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PhD Application

# Document-level Event Extraction with Knowledge Injection

Presented by: M. Martinelli  
June 20<sup>th</sup>, 2024



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# Introduction

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## Contemporary Data Landscape

Digital text sources are always-increasing in terms of volume and complexity.



## Information Overload

Information overload challenges our ability to process and utilize data effectively.



## Need for Effective IE

Information Extraction (IE) is essential for extracting information from unstructured text

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## Contemporary Data Landscape

Digital text sources are always-increasing in terms of volume and complexity.



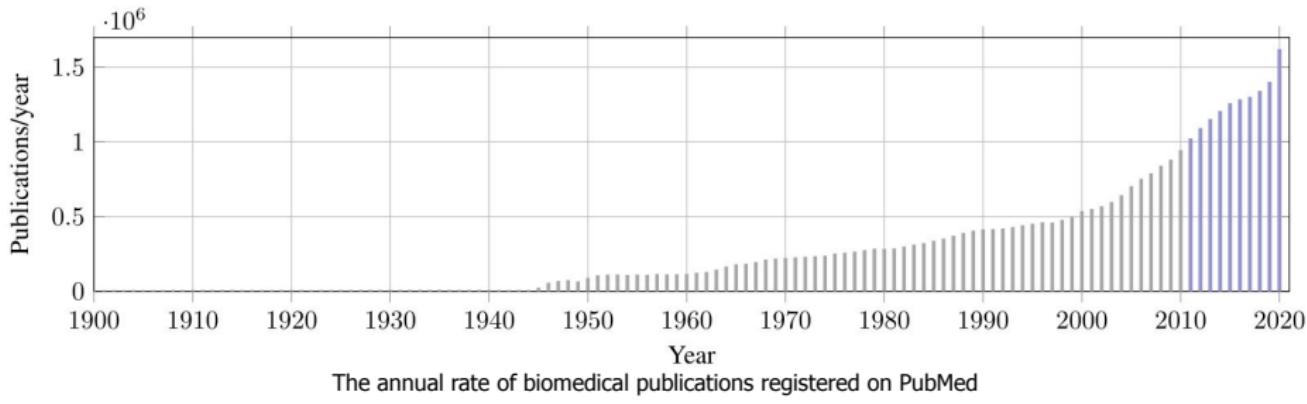
## Information Overload

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Information Extraction (IE) is essential for extracting information from unstructured text



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**Event Extraction (EE)** transforms unstructured text into a structured description of what happened, answering the who, what, when, where, why, and how questions about an occurrence in a structured manner.

## Possible domains of application:

Literature Processing

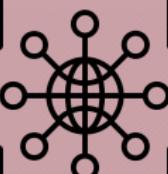


LLMs Training

Healthcare



News Reporting



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**Event Extraction (EE)** transforms unstructured text into a structured description of what happened, answering the who, what, when, where, why, and how questions about an occurrence in a structured manner.

**In January 2023, protests in Atlanta, Georgia, escalated following the fatal shooting of an environmental activist, known as Tortuguita, by authorities during a raid, with protesters throwing rocks and Molotov cocktails at officers.**

# Introduction



**Event Extraction (EE)** transforms unstructured text into a structured description of what happened, answering the who, what, when, where, why, and how questions about an occurrence in a structured manner.

In January 2023, protests in Atlanta, Georgia, escalated following the fatal shooting of an environmental activist, known as Tortuguita, by authorities during a raid, with protesters throwing rocks and Molotov cocktails at officers.

Event Extraction ("Protest" event)	
Event Schema	Event Argument
Date	January 2023
Location	Atlanta, Georgia
Protesters	Environmental activists
Cause	Fatal shooting by the authorities of an environmental activist, known as Tortuguita
Method	Throwing rocks and Molotov Cocktails at officers



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# Approaches to EE

# Approaches to EE



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## Sentence-level EE (SEE)

In January 2023, protests in Atlanta, Georgia, escalated following the fatal shooting of an environmental activist, known as Tortuguita, by authorities during a raid, with protesters throwing rocks and Molotov cocktails at officers.

