Efficient Generation of C Code from CCSL

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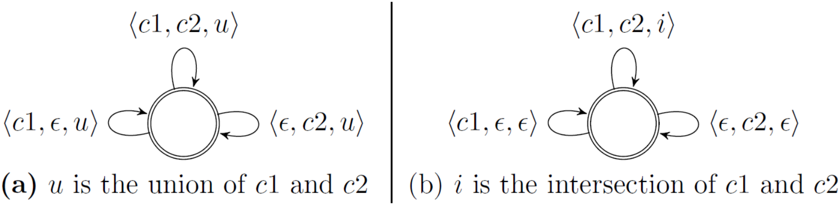
Presentation of CCSL

```
Specification Example{
    Clock a b c d e
    [
        Let A be a or b
        Let B be A and c
        Let C be B minus d
        Let D be inf(A, B)
        Let E be sup(A, B)

        repeat F every 4 C
        SubClocking e <- D
        Precedence C < E
        Precedence D <= E
        Exclusion d # e
    ]
}
```

Figure 1: LightCCSL Example

Semantic of CCSL



(a) u is the union of $c1$ and $c2$ | (b) i is the intersection of $c1$ and $c2$

Figure 2: Union and Intersection of Clocks in CCSL

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The goal is to generate C code from a CCSL specification that will efficiently compute one solution to the specification.

Looking for possible Precomputations

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Let C and D be a determined components.

$$
\begin{aligned}
Repeat\ a\ Every\ k\ b &: (a \in C \wedge b \in D) \rightarrow C = D \\
a = Def(b, c) &: (b \in D \wedge c \in D) \rightarrow a \in D
\end{aligned}
$$

Figure 3: Clocks in Determined Components.

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  - Separation of A and $\neg A$.
- Union, Intersection, Minus.
  - No simple Implication translation.

Union Case

$a = b \text{ or } c \Rightarrow$

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$\neg b \rightarrow a \rightarrow c$

$\neg c \rightarrow a \rightarrow b$

Main Issue

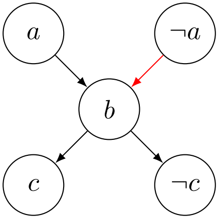

Figure 4: Main Issue

Issue from Union

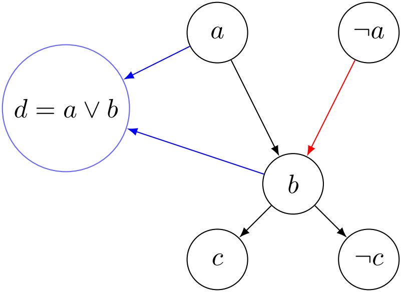

Figure 5: Union Issue

Issue from Minus

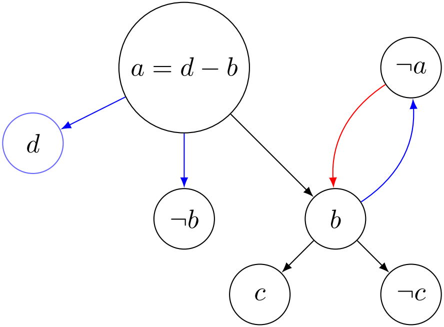

Figure 6: Minus Issue

The Order Approach

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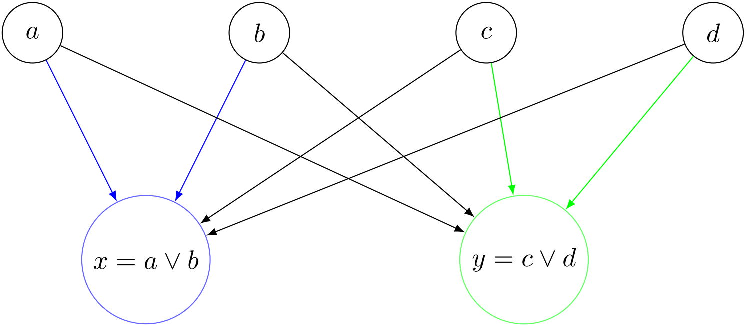

