Introduction to Optimization[1]

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Compiler Construction
CSCI-GA.2130-001/Spring 2014
NYU Courant Institute

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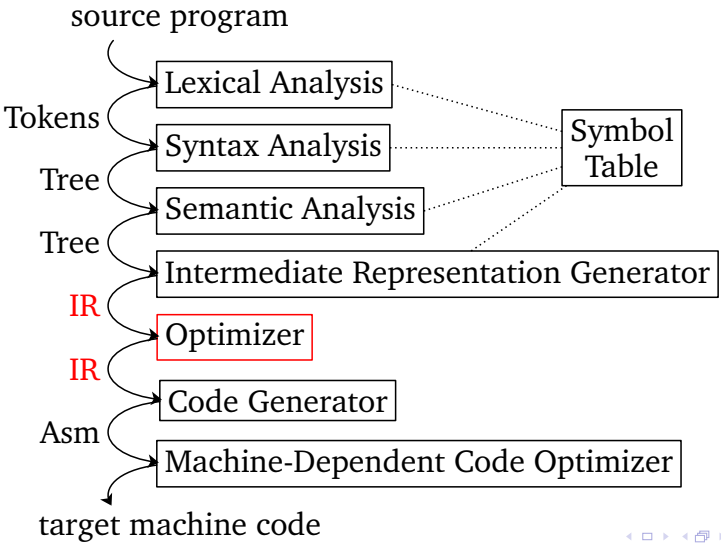
[1] ALSU §9.1

Sixth compilation phase



Sources of Redundancy

- Programmer “cut-n-paste”
- Compiler templates.
- Insufficient state transfer.

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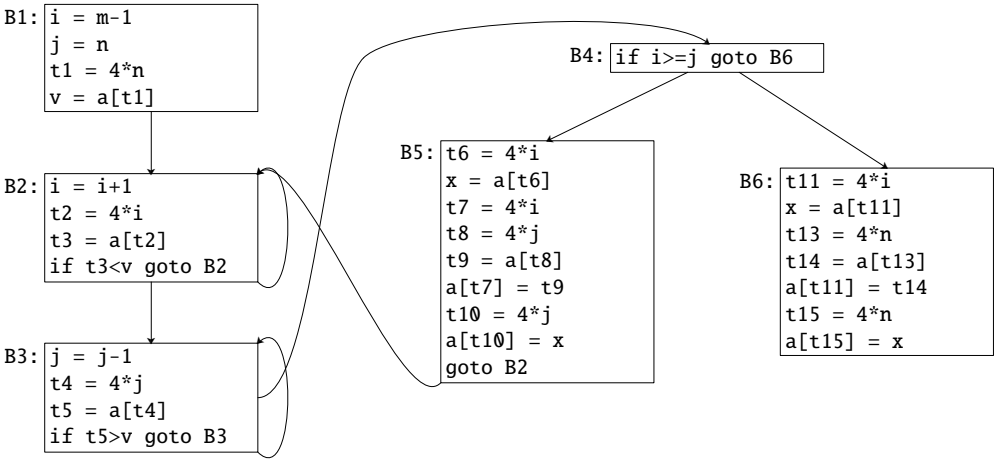
Example

```
void quicksort(int a[], int m, int n)
{
  int i, j, v, x; if (n <= m) return;

  i = m-1; j = n; v = a[n];
  while (1) {
    do i = i+1; while (a[i] < v);
    do j = j-1; while (a[j] > v);
    if (i >= j) break;
    x = a[i]; a[i] = a[j]; a[j] = x;
  }
  x = a[i]; a[i] = a[n]; a[n] = x;

  quicksort(a,m,j); quicksort(a,i+1,n);
}
```

Basic Blocks



(Local) Common Subexpression Elimination

B5:
```
t6 = 4*i
x = a[t6]
t7 = 4*i
t8 = 4*j
t9 = a[t8]
a[t7] = t9
t10 = 4*j
a[t10] = x
goto B2
```

