Formal Languages and Compilers
Prof. Breveglieri, Morzenti, Agosta
Written exam: laboratory question   09/02/2015[1]

Time: 60 minutes. Textbooks and notes can be used. Pencil writing is allowed.
Important: Write your name on any additional sheet.

SURNAME (Cognome): ....

NAME (Nome):..

Matricola:................................or Person Code:...................................

Instructor: ☐ Prof. Breveglieri   ☐ Prof. Morzenti   ☐ Prof. Agosta

The laboratory question must be answered taking into account the implementation of the `Acse` compiler given with the exam text.

Modify the specification of the lexical analyser (`flex` input) and the syntactic analyser (`bison` input) and any other source file required to extend the `Lance` language with the ability to evaluate the factorial operator of an expression and with the absolute value of an expression.

This operations are available through two new expressions ! (**factorial**) and $|\cdot|$ (**absolute value**), having the following syntax respectively:

$$\langle exp.\ 1\rangle!$$
$$|\langle exp.\ 2\rangle|$$

It's unnecessary to consider the case where the result of the factorial and absolute value are not representable in the register.

```
int x, y;

read(x);
read(y);

// factorial of x
write(x!);

// factorial of x!
write(x! !);

// abs of x
write(|x|);

// abs of |x| - y!
write(| |x| - y! |);
```

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[1]The text and solution to this exam have been adapted to ACSE 2.0 from its initial formulation.

1. Define the tokens (and the related declarations in **scanner.l** and **parser.y**). (3 points)

2. Define the syntactic rules or the modifications required to the existing ones. (4 points)

3. Define the semantic actions needed to implement the required functionality. (18 points)

4. Given the following `Lance` code snippet:

$$y = -!x + 2;$$

write down the syntactic tree generated during the parsing with the Bison grammar described in Acse.y *starting from the* `statements` *nonterminal*. (5 points)

5. (**Bonus**) We are asked to extend the absolute value operator to the arrays. Describe how to implement the absolute value operator for arrays inside assignment statements.

$$\langle id\ .1\rangle \ = \ |\langle id\ .2\rangle|$$

Where $\langle id\ .1\rangle$ and $\langle id\ .2\rangle$ are ids of arrays of the same lengths