Incremental Semantic Role Labeling with Tree Adjoining Grammar

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Human Language Processing

Human language processing is *incremental:* we update our parse of the input for each new word that comes in.

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Incrementality leads to local ambiguity, which we can observe in *garden path sentences:*

(1) a. The old man the boat.
b. I convinced her children are noisy.

Human Language Processing

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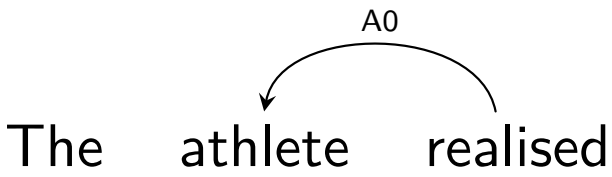
This indicates that humans *incrementally* assign semantic roles.

Let's look at this example in more detail.

Human Language Processing - Example



⟨A0,athlete,realised⟩

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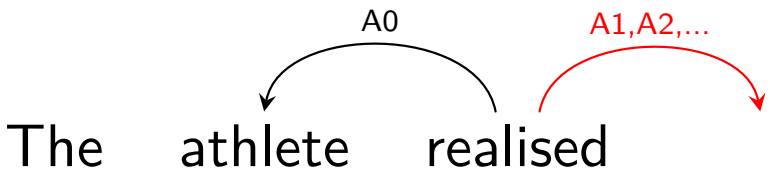
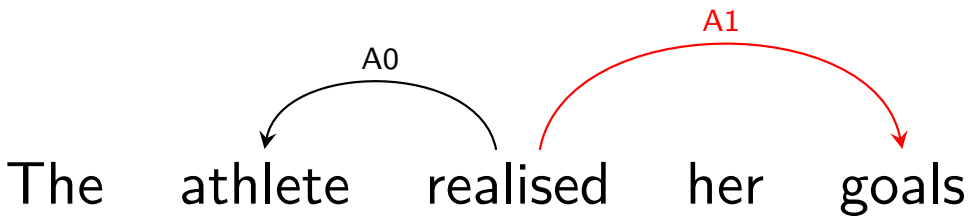


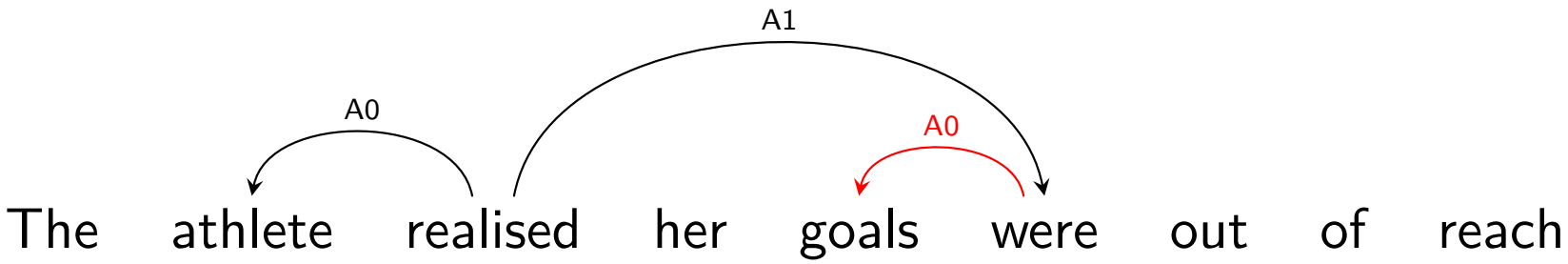
⟨A0,athlete,realised⟩
⟨[A1,A2],nil,realised⟩

Human Language Processing - Example



⟨A0,athlete,realised⟩
⟨A1,goals,realised⟩

Human Language Processing - Example



⟨A0,athlete,realised⟩
⟨A1,were,realised⟩
⟨A0,goals,were⟩

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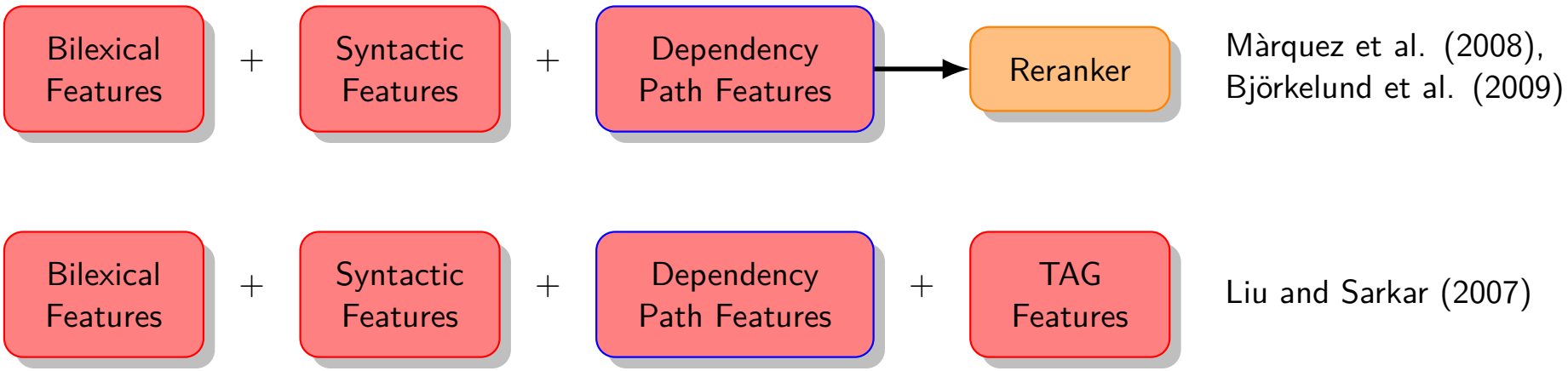
- Given a sentence prefix and its partial syntactic structure:
  1. Identify Arguments and Predicates
  2. Assign correct role labels
- Assign incomplete semantic roles

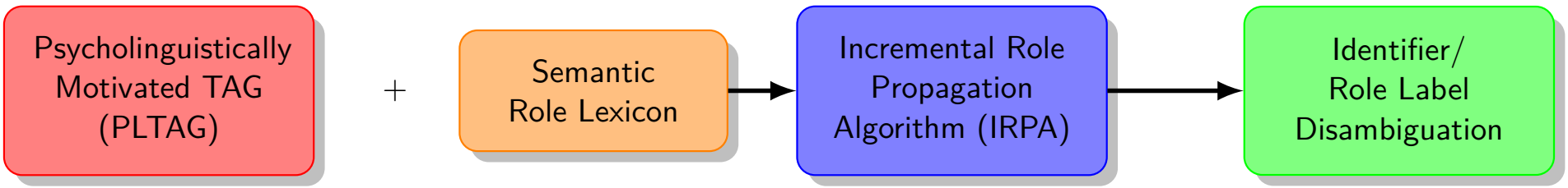
Non-incremental SRL

Pipeline approach

- Liu and Sarkar (2007)
- Màrquez et al. (2008)
- Björkelund et al. (2009) (MATE)



Model


Psycholinguistically Motivated TAG (PLTAG)
+
Semantic Role Lexicon
Incremental Role Propagation Algorithm (IRPA)
Identifier/ Role Label Disambiguation

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- it adds verification to verify predictive trees;

PLTAG supports parsing with incremental, fully connected structures.