$\Rightarrow$

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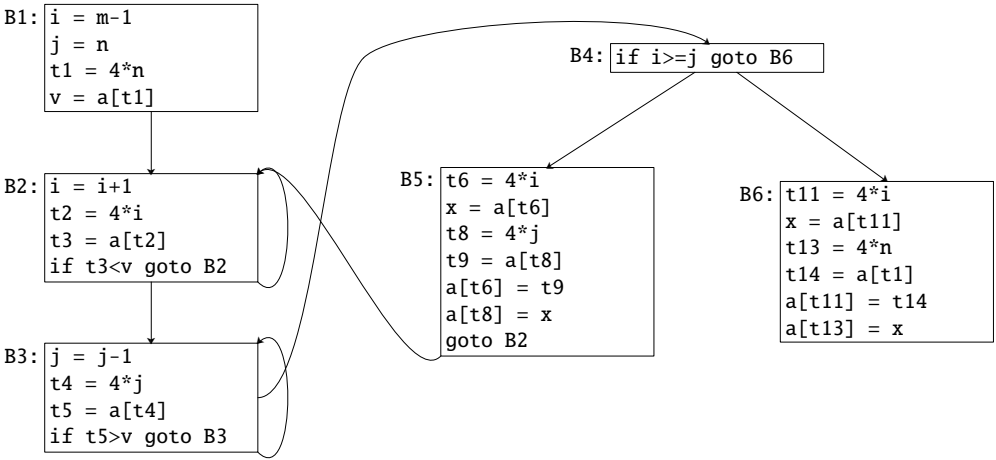
Global Common Subexpression Elimination



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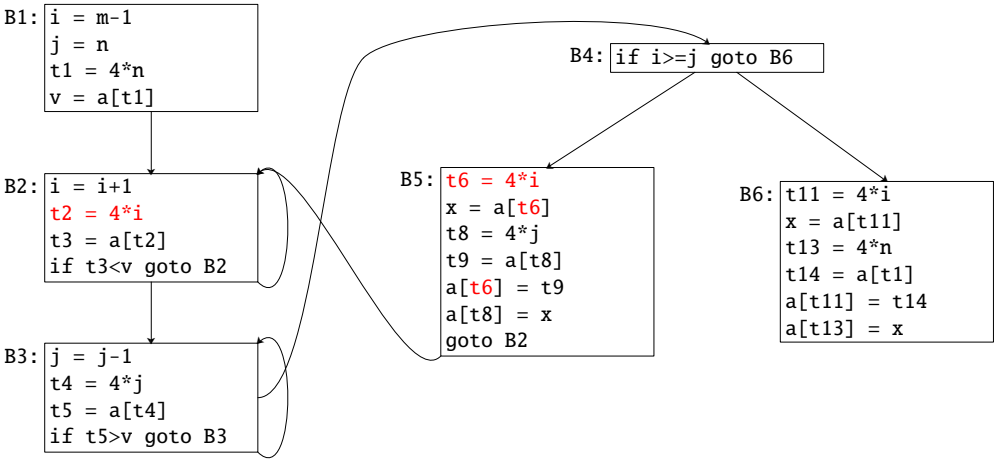

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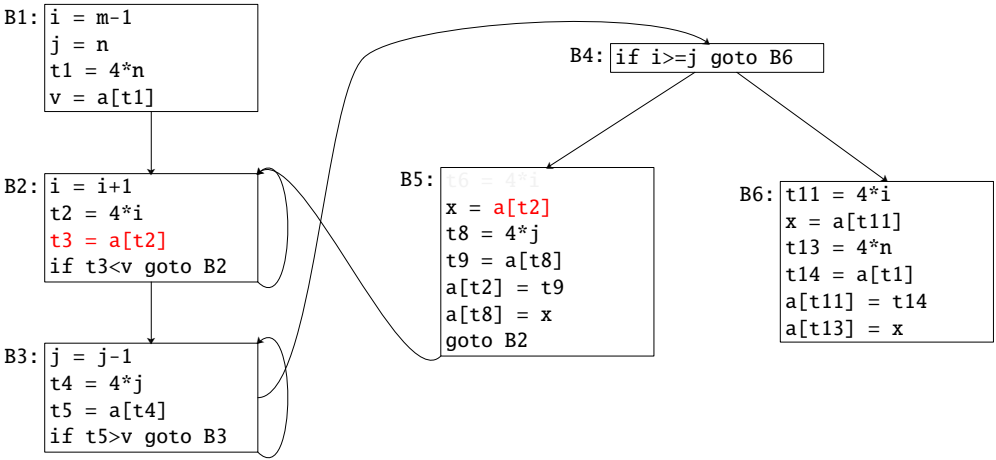

