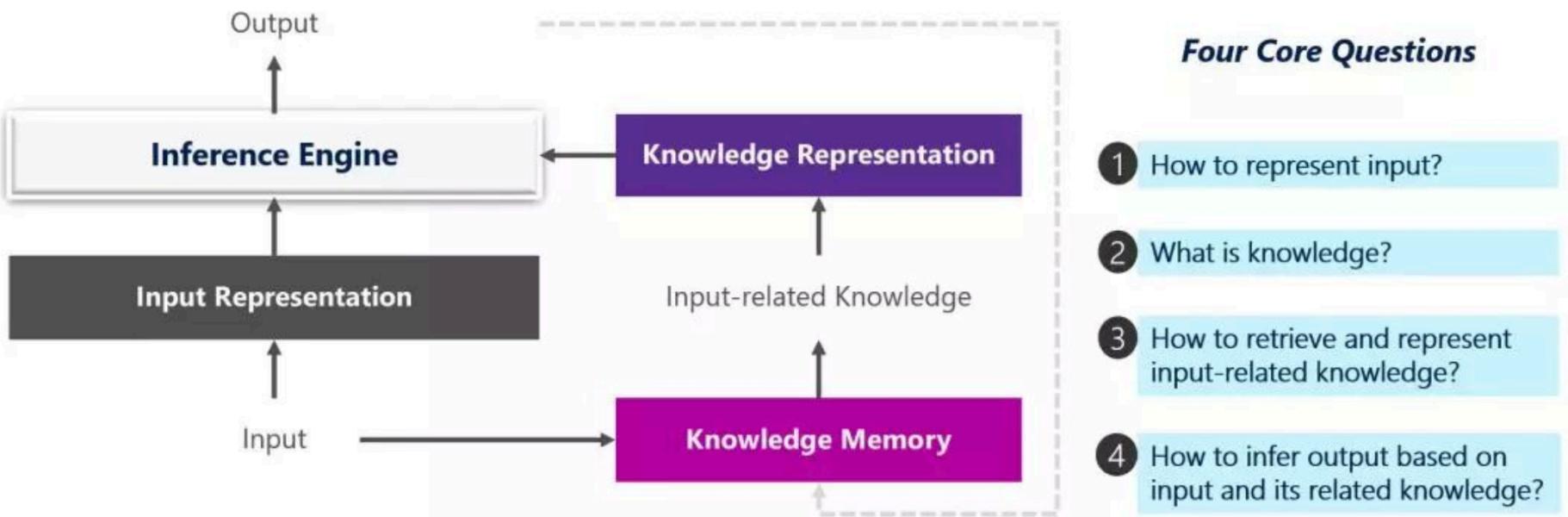


Machine Reasoning

Zili Wang

We define **reasoning** as a mechanism that can generate answers to unseen questions by manipulating existing knowledge with inference techniques.^[1]



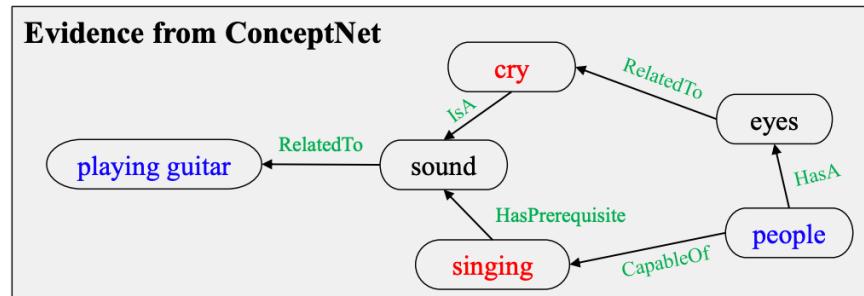
[1] Ming Zhou, Nan Duan, Shujie Liu, Heung-Yeung Shum. Progress in Neural NLP: Modeling, Learning and Reasoning. Accepted by Engineering, 2019.

- GCN Based Multi-hop reasoning
 - QA、Fact checking、VQA、Visual Dialog
- Counterfactual Reasoning
 - Story generation
- Multi step reasoning chain

Graph-Based Reasoning over Heterogeneous External Knowledge for Commonsense Question Answering (AAAI 2020)

Question: What do **people** typically do while **playing guitar**?

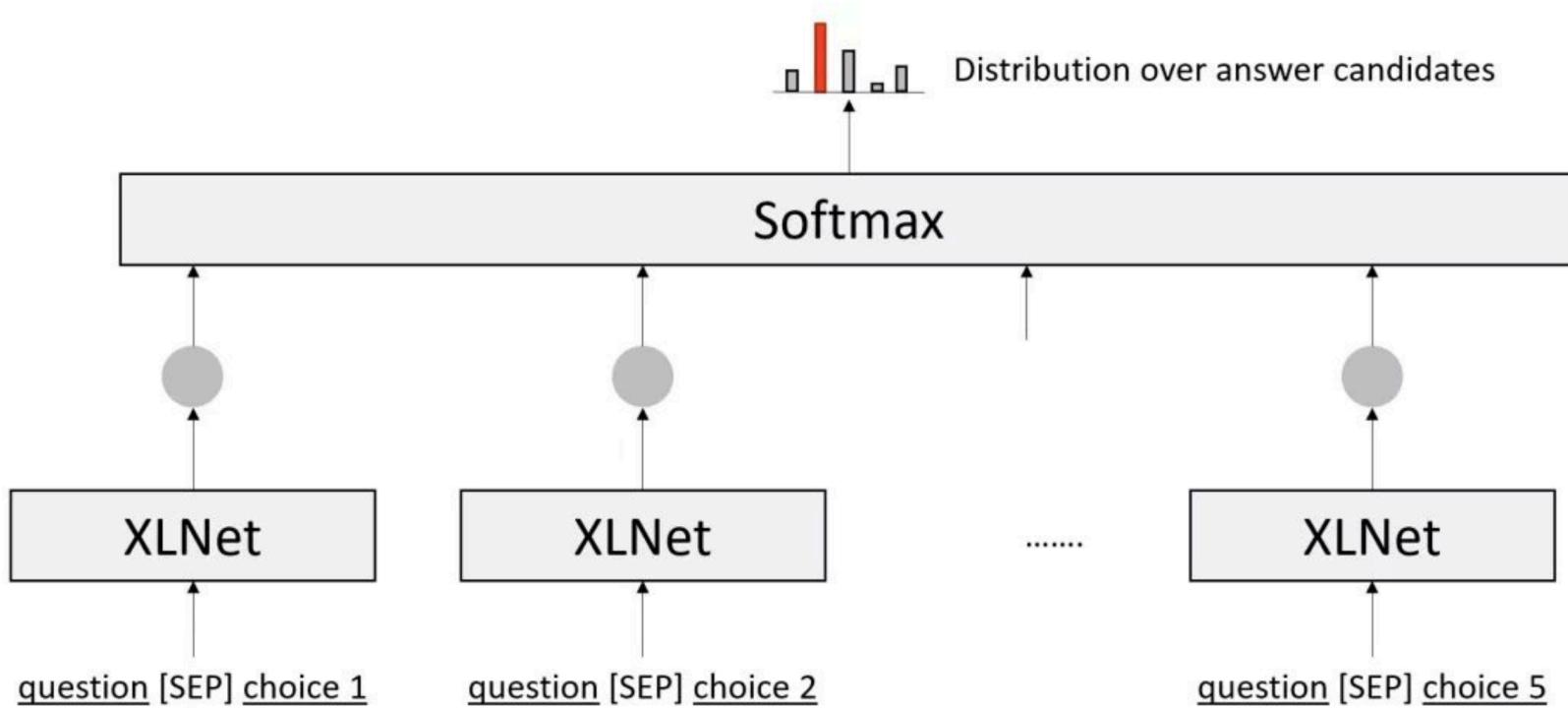
- A. cry
- B. hear sounds
- C. singing (✓)
- D. anthritis
- E. making music