The protesters, opposing the construction of the 'Cop City' training complex in the forest area of Dekalb County, intensified their actions by setting fire to some police cruisers.

Governor Brian Kemp declared a state of emergency and authorized the deployment of National Guard troops in response to the growing unrest, leading to the arrest of a dozen protesters charged with domestic terrorism.



## Document-level EE (DEE)

# Approaches to EE



## Sentence-level EE (SEE)



In **January 2023**, protests in **Atlanta, Georgia**, escalated following the **fatal shooting of an environmental activist, known as Tortuguita**, by authorities during a raid, with protesters **throwing rocks and Molotov cocktails at officers**.

The protesters, opposing the **construction of the 'Cop City' training complex** in the forest area of **Dekalb County**, intensified their actions by **setting fire to some police cruisers**.

Governor Brian Kemp declared a state of emergency and authorized the deployment of National Guard troops in response to the growing unrest, leading to the **arrest of a dozen protesters charged with domestic terrorism**.

Event Type: Protest	
Date	January 2023
Location	Atlanta, Georgia
Protesters	Environmental activists
Cause	Fatal Shooting of an environmental activist, known as Tortuguita
Method	Throwing rocks and Molotov Cocktails at officers

Event Type: Protest	
Location	Dekalb County
Cause	Construction of the 'Cop City' training complex
Damaged Property	Some police cruisers set to fire

Event Type: Protest	
Government Reaction	<ul style="list-style-type: none"><li>State of emergency declared</li><li>National Guard deployed</li></ul>
Arrested	A dozen protesters charged with domestic terrorism

# Approaches to EE



Sentence-level EE (SEE)

In January 2023, protests in Atlanta, Georgia, escalated following the fatal shooting of an environmental activist, known as Tortuguita, by authorities during a raid, with protesters throwing rocks and Molotov cocktails at officers.

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## Document-level EE (DEE)

Event Type: Protest	
Date	January 2023
Location	Atlanta, Georgia
Protesters	Environmental activists
Cause	Construction of the 'Cop City' training complex
Method	Throwing rocks and Molotov Cocktails at officers
Arrested	A dozen protesters charged with domestic terrorism
Government Reaction	<ul style="list-style-type: none"><li>State of emergency declared</li><li>National Guard deployed</li></ul>
Casualties and Losses	Fatal Shooting of an environmental activist, known as Tortuguita
Damaged Property	Some police cruisers set to fire

# DEE Challenges



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1

Maintain extraction  
effectiveness



Many lexical and  
syntactical possibilities



Coreference resolution



Event merging



Entity disambiguation

2

Scarce availability  
of training data



Annotated data are  
expensive to produce



Under-representation of  
certain event types



Under-representation of  
abbreviations and acronyms



Under-representation of  
domain-specific terminology



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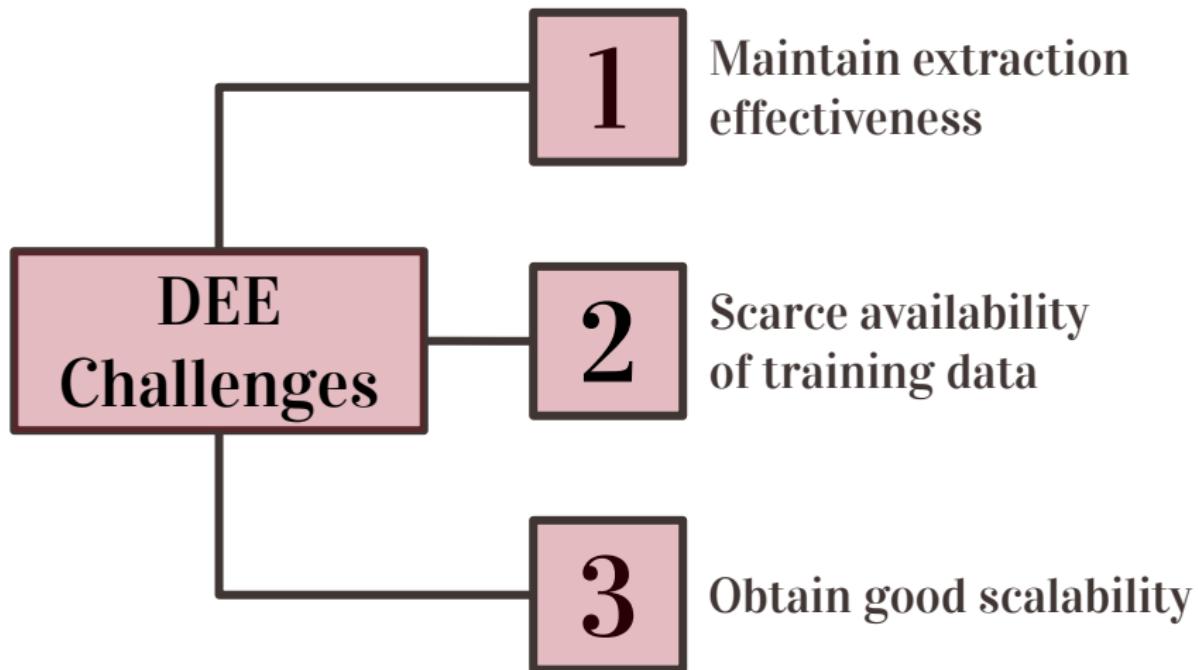
# Research Directions

