

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

Many garden paths are not due to syntactic ambiguity alone, they also involve *semantic role ambiguity*.

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- (2) The athlete realised her goals ...
 - a. ... at the competition.
 - b. ... were out of reach.

This indicates that humans *incrementally* assign semantic roles.

Human Language Processing

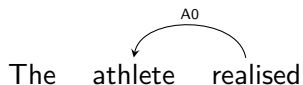
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Let's look at this example in more detail.

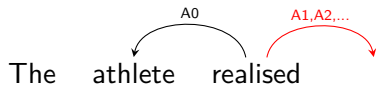
Human Language Processing - Example



Semantic Triples: \langle [role labels], arg, pred \rangle

\langle A0,athlete,realised \rangle

Human Language Processing - Example

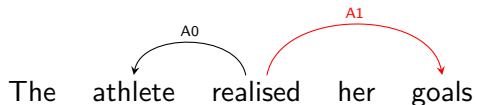


Semantic Triples: $\langle [\text{role labels}], \text{arg}, \text{pred} \rangle$

$\langle A0, \text{athlete}, \text{realised} \rangle$

$\langle [A1, A2], \text{nil}, \text{realised} \rangle$

Human Language Processing - Example

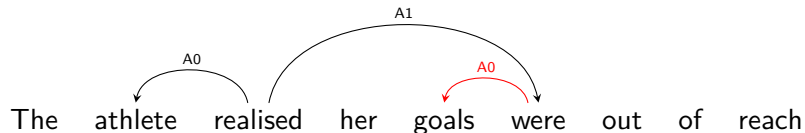


Semantic Triples: \langle [role labels], arg, pred \rangle

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Human Language Processing - Example



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$\langle \text{A0}, \text{athlete}, \text{realised} \rangle$

$\langle \text{A1}, \text{were}, \text{realised} \rangle$

$\langle \text{A0}, \text{goals}, \text{were} \rangle$

Incremental Semantic Role Labeling

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- Determine Semantic Role Labels as the input unfolds
- Given a sentence prefix and its partial syntactic structure:
 - 1 Identify Arguments and Predicates
 - 2 Assign correct role labels
- Assign incomplete semantic roles

Sentence Auto-completion



the criminal arrested|



the **sims 3** criminal arrested

the **doctor with** arrested criminal **girl**

Press Enter to search.

Sentence Auto-completion

Google

the criminal arrested|

the **sims 3** criminal arrestedthe **doctor with** arrested criminal **girl**

Press Enter to search.



Sentence Auto-completion



A screenshot of a Google search bar. The search bar contains the text "the police officer arrested|". To the right of the search bar is a microphone icon and a search button with a magnifying glass icon. Below the search bar, a dropdown menu displays several suggestions:

- the police officer arrested
- the police officer arrested **two burglars**
- why did** the police officer **arrest** the **turkey**
- what happened to** the police officers **who** arrested **karunanidhi**

A "Remove" button is located to the right of the first suggestion.

Sentence Auto-completion

Google

the police officer arrested|



the police officer arrested

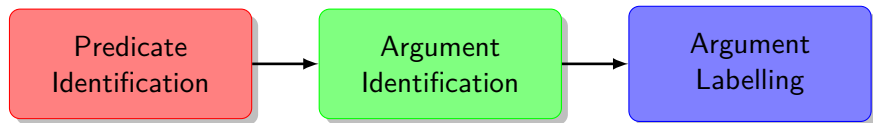
Remove

the police officer arrested **two burglars****why did** the police officer **arrest** the **turkey****what happened to** the police officers **who** arrested**karunanidhi**

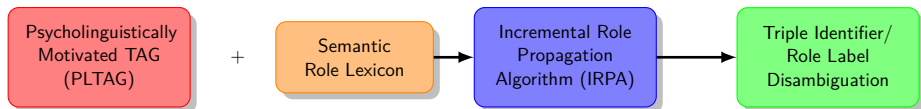
Non-incremental SRL

Pipeline approach

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



Model



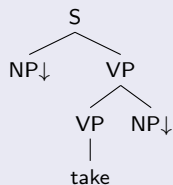
Psycholinguistically Motivated TAG (PLTAG)

Psycholinguistically Motivated TAG (PLTAG), is a variant of **tree-adjoining grammar** (Demberg et al., 2014) that supports parsing with **incremental**, fully **connected** structures.

