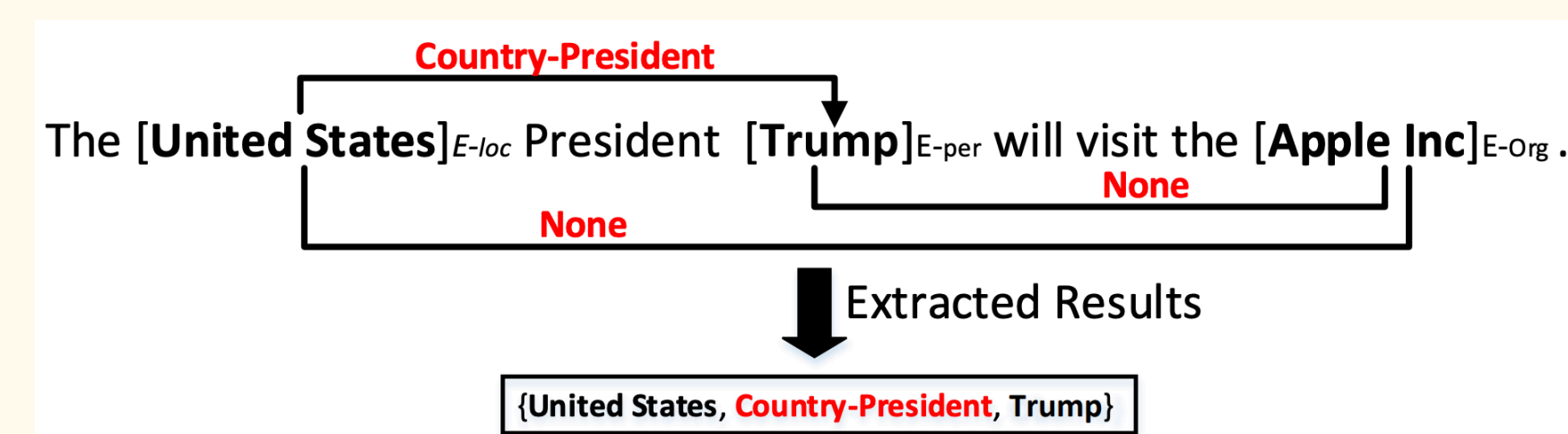


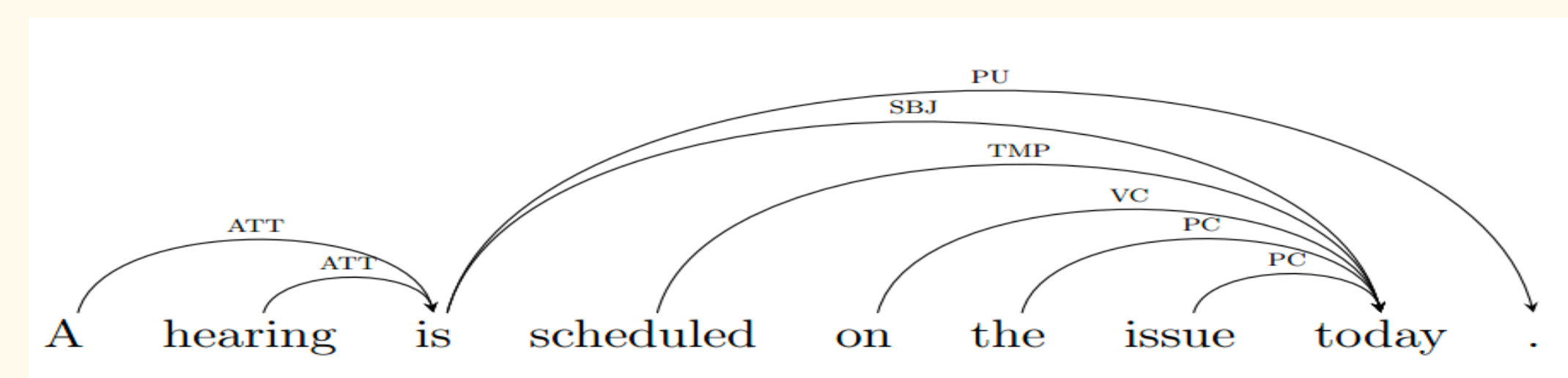
## Abstract

We present **GraphRel**, an end-to-end relation extraction model which uses GCN to jointly learn named entities and relations. **Linear and dependency structures** are used to extract both sequential and regional features of the text. We then consider **the interaction between named entities and relations** via a 2nd-phase relation-weighted GCN to better extract relations. Results show that GraphRel **maintains high precision while increasing recall** substantially on both NYT and WebNLG dataset.

