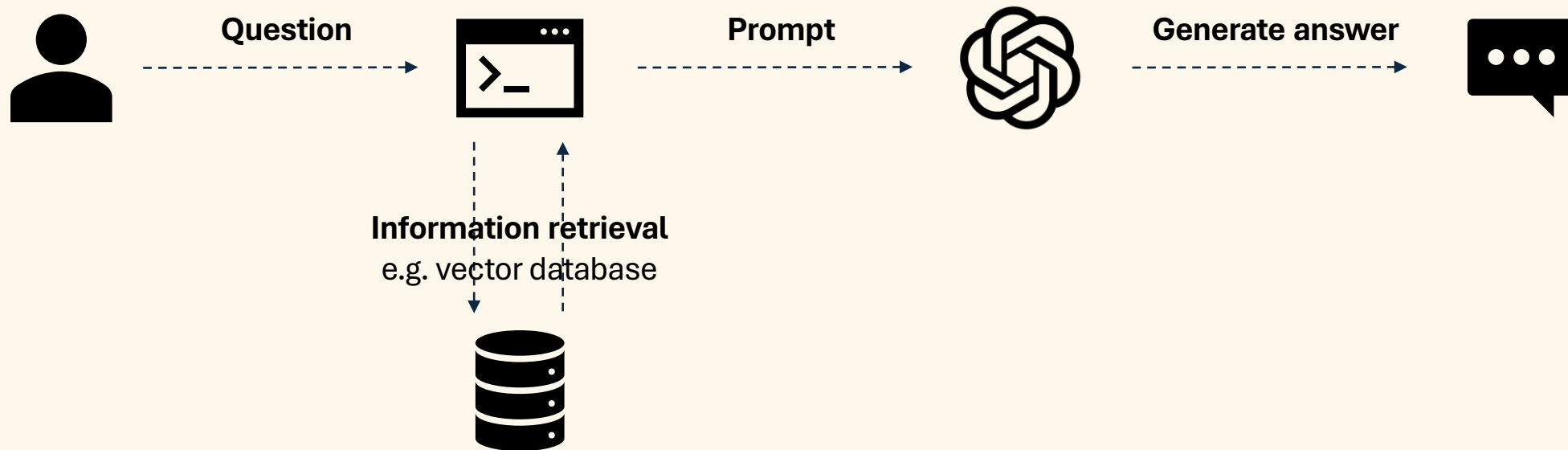
Module 3 Graphs meet LLMs

Basic **Generation** pipeline



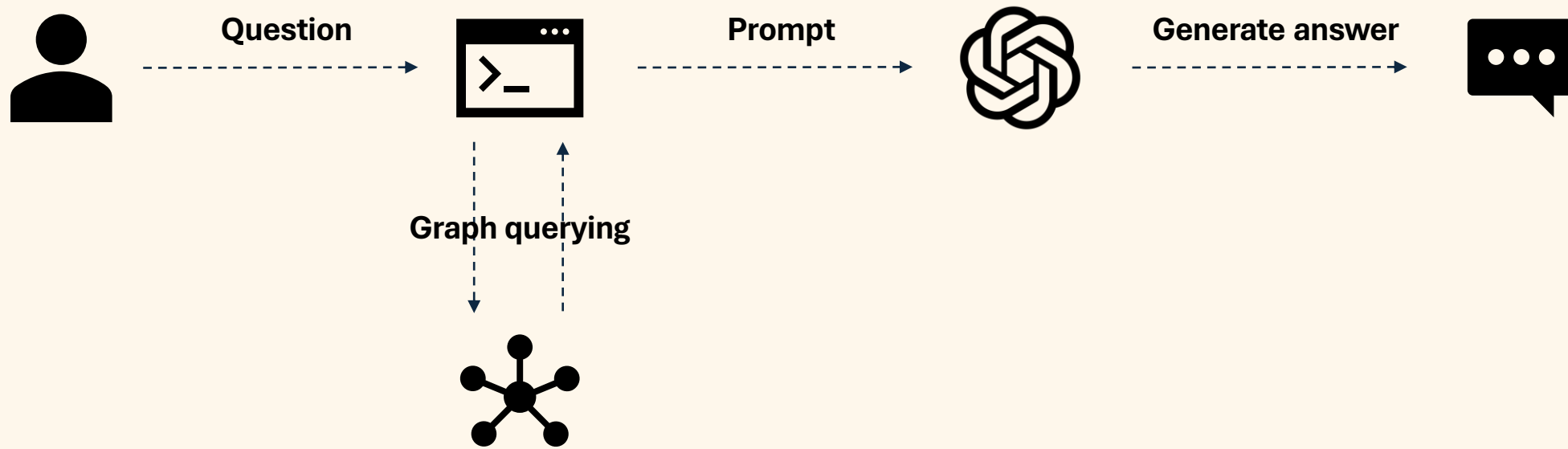
Module 3 Graphs meet LLMs

Basic **RAG** pipeline



Module 3 Graphs meet LLMs

Basic **GraphRAG** pipeline

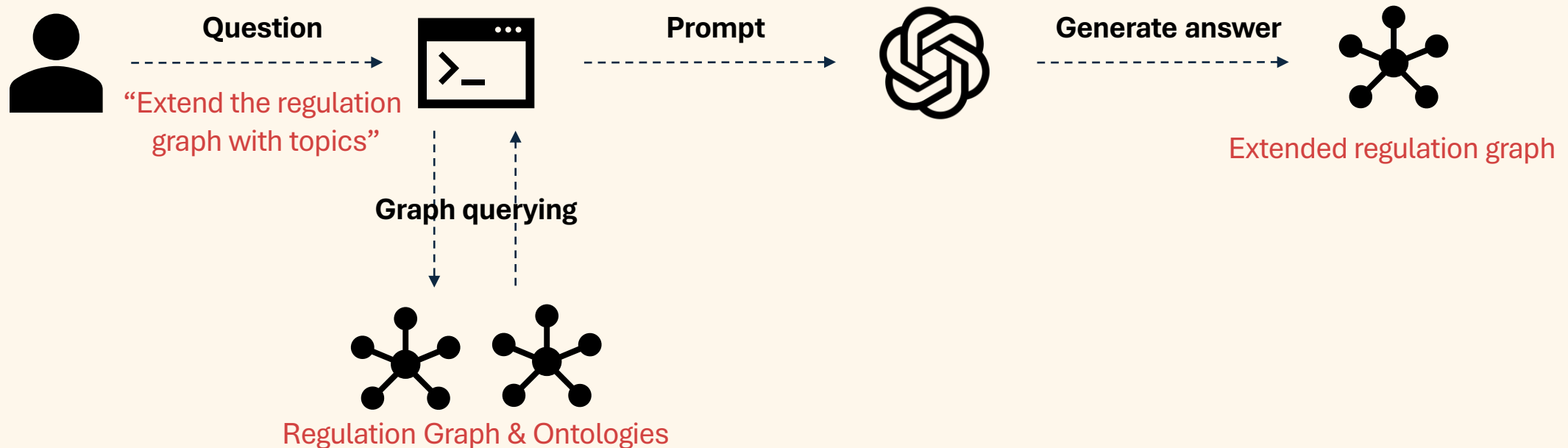


Module 3 Graphs meet LLMs

Pipelines that we'll test today:

fbr-nl:Clause_3.46

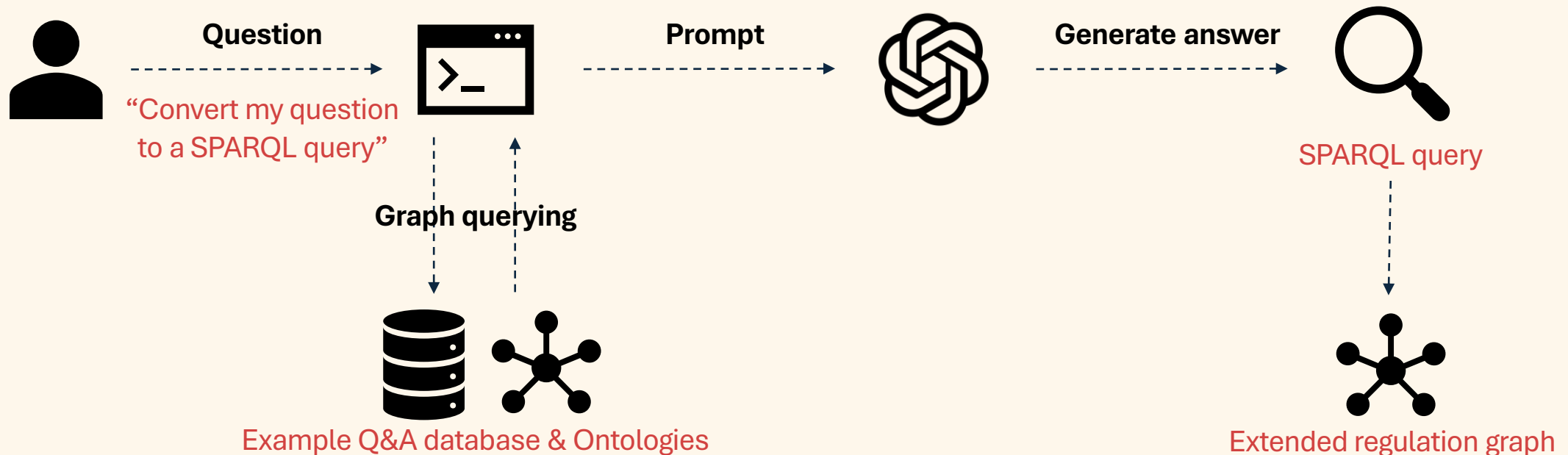
```
rdf:type          fro:Clause ;  
fro:hasText "De volgens NEN 6075 bepaalde weerstand  
tegen rookdoorgang van een subbrandcompartiment naar  
een besloten ruimte in het brandcompartiment is ten  
minste 20 minuten."@nl .  
fro:isAbout      fbo:FireCompartment
```



