Verbose labels for Semantic Roles

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Semantic Role Labeling

Definition: identifying semantic arguments for a verb of a sentence and defining their roles such as who did what to whom, when and where

The boy hit a ball

hit : Predicate

The boy : Agent — Hitter

a ball : Patient — Thing Hit

Arguments → Semantic Roles → Verbose Labels

Task Description

- Verbose labels depend on verb sense

Imports have gone down.
patient
entity in motion

Managers go after highest rates.
patient
goal

- But not always

John made up all the answers on his midterm.
Agent
creator

Loews Corp makes Kent cigarettes.
Agent
creator

Motivation

- Question Answering
  - Query : Who defeated Sparta?
  - Answer: sentence with `Sparta' as `thing defeated', for example: Persia defeated Sparta
- Text visualization tool for browsing document collection
  - Illustrate importance of verbose labeling

Resources

PropBank

Sentence : Loews Corp makes Kent Cigarettes.

```
(S
   (NP (NNP Loews) (NNP Corp))                A0
   (VP   (VBZ makes)
         (NP (NNP Kent) (NNS cigarettes)))    A1
   (. .)))
```

*make.*01

<role descr="creator" n="A0"/>
<role descr="creation" n="A1"/>
<role descr="created-from" n="A2"/>
<role descr="benefactive" n="A3"/>

Sentence: NE Edison made a bid.

```
(S
   (NP (NNP NE) (NNP Edison))      A0
   (VP (VBD made)
       (NP (DT a) (NN bid)))))     A1
```

*make.*03

<role descr="maker" n="A0"/>
<role descr="bid or purchase" n="A1"/>
<role descr="benefactive" n="A2"/>

3328 predicates, A0-A5 argument roles and 13 adjunct roles (AM-LOC, ..)

Contributions

- Introduce Verbose label prediction
  - Extends SRL for applications such as text visualization
- Tools released
  - Verbose labeling module for UIUC SRL
  - In-House SRL with verbose labeling module
  - Interactive text visualization tool for browsing large document collection

Related Work

Related Work

- Semantic Role Labeling
  - Phrase Structure trees
    - State-of-Art (Toutanova et.al)
    - UIUC SRL (Punyakanok et al)
    - ASSERT (Pradhan et al)
    - Sentence Simplification (Vickrey & Koller)
  - LTAG Spinal
    - Liu and Sarkar
      - Extended domain of locality
      - Extraction of LTAG-Spinal Treebank

In-House SRL

SRL Pipeline

- Predicate identification

  Ex: I went to Apple store to buy iPhone

- Argument identification

  Ex: **I** went to Apple store to buy **iPhone**

- Argument classification

  Ex: I (A0) went to Apple store to buy iPhone (A1)

- Verbose label prediction

  Ex: I(buyer) went to Apple store to buy iPhone(thing bought)

Experiments

- Argument Identification

Tool	Precision / Recall / F-measure
LibLinear	95.93 / 96.85 / 96.39
LibSVM	77.95 / 97.21 / 86.52
SVM SGD	95.96 / 98.16 / 96.84
MegaM	96.02 / 97.40 / 96.71

- Argument Classification

Approach	Gold Trees	SPINC Trees
Ident and Class	83.47/82.33/82.89	53.63/39.46/45.47
Class	83.23/83.29/83.26	52.79/40.58/45.89

Verbose Label Prediction

Picking ground truth for Verbose Labeling Task

- Identify sense of a predicate

  Mary gamely kicked in $5 to John's bail.