PLTAG

Lexicon:

- Standard TAG lexicon
- Predictive lexicon (PLTAG)

Operations:

- Substitution
- Adjunction
- Verification (PLTAG)

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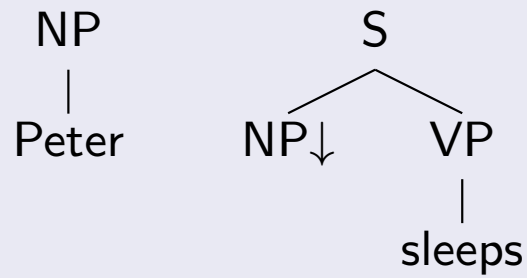
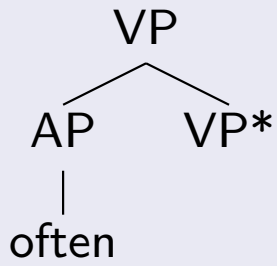
Example

Initial Tree:



Auxiliary Tree:



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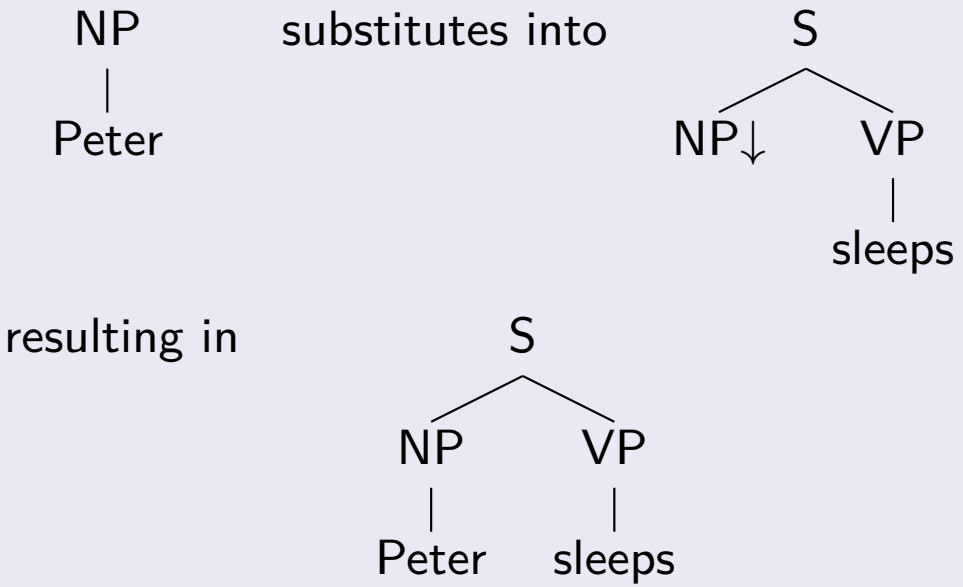

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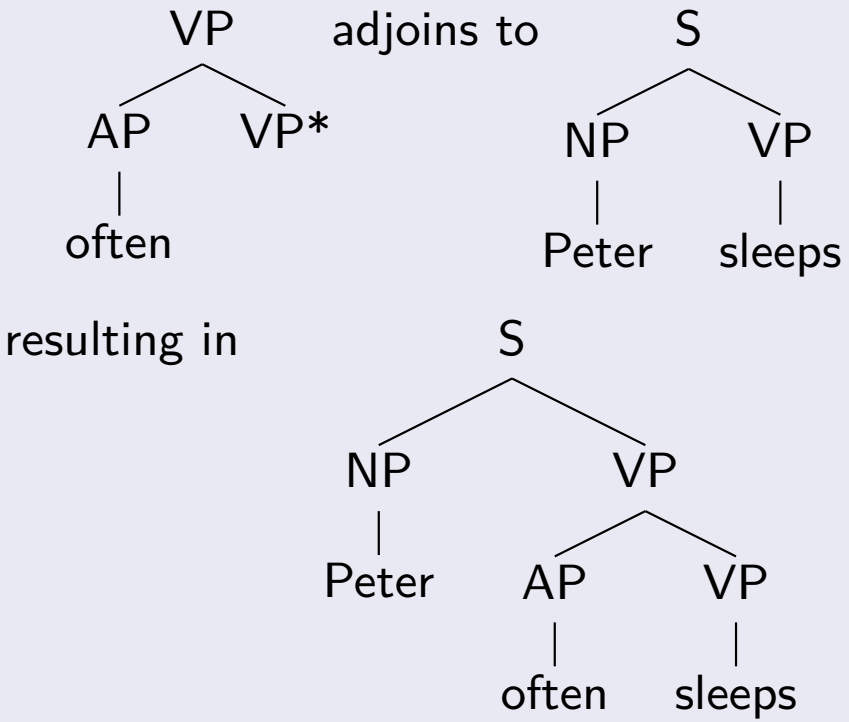

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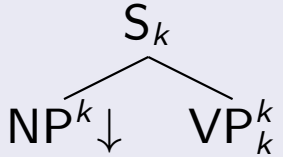
Example

Prediction Tree:



Index k marks predicted node.

