

Retrieval-Augmented Generation for Immersive Formal Dialogue

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Overview

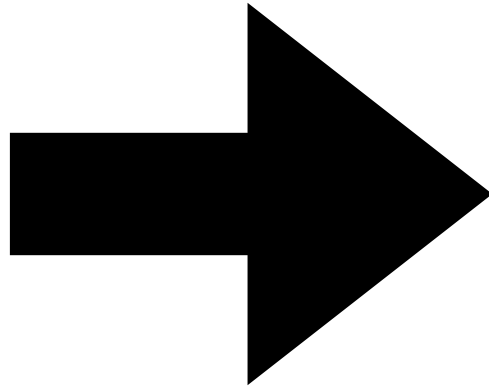
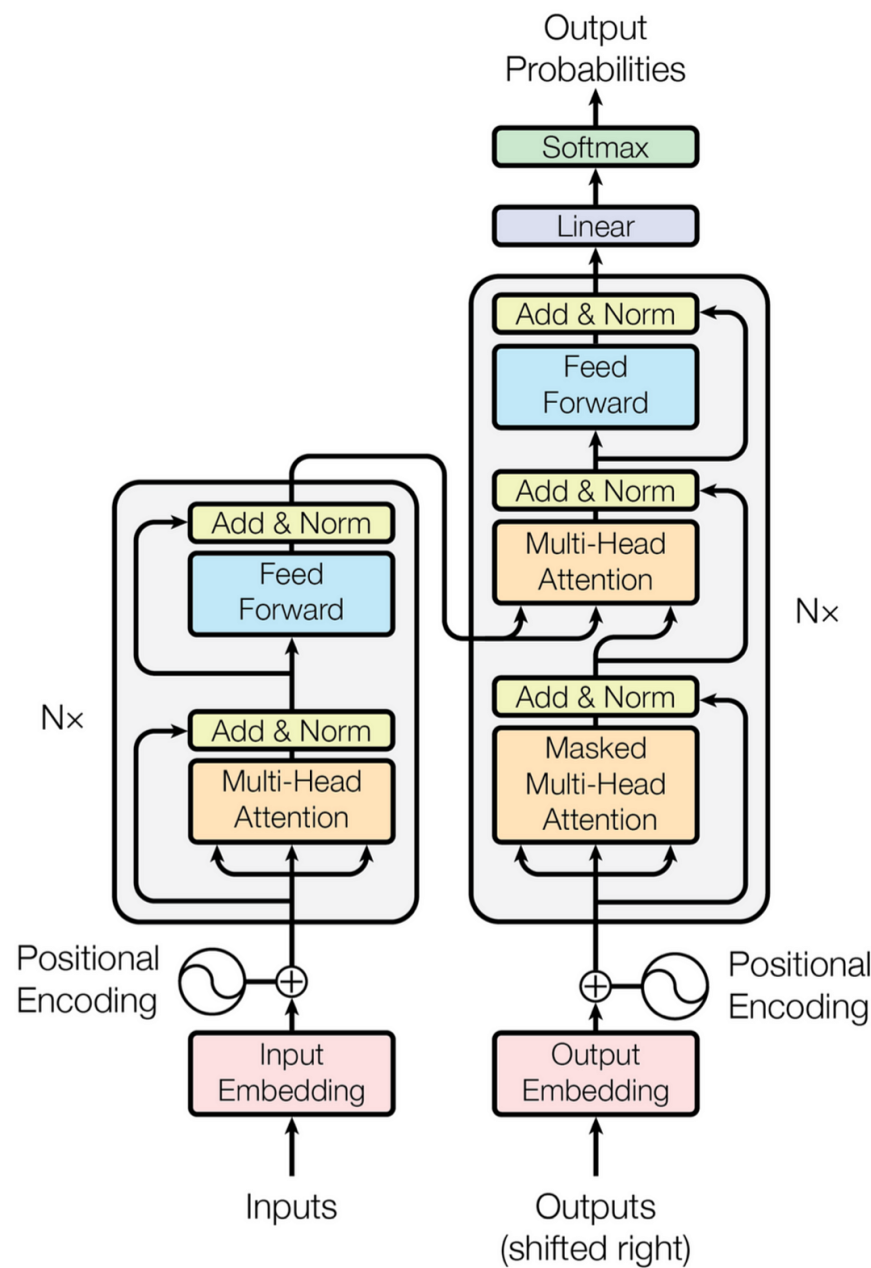
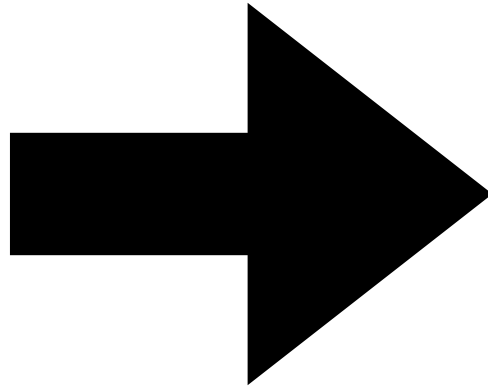
- A brief introduction to LLMs, RAG and Formal Dialogue
- Formal Dialogue vs LLMs vs LLMs + RAG + Formal Dialogue
- RAG-based pipeline

Large Language Models



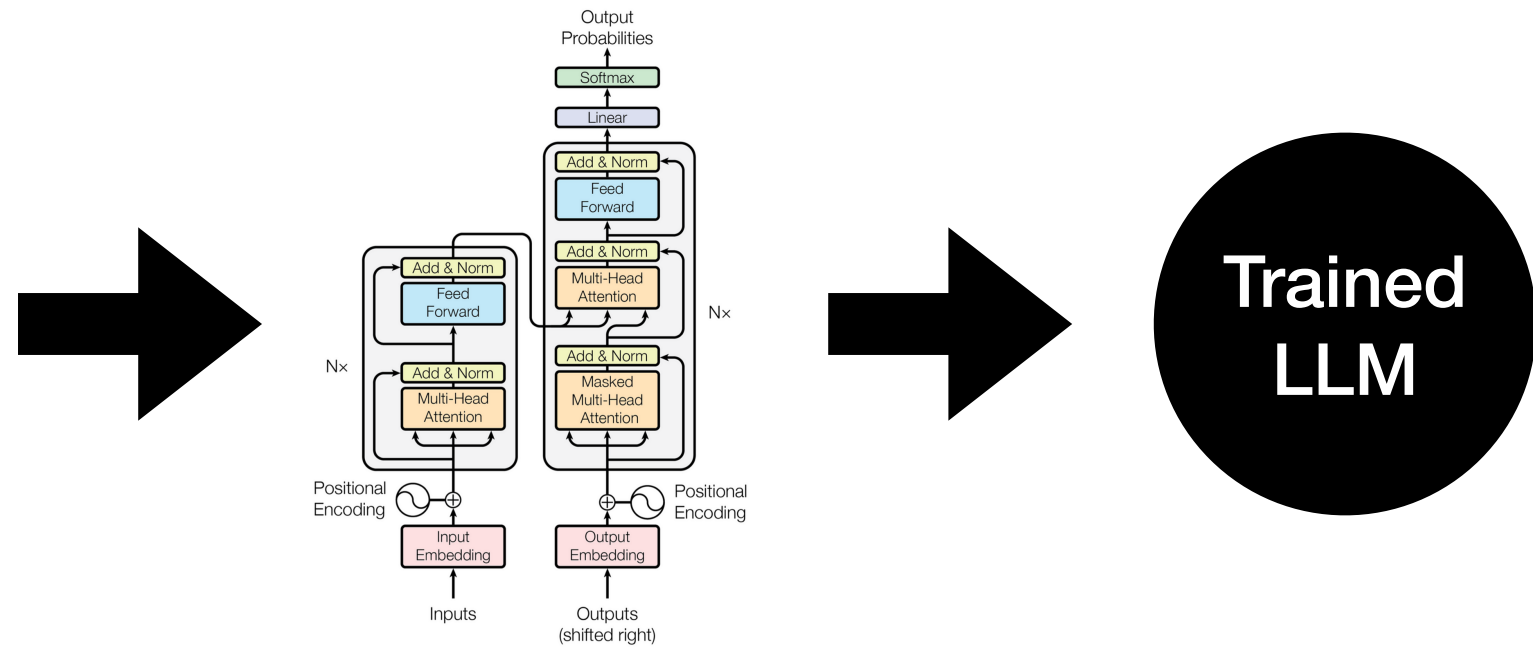
Large Language Models (LLMs)

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Large Language Models (LLMs)

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Prediction and generation of words in context

Natural conversational responses

But...can go off-topic...

Please give me a recipe for cupcakes

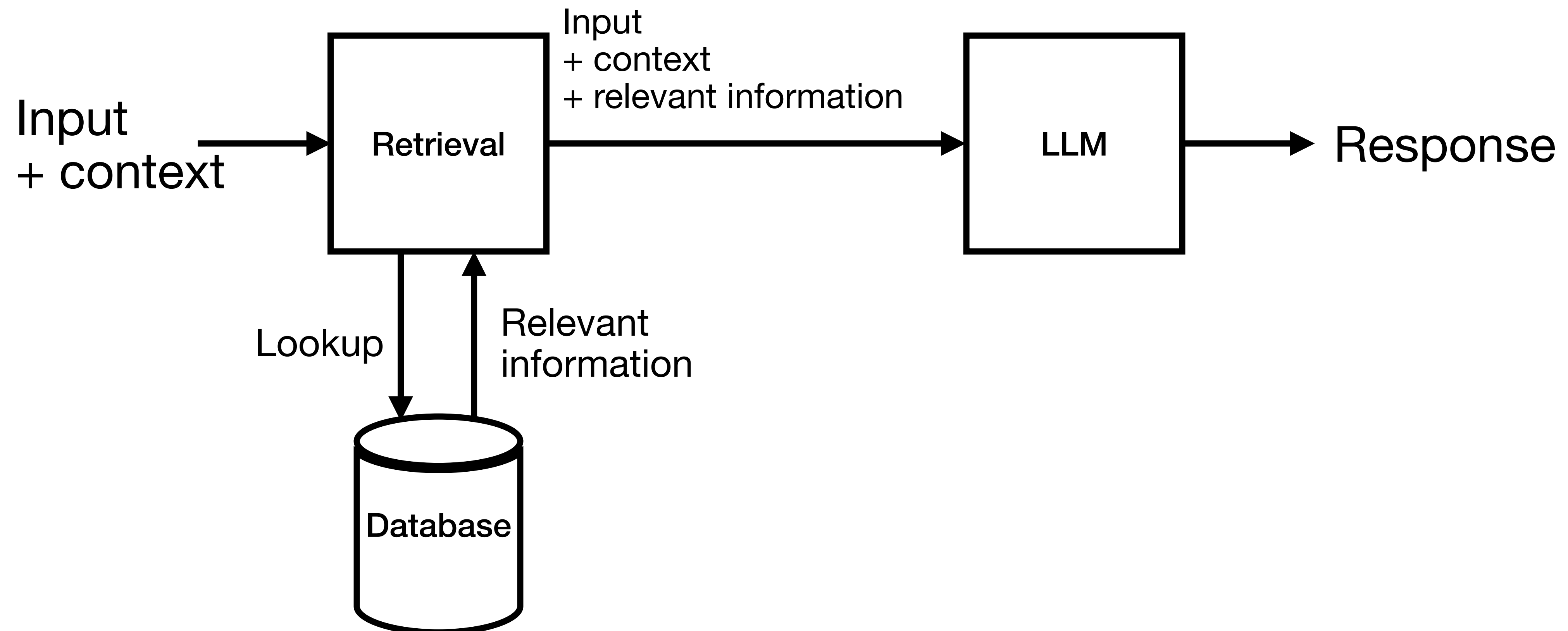
Can also hallucinate - responses not grounded in truth

