

Resolving “This-issue” Anaphora

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- What's the **issue**?

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- What's the **issue**?
- This work: Resolving such anaphora

Background and Motivation

Abstract Anaphora

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Abstract Anaphora

antecedent

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anaphor

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anaphor

Abstract object anaphora (Asher 1993)

Anaphora in which the anaphor refers to an abstract object

- an event, a proposition, or a property

Different Syntactic Shapes

1. *There is a controversial debate whether back school program might improve quality of life in back pain patients. This study aimed to address this issue.*

Different Syntactic Shapes



clause

1. *There is a controversial debate whether back school program might improve quality of life in back pain patients. This study aimed to address this issue.*

Different Syntactic Shapes



clause

1. *There is a controversial debate whether back school program might improve quality of life in back pain patients. This study aimed to address this issue.*
2. *Women are a rarity in mathematics and engineering. As a female engineering student, I see this every day. That said, the idea that this fact is representative of the different biological programming between men and women is utter nonsense.*

Different Syntactic Shapes



clause

1. *There is a controversial debate whether back school program might improve quality of life in back pain patients. This study aimed to address this issue.*



sentence

2. *Women are a rarity in mathematics and engineering. As a female engineering student, I see this every day. That said, the idea that this fact is representative of the different biological programming between men and women is utter nonsense.*

Imprecise Boundaries

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Other Challenges

- Scarce annotated data
- Split antecedents
 - Discontinuous spans of text
- Implicit antecedents
 - Reader has to infer the actual referent

Our Focus

- Several abstract demonstrative nouns:
this problem, this idea, this decision
(Francis 1994, Schmid 2000)
- Resolve abstract anaphora signalled by abstract demonstrative nouns

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VERY HARD!!

This work: Resolve abstract anaphora
signalled by *this issue*

Why “issue”?

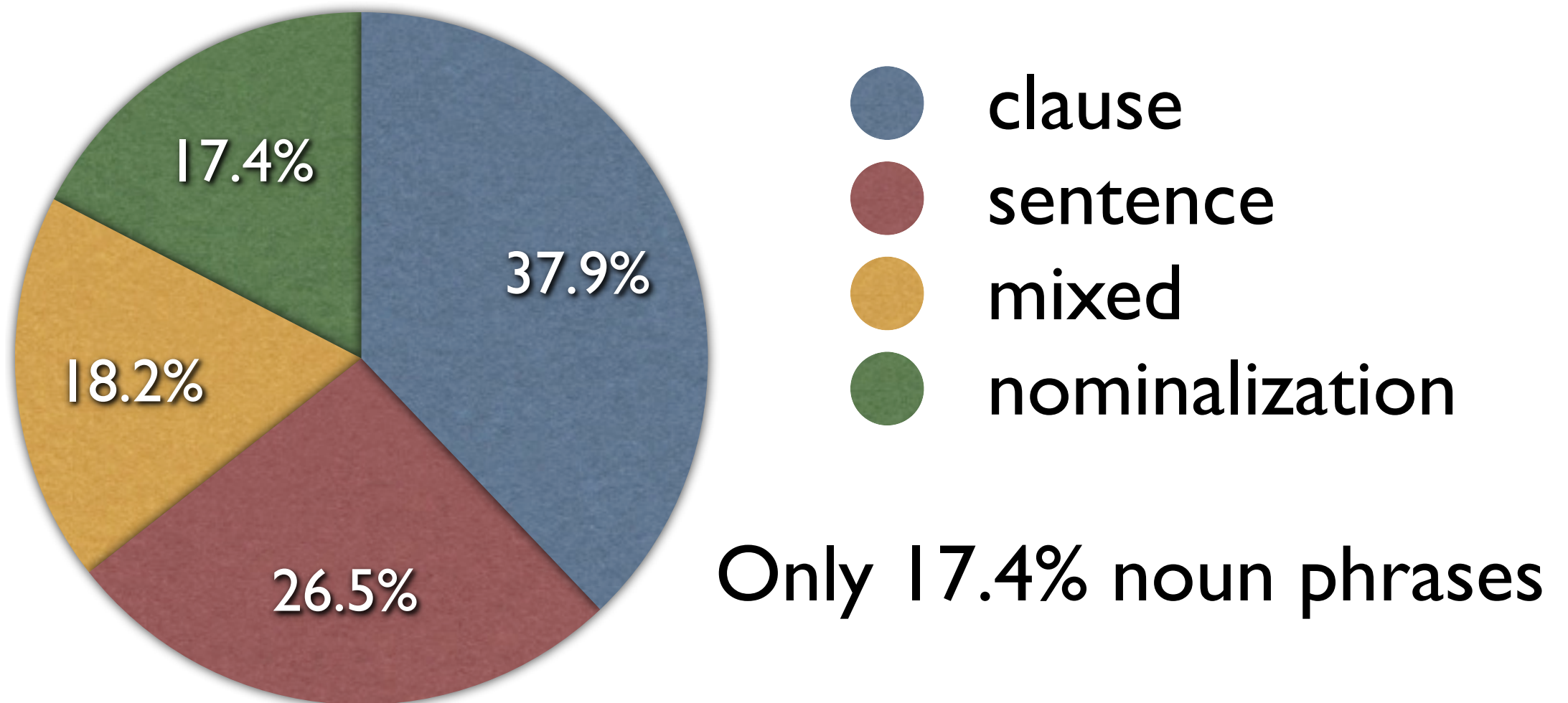
- Common in all kinds of text
(13,489 instances in the NYT and 1,116 instances in 65,000 Medline abstracts)
- Antecedents take several syntactic forms
(e.g., sentence, clause, nominalization, mixed).
- Tractable problem at least in certain domains

Annotation

Data and Annotation

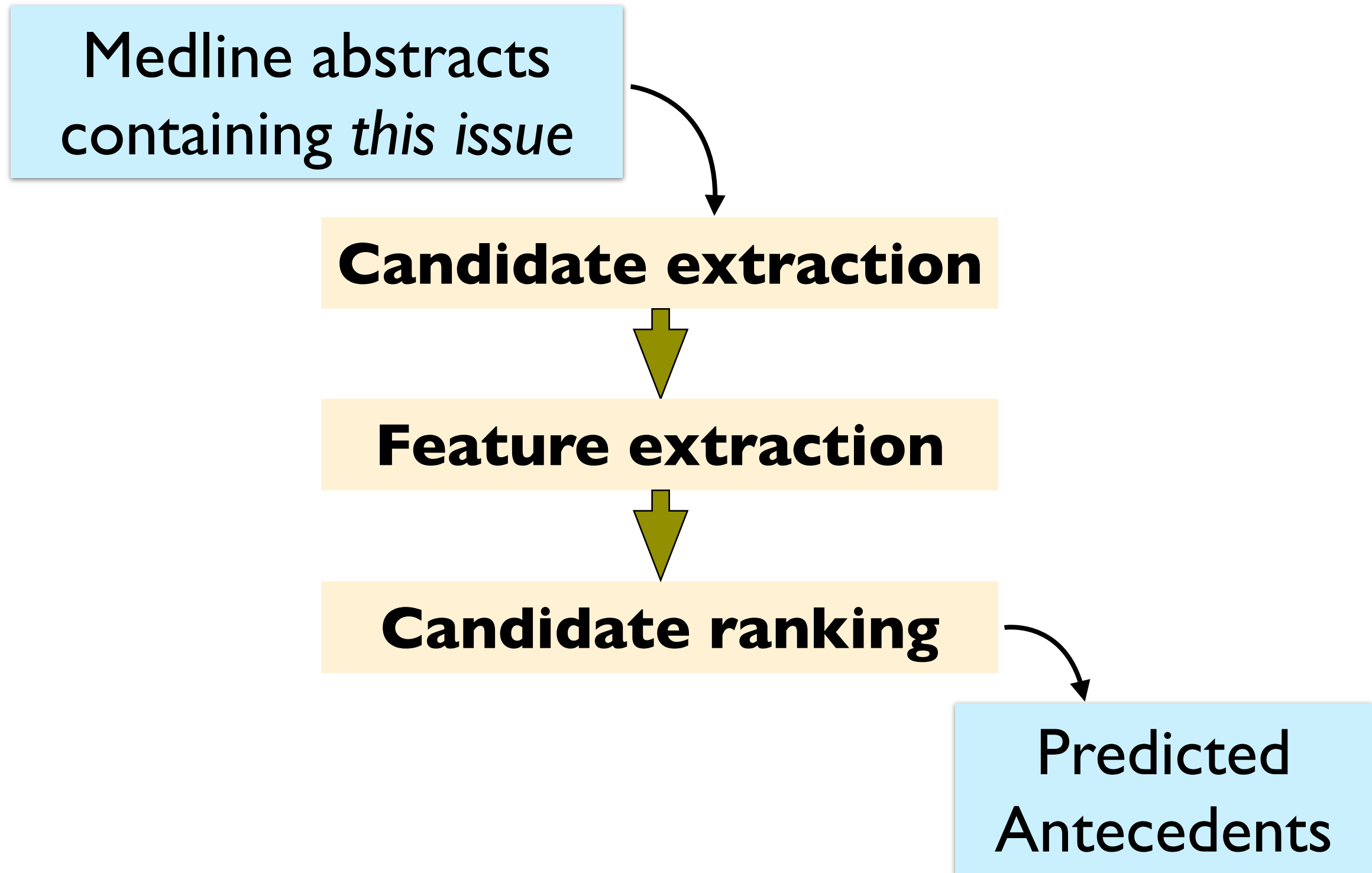
- 183 *this issue* instances from the Medline abstracts
- Task: marking text segments as antecedents
- Two annotators independently annotated 132 instances
- Inter-annotator agreement of 0.86 using Krippendorff's **unitizing** alpha (Krippendorff 1995)
- One annotator annotated remaining 51 instances