  Kick. 01
  A0 : kicker
  A1 : thing kicked
  A2 : instrument

  Kick. 03
  A0 : contributor
  A1 : contribution
  A2 : given to

- Pick most frequent verbose label

  go.01
  A0 : entity in motion, goer

  motivate.01
  A0 : decision or attitude being shown to be right

Data & Evaluation

- Data
  - Train : 90,819, Sec. 24 : 3252 , Sec. 23 : 5273
- Evaluation
  - Verb Sense Prediction

$$Accuracy = \frac{\#\ currectly\ predicted\ senses}{\#\ predicates}$$

  - Verbose Label Prediction

$$Accuracy = \frac{\#\ correct\ labels\ for\ identified\ args}{total\ identified\ args}$$

Baselines

- Baseline 1 : Assign most frequent verbose label across PropBank

Approach	Section -24	Section -23
Baseline – 1	**58.2**	**31.3**

- Baseline 2 : Assign most frequent verbose label across predicate frames

Approach	Section -24	Section -23
Baseline – 1	58.2	31.3
Baseline -2	**63.5**	**68.1**

Baselines

- Baseline 3 : Assign verbose labels from default predicate frame `01' (UIUC SRL)

Approach	Section -24	Section -23
Baseline-1	58.2	31.3
Baseline-2	63.5	68.1
UIUC	**91.01**	**92.32**

- Baseline 4 : Assign verbose labels from predicate frame with max arguments coverage

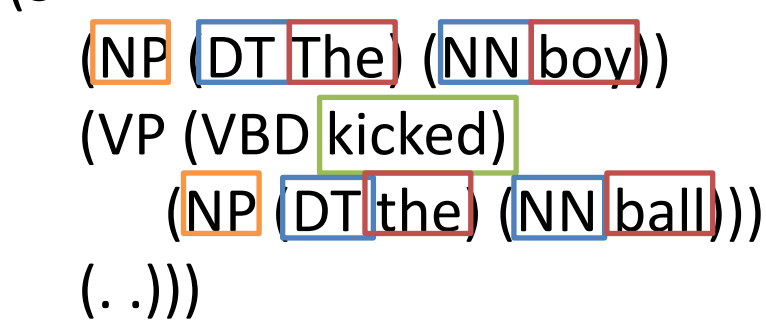
Approach	Section -24	Section -23
Baseline-1	58.2	31.3
Baseline-2	63.5	68.1
UIUC	91.01	92.32
Baseline-4	**93.34**	**94.13**

Approach

1. Sense Prediction
   - Post-processing stage
   - Phrase Structure trees (UIUC SRL)
   - LTAG Spinal trees (In-House SRL)
2. Joint Prediction
   - LTAG Spinal trees (In-House SRL)

Sense Prediction
Phrase Structure Trees

- Standard Features
  - Predicate Lemma
  - Predicate Root Form
  - Predicate Voice
  - Number of Senses
  - POS tags on left & right
  - Chunk tags on left & right
  - Words on left & right



Sense Prediction
Phrase Structure Trees

Verb Sense Prediction

Approach	Sec-24	Sec-23
Def Sense	82.8	82.3
Gold Parses		
Standard	**90.9**	**90.74**
Automatic Parses		
Standard	**90.3**	**90.1**

Verbose Label Prediction

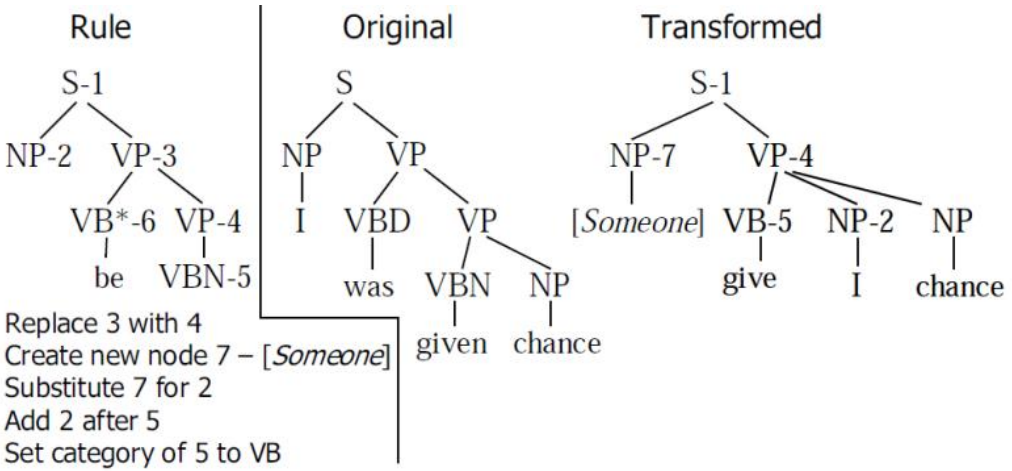
Approach	Sec-24	Sec-23
Gold Parses		
UIUC	91.01	92.32
Baseline-4	93.34	94.13
Standard	**94.9**	**95.1**
Automatic Parses		
UIUC	91.46	90.51
Baseline-4	93.4	92.6
Standard	**94.7**	**93.9**