Retrieval-Augmented Generation (RAG)

Grounds an LLM's output by retrieving relevant information from external sources before generating a response

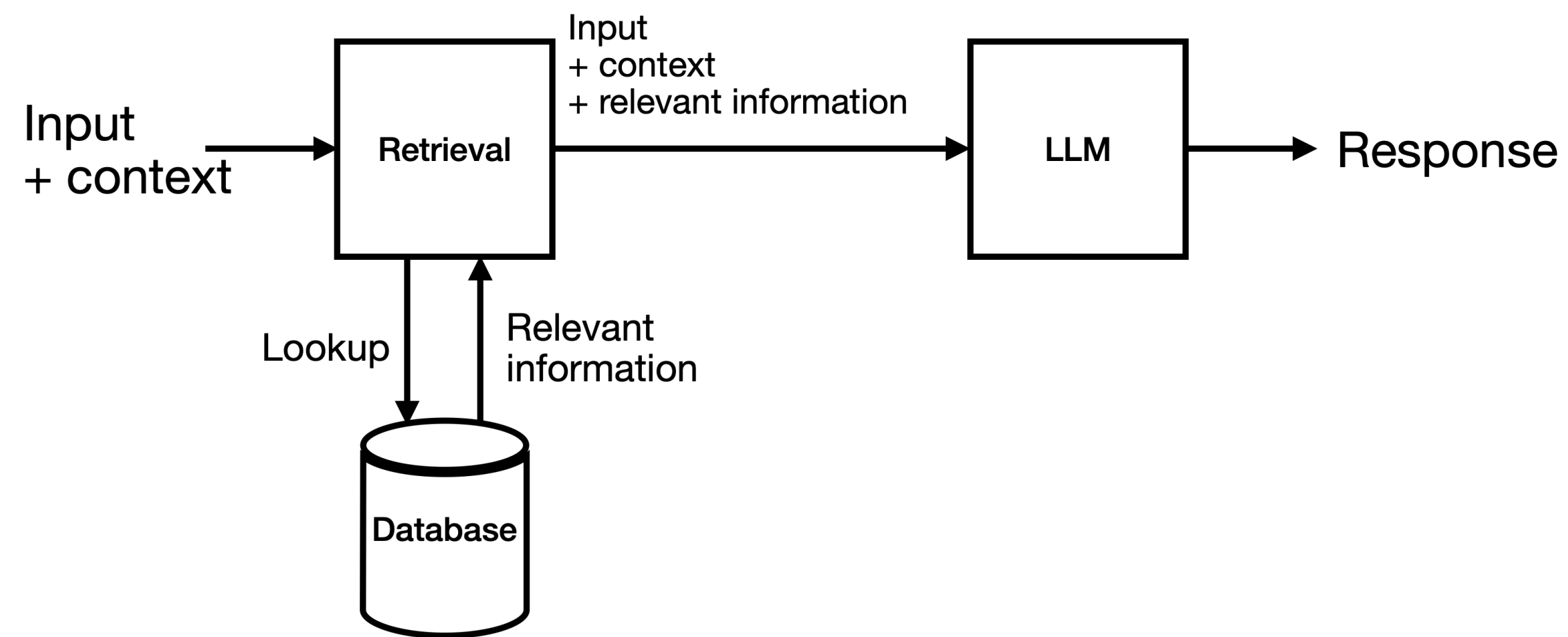
Retrieval-Augmented Generation (RAG)

Grounds an LLM's output by retrieving relevant information from external sources before generating a response



Retrieval-Augmented Generation (RAG)

Grounds an LLM's output by retrieving relevant information from external sources before generating a response



Common use-cases:

- Customer support: LLM retrieves specific company policies etc. to provide bespoke answer
- Summarisation: provide documents and ask LLM to generate a summary

Formal Dialogue

Model conversations as structured, rule-governed exchanges aimed at specific goals (e.g. persuasion, inquiry, negotiation)

Formal Dialogue

Model conversations as structured, rule-governed exchanges aimed at specific goals (e.g. persuasion, inquiry, negotiation)

- Rules for structure, turn-taking, locutions, commitment, termination etc.
- Participants advance valid moves - speech act + content
- Used in human-agent and agent-agent communication
- Can seem rigid and lack expressiveness in human-agent applications

```
grammar dgdl;

game :
    'game' '(' 'id' ':' gameID ')' '{' composition (rules)* (interaction)+ '}' EOF;

gameID : identifier;

composition: roleList? participants player+ store* turntaking? backtrack? extURI*;

roleList :
    'roles' '(' role (',' role)* ')';

role : (LISTENER | SPEAKER | identifier);

participants :
    'participants' '(' 'min' ':' minplayers ',' 'max' ':' maxplayers ')';

player :
    'player' '(' 'id' ':' playerID (',' playerRoleList)? (',' 'min' ':' minplayers)? (',' 'max' ':' maxplayers)? ')';

playerID : identifier;

playerRoleList :
    'roles' ':' '{' role (',' role)* '}';

store :
    'store' '(' 'id' ':' storeID ',' 'owner' ':' storeOwner ',' 'structure' ':' storeStructure ',' 'visibility' ':' storeVisibility (',' storeContent)? ')';

storeID : identifier;

storeOwner :
    (identifier | '{' identifier (',' identifier)+ '}');

storeStructure :
    (SET | QUEUE | STACK);

storeVisibility :
    (PUBLIC | PRIVATE);

storeContent :
    '{' (contentVar | STRINGLITERAL) (',' (contentVar | STRINGLITERAL))* '}';

turntaking :
    'turntaking' '(' turntakingtype ')';

turntakingtype : ('strict' | 'liberal');

backtrack :
    'backtracking' '(' onoff ')';

onoff : ('on' | 'off');

extURI:
    'extURI' '(' 'id' ':' extUriID ',' 'uri' ':' uri ')';

uri : STRINGLITERAL;

extUriID : identifier;

minplayers : number;
maxplayers : (number | 'undefined');

rules :
    'rule' '(' 'id' ':' ruleID ',' 'scope' ':' scopeType ')' ruleBody;

ruleID : identifier;
```



Wells & Reed (2008)

```
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  'store' '(' 'id' ':' storeID ',' 'owner' ':' storeOwner ',' 'structure' ':' storeStructure ',' 'visibility' ':' storeVisibility (',' storeContent)? ')';

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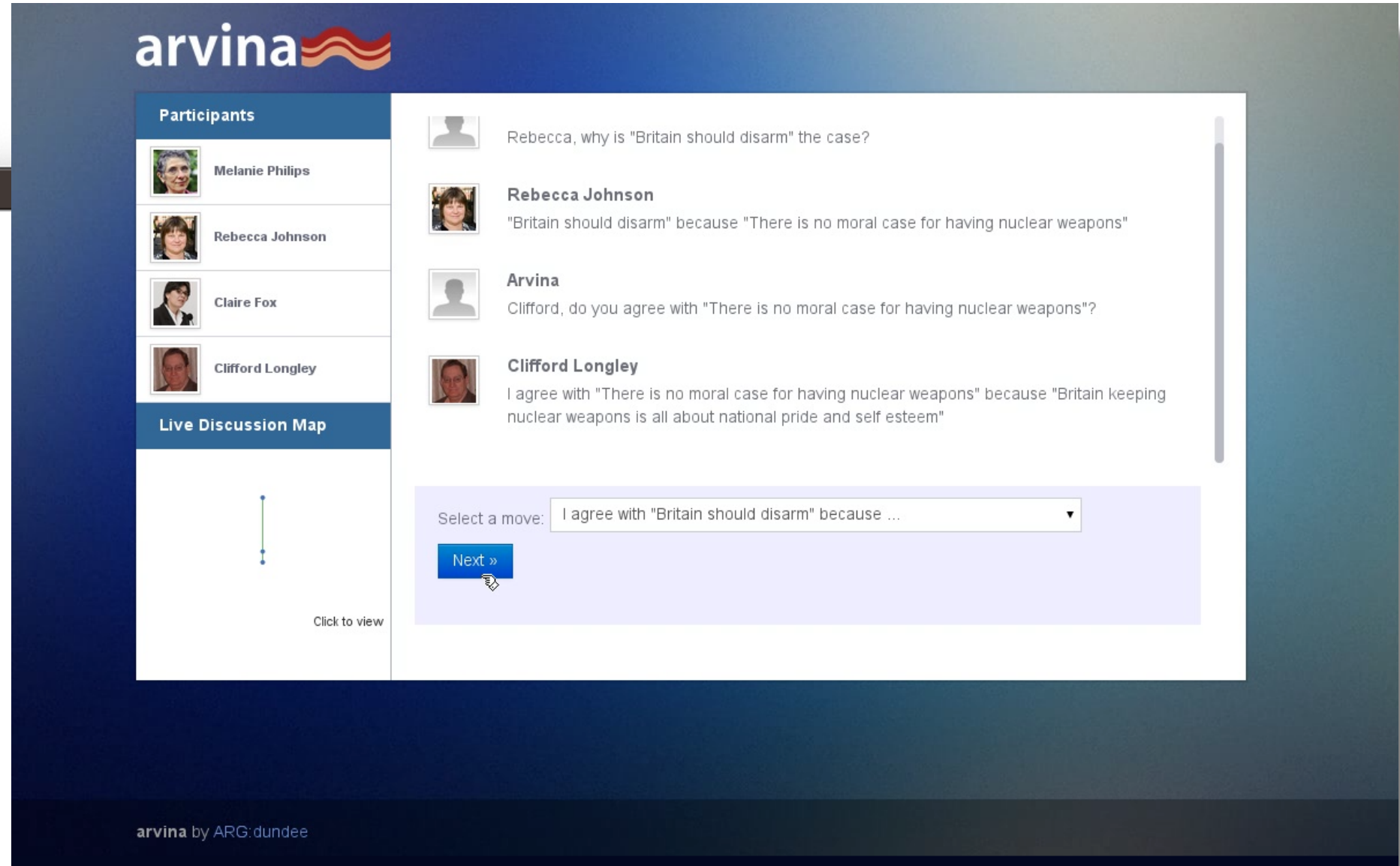
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Wells & Reed (2008)

Bex et. al. (2013)

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```

MagtALO

John Wadham

Director Of Liberty

Martin Linton

Labour MP for Battersea

I agree. They will undermine civil liberties

John:

Yes, I agree. The real target is the people whom the home office has lost

You:

Why do you think the current point is true John?

John:

It will be black people and those from ethnic minorities who will find that they need to show their card most often

Martin:

Click here to make this the current point

No, I don't agree. If you are saying the police might discriminate against black people (even though it is illegal), that is a serious problem that needs to be tackled. But should not stop us having ID cards

Current point »

If you are saying the police might discriminate against black people (even though it is illegal), that is a serious problem that needs to be tackled. But should not stop us having ID cards

I Agree With This

I Don't Agree With This

Who agrees with this?

dgdl.g4 — Edited

rraction)+ '}' EOF;

cktrack? extURI*;

ers '');

n ':' minplayers)? (',' 'max' ':' maxplayers)? '');

arvina

Participants

Melanie Philips

Rebecca Johnson

Claire Fox

Clifford Longley

Live Discussion Map

Click to view

Rebecca, why is "Britain should disarm" the case?

Rebecca Johnson

"Britain should disarm" because "There is no moral case for having nuclear weapons"

Arvina

Clifford, do you agree with "There is no moral case for having nuclear weapons"?

Clifford Longley

I agree with "There is no moral case for having nuclear weapons" because "Britain keeping nuclear weapons is all about national pride and self esteem"

Select a move:

I agree with "Britain should disarm" because ...

Next »

Wells & Reed (2008)

Bex et. al. (2013)