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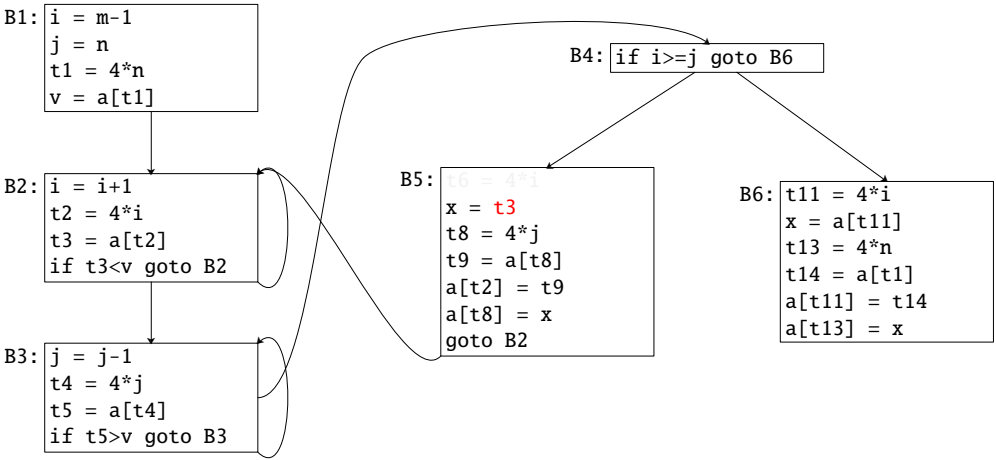

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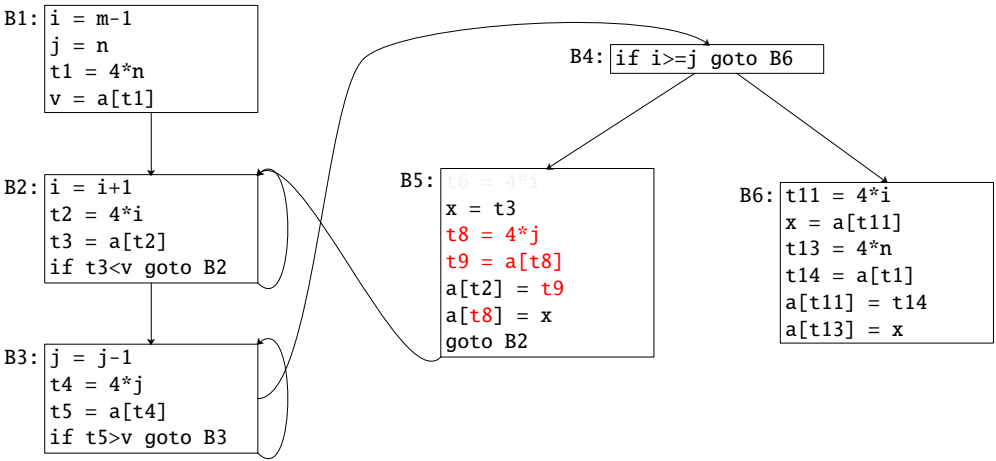

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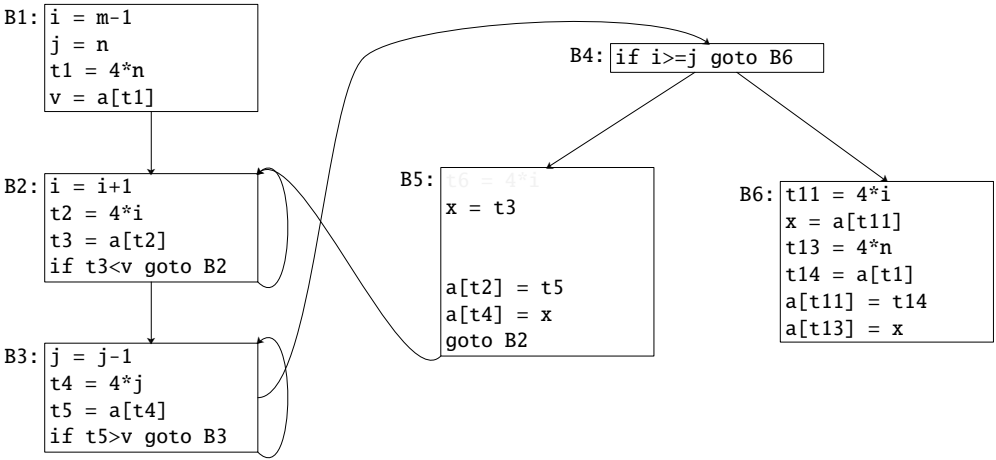

