CC Week 4

Prepared for: 7th Sem, CE, DDU

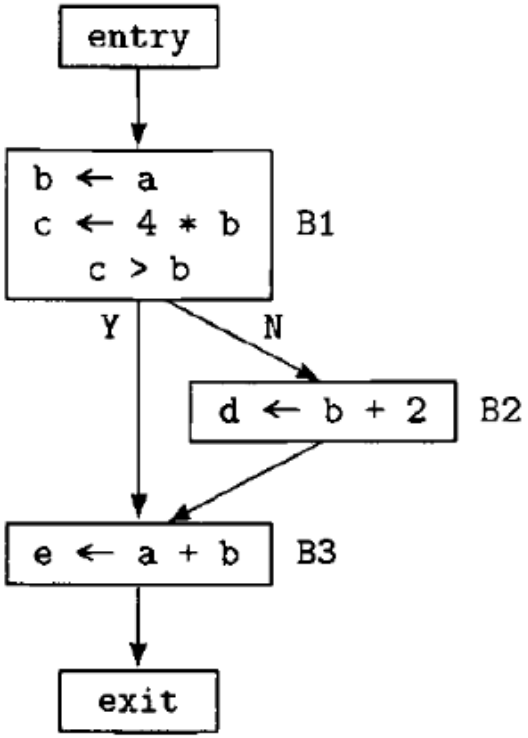
Prepared by: Niyati J. Buch

Ref. Book 1: Compiler: Principles, techniques and tools by Aho, Ullman and Sethi, 2nd Ed., Pearson Education
Ref. Book 2: Advanced Compiler Design & Implementation By Steven S Muchnick

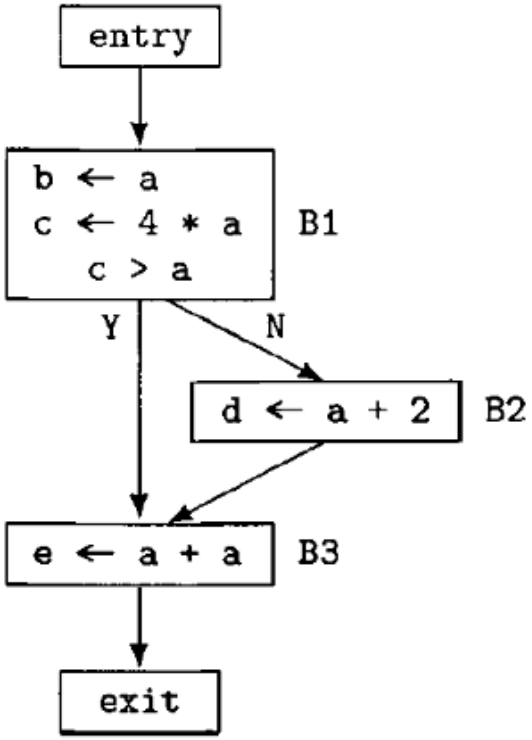
Copy Propagation

- Copy propagation is a transformation that, given an assignment **x ← y** for some variables x and y, replaces later uses of x with uses of y, as long as intervening instructions have not changed the value of **either x or y**.

Example of Copy Propagation



(a) Example of a copy assignment to propagate, namely, b ← a in **B1**



(b) the result of doing copy propagation on it.

Phases of Copy Propagation

- Copy propagation can reasonably be divided into **local** and **global** phases,
  - the first operating within individual basic blocks and
  - the latter across the entire flow- graph,
- or it can be accomplished in a single global phase.

