

Exam *Generic Language Thechnology* (2IS15) 27th of January 2012, 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) Can you consider the IDE Eclipse a product of generic language technology?
- (b) Given a regular expression, a non-deterministic finite automaton can be constructed. Why is a non-deterministic finite automaton not suited for implementing a scanner?
- (c) Translate the regular expression $(a|(bc^*))dc^*$ via a NFA into a DFA. Is the resulting DFA minimal?
- (d) How does (F)lex solve the lexical disambiguation rule "prefer keywords"? What are other lexical disambiguation rules?
- (e) What is the difference between a context-free grammar and a language?
- (f) Explain why a left recursive grammar is problematic for a top-down recursive descent parser? How can this problem be solved?
- (g) What does the set of item sets in the LR parse table construction represent? What is the effect in the constructed LR parse table if the grammar is not LL(1)?

2. Grammars and static semantics

- (a) What is the difference between a scope and a block? Are these syntactical or semantical notions? What is the scope of SDF with respect to the nonterminals (sorts in SDF terminology)? What is the consequence?
- (b) Anneke Kleppe describes that a domain specific language should be defined by first defining the abstract syntax, then the concrete syntax and finally the semantics. Are these the proper steps, or are there steps missing? Is this the proper order of steps? Motivate your answer, if possible by means of a small example.

- (c) Why is it necessary to define a typing rules for a DSL? Give an example of a typing rule? What formalisms can be used to implement typing rules for a DSL?
- (d) What language constructs can a DSL support when we add composite types? Illustrate by means of an example.

3. Dynamic semantics

- (a) Why is a formally defined dynamic semantics of a modeling language necessary for the formal analysis of models (or programs) written in the language? What can be the consequences otherwise?
- (b) In the paper of F. Stappers e.a. on the formalization of the TRECS language, Structural Operational Semantics is used. Why has the natural (big-step) semantics not been considered adequate for this language?
- (c) Assume that two languages L_1 and L_2 both have a formal dynamic semantics defined in the same style (for instance, both have Structural Operational Semantics defined). One wants to show that a construct *ccc* from L_1 can be expressed by the constructs of L_2 . What needs to be proven to show that this is indeed the case?
- (d) Consider the extension of the **While** language with the `abort` statement and with non-determinism `or`. Which of the following statements are pair-wise semantically equivalent:

$S_1 \equiv (x := 1; \text{while true do skip}) \text{ or } y := 2$

$S_2 \equiv x := 1; ((\text{while true do skip}) \text{ or } y := 2)$

$S_3 \equiv (x := 1; \text{abort}) \text{ or } y := 2$

$S_4 \equiv x := 1; (\text{abort or } y := 2)$

$S_5 \equiv (x := 1; \text{skip}) \text{ or } y := 2$

$S_6 \equiv x := 1; (\text{skip or } y := 2)$

$S_7 \equiv x := 1 \text{ or } y := 2$

$S_8 \equiv x := 1; y := 2$

in the natural semantics of the extended **While**, or the structural operational semantics of the extended **While**? Explain your reasoning.

4. DSL Design

- (a) What aspect of a domain specific language definition is covered by EMF?
- (b) What is the difference between a containment relation and an inherit relation?
- (c) What is the difference between the problem domain and problem space? Motivate your answer, for instance by an example.

- (d) Xtext and EMFtext are both based on ANTLR. What are the consequences for both tools? Describe two aspects where Xtext and EMFtext fundamentally differ?
- (e) Give the definition of endogenous and exogenous transformations. How do these transformation concepts fit into the taxonomy of transformations presented by Kleppe?
- (f) The body ATL helper function is an OCL expression, Xtend allows the invocation of Java methods. Explain the concept of ATL helper functions? Why is it impossible to call Java methods in ATL?

Grading of exercises

1	<i>a</i> 10 <i>b</i> 10 <i>c</i> 20 <i>d</i> 10 <i>e</i> 10 <i>f</i> 10 <i>g</i> 20	2	<i>a</i> 40 <i>b</i> 20 <i>c</i> 30 <i>d</i> 20	3	<i>a</i> 10 <i>b</i> 10 <i>c</i> 10 <i>d</i> 30	4	<i>a</i> 10 <i>b</i> 10 <i>c</i> 10 <i>d</i> 20 <i>e</i> 20 <i>f</i> 20
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