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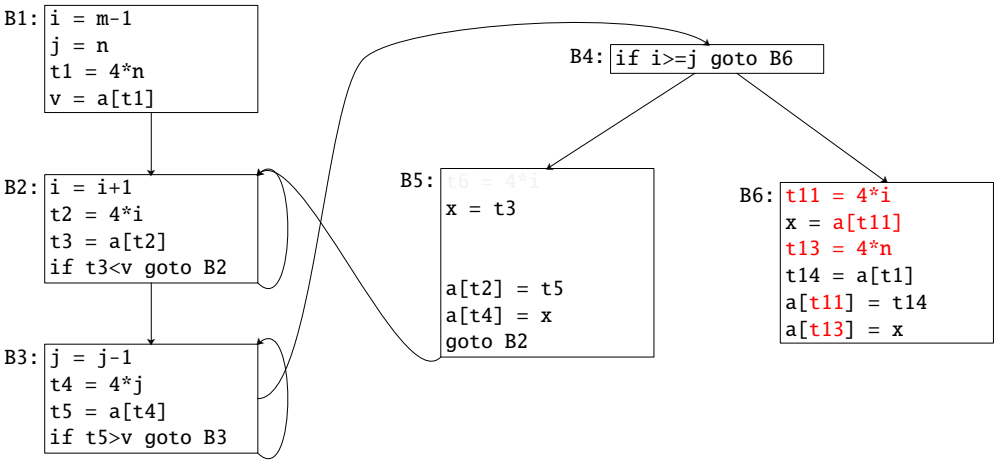

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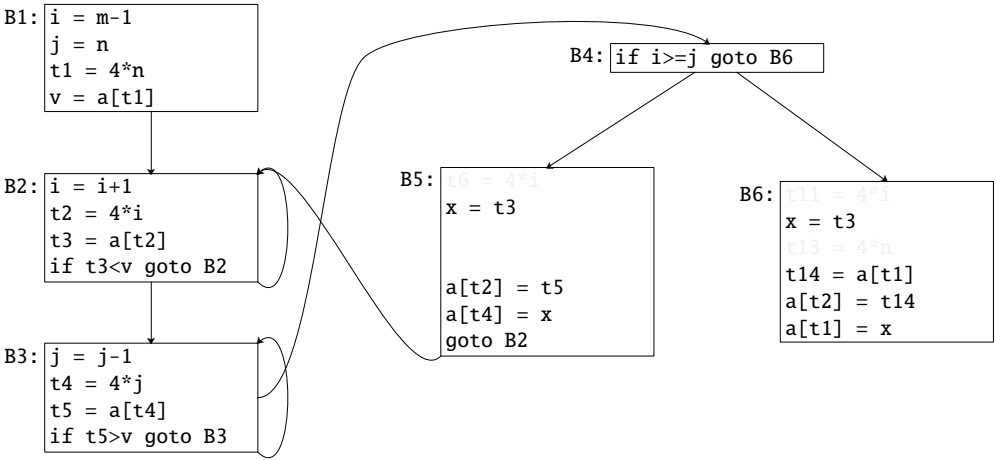

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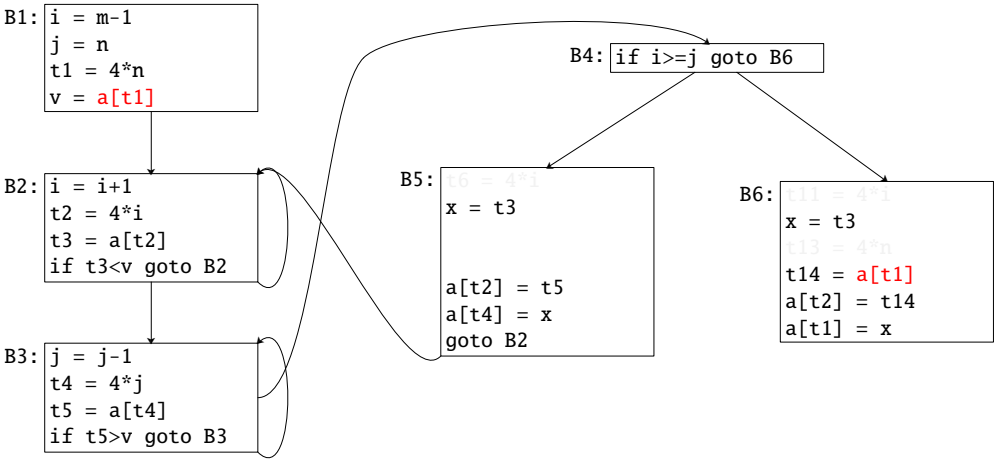