Evidence from Wikipedia

- A. cry {
 - What can yearn, cry without tears?
 - What is to cry and to weep?
}
- C. singing {
 - She also performed them, **playing guitar** and **singing**.
 - Jakszyk led the band, **playing guitar** and **singing**.
}
- E. making music {
 - Making music** and **playing guitar** are his hobbies.
 - He began **making music** when he started **guitar** lessons.
}

Graph-Based Reasoning over Heterogeneous External Knowledge for Commonsense Question Answering (AAAI 2020)



Graph-Based Reasoning over Heterogeneous External Knowledge for Commonsense Question Answering (AAAI 2020)

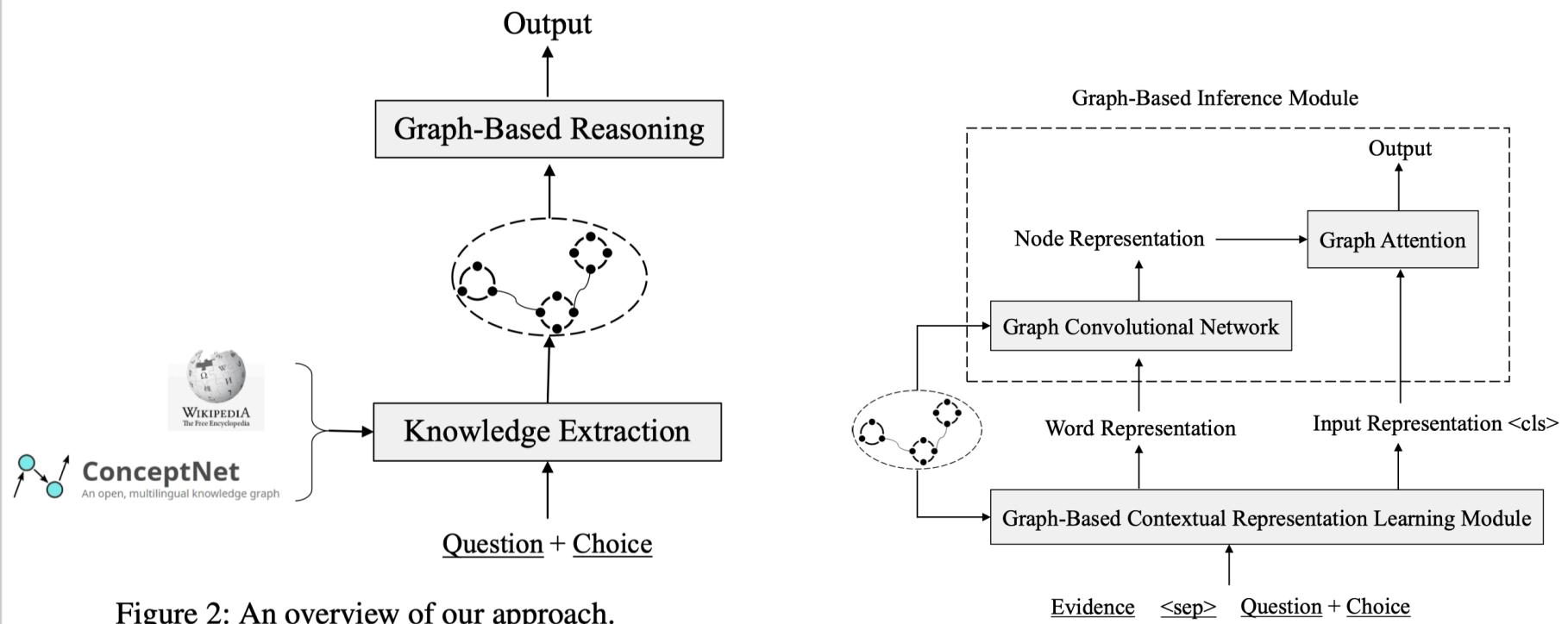
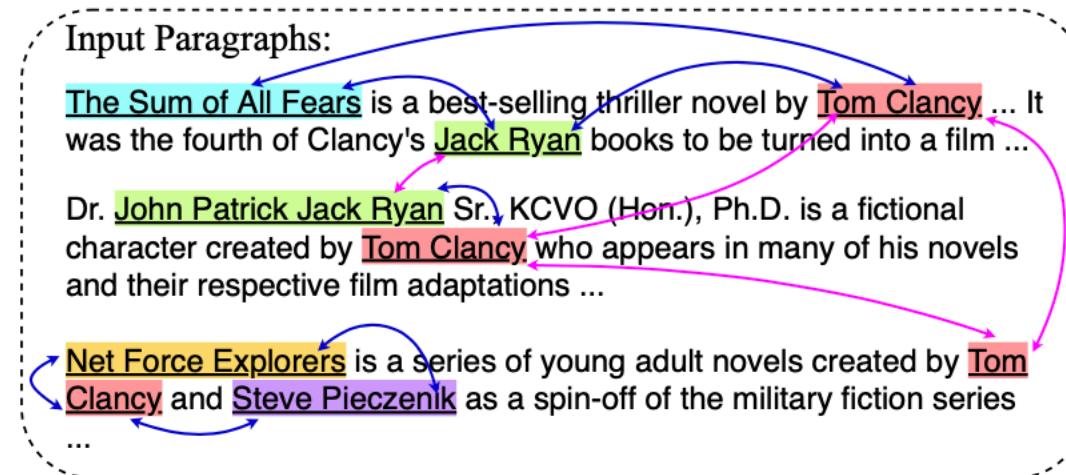


