

Exam *Software Construction* (2IS20) 23rd of June 2008, 14:00-17:00.
Exam *Generic Language Theory* (2IS15) 23rd of June 2008, 14:00-17:00.

This exam consists of 3 questions.
You are allowed to use all distributed material, slides, books, and papers.
You need to give a concise motivation for all the answers.

1. Theory

- (a) What is the goal of Generic Language Technology and how is this achieved?
- (b) Describe 2 implementation aspects which makes the SDF technology unique.
- (c) Describe 2 characteristics which makes the formalism ASF unique.
- (d) Give a concise SDF definition of lists with separators and and a concise SDF definition of lists with terminators. Describe in detail the disadvantage of each of the definitions with respect to corresponding ASF equations to manipulate the lists.
- (e) Give an SDF definition for Sets of Integers "{1, 2, 2, 3}" and give the ASF specification for removing double elements from the set. Use this specification to explain the idea of list matching.
- (f) For which combination of traversal attributes (break, continue, top-down, bottom-up, accu, trafo, accu-trafo) is the behaviour eventual the same and explain why.
- (g) Give 2 typical application areas where ASF+SDF can be applied.
- (h) What is the purpose of the lexical constructor functions and describe their way of working in detail, you may use an example.

2. Given the following EBNF definitions for two simple plotter languages:

```
SPLD1-Program ::= SPLD1-PenBlock*
```

```
SPLD1-PenBlock ::= 'PEN' 'UP' SPLD1-Command* 'NEP' |  
                  'PEN' 'DOWN' SPLD1-Command* 'NEP'
```

```
SPLD1-Command ::= SPLD1-PenBlock |  
                  SPLD1-Newline |
```

```

SPLD1-Draw

SPLD1-Newline ::= "NEWLINE"

SPLD1-Draw ::= "DRAW" Int

Int ::= [0-9]+

SPLD2-Program ::= SPLD2-Command*

SPLD2-Command ::= SPLD2-Move |
                  SPLD2-Draw |
                  SPLD2-Push

SPLD2-Move ::= "MOVETO"

SPLD2-Draw ::= "DRAW"

SPLD2-Push ::= Int

Int ::= [0-9]+

```

SPLD2 is a stack based language. Numeric arguments to the commands are first pushed onto the stack. Each commands removes its required number of arguments fromt the stack:

- MOVETO expects two arguments, x and y (in inverse order) coordinates to which the pen should be moved.
- DRAW expects one argument, the number of ' * ' characters to be drawn starting at the current position in the x direction along the same y coordinate.
- The coordinates " (0, 0) " of the canvas are located at the bottom left corner.

- (a) Give the SDF definition for the language SPLD1.
- (b) The DRAW x command draws x times the character ' * '. Given the following simple SPLD1 program, what is the produced output? Explain concisely the semantics of each of the operations in this language.

```

PEN DOWN DRAW 5 NEWLINE NEP
PEN DOWN DRAW 1 PEN UP DRAW 3 NEP DRAW 1 NEWLINE NEP
PEN DOWN DRAW 1 NEP PEN UP DRAW 3 NEP PEN DOWN DRAW 1 NEWLINE NEP
PEN UP PEN DOWN DRAW 1 NEP DRAW 3 PEN DOWN DRAW 1 NEP NEWLINE NEP
PEN DOWN DRAW 5 NEWLINE NEP

```

- (c) Give the SPLD2 program which draws the same figure as in exercise (d).

(d) Give the simplest but complete ASF+SDF specification to obtain the maximal size in terms of x- and y-coordinates of drawing on the canvas given an SPLD1 program. By complete it is meant that the specification should be executable.

3. The subject of this question is *LR-parsing*, in particular the *SLR(1)* parser construction method.

Consider the following context-free grammar:

1. $S \rightarrow B \perp$
2. $B \rightarrow (B A B)$
3. $B \rightarrow b$
4. $A \rightarrow A a$
5. $A \rightarrow a$

Some examples of strings generated by this grammar are:

- $b\perp$
- $(baaab)\perp$
- $((bab)aab)\perp$

(a) Determine the sets $Follow(A)$ and $Follow(B)$ of sets of symbols that may follow A and b respectively.

(b) Compute the *itemsets* and the *shift* transitions. Use the following layout for the transition table:

	a	b	$($	$)$	\perp	A	B
0							
1							
2							
\vdots							

(c) Complete the transition table by filling in the *reduce* transitions at the appropriate places. What is the general rule for determining reduce transitions?

(d) Give the sequence of acceptance steps for the string $((bab)aab)\perp$.