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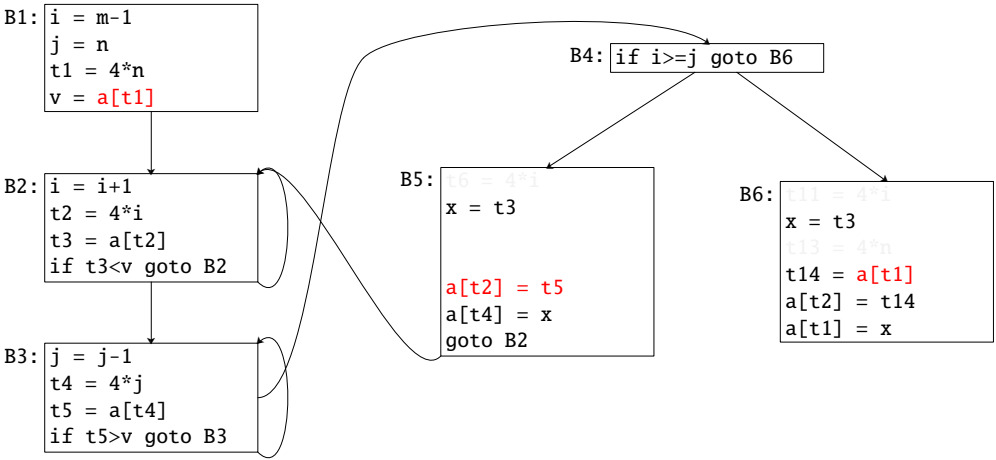
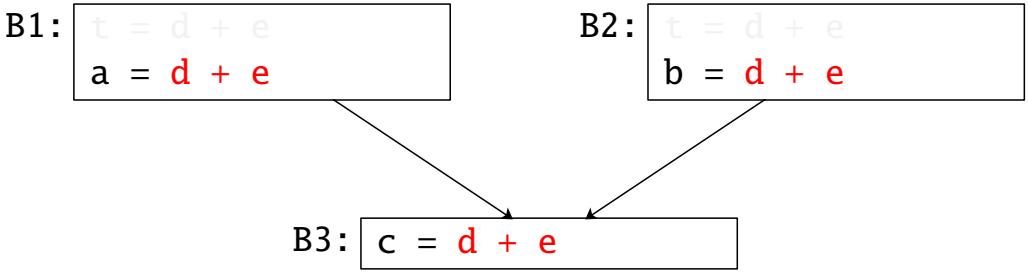


Copy Propagation



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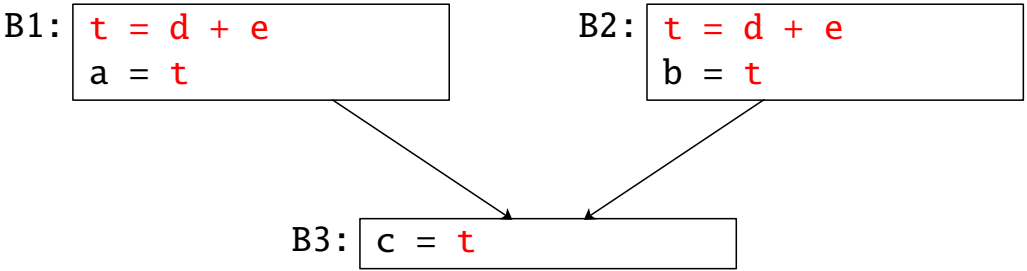

Code Motion

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while (i <= limit-2) /*not changing limit*/
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becomes