```
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ruleID : identifier;
```

polemicist

ARG-tech

Centre for Argument Technology

University of Dundee

Radio 4

Moral Maze

About

Welcome to polemicist. This allows you to play the role of Michael Buerk in chairing your own new version of the Moral Maze debate. Enter a nickname, select a starting topic, and the participants you would like to have virtually join your discussion and click to start.

Setup

Your Name

Name

Starting Topic

Abortion should be a decision for the mother alone

Click to start

Participants

Witnesses

Aisling Hubert

Kate Greasley

Ed Condon

Wendy Savage

Panellists

Giles Fraser

Anne McElvoy

Claire Fox

Tim Stanley

Invite your friends

Via Twitter

Via email

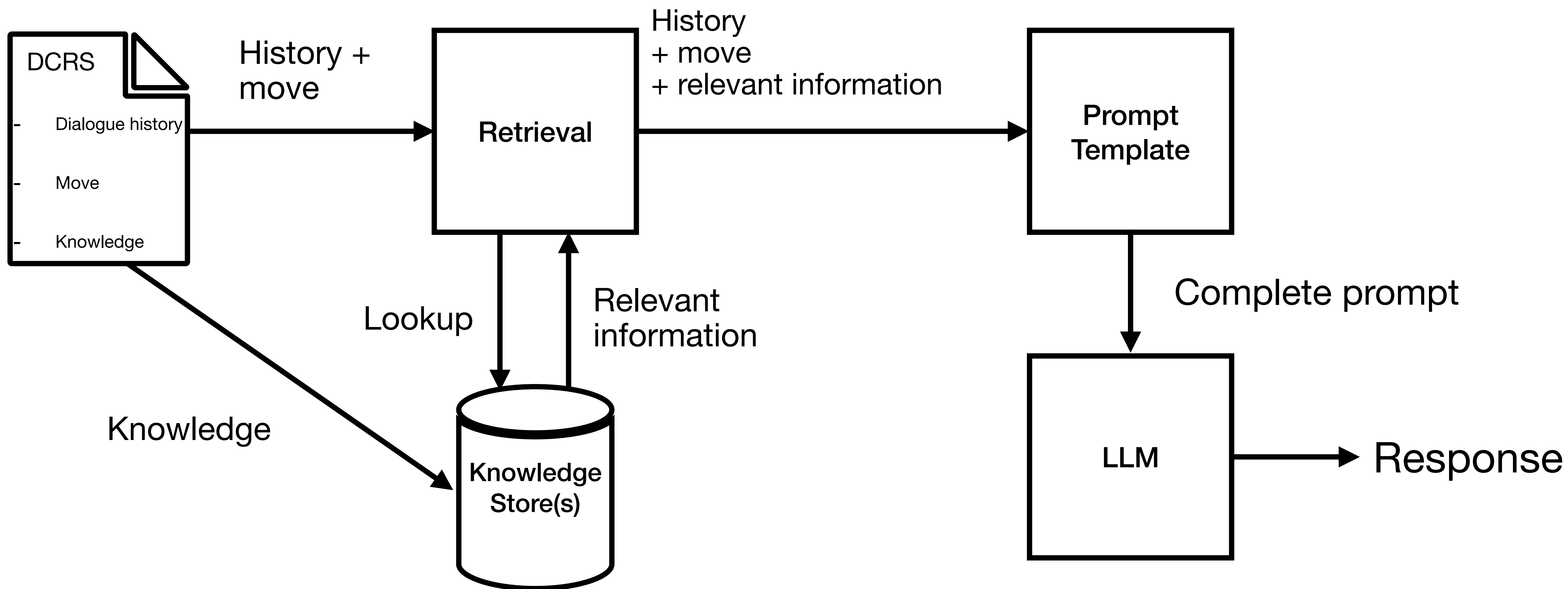
Lawrence et. al. (2022)

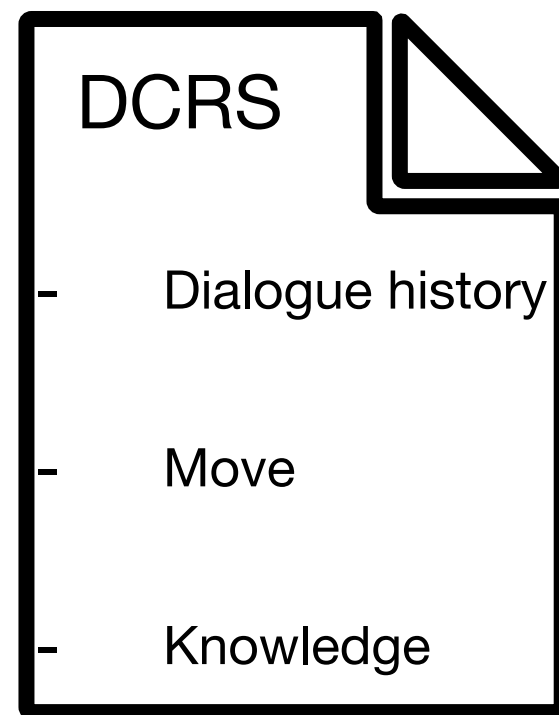
Formal dialogue vs LLMs

Aspect	Formal Dialogue	LLMs
Structure	Rigid, protocol-driven turns	Free-flowing, unconstrained text
Goals	Clear purposes (e.g. persuasion, inquiry, negotiation)	Flexible, task-agnostic
Transparency	High: reasoning explicit through moves	Low: opaque “black box”