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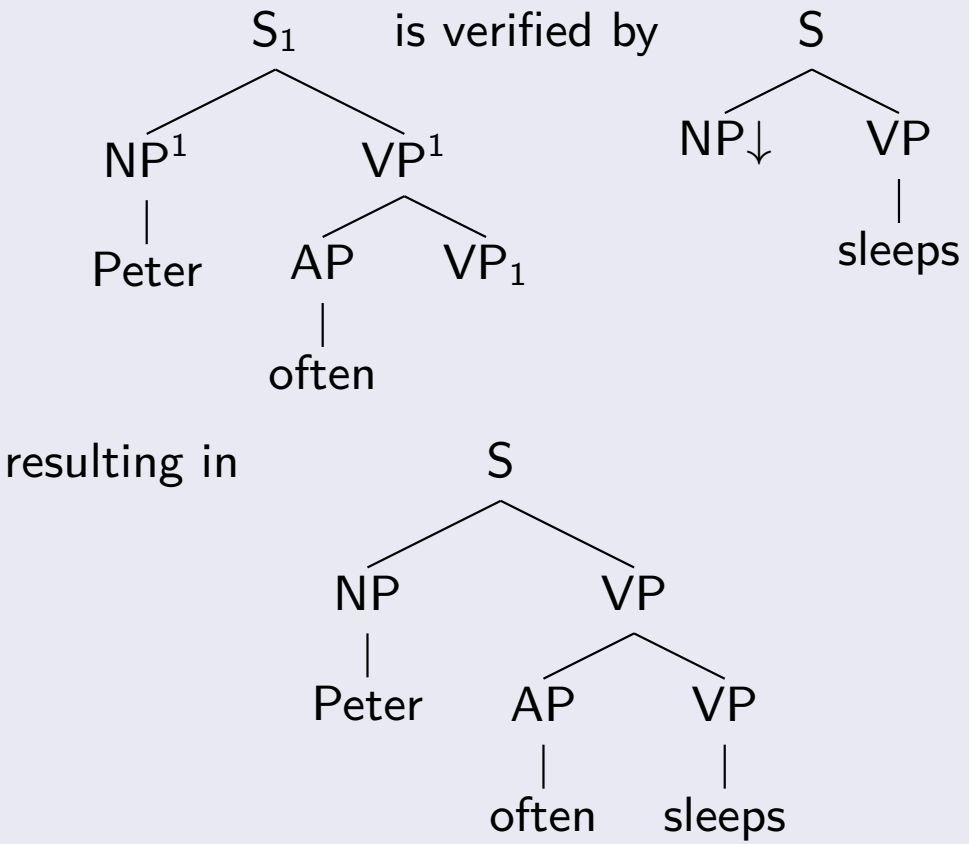
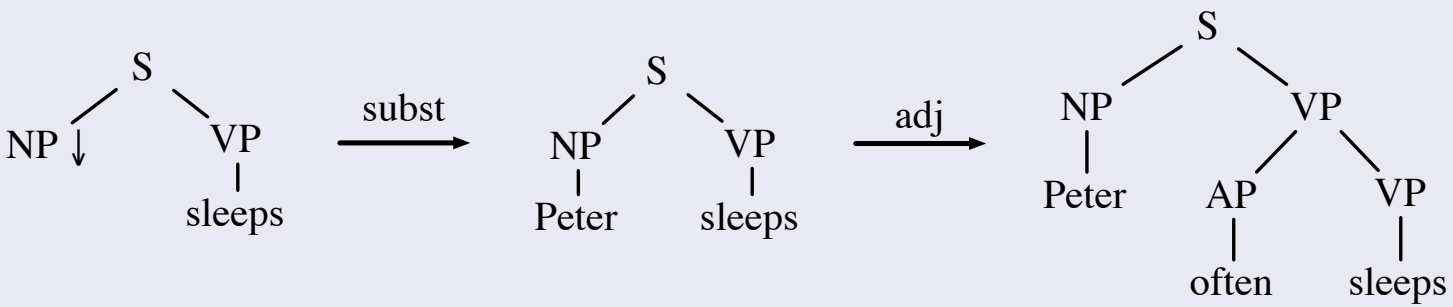


All nodes indexed with k have to be verified.

Comparison with TAG

TAG derivations are not always incremental.

Example



Comparison with TAG

PLTAG derivation are always incremental and fully connected.

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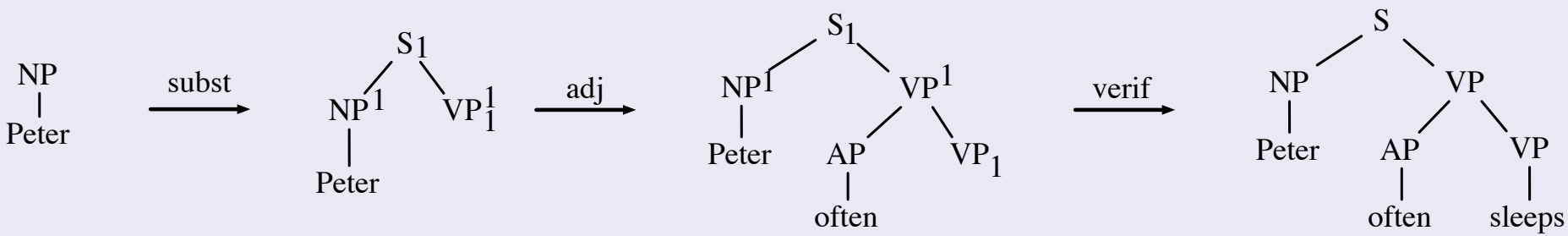
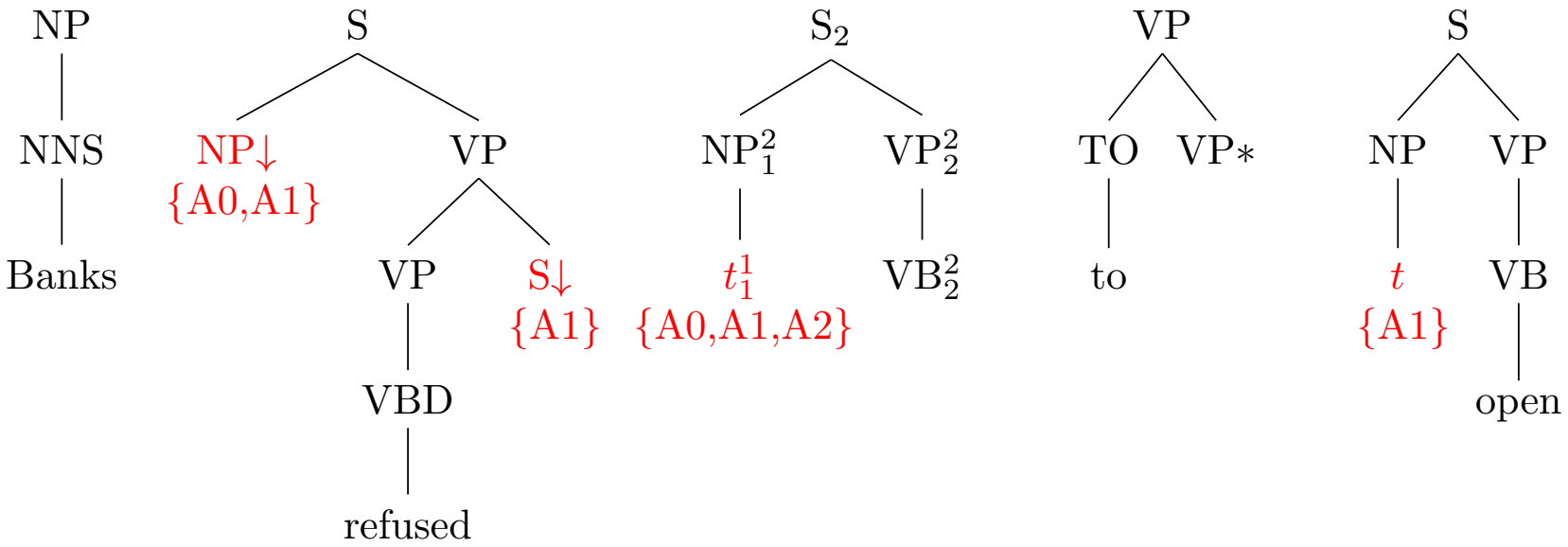
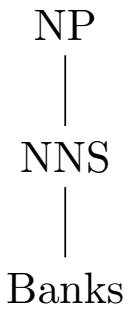


