Fast Profile Driven Partial Dead Code Elimination

for JIT compilers

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Introduction

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  - $O(n^3)$ for each expression
- We need an effective **linear** approximation

Dead Code

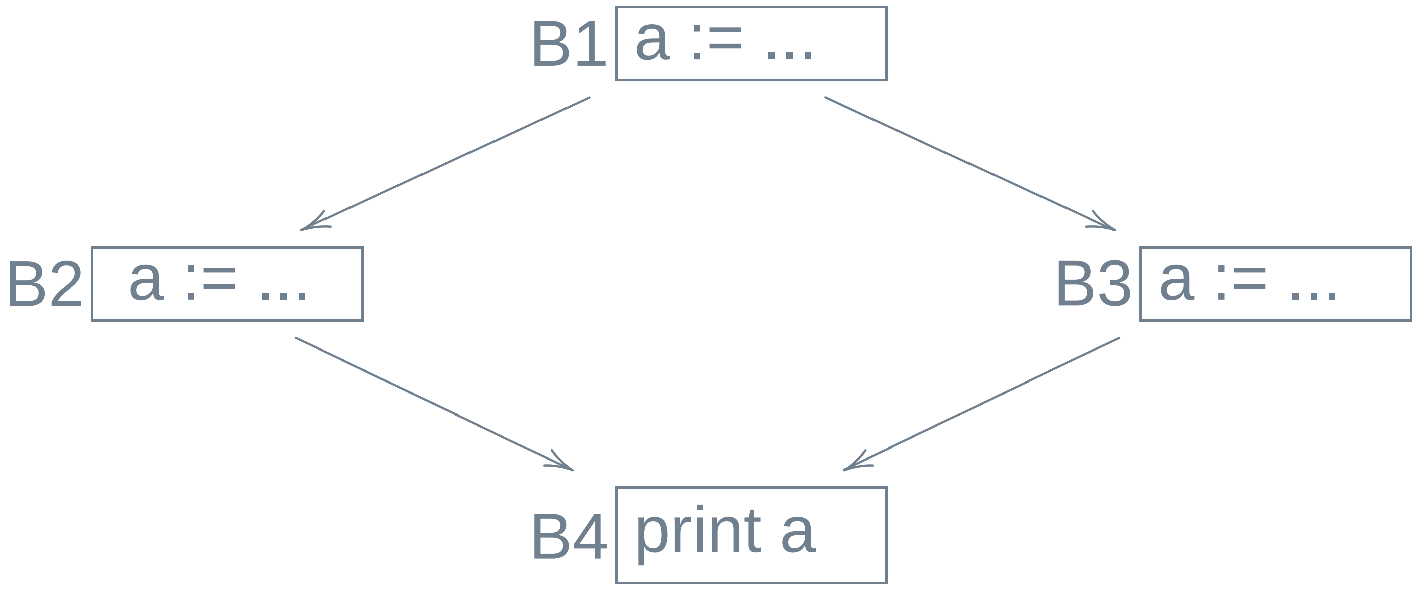