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# Research Directions



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1

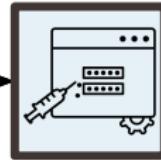
Maintain extraction  
effectiveness

2

Scarce availability  
of training data

3

Obtain good  
scalability



Knowledge  
Injection



## Knowledge Injection (KI)

In January 2023, protests in Atlanta, Georgia, escalated following the fatal shooting of an environmental activist, known as **Tortuguita**, by authorities during a raid, with protesters throwing rocks and Molotov cocktails at officers.

The protesters, opposing the construction of the '**Cop City**' **training complex** in the forest area of Dekalb County, intensified their actions by setting fire to some police cruisers.

Governor Brian Kemp declared a state of emergency and authorized the deployment of National Guard troops in response to the growing unrest, leading to the arrest of a dozen protesters charged with domestic terrorism.

### Cop City:

- Description: Police training facility in **Atlanta, Georgia, USA**
- Also known as: **Atlanta Public Safety Training Center**

### Tortuguita:

- Description: Activist
- Also known as: **Manuel Teran**
- Member of: **Defend the Atlanta Forest**
- Date of death: **18 January 2023**
  - Age of subject at event: **26 years old**

### Defend the Atlanta Forest:

- Description: Social movement
- Slogan: **Defend the forest, Stop cop city**

# Research Directions



## Knowledge Injection (KI)

### Cop City:

- Description: Police training facility in **Atlanta, Georgia, USA**
- Also known as: **Atlanta Public Safety Training Center**

### Tortuguita:

- Description: Activist
- Also known as: **Manuel Teran**
- Member of: **Defend the Atlanta Forest**
- Date of death: **18 January 2023**
  - Age of subject at event: **26 years old**

### Defend the Atlanta Forest:

- Description: Social movement
- Slogan: **Defend the forest, Stop cop city**

### Event Type: Protest

Date	Subsequent to 18th of January 2023
Location	Atlanta, Georgia, USA
Protesters	"Defend the Atlanta Forest" environmental activists
Cause	Construction of the 'Cop City' training complex, officially known as 'Atlanta Public Safety Training Center'
Slogan	<ul style="list-style-type: none"><li>• Defend the forest</li><li>• Stop cop city</li></ul>
Method	Throwing rocks and Molotov Cocktails at officers
Arrested	A dozen protesters charged with domestic terrorism
Government Reaction	<ul style="list-style-type: none"><li>• State of emergency declared</li><li>• National Guard deployed</li></ul>
Casualties and Losses	Fatal Shooting of the 26 years old environmental activist Manuel Teran, known as Tortuguita
Damaged Property	Some police cruisers set to fire

# Research Directions



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## Document-level EE (DEE)