Semantic Roles in Lexicon

Used information for verb predicates *only*, derived from PropBank (Palmer, 2005)



Incremental Role Propagation Algorithm



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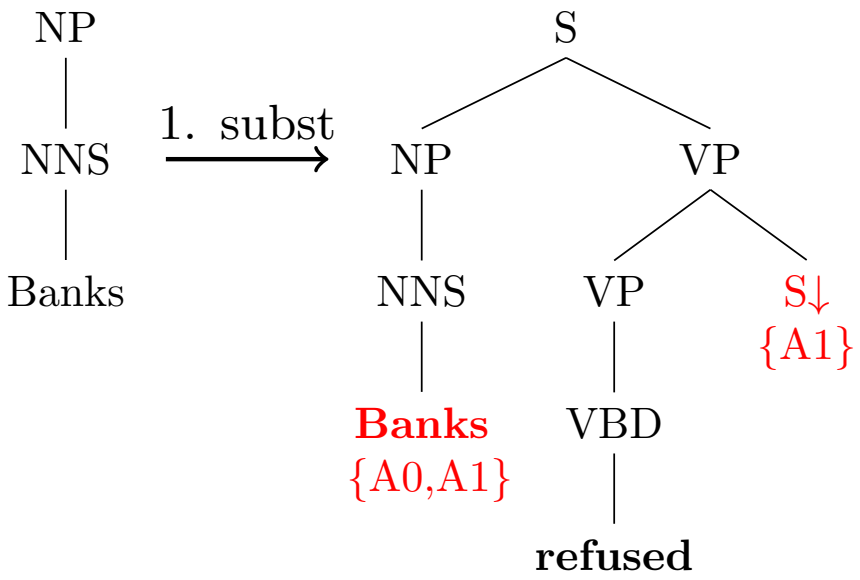

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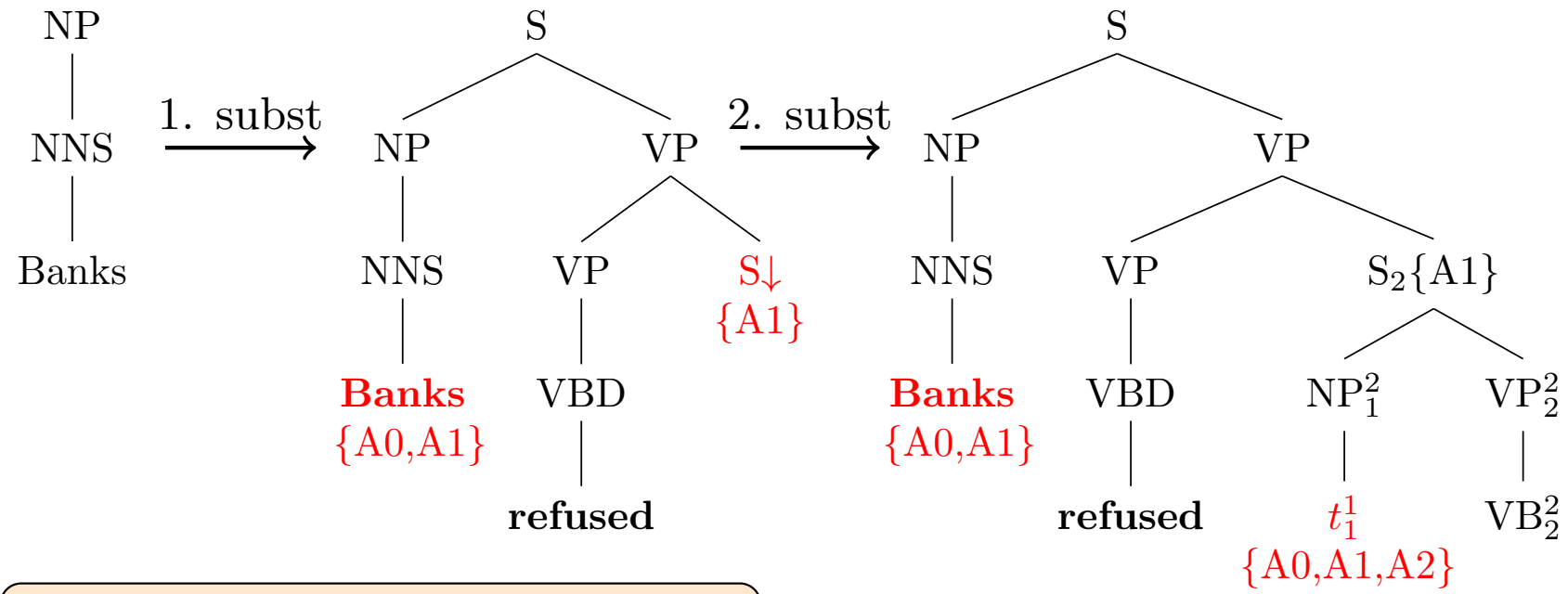

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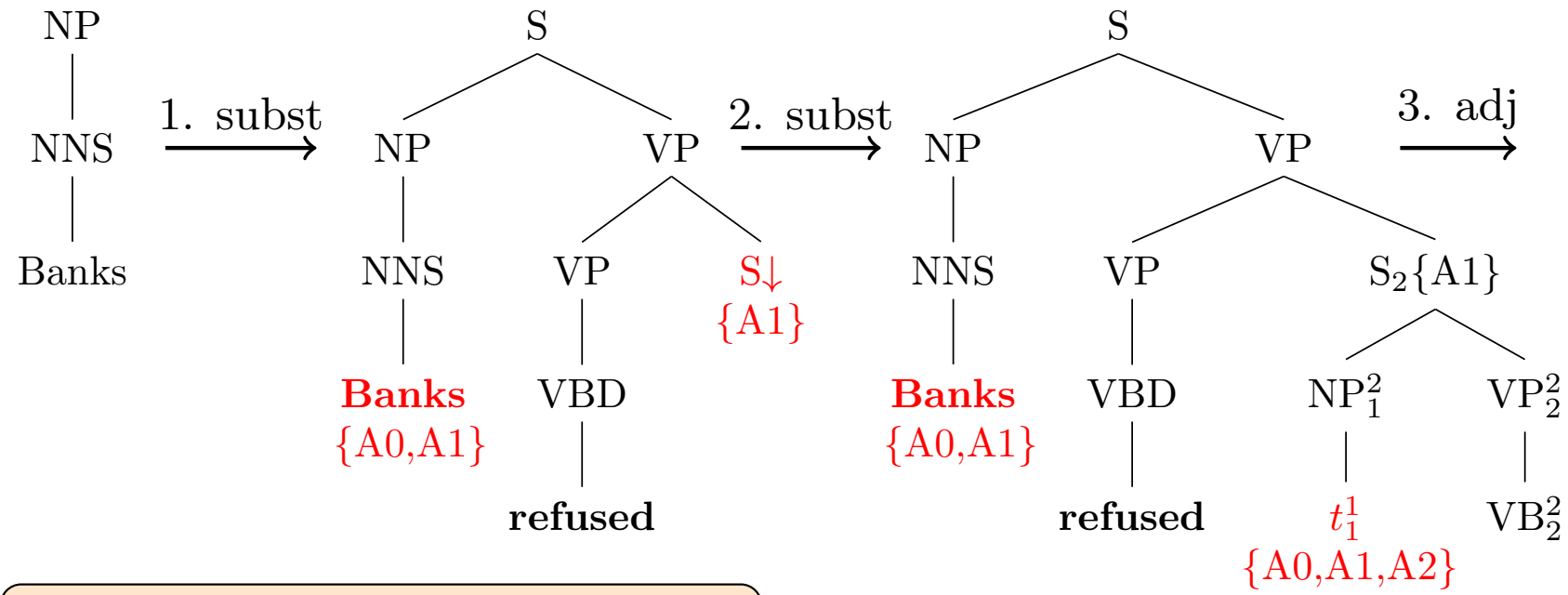