Figure 1: A Dead Store Variable

Dead Code Elimination

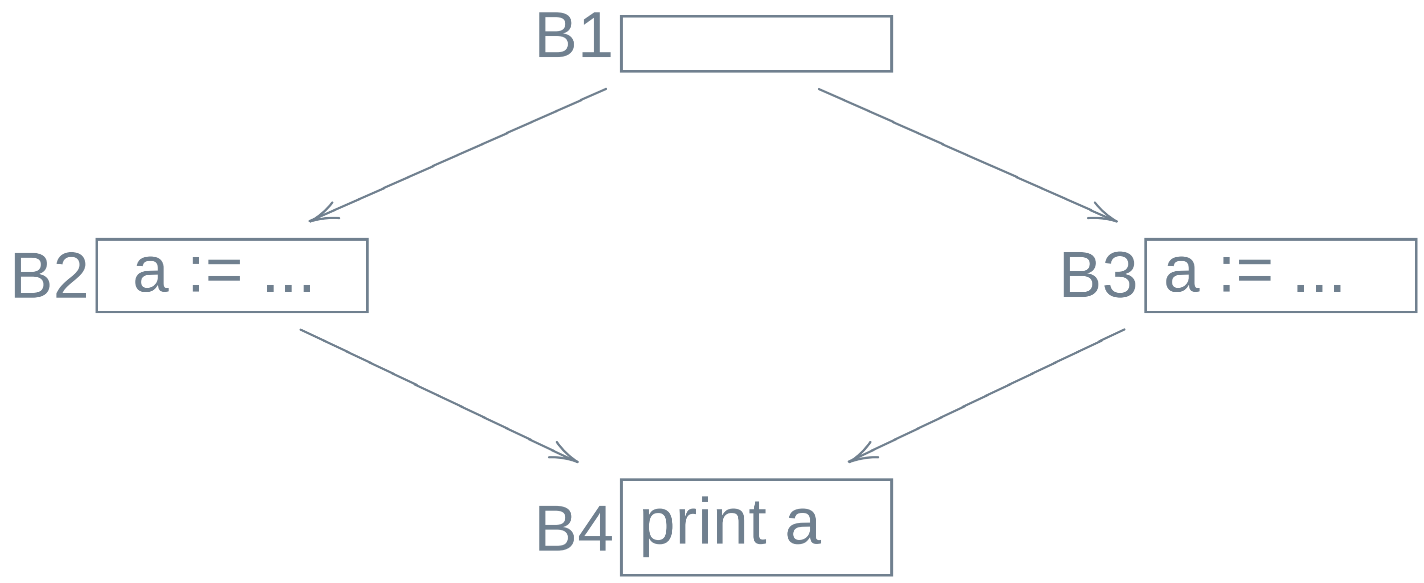

Figure 2: A Dead Store Eliminated

Partially Dead Code

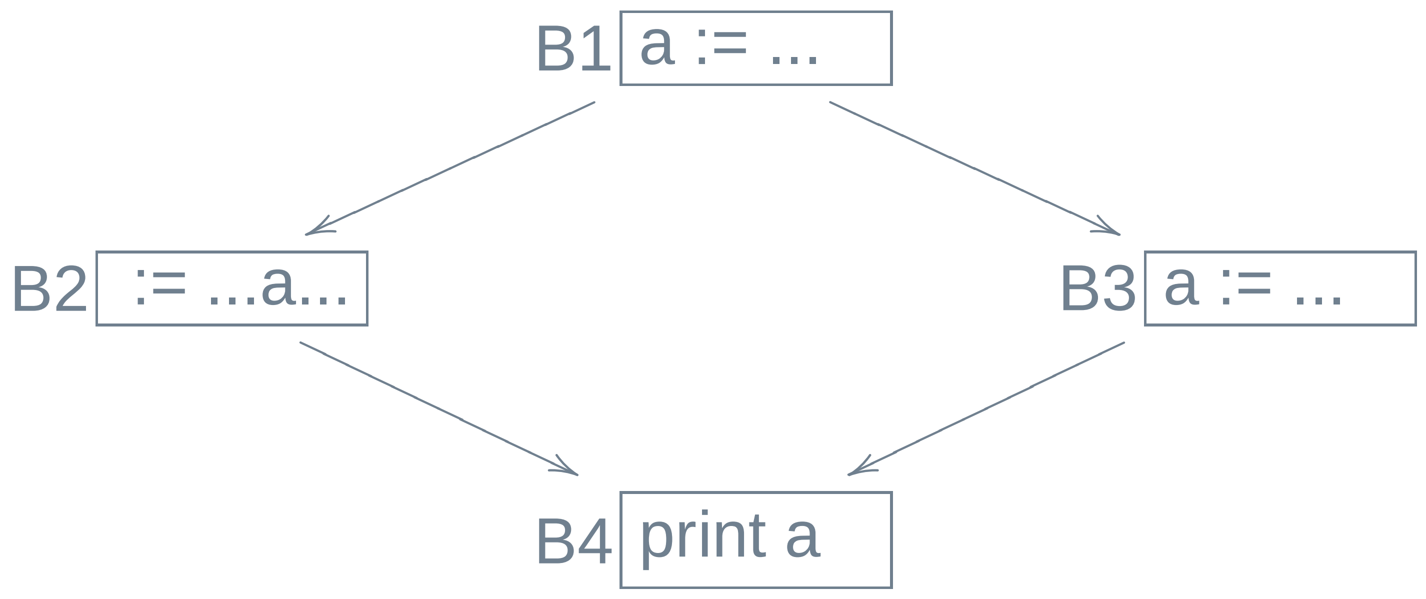

Figure 3: A Partially Live Store Variable

Step 1: Insert Stores At Use-Points

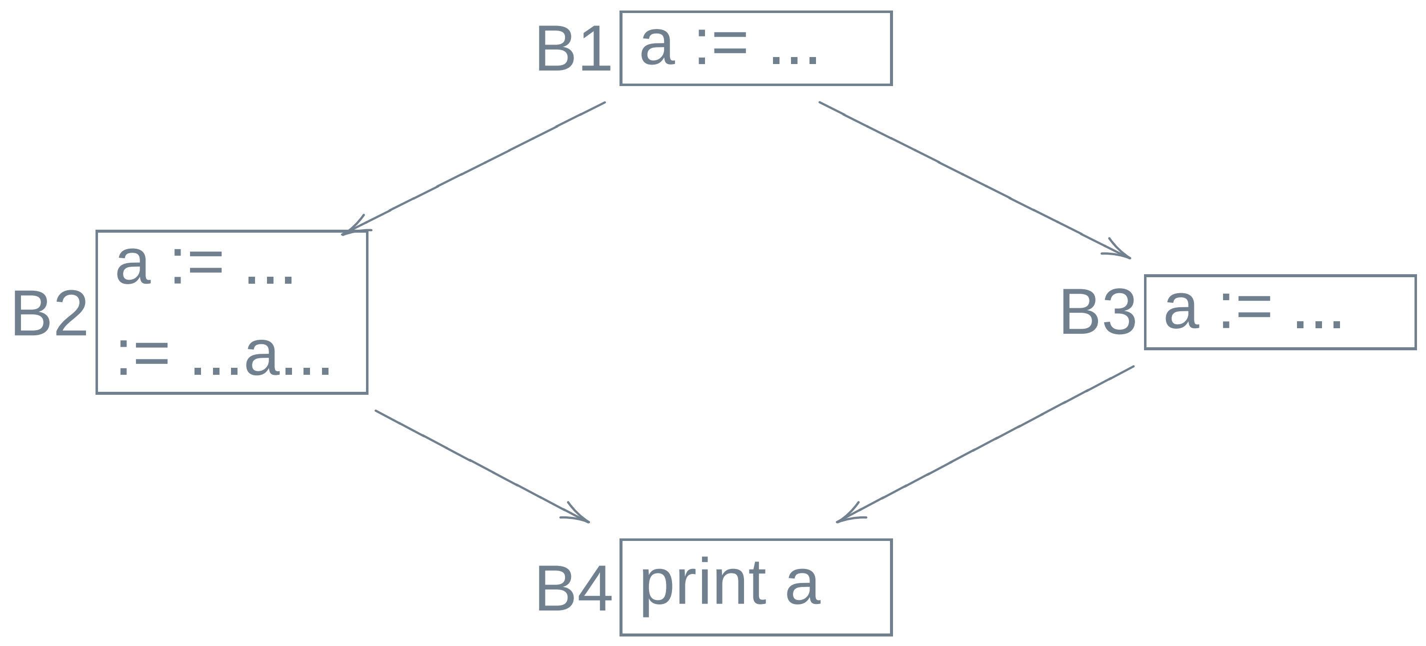

