

# Lecture 15: Summarization

Alan Ritter

(many slides from Greg Durrett)

# This Lecture

---

- ▶ Extractive systems for multi-document summarization
- ▶ Extractive + compressive systems for single-document summarization
- ▶ Single-document summarization with neural networks

# Summarization

---

# Summarization



## Strong earthquake hits Iraq-Iran border area, six killed in Iran

Raya Jalabi, Ahmed Rasheed

3 MIN READ



BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

# Summarization



## Strong earthquake hits Iraq-Iran border area, six killed in Iran

Raya Jalabi, Ahmed Rasheed

3 MIN READ



BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.



 **The Indian EXPRESS**



[Nation](#) [World](#) [Cities](#) [Opinion](#) [Sports](#) [Entertainment](#) [Lifestyle](#) [Technology](#) [Viral](#) [Photos](#) [Videos](#) [ePaper](#) [Brand Solutions](#)

#SundayEye

Fantastic Drawings and Where To Find Them: A sneak peek into Jim Kay's 'Harry Potter' illustrations



[Home](#) > [World](#) > [Live updates- Earthquake of 7.3 magnitude strikes near Iraq-Iran border: Six dead, several injured](#)

## Live updates- Earthquake of 7.3 magnitude strikes near Iraq-Iran border: Six dead, several injured

The quake was even felt in the Iranian capital Tehran, with some villages hit by power cuts, Iranian state TV reported.

# Summarization



## Strong earthquake hits northern Iraq and the capital Baghdad on Sunday, six killed in Iran

Raya Jalabi, Ahmed Rasheed

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit northern Iraq and the capital Baghdad on Sunday, killing six people in Iran and injuring several others in Iraq. The quake, which had a magnitude of 7.3, was felt throughout the region and caused significant damage to buildings and infrastructure. At least six people were killed in Iran, and several others were injured in Iraq. The earthquake centered about 217 miles from Baghdad.



## Powerful earthquake strikes near Iraqi city of Halabja

By Darran Simon, CNN  
Updated 3:11 PM ET, Sun November 12, 2017

### Story highlights

The 7.3 tremor was felt throughout Iraq

The earthquake centered about 217 miles from Baghdad

available.

**(CNN)** — A magnitude 7.3 earthquake has hit near the Iraqi city of Halabja close to the Iraq-Iran border, according the [US Geological Survey](#).

The temblor, centered about 350 kilometers (217 miles) north of Baghdad, was felt throughout Iraq, USGS said. The extent of any damage was not immediately



Photos Videos ePaper Brand Solutions

Jim Kay's 'Harry Potter' illustrations



Several injured

## f 7.3 magnitude er: Six dead,

villages hit by power cuts, Iranian



# Summarization



## Strong earthquake hits northern Iraq and the capital Baghdad on Sunday, six killed in Iran

Raya Jalabi, Ahmed Rasheed

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit northern Iraq and the capital Baghdad on Sunday, killing six people in Iran and injuring several others in Iraq. The quake, which was felt throughout the region, struck near the border between the two countries.



*The Indian* **EXPRESS**



World » Africa | Americas | Asia | Europe | Middle East

Live TV

U.S. Edition +



## Powerful earthquake strikes near Iraqi city of Halabja

By Darran Simon, CNN

Updated 3:11 PM ET, Sun November 12, 2017

### Story highlights

The 7.3 tremor was felt throughout Iraq

The earthquake centered about 217 miles from Baghdad

available.

**(CNN)** — A magnitude 7.3 earthquake has hit near the Iraqi city of Halabja close to the Iraq-Iran border, according the [US Geological Survey](#).

The temblor, centered about 350 kilometers (217 miles) north of Baghdad, was felt throughout Iraq, USGS said. The extent of any damage was not immediately



Photos Videos ePaper **Brand Solutions**

Jim Kay's 'Harry Potter' illustrations



Several injured

## f 7.3 magnitude er: Six dead,

villages hit by power cuts, Iranian

► What makes a good summary?

# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...



# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...

# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...

# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...

# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...



# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...

# Summarization

---

BAGHDAD/ERBIL, Iraq (Reuters) - A strong earthquake hit large parts of northern Iraq and the capital Baghdad on Sunday, and also caused damage in villages across the border in Iran where state TV said at least six people had been killed.

There were no immediate reports of casualties in Iraq after the quake, whose epicenter was in Penjwin, in Sulaimaniyah province which is in the semi-autonomous Kurdistan region very close to the Iranian border, according to an Iraqi meteorology official.

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The US Geological Survey said the quake measured a magnitude of 7.3, while an Iraqi meteorology official put its magnitude at 6.5 according to preliminary information.

Many residents in the Iraqi capital Baghdad rushed out of houses and tall buildings in panic.

...



# Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.

The quake has been felt in several Iranian cities and eight villages have been damaged. Electricity has also been disrupted at many places, suggest few TV reports.

# Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.

The quake has been felt in several Iranian cities and eight villages have been damaged. Electricity has also been disrupted at many places, suggest few TV reports.

# Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.

The quake has been felt in several Iranian cities and **eight villages have been damaged.** Electricity has also been disrupted at many places, suggest few TV reports.

## Summary

A massive earthquake of magnitude 7.3 struck Iraq on Sunday. The epicenter was close to the Iranian border. Eight villages were damaged and six people were killed in Iran.

# Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.

The quake has been felt in several Iranian cities and eight villages have been damaged. Electricity has also been disrupted at many places, suggest few TV reports.

## Summary

A massive earthquake of magnitude 7.3 struck Iraq on Sunday. The epicenter was close to the Iranian border. Eight villages were damaged and six people were killed in Iran.

# What makes a good summary?

---

## Summary

A strong earthquake of magnitude 7.3 struck Iraq and Iran on Sunday. The epicenter was close to the Iranian border. Eight villages were damaged and six people were killed in Iran.

# What makes a good summary?

---

## Summary

A strong earthquake of magnitude 7.3 struck Iraq and Iran on Sunday. The epicenter was close to the Iranian border. Eight villages were damaged and six people were killed in Iran.

- ▶ Content selection: pick the right content
  - ▶ Right content was repeated within and across documents
  - ▶ Domain-specific (magnitude + epicenter of earthquakes are important)



# What makes a good summary?

---

## Summary

A strong earthquake of magnitude 7.3 struck Iraq and Iran on Sunday. The epicenter was close to the Iranian border. Eight villages were damaged and six people were killed in Iran.

- ▶ Content selection: pick the right content
  - ▶ Right content was repeated within and across documents
  - ▶ Domain-specific (magnitude + epicenter of earthquakes are important)
- ▶ Generation: write the summary
  - ▶ Extraction: pick whole sentences from the summary
  - ▶ Compression: compress those sentences but basically just do deletion
  - ▶ Abstraction: rewrite + reexpress content freely

# Extractive Summarization

# Extractive Summarization: MMR

---

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary

# Extractive Summarization: MMR

---

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

# Extractive Summarization: MMR

---

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

While summary is  $< k$  words

# Extractive Summarization: MMR

---

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

While summary is  $< k$  words

$$\text{Calculate } MMR \stackrel{\text{def}}{=} \text{Arg} \max_{D_i \in R \setminus S} \left[ \lambda (Sim_1(D_i, Q)) - (1 - \lambda) \max_{D_j \in S} Sim_2(D_i, D_j) \right]$$



# Extractive Summarization: MMR

---

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

While summary is  $< k$  words

Calculate  $MMR \stackrel{\text{def}}{=} \underset{D_i \in R \setminus S}{\text{Arg max}} \left[ \lambda (Sim_1(D_i, Q)) - (1 - \lambda) \max_{D_j \in S} Sim_2(D_i, D_j) \right]$

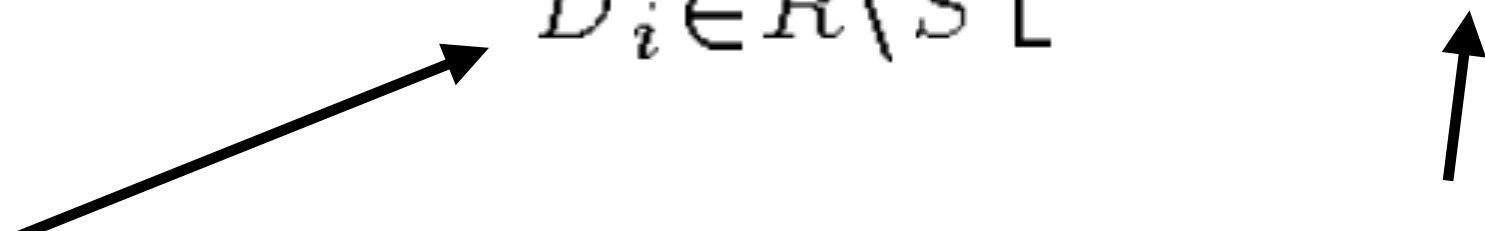
“max over all sentences  
not yet in the summary”

# Extractive Summarization: MMR

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

While summary is  $< k$  words

Calculate  $MMR \stackrel{\text{def}}{=} \underset{D_i \in R \setminus S}{\text{Arg max}} \left[ \lambda (Sim_1(D_i, Q)) - (1 - \lambda) \underset{D_j \in S}{\text{max}} Sim_2(D_i, D_j) \right]$



“max over all sentences  
not yet in the summary”

“make this sentence  
similar to a query”

# Extractive Summarization: MMR

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

While summary is  $< k$  words

Calculate  $MMR \stackrel{\text{def}}{=} \underset{D_i \in R \setminus S}{\text{Arg max}} \left[ \lambda (\underset{\uparrow}{\text{Sim}_1(D_i, Q)}) - (1 - \lambda) \underset{\uparrow}{\text{max}_{D_j \in S} \text{Sim}_2(D_i, D_j)} \right]$

“max over all sentences  
not yet in the summary”

“make this sentence  
similar to a query”

“make this sentence  
maximally different from  
all others added so far”

# Extractive Summarization: MMR

- ▶ Given some articles and a length budget of  $k$  words, pick some sentences of total length  $\leq k$  and make a summary
- ▶ Pick important yet diverse content: maximum marginal relevance (MMR)

While summary is  $< k$  words

Calculate  $MMR \stackrel{\text{def}}{=} \underset{D_i \in R \setminus S}{\text{Arg max}} \left[ \lambda (\underset{\uparrow}{\text{Sim}_1(D_i, Q)}) - (1 - \lambda) \underset{\uparrow}{\text{max}}_{D_j \in S} \text{Sim}_2(D_i, D_j) \right]$

“max over all sentences  
not yet in the summary”

“make this sentence  
similar to a query”

“make this sentence  
maximally different from  
all others added so far”

Add highest MMR sentence that doesn't overflow length

# Extractive Summarization: Centroid

---

- ▶ Represent the documents and each sentences as bag-of-words with TF-IDF weighting

# Extractive Summarization: Centroid

---

- ▶ Represent the documents and each sentences as bag-of-words with TF-IDF weighting

While summary is  $< k$  words



# Extractive Summarization: Centroid

---

- ▶ Represent the documents and each sentences as bag-of-words with TF-IDF weighting

While summary is  $< k$  words

Calculate  $\text{score}(\text{sentence}) = \text{cosine}(\text{sent-vec}, \text{doc-vec})$

# Extractive Summarization: Centroid

---

- ▶ Represent the documents and each sentences as bag-of-words with TF-IDF weighting

While summary is  $< k$  words

Calculate  $\text{score}(\text{sentence}) = \text{cosine}(\text{sent-vec}, \text{doc-vec})$

Discard all sentences whose similarity with some sentence already in the summary is too high

# Extractive Summarization: Centroid

---

- ▶ Represent the documents and each sentences as bag-of-words with TF-IDF weighting

While summary is  $< k$  words

Calculate  $\text{score}(\text{sentence}) = \text{cosine}(\text{sent-vec}, \text{doc-vec})$

Discard all sentences whose similarity with some sentence already in the summary is too high

Add the best remaining sentence that won't overflow the summary

# Extractive Summarization: Bigram Recall

---

- ▶ Count number of *documents* each bigram occurs in to measure importance

# Extractive Summarization: Bigram Recall

---

- ▶ Count number of *documents* each bigram occurs in to measure importance

$\text{score}(\textit{massive earthquake}) = 3$

$\text{score}(\textit{magnitude 7.3}) = 2$

$\text{score}(\textit{six killed}) = 2$

$\text{score}(\textit{Iraqi capital}) = 1$

# Extractive Summarization: Bigram Recall

---

- ▶ Count number of *documents* each bigram occurs in to measure importance

$\text{score}(\textit{massive earthquake}) = 3$

$\text{score}(\textit{magnitude 7.3}) = 2$

$\text{score}(\textit{six killed}) = 2$

$\text{score}(\textit{Iraqi capital}) = 1$

- ▶ Find summary that maximizes the score of bigrams it covers

# Extractive Summarization: Bigram Recall

---

- ▶ Count number of *documents* each bigram occurs in to measure importance

$\text{score}(\textit{massive earthquake}) = 3$                        $\text{score}(\textit{magnitude 7.3}) = 2$

$\text{score}(\textit{six killed}) = 2$                                        $\text{score}(\textit{Iraqi capital}) = 1$

- ▶ Find summary that maximizes the score of bigrams it covers
- ▶ ILP formulation:  $c$  and  $s$  are indicator variables indexed over bigrams (“concepts”) and sentences, respectively



# Extractive Summarization: Bigram Recall

---

- ▶ Count number of *documents* each bigram occurs in to measure importance

$\text{score}(\textit{massive earthquake}) = 3$                        $\text{score}(\textit{magnitude 7.3}) = 2$

$\text{score}(\textit{six killed}) = 2$                                        $\text{score}(\textit{Iraqi capital}) = 1$

- ▶ Find summary that maximizes the score of bigrams it covers
- ▶ ILP formulation:  $c$  and  $s$  are indicator variables indexed over bigrams (“concepts”) and sentences, respectively

$$\text{Maximize: } \sum_i w_i c_i$$

$$\text{Subject to: } \sum_j l_j s_j \leq L$$

sum of included sentences' lengths can't exceed  $L$

Gillick and Favre (2009)

# Extractive Summarization: Bigram Recall

- ▶ Count number of *documents* each bigram occurs in to measure importance

$\text{score}(\textit{massive earthquake}) = 3$        $\text{score}(\textit{magnitude 7.3}) = 2$

