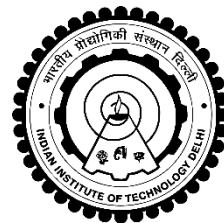


# Knowledge-Guided Linguistic Rewrites (KGLR) for Inference Rule Verification

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India



***(X, be wounded in, Y)***

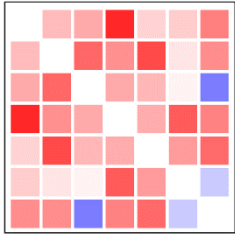
***(X, be killed in, Y)***

**Inference  
Rule  
Corpus**

***(X, make a note of, Y)***

***(X, write down, Y)***

## Statistical Co-occurrence



(Schoenmackers et al., 2010)

## Textual Patterns

Y such as X ((, X)\* (, and|or) X)  
such Y as X  
Y including X  
X and other Y

(Hearst et al., 1992)

*(X, be wounded in, Y)*    *(X, be killed in, Y)*

Inference  
Rule  
Corpus

Low precision

*(X, make a note of, Y)*    *(X, write down, Y)*

## Knowledge Sources

**WordNet**

(Fellbaum, 1998)

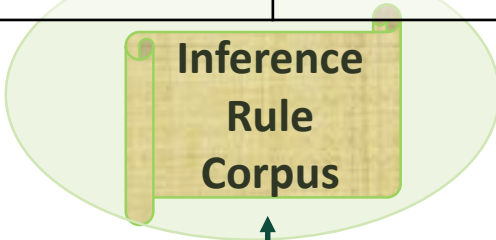
## Foreign Language Translations



Paraphrase.org

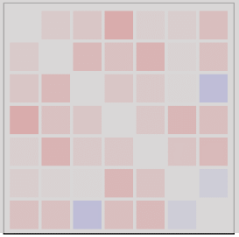
(Pavlick et al., 2015)

(X, make a note of, Y) (X, write down, Y)



**Linguistic Rules (KGLR)**

Statistical Co-occurrence



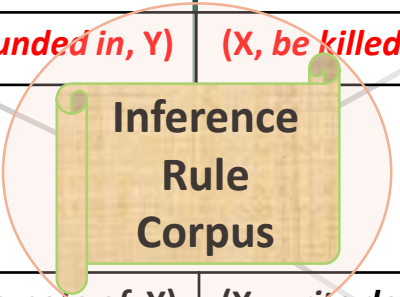
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Knowledge Sources



(Fellbaum, 1998)

Foreign Language Translations



(Pavlick et al., 2015)

<b>Antecedent</b>	<b>Consequent</b>
<i>(X, offer wide range of, Y)</i>	<i>(X, offer variety of, Y)</i>
<i>(X, make a note of, Y)</i>	<i>(X, write down, Y)</i>
<i>(X, make full use of, Y)</i>	<i>(Y, be used by, X)</i>
<i>(X, be wounded in, Y)</i>	<i>(X, be killed in, Y)</i>
<i>(X, be director of, Y)</i>	<i>(X, be vice president of, Y)</i>
<i>(X, be a student at, Y)</i>	<i>(X, be enrolled at, Y)</i>

***KGLR***



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***KGLR***



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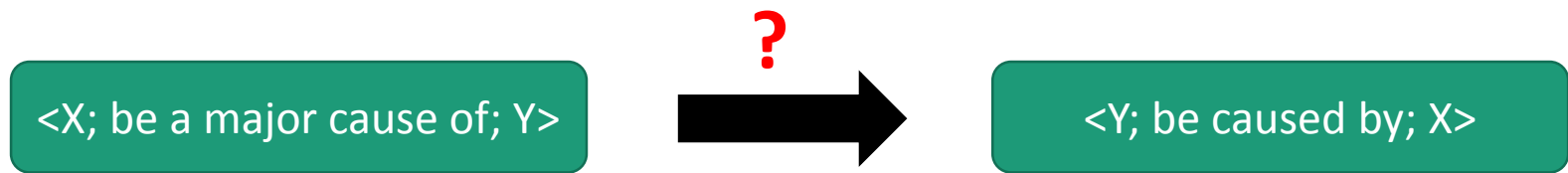
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***KGLR***



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# To verify






# Operators: Knowledge-guided Linguistic Rewrites (KGLR)

<b>Deverbal Nouns</b>	<b>WordNet</b>
direct; be the director of	
be president of; chair	





  

<b>Light Verbs &amp; Serial Verbs</b>	
help protect → protect	
take a look at → look at	