Figure 4: “Promotion” to a Completely Dead Store

Step 2: Eliminate Dead Stores

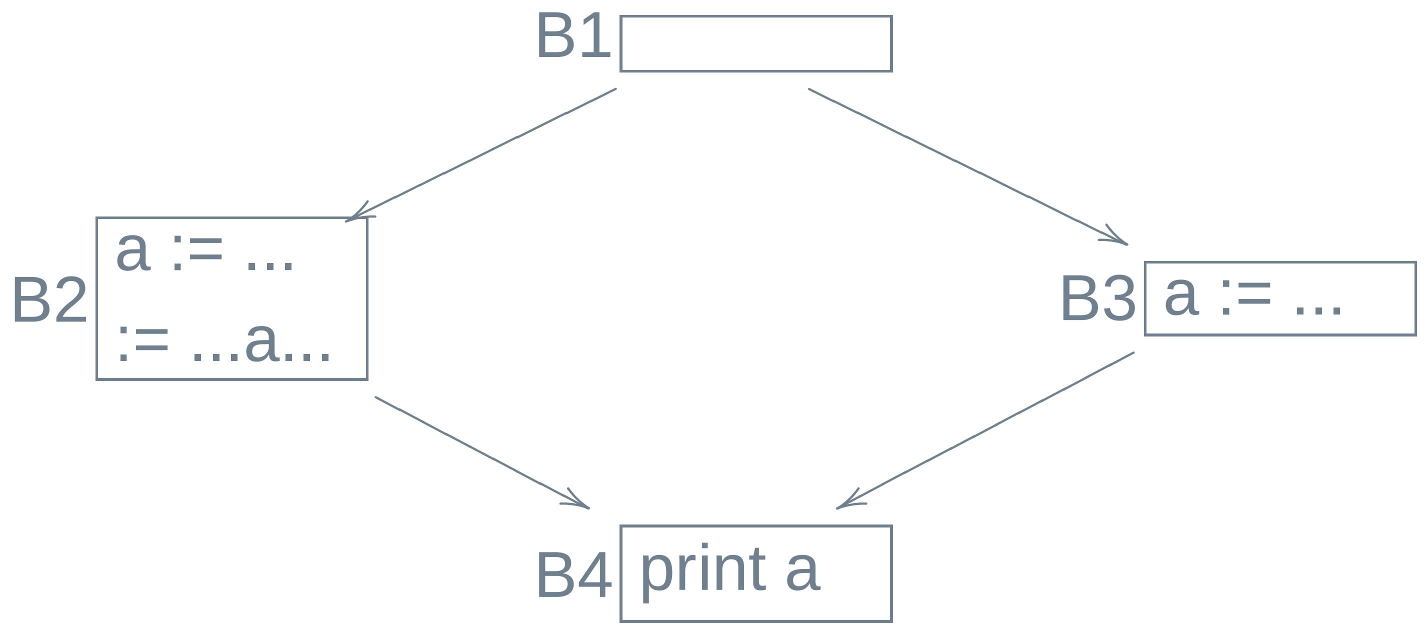

Figure 5: Partially Dead Store Eliminated

Speculative PDCE Algorithm

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- Perform elementary dead code elimination.

Note

We present this algorithm in Static Single Assignment form.