Sense Prediction
Phrase Structure Trees

- Canonical form generation
  - Definition: Representation of verb and its arguments abstracted away from syntax

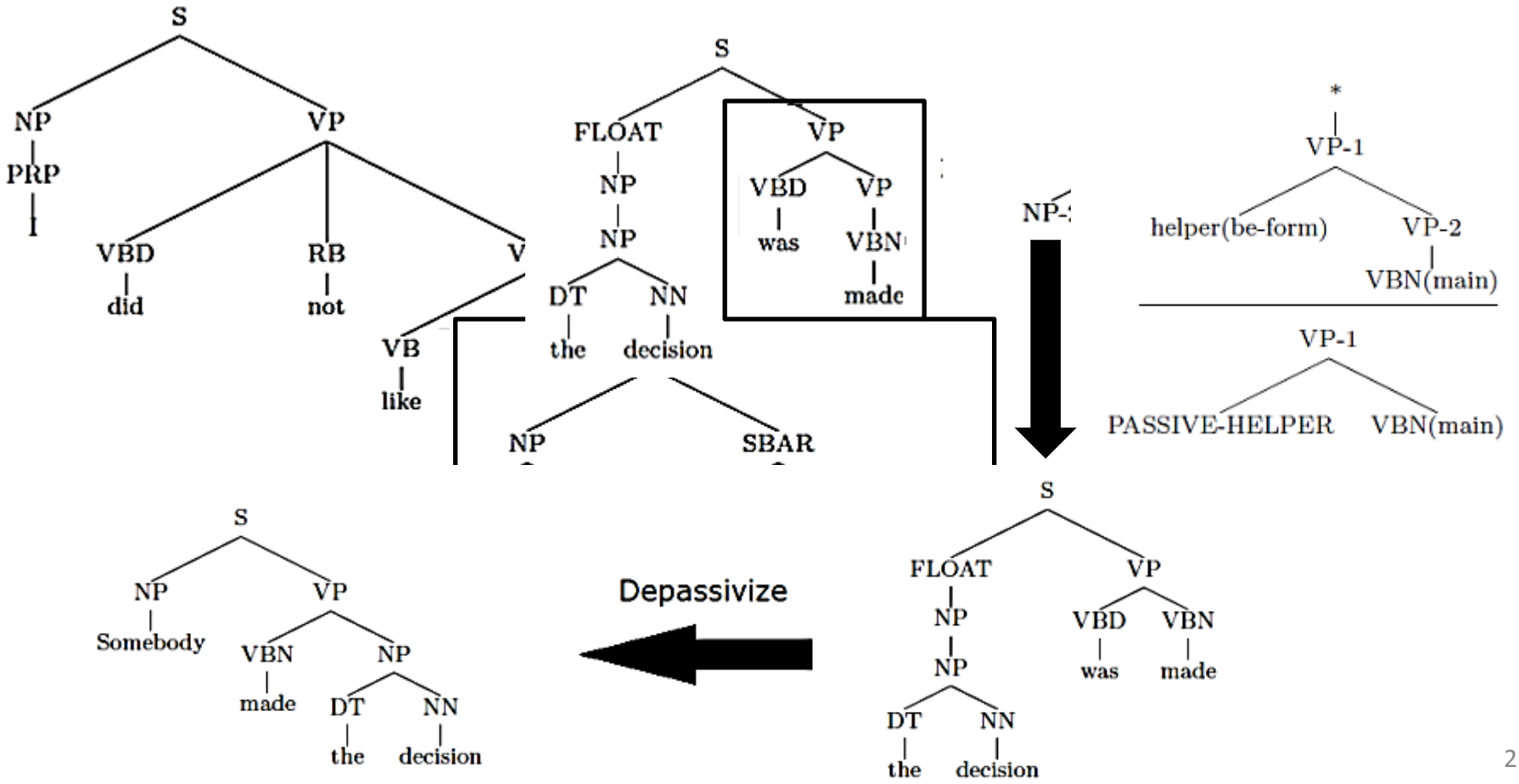
    1) A car hit Bob 2) Bob was hit by a car