## Knowledge Injection

Event Type: Protest	
Date	January 2023
Location	Atlanta, Georgia
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Arrested	A dozen protesters charged with domestic terrorism
Government Reaction	<ul style="list-style-type: none"><li>State of emergency declared</li><li>National Guard deployed</li></ul>
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Arrested	A dozen protesters charged with domestic terrorism
Government Reaction	<ul style="list-style-type: none"><li>State of emergency declared</li><li>National Guard deployed</li></ul>
Casualties and Losses	Fatal Shooting of the 26 years old environmental activist Manuel Teran, known as Tortuguita
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# Research Directions

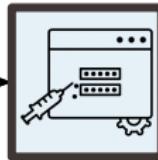


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1

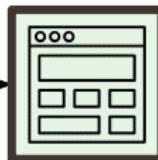
Maintain extraction  
effectiveness



Knowledge  
Injection

2

Scarce availability  
of training data



Template-based  
models

3

Obtain good  
scalability



## Template-based (TB) models

### 1. Template Creation



The protest took place on [Date] in [Location], organized by [Protesters].  
The primary cause of this demonstration was [Cause], with participants unified under the slogan [Slogan].

Protest methods employed included [Method], and [Damaged Property] was reported as damaged property.

In response, the government [Government Reaction].

The event led to [Arrested] being arrested and to [Casualties and Losses].

# Research Directions



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In response, the government [Government Reaction].  
The event led to [Arrested] being arrested and to [Casualties and Losses].

### 2. Prompt to LLM



Perform the Event Extraction task by completing the template below by extracting relevant information about a "Protest" event from the provided news article.

Focus on accurately filling in the specific details within square brackets to summarize the key points of the event.

If you cannot find the match for a specific field, fill with the symbol 'X'

Template to complete:

...

News Article:

...

# Research Directions



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## Template-based (TB) models

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In response, the government [Government Reaction].  
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If you cannot find the match for a specific field, fill with the symbol 'X'

Template to complete:

...  
News Article:  
...

### 2. Prompt to LLM



The protest took place on [January 2023] in [Atlanta, Georgia], organized by [environmental activists].

The primary cause of this demonstration was [opposition to the construction of the 'Cop City' training complex in Dekalb County forest area], with participants unified under the slogan [X].

Protest methods employed included [throwing rocks and Molotov cocktails at officers, setting fire to police cruisers], and [police cruisers] was reported as damaged property..

In response, the government [declared a state of emergency and authorized the deployment of National Guard troops].

The event led to [a dozen protesters] being arrested and to [the fatal shooting of the environmental activist Tortuguita].

# Research Directions - Challenges



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## Knowledge Injection



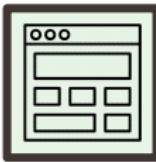
Controlling the introduction of noise



Maintaining the accuracy of injected knowledge



Avoiding the sub-optimal injection of knowledge



## Template-based models



Adapting to variations in events descriptions



Learning from data and improving over time



Managing syntactic and semantic variations



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# Research Questions

# Research Questions



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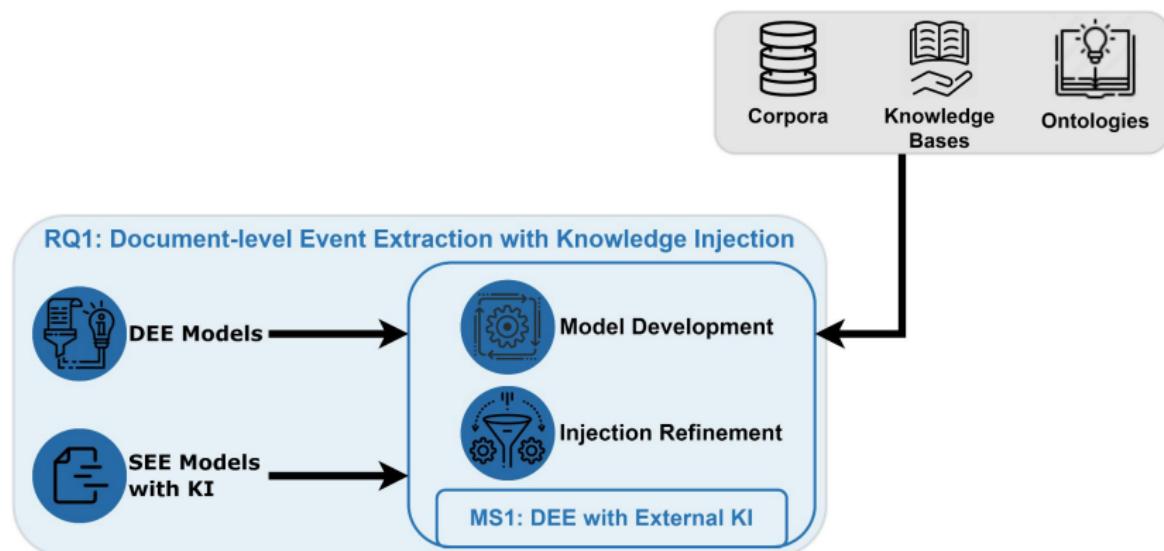
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RQ1