Module 3 Graphs meet LLMs

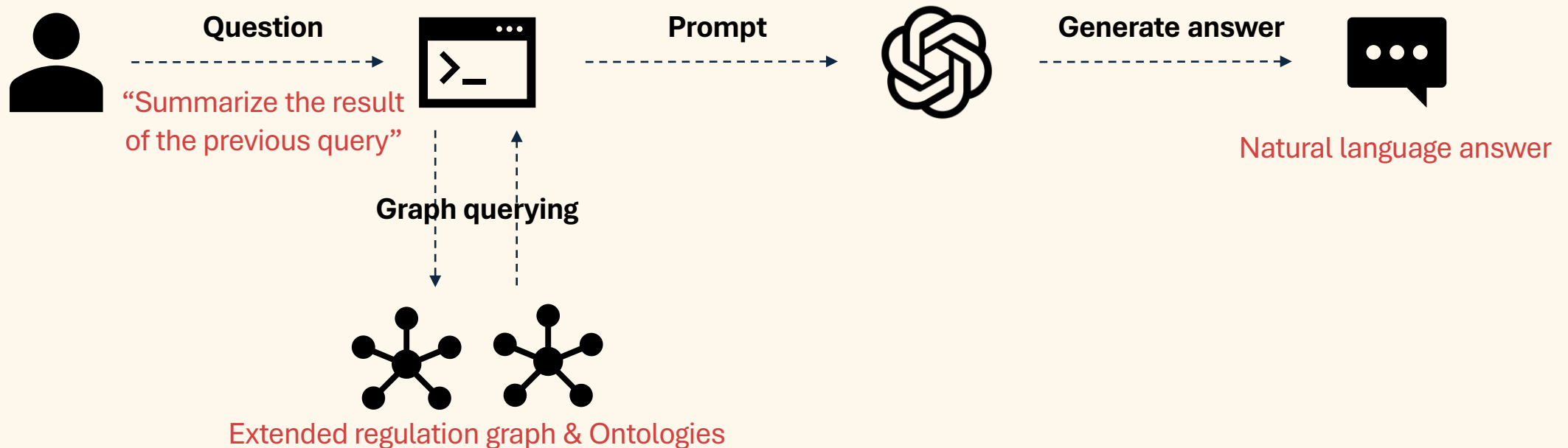
Pipelines that we'll test today:

```
fbr-nl:Clause_3.46
  rdf:type          fro:Clause ;
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  tegen rookdoorgang van een subbrandcompartiment naar
  een besloten ruimte in het brandcompartiment is ten
  minste 20 minuten."@nl .
  fro:isAbout       fbo:FireCompartment
```



Module 3 Graphs meet LLMs

Pipelines that we'll test today:



Let's start coding!

1. Make a Gemini API key:

<https://aistudio.google.com/app/api-keys>

2. Open the Notebook:

https://colab.research.google.com/drive/1_Z2fGH9Izpnvosbnmc1MQuU0T9b3oy0q?usp=sharing

3. Star/Fork the GitHub repository:

<https://github.com/AlexDonkers/ISBECodingCafe/>

4. Ideas or comments? Please add an [Issue](#) or send an email

Thanks for joining!

Other open software and data:

<https://github.com/AlexDonkers>

Research:

<https://research.tue.nl/nl/persons/alex-ja-donkers/>

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