    verb : hit subject : a car object : Bob
  - Transformation rules (Vickrey & Koller)



Sense Prediction
Phrase Structure Trees

- Canonical forms for Sense prediction



Sense Prediction
Phrase Structure Trees

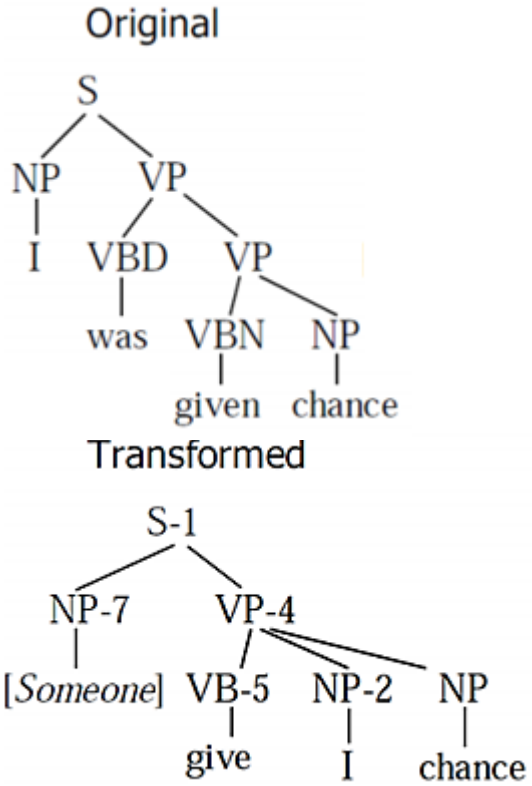
- Algorithm
  - P ; R ; initialize S = {P}

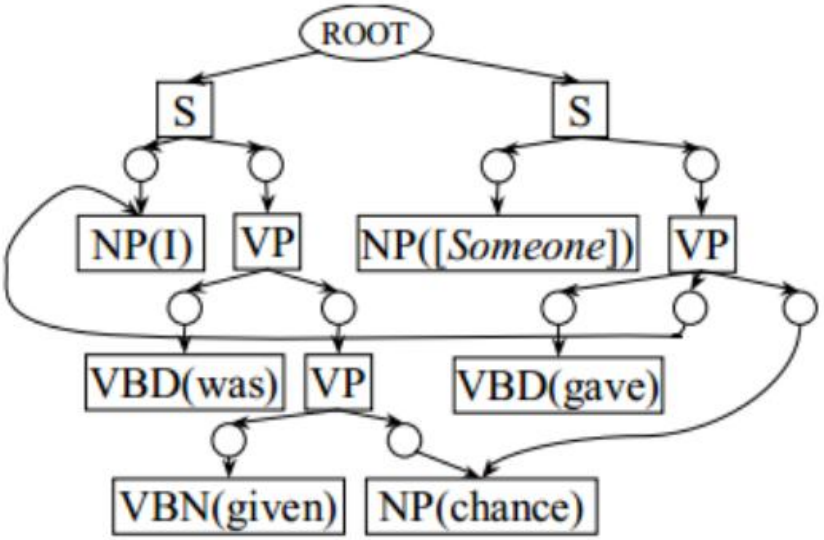
```
For r in R
    For p in S
        IF r matches p
            q = transformed p
            S = S U q
```