Figure 7: Order Counter-Example

The Backtrack Approach

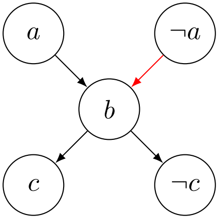

Figure 8: Basic Issue

The Backtrack Approach

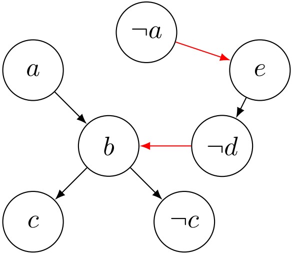

Figure 9: Backtrack Issue

Proof of NP-Completeness

Definition (Single-Step CCSL)

Let S be a CCSL specification, $n \in \mathbb{N}$, and T a valid schedule of S for the n first steps. Single-Step CCSL is defined as the problem of computing a valid $n + 1^{th}$ step.

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Not detailed here. □

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The smallest counter-example just has to be bigger (for some measure) than the specification.
Works in practice, still to be formalised...

Idea of the Architecture

1. Each alone constraint (or determined component) produces its current stateless constraint.
2. The solver gets the constraints and gives back an array with the result.
3. Each constraints check the array and updates its state if needed.

Optimisation of the Generated Code

Optimisation of the code using:

- Many compilers and compilation options.
- Two profilers: gprof and IntelVsyncProfiler.

Initial Version

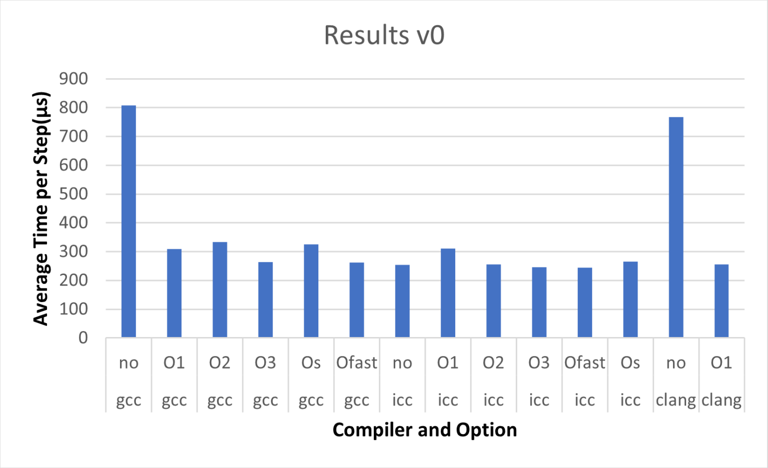

Figure 10: Performance of the Initial Code Generation

Final Version

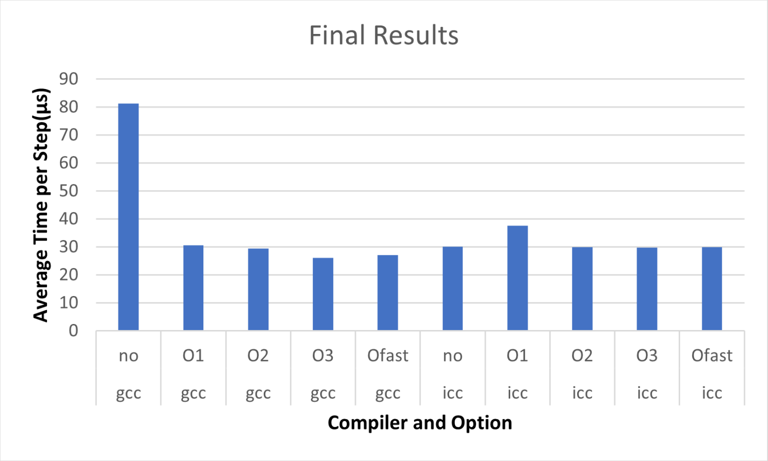

Figure 11: Performance of the Final Code Generation

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- Still correctness Issues.
  - Formalise the minimum failure approach.
  - Switch to LightC.
  - Deal with dead-ends.

Thank you very much for your attention.