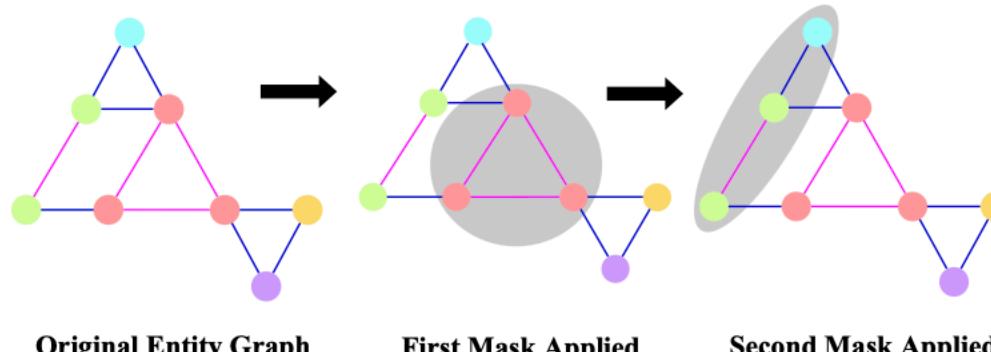
Figure 2: An overview of our approach.

Dynamically Fused Graph Network for Multi-hop Reasoning ACL 2019

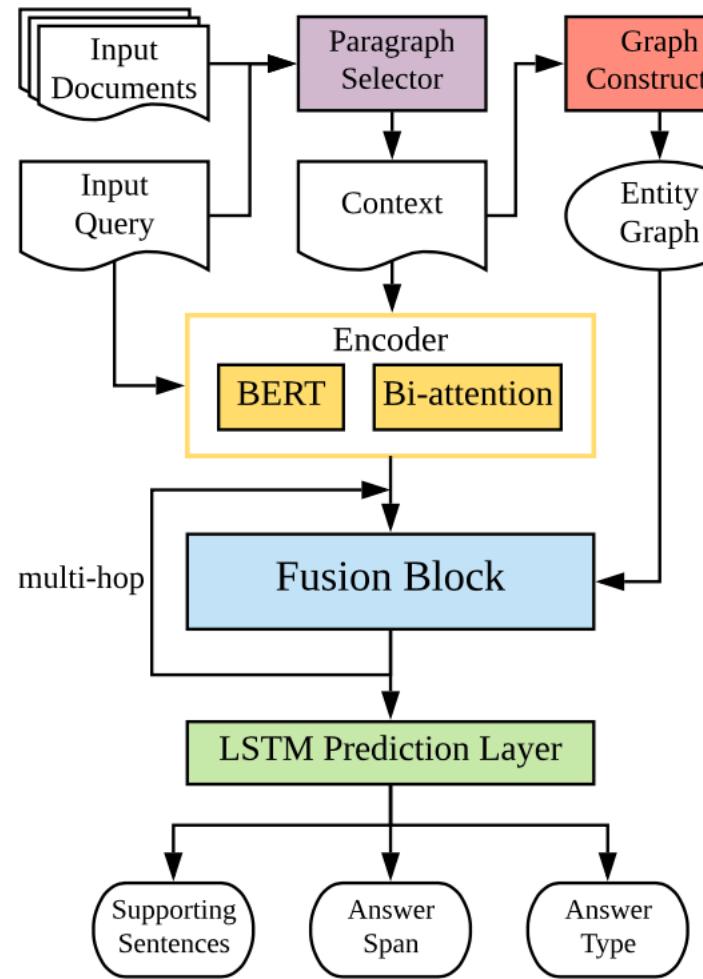


Question: What fiction character created by Tom Clancy was turned into a film in 2002?