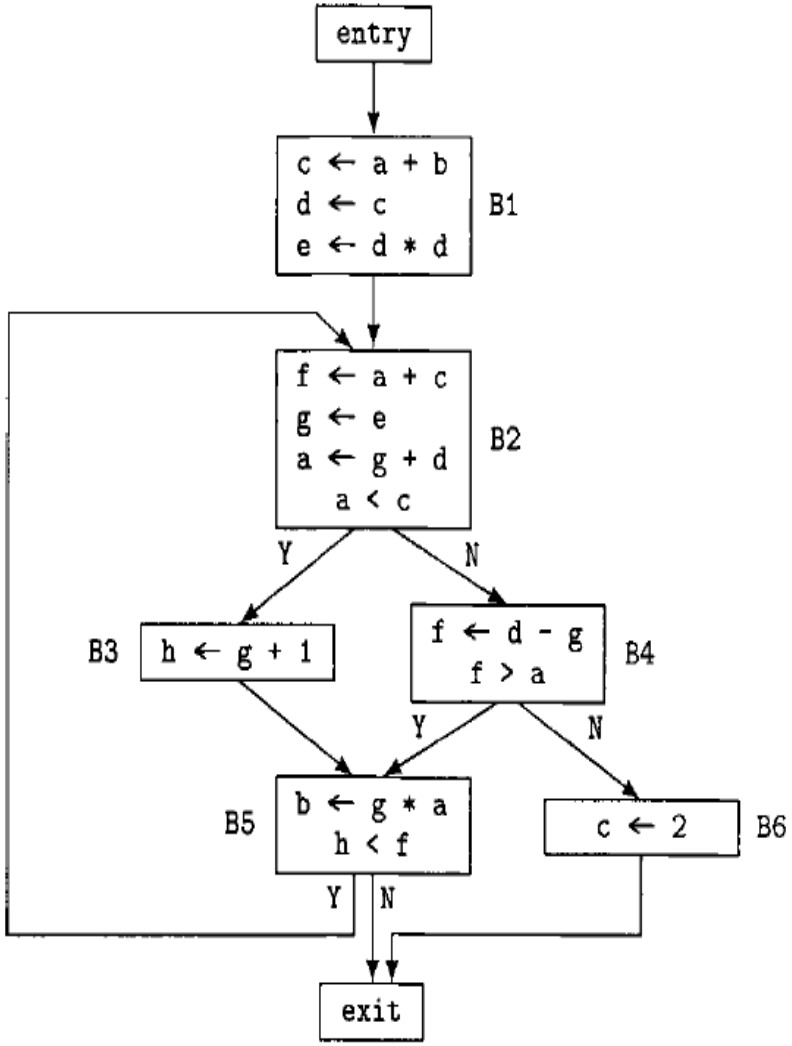
Example 1: Basic block of 5 instructions

Position	Code Before	ACP	Code After
		∅	
1	b ← a		b ← a
		{⟨b,a⟩}	
2	c ← b + 1		c ← a + 1
		{⟨b,a⟩}	
3	d ← b		d ← a
		{⟨b,a⟩,⟨d,a⟩}	
4	b ← d + c		b ← a + c
		{⟨d,a⟩}	
5	b ← d		b ← a
		{⟨d,a⟩,⟨b,a⟩}	

- The first column shows the position
- The second column shows a basic block of five instructions before applying the ACP algorithm
- The third column shows the value of ACP at each step
- The fourth column shows the result of applying ACP