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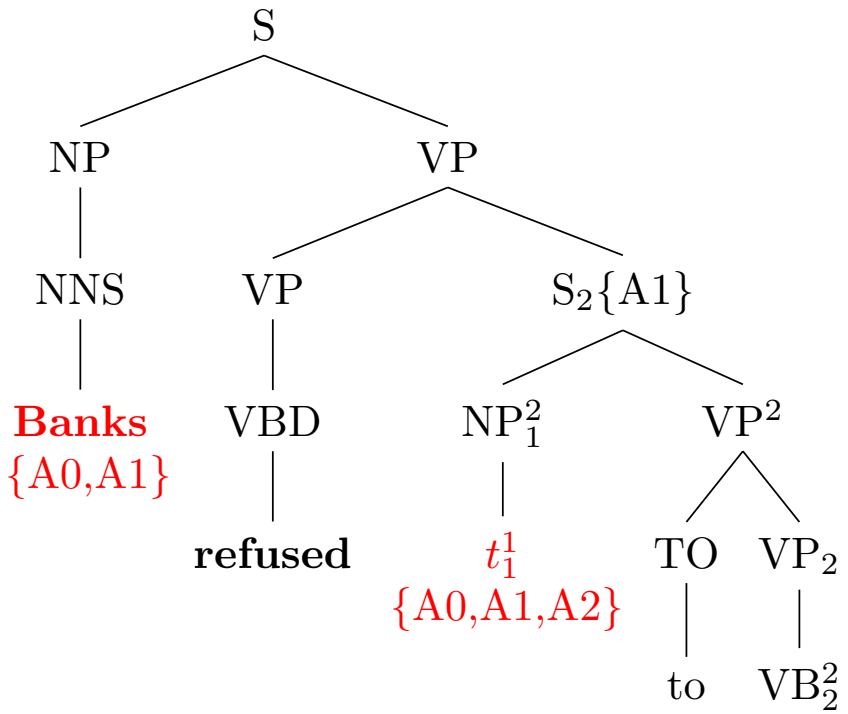
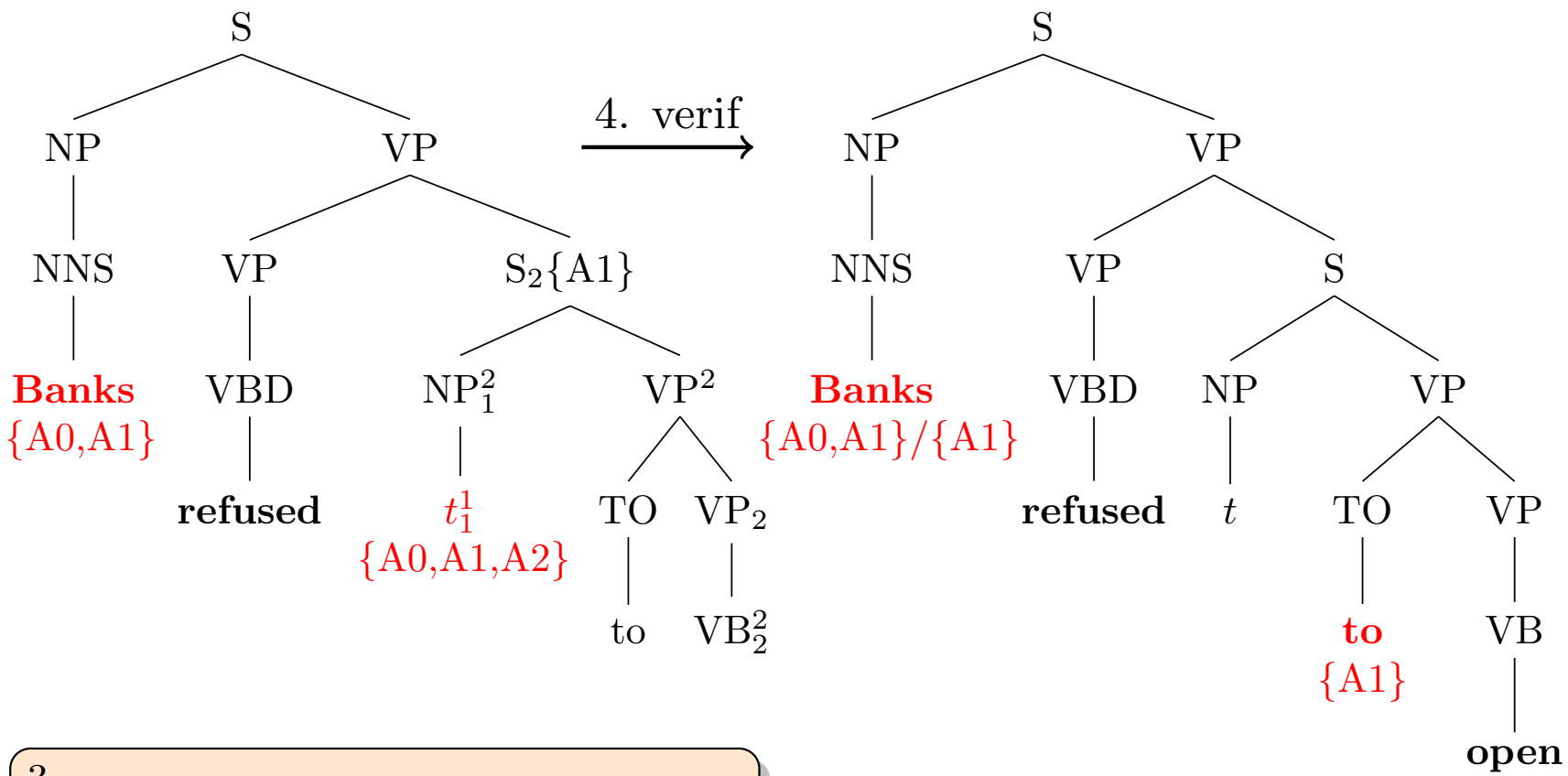


