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COMPUTER SCIENCE

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Compiler Construction WS11/12

Exercise Sheet 4

Please hand in the solutions to the theoretical exercises until the beginning of the lecture next Friday 2011-11-18, 12:00. Please write the number of your tutorial group or the name of your tutor on the first sheet of your solution.

Exercise 4.1 FiFo-sets for LL-parsing with regular right sides (Points: 2+2+2)

In the lecture a formula was given that describes how to construct the $FiFo$-set from the $First_1$ and $Follow_1$ sets (page 44 in the slides about LL-parsing). However this formula only describes the $FiFo$-sets for the productions of a grammar.

1. Describe in which situations the non-determinism in LL-parsing with non-regular right sides arises and why the $FiFo$-sets as described for grammar productions can be used to get rid of this non-determinism for $LL(1)$-grammars.

2. Describe where the non-determinism arises when using LL-parsing with regular right sides. For which constructs do we need to calculate $FiFo$-sets in this case?

3. Give the missing formal definitions of the $FiFo$-sets for those constructs. Provide them in such a way that they are compatible to the schematic recursive descent parser for regular right sides (slides 45 to 49).

Exercise 4.2 Grammar flow analyses for context-free grammars with regular right sides (Points: 6+6+6)

Let $G = (\{S, A, B\}, \{+, -, /, !, id, num\}, P, S)$ describe a context-free grammar with regular right sides and the productions P defined as follows:

$$
\begin{aligned}
S &\rightarrow A \\
A &\rightarrow B((+|-|\varepsilon)B)^* \\
B &\rightarrow (id(+|-|\varepsilon)num|!(/|!)id)
\end{aligned}
$$

1. Perform the following grammar flow analyses for grammar G as they were defined for context-free grammars with regular right sides:
   - ε-productivity
   - ε-free $first_1$
   - $follow_1$

   Write down all the equations you need for the analyses and explicitly write down the fixed point iterations.

2. We had to introduce special versions of the grammar flow analyses to support context-free grammars with regular right sides. In this exercise you should describe a grammar transformation that transforms a context-free grammar with regular right sides into a usual context-free grammar without regular right sides such that the normal versions of the grammar flow analyses for ε-productivity, ε-free $first_1$ and $follow_1$ can be used (as described on pages 56 to 58 in the script). However the results of these analyses should be easily mapped

back to the grammar with regular right sides. In this way we want to make use of the advantages of regular right sides without having to introduce more complex analyses. For simplicity we allow no $+$-metacharacter in regular expressions here.

- Formally specify your grammar transformation. Which constructs of the regular right sides have to be replaced and which new productions and non-terminals have to be introduced?
- How can the results of the analyses on the transformed grammar be interpreted as results for the original grammar? Only consider those results that are really used in the recursive descent parser with regular right sides. You do not have to care about all the other results the analyses for regular right sides additionally deliver.

3. Demonstrate the use of your grammar transformation on grammar G.

- Transform it to a context free grammar without regular right sides.
- Perform the grammar flow analyses for ε-productivity, ε-free $first_1$ and $follow_1$. An analysis for ε-productivity without regular right sides was not formally described. You can just directly derive some intuitive equations for that case. Explicitly write down all equations and the fixed point iteration for each analysis.
- How can the results of the analyses on the transformed grammar be interpreted as results for the original grammar. Only consider those results that are really used in the recursive descent parser with regular right sides. You do not have to care about other possible results the analyses for regular right sides additionally deliver.

Exercise 4.3 Reliable Prefixes (Points: 2)

The grammar G is given by the productions

$$
\begin{aligned}
S &\rightarrow AB \\
A &\rightarrow aA \,|\, B \\
B &\rightarrow bB \,|\, c
\end{aligned}
$$

Which of the following strings are reliable prefixes of a right sentential form (RSF) of G? Give either the corresponding rightmost derivation or tell why no such rightmost derivation exists.

- aAbB

- AbbB