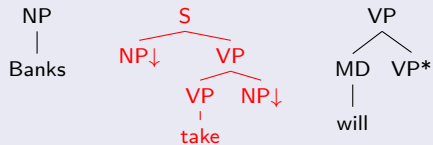
Comparison with TAG

TAG derivations are not always incremental.

Example



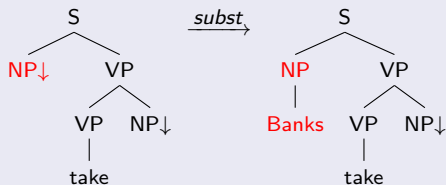
Lexicon



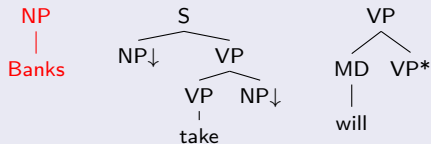
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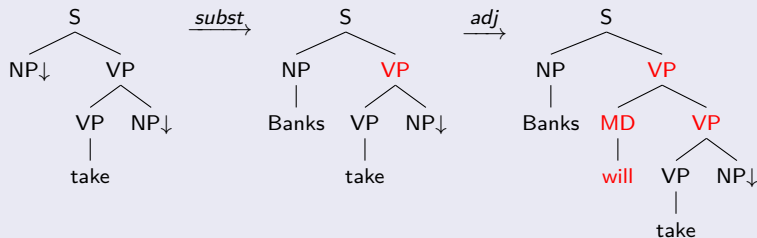
Lexicon



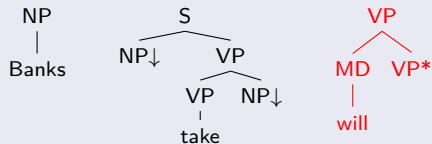
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Comparison with TAG

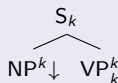
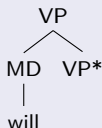
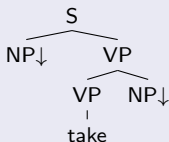
PLTAG derivation are always incremental and fully connected.

Example

NP
|
Banks

Lexicon

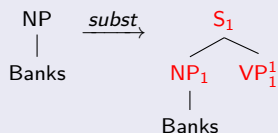
NP
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Banks



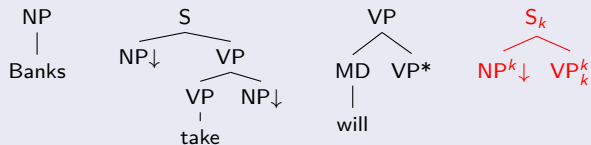
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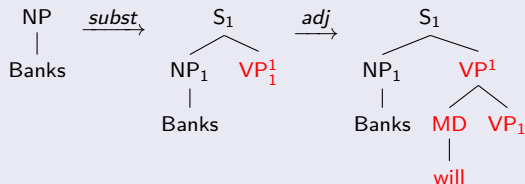
Lexicon



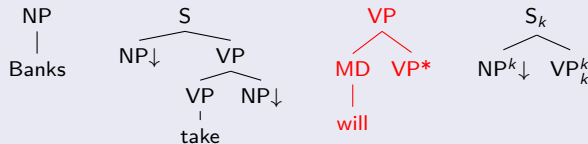
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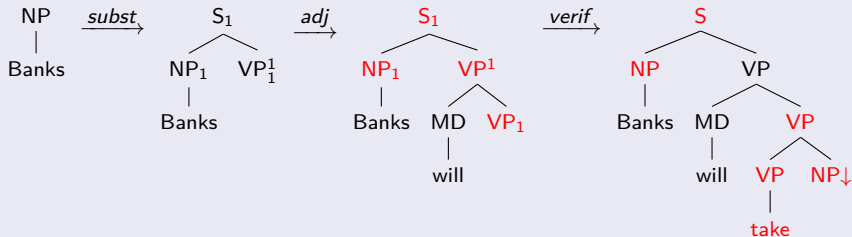
Lexicon