Antecedent Types



Resolution Algorithm

Resolution Algorithm



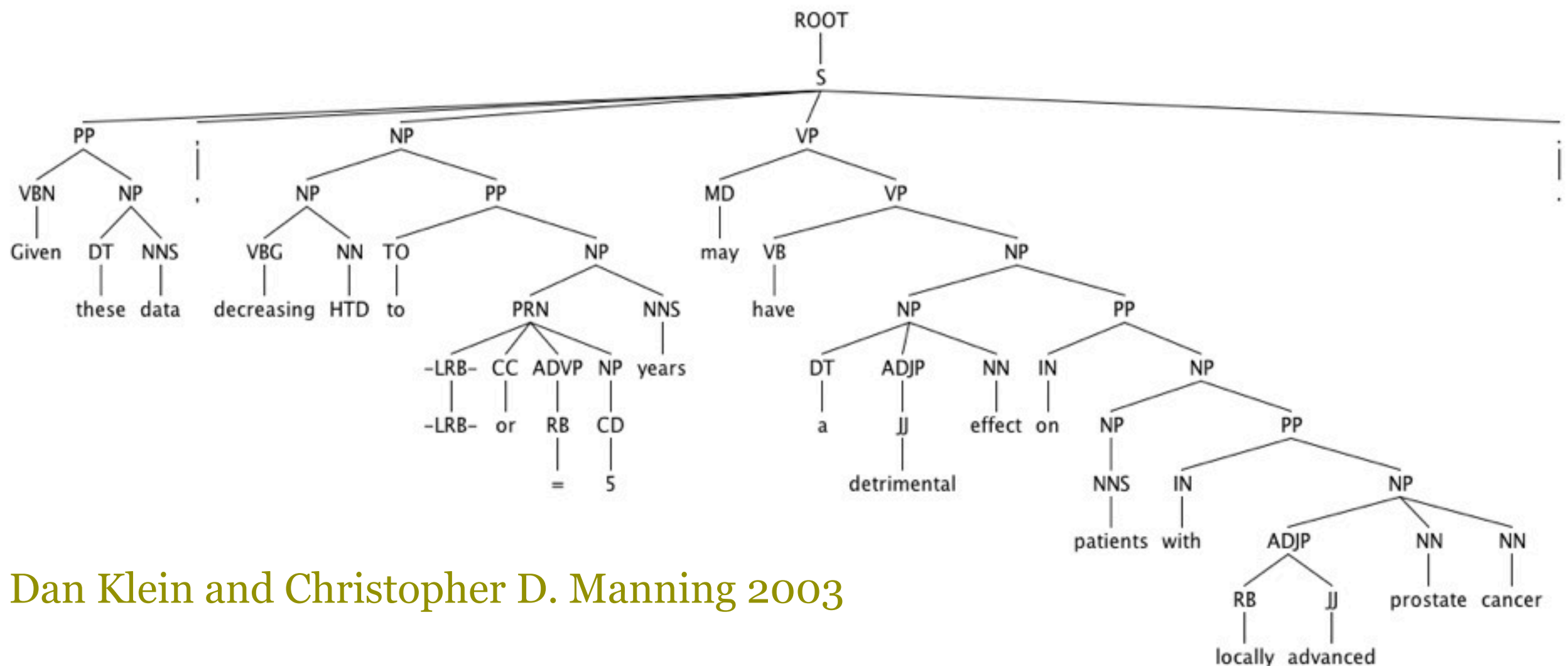
Candidate Extraction

- Three sentences as a source for candidates

*In this hypothesis-generating analysis, prolonged HTD of more than 5 years seems significantly associated with improvements in most outcomes. Given these data, decreasing HTD to $<$ or $=$ 5 years may have a detrimental effect on patients with locally advanced prostate cancer. Only a randomized trial will conclusively clarify **this issue**.*

Candidate Extraction

Given these data, decreasing HTD to \leq 5 years may have a detrimental effect on patients with locally advanced prostate cancer.