Naturalness	Often stilted and hard for users to engage with	Human-like fluency
Grounding	Rules and knowledge bases explicitly defined	Implicit in training data

Formal dialogue vs LLMs

Aspect	Formal Dialogue	LLMs	Formal Dialogue + LLM + RAG
Structure	Rigid, protocol-driven turns	Free-flowing, unconstrained text	Natural expression mapped to structured moves
Goals	Clear purposes (e.g. persuasion, inquiry, negotiation)	Flexible, task-agnostic	Preserve dialogue goals while adapting language
Transparency	High: reasoning explicit through moves	Low: opaque “black box”	Retrieved evidence grounds outputs, explanations possible
Naturalness	Often stilted and hard for users to engage with	Human-like fluency	Formal logic preserved, but phrased naturally
Grounding	Rules and knowledge bases explicitly defined	Implicit in training data	Retrieval ensures domain-specific, up-to-date knowledge from multiple sources

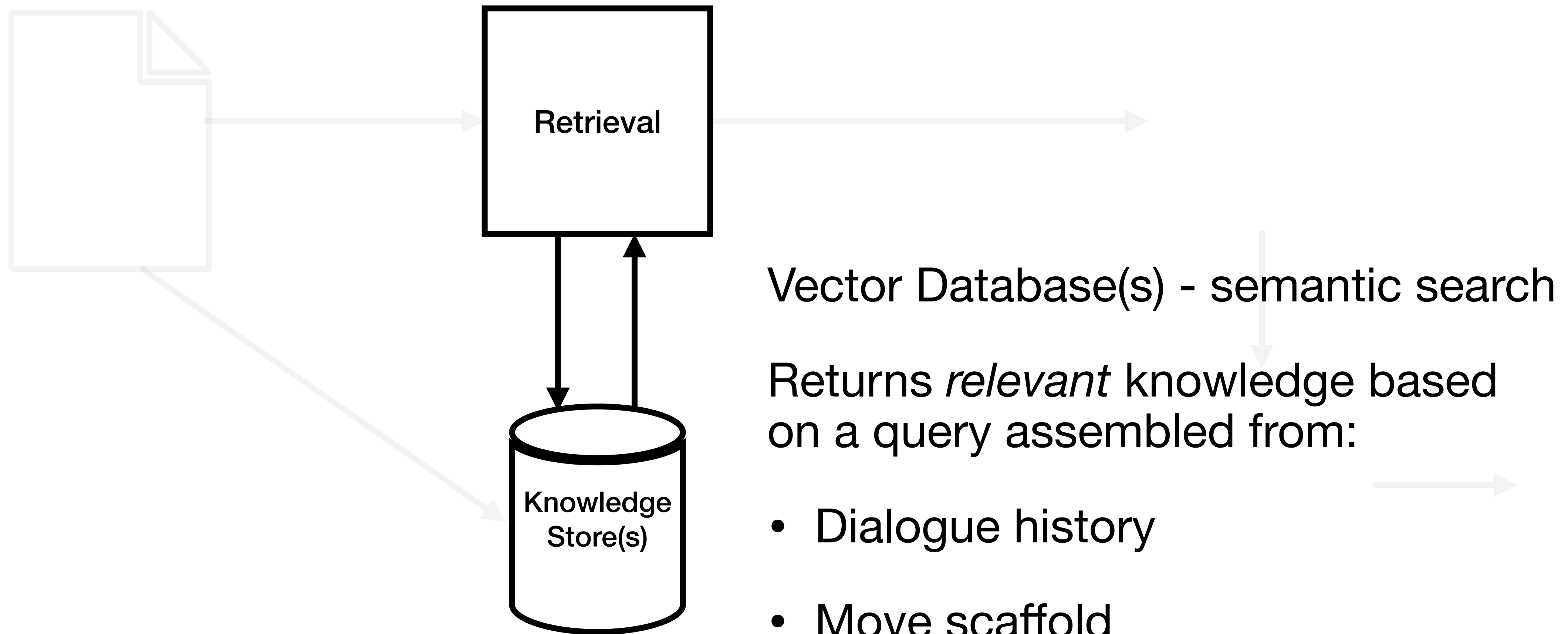




Dialogue Context Request Structure

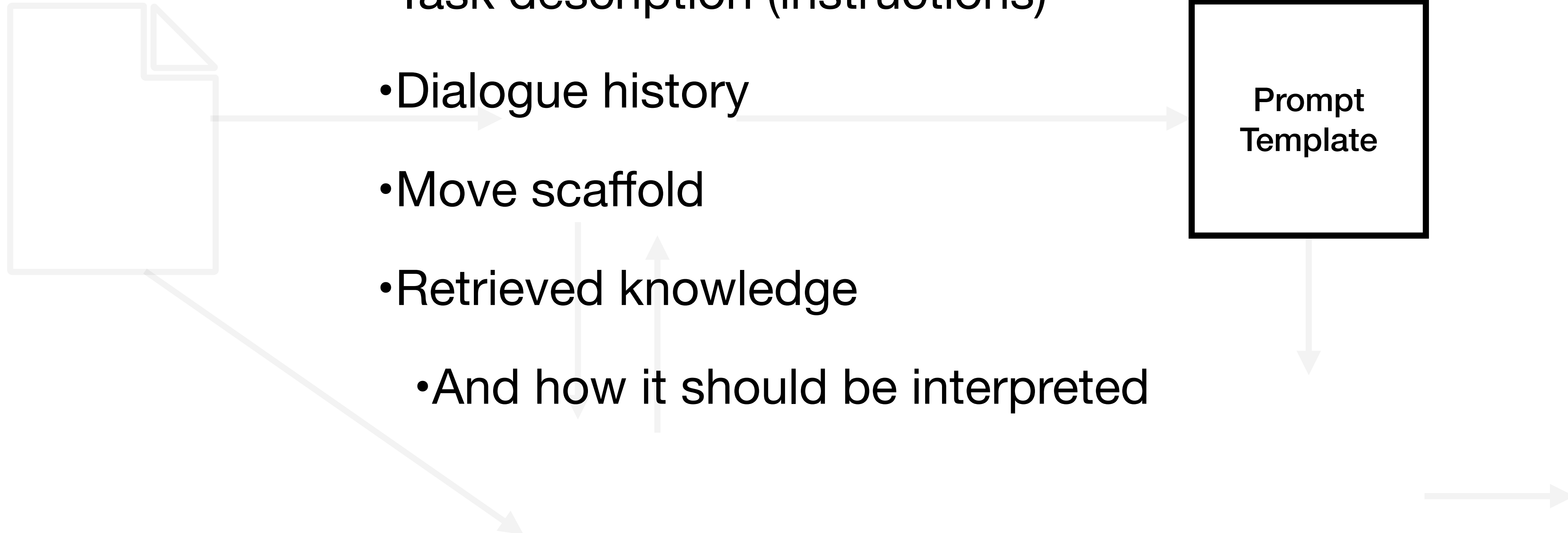
Contains:

- Knowledge (from the agent)
- Dialogue history (for context)