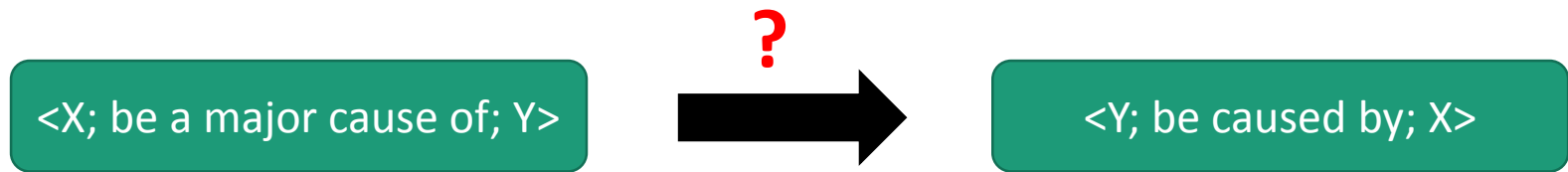
  

<b>Wordnet Hypernyms</b>	<b>WordNet</b>
be the highlight of → be a component of	
audition for → perform for	

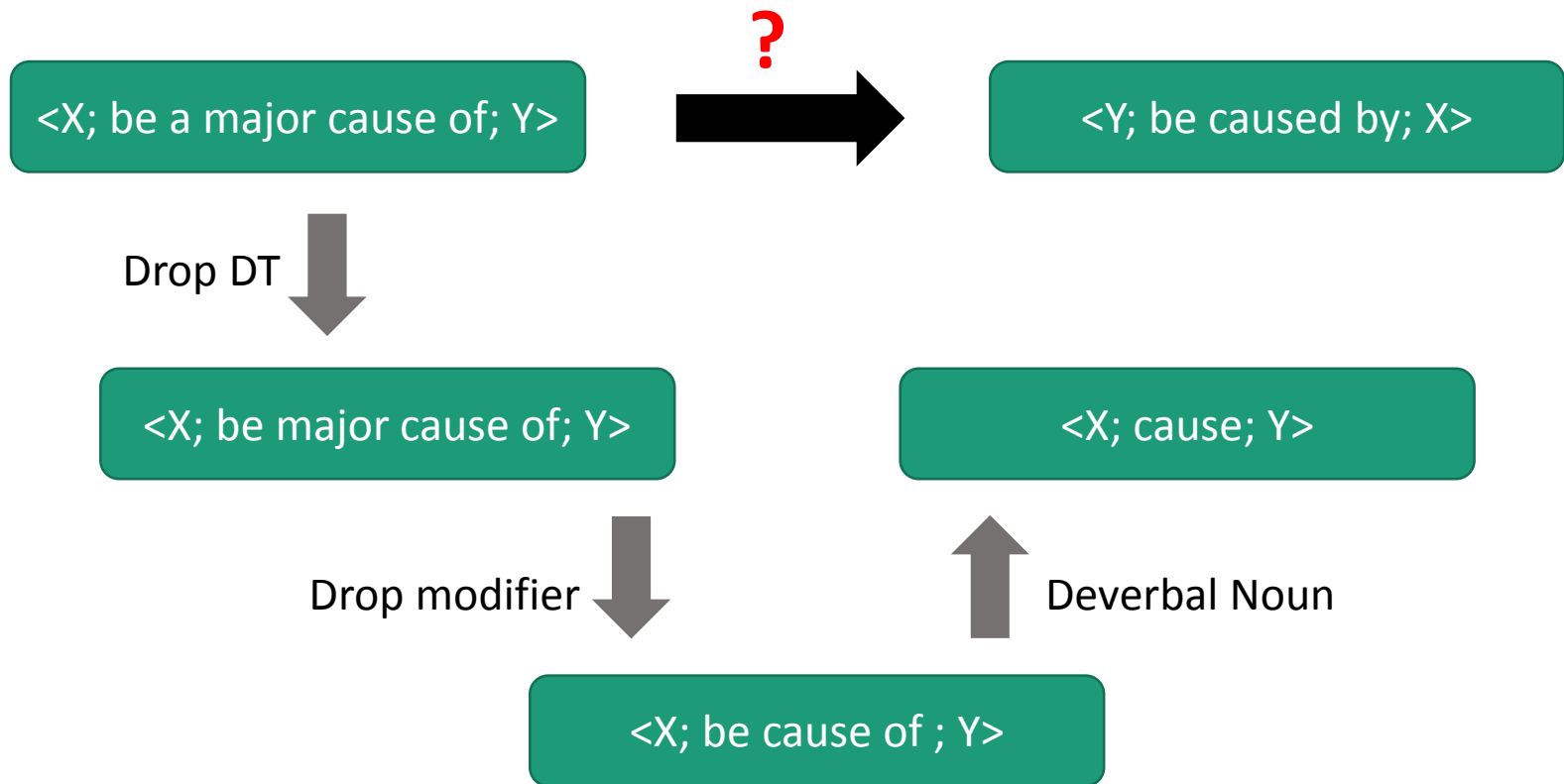
# Operators: Knowledge-guided Linguistic Rewrites (KGLR)