$\text{score}(\textit{six killed}) = 2$        $\text{score}(\textit{Iraqi capital}) = 1$

- ▶ Find summary that maximizes the score of bigrams it covers
- ▶ ILP formulation:  $c$  and  $s$  are indicator variables indexed over bigrams (“concepts”) and sentences, respectively

$$\begin{array}{ll} \text{Maximize: } \sum_i w_i c_i & s_j \text{Occ}_{ij} \leq c_i, \quad \forall i, j \\ \text{Subject to: } \sum_j l_j s_j \leq L & \sum_j s_j \text{Occ}_{ij} \geq c_i \quad \forall i \end{array}$$

“set  $c_i$  to 1 iff some sentence that contains it is included”

sum of included sentences’ lengths can’t exceed  $L$

Gillick and Favre (2009)

# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

A massive earthquake of magnitude 7.3 struck Iraq on Sunday

prediction

An earthquake was detected in Iraq on Sunday

reference

# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

~~A~~ massive earthquake ~~of~~ magnitude 7.3 struck Iraq ~~on~~ Sunday

prediction

~~An~~ earthquake ~~was~~ detected ~~in~~ Iraq ~~on~~ Sunday

reference

# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

~~A~~ massive earthquake ~~of~~ magnitude 7.3 struck Iraq ~~on~~ Sunday

prediction

~~An~~ earthquake ~~was~~ detected ~~in~~ Iraq ~~on~~ Sunday

reference

ROUGE 2 recall = 1 correct bigram (Iraq, Sunday) / 3 reference bigrams

# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

<del>A</del> massive earthquake <del>of</del> magnitude 7.3 struck Iraq <del>on</del> Sunday	prediction
<del>An</del> earthquake <del>was</del> detected <del>in</del> Iraq <del>on</del> Sunday	reference

ROUGE 2 recall = 1 correct bigram (Iraq, Sunday) / 3 reference bigrams

ROUGE 2 precision = 1 correct bigram (Iraq, Sunday) / 6 predicted bigrams



# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

<del>A</del> massive earthquake <del>of</del> magnitude 7.3 struck Iraq <del>on</del> Sunday	prediction
<del>An</del> earthquake <del>was</del> detected <del>in</del> Iraq <del>on</del> Sunday	reference

ROUGE 2 recall = 1 correct bigram (Iraq, Sunday) / 3 reference bigrams

ROUGE 2 precision = 1 correct bigram (Iraq, Sunday) / 6 predicted bigrams

- ▶ Many hyperparameters: stemming, remove stopwords, etc.

# Evaluation: ROUGE

---

- ▶ Rouge-n: n-gram precision/recall/F1 of summary w.r.t. gold standard
- ▶ Rouge-2 correlates well with human judgments for multi-document summarization tasks

<del>A</del> massive earthquake <del>of</del> magnitude 7.3 struck Iraq <del>on</del> Sunday	prediction
<del>An</del> earthquake <del>was</del> detected <del>in</del> Iraq <del>on</del> Sunday	reference

ROUGE 2 recall = 1 correct bigram (Iraq, Sunday) / 3 reference bigrams

ROUGE 2 precision = 1 correct bigram (Iraq, Sunday) / 6 predicted bigrams

- ▶ Many hyperparameters: stemming, remove stopwords, etc.
- ▶ Historically: ROUGE recall @ k {words, characters}. Now: ROUGE F1

# Results

---

Model	R-1	R-2	R-4
Centroid	36.03	7.89	1.20
LexRank	35.49	7.42	0.81
KLSum	37.63	8.50	1.26
CLASSY04	37.23	8.89	1.46
ICSI	38.02	<b>9.72</b>	<b>1.72</b>
Submodular	38.62	9.19	1.34
DPP	<b>39.41</b>	9.57	1.56
RegSum	38.23	9.71	1.59

Gillick and Favre / bigram recall

Better centroid: 38.58 9.73 1.53

# Results

---

Model	R-1	R-2	R-4
Centroid	36.03	7.89	1.20
LexRank	35.49	7.42	0.81
KLSum	37.63	8.50	1.26
CLASSY04	37.23	8.89	1.46
ICSI	38.02	<b>9.72</b>	<b>1.72</b>
Submodular	38.62	9.19	1.34
DPP	<b>39.41</b>	9.57	1.56
RegSum	38.23	9.71	1.59

Gillick and Favre / bigram recall

Better centroid: 38.58   9.73   1.53

- Caveat: these techniques all work better for multi-document than single-document!

# Multi-Document vs. Single Document

---

- ▶ “a massive earthquake hit Iraq” “a massive earthquake struck Iraq” — lots of redundancy to help select content in multi-document case

# Multi-Document vs. Single Document

---

- ▶ “a massive earthquake hit Iraq” “a massive earthquake struck Iraq” — lots of redundancy to help select content in multi-document case
- ▶ When you have a lot of documents, there are more possible sentences to extract:



# Multi-Document vs. Single Document

---

- ▶ “a massive earthquake hit Iraq” “a massive earthquake struck Iraq” — lots of redundancy to help select content in multi-document case
- ▶ When you have a lot of documents, there are more possible sentences to extract:

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

# Multi-Document vs. Single Document

---

- ▶ “a massive earthquake hit Iraq” “a massive earthquake struck Iraq” — lots of redundancy to help select content in multi-document case
- ▶ When you have a lot of documents, there are more possible sentences to extract:

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The quake has been felt in several Iranian cities and eight villages have been damaged.

# Multi-Document vs. Single Document

---

- ▶ “a massive earthquake hit Iraq” “a massive earthquake struck Iraq” — lots of redundancy to help select content in multi-document case
- ▶ When you have a lot of documents, there are more possible sentences to extract:

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The quake has been felt in several Iranian cities and eight villages have been damaged.

# Multi-Document vs. Single Document

---

- ▶ “a massive earthquake hit Iraq” “a massive earthquake struck Iraq” — lots of redundancy to help select content in multi-document case
- ▶ When you have a lot of documents, there are more possible sentences to extract:

But eight villages were damaged in Iran and at least six people were killed and many others injured in the border town of Qasr-e Shirin in Iran, Iranian state TV said.

The quake has been felt in several Iranian cities and eight villages have been damaged.

- ▶ Multi-document summarization is easier?

# Compressive Summarization

# Compressive Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.



# Compressive Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.

# Compressive Summarization

---

Indian Express — A massive earthquake of magnitude 7.3 struck Iraq on Sunday, 103 kms (64 miles) southeast of the city of As-Sulaymaniyah, the US Geological Survey said, reports Reuters. US Geological Survey initially said the quake was of a magnitude 7.2, before revising it to 7.3.

- ▶ Sentence extraction isn't aggressive enough at removing irrelevant content
- ▶ Want to extract sentences and also delete content from them

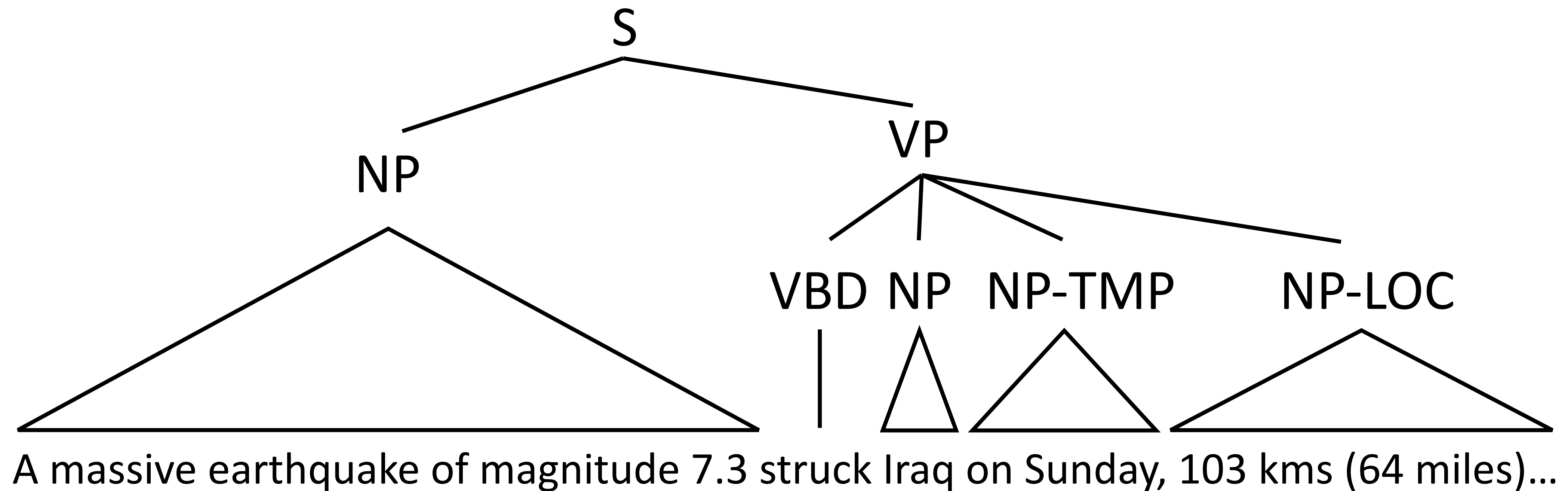
# Syntactic Cuts

---

- ▶ Use syntactic rules to make certain deletions
- ▶ Delete adjuncts

# Syntactic Cuts

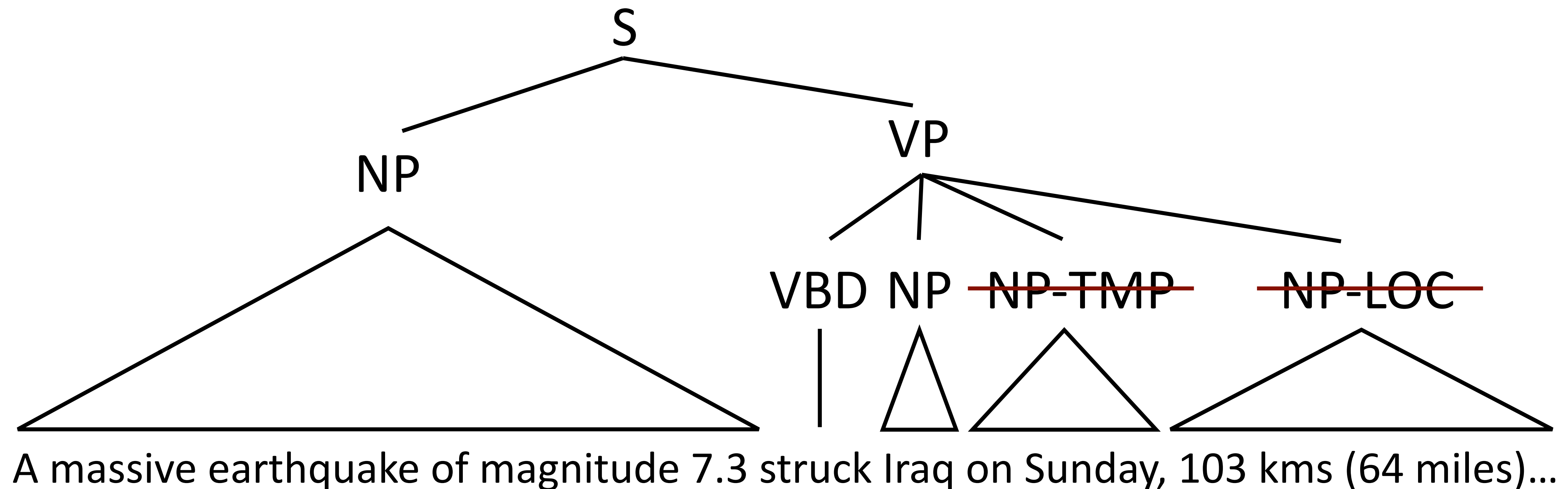
- ▶ Use syntactic rules to make certain deletions
- ▶ Delete adjuncts



Berg-Kirkpatrick et al. (2011)

# Syntactic Cuts

- ▶ Use syntactic rules to make certain deletions
- ▶ Delete adjuncts



Berg-Kirkpatrick et al. (2011)

# Syntactic Cuts

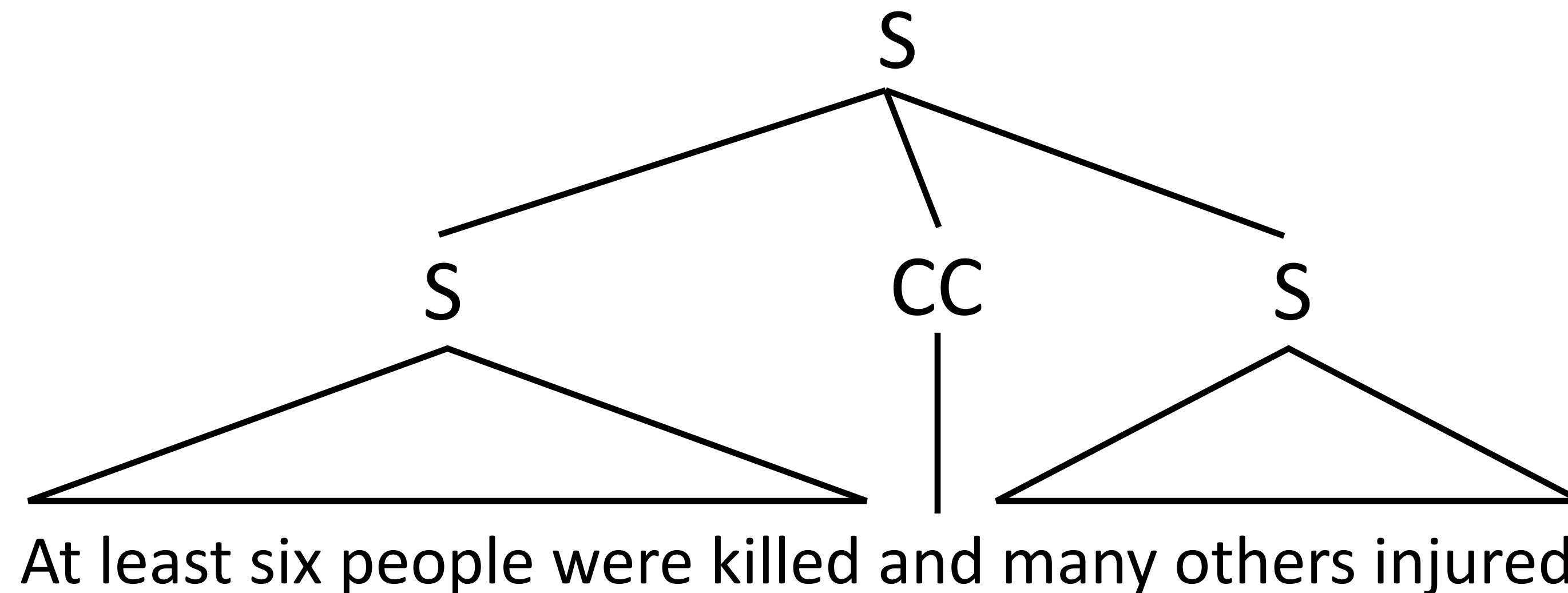
---

- ▶ Use syntactic rules to make certain deletions
- ▶ Delete second parts of coordination structures