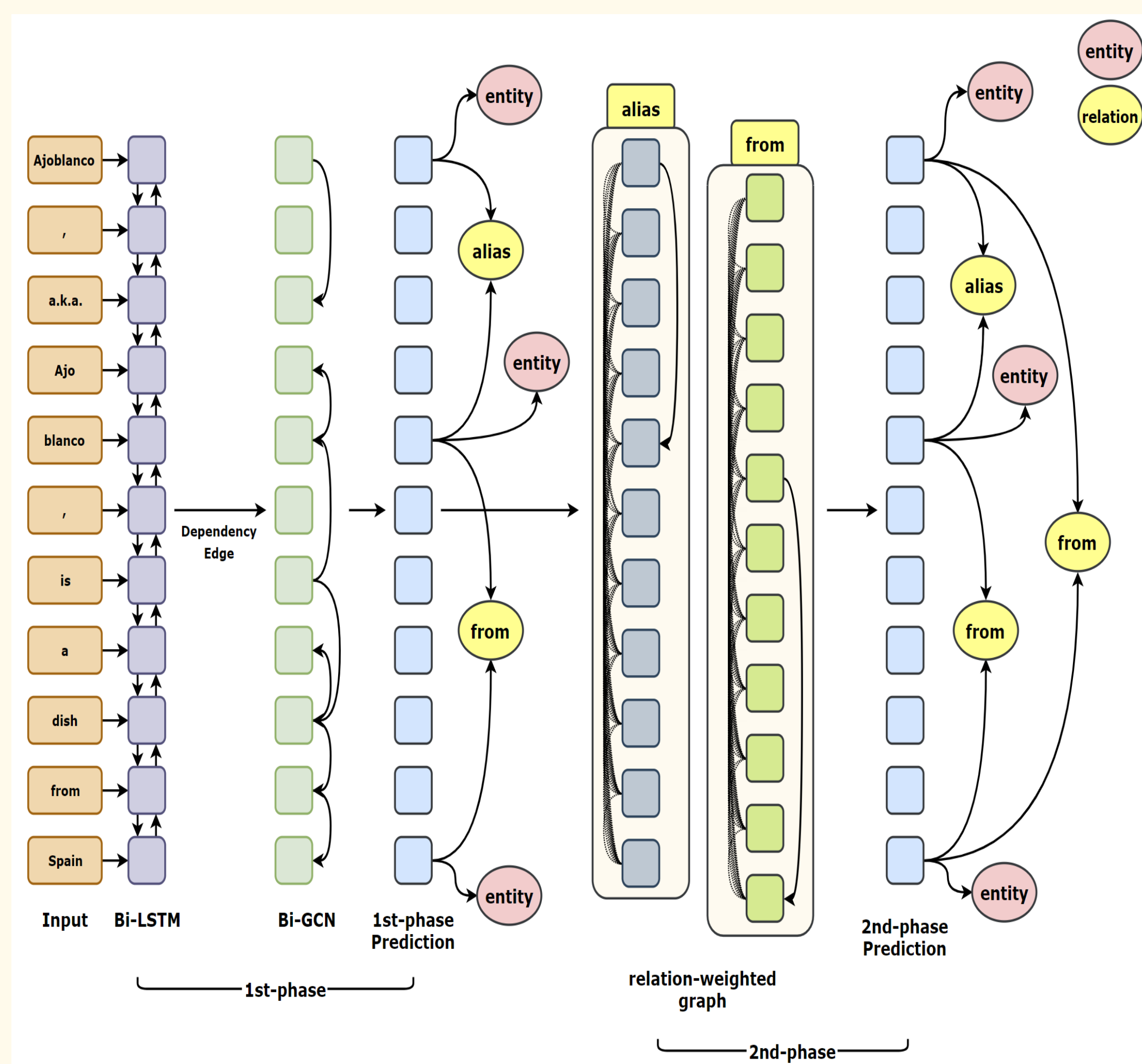
## joint extraction of NER and RE



## dependency parsing



## Model

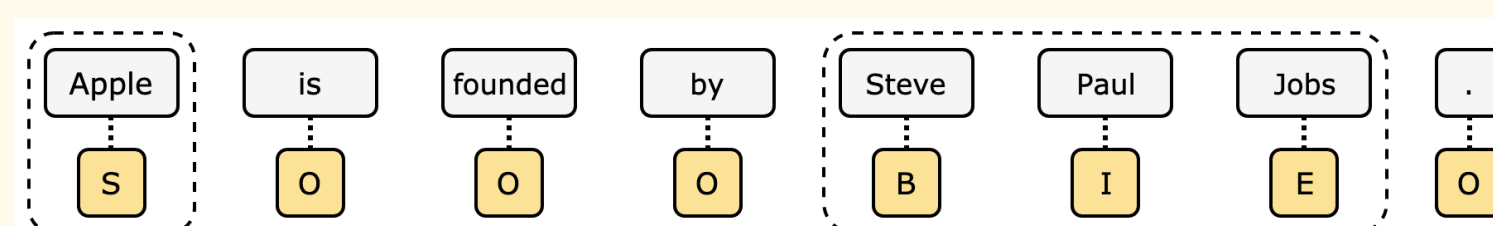


## 1st-phase

- Given a **text sequence**
- Bi-LSTM** to model linear
- Bi-GCN** to model dependency