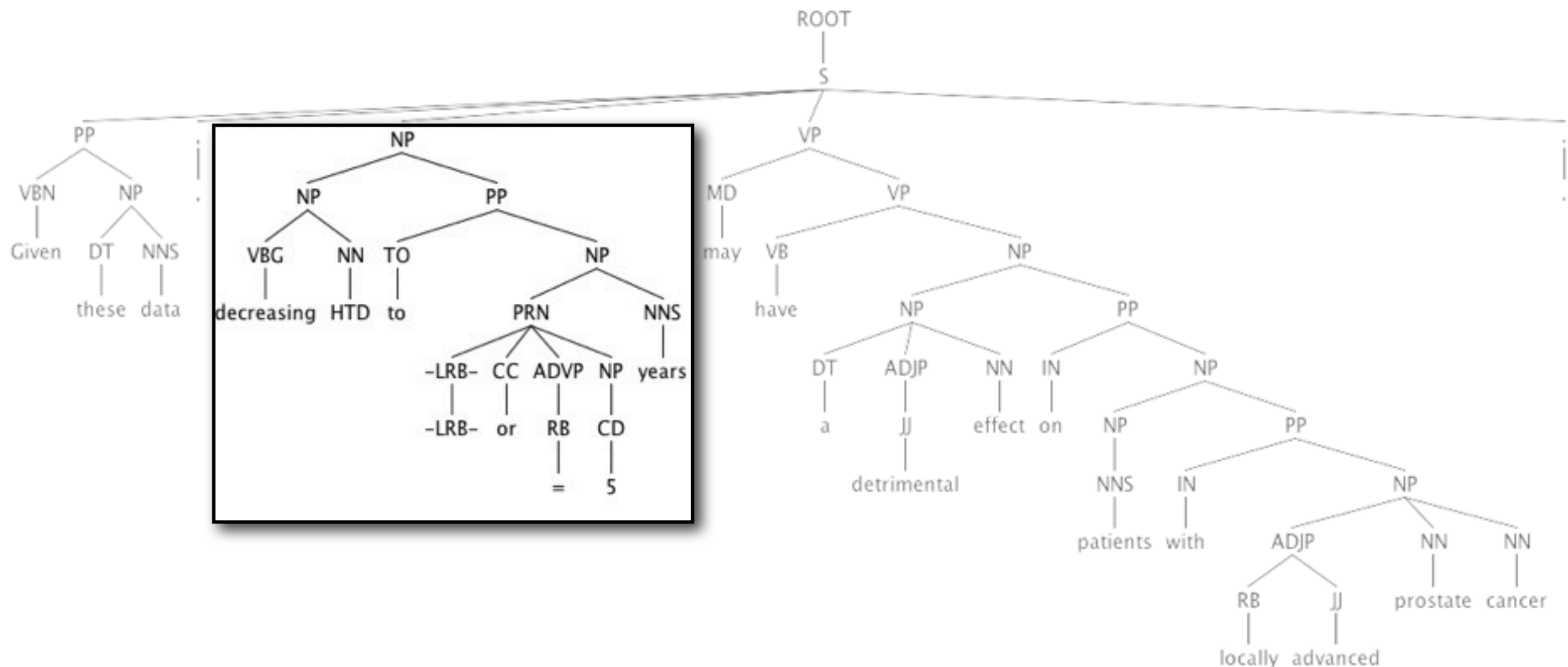


Dan Klein and Christopher D. Manning 2003

Candidate Extraction

Candidate: *decreasing HTD to < or = 5 years*

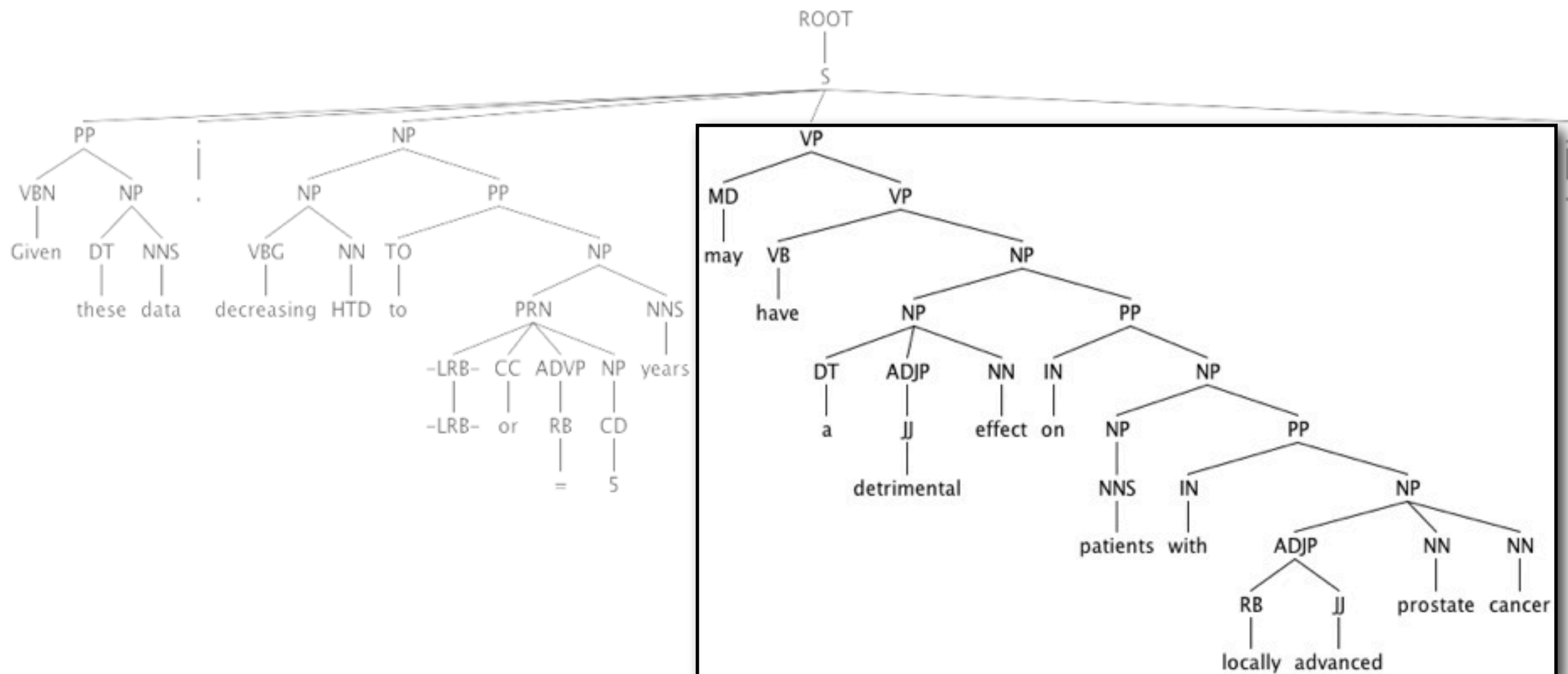
Syntactic type: **noun phrase**



Candidate Extraction

Candidate: *may have a detrimental effect on patients with locally advanced prostate cancer*