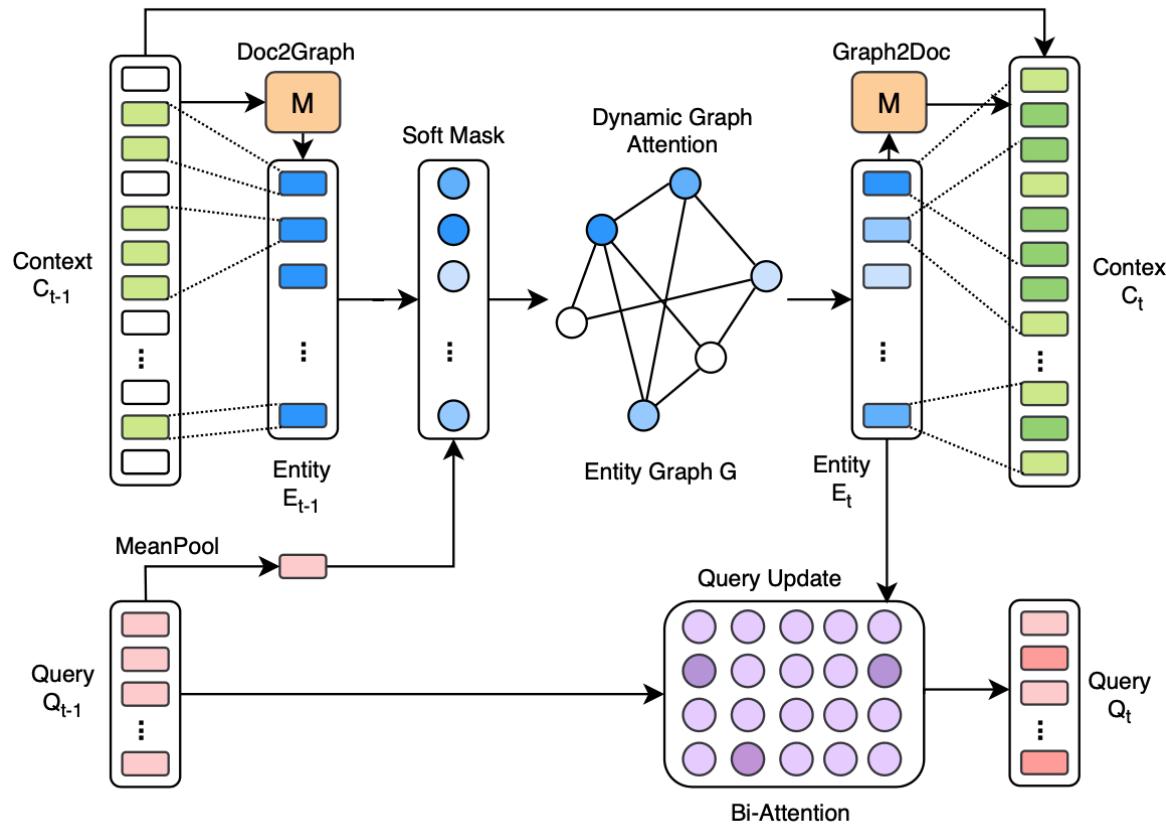
Answer: Jack Ryan



Dynamically Fused Graph Network for Multi-hop Reasoning ACL 2019



Dynamically Fused Graph Network for Multi-hop Reasoning ACL 2019

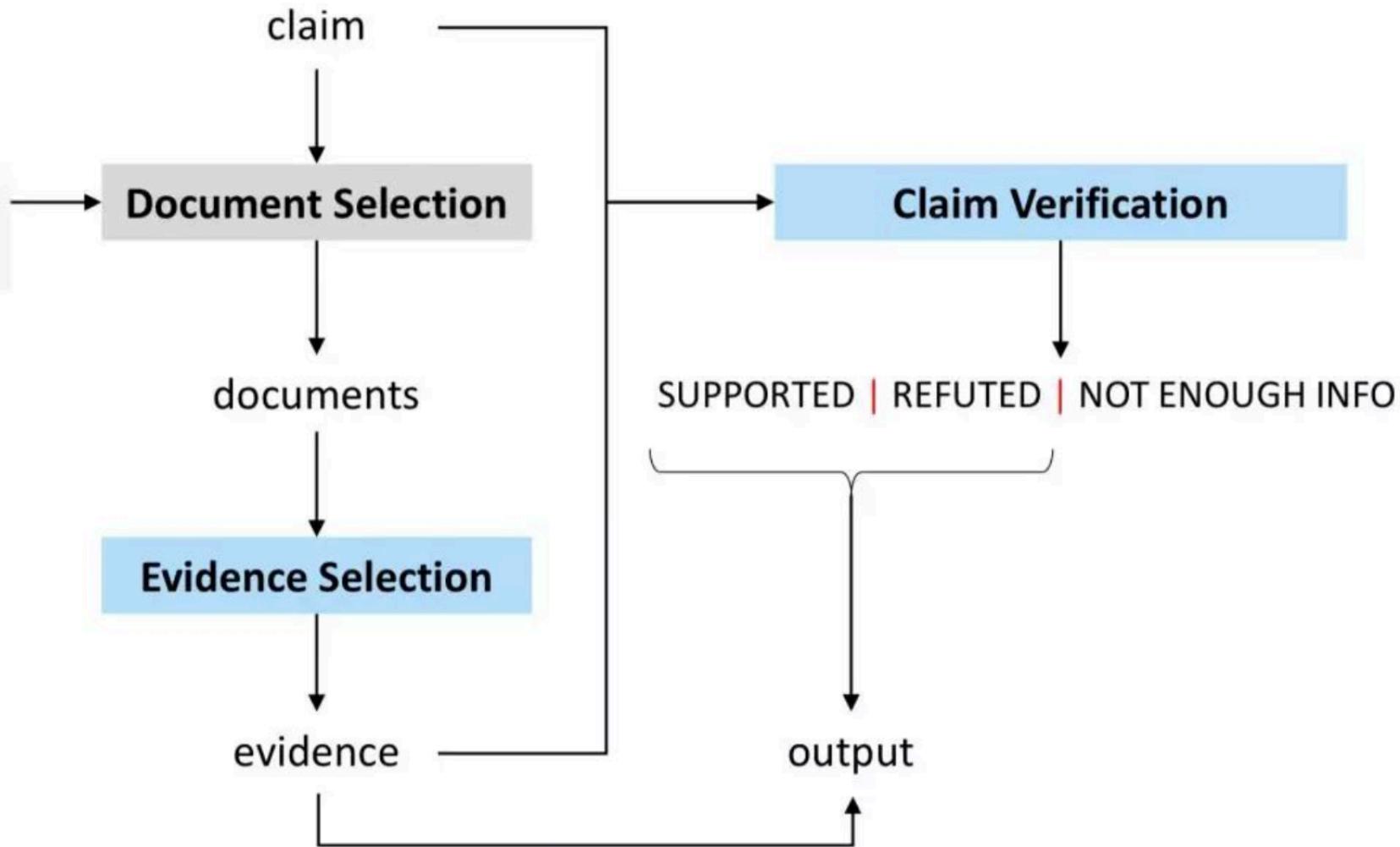


Reasoning Over Semantic-Level Graph for Fact Checking AAAI 2020

What is Fact Checking ?

Claim	The Rodney King riots took place in the most populous county in the USA.
Evidence #1	The 1992 Los Angeles riots, also known as the Rodney King riots were a series of riots, lootings, arsons, and civil disturbances that occurred in Los Angeles County, California in April and May 1992.
Evidence #2	Los Angeles County, officially the County of Los Angeles, is the most populous county in the USA.
Verdict	Supported

Reasoning Over Semantic-Level Graph for Fact Checking AAAI 2020

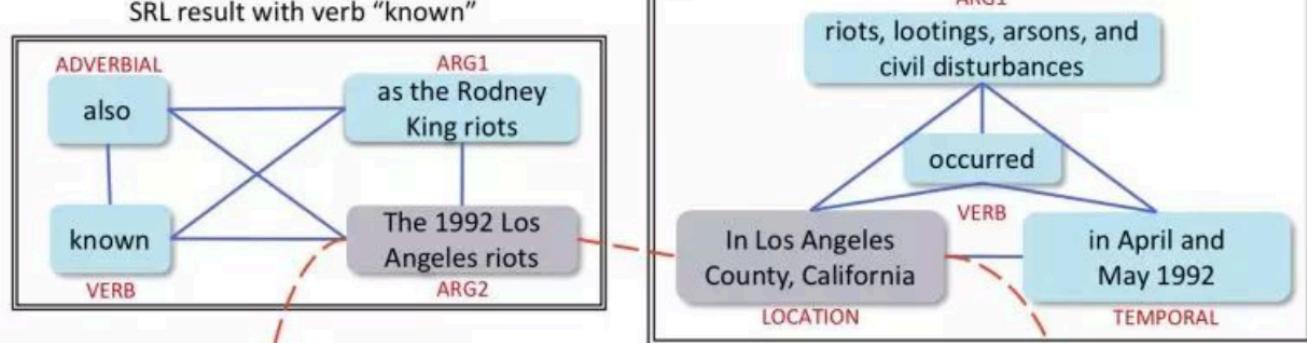


Reasoning Over Semantic-Level Graph for Fact Checking AAAI 2020

Evidence #1

The 1992 Los Angeles riots, also known as the Rodney King riots were a series of riots, lootings, arsons, and civil disturbances that occurred in Los Angeles County, California in April and May 1992