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t = limit-2;
while (i <= t) /*not changing limit or t*/
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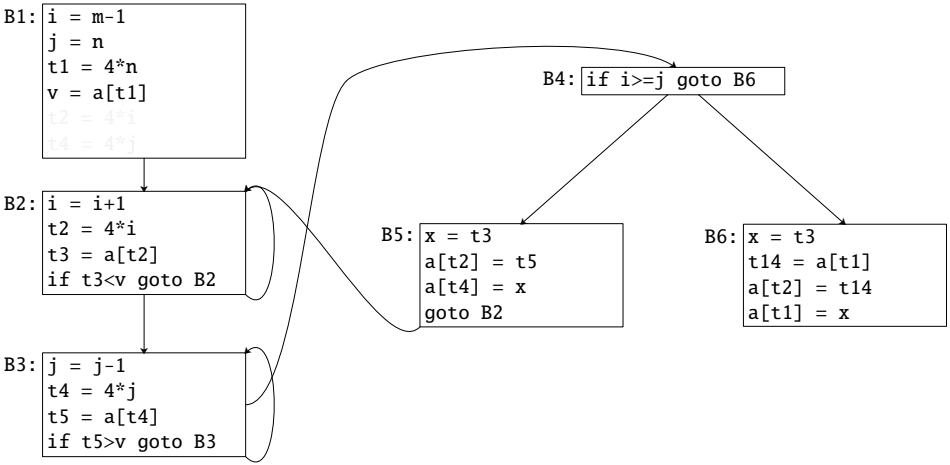
Induction Invariants and Reduction in Strength



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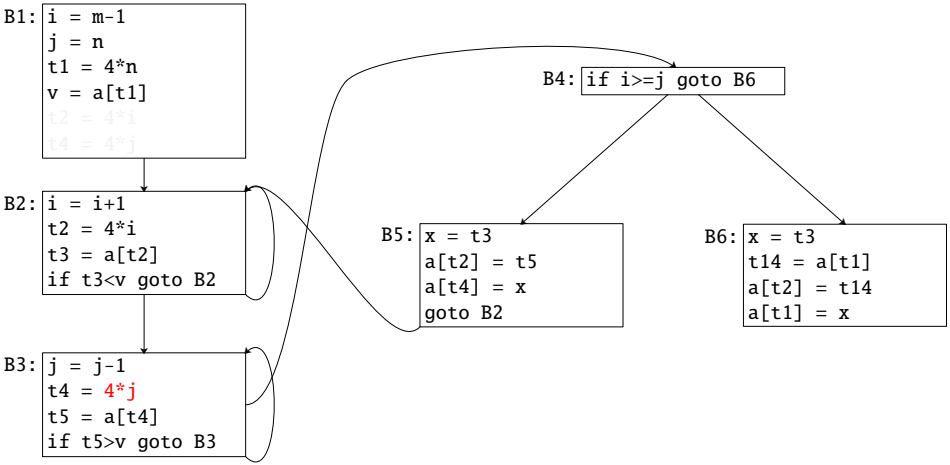

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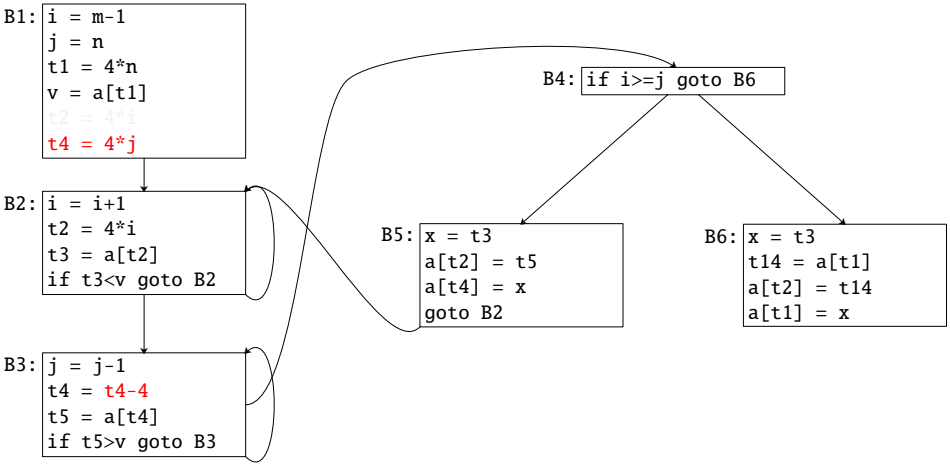