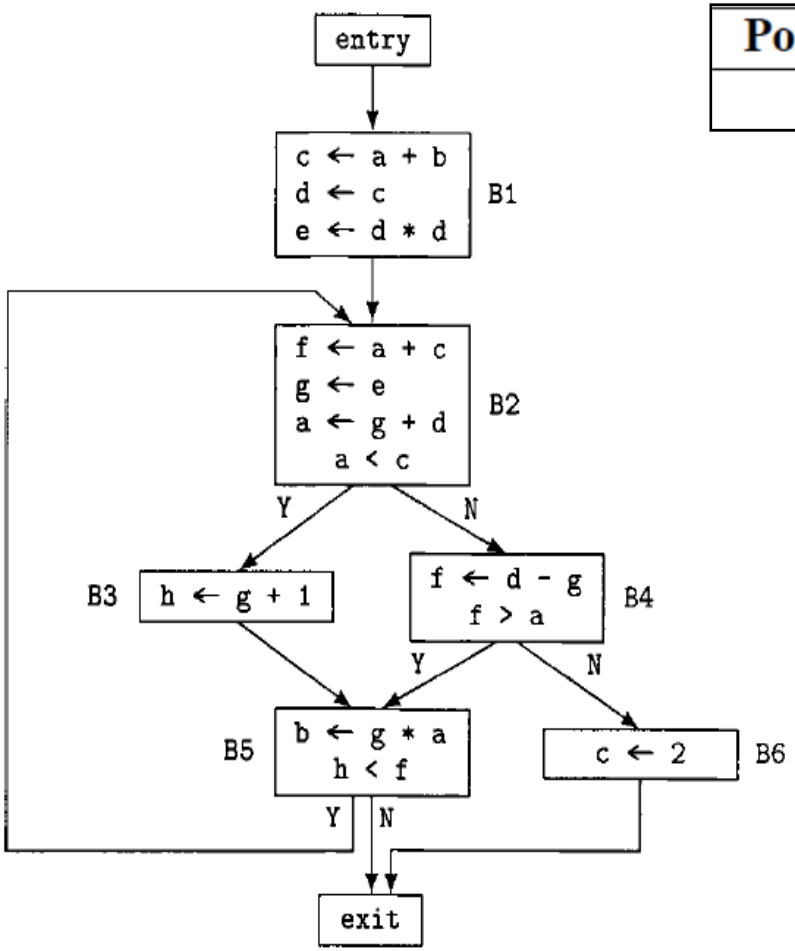
- ACP = Available Copy Propagation

Example 2



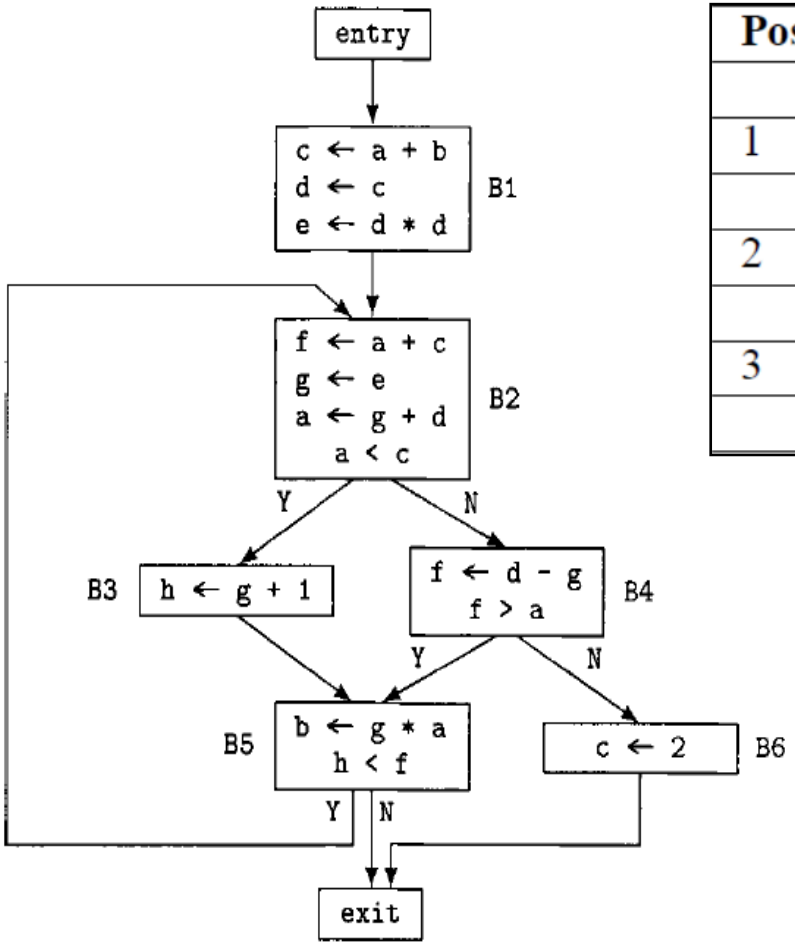
- This is the flow graph **before** copy propagation.