A PDCE problem in SSA

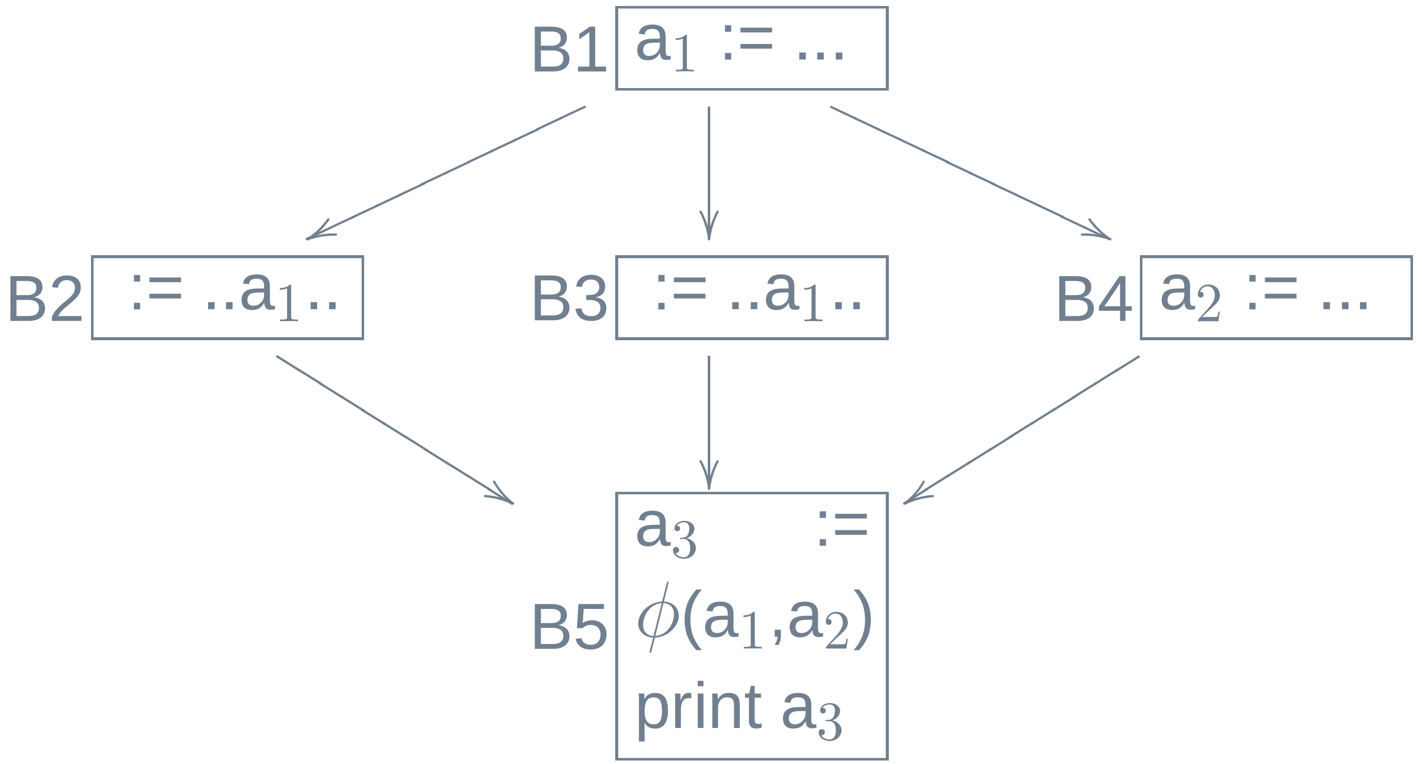

Figure 6: Reformulation of Figure 1 in SSA

... with execution frequencies

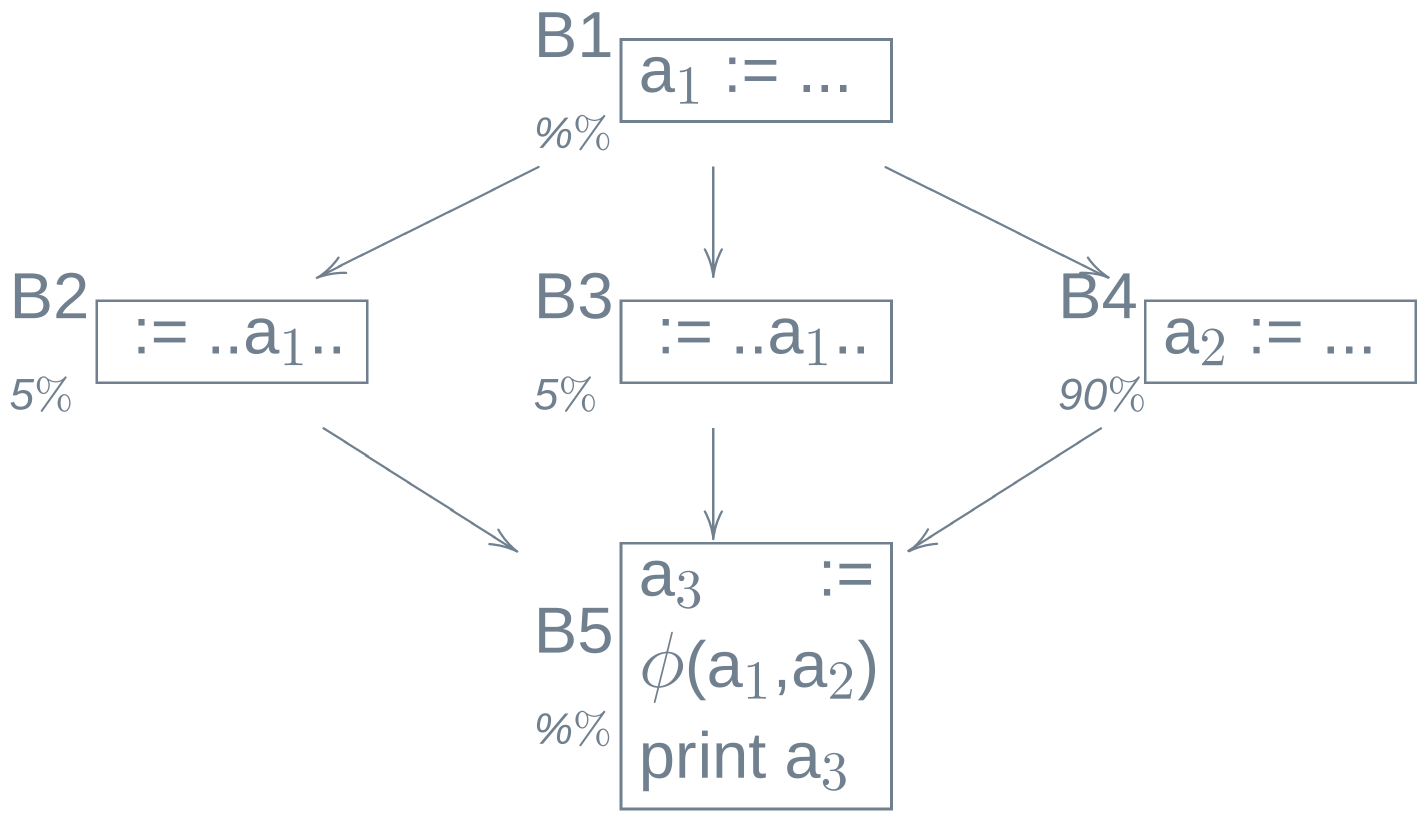

Figure 7: Reformulation of Figure 1 in SSA

Outline of Algorithm

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  - Insert store a=x on the edge.

Placement in Action...