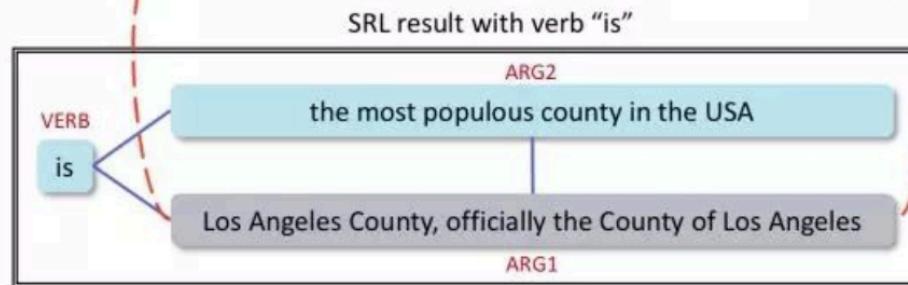
SRL



Evidence #2

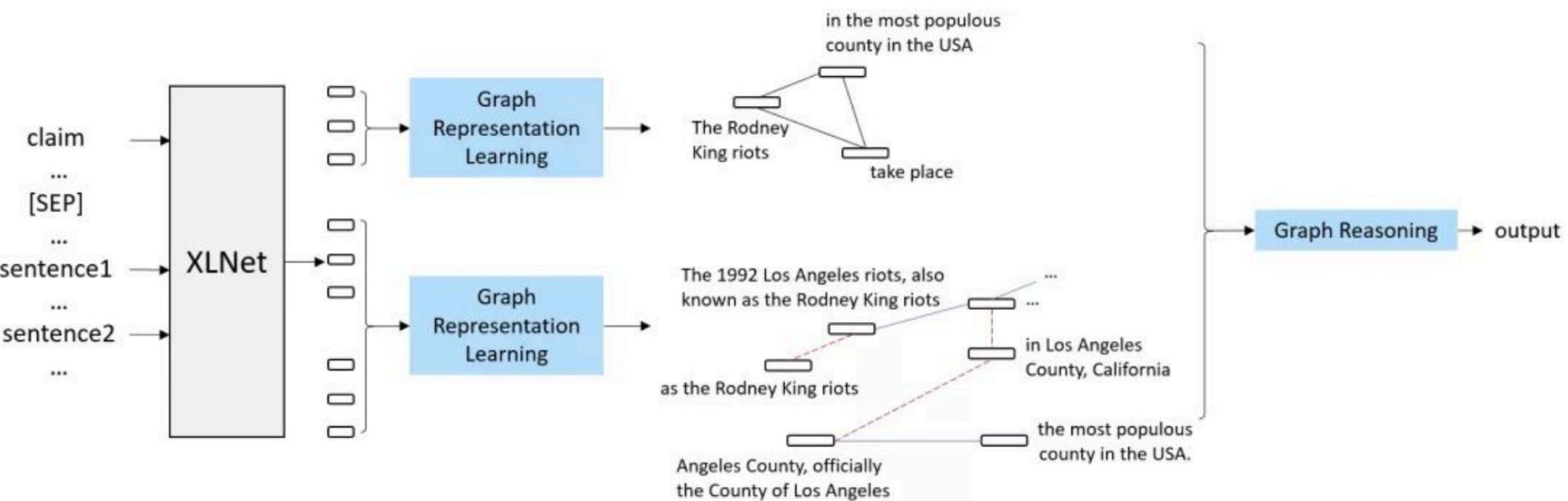
Los Angeles County, officially the County of Los Angeles, is the most populous county in the USA.