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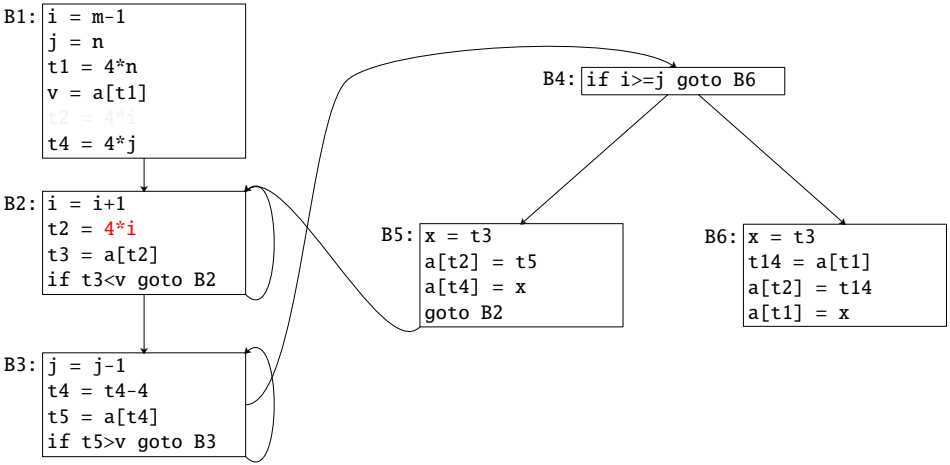

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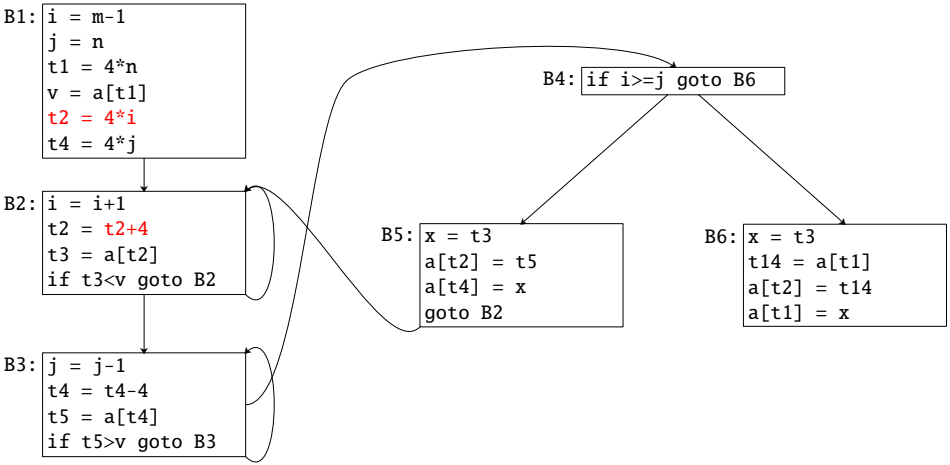

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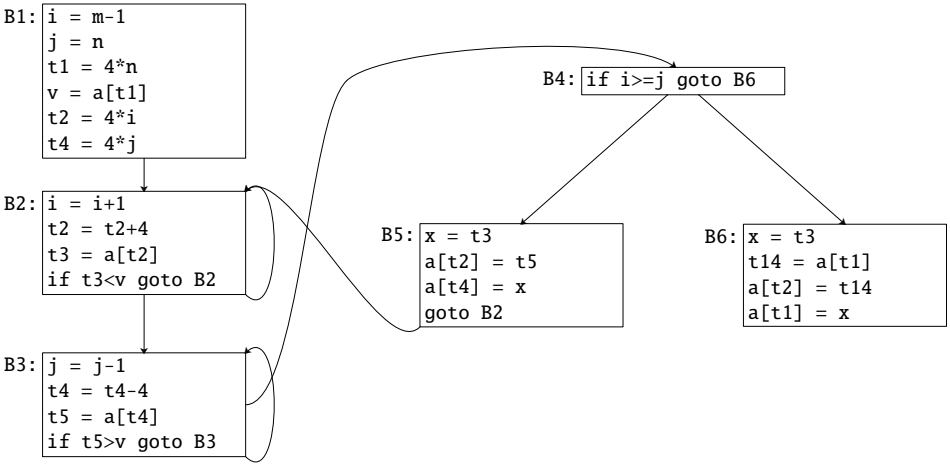