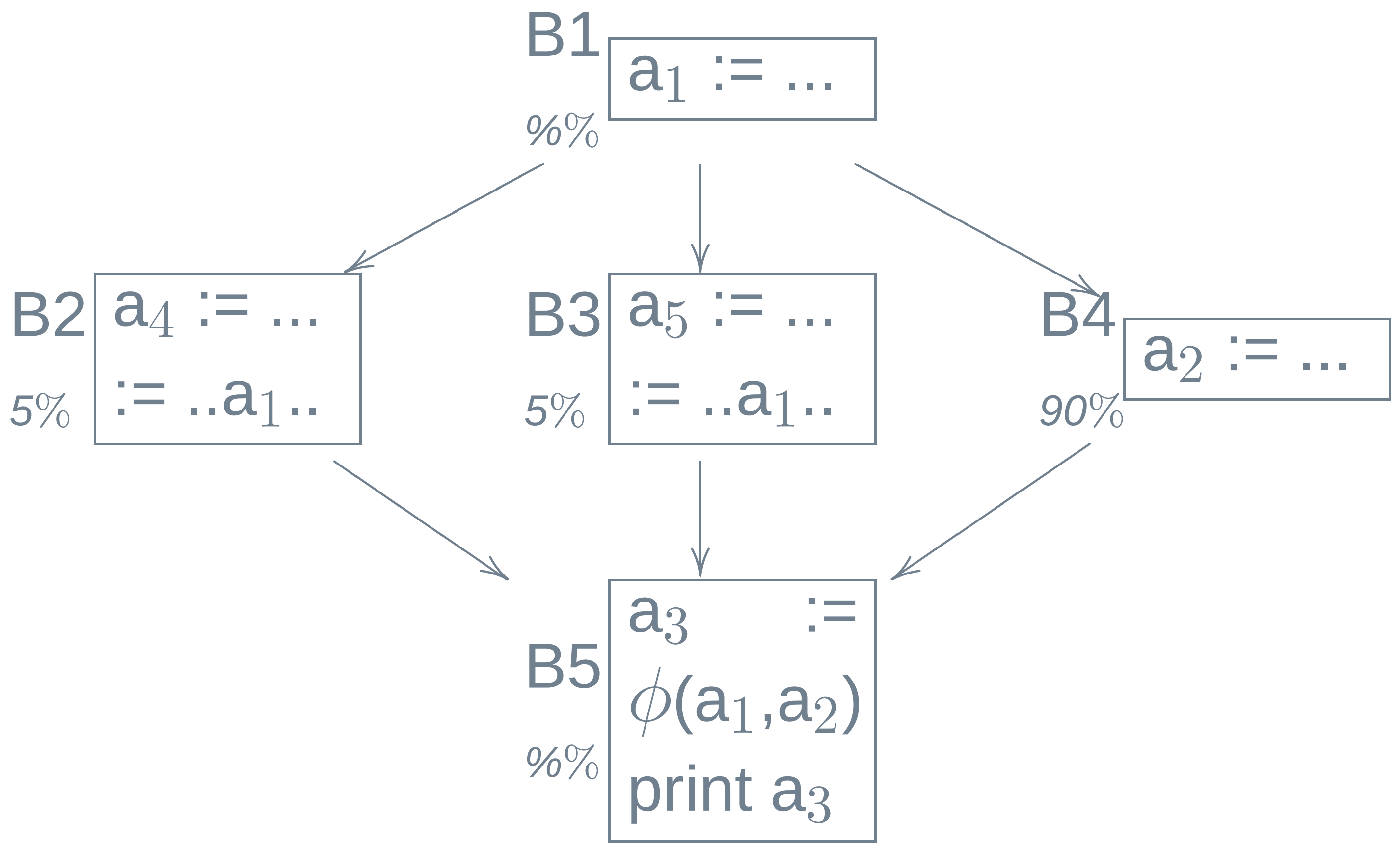

Figure 8: Placement of Stores to Alternate Store Variables

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- Decorate dominator tree so that each node (basic block) is associated with closest store above it. This associates an ASV with each node
- For each block, replace all uses of the PSLV with the block’s ASV.

Renaming in Action...

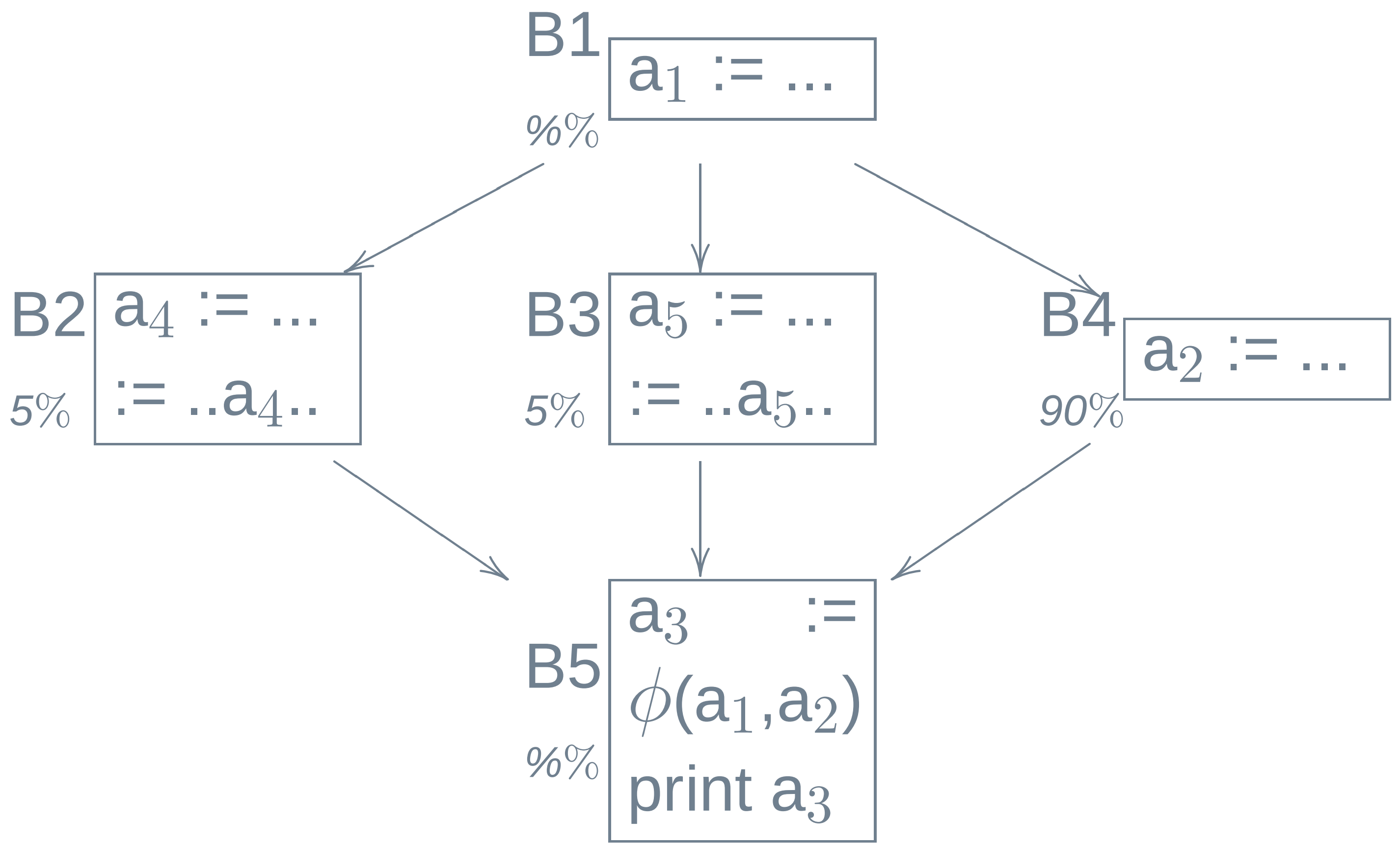

Figure 9: Renaming of uses of PLSV

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  - The ϕ-functions occur in the dominance *frontiers* and so would not have been modified by the renaming step.

Integration in Action...