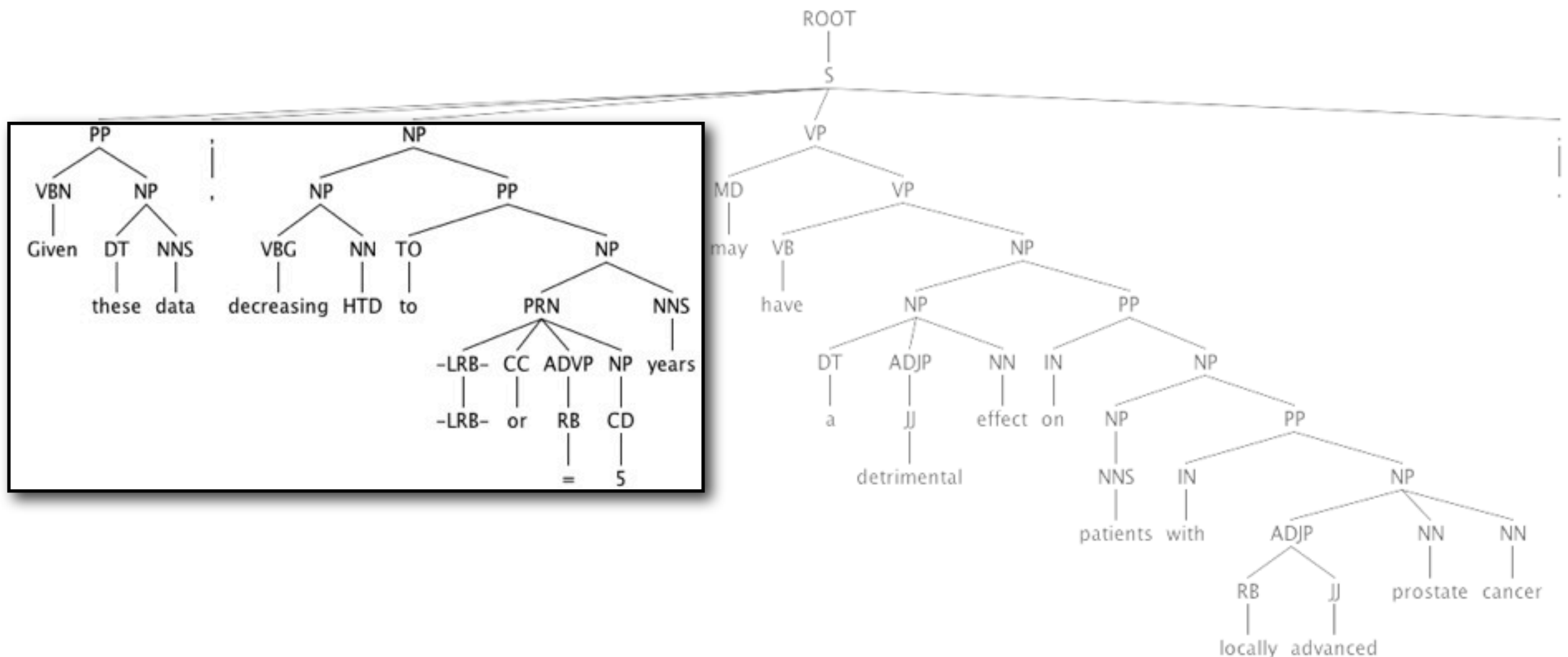
Syntactic type: **verb phrase**



Candidate Extraction

Candidate: *Given these data, decreasing HTD to \leq 5 years*

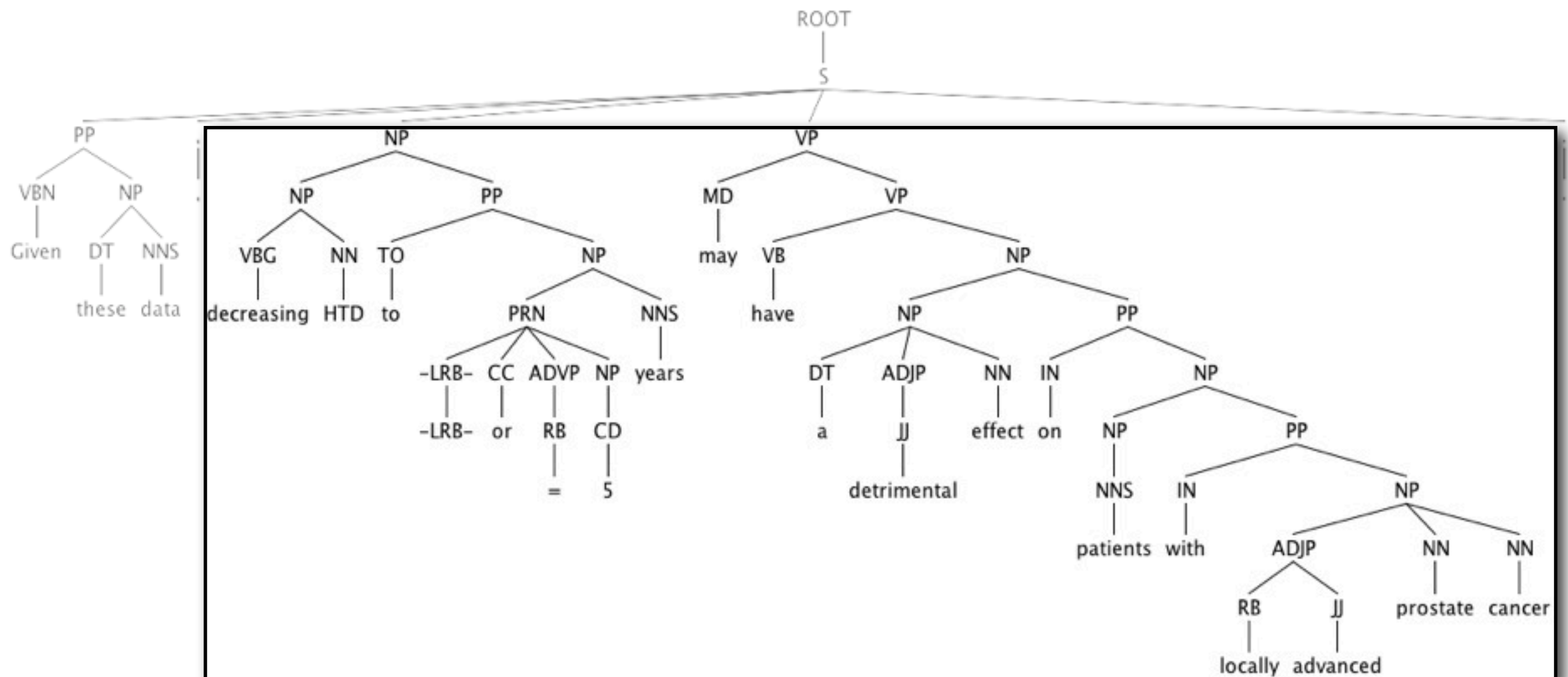
Syntactic type: **mixed (PP + NP)**



Candidate Extraction

Candidate: *decreasing HTD to < or = 5 years may have a detrimental effect on patients with locally prostate cancer*

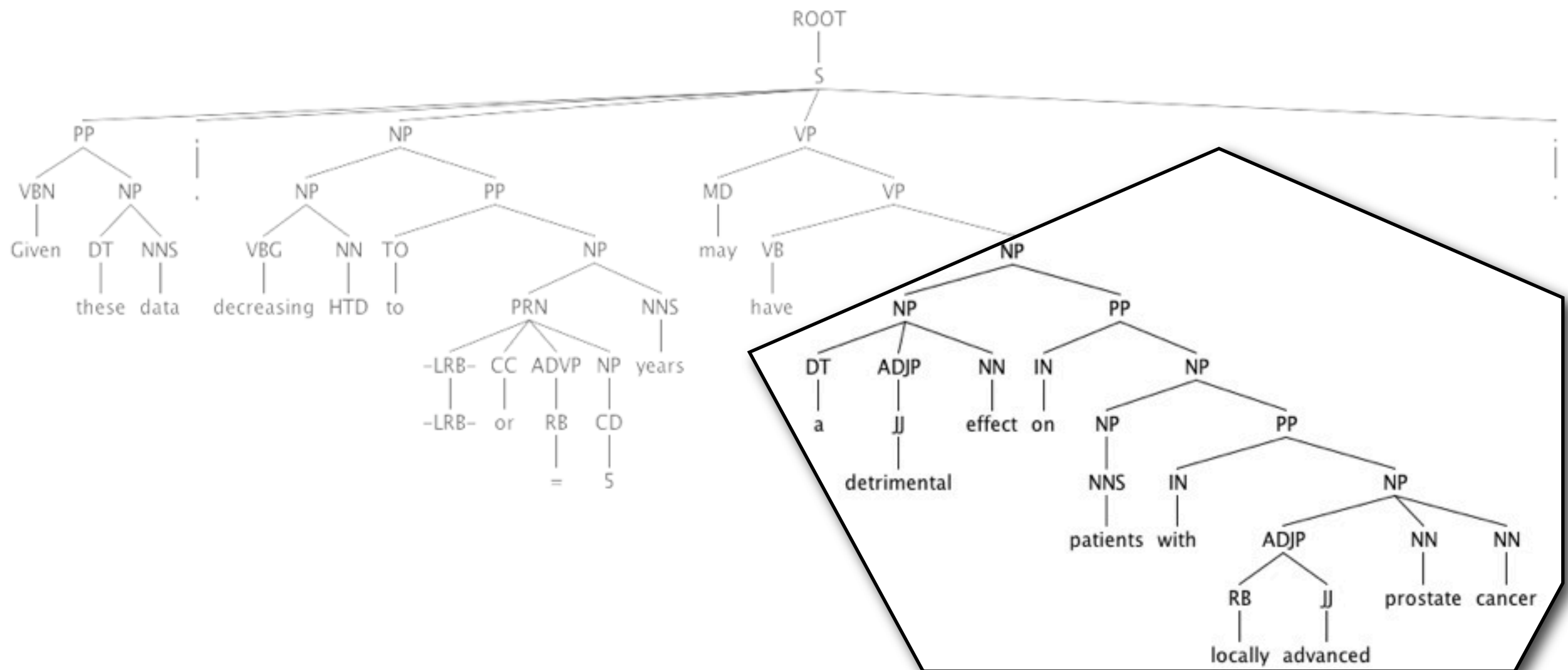
Syntactic type: **mixed (NP + VP)**



Candidate Extraction

Candidate: *a detrimental effect on patients with locally advanced prostate cancer*

Syntactic type: **noun phrase**



Feature Extraction

- 12 feature classes, 43 automatically extracted features
- *Issue-specific features*
 - *Issue pattern*
(e.g., (IN whether) (S ...))
 - *Governing verb of the candidate*
(e.g., *debate, argue, speculate*)
 - *Candidate head in the dependency tree*
(e.g., *controversial, unknown*)

Non-*issue* Features

Feature	Description
syntactic type	syntactic type of the candidate
embedding level	embedding level in the parse tree
main clause	whether the candidate is in the main clause
dependency	dependency relation of the candidate to its head
semantic role	semantic role of the candidate
context	context of the candidate
modals	presence of modals
subordinating conjunction	presence of subordinating conjunctions
lexical overlap	word overlap (e.g., with anaphor sentence)
distance	distance of the candidate from the anaphor
length	number of words in the candidate

Müller 2008; Srikumar and Roth 2011; de Marneffe et. al. 2006

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	lexical overlap	word overlap (e.g., with anaphor sentence)
other	distance	distance of the candidate from the anaphor
	length	number of words in the candidate

Müller 2008; Srikumar and Roth 2011; de Marneffe et. al. 2006

Candidate Ranking

- Candidate ranking model (Denis and Baldridge 2008)
- Candidates for anaphor instance A_i
 $C = \{C_1, C_2, \dots, C_k\}$
- Corresponding feature vectors
 $C_f = \{C_{f1}, C_{f2}, \dots, C_{fk}\}$
- Training instances for anaphor instance A_i
 $(A_i, C_{fj}, \text{rank}) \forall C_{fj} \in C_f$
- SVM^{rank} (Joachims 2002)

Evaluation and Results

Evaluation Metrics

- Exact Match (EXACT-M)
 - Percentage of instances on which the system and the gold data agree
 - Rather a strict evaluation
- ROUGE-L-Like (RLL)
 - Similar to ROUGE-L (Lin 2004)
 - LCS (Longest Common Subsequence)
 $\text{LCS}(\text{'A B C D'}, \text{'B D E'}) = 2$

Evaluation Metric: RLL

- System-annotated antecedents: $S = \{S_1, S_2, \dots, S_n\}$
Gold antecedents: $G = \{G_1, G_2, \dots, G_n\}$