Local Copy Propagation on block entry



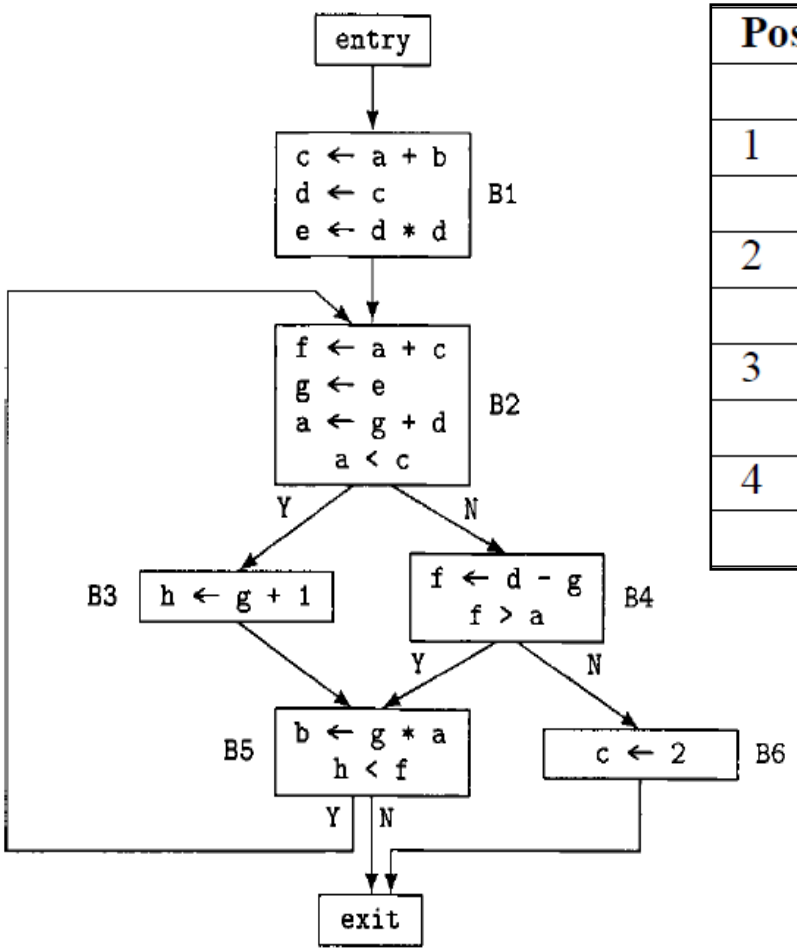
Position	Code Before	ACP	Code After
		∅	

Local Copy Propagation on block B1



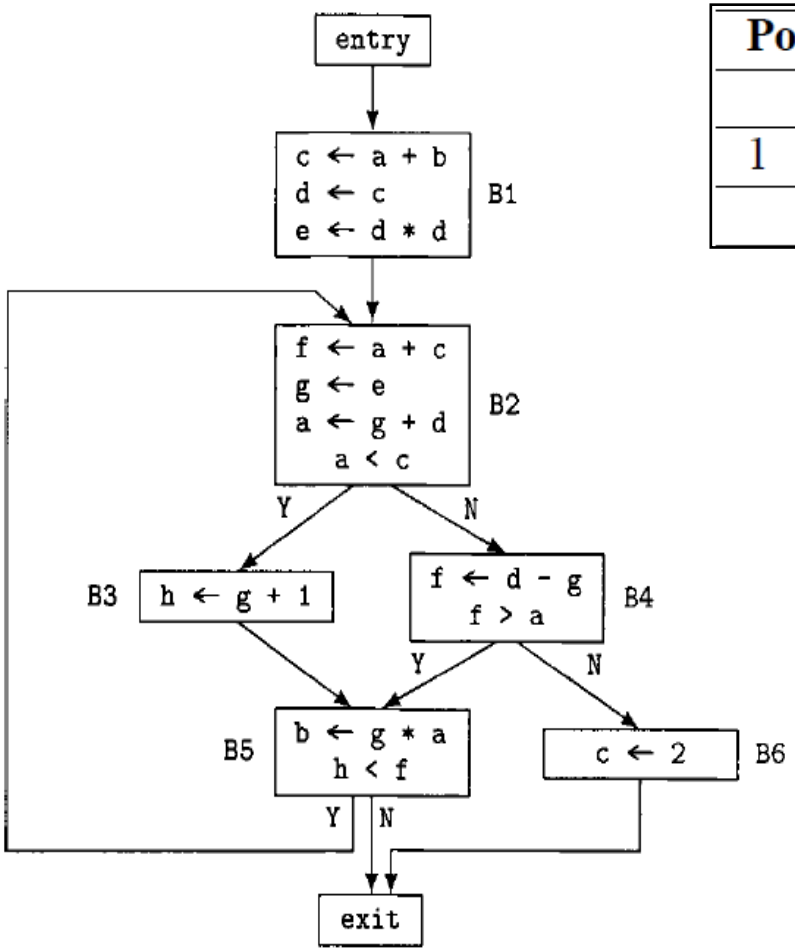
Position	Code Before	ACP	Code After
		$\emptyset$	
1	c ← a + b		c ← a + b
		$\emptyset$	
2	d ← c		d ← c
		$\{\langle d, c\rangle\}$	
3	e ← d * d		e ← c * c
		$\{\langle d, c\rangle\}$	

