CvP - Homework 3

- Deadline: September 28, at the start of the werkcollege.
- Your solution can typed (preferred!) or handwritten.
- You can submit your solution in person or via liacscvp2018@gmail.com
- Don't forget your name and student number.

Chapter 3

1. In denotational semantics, what are the syntactical and semantic domains?
2. What is stored in the state of a program in denotational semantics?
3. Using the grammar in Example 3.4, show the parse tree for each of the following statements:
   (a) $A = (A * B) + C$
   (b) $A = B * C + A$
   (c) $A = A + (B * C)$
   (d) $A = B * (C + (A * B))$
4. When is a grammar rule said to be left-recursive?
5. Give an example of an ambiguous grammar.
6. Give an unambiguous grammar for if-then-else.
7. Extend the BNF of Example 3.4 into an unambiguous grammar that also includes operators - and /.
8. Extend the BNF of question 7, above, into an unambiguous grammar that also includes the unary operators + and -. Assume these unary operators have the highest priority, i.e., in this language, -A + 2 means (-A) + 2.
9. Extend the BNF of question 8, above, into an unambiguous grammar that also includes the binary exponentiation operator $\wedge$. Assume that in this language the exponentiation operator has less priority than the unary operators of question 7, above, but higher priority than multiplication and division; i.e., $Z/X \wedge -Y$ means $Z/(X \wedge (-Y))$.

10. Write an attribute grammar whose BNF basis is that of Example 3.6 in Section 3.4.5 but whose language rules are as follows: Data types cannot be mixed in expressions, but assignment statements need not have the same types on both sides of the assignment operator.

11. Write an attribute grammar whose base BNF is that of Example 3.2 and whose type rules are the same as for the assignment statement example of Section 3.4.5.

12. Consider the BNF in exercise 1 of werkcollege 3. Compute the denotational semantics of the following program:

$$x := 0; y := 0;\ \textbf{while}\ (y < 5)\ \textbf{do}\ y := y + 1; x := x + 2;\ \textbf{od}$$