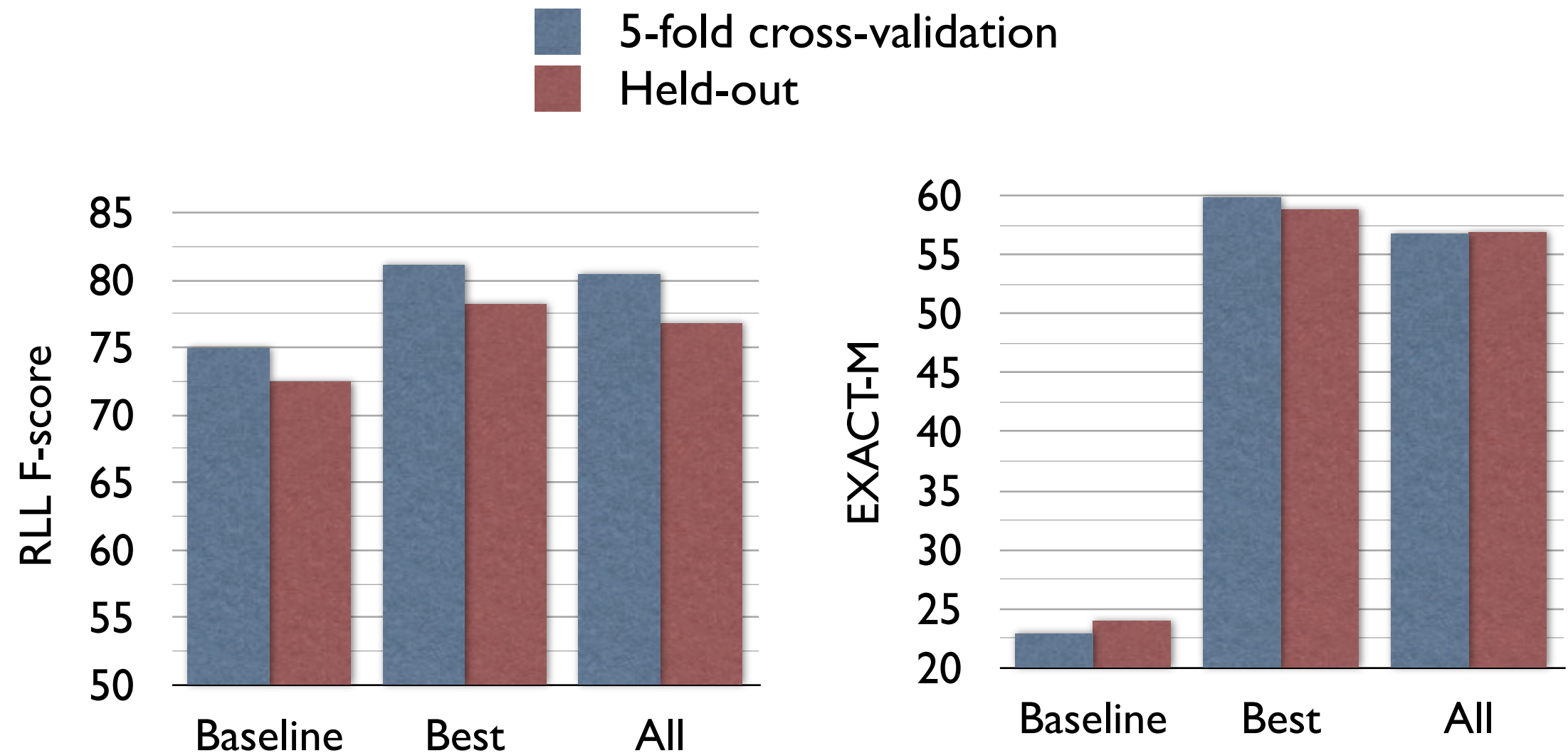
$$K = \sum_{i=1}^n LCS(S_i, G_i)$$

- $P_{RLL} = K / \text{\#words in } S$
- $R_{RLL} = K / \text{\#words in } G$
- RLL F-score = harmonic mean of P_{RLL} and R_{RLL}

Baseline

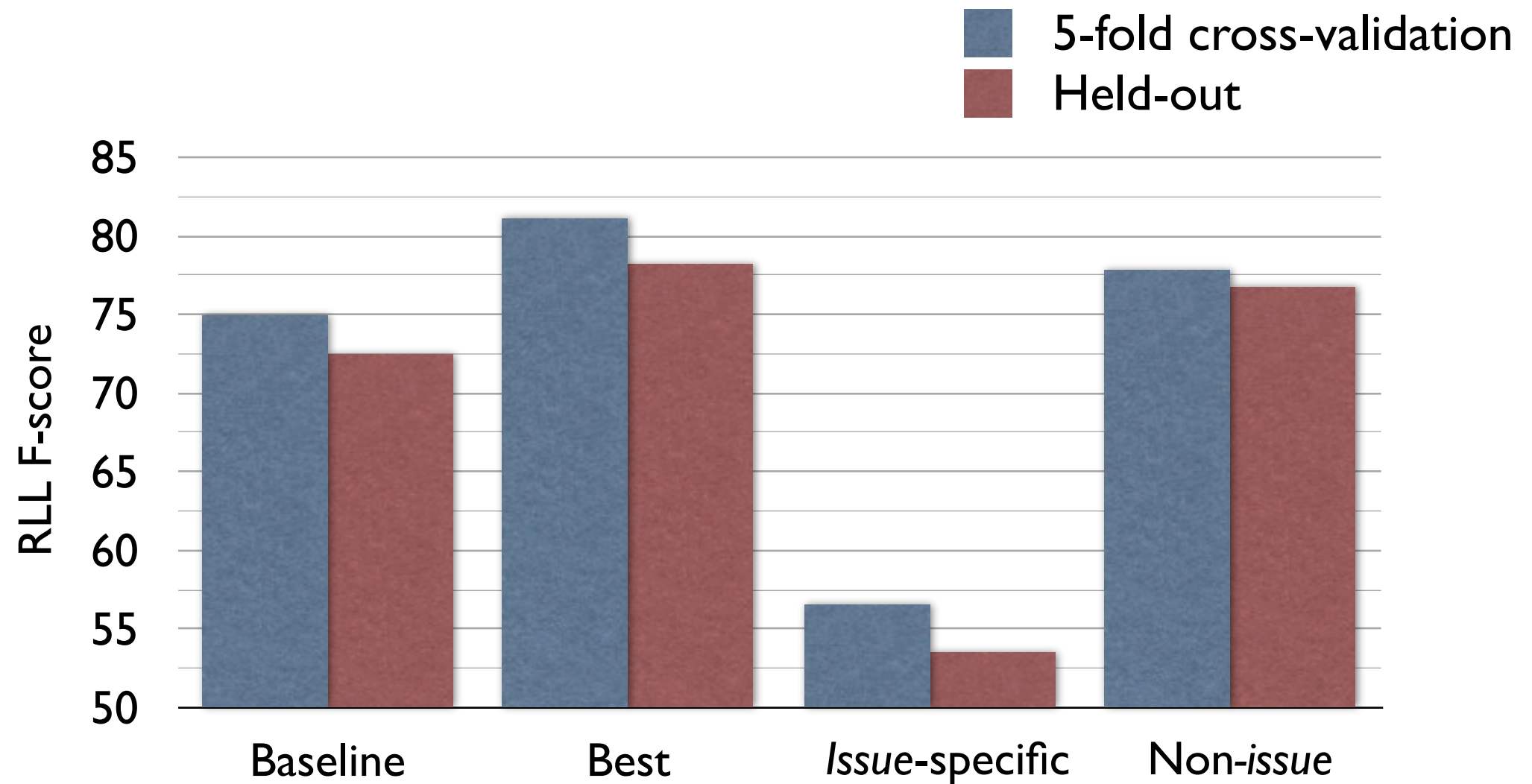
- Guess previous sentence as the antecedent
- High baseline
 - 84% of antecedents lie within this sentence