Local Copy Propagation on block B2



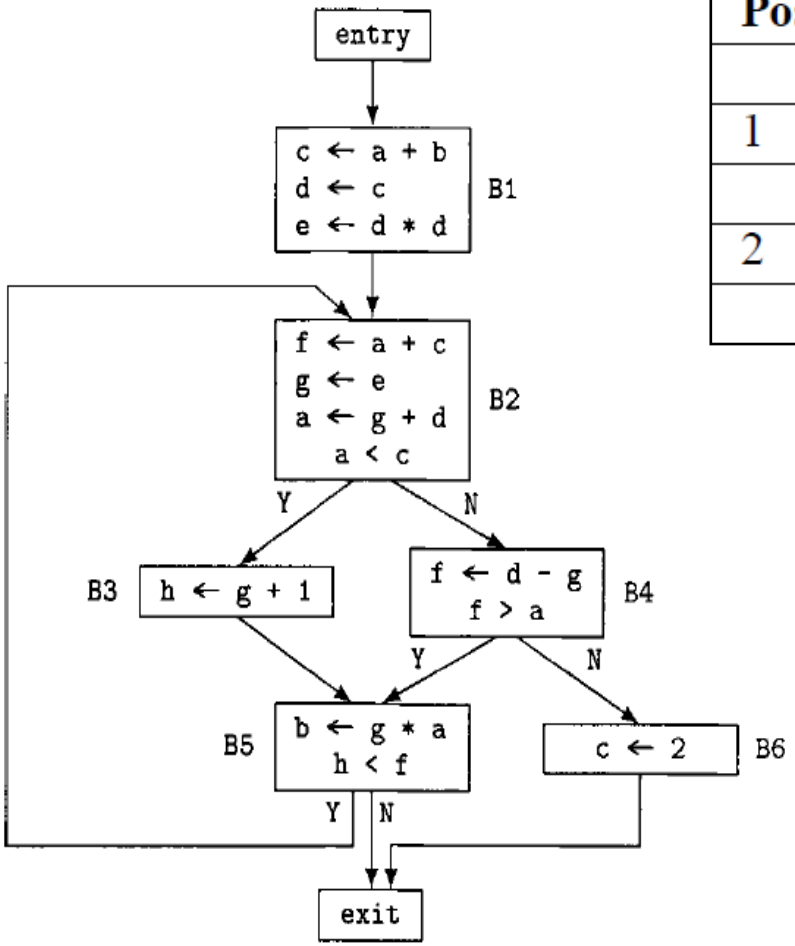
Position	Code Before	ACP	Code After
		$\emptyset$	
1	f ← a + c		f ← a + c
		$\emptyset$	
2	g ← e		g ← e
		$\{\langle g, e\rangle\}$	
3	a ← g + d		a ← e + d
		$\{\langle g, e\rangle\}$	
4	a < c		a < c
		$\{\langle g, e\rangle\}$	