# Syntactic Cuts

---

- ▶ Use syntactic rules to make certain deletions
- ▶ Delete second parts of coordination structures

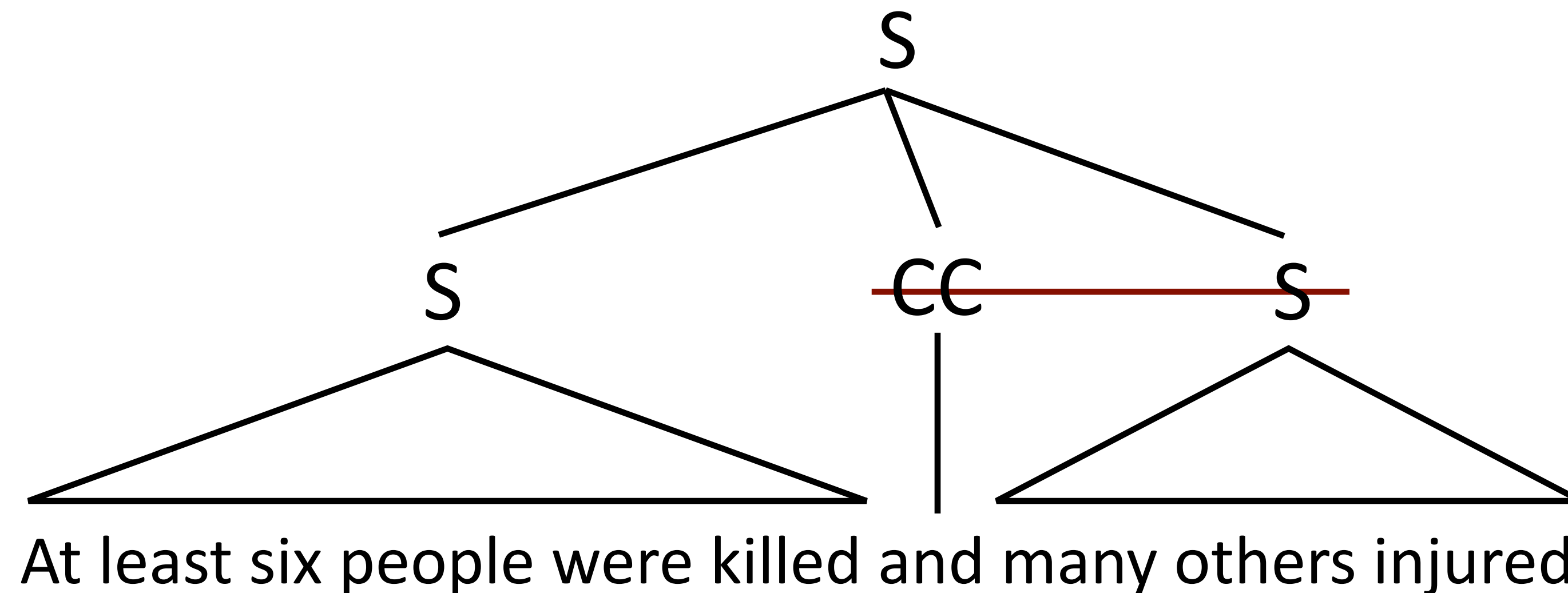




# Syntactic Cuts

---

- ▶ Use syntactic rules to make certain deletions
- ▶ Delete second parts of coordination structures

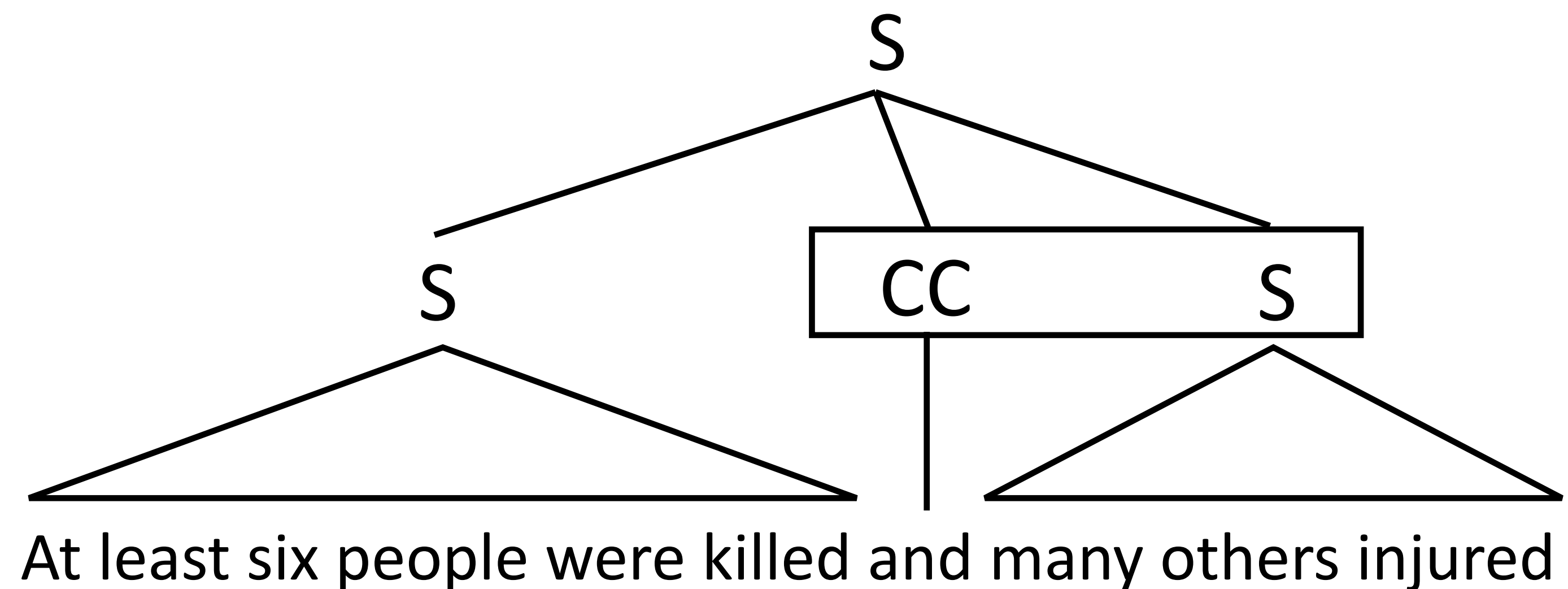


# Compressive ILP

- Recall the Gillick+Favre ILP:

Berg-Kirkpatrick et al. (2011)

$$\begin{aligned} \text{Maximize: } & \sum_i w_i c_i \\ \text{Subject to: } & \sum_j l_j s_j \leq L \\ & s_j \text{Occ}_{ij} \leq c_i, \quad \forall i, j \\ & \sum_j s_j \text{Occ}_{ij} \geq c_i \quad \forall i \end{aligned}$$



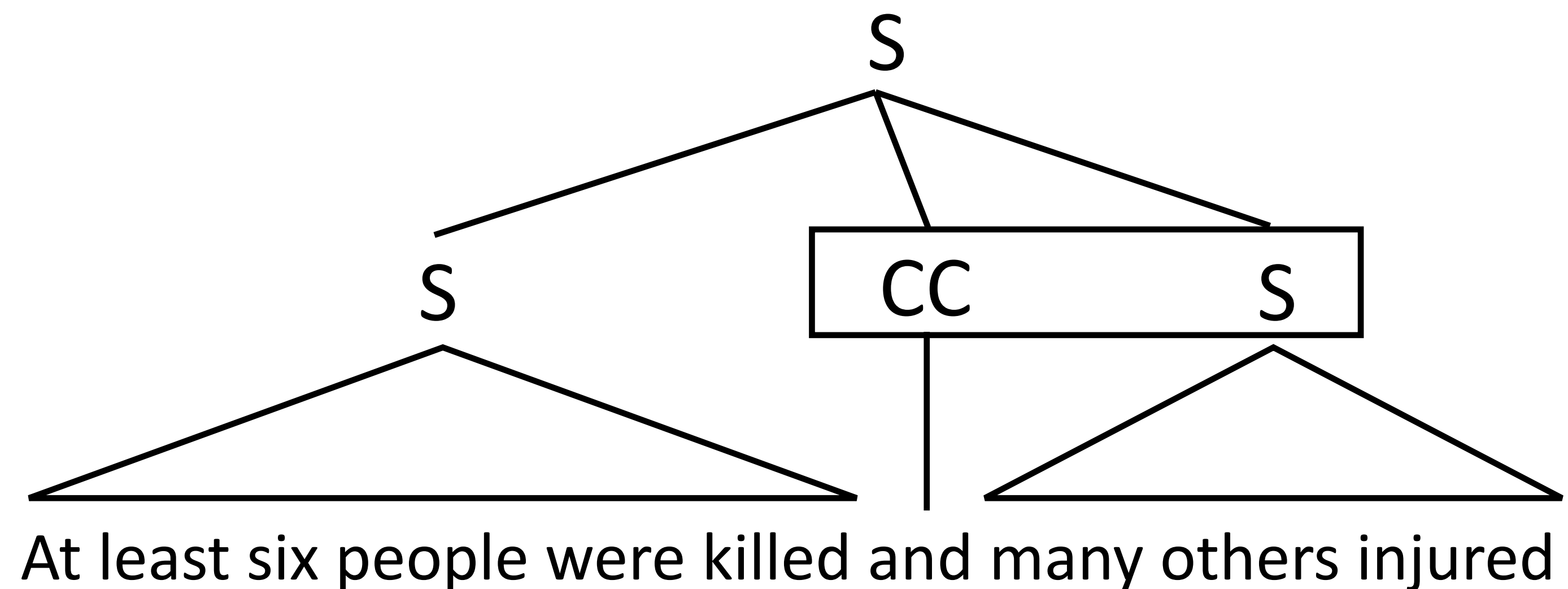
# Compressive ILP

- Recall the Gillick+Favre ILP:

Berg-Kirkpatrick et al. (2011)

$$\begin{aligned} \text{Maximize: } & \sum_i w_i c_i & s_j \text{Occ}_{ij} &\leq c_i, \quad \forall i, j \\ \text{Subject to: } & \sum_j l_j s_j \leq L & \sum_j s_j \text{Occ}_{ij} &\geq c_i \quad \forall i \end{aligned}$$

- Now  $s_j$  variables are nodes or sets of nodes in the parse tree



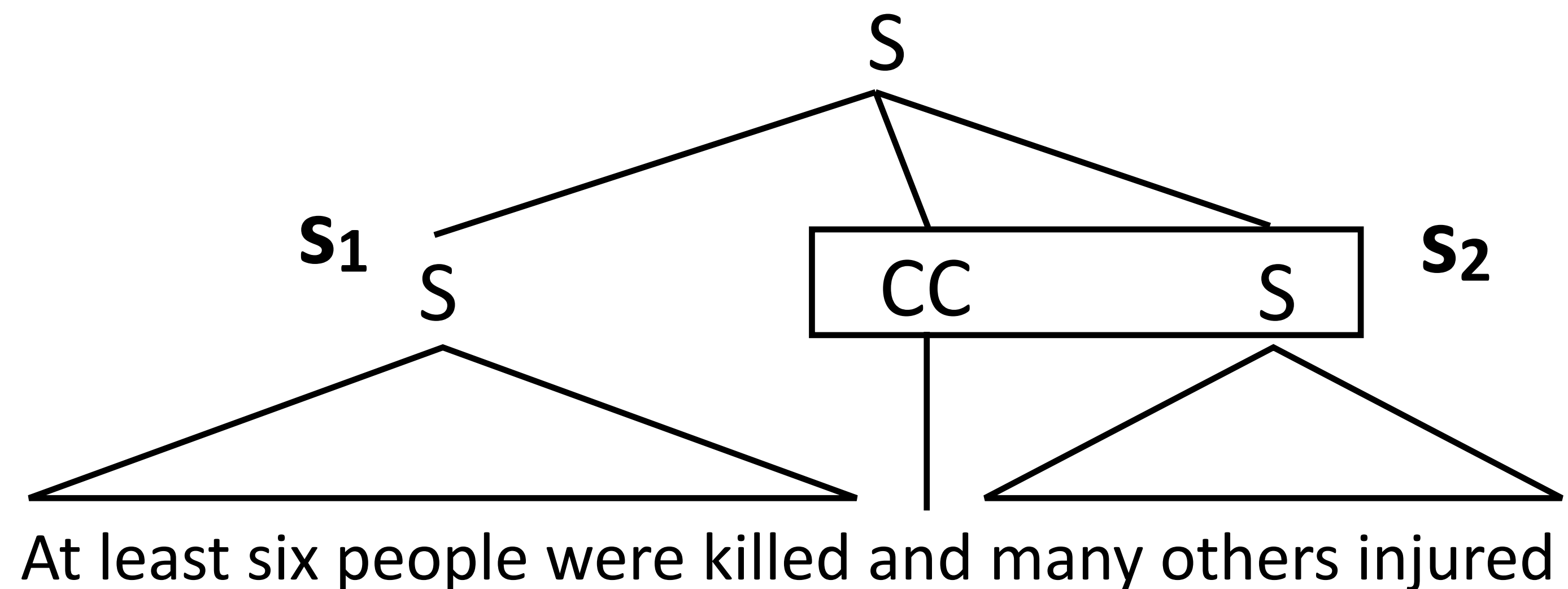
# Compressive ILP

- Recall the Gillick+Favre ILP:

Berg-Kirkpatrick et al. (2011)

$$\begin{array}{ll} \text{Maximize:} & \sum_i w_i c_i \\ \text{Subject to:} & \sum_j l_j s_j \leq L \end{array} \quad \begin{array}{l} s_j \text{Occ}_{ij} \leq c_i, \quad \forall i, j \\ \sum_j s_j \text{Occ}_{ij} \geq c_i \quad \forall i \end{array}$$

- Now  $s_j$  variables are nodes or sets of nodes in the parse tree



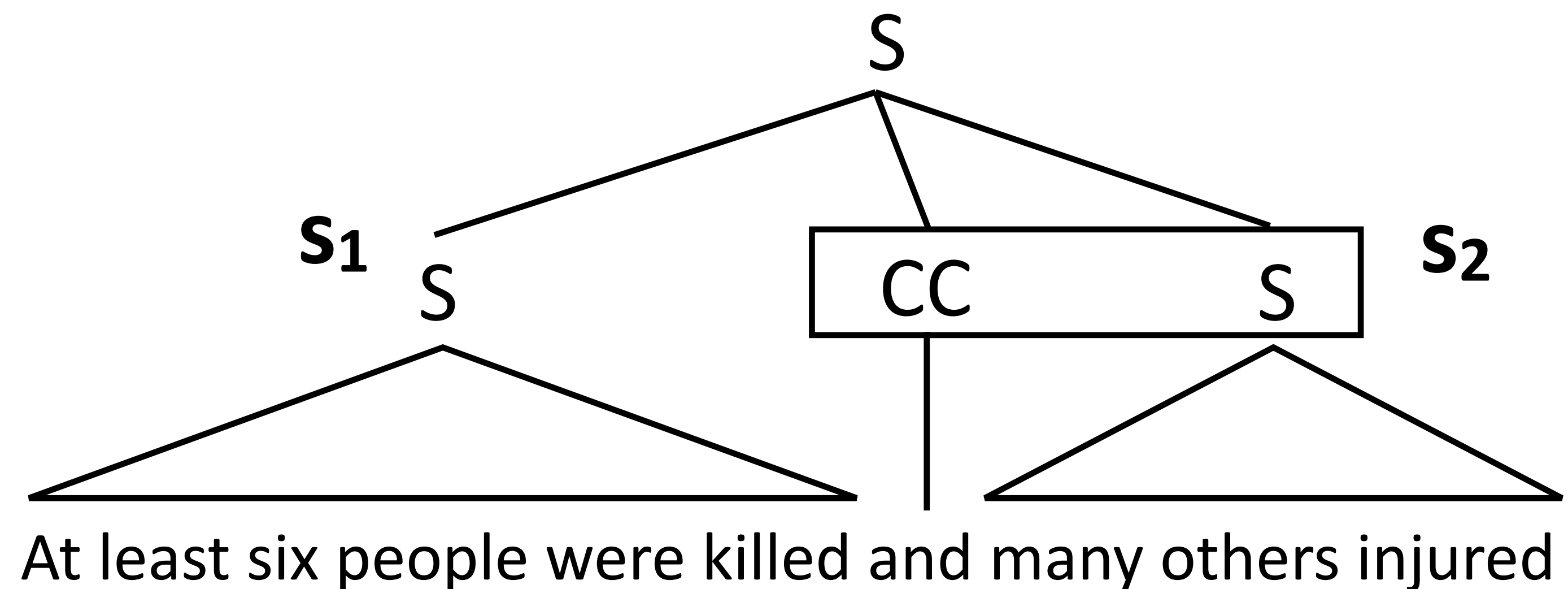
# Compressive ILP

- Recall the Gillick+Favre ILP:

Berg-Kirkpatrick et al. (2011)

$$\begin{aligned} \text{Maximize: } & \sum_i w_i c_i & s_j \text{Occ}_{ij} &\leq c_i, \quad \forall i, j \\ \text{Subject to: } & \sum_j l_j s_j \leq L & \sum_j s_j \text{Occ}_{ij} &\geq c_i \quad \forall i \end{aligned}$$

- Now  $s_j$  variables are nodes or sets of nodes in the parse tree
- New constraint:  $s_2 \leq s_1$



# Compressive ILP

- Recall the Gillick+Favre ILP:

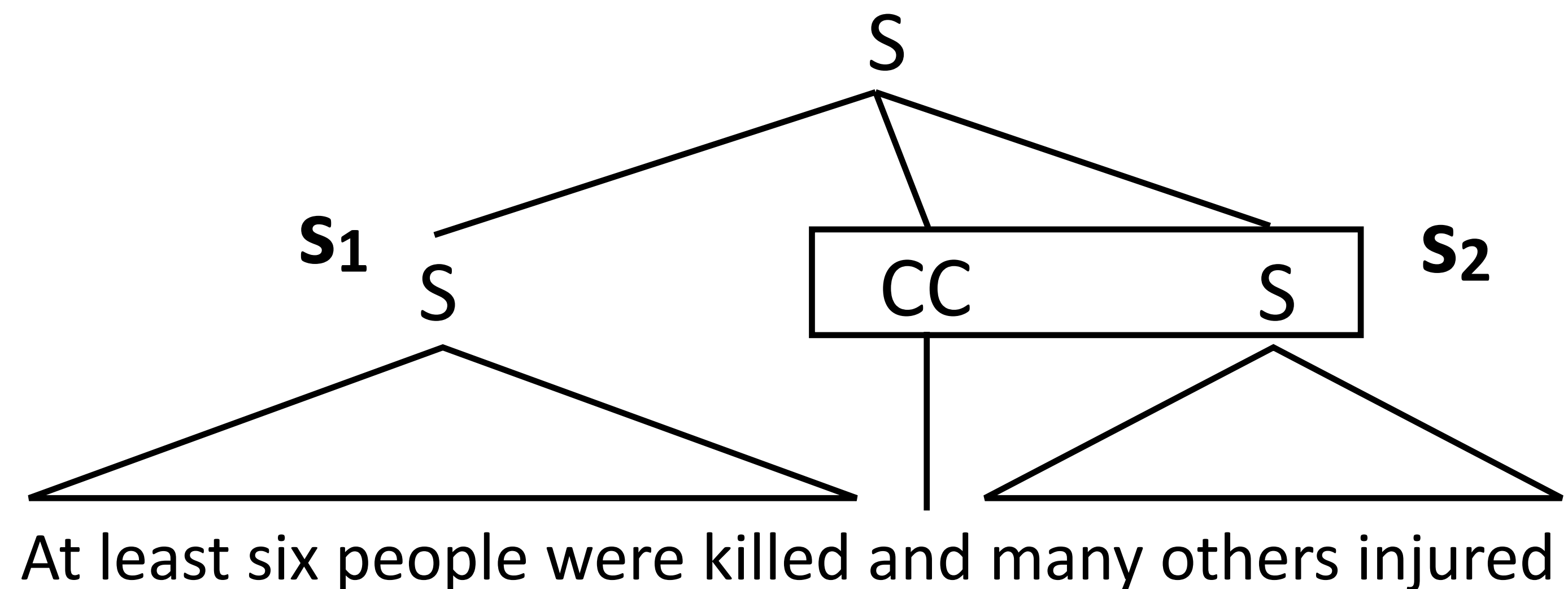
Berg-Kirkpatrick et al. (2011)

$$\begin{array}{ll} \text{Maximize:} & \sum_i w_i c_i \\ \text{Subject to:} & \sum_j l_j s_j \leq L \\ & s_j \text{Occ}_{ij} \leq c_i, \quad \forall i, j \\ & \sum_j s_j \text{Occ}_{ij} \geq c_i \quad \forall i \end{array}$$

- Now  $s_j$  variables are nodes or sets of nodes in the parse tree

- New constraint:  $s_2 \leq s_1$

“ $s_1$  is a prerequisite for  $s_2$ ”



# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.

And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.



# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.

And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.

And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.

And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.

And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

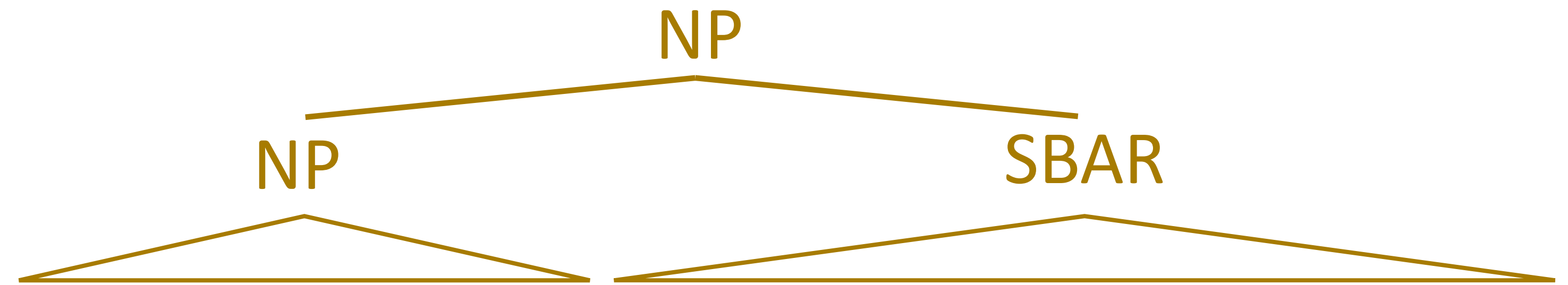
# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.



And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

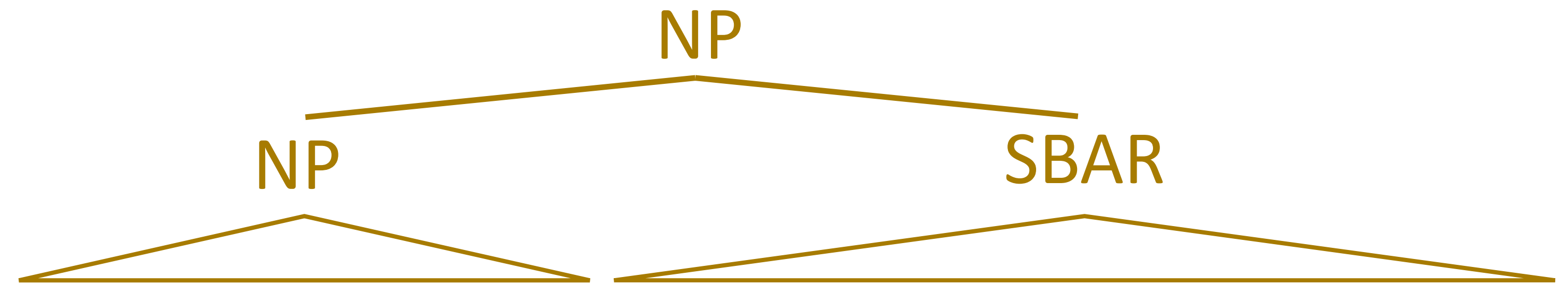
# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost **it** market share.

Its president quit suddenly.



And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

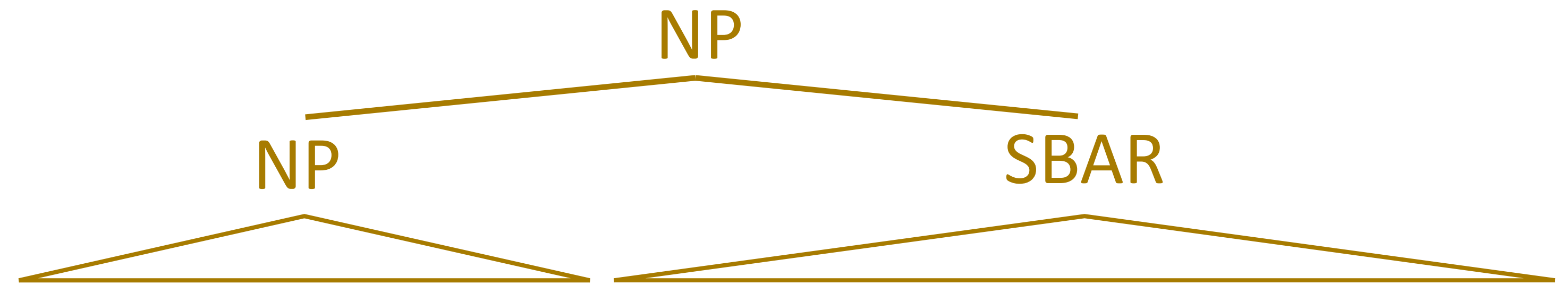
# Compressive Summarization

---

This hasn't been Kellogg's year.

The oat-bran craze has cost it market share.

Its president quit suddenly.



And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.



# Compressive Summarization

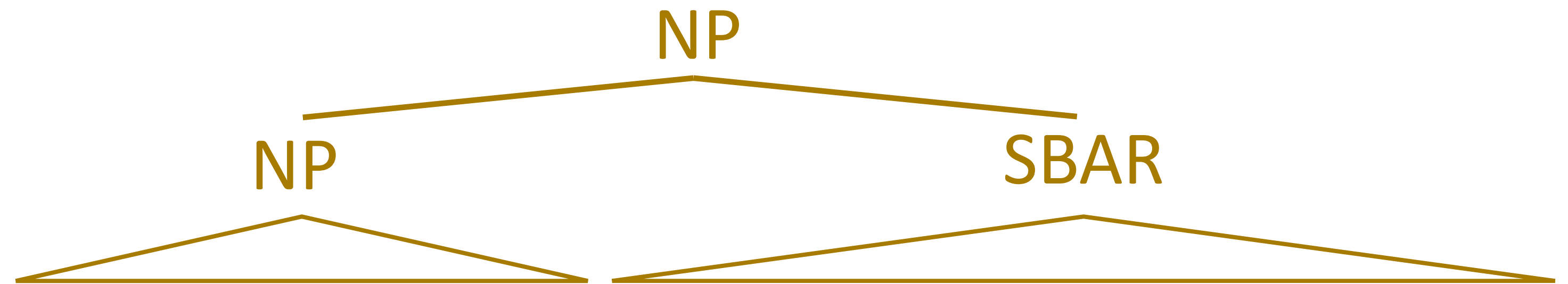
---

This hasn't been Kellogg's year.