<b>Gerund-Infinitive Equivalence</b>	<b>WordNet</b>
start to drink → start drinking	
<b>Redundant Prepositions</b>	
<X; be absorbed in; Y> → <Y; absorbs; X>	
<b>Thesaurus Synonyms</b>	
provide a wide variety of → offer a vast variety of	
<b>Preposition Synonyms</b>	
translated into → translated to	
<b>'be'-words and Determiners</b>	
<i>be</i> sick of → tire of	
be <i>all</i> about → be about	
<b>Dropping adjectives/adverbs/superlatives</b>	<b>WordNet</b> 
<b>Active Passive</b>	<b>WordNet</b>

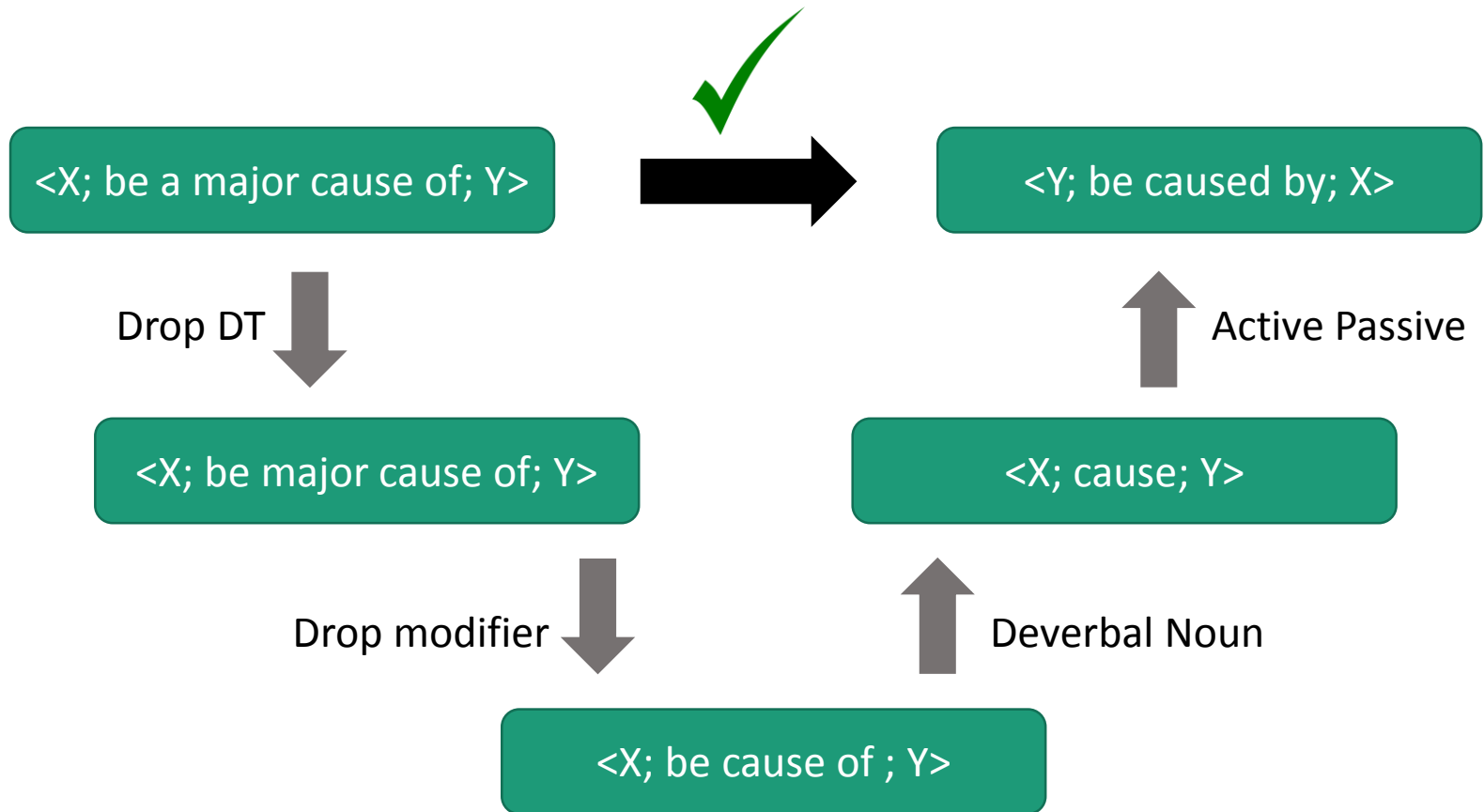
# To verify



# Verification chain

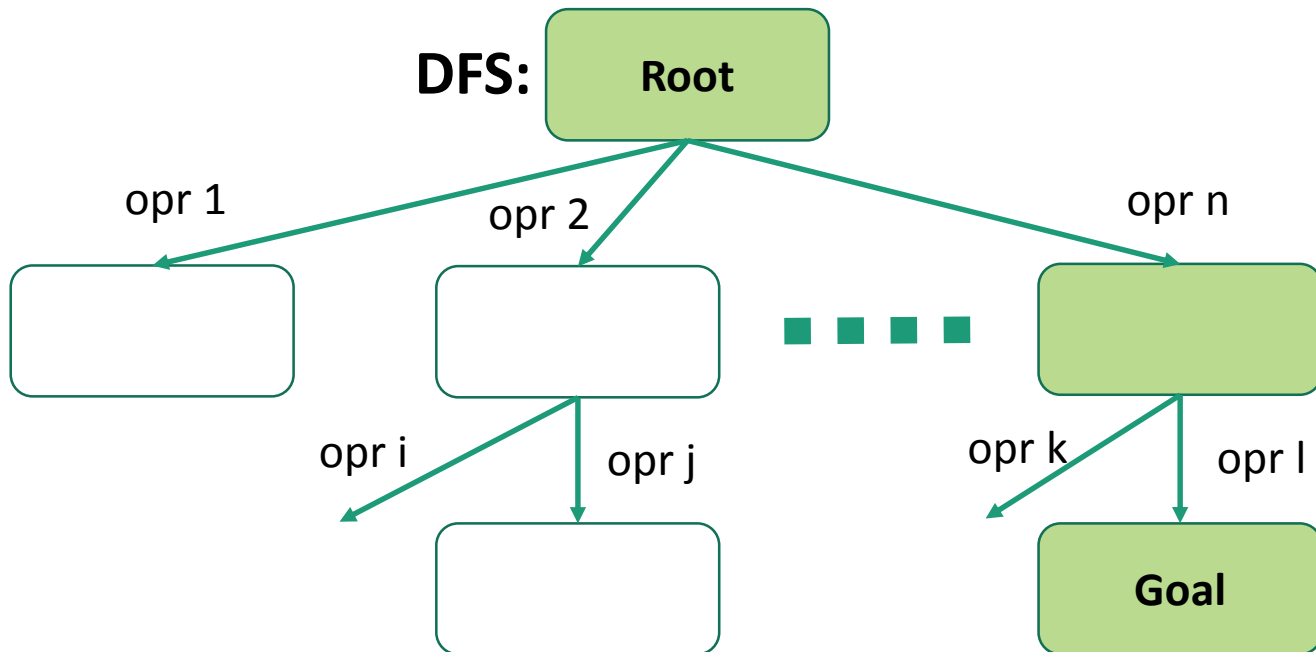


# Verification chain



# Finding Verification Chain

**Rule:**  $\text{relation}_1 \xrightarrow{\checkmark} \text{relation}_2$



# Experiments



## Metric

Precision of rules

Precision of generated facts

## Datasets

PPDB <sub>e</sub> (Pavlick et al., 2015)	CLEAN (Berant et al., 2012)
Confidence score w/t rule	<b>No</b> Confidence score w/t rule