Local Copy Propagation on block B3



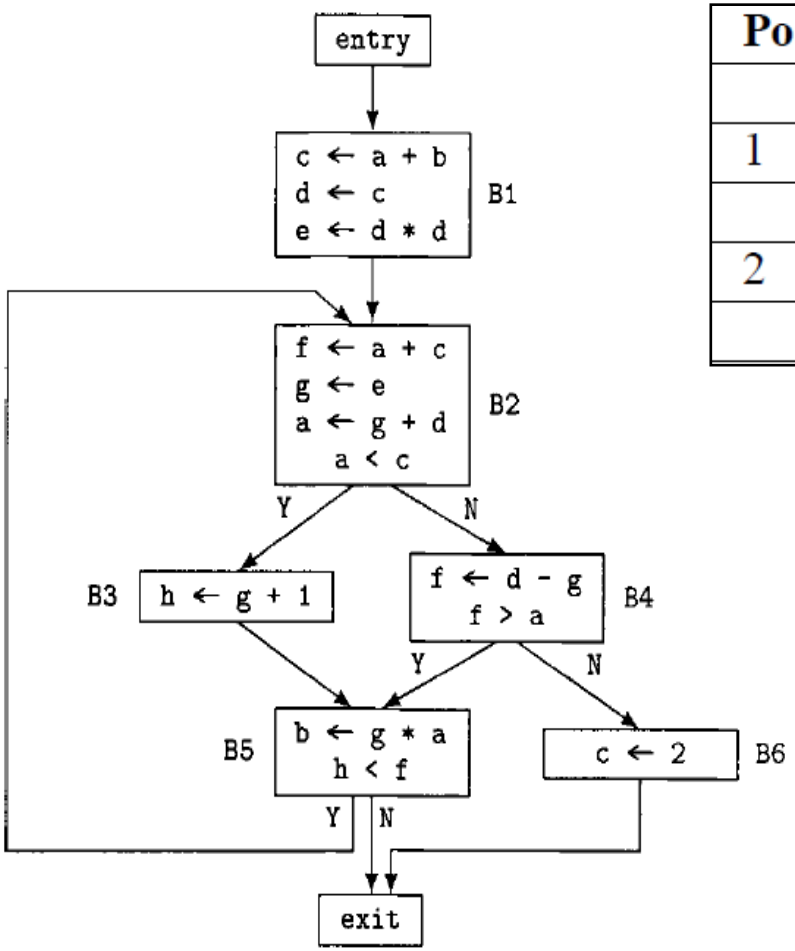
Position	Code Before	ACP	Code After
		∅	
1	h ← g + 1		h ← g + 1
		∅	

Local Copy Propagation on block B4



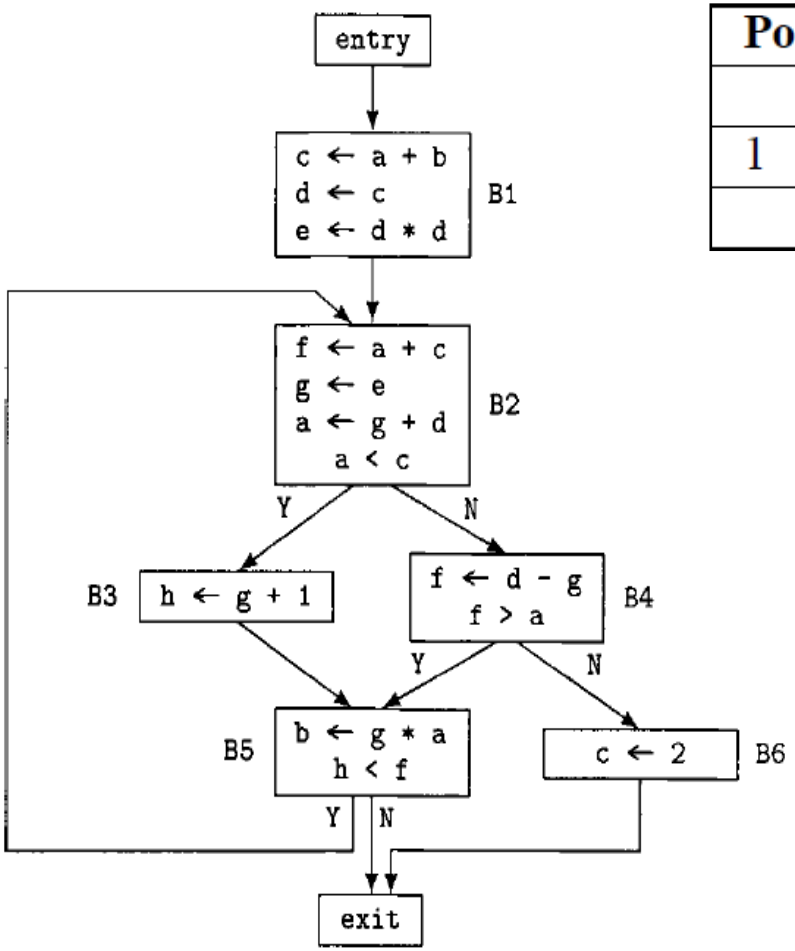
Position	Code Before	ACP	Code After
		∅	
1	f ← d - g		f ← d - g
		∅	
2	f < a		f < a
		∅	