The oat-bran craze has cost Kellogg market share.

Its president quit suddenly.

And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.



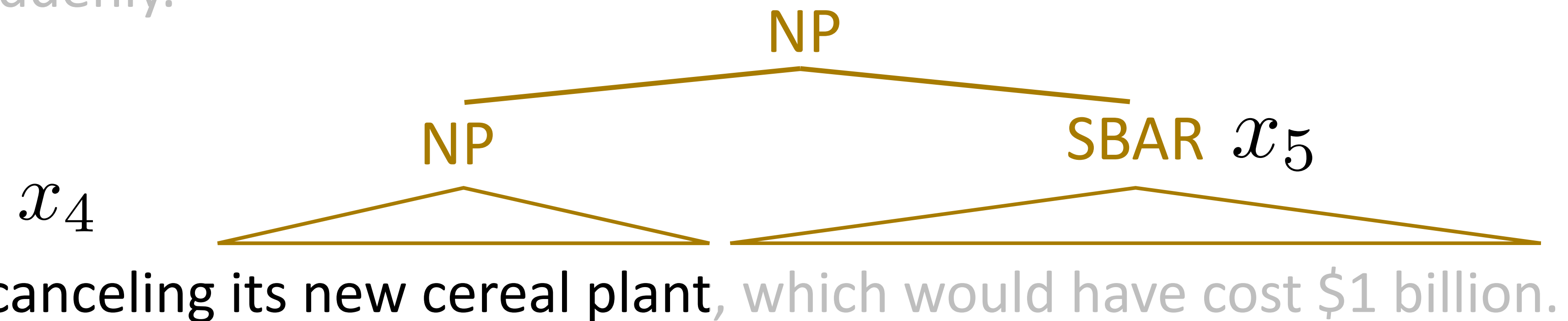
# Compressive Summarization

---

$x_1$  This hasn't been Kellogg's year.

$x_2$  The oat-bran craze has cost Kellogg market share.

$x_3$  Its president quit suddenly.



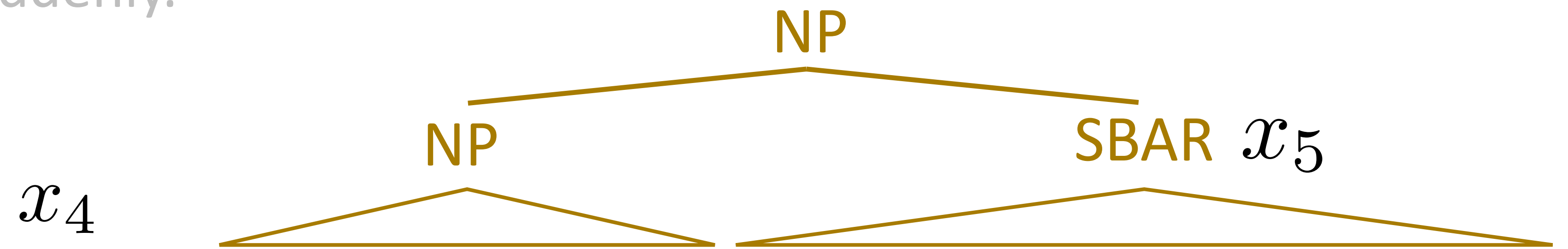
# Compressive Summarization

---

$x_1$  This hasn't been Kellogg's year.

$x_2$  The oat-bran craze has cost Kellogg market share.

$x_3$  Its president quit suddenly.



And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

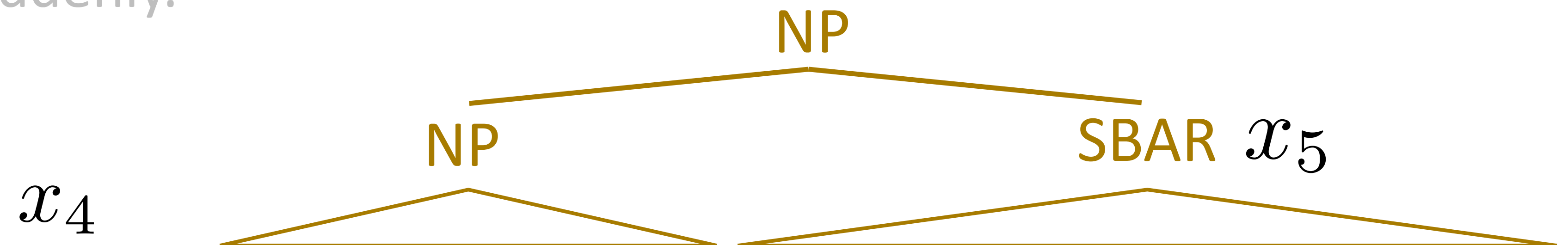
$$\text{ILP: } \max_{\mathbf{x}} (w^{\top} f(\mathbf{x}))$$

# Compressive Summarization

$x_1$  This hasn't been Kellogg's year.

$x_2$  The oat-bran craze has cost Kellogg market share.

$x_3$  Its president quit suddenly.



And now Kellogg is canceling its new cereal plant, which would have cost \$1 billion.

$$\text{ILP: } \max_{\mathbf{x}} (w^\top f(\mathbf{x}))$$

*s.t.* summary( $\mathbf{x}$ ) obeys length limit

summary( $\mathbf{x}$ ) is grammatical

summary( $\mathbf{x}$ ) is coherent

# Constraints

---

$$\max_{\mathbf{x}} \left( w^\top f(\mathbf{x}) \right) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

# Constraints

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

Grammaticality constraints: allow cuts within sentences

# Constraints

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

Grammaticality constraints: allow cuts within sentences

Coreference constraints: do not allow pronouns that would refer to nothing



# Constraints

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

Grammaticality constraints: allow cuts within sentences

Coreference constraints: do not allow pronouns that would refer to nothing

- ▶ If we're confident about coreference, rewrite the pronoun (it→Kellogg)

# Constraints

---

$$\max_{\mathbf{x}} \left( w^\top f(\mathbf{x}) \right) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

Grammaticality constraints: allow cuts within sentences

Coreference constraints: do not allow pronouns that would refer to nothing

- ▶ If we're confident about coreference, rewrite the pronoun (it → Kellogg)
- ▶ Otherwise, force its antecedent to be included in the summary

# Features

---

$$\max_{\mathbf{x}} \left( w^\top f(\mathbf{x}) \right) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Now uses a feature-based model, where features identify good content

# Features

---

$$\max_{\mathbf{x}} \left( w^\top f(\mathbf{x}) \right) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Now uses a feature-based model, where features identify good content

$f$  (And now Kellogg is canceling its new cereal plant) =

# Features

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Now uses a feature-based model, where features identify good content

$$f(\text{And now Kellogg is canceling its new cereal plant}) = \left\{ \right.$$

# Features

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Now uses a feature-based model, where features identify good content

$$f(\text{And now Kellogg is canceling its new cereal plant}) = \left\{ \begin{array}{l} \text{Centrality:} \\ \mathbb{I}(\text{NumContentWords}=4) \end{array} \right.$$

# Features

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Now uses a feature-based model, where features identify good content

$$f(\text{And now Kellogg is canceling its new cereal plant}) = \left\{ \begin{array}{l} \text{Centrality:} \\ \quad \mathbb{I}(\text{NumContentWords}=4) \\ \\ \text{Document position:} \\ \quad \mathbb{I}(\text{SentenceIndex}=4) \end{array} \right.$$



# Features

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Now uses a feature-based model, where features identify good content

$$f(\text{And now Kellogg is canceling its new cereal plant}) = \left\{ \begin{array}{l} \text{Centrality:} \\ \quad \mathbb{I}(\text{NumContentWords}=4) \\ \\ \text{Document position:} \\ \quad \mathbb{I}(\text{SentenceIndex}=4) \\ \\ \text{Lexical features:} \\ \quad \mathbb{I}(\text{FirstWord}=\text{And}) \end{array} \right.$$

# Learning

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad \begin{array}{l} s.t. \text{ summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

# Learning

---

$$\max_{\mathbf{x}} (w^\top f(\mathbf{x})) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Train on a large corpus of New York Times documents with summaries (100,000 documents)

# Learning

---

$$\max_{\mathbf{x}} \left( w^\top f(\mathbf{x}) \right) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

- ▶ Train on a large corpus of New York Times documents with summaries (100,000 documents)
- ▶ Structured SVM with ROUGE as loss function

# Learning

---

$$\max_{\mathbf{x}} \left( w^\top f(\mathbf{x}) \right) \quad s.t. \begin{array}{l} \text{summary}(\mathbf{x}) \text{ obeys length limit} \\ \text{summary}(\mathbf{x}) \text{ is grammatical} \\ \text{summary}(\mathbf{x}) \text{ is coherent} \end{array}$$

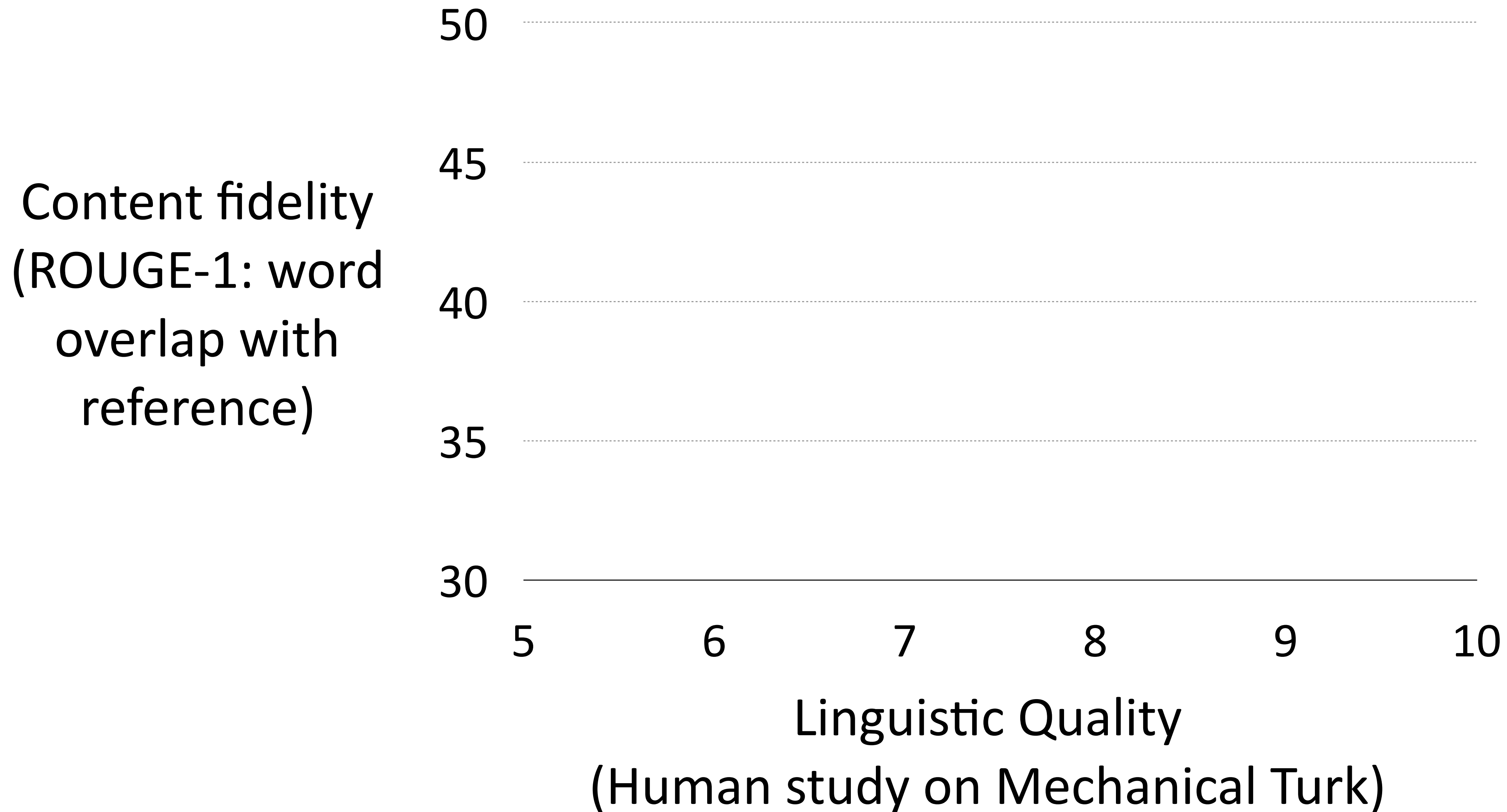
- ▶ Train on a large corpus of New York Times documents with summaries (100,000 documents)
- ▶ Structured SVM with ROUGE as loss function
  - ▶ Augment the ILP to keep track of which bigrams are included or not, use these for loss-augmented decode