- Move scaffold (to help the LLM structure its response)



Four key elements:

- Task description (instructions)
- Dialogue history
- Move scaffold
- Retrieved knowledge
 - And how it should be interpreted



Prompt Template

You are assisting in a dialogue by generating the next utterance. Use the provided scaffold, dialogue history, and structured knowledge sources below. *Prioritise the provided knowledge sources in generating the next utterance, but if a suitable utterance can't be generated you may use your own knowledge, in which case identify the source as "generated".*

Dialogue History
{{history}}

Utterance Scaffold
{{Utterance}}

You may adapt the scaffold to better match the tone, style, or conversational flow of the dialogue history. The goal is to maintain coherence and sound natural within the ongoing dialogue.

Knowledge Sources

The knowledge provided below includes different structures. Each structure has a name, a formal representation, and a description of how to interpret it.

{{knowledge}}

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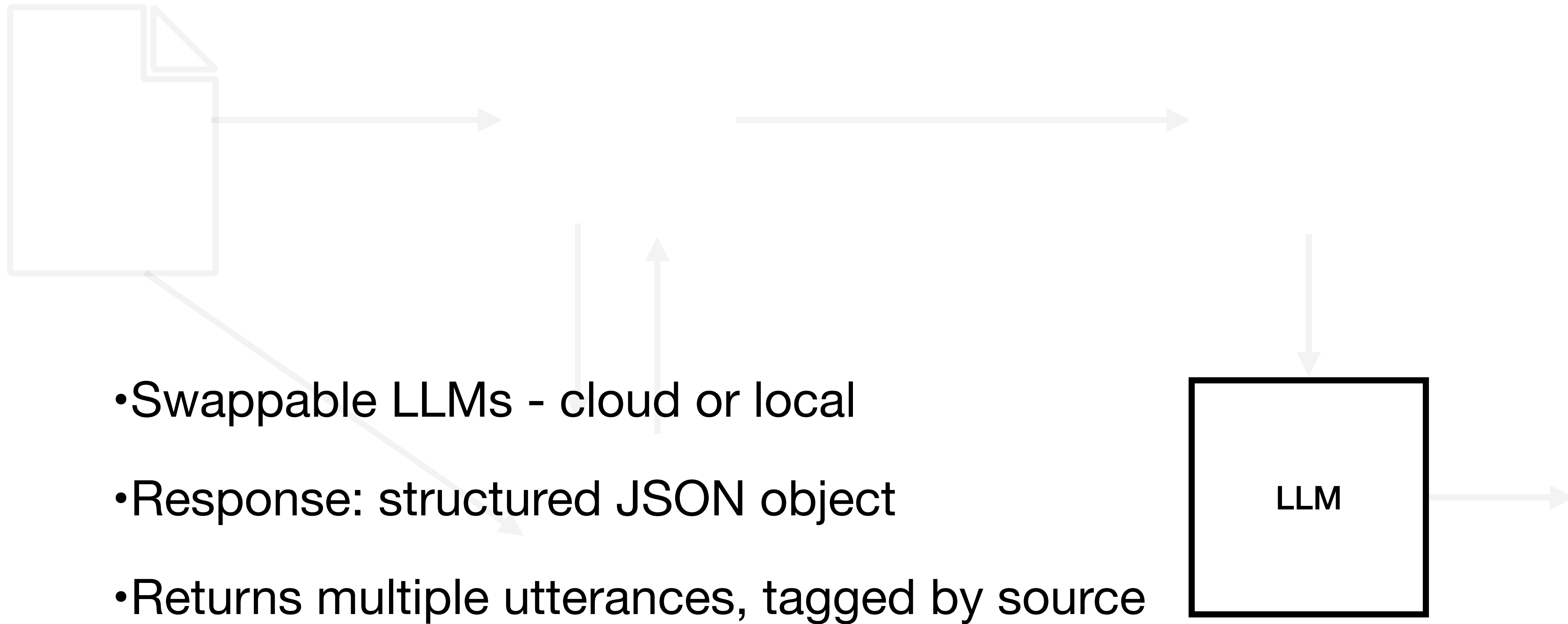