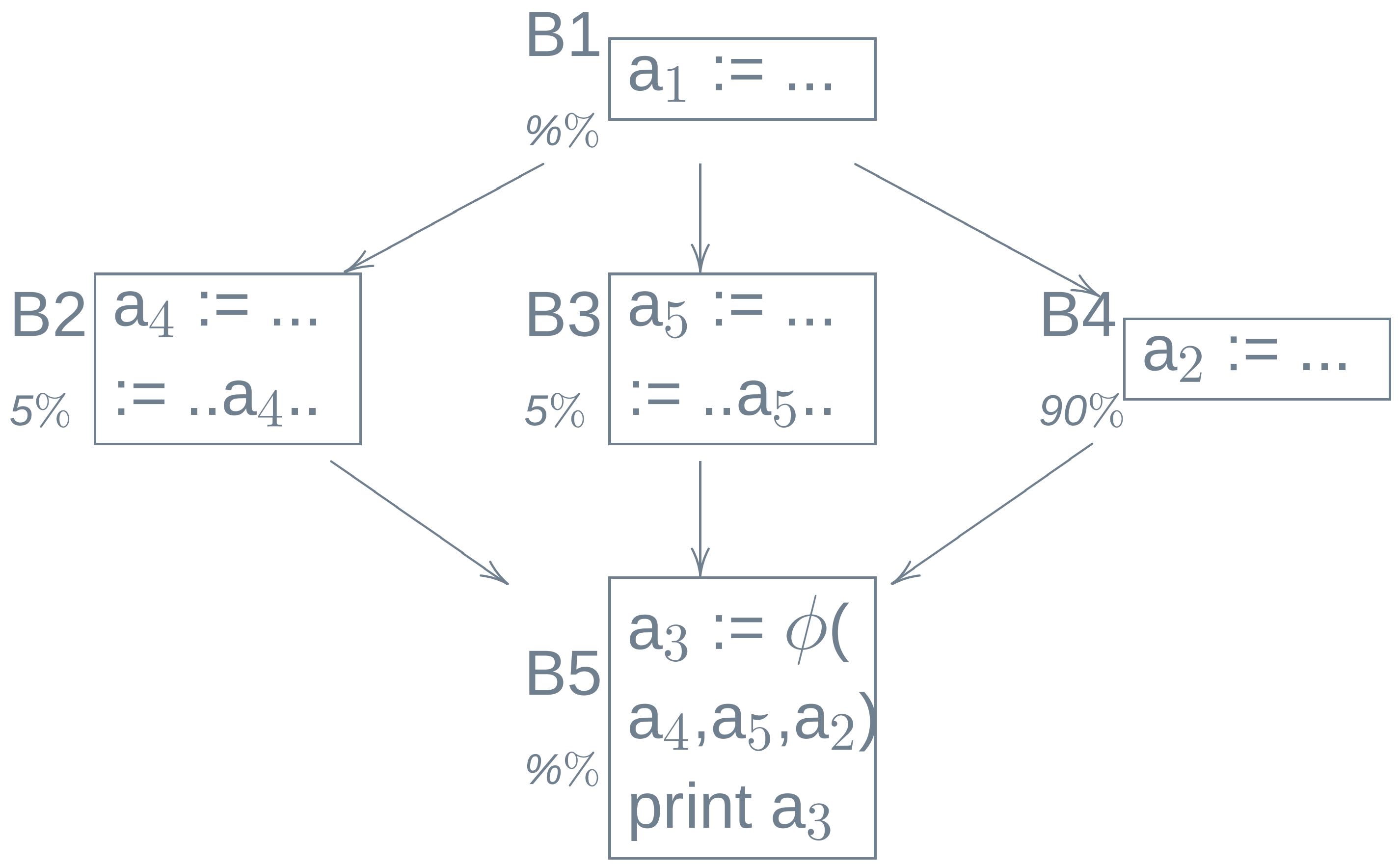

Figure 10: Renaming of uses of PLSV

Trivial DCE gives...

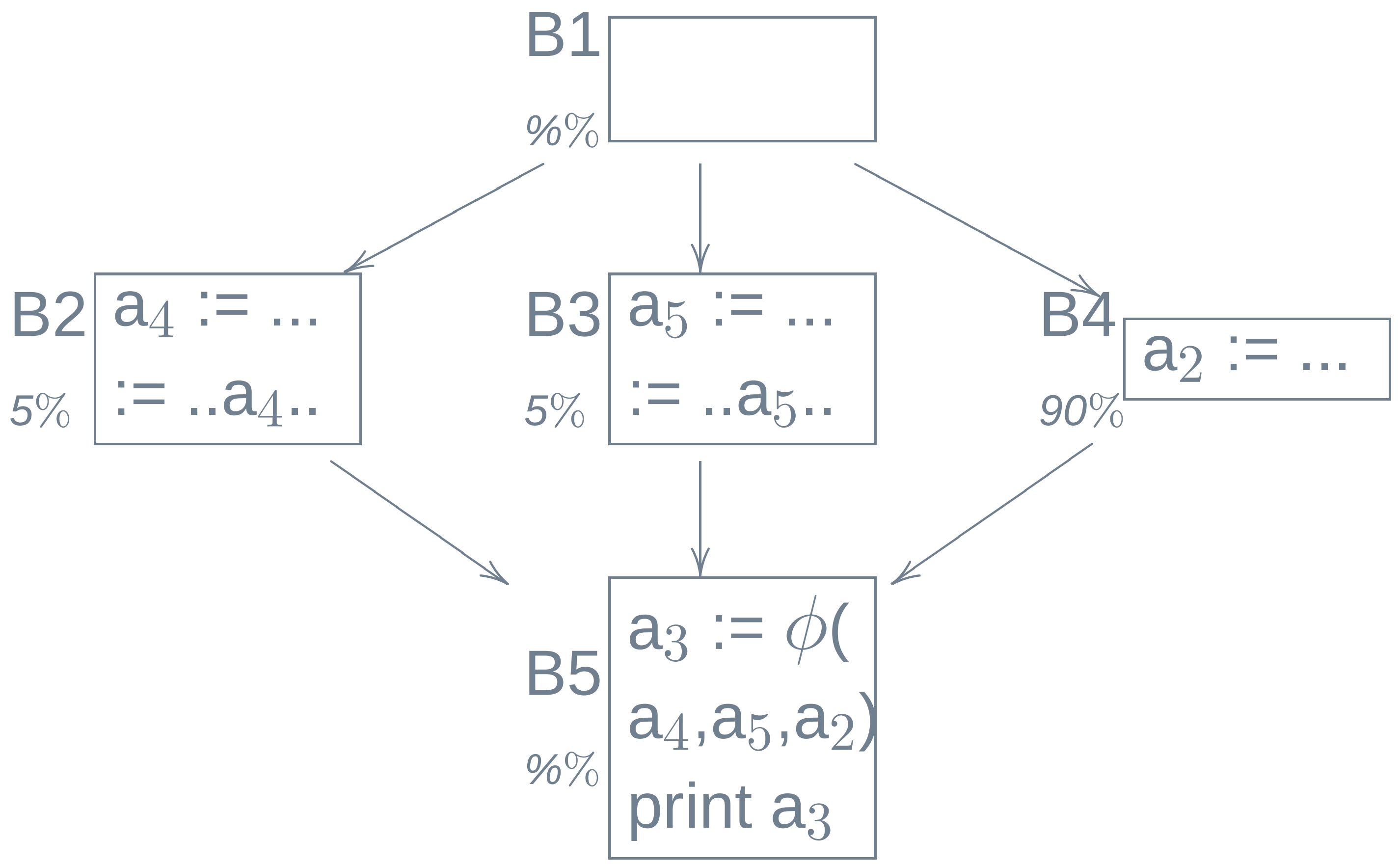

Figure 11: Renaming of uses of PLSV

Why SSA ?