## Knowledge Injection in DEE Models

To improve the extraction of entities and relations



# Research Questions



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## Knowledge Injection in DEE Models

To improve the extraction of entities and relations

RQ1



Fine-tuning a LM on externally annotated corpus

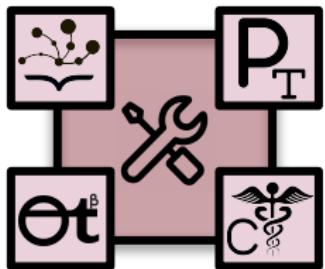


Augmenting word embeddings with additional features



Enriching input data before model processing

DBpedia spotlight



PubTator

OpenTapioca

cTakes

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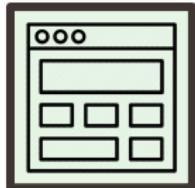
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RQ1

## Knowledge Injection in DEE Models

To improve the extraction of entities and relations



RQ2

## Knowledge Injection in TB Models

To enhance the robustness and flexibility

# Research Questions



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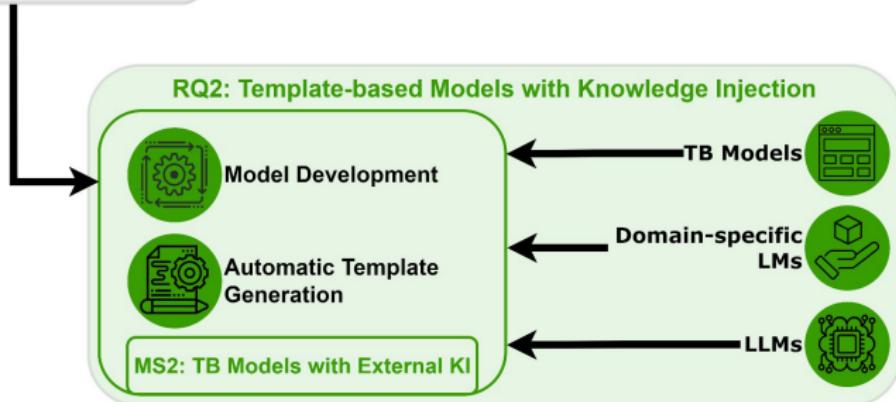
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RQ2

## Knowledge Injection in TB Models

To enhance the robustness and flexibility

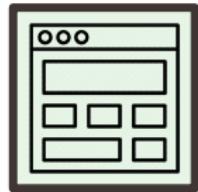


# Research Questions



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RQ2

## Knowledge Injection in TB Models

To enhance the robustness and flexibility



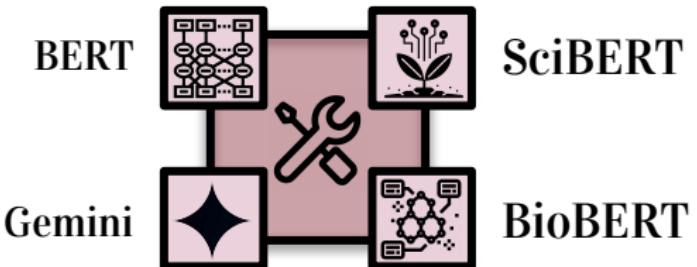
Augmenting event templates with external knowledge