  - Naïve implementation can lead to exponential number of parses

Sense Prediction
Phrase Structure Trees

- Algorithm
  - Store S in chart data structure





Sense Prediction
Phrase Structure Trees

Verb Sense Prediction

Approach	Sec-24	Sec-23
Def Sense	82.8	82.3
Gold Parses		
Standard	90.9	90.74
Transform	**91.3**	**90.85**
Automatic Parses		
Standard	90.3	90.1
Transform	**90.5**	**90.3**

Verbose Label Prediction

Approach	Sec-24	Sec-23
Gold Parses		
UIUC	91.01	92.32
Baseline-4	93.34	94.13
Standard	94.9	95.1
Transform	**95.04**	**95.2**
Automatic Parses		
UIUC	91.46	90.51
Baseline-4	93.4	92.6
Standard	94.7	93.9
Transform	**94.85**	**94**

Sense Prediction
LTAG Spinal Trees

- Standard Features
  - Predicate lemma, root form, voice, number of senses, POS
  - POS tags on left & right
  - Words on left & right
  - Argument Relative Position
  - Argument Head
  - Argument Label
  - Argument Path to Predicate

Sense Prediction
LTAG Spinal Trees

Verb Sense Prediction

Approach	Sec-24
Def Sense	82.8
Gold Parses	
Standard	**90.55**
Automatic Parses	
Standard	**88**

Verbose Label Prediction

Approach	Sec-24
Gold Parses	
Baseline-3	91.01
Baseline-4	93.34
Standard	**94.5**
Automatic Parses	
Baseline-3	87.6
Baseline-4	87.71
Standard	**90.89**

Joint Prediction
LTAG Spinal Trees

Verb Sense Prediction

Approach	Sec-24
Def Sense	82.8
Gold Parses	
Standard	**90.55**
Joint	71.4
Automatic Parses	
Standard	**88**
Joint	68.5

Verbose Label Prediction

Approach	Sec-24
Gold Parses	
Baseline-3	91.01
Baseline-4	93.34
Standard	**94.5**
Joint	80.2
Automatic Parses	
Baseline-3	87.6
Baseline-4	87.71
Standard	**90.89**
Joint	76.15

Text Visualization

Introduction

- LensingWikipedia
  - Illustrate importance of verbose labeling
  - Wikipedia History articles
    - Event descriptions follow Who did what to whom where and how
    - History of World in 100 seconds project: Articles from 500 BC to 2000 AD

Data Processing

1066 AD	53.989, 0.903	Battle of Stamford Bridge: King Harold II of England defeats the Vikings under Harald Hardrada.

Time
Place
Event
Who
Whom
RoleA0 defeater
RoleA1 thing defeated

King Harold II of England
defeat
Vikings

Visualize
- Map, Timeline & Rgraph
- Map, Timeline & Facets

Demo

Conclusion

- Introduced Verbose label Prediction
- Proposed Baselines and more informed models
  - Phrase Structure for UIUC SRL
  - LTAG-Spinal trees for In-House SRL
- Illustrated importance by extending to Text visualization
  - Map, Timeline & Rgraph
  - Map, Timeline & Facets

Thank you

- Extras

Overview

- Introduction
- Related Work
- In-House SRL
- Verbose Label Prediction
- Text Visualization
- Conclusion