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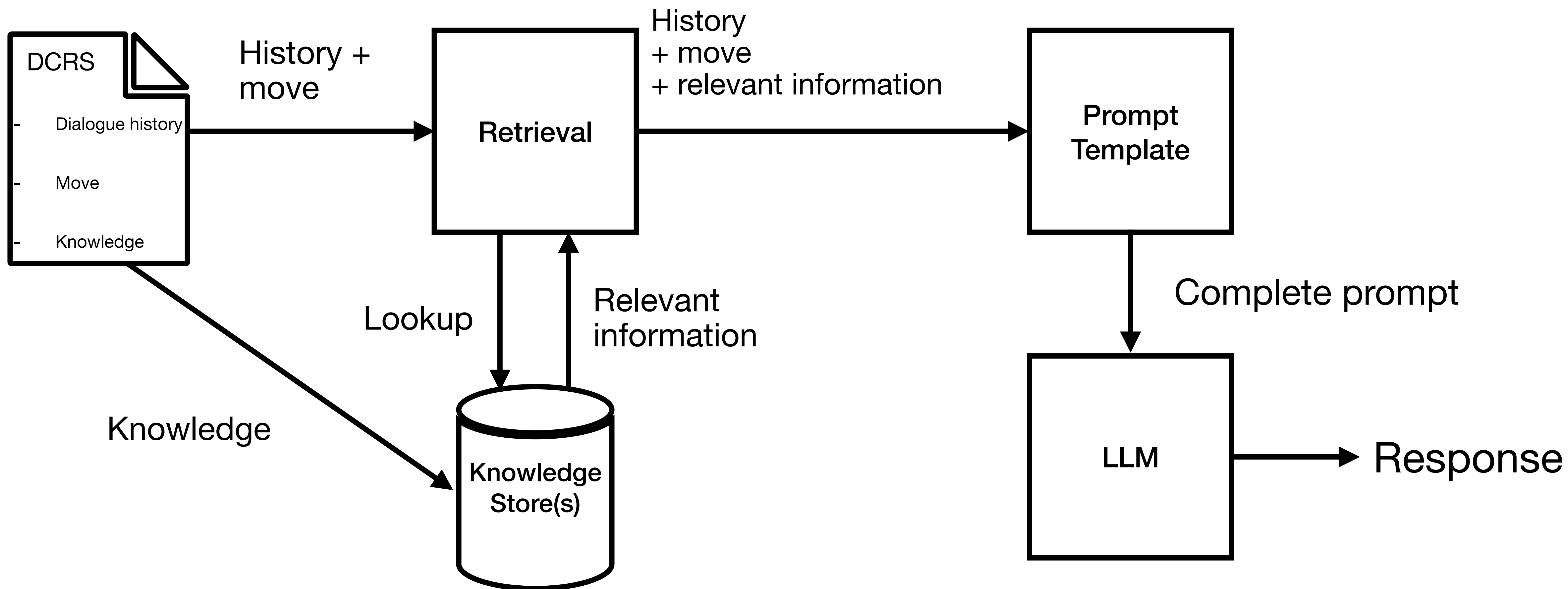
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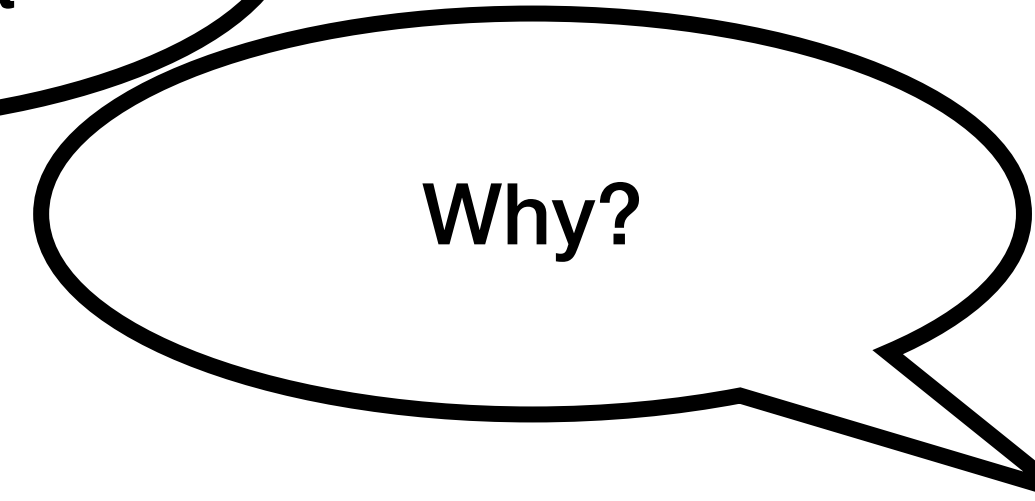
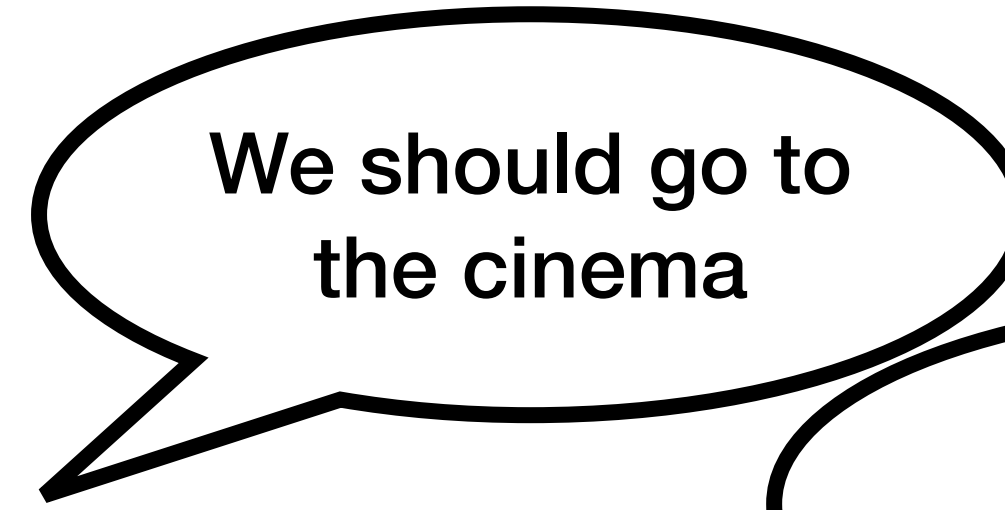
Knowledge Sources

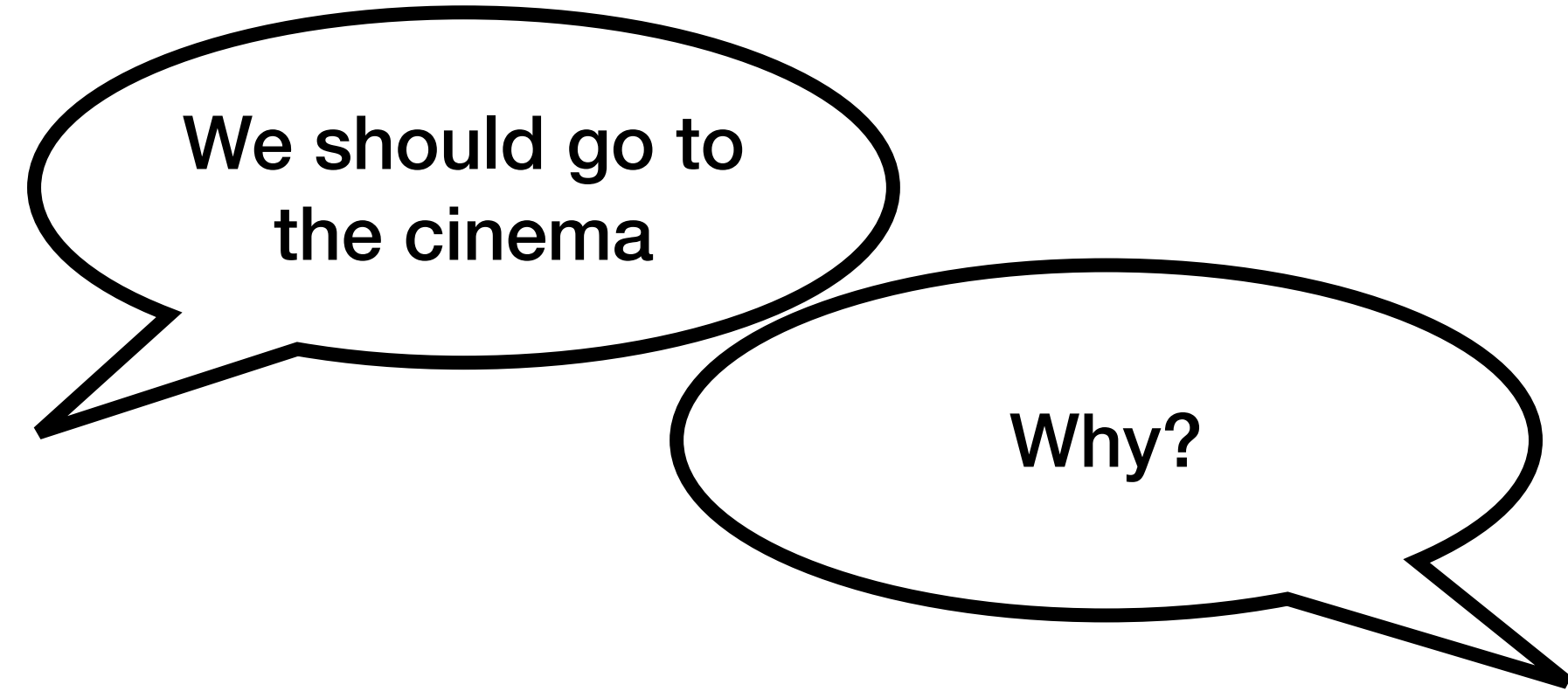
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{{knowledge}}



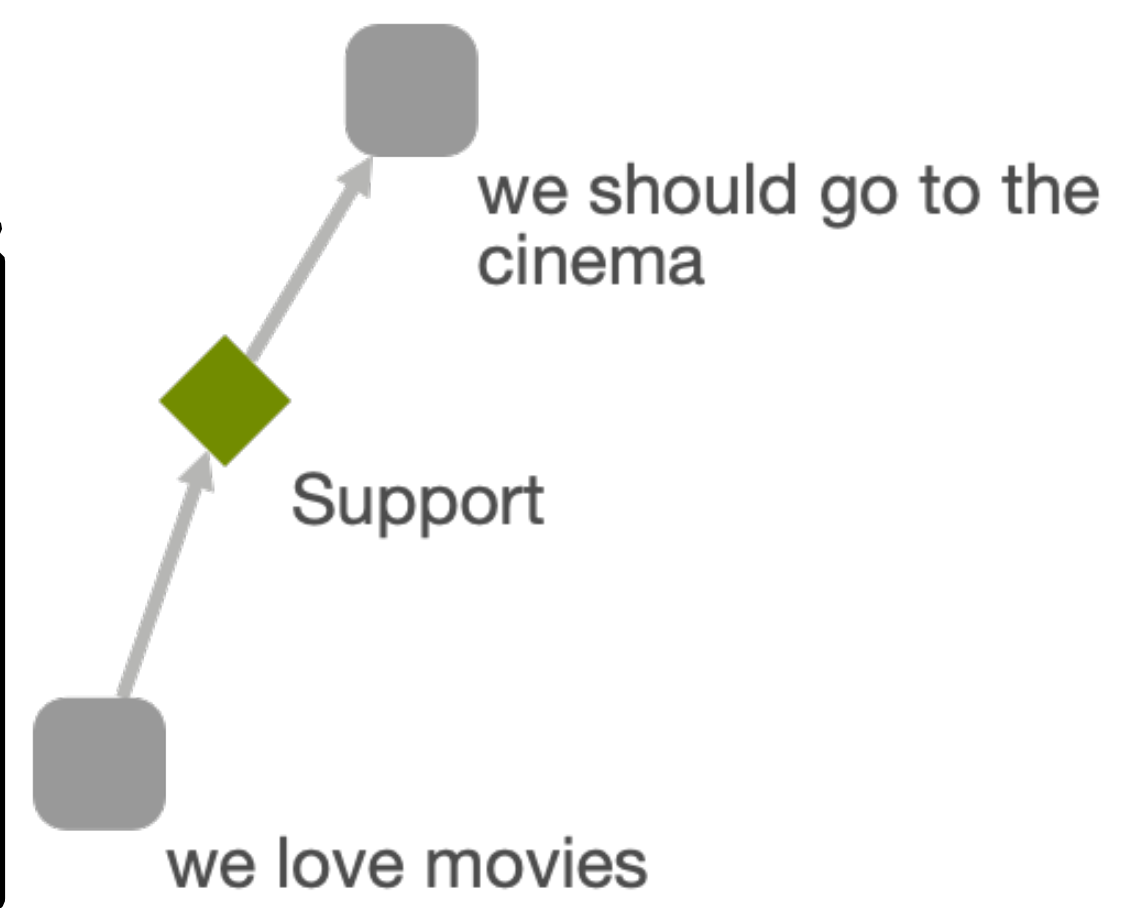


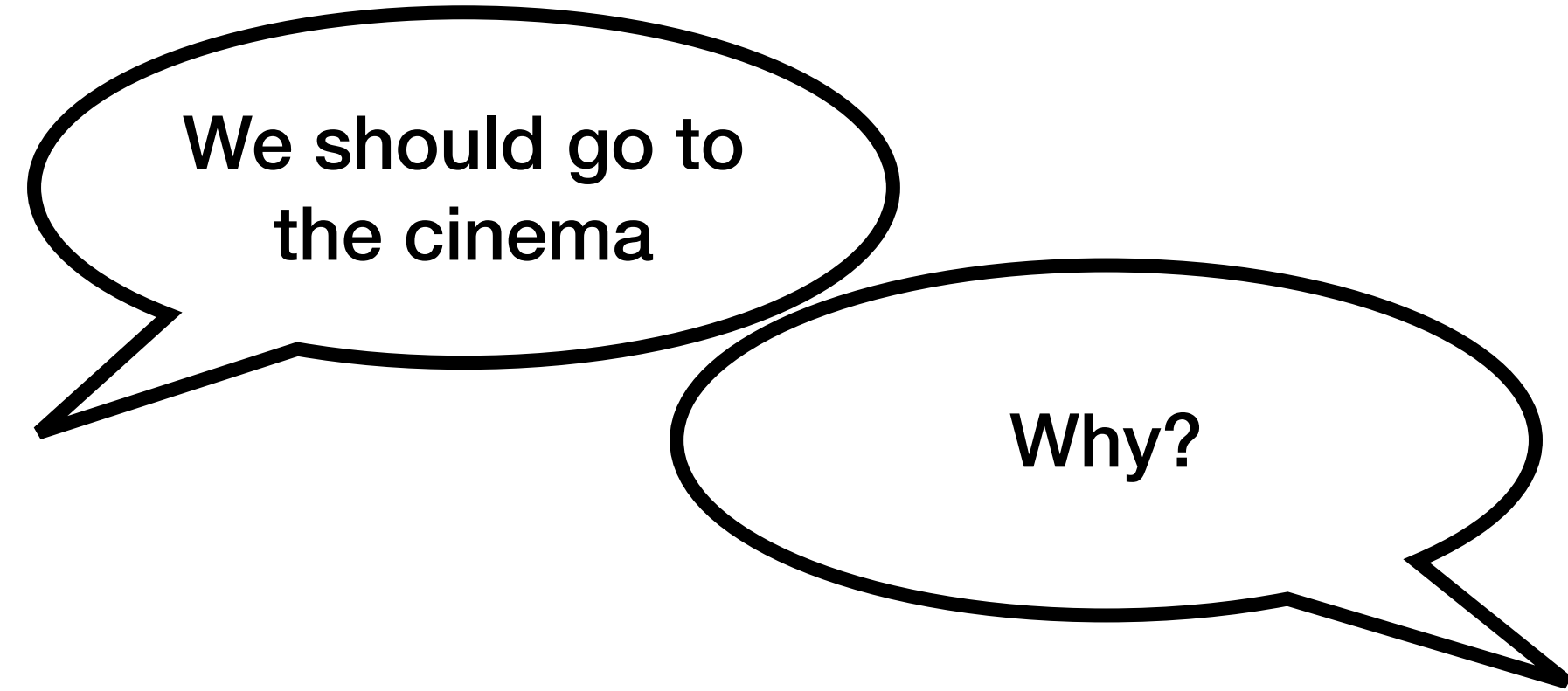




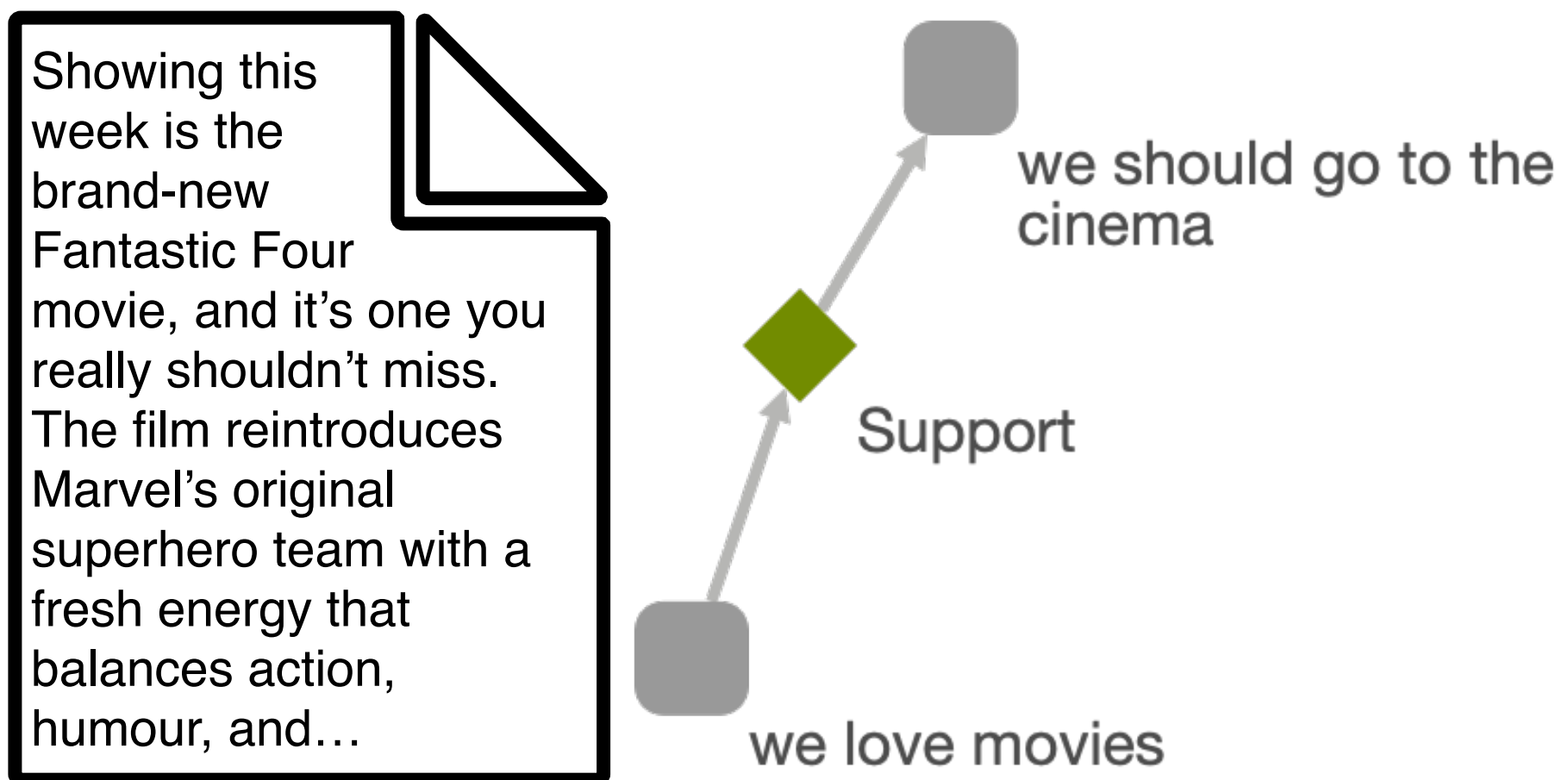
Knowledge

Showing this week is the brand-new Fantastic Four movie, and it's one you really shouldn't miss. The film reintroduces Marvel's original superhero team with a fresh energy that balances action, humour, and...





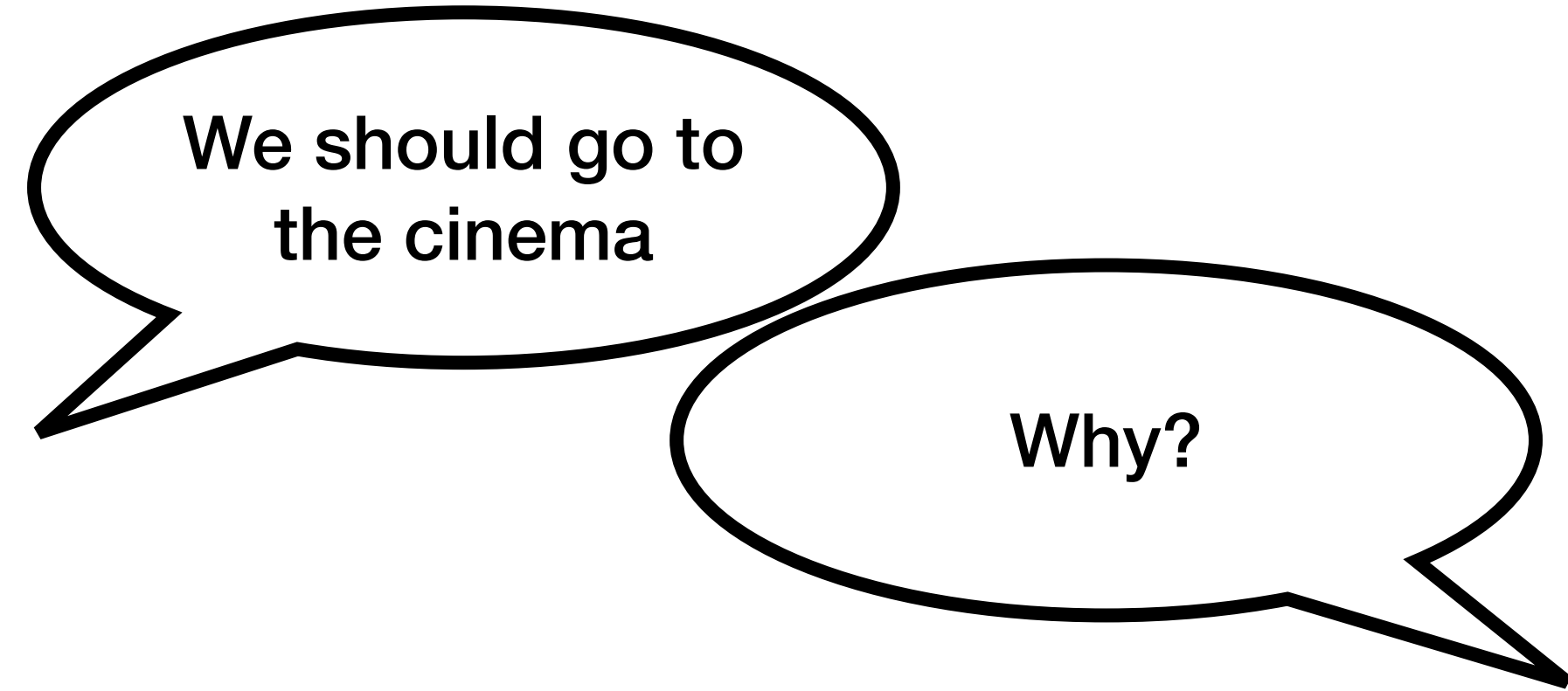
Knowledge



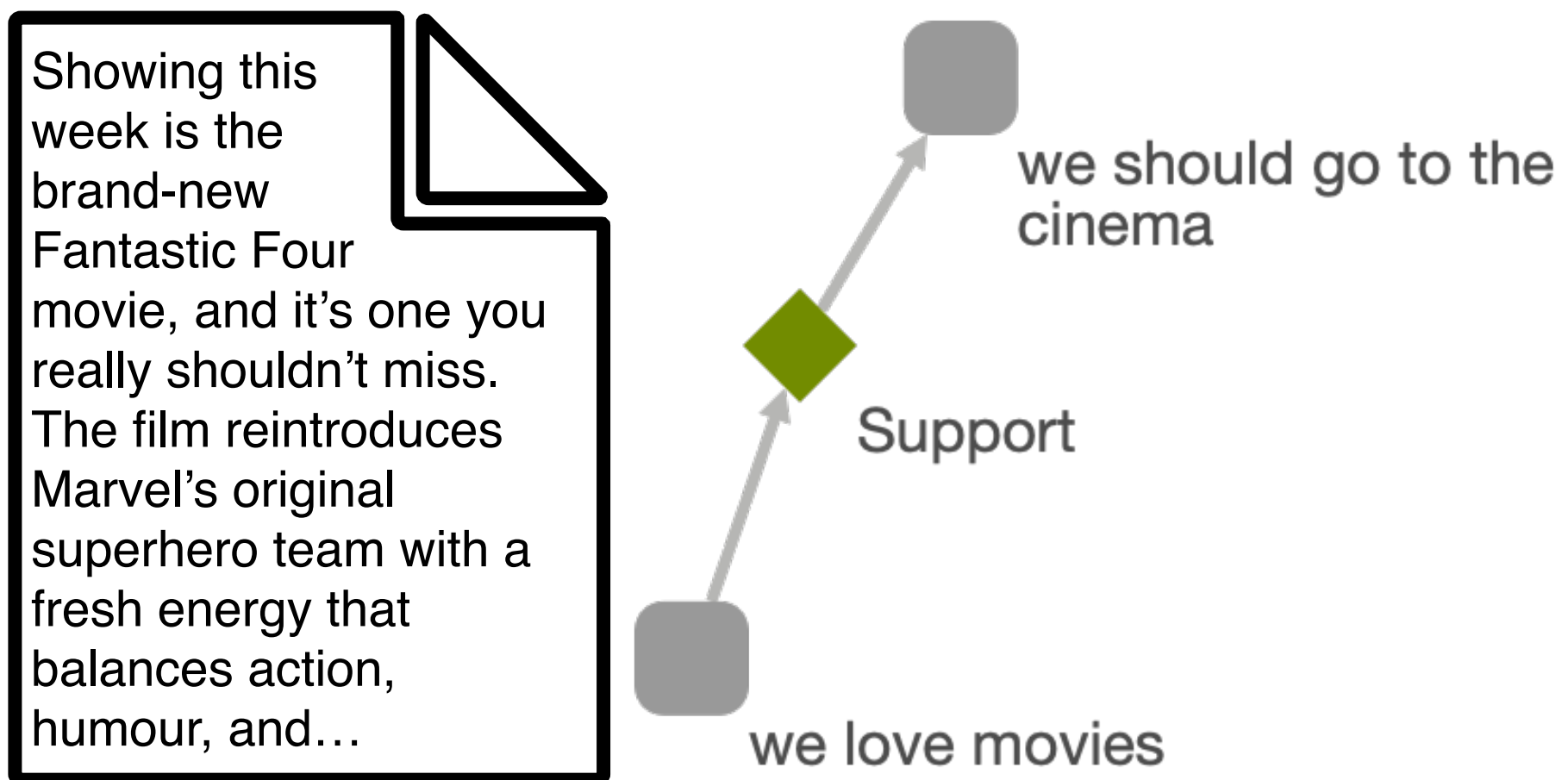
Dialogue history

Alice: We should go to the cinema [assert]

Bob: Why? [challenge]



Knowledge



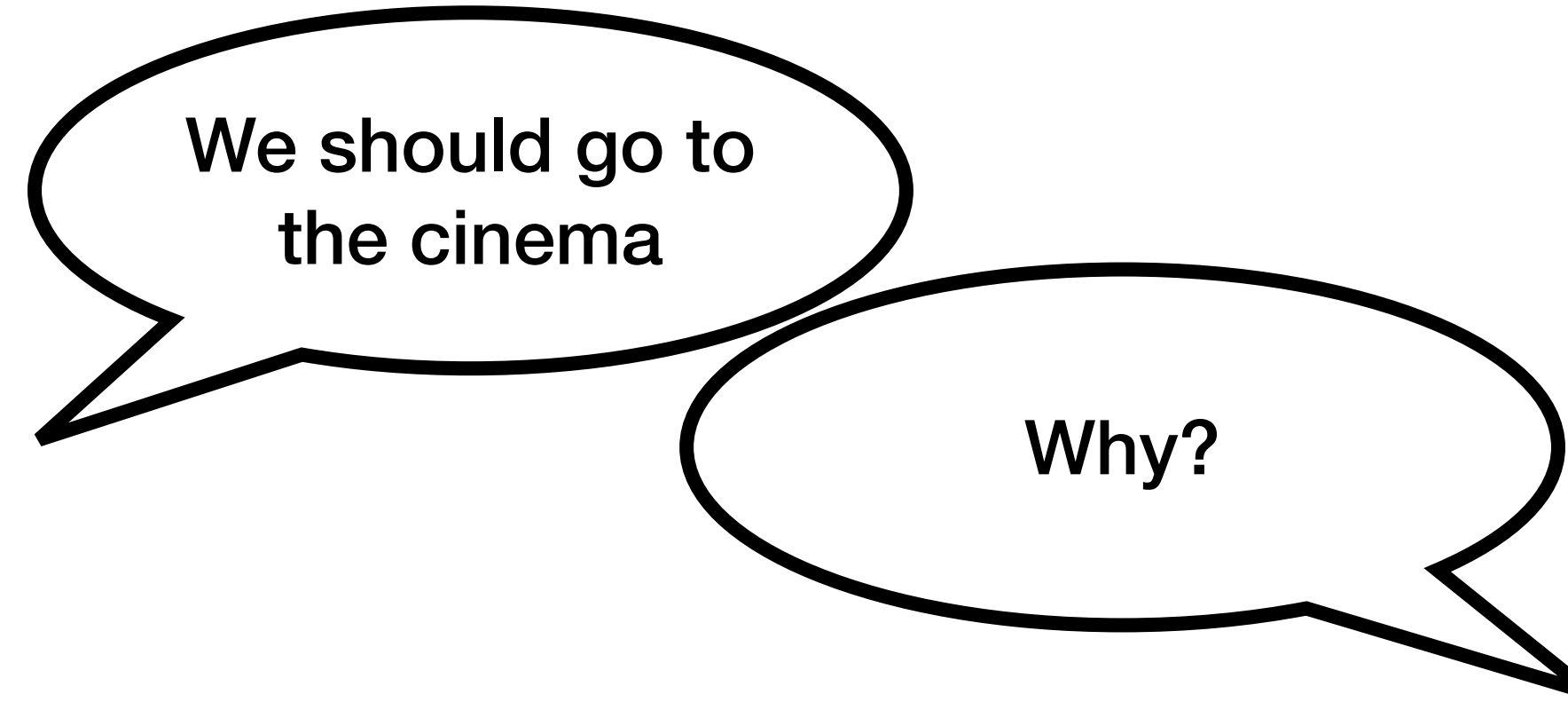
Dialogue history

Alice: We should go to the cinema [assert]

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Scaffold

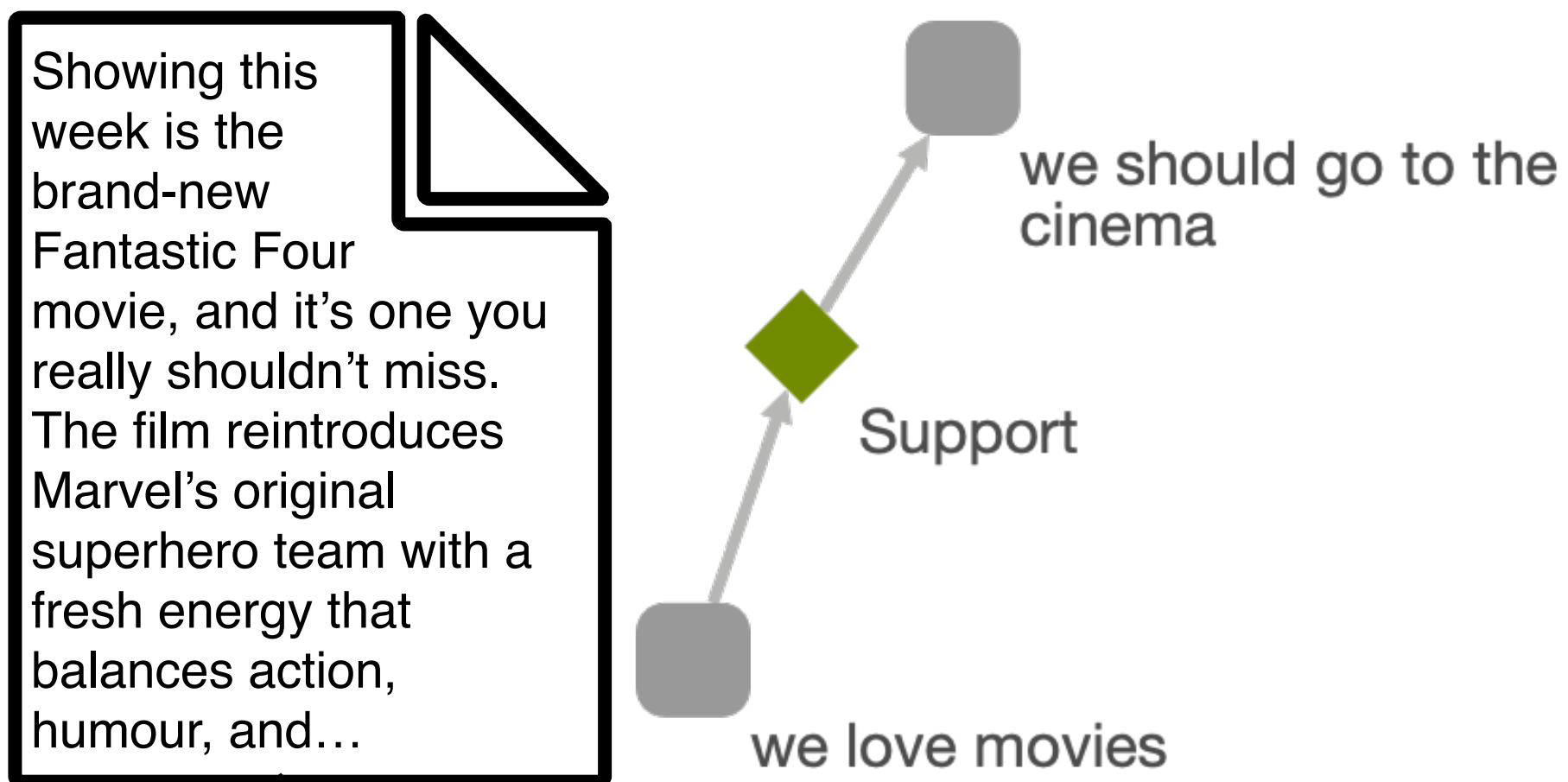
“We should go to the cinema because \$p”