SRL

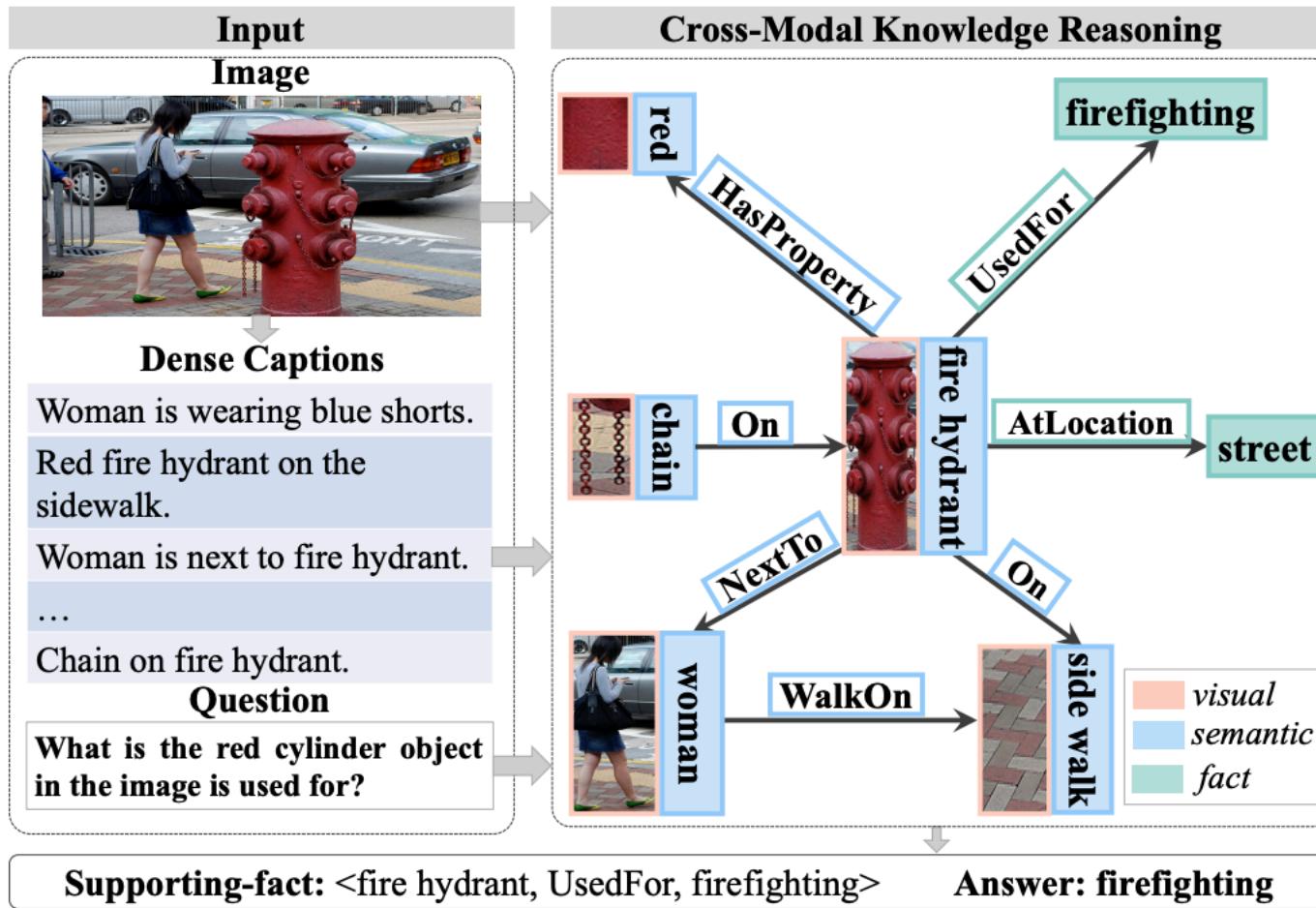


semantic role labeling

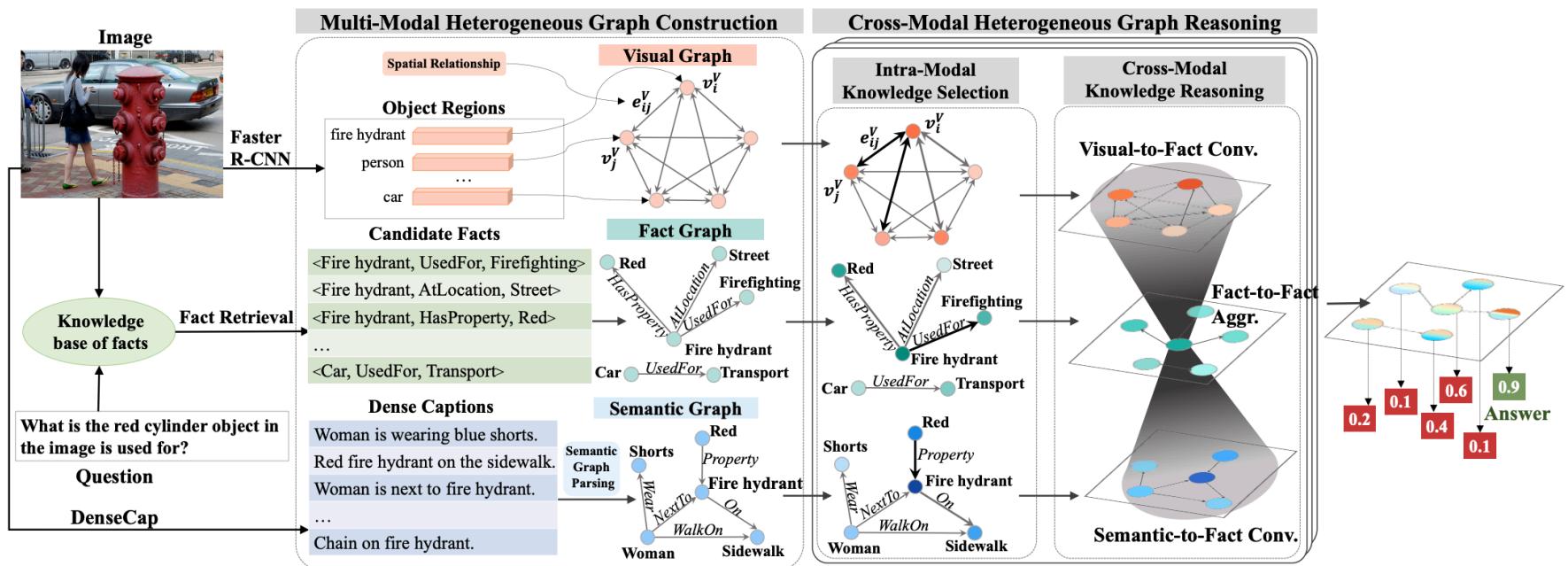
Reasoning Over Semantic-Level Graph for Fact Checking AAAI 2020



Mucko: Multi-Layer Cross-Modal Knowledge Reasoning for Fact-based Visual Question Answering (IJCAI 2020)

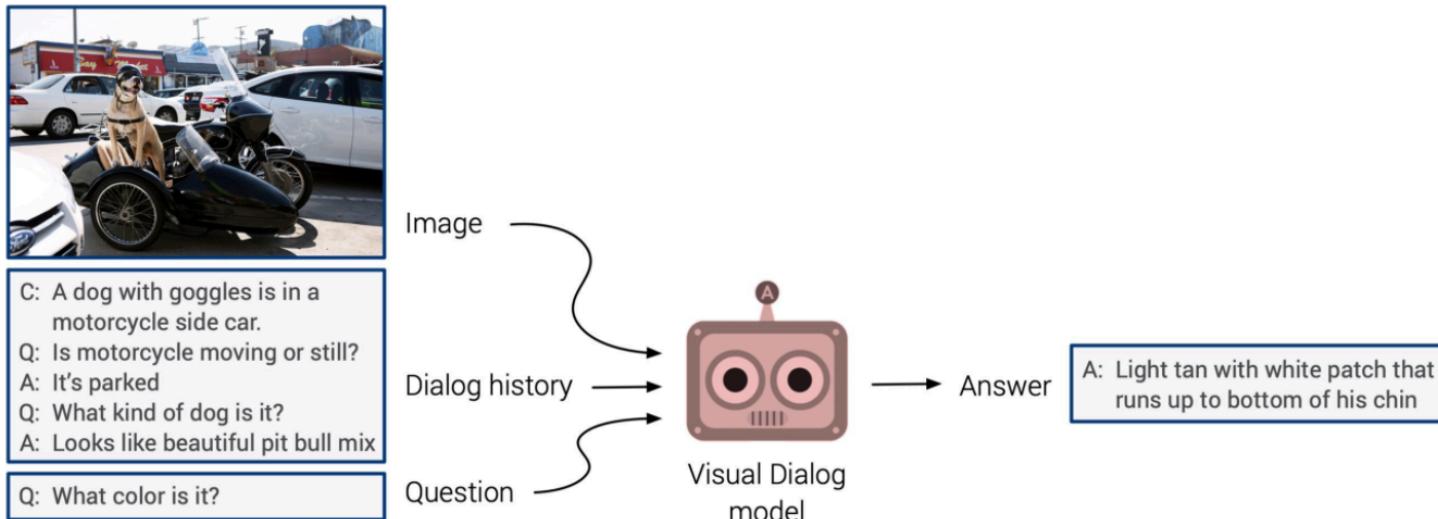


Mucko: Multi-Layer Cross-Modal Knowledge Reasoning for Fact-based Visual Question Answering (IJCAI 2020)