Experiments

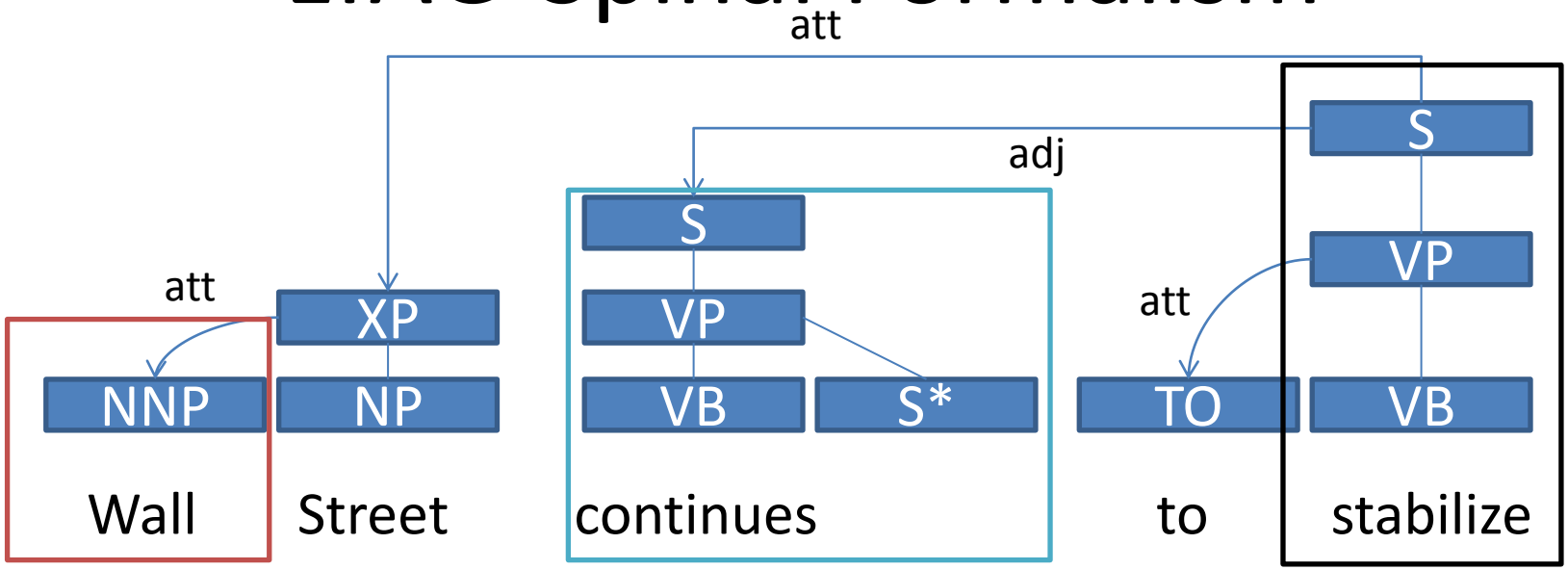
- Evaluation measure

$$Precision = \frac{n.o\ correctly\ labeled\ arguments}{n.o\ of\ labeled\ arguments}$$

$$Recall = \frac{n.o\ of\ currectly\ labeled\ arguments}{n.o\ of\ gold\ arguments}$$