$$h_u^{l+1} = \text{ReLU} \left( \sum_{v \in N(u)} (W^l h_v^l + b^l) \right)$$

- Predict entity** of each word

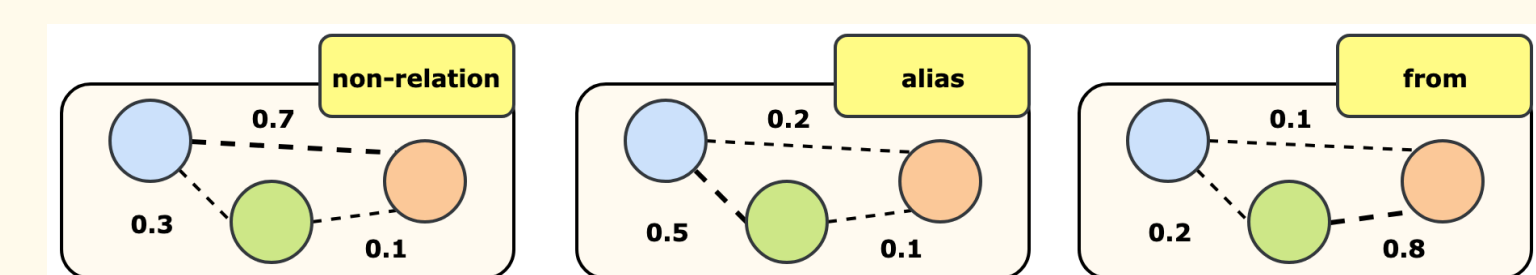


- Predict relation** of word-pair

$$S_{(w1,r,w2)} = W_r^3 \text{ReLU} (W_r^1 h_{w1} \oplus W_r^2 h_{w2})$$

## 2nd-phase

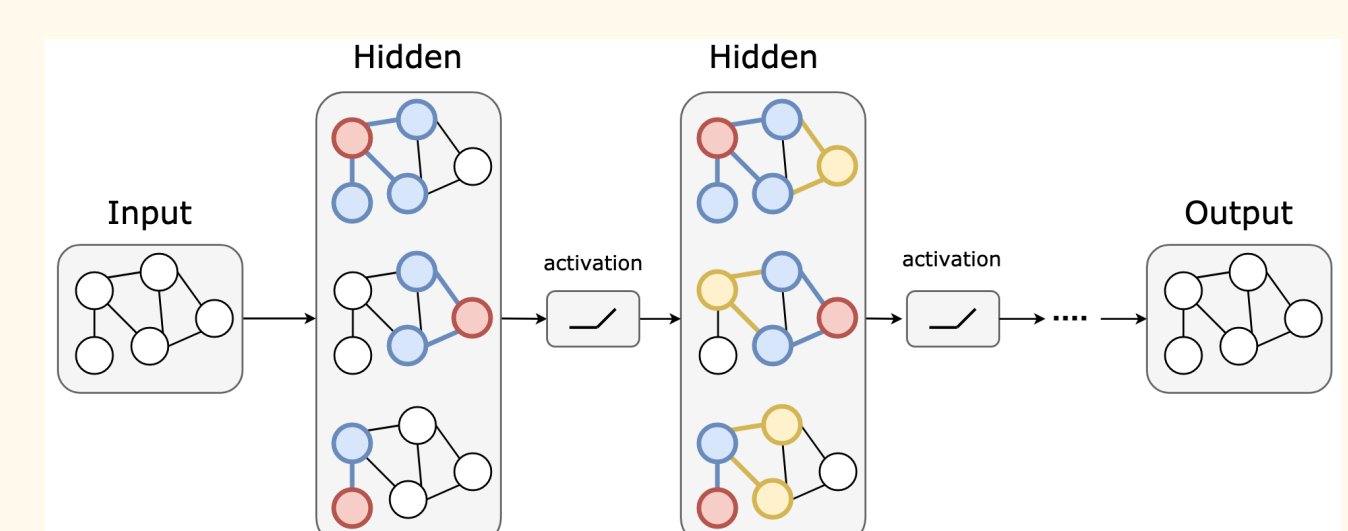
- With **relation-weighted graph** from 1p



- Aggregate features by **relation type** and **strength**

$$h_u^{l+1} = \text{ReLU} \left( \sum_{v \in V} \sum_{r \in R} P_r(u, v) \times (W_r^l h_v^l + b_r^l) \right) + h_u^l$$

## GCN



## Experiment

### NYT (#24)

Method	P	R	F1	NER
NovelTag	62.4%	31.7%	42.0%	-
CopyRE	61.0%	56.6%	58.7%	-
GraphRel <sub>1p</sub>	62.9%	57.3%	60.0%	88.8%
GraphRel <sub>2p</sub>	<b>63.9%</b>	<b>60.0%</b>	<b>61.9%</b>	<b>89.2%</b>

### WebNLG (#246)

P	R	F1	NER
<b>52.5%</b>	19.3%	28.3%	-
37.7%	36.4%	37.1%	-
42.3%	39.2%	40.7%	89.1%
44.7%	<b>41.1%</b>	<b>42.9%</b>	<b>91.9%</b>

### Different #GCN

Phase	# GCN	NYT	WebNLG
1-Phase	3 (2)	60.0% (60.0%)	40.5% (40.7%)
2-Phase	2 (1)	61.6% <b>(61.9%)</b>	42.4% <b>(42.9%)</b>
3-Phase	1	61.8%	42.7%

### Case Study

Sentence	GraphRel <sub>1p</sub>	GraphRel <sub>2p</sub>
In <b>Italy</b> , the capital is <b>Rome</b> and <b>A.S. Gubbio 1910</b> is located there.	(Italy, captical, Rome)	(Italy, captical, Rome) (A.S. Gubbio 1910, ground, Italy)
Water is an ingredient in <b>Ajoblanco</b> , also known as <b>Ajo blanco</b> , a dish that comes from Andalusia <b>Spain</b> .	(Ajoblanco, alias, Ajo blanco) (Ajo blanco, from, Spain)	(Ajoblanco, alias, Ajo blanco) (Ajo blanco, from, Spain) (Ajoblanco, from, Spain)

• please visit our paper for more analysis on different **entity types** and **decision thresholds**