3. —

Incremental Role Propagation Algorithm



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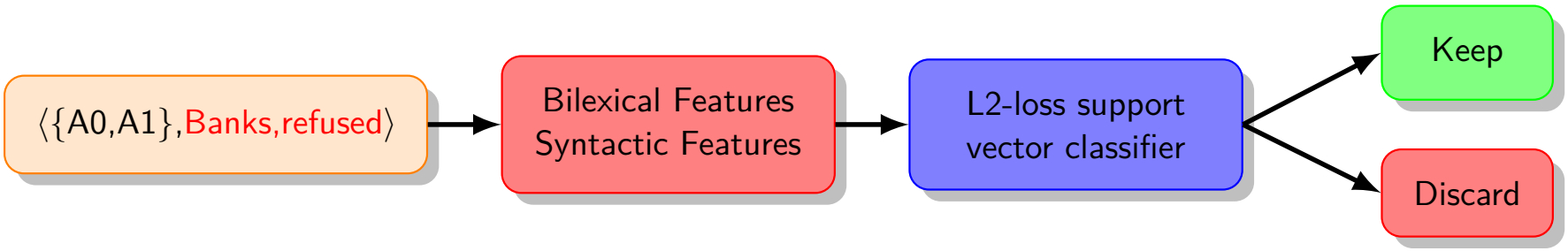
4. NP $\rightarrow$ ⟨{A0,A1},Banks,refused⟩
   S $\rightarrow$ ⟨A1,to,refused⟩
   NP $\rightarrow$ ⟨A1,Banks,open⟩

Argument Identification - Role Label Disambiguation

Argument Identification



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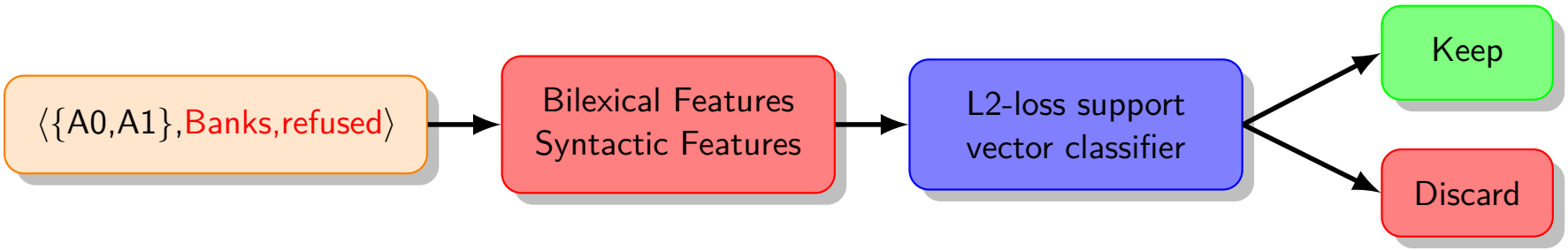

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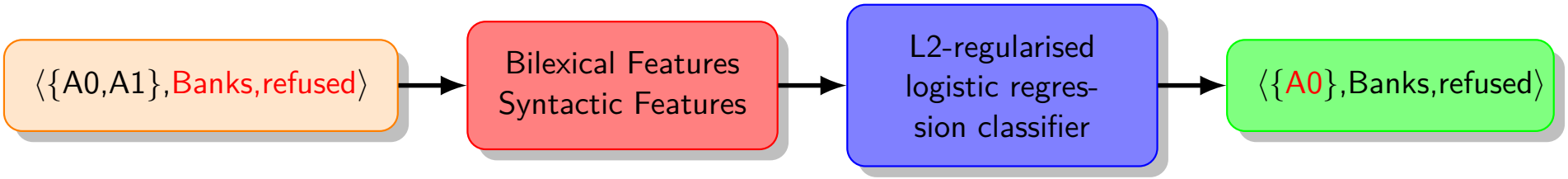

Experiments

- Train PLTAG on sections WSJ 02-21 (79.41% F_1)
- Train classifiers on CoNLL 2009 (Ident.: 92.18%, Lab.: 82.37%)
- Gold lexicon entries during parsing - CoNLL-SRL-only task

