Parsing

Homework 7 (Shift Reduce), due 24 May 2022, 10.30 am

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Question 1 (Shift reduce parsing)

Consider a slightly modified version of Shift-reduce parsing for Chomsky Normal Form Grammars.

- *Item form:* $[\Gamma, i]$ *with* $\Gamma \in N^*$ *(i.e., only non-terminals), and* $1 \leq i \leq |w|$ *where* w *is the input.*
- *Goal item as in standard shift-reduce:* $[S, |w|]$
- *Deduction rules:*

$$\textit{Shift\_reduce:} \quad \frac{[\Gamma, i]}{[\Gamma A, i+1]} \quad A \to w_{i+1} \in P$$

$$\textit{Reduce:} \quad \frac{[\Gamma \alpha, i]}{[\Gamma A, i]} \quad A \to \alpha \in P$$

Consider a CFG with non-terminal S*, terminal* a*, start symbol* S *and productions* $S \to S\ S$*,* $S \to a$*. (This grammar is in Chomsky Normal Form.)*

1. *Perform a shift-reduce parsing for the input aaa. List the different items in a table as follows, including the respective productions* $S \to a$ *(for shifr_reduce) or* $S \to SS$ *(for reduce) that have been used, and a backpointer to the antecedent item(s) (sometimes there is more than one that can lead to an item).*

id	*item*	*remaining input*	*production & antecedent*
1	$[\varepsilon, 0]$	*aaa*	–
2	$[S, 1]$	*aa*	$S \to a$ *from 1*
	...	...	

   All *possibilities must be listed.*

2. *Now follow your backpointers backwards, starting from the goal item, and collect all productions. This gives you the rightmost derivations. Apply the productions and give the different rightmost derivations one obtains.*
3. *Give the corresponding parse trees.*

Question 2 (Soundness of shift-reduce parsing)

Consider the standard deduction-based definition of shift-reduce parsing.[1] *Show the soundness of the algorithm, i.e., if* $[\Gamma, i]$ *can be deduced then* $\Gamma \stackrel{*}{\Rightarrow} w_1 \dots w_i$ *holds.*

(Can be shown with an induction over the deduction rules.)

Note that $w_1 \dots w_0$ *is considered to be the empty word preceding the first terminal in the input.*

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[1]

- Item form: $[\Gamma, i]$ with $\Gamma \in (N \cup T)^*$, and $1 \leq i \leq |w|$ where w is the input.
- Goal item: $[S, |w|]$
- Deduction rules:

$$\text{Shift:} \quad \frac{[\Gamma, i]}{[\Gamma a, i+1]} \quad a = w_{i+1}$$

$$\text{Reduce:} \quad \frac{[\Gamma \alpha, i]}{[\Gamma A, i]} \quad A \to \alpha \in P$$