Knowledge

Dialogue history

Scaffold

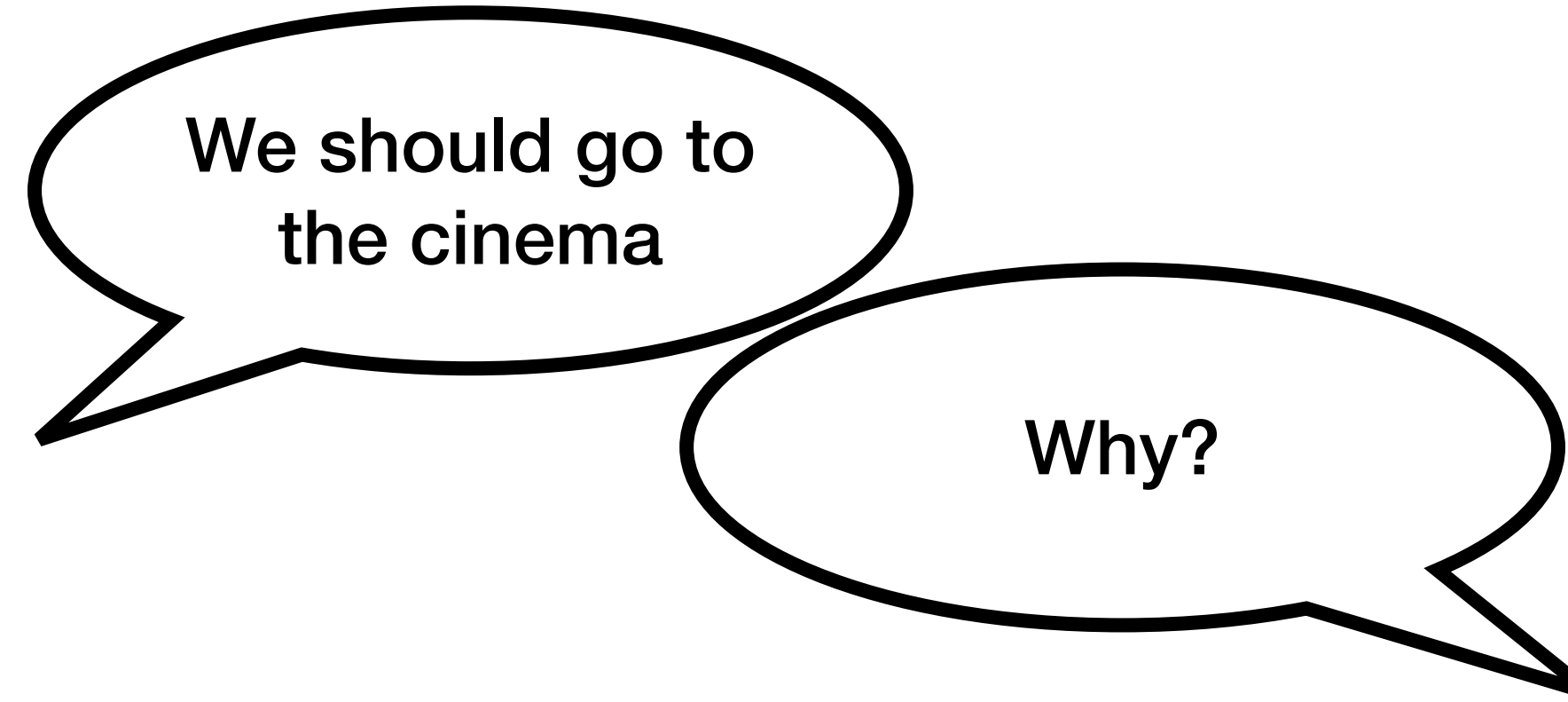


Alice: We should go to the cinema [assert]

Bob: Why? [challenge]

“We should go to the cinema because \$p”

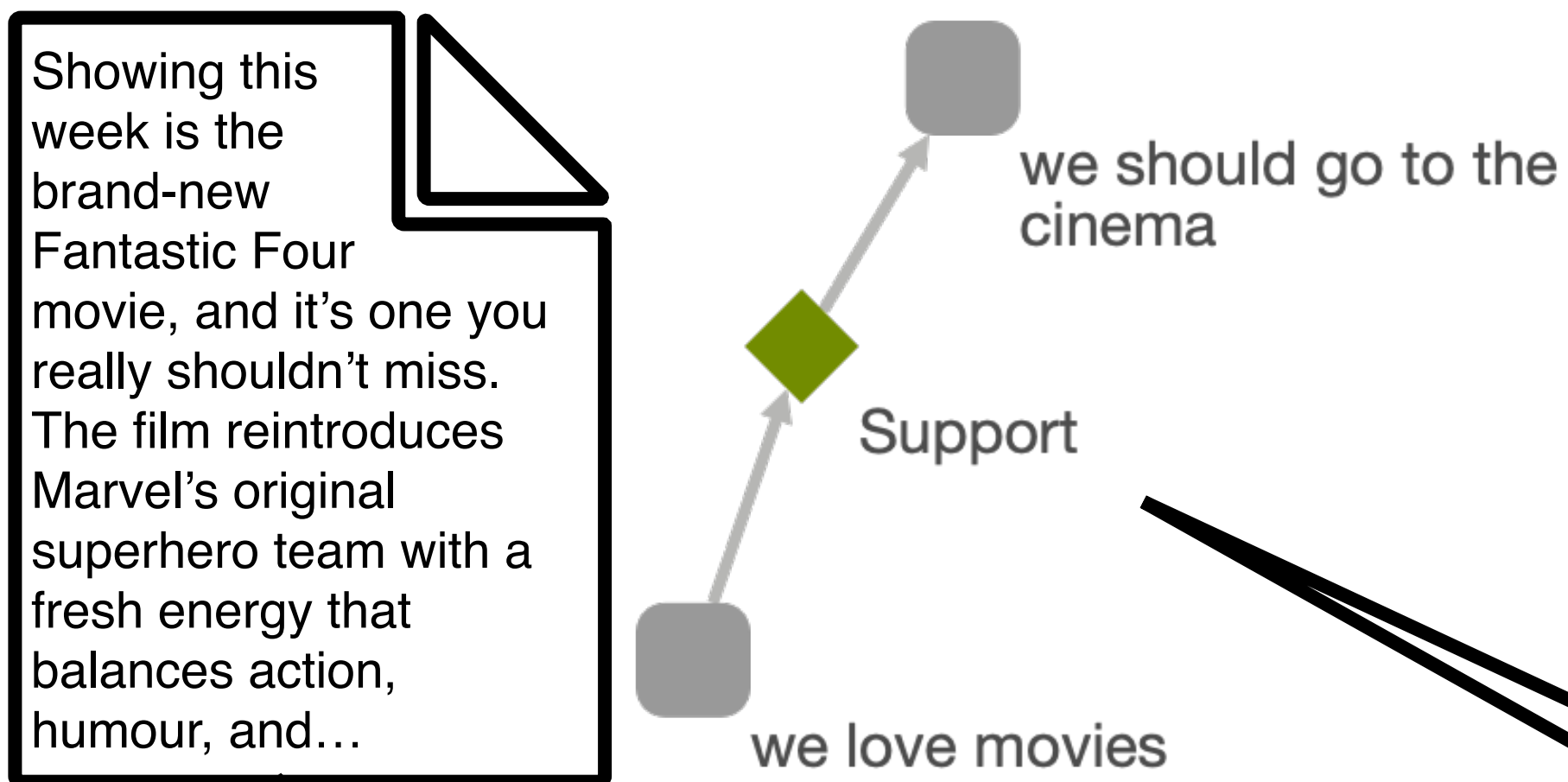
Natural language text to interpret. Rephrase if needs be to make short responses using this source.



Knowledge

Dialogue history

Scaffold



Alice: We should go to the cinema [assert]

Bob: Why? [challenge]

“We should go to the cinema because \$p”

- *sadface-inference*
Format: $p_1, \dots, p_n \Rightarrow q$
Description: $p_1, \dots, p_n$ are premises that together support the conclusion q

Showing this week is the brand-new Fantastic Four movie, and it's one you really shouldn't miss. The film reintroduces Marvel's original superhero team with a fresh energy that balances action, humour, and...

```
{
  "responses": [
    {
      "response": "We should go to the cinema because the brand-new Fantastic Four movie is showing this week, with great effects and a fun team dynamic that's best enjoyed on the big screen.",
      "source": "text"
    },
    {
      "response": "We should go to the cinema because we love movies, and it's a perfect chance to enjoy one together.",
      "source": "sadface"
    }
  ]
}
```

fold
to to the
use \$p"

Ongoing and future work

- Evaluation - Two types:
 - Is the LLM giving “good” responses?
 - How “good” are the responses from different LLMs?
- Combining knowledge sources in a single response
 - Currently limited to one source per response
- Strategic support - LLM judgement of the “best” response to put forward

DiSCoAI - Dialogue-based Structured Conversational AI

2025-2028

- Automated implementation of computational dialogue games from real (human-human) examples
- Underpinning conversational systems with formal dialogue without the design and development overhead
- When combined with RAG pipeline = rapid development of rich and immersive systems across a wide variety of domains



<https://gtr.ukri.org/projects?ref=220>

Summary

- LLM and RAG-based pipeline for generated responses in formal dialogue
- Knowledge, history and move scaffold used to ground the response
- Bridges the vocabulary gap to make formal dialogue responses more natural

Thank you