Performance of Our System

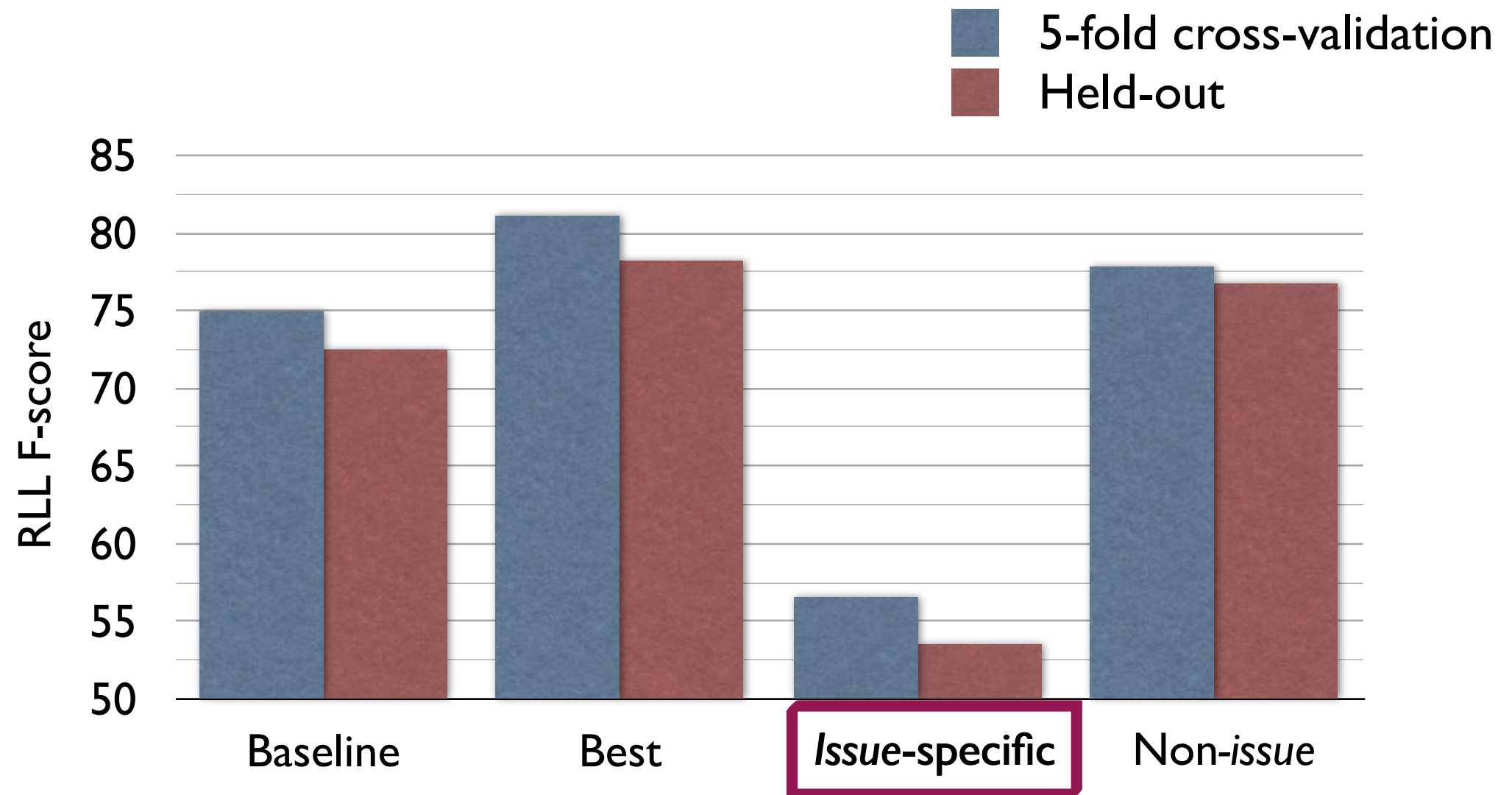


Our systems beat baselines.