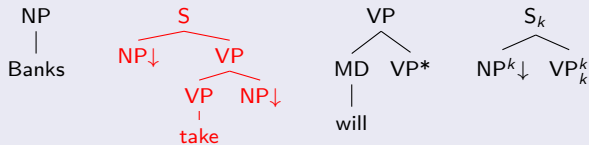
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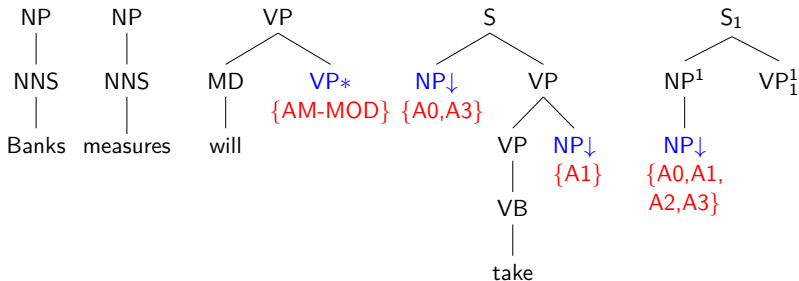


Lexicon



Semantic Roles in Lexicon

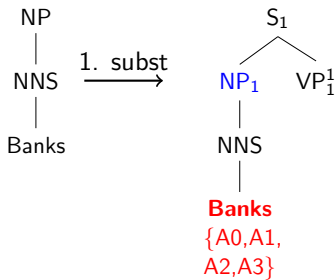
Used information for verb predicates *only*, derived from PropBank (Palmer, 2005).



Incremental Role Propagation Algorithm

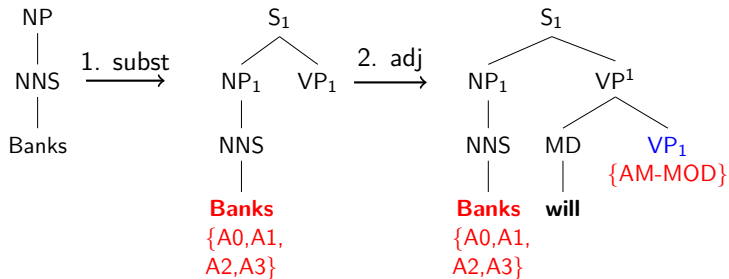
NP
|
NNS
|
Banks

Incremental Role Propagation Algorithm



1. NP \rightarrow $\langle \{A0, A1, A2, A3\}, \text{Banks}, \text{nil} \rangle$

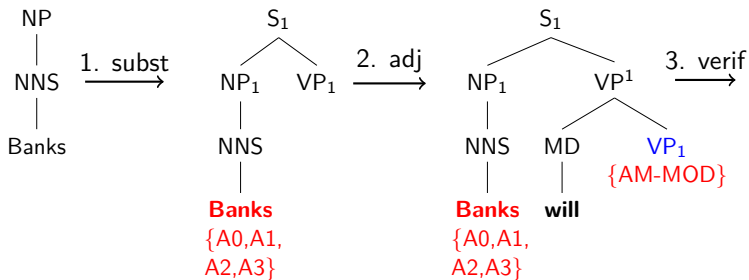
Incremental Role Propagation Algorithm



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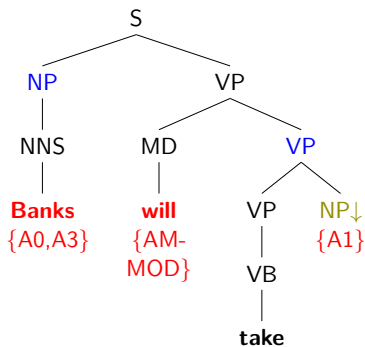
2. VP → ⟨AM-MOD,will,nil⟩

Incremental Role Propagation Algorithm



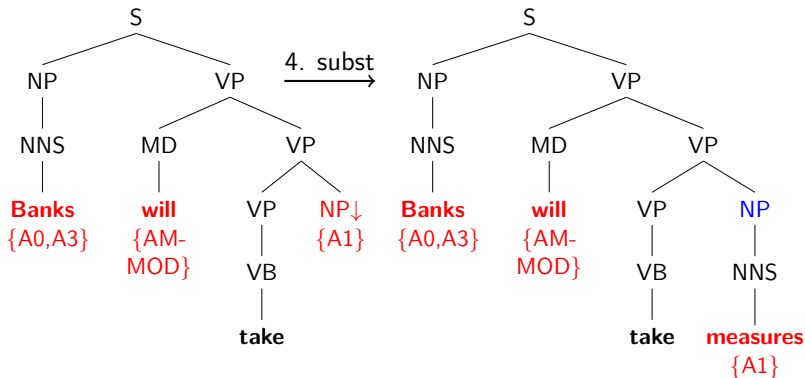
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Incremental Role Propagation Algorithm