- Dominance Based Rematerialization
- Preserving Checks

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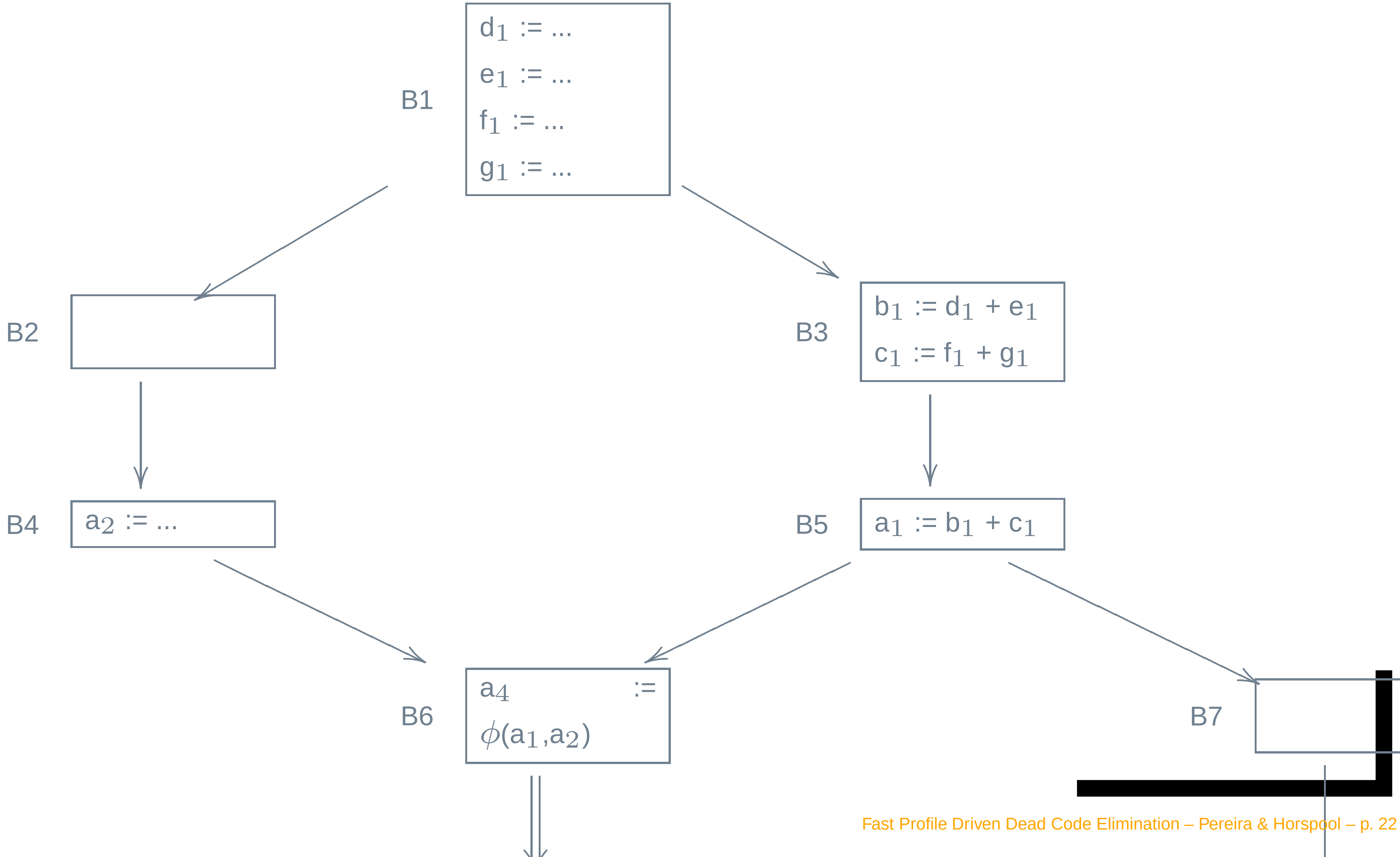
- But the store may not dominate the egress edge
- But if the definition point of a and b dominate the edge we can recompute a and b where we need them.

Example: Rematerialization



Example: The Dominator Tree

$$\begin{tikzcd}
 & & B1 \arrow[dll] \arrow[dl] \arrow[d] \arrow[dr] \arrow[drr] & & \\
B2 \arrow[d] & B3 \arrow[d] & B6 & B8 & B10 \\
B4 & B5 \arrow[d] & & & \\
 & B7 \arrow[d] & & & \\
 & B9 & & &
\end{tikzcd}$$