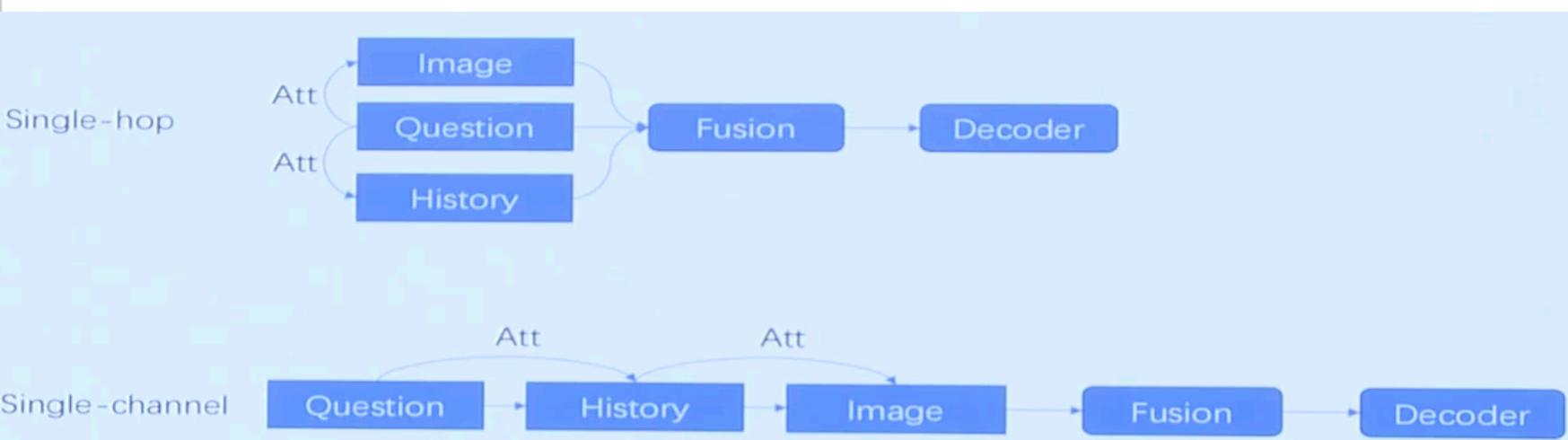
DMRM: A Dual-channel Multi-hop Reasoning Model for Visual Dialog AAAI 2020

What is Visual Dialog?

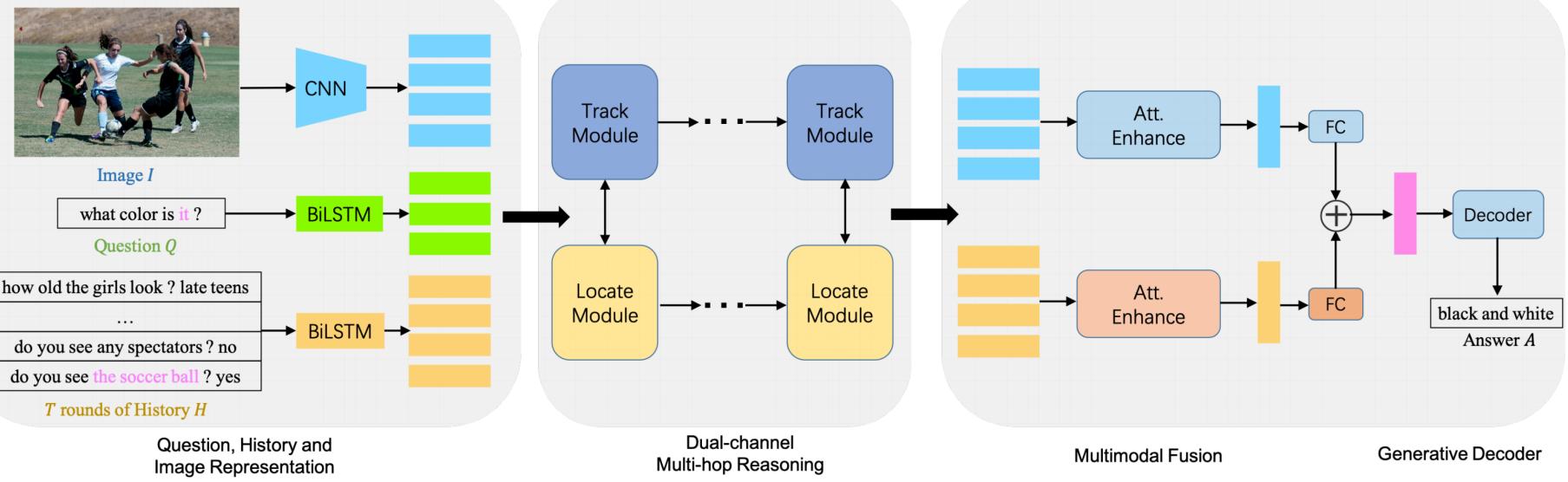


Visual Dialog requires an AI agent to hold a meaningful dialog with humans in natural, conversational language about visual content. Specifically, given an image, a dialog history, and a follow-up question about the image, the task is to answer the question.