Enhancing the accuracy of augmented templates using techniques from automatic KBs enrichment



Leveraging LMs to automate template generation



# Research Questions



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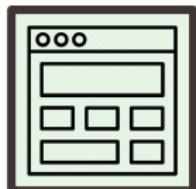
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RQ1

## Knowledge Injection in DEE Models

To improve the extraction of entities and relations



RQ2

## Knowledge Injection in TB Models

To enhance the robustness and flexibility



RQ3

## Performance Evaluation

To evaluate the impact of the injection approaches  
on effectiveness and efficiency

# Research Questions



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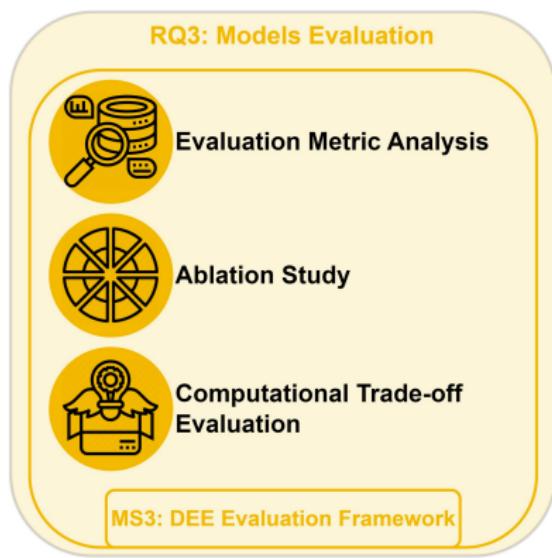
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RQ3

## Performance Evaluation

To evaluate the impact of the injection approaches on effectiveness and efficiency



# Research Questions



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RQ3

## Performance Evaluation

To evaluate the impact of the injection approaches on effectiveness and efficiency



- Evaluating effectiveness using precision, recall, and F1-score as metrics
- Conducting ablation studies to understand the impact of the various injection approaches
- Evaluating computational load to determine the most scalable approaches

# Research Questions



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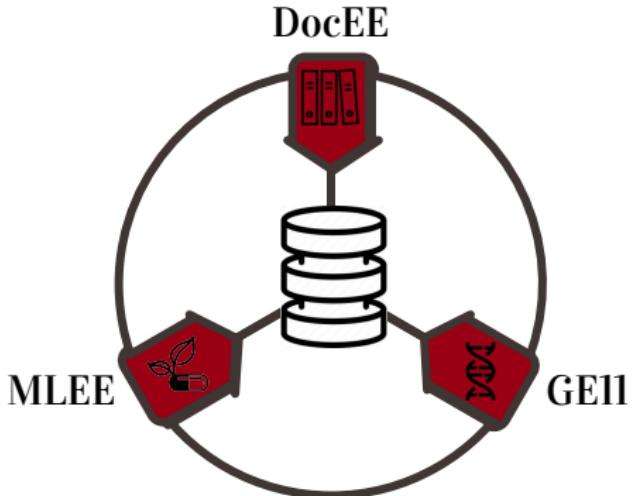


RQ3

## Performance Evaluation

To evaluate the impact of the injection approaches  
on effectiveness and efficiency

## Test Collections



# Research Questions



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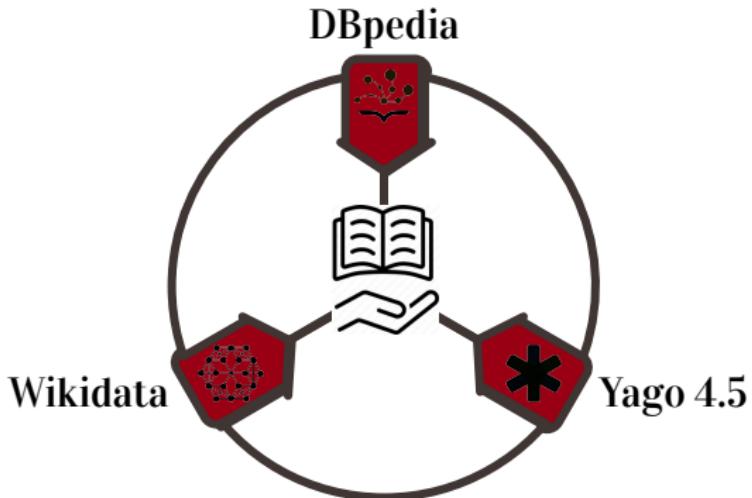