Figure 13: Dominator Tree for Example CFG

Check Preservation

... is preservation of dominance relationships

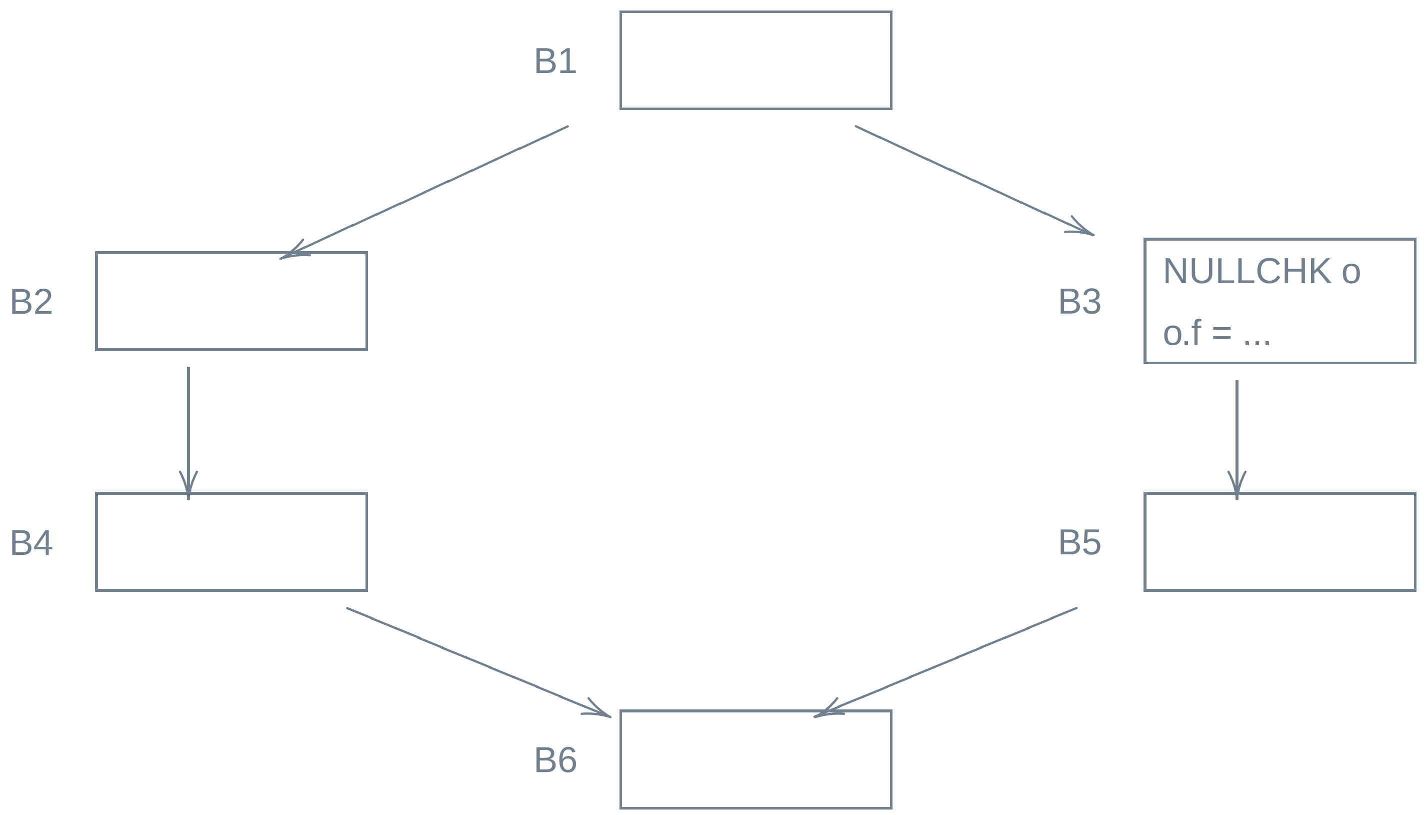


Figure 14: Store Motion Constrained

A Wrong Movement

... violates dominance relationships

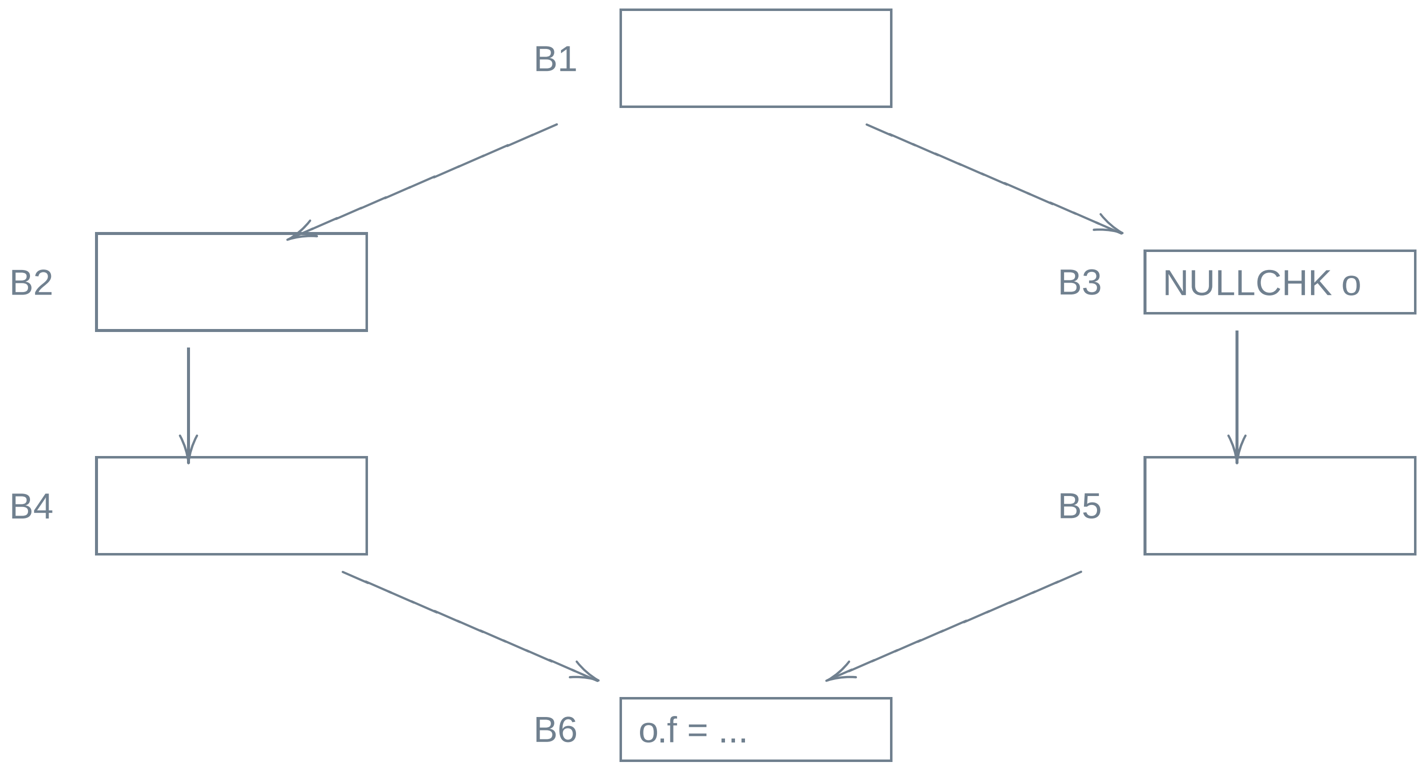


Figure 15: PLS No Longer Safe

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- SSA ties in well with Java’s checked instructions.
  - In fact, it provides a framework to think about them.
- We are currently working on benchmarks.

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We need to determine how these costs offset the code motions we have done.

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Question Period