3. NP → ⟨{A0, ~~A1~~, A2, A3}, Banks, take⟩
 VP → ⟨AM-MOD, will, take⟩
 NP → → ⟨A1, nil, take⟩

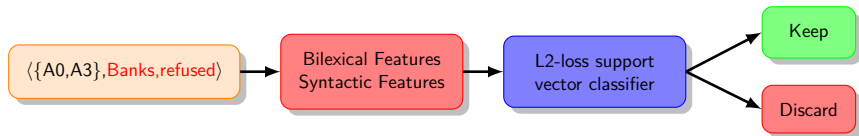
Incremental Role Propagation Algorithm



- 3. NP → ⟨{A0,A3},Banks,take⟩
 VP → ⟨AM-MOD,will,take⟩
- 4. NP → ⟨A1,measures,take⟩

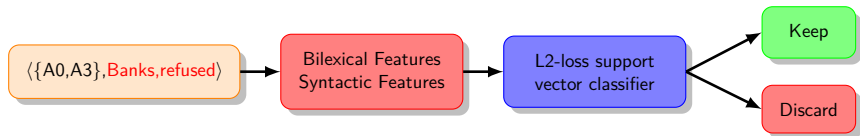
Argument Identification - Role Label Disambiguation

Argument Identification

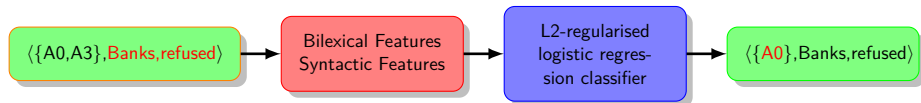


Argument Identification - Role Label Disambiguation

Argument Identification



Role Label Disambiguation



Experiments

- Propositions with verb predicates only
- Gold lexicon entries during parsing - CoNLL-SRL-only task

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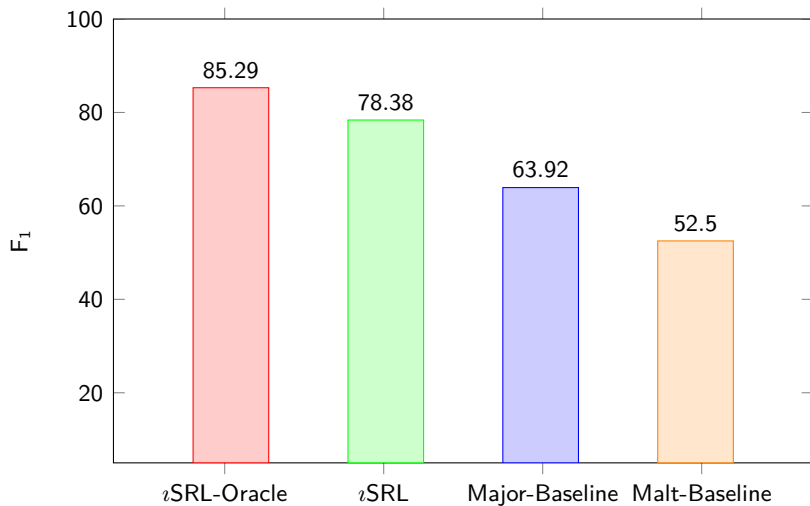
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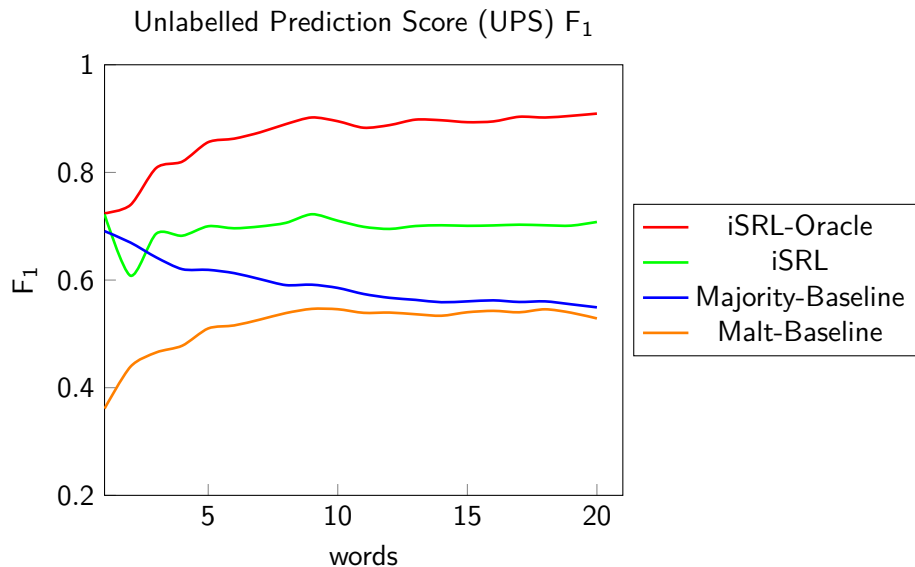
System Comparison

