# **10.** **Project 1: Syntax and axiomatic semantics**

Wed. 1 October

Due date: Wed. 15 October

## **Informal language definition**

a. Consider a simple block structured language that provides the following constructs:

- simple integer identifiers

- arithmetic expressions involving only addition and subtraction over integers (when used as predicates a strictly positive value is treated as *true* and zero or negative values as *false*)

- assignment statement to a single variable

- statement sequence

- conditional **if-then-else-fi**

- parallel execution construct **cobegin-coend** (e.g., **cobegin** x:=x+1 **co** y:=y-z **coend**) which allows each branch to execute on a separate processor in parallel and without any interactions among the branches; the construct is exited when all branches terminate; **cobegin-coend** constructs cannot be nested but may have arbitrary number of branches

b. Assume the availability of a function ** which, when presented with an expression (e.g., x+y-3) returns a count of the number of additions and subtractions appearing in the expression (e.g., 2 for the earlier expression).

c. Assume that the time it takes to execute a strictly sequential program equals the number of additions, subtractions, tests, and assignments performed during its execution. The number of processors available to execute a **cobegin-coend** block is assumed to equal the number of branches in the construct.

## **Assignment**

a. Develop an axiomatic semantic model that allows you to reason both about the computation and the time it takes to execute it. Use T to denote the current execution time.

b. Follow the format indicated below.

c. If you are unable to complete the full assignment, solve the problem using a subset of the full language described above and adjust the program used in the verification section accordingly. You will receive partial credit.

## **Homework format**

A. Cover Page (1 page)

• class

• project number

• project name

• date

• name

• statement (optional)

B. Language Syntax (1 page)

• brief informal overview of the language

• abstract syntax

• additional constraints not captured by the syntax

• example program

C. Language Semantics (2 pages)

• briefoverview identifying the model type and the general modeling strategy you plan to pursue; focus the presentation on the more subtle aspects of the problem (e.g., time, cobegin-coend)

• show formally how  is computed for a given expression

• explain how to compute the *wp* for each construct in the language

D. Program Verification (1 page)

• formally derive the initial condition *P* for which you can prove

*{ P T=2 }*

**cobegin**

**if** y-x **then** x:=y **fi**

**co**

**if** v-u **then** u:=v+0 **fi**

**coend**

**if** u-x **then** x:=x-u+x **fi**

*{ T=6  x=0 }*

• T denotes the execution time

• for each statement simply show its precondition, you do not need to prove formally that the derivation of the precondition is correct