# Results: New York Times Corpus

---

# Results: New York Times Corpus

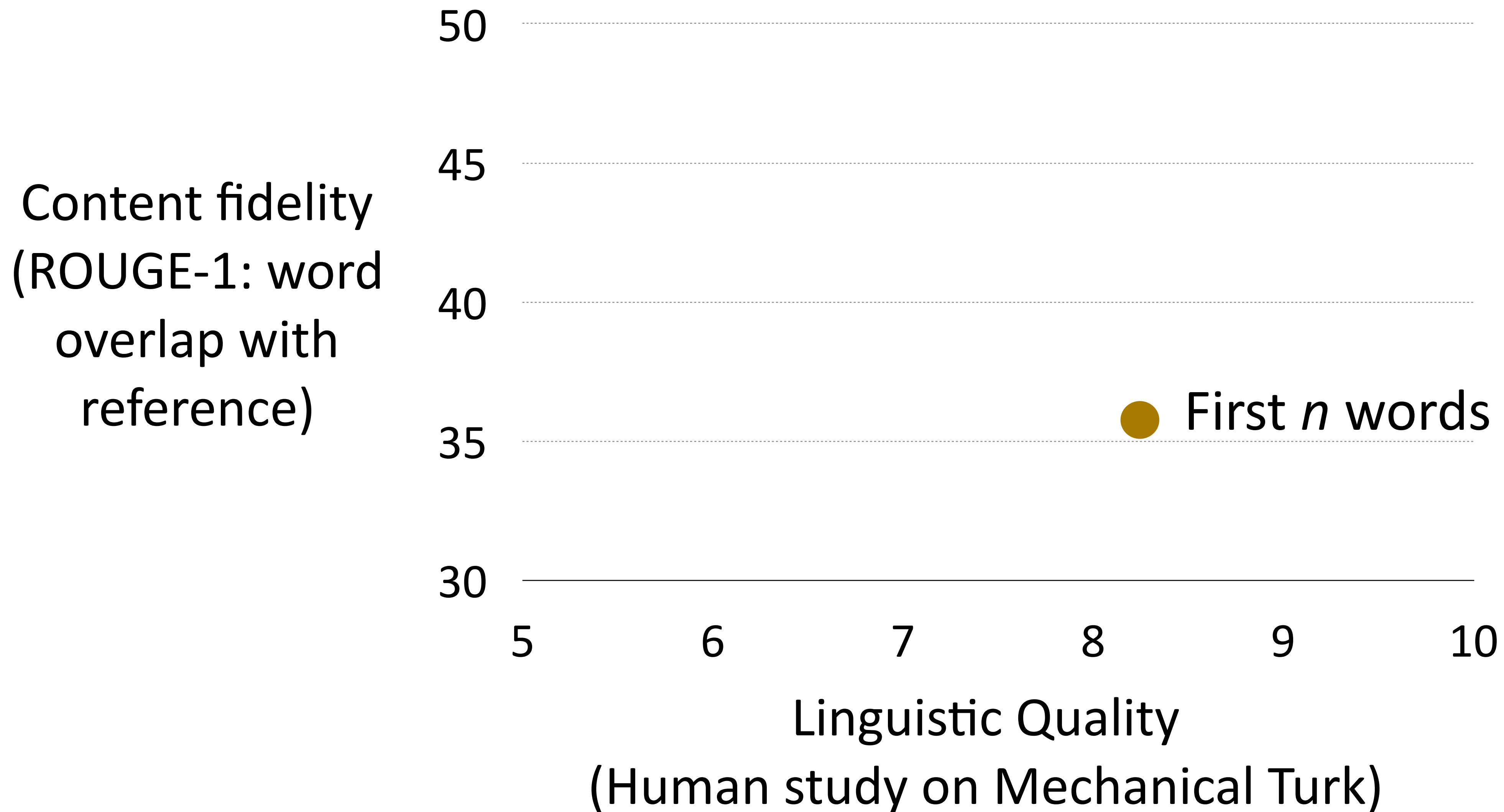
---





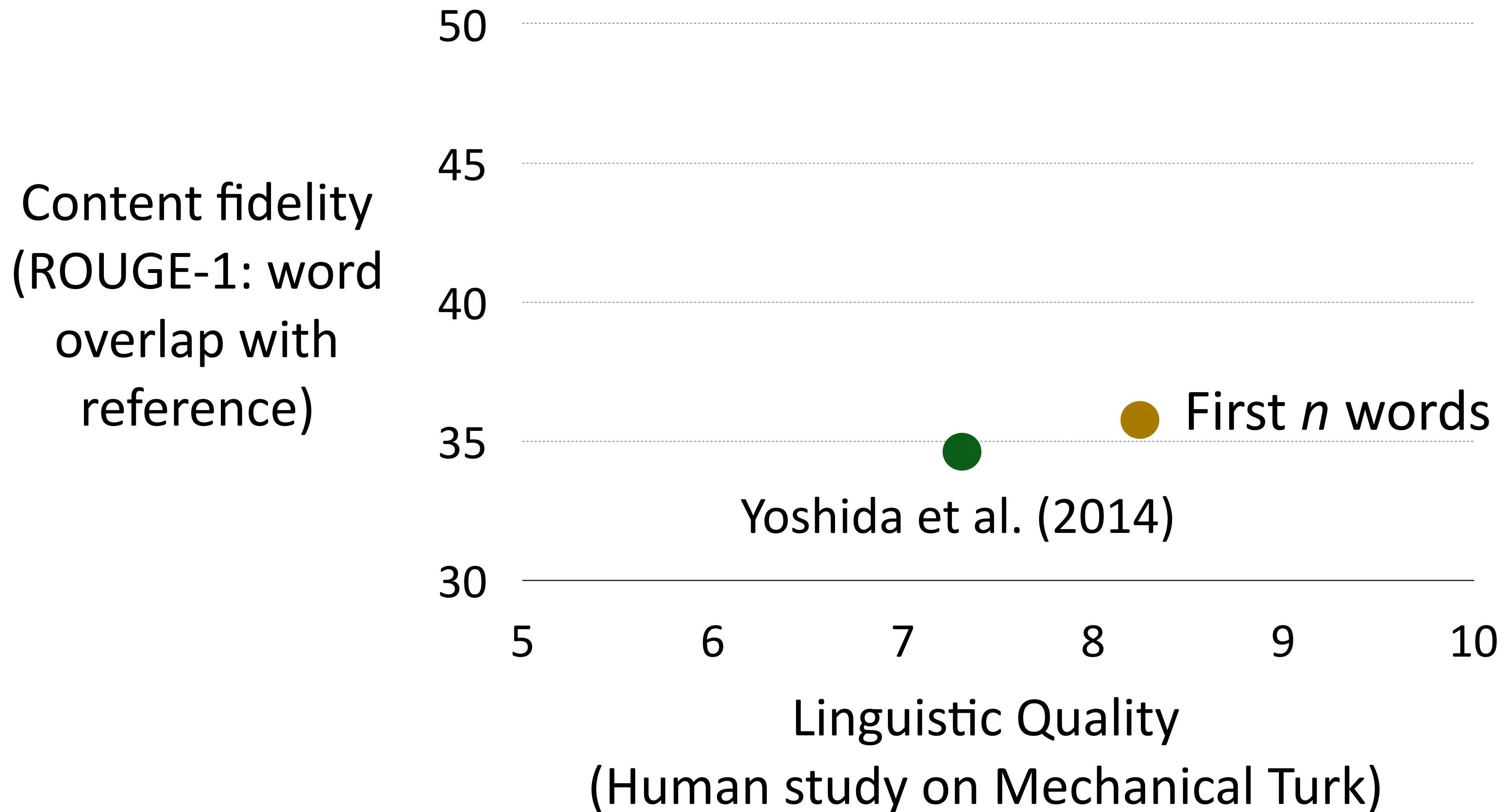
# Results: New York Times Corpus

---



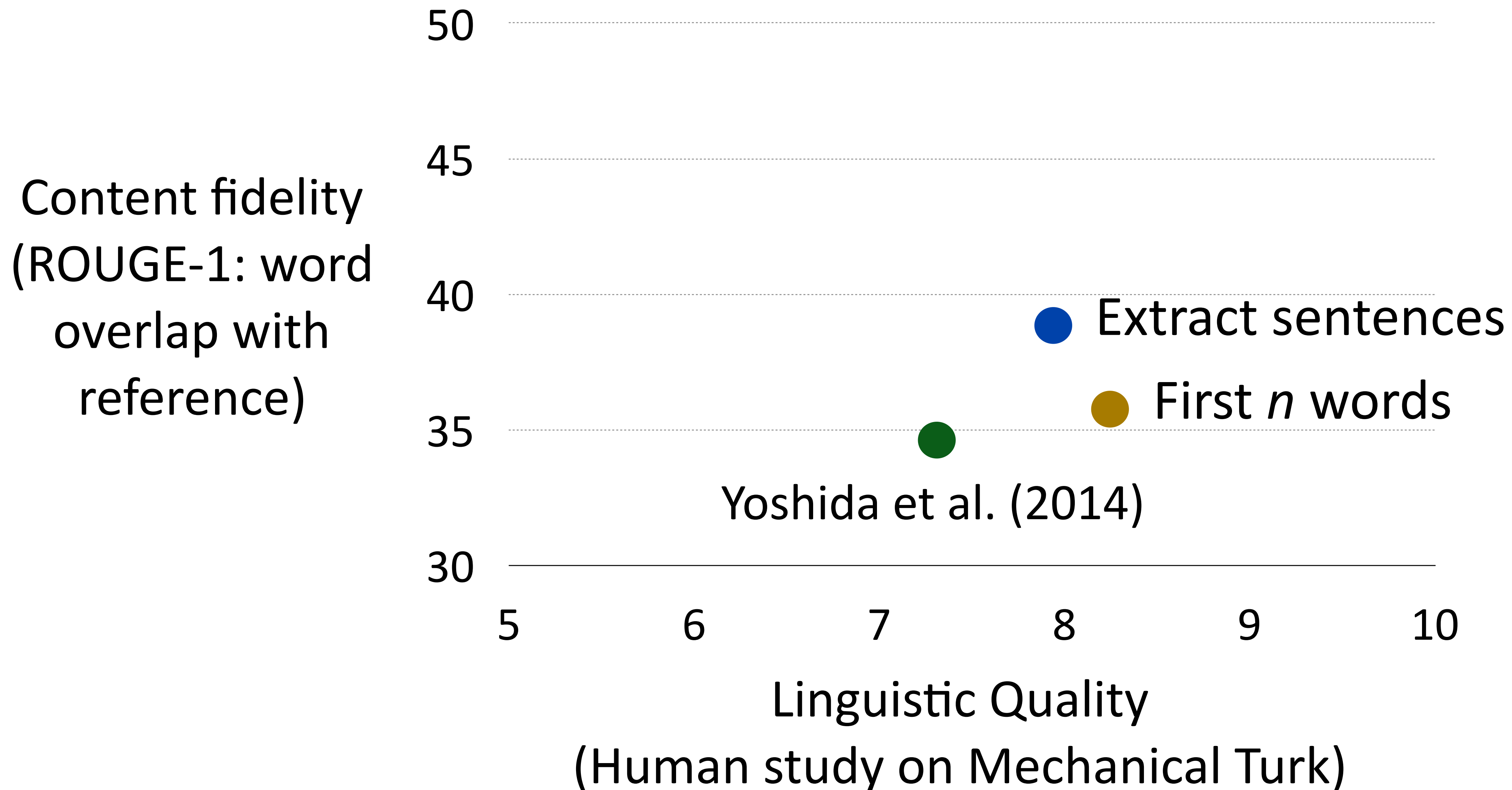
# Results: New York Times Corpus

---



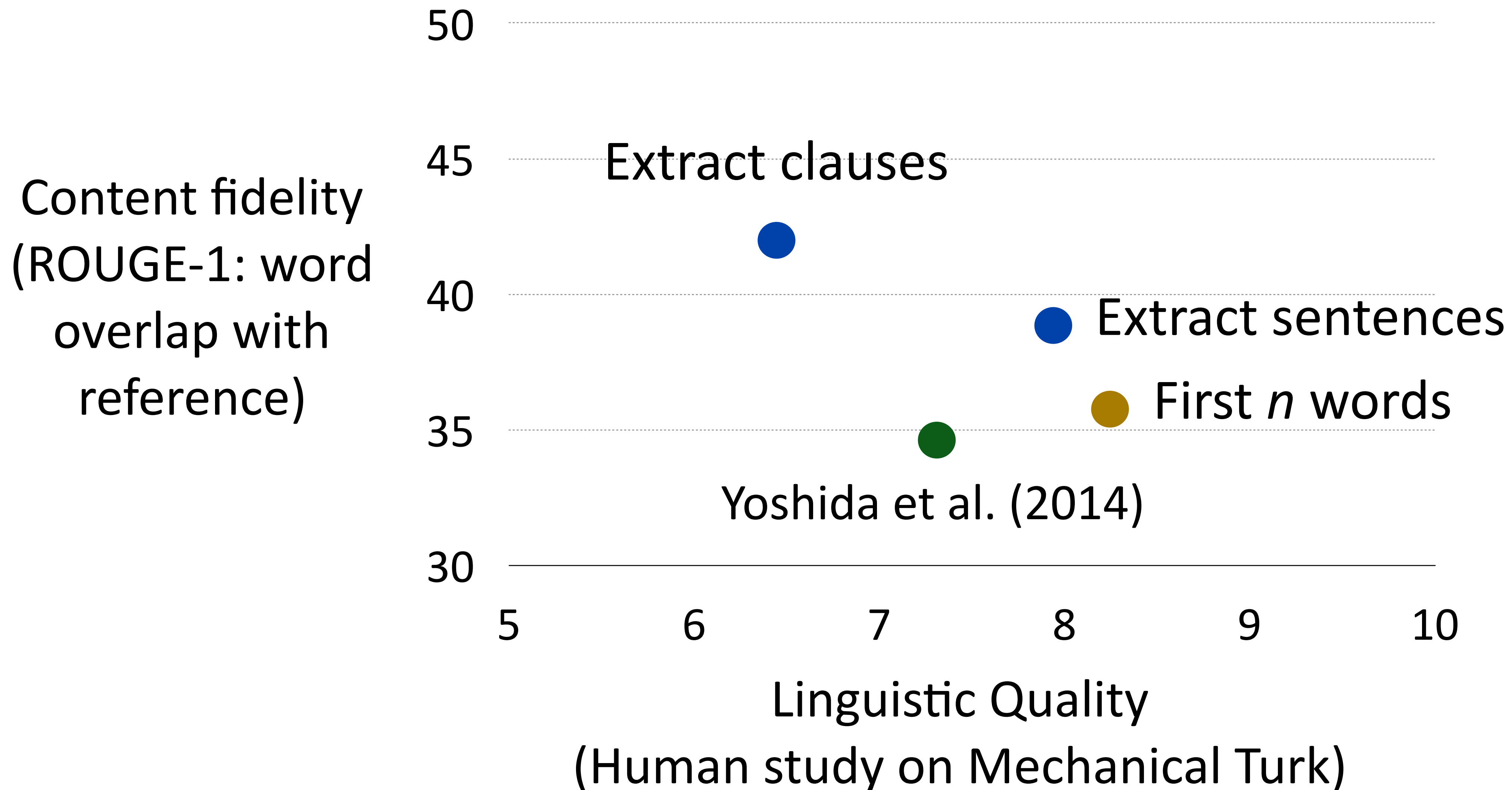
# Results: New York Times Corpus

---



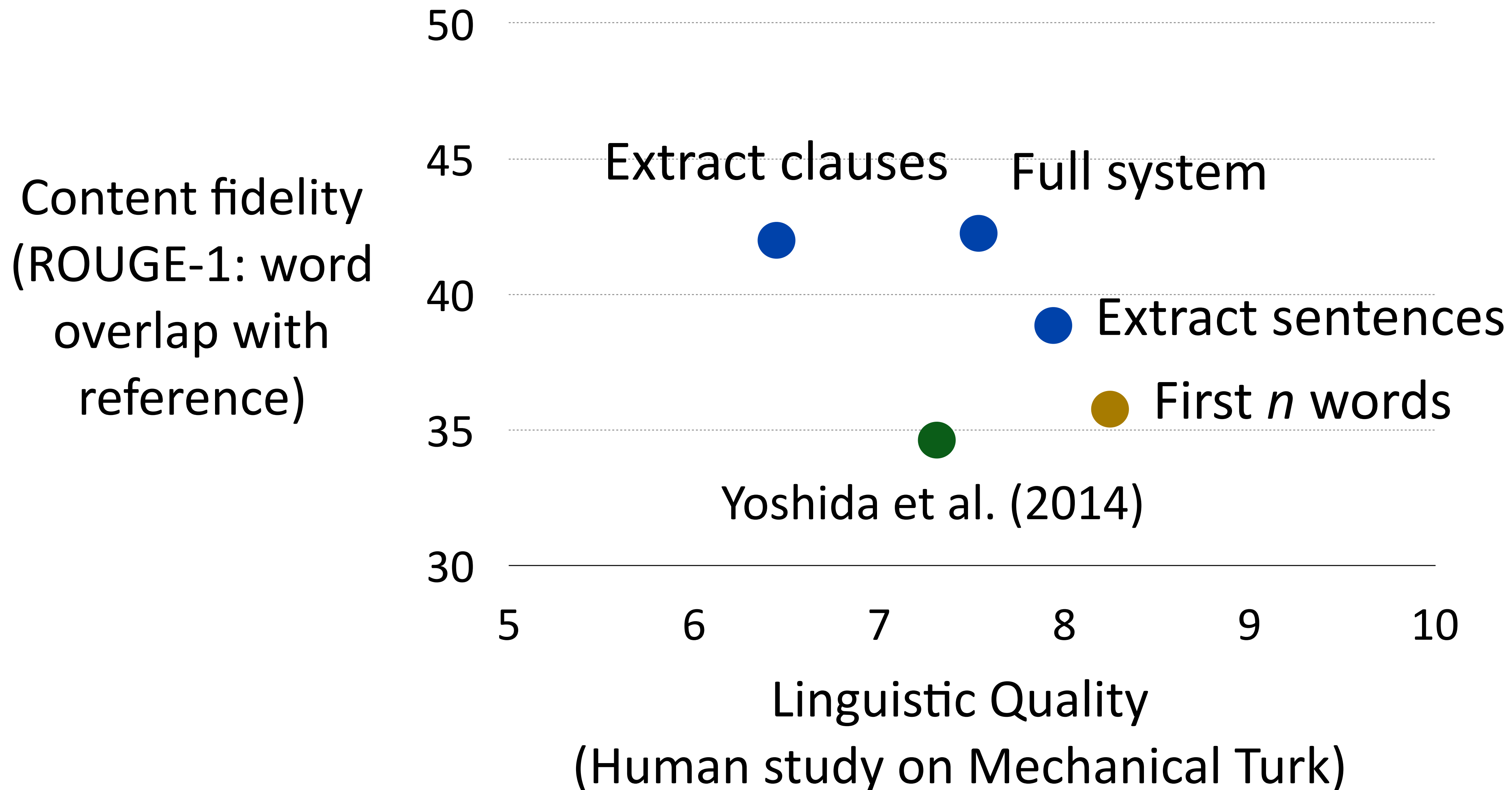
# Results: New York Times Corpus

---



# Results: New York Times Corpus

---



# Where We are At

---

- ▶ Extractive systems for multi-document summarization
- ▶ Extractive + compressive systems for single-document summarization
- ▶ Single-document summarization with neural networks

# Where We are At

---

- ▶ Extractive systems for multi-document summarization
- ▶ Extractive + compressive systems for single-document summarization
- ▶ Single-document summarization with neural networks ←



# Neural Summarization

# Seq2seq Summarization

---

- ▶ Extractive paradigm isn't all that flexible, even with compression

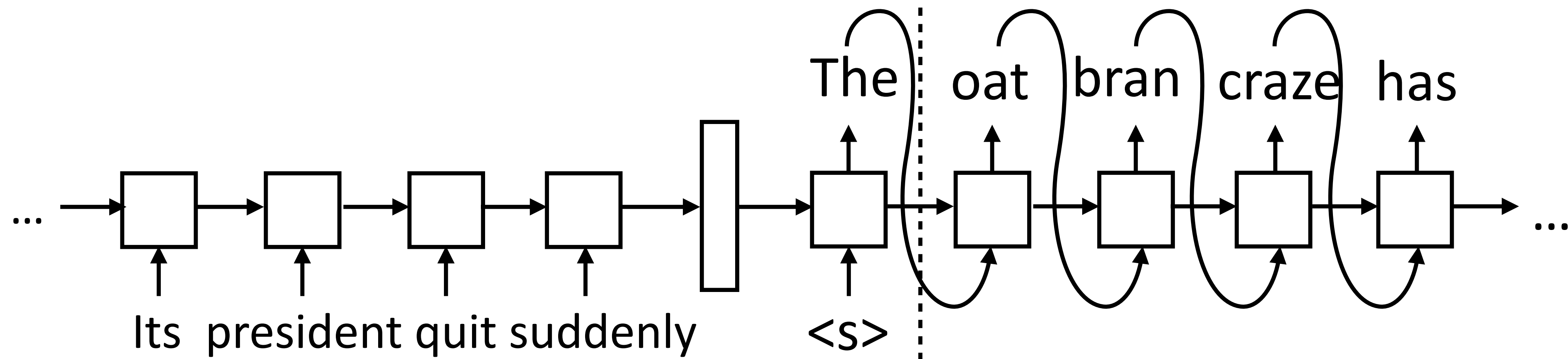
# Seq2seq Summarization

---

- ▶ Extractive paradigm isn't all that flexible, even with compression
- ▶ Training is hard! ILPs are hard! Maybe just use seq2seq?

# Seq2seq Summarization

- ▶ Extractive paradigm isn't all that flexible, even with compression
- ▶ Training is hard! ILPs are hard! Maybe just use seq2seq?
- ▶ Train to produce summary based on document



# Seq2seq Summarization

---

- ▶ Task: generate headline from first sentence of article (can get lots of data!)

# Seq2seq Summarization

---

- ▶ Task: generate headline from first sentence of article (can get lots of data!)

**I(1):** brazilian defender pepe is out for the rest of the season with a knee injury , his porto coach jesualdo ferreira said saturday . sentence

**G:** football : pepe out for season reference

**A+:** ferreira out for rest of season with knee injury no attention

**R:** brazilian defender pepe out for rest of season with knee injury with attention

# Seq2seq Summarization

---

- ▶ Task: generate headline from first sentence of article (can get lots of data!)

**I(1):** brazilian defender pepe is out for the rest of the season with a knee injury , his porto coach jesualdo ferreira said saturday . sentence

**G:** football : pepe out for season reference

**A+:** ferreira out for rest of season with knee injury no attention

**R:** brazilian defender pepe out for rest of season with knee injury with attention

- ▶ Works pretty well, though these models can generate incorrect summaries (who has the knee injury?)



# Seq2seq Summarization

---

- ▶ Task: generate headline from first sentence of article (can get lots of data!)

