Constraint Propagation

with Interval Labels

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- 'Old' paper (1987)
  $\rightarrow$ terminology slightly different

- Interval labels: continuous domains
  Section 8: sign labels (discrete)

- Concerned with Waltz algorithm
  (e.g., quiescence, completeness)
  Constraint types vs. domain types (Table 3)

- Addresses applications from reasoning
  about Physical Systems (circuit, `SPAM`)
  about time relations (`TMM`)

Things to remember

- Terminology:
  effectiveness vs. effeciency
  Inference: constraint, label, value..

- Waltz algorithm
  (soundness, completeness, quiescence)

- Continuous domains are difficult (infinite loops)

- What if problem is inconsistent?

Terminology

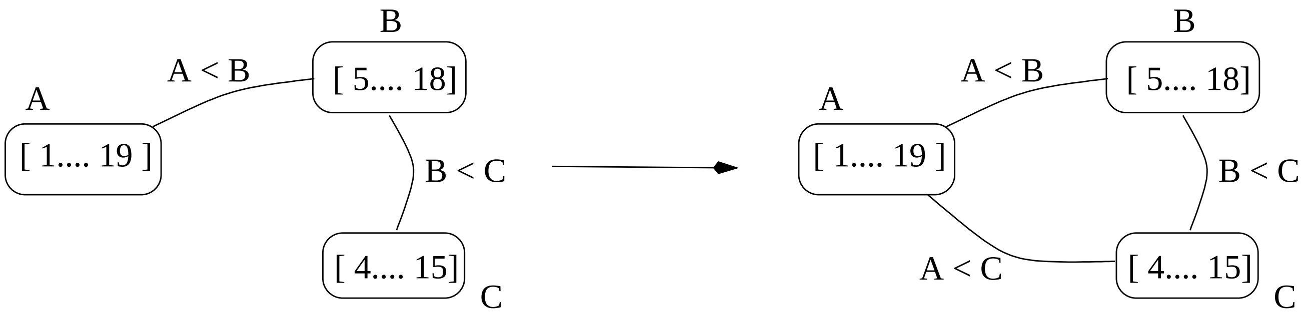
Effective: An effective procedure is a procedure with finitely-long and exact instructions that avoids random devices, and answers in a finite number of steps. [Enderton 72]

Efficient: An efficient procedure is a procedure that returns an answer in a time **polynomial** in the size of the input.

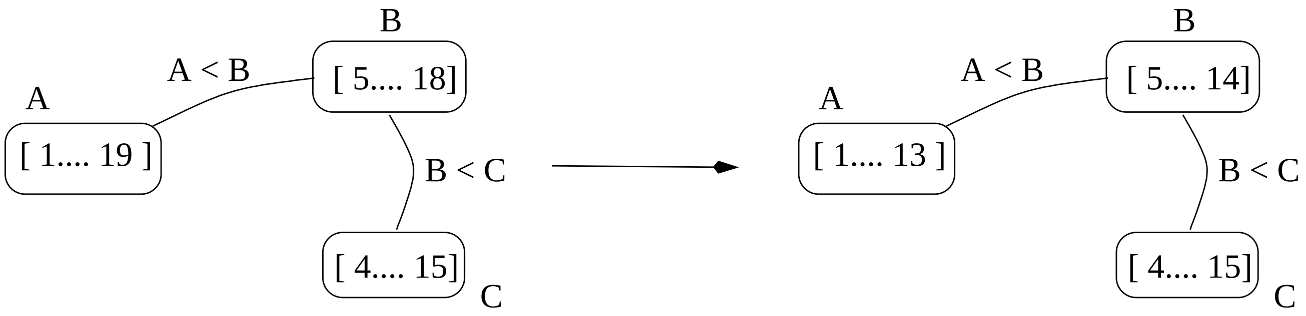
$\surd$ **Constraint inference**
$\surd$ **Label inference**
$\surd$ **Value inference**

$\times$ **Expression inference**
$\times$ **Relaxation**
$\times$ **Relaxation labeling**