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- Unlabelled Prediction Score (UPS)
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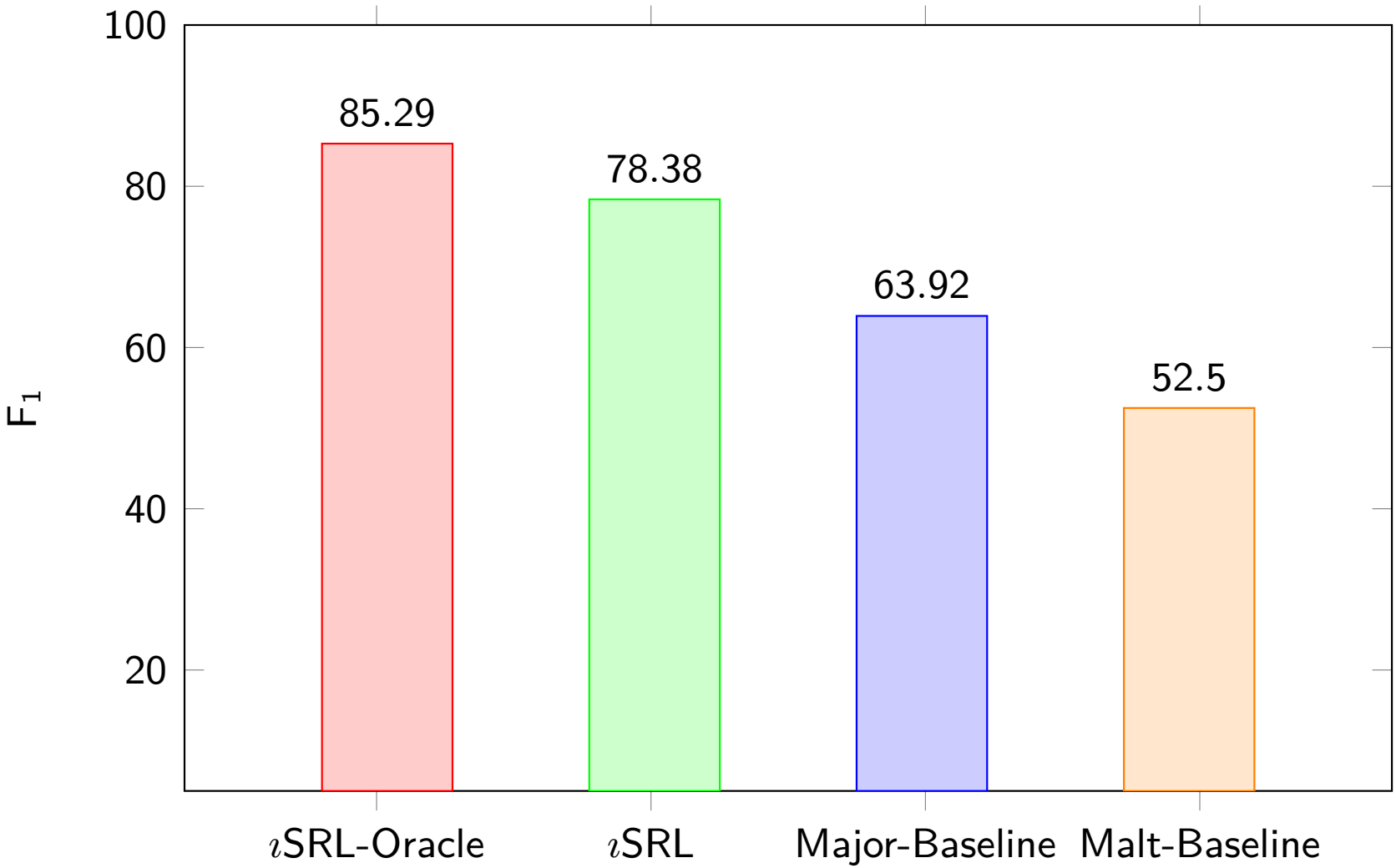
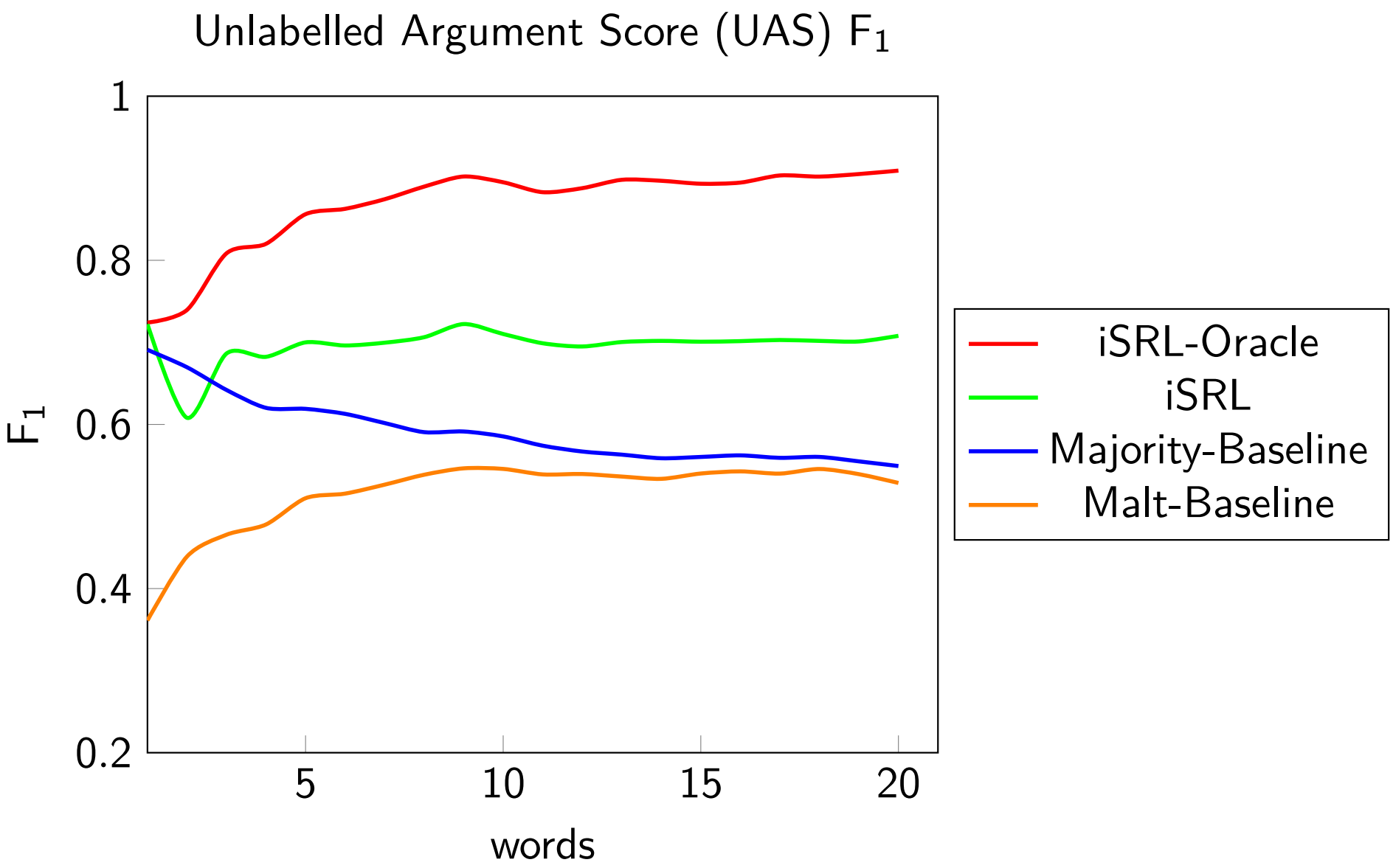
System Comparison

