

Transition Based Parsing: Formulation

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Deterministic Parsing

Basic idea

Derive a single syntactic representation (dependency graph) through a deterministic sequence of elementary parsing actions

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Derive a single syntactic representation (dependency graph) through a deterministic sequence of elementary parsing actions

Configurations

A parser configuration is a triple $c = (S, B, A)$, where

- S : a stack $[\dots, w_i]_S$ of partially processed words,
- B : a buffer $[w_j, \dots]_B$ of remaining input words,
- A : a set of labeled arcs (w_i, d, w_j) .

Stack

[sent, her, a]_S

Buffer

[letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent

Transition System

A transition system for dependency parsing is a quadruple $S = (C, T, c_s, C_t)$, where

- C is a set of configurations,
- T is a set of transitions, such that $t : C \rightarrow C$,
- c_s is an initialization function
- $C_t \subseteq C$ is a set of terminal configurations.

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A transition sequence for a sentence x is a set of configurations

$C_{0,m} = (c_o, c_1, \dots, c_m)$ such that
 $c_o = c_s(x)$, $c_m \in C_t$, $c_i = t(c_{i-1})$ for some $t \in T$

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Initialization: $([\]_S, [w_1, \dots, w_n]_B, \{\})$

Termination: $(S, [\]_B, A)$

Transitions for Arc-Eager Parsing

$$\text{Left-Arc}(d) \frac{([\dots, w_i]_S, [w_j, \dots]_B, A)}{([\dots]_S, [w_j, \dots]_B, A \cup \{(w_j, d, w_i)\})} \neg \text{HEAD}(w_i)$$

$$\text{Right-Arc}(d) \frac{([\dots, w_i]_S, [w_j, \dots]_B, A)}{([\dots, w_i, w_j]_S, [\dots]_B, A \cup \{(w_i, d, w_j)\})}$$

$$\text{Reduce} \frac{([\dots, w_i]_S, B, A)}{([\dots]_S, B, A)} \text{HEAD}(w_i)$$

$$\text{Shift} \frac{([\dots]_S, [w_i, \dots]_B, A)}{([\dots, w_i]_S, [\dots]_B, A)}$$

Parse Example

Transitions:

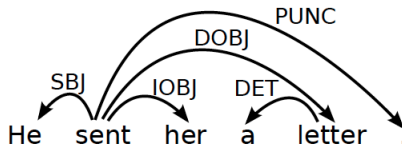
Stack

[]_S

Buffer

[He, sent, her, a, letter, .]_B

Arcs



Parse Example

Transitions: SH

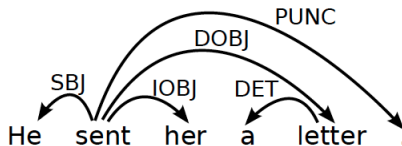
Stack

[He]_S

Buffer

[sent, her, a, letter, .]_B

Arcs



Parse Example

Transitions: SH-LA

Stack

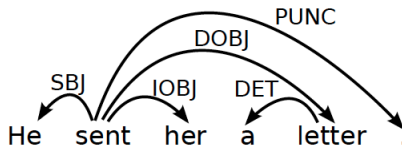
[]_S

Buffer

[sent, her, a, letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent



Parse Example

Transitions: SH-LA-SH

Stack

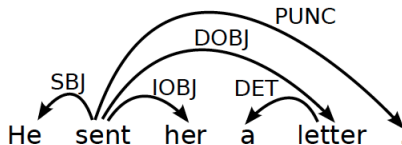
[sent]_S

Buffer

[her, a, letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent



Parse Example

Transitions: SH-LA-SH-RA

Stack

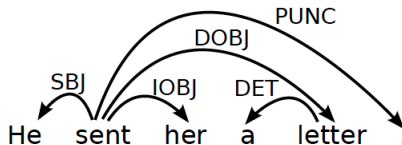
[sent, her]_S

Buffer

[a, letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her



Parse Example

Transitions: SH-LA-SH-RA-SH

Stack

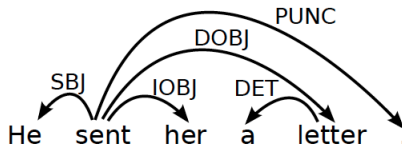
[sent, her, a]_S

Buffer

[letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her



Parse Example

Transitions: SH-LA-SH-RA-SH-LA

Stack

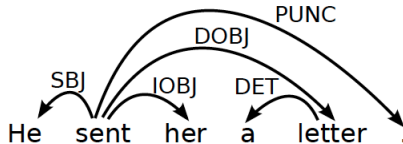
[sent, her]_S

Buffer

[letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her
a $\xleftarrow{\text{DET}}$ letter



Parse Example

Transitions: SH-LA-SH-RA-SH-LA-RE

Stack

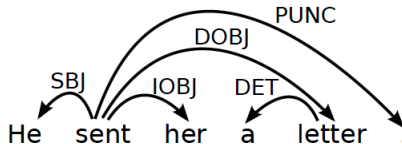
[sent]_S

Buffer

[letter, .]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her
a $\xleftarrow{\text{DET}}$ letter



Parse Example

Transitions: SH-LA-SH-RA-SH-LA-RE-RA

Stack

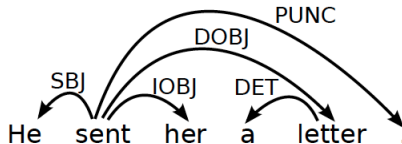
[sent, letter]_S

Buffer

[.]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her
a $\xleftarrow{\text{DET}}$ letter
sent $\xrightarrow{\text{DOBJ}}$ letter



Parse Example

Transitions: SH-LA-SH-RA-SH-LA-RE-RA-RE

Stack

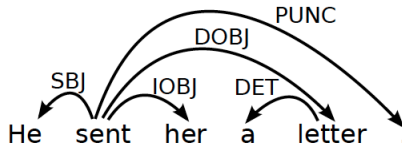
[sent]_S

Buffer

[.]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her
a $\xleftarrow{\text{DET}}$ letter
sent $\xrightarrow{\text{DOBJ}}$ letter



Parse Example

Transitions: SH-LA-SH-RA-SH-LA-RE-RA-RE-RA

Stack

[sent, .]_S

Buffer

[]_B

Arcs

He $\xleftarrow{\text{SBJ}}$ sent
sent $\xrightarrow{\text{IOBJ}}$ her
a $\xleftarrow{\text{DET}}$ letter
sent $\xrightarrow{\text{DOBJ}}$ letter
sent $\xrightarrow{\text{PUNC}}$.