**I(1):** brazilian defender pepe is out for the rest of the season with a knee injury , his porto coach jesualdo ferreira said saturday . sentence

**G:** football : pepe out for season reference

**A+:** ferreira out for rest of season with knee injury no attention

**R:** brazilian defender pepe out for rest of season with knee injury with attention

- ▶ Works pretty well, though these models can generate incorrect summaries (who has the knee injury?)
- ▶ What happens if we try this on a longer article?



# Seq2seq Summarization

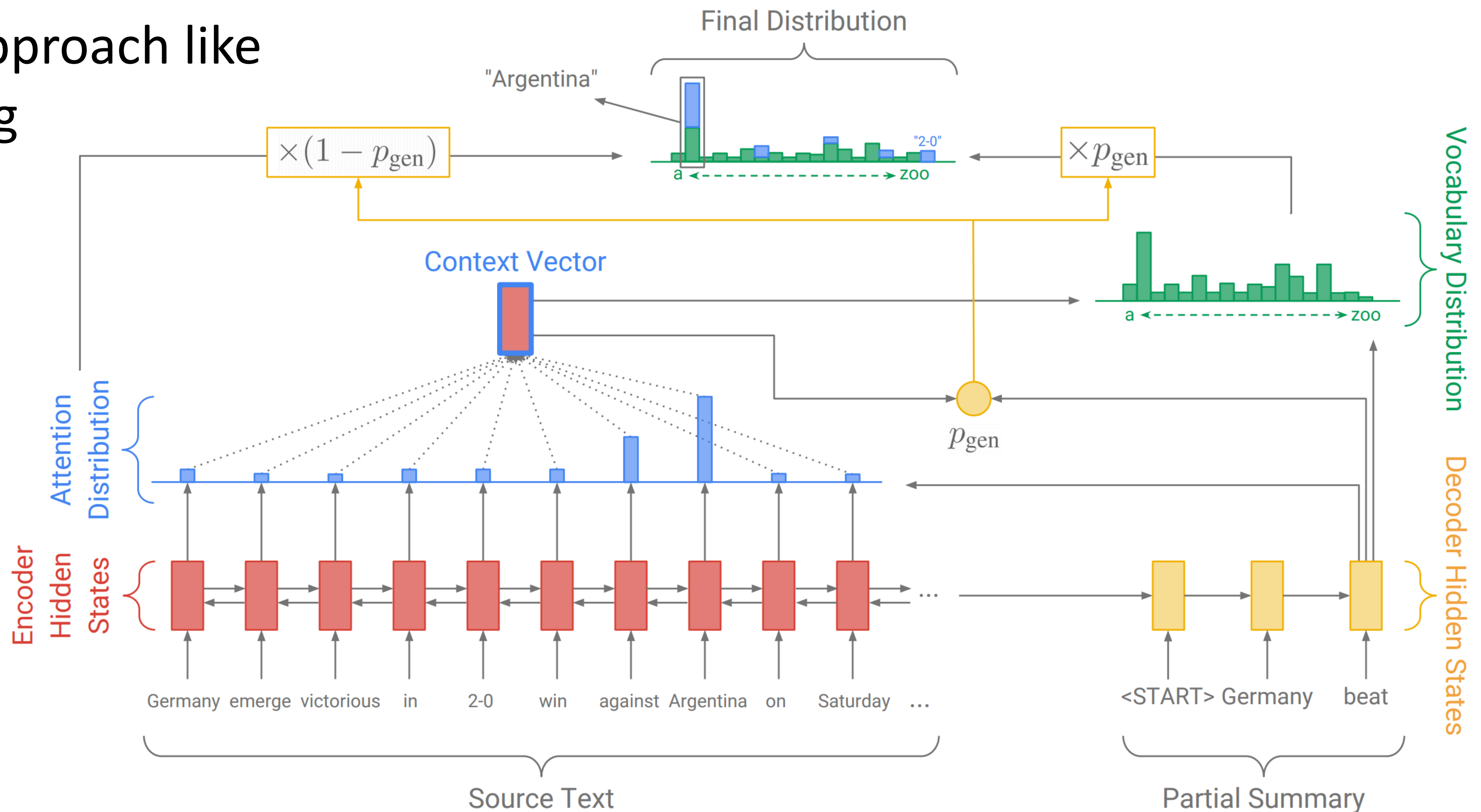
**Original Text (truncated):** lagos, nigeria (cnn) a day after winning nigeria's presidency, *muhammadu buhari* told cnn's christiane amanpour that **he plans to aggressively fight corruption that has long plagued nigeria** and go after the root of the nation's unrest. *buhari* said he'll "rapidly give attention" to curbing violence in the northeast part of nigeria, where the terrorist group boko haram operates. by cooperating with neighboring nations chad, cameroon and niger, **he said his administration is confident it will be able to thwart criminals** and others contributing to nigeria's instability. for the first time in nigeria's history, the opposition defeated the ruling party in democratic elections. *buhari* defeated incumbent goodluck jonathan by about 2 million votes, according to nigeria's independent national electoral commission. **the win comes after a long history of military rule, coups and botched attempts at democracy in africa's most populous nation.**

**Baseline Seq2Seq + Attention:** **UNK UNK** says his administration is confident it will be able to **destabilize nigeria's economy**. **UNK** says his administration is confident it will be able to thwart criminals and other **nigerians**. **he says the country has long nigeria and nigeria's economy.**

- What's wrong with this summary?

# Pointer-Generator Model

- Copying approach like in Jia+Liang



See et al. (2017)



# Seq2seq Summarization

---

- Solutions: copy mechanism, coverage, just like in MT...

**Baseline Seq2Seq + Attention:** UNK UNK says his administration is confident it will be able to **destabilize nigeria's economy**. UNK says his administration is confident it will be able to thwart criminals and other **nigerians**. **he says the country has long nigeria and nigeria's economy.**

**Pointer-Gen:** *muhammadu buhari* says he plans to aggressively fight corruption **in the northeast part of nigeria**. he says he'll "rapidly give attention" to curbing violence **in the northeast part of nigeria**. he says his administration is confident it will be able to thwart criminals.