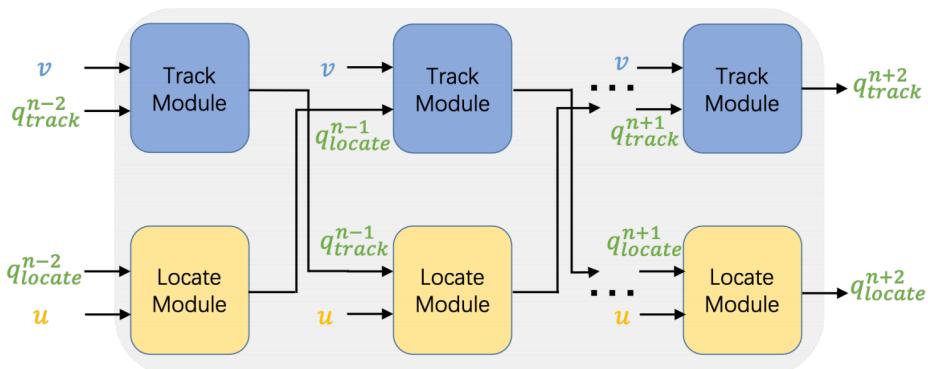
<https://visualdialog.org/>



DMRM: A Dual-channel Multi-hop Reasoning Model for Visual Dialog AAAI 2020



DMRM: A Dual-channel Multi-hop Reasoning Model for Visual Dialog AAAI 2020



All q at different hops denote different query features, v denotes the image features and u denotes the dialog history features.

$$\begin{aligned} S &= f_{track}^q(q_{track}) \circ f_{track}^v(v), \\ \alpha &= \text{softmax}(W^S S + b^S), \end{aligned}$$

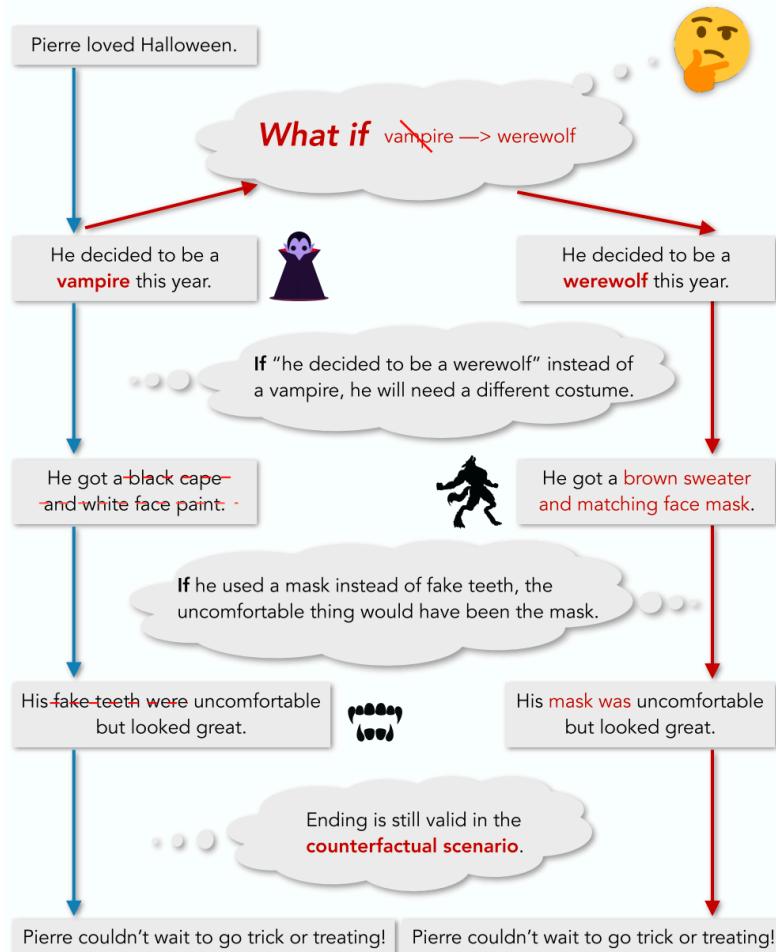
$$q_{track}^{out} = \sum_{j=1}^K \alpha_j v_j.$$

- step 1 : $\text{Track}(q, v) \rightarrow q_{track}^1;$
- step 2 : $\text{Locate}(q_{track}^1, u) \rightarrow q_{track}^2;$
- step 3 : $\text{Track}(q_{track}^2, v) \rightarrow q_{track}^3;$
...
- step n : $\text{Track}(q_{track}^{n-1}, v) \rightarrow q_{track}^n.$

The reasoning pathway $H_1 \rightarrow I_2 \rightarrow H_3 \dots \rightarrow H_n$ includes the following steps:

- step 1 : $\text{Locate}(q, u) \rightarrow q_{locate}^1;$
- step 2 : $\text{Track}(q_{locate}^1, v) \rightarrow q_{locate}^2;$
- step 3 : $\text{Locate}(q_{locate}^2, u) \rightarrow q_{locate}^3;$
...
- step n : $\text{Locate}(q_{locate}^{n-1}, u) \rightarrow q_{locate}^n.$

Counterfactual Story Reasoning and Generation EMNLP 2019



We present TIMETRAVEL, a new dataset of 29,849 counterfactual rewritings, each with the original story, a counterfactual event, and human-generated revision of the original story compatible with the counterfactual event. Additionally, we include 80,115 counterfactual “branches” without a rewritten storyline to support future work on semi- or un-supervised approaches to counterfactual story rewriting.

The modified parts in the new story (right column) are highlighted in red.

Counterfactual Story Reasoning and Generation EMNLP 2019

Data from ROCStories

Premise:

- 1) Jaris wanted to pick some wildflowers for his vase.

Initial:

- 2) He went to the state park.

Original Ending:

- 3) He picked many kinds of flowers.
- 4) Little did Jaris realize that it was a national park.
- 5) Jaris got in trouble and apologized profusely.

Data Collection



Step1 - Workers Produce a Counterfactual given original story
(One counterfactual for 98,159 examples)

2') He went to the local playground area.



Step2 - Workers Edit Ending given the above
(One ending for 16,752 training examples
Three endings for 1,871 dev examples
Four endings for 1,871 test examples)

3') He picked many kinds of flowers.
4') Little did Jaris realize that he was trespassing on private property.
5') Jaris got in trouble and apologized profusely.

Task Flow

Input:

Premise + Initial + Original Ending
+ Counterfactual



Output:

- 3') He found a very large bush of wildflowers.
- 4') He picked them up with his hands.
- 5') He carried them home and planted them in his vase.

Counterfactual Story Reasoning and Generation EMNLP 2019

Fine-tuning (FT)

$$\mathcal{L}^{ft}(\boldsymbol{\theta}) = \log p_{\boldsymbol{\theta}}(S), \quad (1)$$

Fine-tuning + Counterfactual (FT + CF)

$$\mathcal{L}^{cf}(\boldsymbol{\theta}) = \log p_{\boldsymbol{\theta}}(\mathbf{s}'_2 | \mathbf{s}_1), \quad (2)$$

$$\mathcal{L}^{ft+cf}(\boldsymbol{\theta}) = \mathcal{L}^{ft} + \mathcal{L}^{cf}, \quad (3)$$