$$F - Measure = \frac{2 * precision * recall}{precision + recall}$$

LTAG-Spinal Formalism

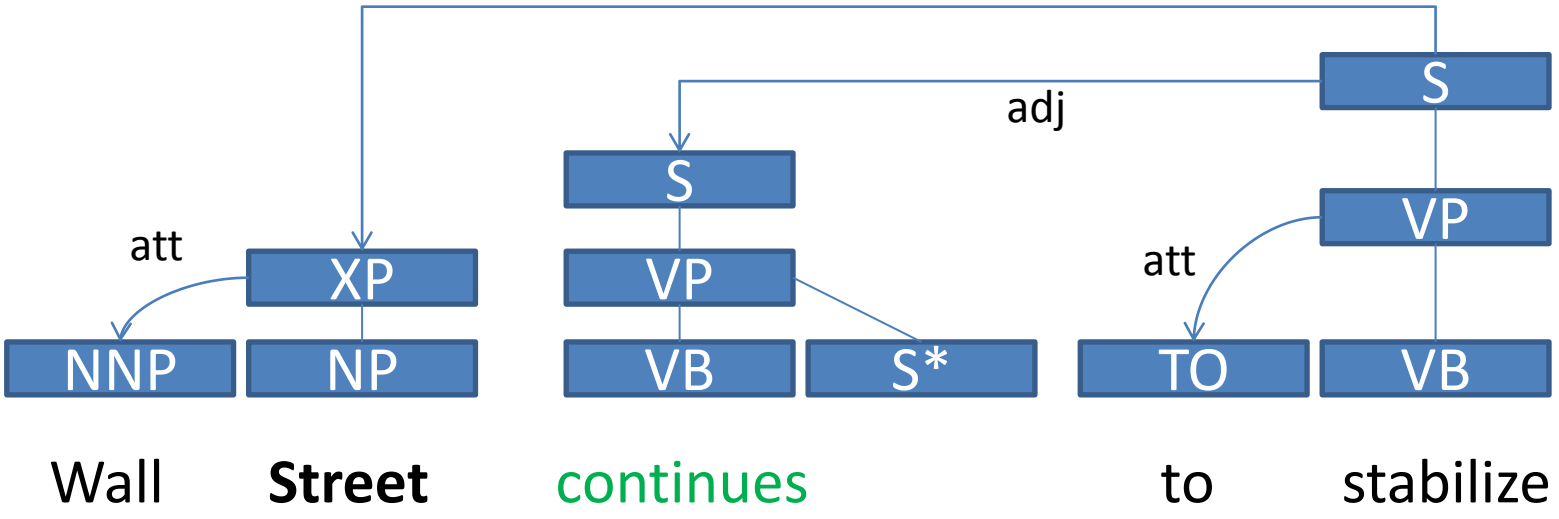


– Extended domain of locality

P -> A
P <- A
P <- Px -> A
P <- Cord -> Px -> A
P <- Ax -> Py -> A
P <- Cord <- Px -> A
P <- Px <- Py -> A

stabilize -> Street
continues <- Stabilize
continues <- Stabilize -> Street

Features for SRL



- Argument e-tree

  lemma: Street, *pos:* NNP, *spine:* XP-NP-street

- Predicate e-tree

  lemma: continue, *pos:* VB, *voice:* active

  spine: S-VP-VB-continue & S-VP-VB-active

Overview

- Introduction
  - Task Description
  - Motivation
  - SOA SRL tools
  - Resources
  - Contributions
- Related Work
- In-House SRL
  - SRL Pipeline
  - LTAG Formalism
  - Approach
  - Features
  - Data & Evaluation
  - Results
- Verbose Label Prediction
  - Introduction
  - Baselines
  - Data Processing
  - Experiments
  - Demo
    - Reference data
    - SRL output
- Text Visualization
- Conclusion

Overview

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Task Description

Verbose Label Prediction

The boy hit a ball

hit : Predicate

The boy : Agent Hitter

a ball : Patient Thing Hit

Semantic Roles Verbose Labels

Overview

- Introduction
- Related Work
- In-House SRL
- Verbose Label Prediction
- Text Visualization
- Conclusion

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Picking ground truth for Verbose Labeling Task

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  Kick. 03
  A0 : contributor
  A1 : contribution
  A2 : given to

- Pick most frequent verbose label

  go.01
  A0 : entity in motion, goer

  go.02
  A0 : goer

Results

Phrase Structure Trees

Approach	Section -24	Section - 23
Default Sense	82.8	82.3
VSD Standard	90.9	90.74
VSD Transform	91.3	90.85

LTAG Spinal Trees

VSD Std Gold Args	90.58	
VSD Std Auto Args	90.55	
VSD Joint	71.4	

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- Text Visualization
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