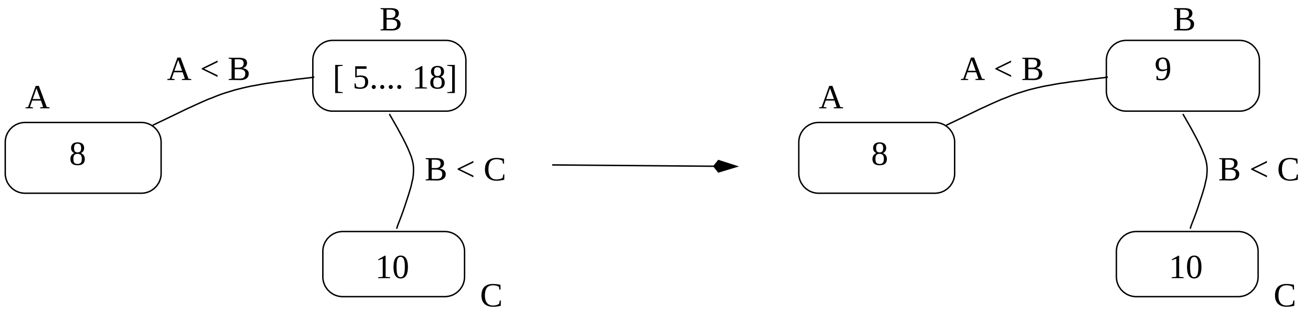
Constraint inference



Label inference

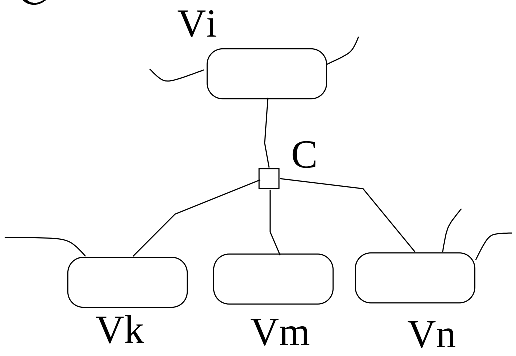


Value inference (dataflow constraint)



Waltz Algo. for label inference

`Refine`$(C(V_i, V_k, V_m, V_n)$, $V_i)$ finds a new label for V_i consistent with C



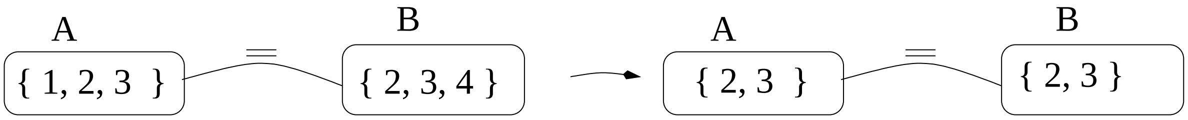
`Revise`$(C(V_i, V_k, V_m, V_n))$ **refines** the domains of V_i, V_k, V_m, V_n by iterating over these variables until quiescence (no domains is further refined)

`Waltz Algorithm` **revises** all constraints by iterating over each constraint connected to a variable whose domain has been revised

`Waltz Algorithm` $\rightarrow$ ancestor of arc-consistency

WARNING

$\longrightarrow$ Running the `Waltz Algorithm` does not solve the problem



A=2 and B=3 is still not a solution!

$\longrightarrow$ The Waltz algorithm may go into infinite loops even if problems is solvable

$$x \in [0, 100] \quad x = y$$
$$y \in [0, 100] \quad x = 2y$$

$\longrightarrow$ Davis provides a classification of problems f(constraint types, domain types) in terms of completeness and quiescence of the Waltz algorithm.

Importance of this paper

$\longrightarrow$ Establishes that constraints of bounded differences (temporal reasoning) can be efficiently solved by the Waltz algorithm

$\longrightarrow$ Early paper that attracts attention on the difficulty of label propagation in interval labels.

This work has been continued by Faltings (AIJ 92) who studied the quiescence problem of the Waltz algorithm.