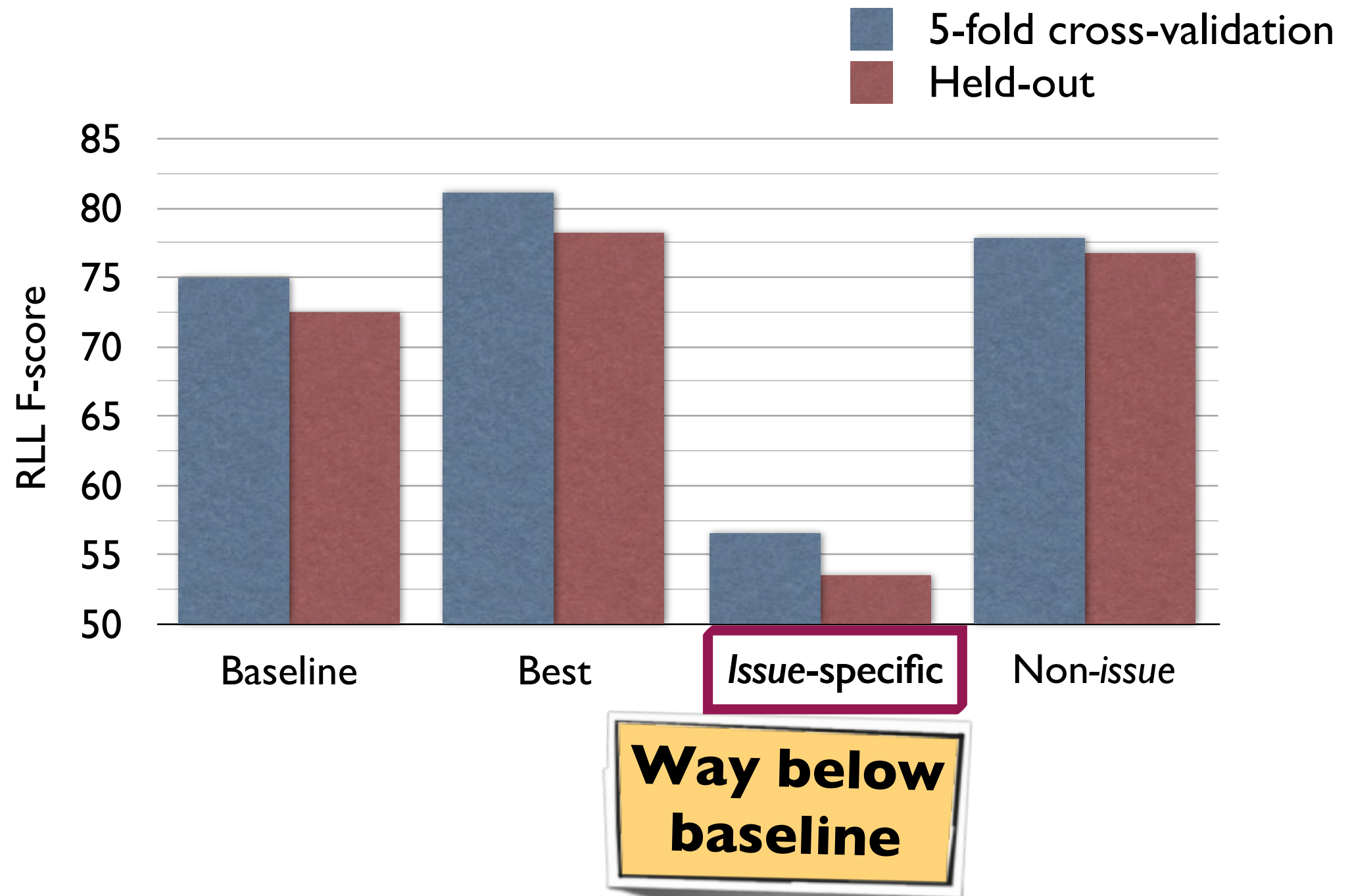
Issue-specific vs Non-issue



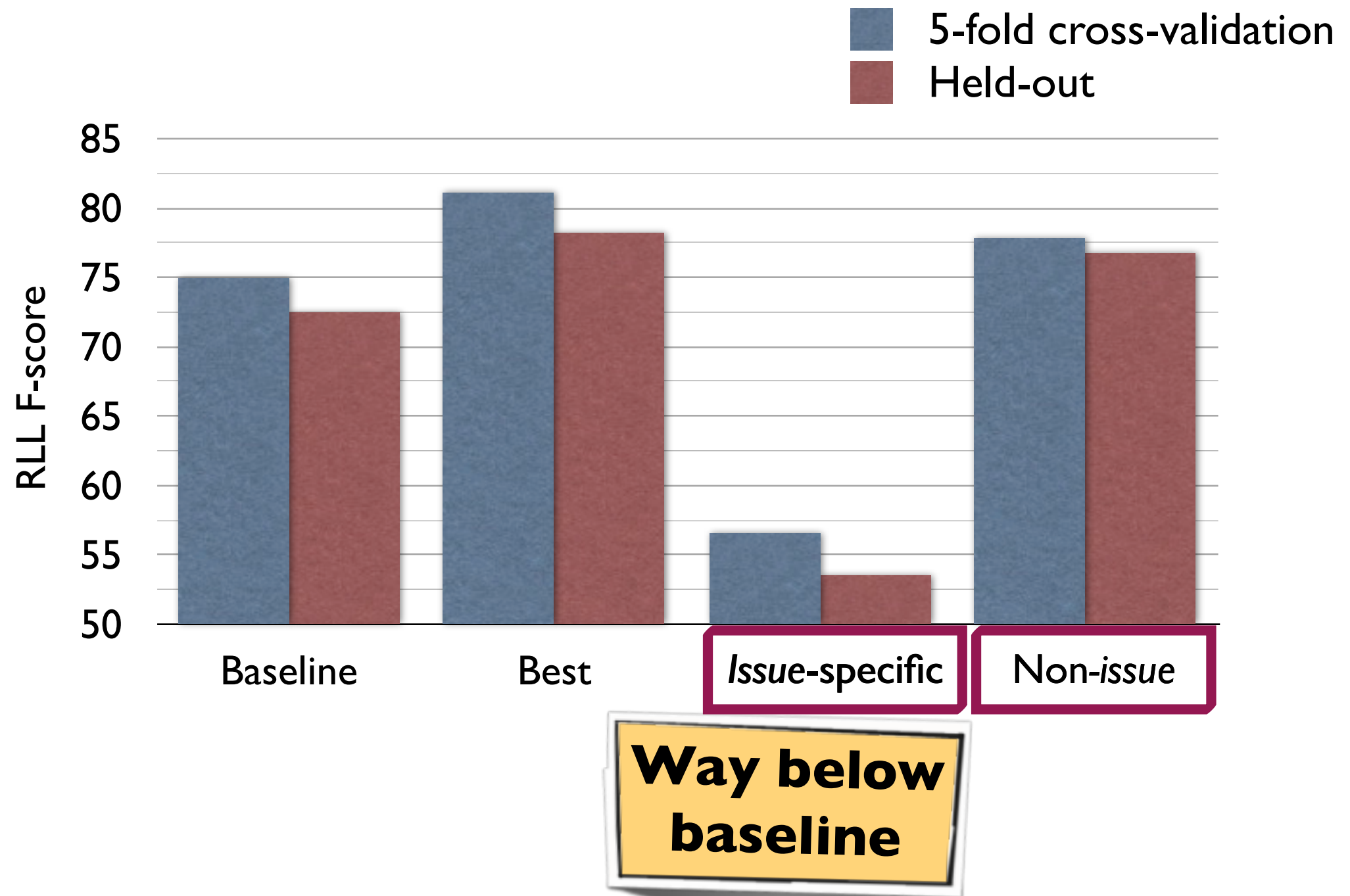
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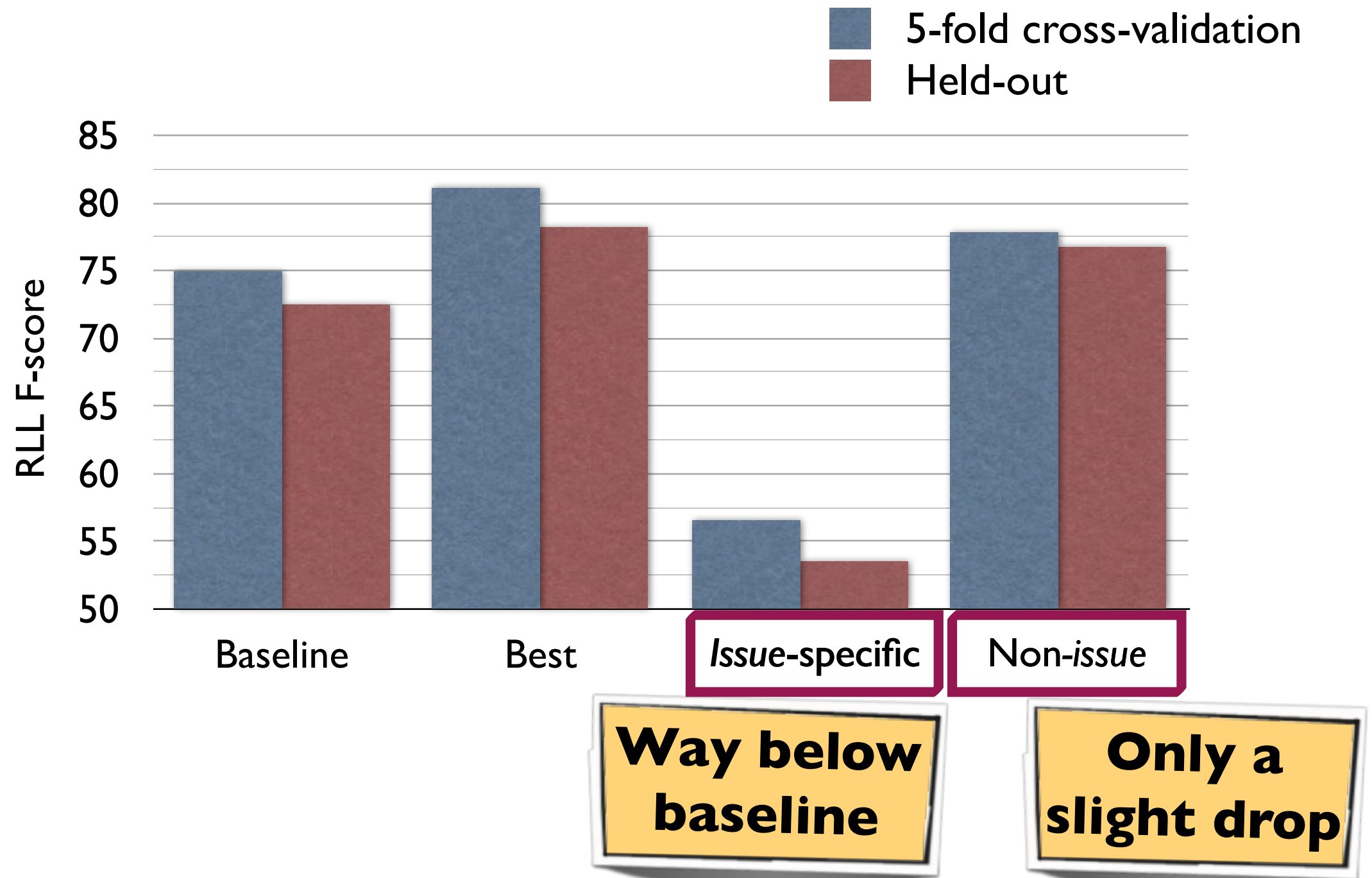
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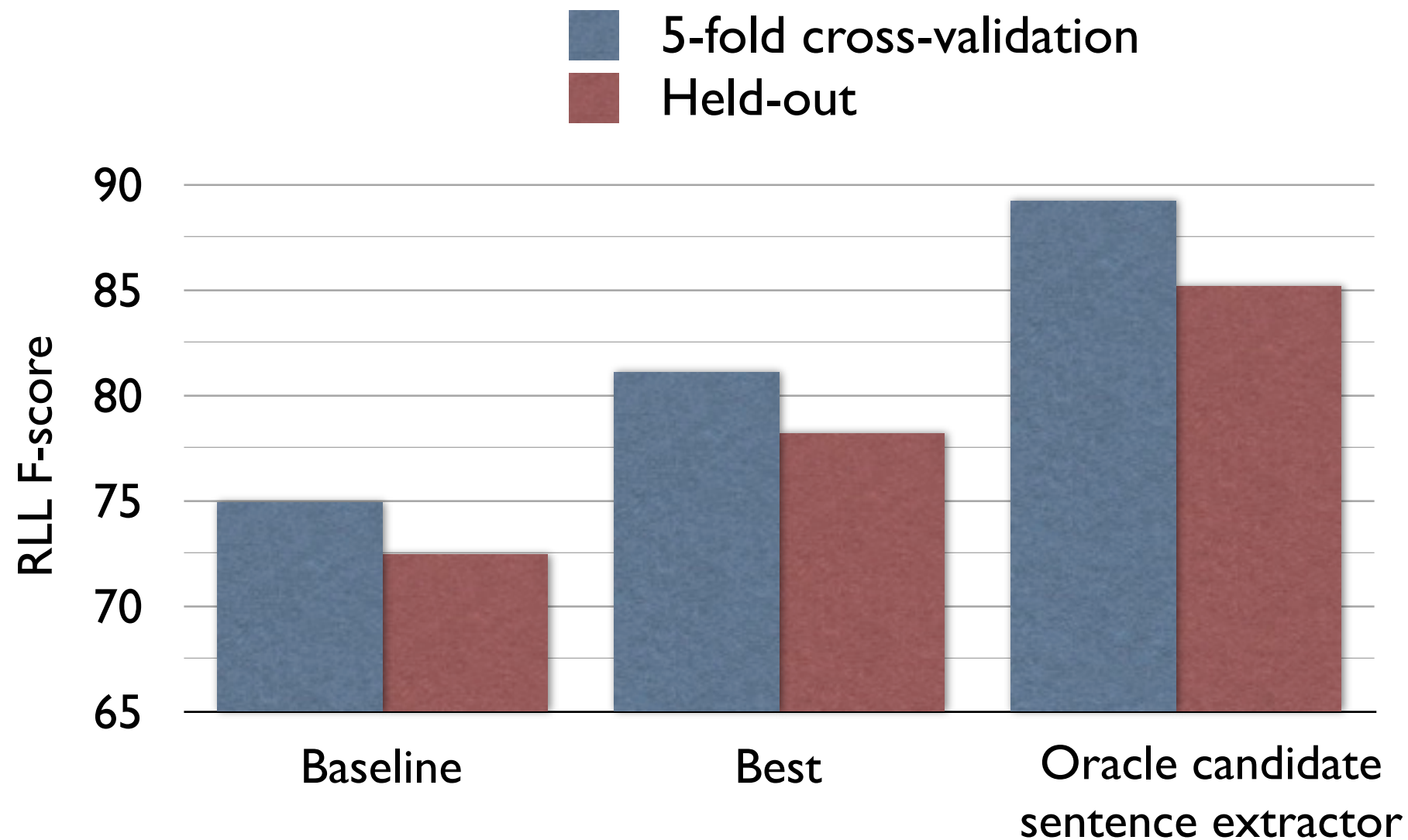
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Reducing Search Space

