# Implementation of a compiler from Pluscal to TLA+ with Tom

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# Introduction

- Location: Loria
- Team: AIGorille
- Supervisor: Martin Quinson
- Task: Rework on a thesis compiler
- Subject: Compiler form Pluscal2.0 to TLA+

# Introduction

Situation:

TLA+, a language used to specify a system :

- Very mathematical specification
- Permit to use a model-checker
- But not an easy language to learn, for program designers.

Leslie Lamport introduced Pluscal. But it was still not really easy to use.

# Pluscal2.0

- Syntax close to standard algorithms
  - Procedures can be used
  - Non typed variables
- Accept processes and hierarchical processes
- Atomicity for some part of code accepted
- Embedded TLA+ code

# Pluscal2.0 code

```
algorithm Peterson
extends Naturals
constants
    numPeers                (* Number of processes *)

variables
    lockReq = [id \in Node |-> FALSE],
    turn = 1,               (* tie-break variable *)
    count = 0               (* number of processes holding
                            the lock *)


fair process Node[numPeers]
definition other == CHOOSE id \in Node : id # self
```

# Pluscal2.0 code

```
begin
ncs:    loop
                skip;
                lockReq[self] := TRUE;
                turn := other;
try:
                when ~lockReq[other] \/ turn = self;

cs:
                count := count + 1;

leave:
                count := count - 1;
                lockReq[self] := FALSE;
        end loop;
```

# Pluscal2.0 code

```
end process;

(*No Main process*)

(* Assert: at most one process have the lock *)
invariant count <= 1

(* Liveness: each requested lock is eventually granted *)
temporal \A p \in Node: [] (<> lockReq[p])

(* Instantiating the model for 2 processes *)
constants numPeers = 2
```

# TLA+

- Set of Actions
- Action :
  - Guard conditions
  - Variable modifications
  - List of unchanged variables
- Special actions that ensure liveness properties

# TLA+ code

```
----------------MODULE HourClock----------------------

EXTENDS Naturals
VARIABLE hr


HCini == hr \in (1..12)
HCnxt == hr' = IF hr # 12 THEN hr+1 ELSE 1
HC == HCini /\ [][HCnxt]_hr
-----------------------------------------------------

THEOREM HC => []HCini

Vrai == hr # 13
Faux == hr # 7
```

# Outils

Main tools:

- Tom: Language extension. Permit easy tree manipulations.
- Antlr: Automatic Parser/Lexer generator.
- Others: Text editor, TlaToolbox,Tlc...

# Grammars

Grammars are divided in two set: one for Pluscal2.0, the other for TLA+
For each set, two grammars. The antlr version and the Tom version.

Four files:

- Antlr grammar for Pluscal2.0
- Antlr grammar for TLA+
- Gom signature for Pluscal2.0
- Gom signature for TLA+

# Tree rewriting

Tree rewriting are executed by tom.

Two tools:

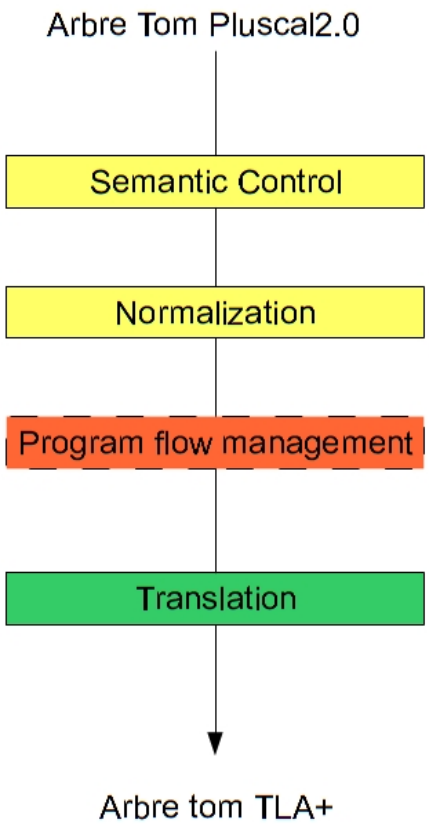
- match: Applied on a piece of the tree.
- strategy: Applied on the whole tree.

Exemple:

```
visit LabeledStatement{
  /* Add label to any loop statement.*/
  Labellisation(EmptyLabel(),Loop(labeledStatementList))->
 {

  return `Labellisation(GivenLabel(OptionString("loop",
                ConcOption())),Loop(labeledStatementList));
  }
}
```

# Rewriting steps




Terminé pour la version actuelle

Incomplet pour la version actuelle

Éventuel ajout

# Code generation

- Use of a 'pretty printer'
- Recursive walk of the tree
- Two output files (.tla et .cfg)
- Completed step for the actual TLA+ signature

# Tests

- Approach close to the TDD (Test-Driven Development) used.
- Set of tests, divided in subset, available
  Tests identify working instructions.
- Scripted tests with recorded answers.

# Test of the whole compiler

Implementation of a simple test requiring every steps of the compiler

Test accepeted by the model-checker

Verification of trivial properties validated

# Unfinished parts

- Semantic control
- Normalization for some instructions
- Potential add of a separate step to manage the PC value or Translator completion.
- Add of new features to the compiler

# Conclusion

For the compiler:

- Use of traditional tools and separation of the work in steps to make sources more accessible
- Completed main process
- Some steps need to be completed or extended.

As a personnal experience:

- Rewarding intership and good approach of the research world
- New tools and new way to program discovered
- Management and teamwork pleasant

# Sources

Vérification Formelle d'Algorithmes Distribués en PlusCal-2 - *Sabina AKHTAR*

Specifying Systems - *Leslie Lamport*

A Pluscal User's Manual - *Leslie Lamport*

# Thanks

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