

Exam *Generic Language Thechnology* (2IS15) 29th of October 2013, 09:00-12:00.

This exam consists of 4 questions.

You are allowed to use all distributed material, slides, books, papers, and laptop.

You need to give a concise motivation for all the answers.

1. Basic technology

- (a) The Eclipse evolved from an IDE for Java into a language workbench. Give 2 ingredients that facilitated this evolution.
- (b) What is a lexeme? Give an example.
- (c) Why is it necessary to translate an NFA into a DFA? What is the effect of minimizing the DFA?
- (d) Give both an ambiguous and non-ambiguous grammar for the binary expression language, with the unary operator, "-", the binary operators, "+", "*", and "**", brackets, "(" and ")", and natural numbers. Please indicate explicitly what the priorities of these operators (the priorities should all be different) and associativity you assume. What kind of technique did you use to transform the ambiguous grammar into a non-ambiguous one.
- (e) Given the following grammar G

$S ::= A a A b$
 $S ::= B b B a$
 $A ::=$
 $B ::=$

Calculate the first and follow sets for grammar G . Is this grammar LL(1)? Is this grammar SLR(1)? Please motivate your answer.

- (f) How will the string `beginx` be recognized, given the following facts `begin` is a keyword, the lexical syntax rule $ID ::= [a-z]^+$, and the lexical disambiguation rules *prefer longest match* and *prefer keywords*? Does this cause any problems for SGLR? Motivate your answer.

2. Grammar and syntax

- (a) Why are external DSLs fundamentally different for embedded DSLs? Motivate your answer.

- (b) What is consequence of the unification property of MDE? What is unification property for *grammarware*?
- (c) What is a containment association? What is the effect of a containment association?
- (d) Why is it necessary to remove left recursion and perform left factorization for an Xtext grammar?
- (e) What is the effect of *return types* in Xtext?
- (f) What is the relation between the nonterminal in the left hand side and the nonterminals occurring in the right hand side in an Xtext production rule and the corresponding meta-model? Illustrate this by an example.

3. Transformations

- (a) Not all horizontal transformations are exogenous, explain why? Illustrate via an example.
- (b) What is the difference between a *sequence* and a *map* in EOL?
- (c) EOL and ETL can deal with user input, how is this realized?
- (d) Why is ETL a hybrid transformation language? What is the advantage of being a hybrid transformation language?

4. Semantics

- (a) Give an example of errors that can be detected via type checking? Illustrate this by means of an example.
- (b) Why is it necessary to use type information for overloading during the identification phase?
- (c) The data structure to represent the type environment for the PICO language is extremely simple, because PICO has a monolithic block structure. What is meant by a monolithic block structure? How would you adapt the underlying data structure of the type environment to accommodate a language with a nested block structure?
- (d) Why is it necessary to have a precise definition of the dynamic semantics of a language? The informal description of the dynamic semantics of PICO as given in the slides is insufficient. Explain why, you may give a small PICO program for illustration.

Grading of exercises

1	a	10	2	a	10	3	a	20	4	a	10
	b	20		b	20		b	10		b	10
	c	20		c	10		c	10		c	20
	d	40		d	10		d	20		d	20
	e	30		e	10						
	f	20		f	20						

The total score is 340 points, this will be divided by 34 to obtain the final mark for this exam. This final mark counts for 70% and the practical exercises count for 30%, both with a minimum of 5.5, for the total final mark of GLT.