RQ3

## Performance Evaluation

To evaluate the impact of the injection approaches on effectiveness and efficiency

## Knowledge Sources – General Purpose



# Research Questions



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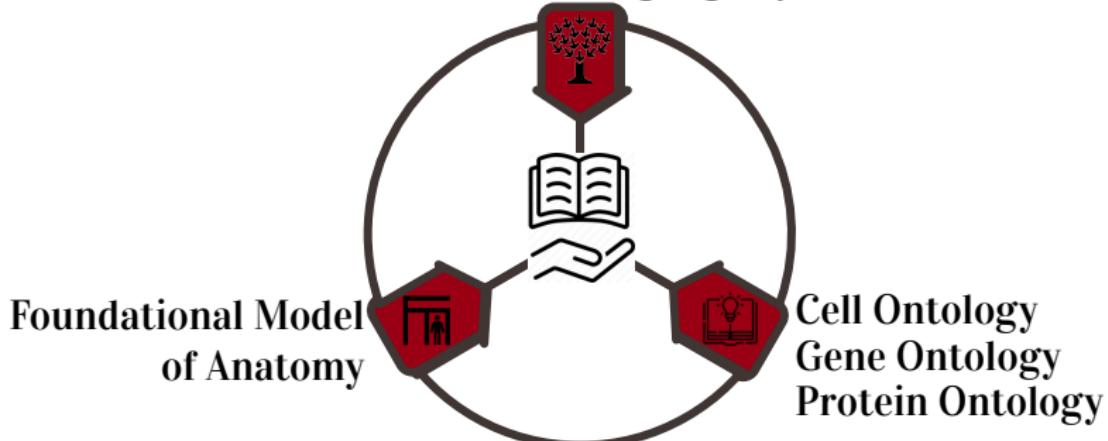
## Performance Evaluation

To evaluate the impact of the injection approaches  
on effectiveness and efficiency