80% of PPDB <sub>e</sub> relation phrases are of length 1 or 2	50% of CLEAN relation phrases are of length $\geq 3$

# Performance: Inference rules & Inferred facts

System	PPDB <sub>e</sub> (0.342)	KGLR(PPDB <sub>e</sub> ) = VPPDB <sub>e</sub>
Size	85,272	85,261
Rule Precision	44.2%	71.4%
Rule Yield	37,690	60,876
Fact Precision	22.2%	51.3%
Fact Yield	41 million	35 million



# Performance: Inference rules & Inferred facts

<b>System</b>	<b>CLEAN</b>	<b>KGLR(CLEAN) = VCLEAN</b>
Size	102,565	36,229
Rule Precision	48.9%	82.5%
Rule Yield	50,154	29,889
Fact Precision	49.1%	81.6%
Fact Yield	7 million	4.5 million

(Berant et al., 2012)

# Summary

## Knowledge-Guided Linguistic Rewrites

Independent rule verification

Compositional

Guided by existing knowledge sources

😊 High precision

☹️ No rule to capture common sense knowledge

Antecedent	Consequent	Y/N?
(X, be a student at, Y)	(X, be enrolled at, Y)	N

Code & Data: <https://github.com/dair-iitd/kglr>

# Thank You

<https://github.com/dair-iitd/kglr>



**Bloomberg**