- ι SRL-Oracle : Gold Semantic Role Labels
- ι SRL: All Semantic Role Labels
- Majority-Baseline
- Malt-Baseline

Results - Full sentence



Results - Incremental



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
- Download the code from <http://homepages.inf.ed.ac.uk/ikonstas/>

Thank you



Lexicon:

- Standard TAG lexicon
- Predictive lexicon (PLTAG)

Operations:

- Substitution
- Adjunction
- Verification (PLTAG)

Bonus Material - PLTAG

Lexicon:

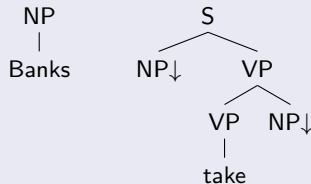
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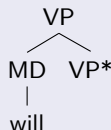
- Substitution
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Example

Initial Tree:



Auxiliary Tree:



Bonus Material - PLTAG

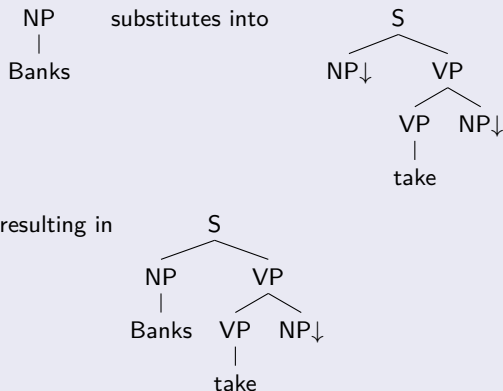
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Example



Bonus Material - PLTAG

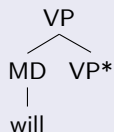
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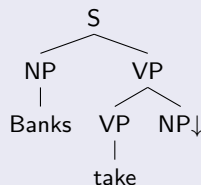
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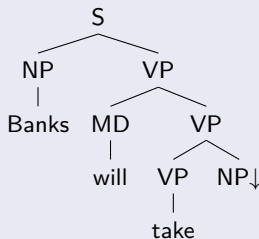
Example



adjoins to



resulting in



Bonus Material - PLTAG

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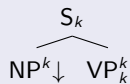
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- Verification (PLTAG)

Example

Prediction Tree:



Index k marks predicted node.

Bonus Material - PLTAG

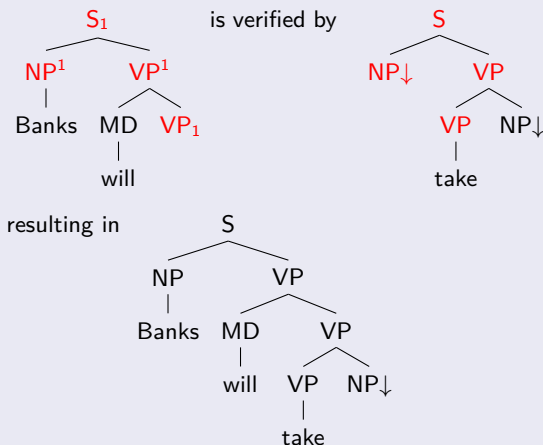
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- Predictive lexicon (PLTAG)

Operations:

- Substitution
- Adjunction
- **Verification (PLTAG)**

Example



All nodes indexed with k have to be verified.