- $\imath$SRL -Oracle
- $\imath$SRL
- Majority-Baseline
- Malt-Baseline

Results - Full sentence



Results - Incremental



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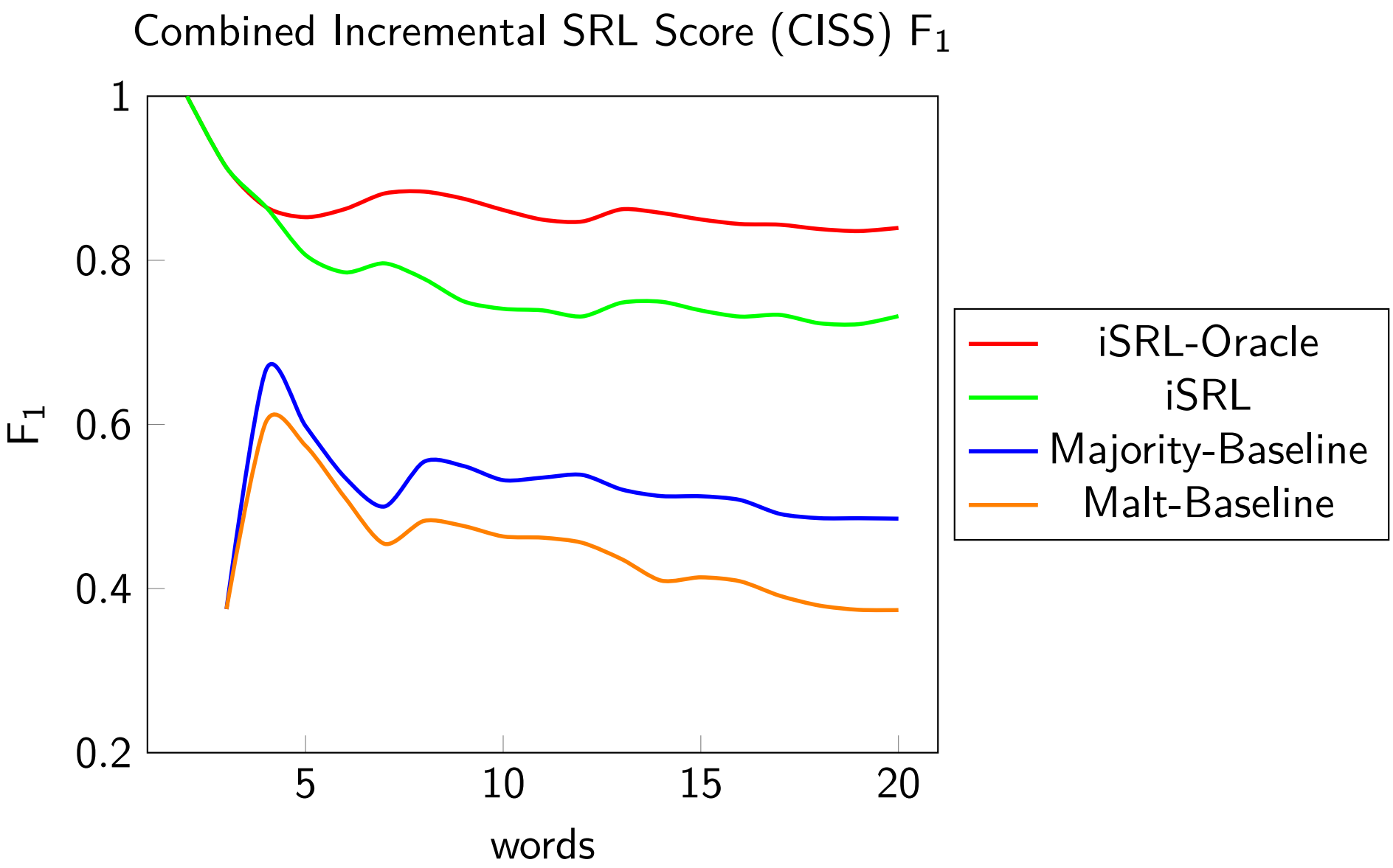

Conclusions

- New task of Incremental Semantic Role Labeling
- Our system combines:
  - Psycholinguistically Motivated TAG (PLTAG)
  - Semantic Role Lexicon
  - Incremental Role Propagation Algorithm (IRPA)
  - Argument Identification, Role Disambiguation Classifiers
- Outperforms baselines
- Performs well incrementally: predicts (in)-complete triples early in the sentence

Fusing Syntax with Semantics

- Use $\imath$SRL labels as pivotal points and score with model of semantics
- PLTAG Parser Reranker

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Banks

y^* $\quad f(d_1^*) \times \alpha$

$\hat{y}$ $\quad \begin{pmatrix} f(d_{11}) \times \alpha \\ f(d_{21}) \times \alpha \\ f(d_{31}) \times \alpha \\ f(d_{41}) \times \alpha \\ f(d_{51}) \times \alpha \end{pmatrix} \rightarrow \hat{y_1}$

$$\alpha \leftarrow \alpha + f(d_1^*) - f(d_{41})$$

Fusing Syntax with Semantics

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	Banks	refused
y^*	$f(d_1^*) \times \alpha$	$f(d_2^*) \times \alpha$
$\hat{y}$	$\begin{pmatrix} f(d_{11}) \times \alpha \\ f(d_{21}) \times \alpha \\ f(d_{31}) \times \alpha \\ f(d_{41}) \times \alpha \rightarrow \hat{y_1} \\ f(d_{51}) \times \alpha \end{pmatrix}$	$\begin{pmatrix} f(d_{12}) \times \alpha \\ f(d_{22}) \times \alpha \rightarrow \hat{y_2} \\ f(d_{32}) \times \alpha \\ f(d_{42}) \times \alpha \\ f(d_{52}) \times \alpha \end{pmatrix}$
	$\alpha \leftarrow \alpha + f(d_1^*) - f(d_{41})$	$\alpha \leftarrow \alpha + f(d_2^*) - f(d_{22})$

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	Banks	refused	to
y^*	$f(d_1^*) \times \alpha$	$f(d_2^*) \times \alpha$	$f(d_3^*) \times \alpha$
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	Banks	refused	to	open
y^*	$f(d_1^*) \times \alpha$	$f(d_2^*) \times \alpha$	$f(d_3^*) \times \alpha$	$f(d_4^*) \times \alpha$
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Features

- Baseline PLTAG probability model score
- Syntactic Features
  - Current lexicon entry
  - Previous lexicon entry
  - Bigram lexicon entries
  - Unlexicalised features
- Current SRL triple(s)
- Semantic Score

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Semantic Score

- Blacoe and Lapata, 2013: CDT model trained using SRL instead of dependencies
- Sayeed and Demberg, ongoing: Baroni and Lenci, 2010 -inspired also trained using SRL instead of dependencies
- Baselines (No syntax)
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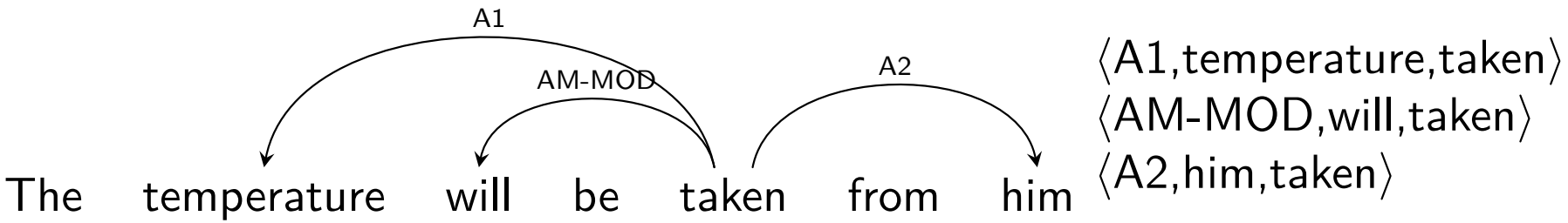
Multiple Triples (vary composition function)



Thank you