RQ3

## Knowledge Sources – Biomedical Domain

### Unified Medical Language System

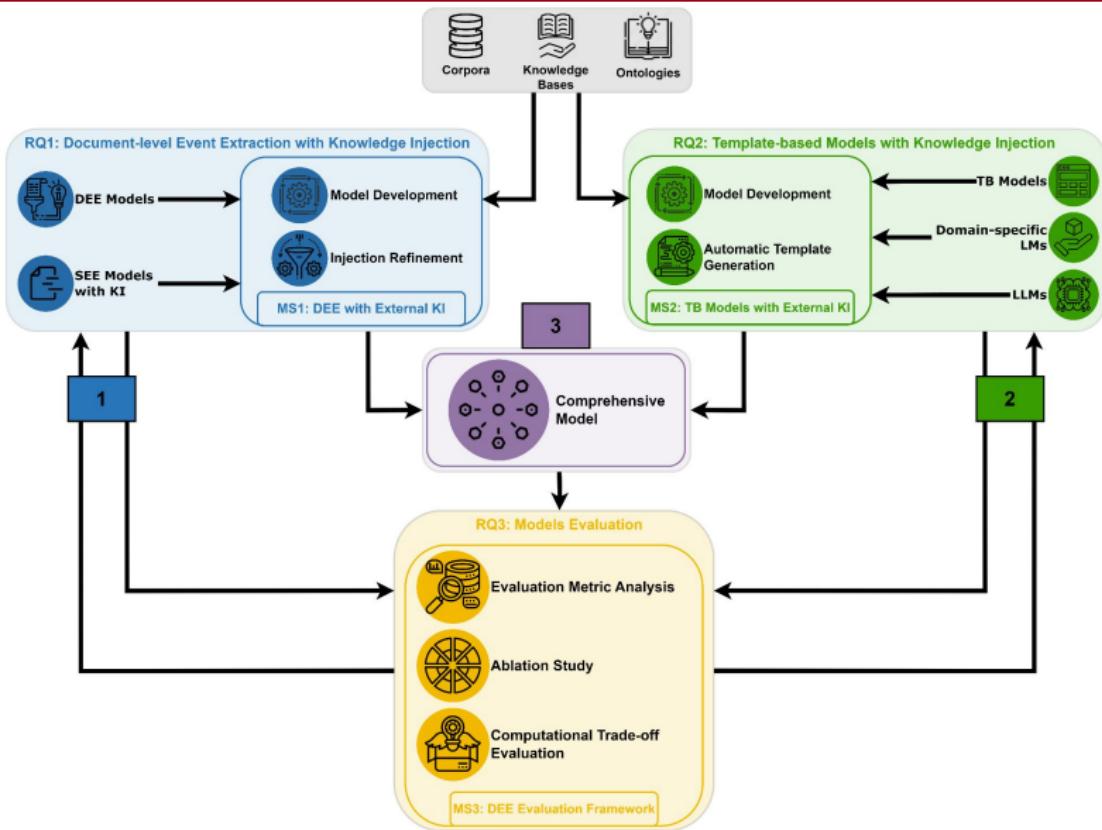


# Research Framework



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# Research Timeline

# Work Packages and Milestones



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## MS1

Literature  
Review



## WP2 - MS1

Develop an effective  
DEE model with KI



## WP3 - MS2

Develop an efficient  
TB model with KI for  
DEE



## WP4 - MS3

Develop an  
evaluation  
framework for  
DEE models

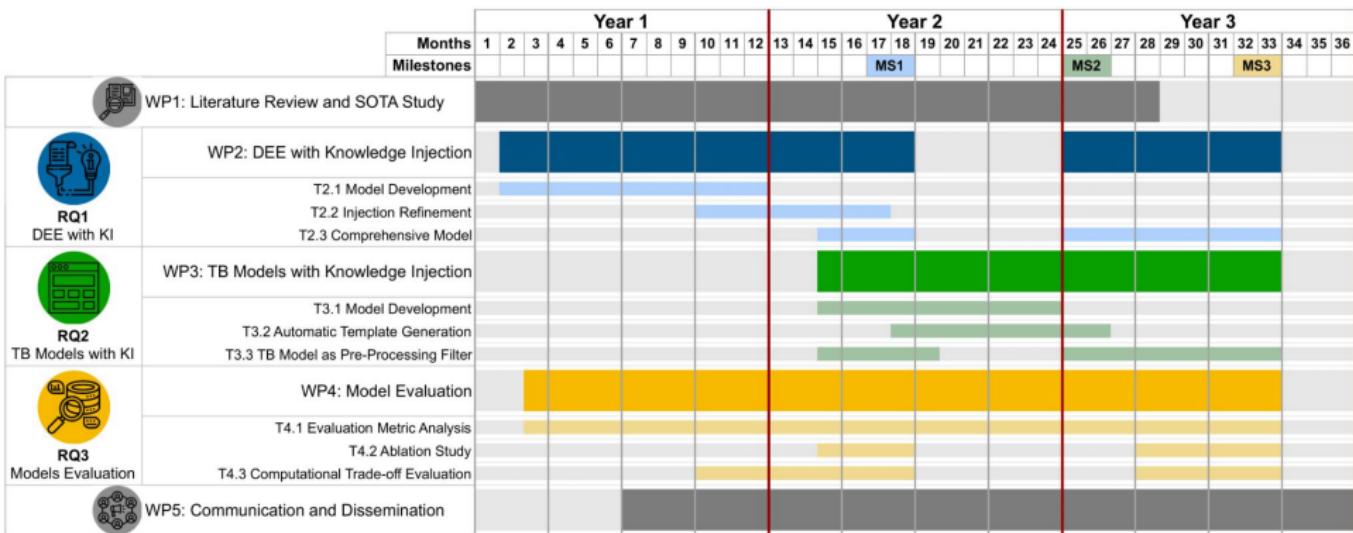


## WP5

Communication  
and  
Dissemination



# Gantt Chart





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# Thank you for the attention!

# Questions?