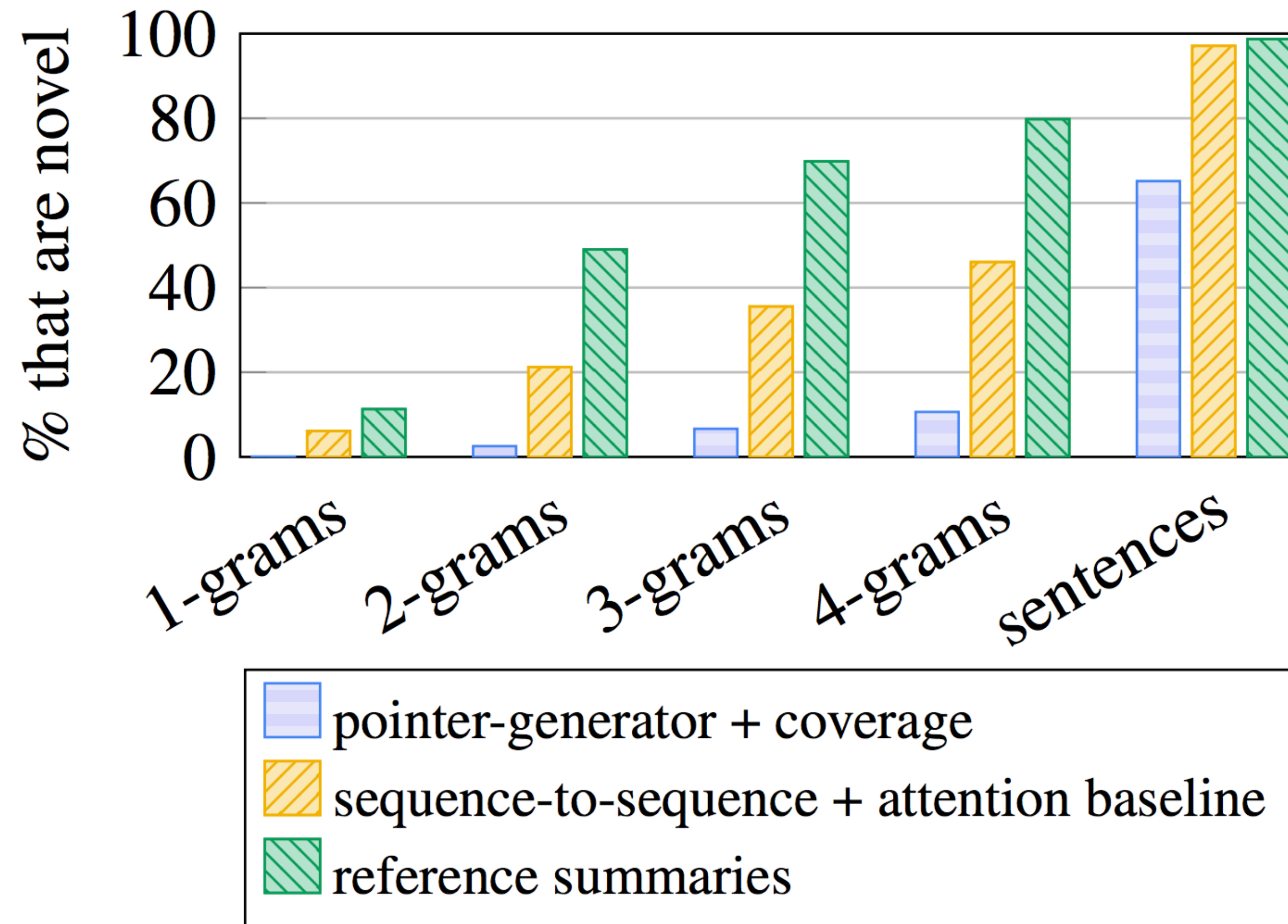
**Pointer-Gen + Coverage:** *muhammadu buhari* says he plans to aggressively fight corruption that has long plagued nigeria. he says his administration is confident it will be able to thwart criminals. the win comes after a long history of military rule, coups and botched attempts at democracy in africa's most populous nation.

- Things might still go wrong, no way of preventing this...

See et al. (2017)

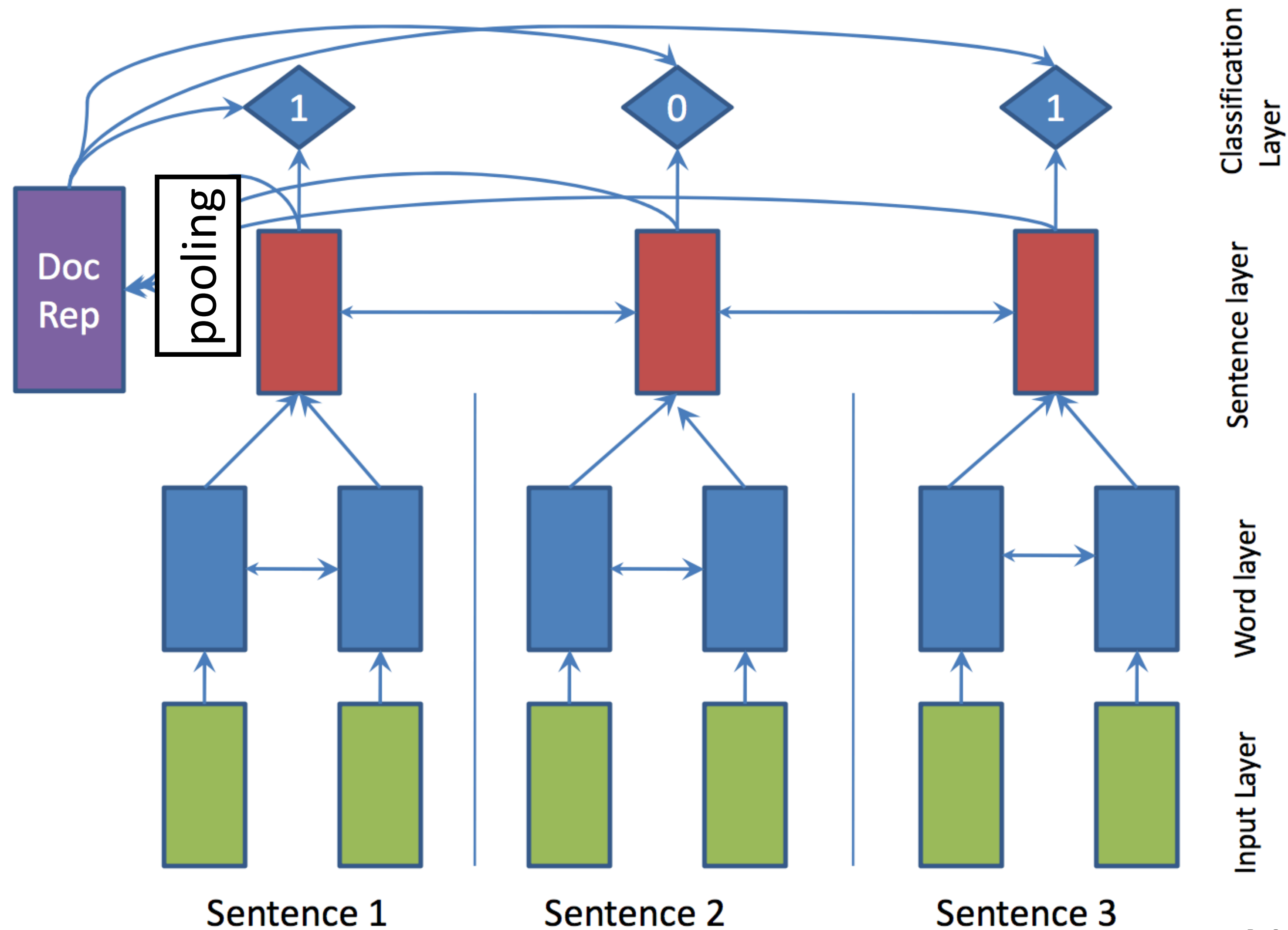
# Neural Abstractive Systems

- ▶ How abstractive is this, anyway?



See et al. (2017)

# Neural Extractive Systems





# Neural Systems: Results

---

	ROUGE		
	1	2	L
abstractive model (Nallapati et al., 2016)*	35.46	13.30	32.65
seq-to-seq + attn baseline (150k vocab)	30.49	11.17	28.08
seq-to-seq + attn baseline (50k vocab)	31.33	11.81	28.83
pointer-generator	36.44	15.66	33.42
pointer-generator + coverage	<b>39.53</b>	<b>17.28</b>	<b>36.38</b>
lead-3 baseline (ours)	40.34	17.70	36.57
lead-3 baseline (Nallapati et al., 2017)*	39.2	15.7	35.5
extractive model (Nallapati et al., 2017)*	39.6	16.2	35.3

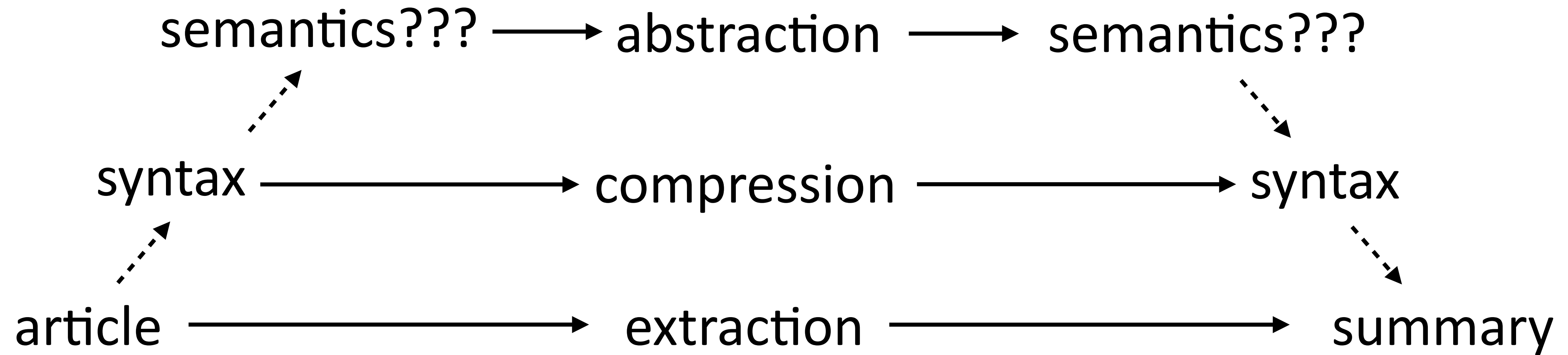
- ▶ Copy mechanism and coverage help substantially
- ▶ Abstractive systems don't/barely beat a "lead" baseline on ROUGE

See et al. (2017)



# Challenges of Summarization

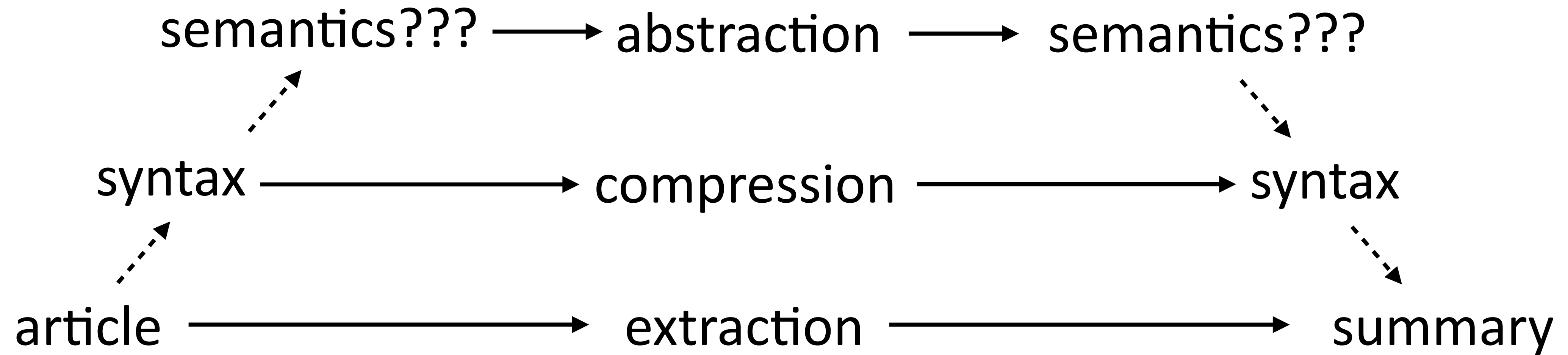
---



- ▶ True abstraction?

# Challenges of Summarization

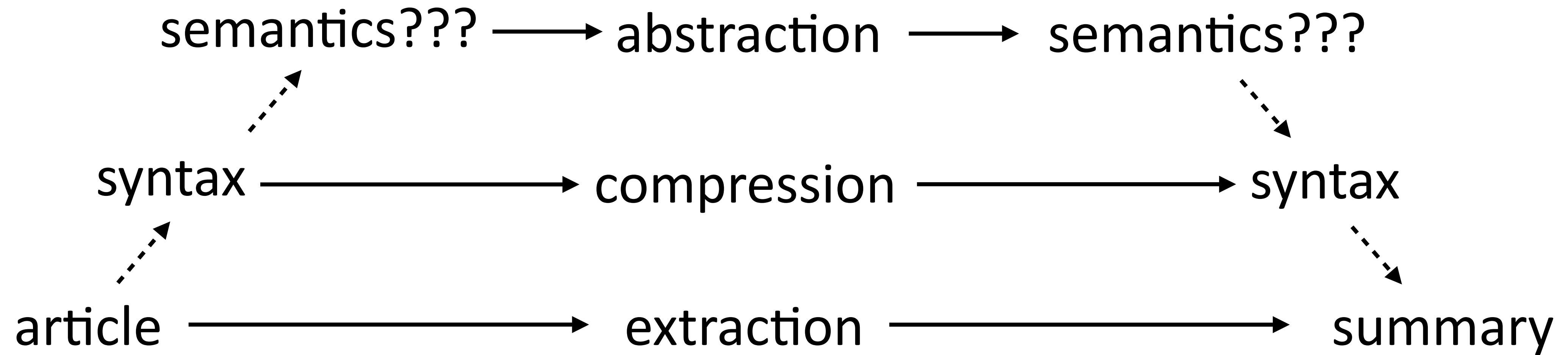
---



- ▶ True abstraction?
  - ▶ Not really necessary for articles

# Challenges of Summarization

---



- ▶ True abstraction?
  - ▶ Not really necessary for articles
  - ▶ Generating from structured information can usually be done with templates...

# Takeaways

---

- ▶ Extractive systems built on heuristics / ILPs work pretty well
- ▶ Compression can make things better, especially in the single-document setting
- ▶ Neural systems (like MT models) can do abstractive summarization, but they often just copy inputs (or deviate from inputs in bad ways)