

Some exercises to prepare the course

Programming Language Semantics and Compiler Design

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In addition to the exercises proposed in the Logic and Proof techniques course, we propose a couple of exercises.

Exercise 1

We suppose a processor with registers noted R_i and with the following instructions :

- LD R_i, op the value of op in register R_i , op designates a variable or a constant.
- ST R_i, x gives to x the value contained in register R_i , x designates a variable.
- ADD $R_i, op1, op2$ puts in R_i the sum $op1 + op2$,
- MUL $R_i, op1, op2$ puts in R_i the product $op1 * op2$,
where $op1$ designates a register and $op2$ designates a register or a constant.

We suppose that variables x and y were loaded in registers $R1$ and $R2$. What are the correct translations of the following expression :

$$x := 5 + x * 2 + y;$$

1. ADD R3, R1, 5
MUL R4, 2, R3
ADD R5, R4, R2
ST R5, x
2. ADD R3, R1, 5
ADD R4, 2, R2
MUL R5, R3, R4
ST R5, x
3. LD R3, 5
MUL R4, R1, 2
ADD R5, R4, R3
ADD R6, R5, R2
ST R6, x
4. MUL R3, R1, 2
ADD R3, R3, 5
ADD R3, R3, R2
ST R3, x

Exercise 2

We consider the C program below :

```
#include <stdio.h>

int *f() {
    int *a, b ;
    b = 2 ;
    a = &b ;
    return a ;
} ;

int main () {
```

```
    int *y ;  
    y = f() ;  
    printf("%d\n", *y) ;  
    return 0 ;  
} ;
```

Among the following statements, which ones are correct ?

1. Value 2 is always displayed at runtime.
2. There is an error at runtime, the program stops without displaying anything.
3. There is a compilation error, no executable is produced.
4. The value displayed at runtime is non-deterministic (it can change at each execution).