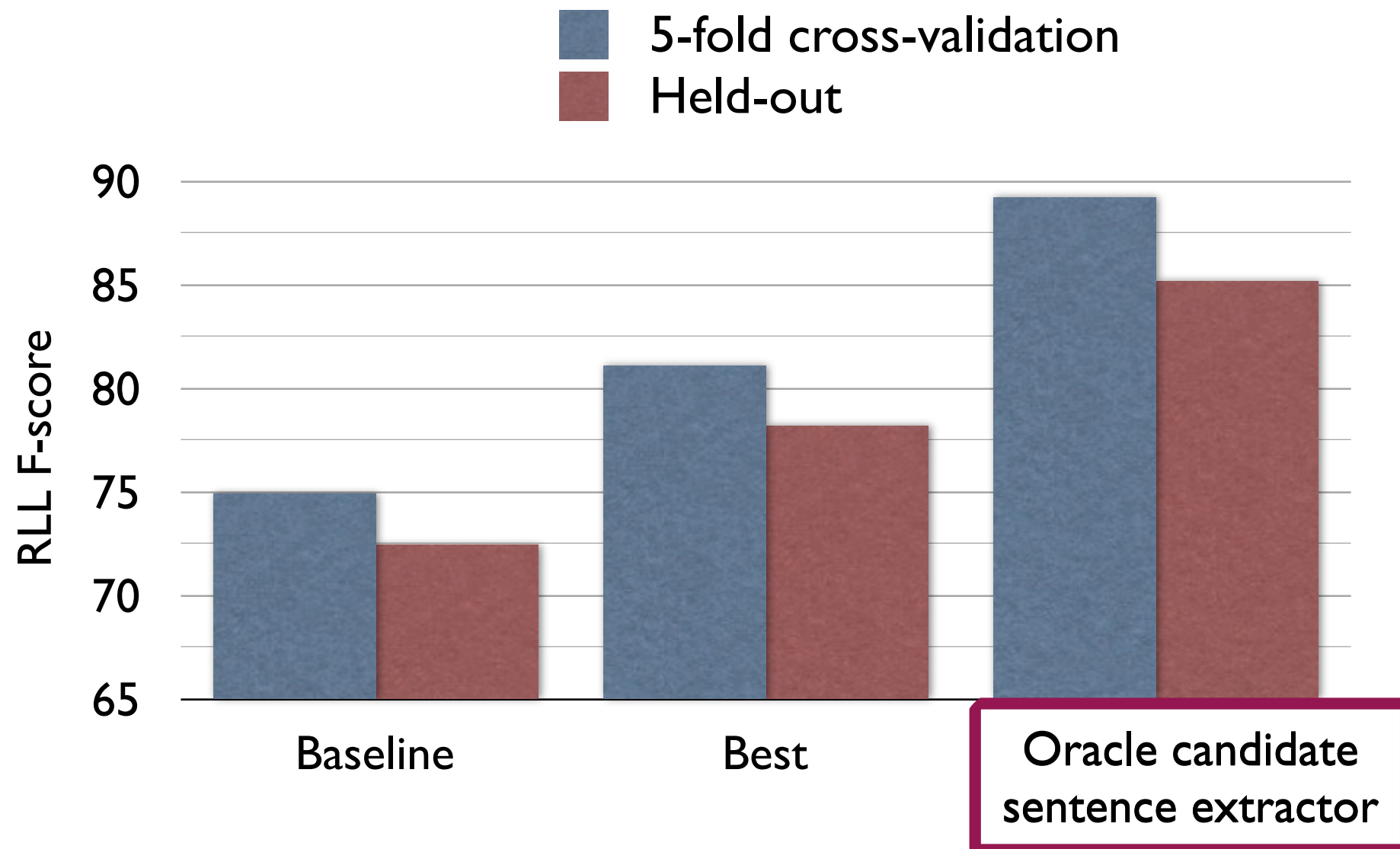
- Large search space
 - On average 43.6 constituents per sentence
- Can we reduce it?
 - Oracle candidate sentence extractor

Reduced Search Space



Reduction of search space markedly improved the performance.

Reduced Search Space



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Conclusion

Annotation and Resolution

- Possible to resolve abstract anaphora
 - In particular, *this-issue* anaphora
 - Text segments as antecedents

Non-*issue* Features

- Big role in *this issue* resolution
- Possible to generalize the approach to other abstract nouns
 - *decision, problem, and fact.*

Search Space Reduction

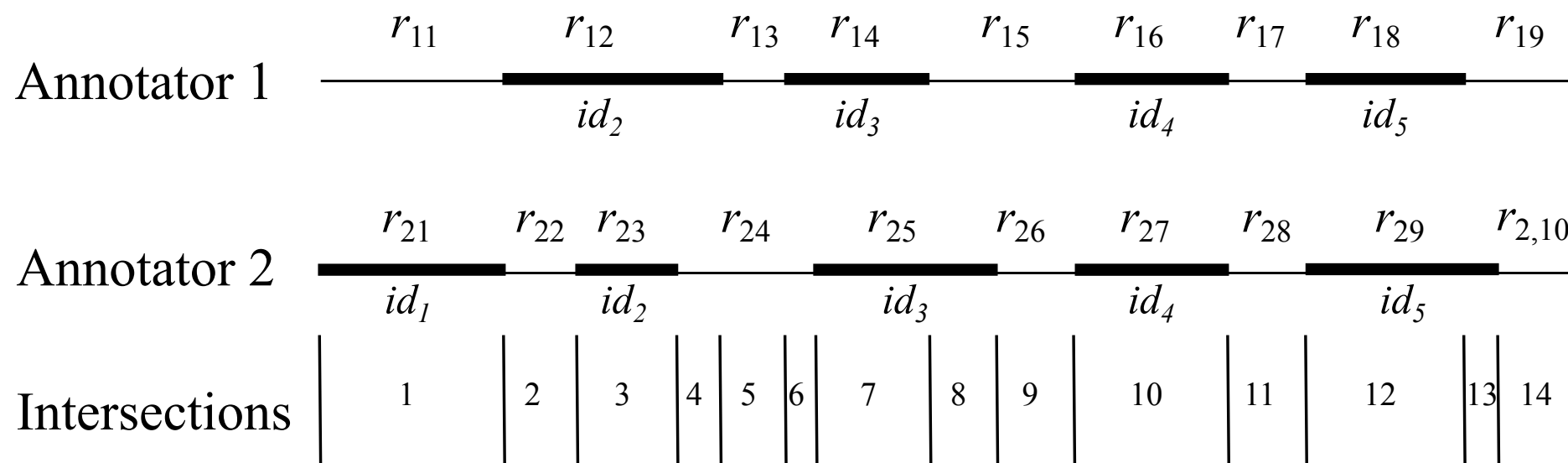
- Reduction of search space helps
- Possible to reduce the search space
 - Two-stage approach

Future Work

- Extend the work to other abstract nouns such as *problem*, *fact*, and *decision*.
- Experiment with a two-stage resolution approach.
- Extract issues from text using observed issue patterns (e.g., *X is controversial*, *X is under debate*) as seed patterns.

Thanks!

Krippendorff's Unitizing alpha



inter-annotator agreement = 0.86

LCS

- LCS definition:
A subsequence of a string S is the sequence of words that are not necessarily contiguous but are nevertheless taken in order .
- $LCS(\text{"There is a controversial debate whether back school program might improve quality of life in back pain patients."}, \text{"whether back school program might improve quality of life in back pain patients."}) = 13$

Split Antecedent

Because all of us carry some baggage from our past, I seldom arrive in Paris, where work takes me four or five times a year, without some feeling of being an ugly duckling or, at any rate, a small town person. No doubt it is for this reason -- I can think of no other -- that I stay in the same hotel, in the same room, and consider the area around the Place Vendôme my neighbourhood.

Label Nouns in NYT

Label Noun	Frequency	Schmid's Category
way	41,279	circumstantial
point	31,442	factual
issue	13,489	factual
area	11,961	circumstantial
decision	8,794	mental
problem	8,116	factual
situation	7738	circumstantial
approach	7434	circumstantial
question	6389	linguistic
view	6305	mental
information	6102	linguistic
plan	5990	mental
idea	4974	mental
reason	4558	factual
goal	3821	mental
argument	3501	linguistic
trend	3078	modal
fact	3001	factual
effect	2018	factual
conflict	1700	factual
feature	919	factual

After the loss of the Columbia, NASA considered removing or redesigning the PAL ramp. But agency officials said that no good alternatives emerged, and ultimately decided **not to change it. Instead, the ramp would be examined through an internal scan that would not require cutting into the material**, to look for the air pockets, or voids, that are the leading cause of foam shedding.

Agency officials have broadly admitted since then that **this decision** was a mistake. As Dr. Griffin said in a television interview on Sunday, "We goofed on that one."