Local Copy Propagation on block B5



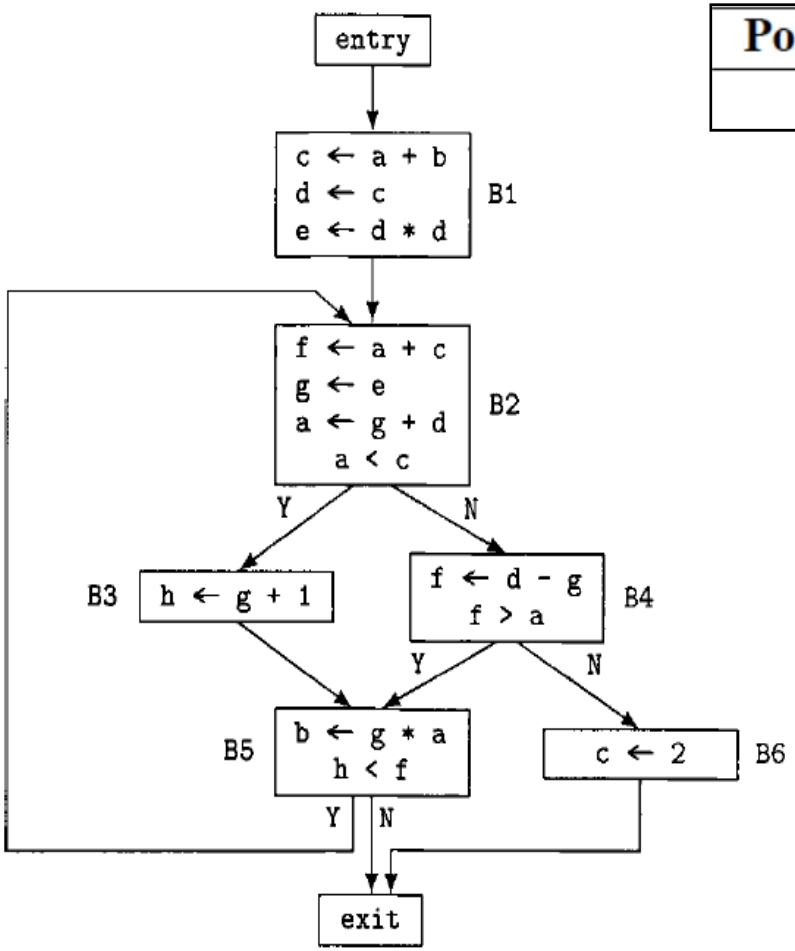
Position	Code Before	ACP	Code After
		∅	
1	b ← g * a		b ← g * a
		∅	
2	h < f		h < f
		∅	

Local Copy Propagation on block B6



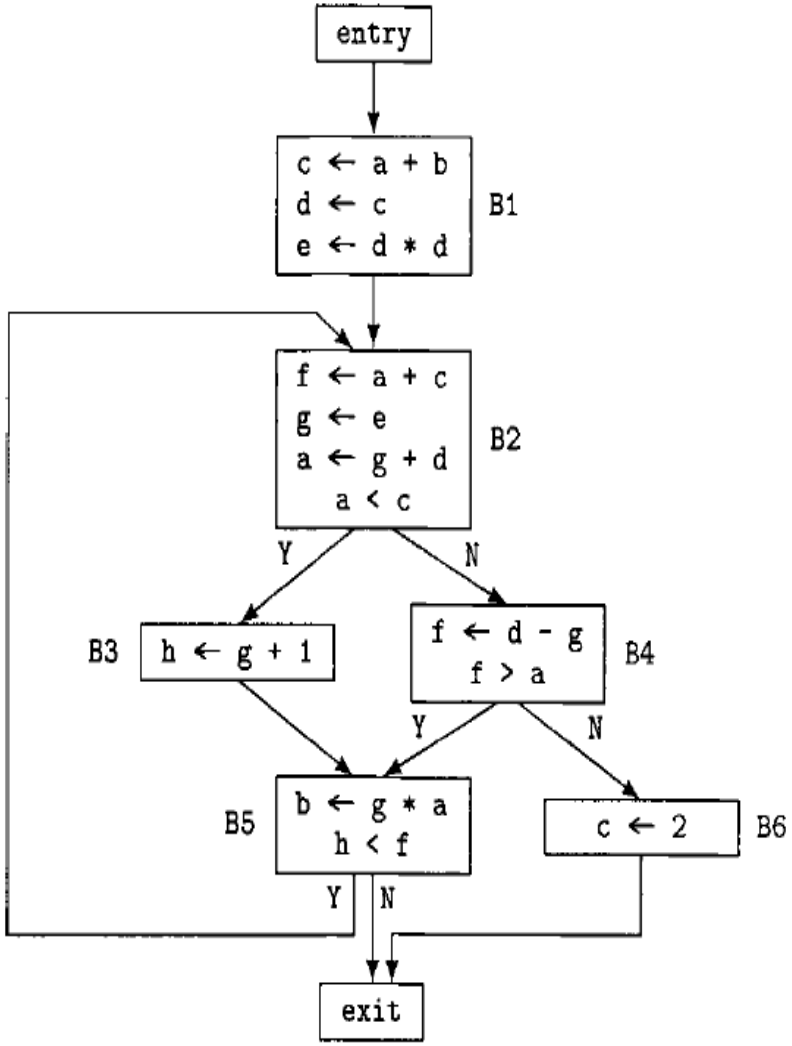
Position	Code Before	ACP	Code After
		∅	
1	c ← 2		c ← 2
		∅	

Local Copy Propagation on block exit



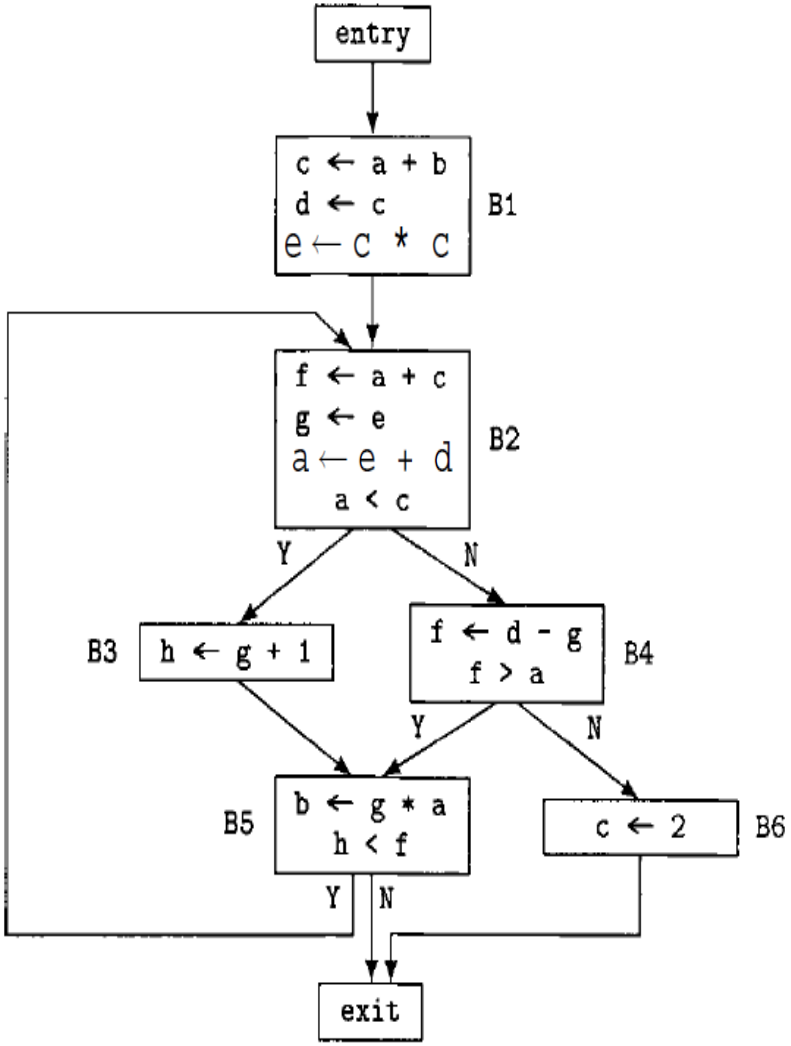
Position	Code Before	ACP	Code After
		∅	

Before local copy propagation



- This is the flow graph **before** local copy propagation.

After local copy propagation



- This is the flow graph **after** local copy propagation.