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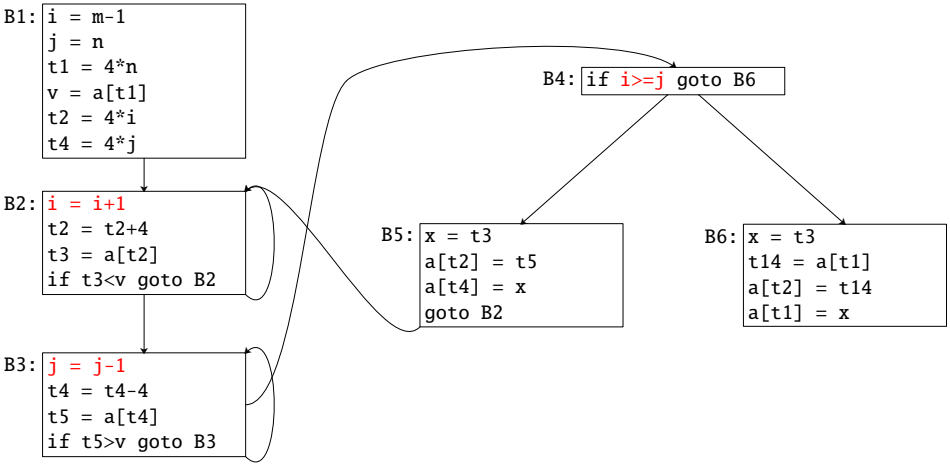

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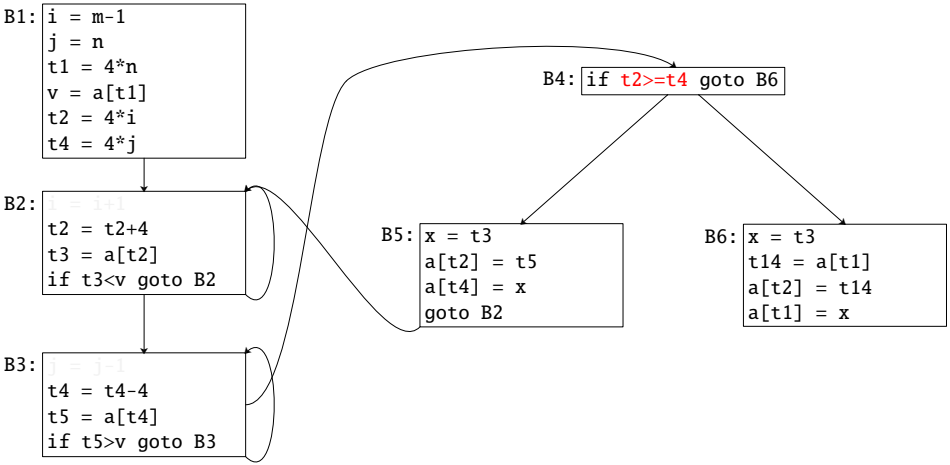

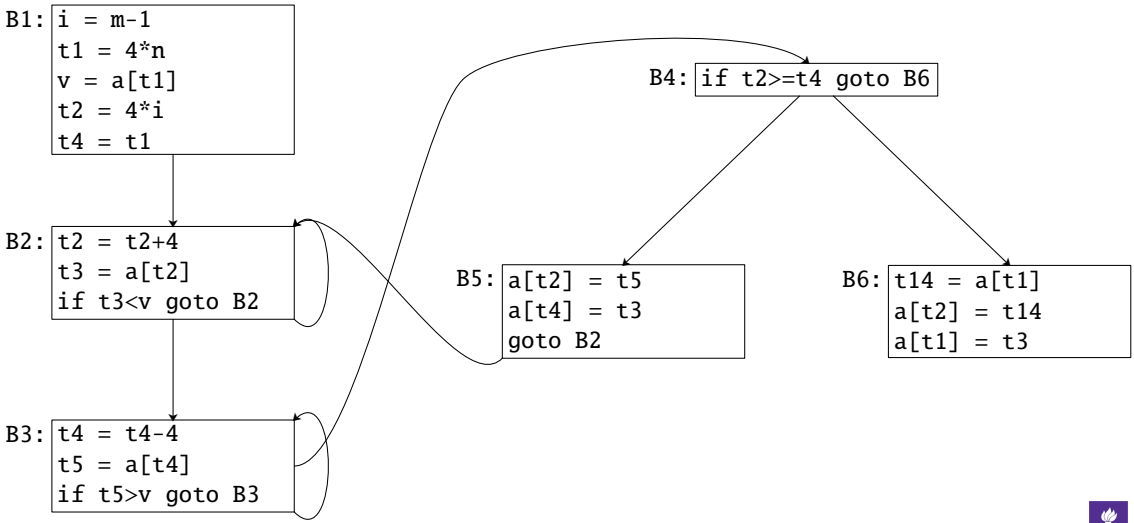
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t1 = 4*n
v = a[t1]
t2 = 4*i
t4 = t1
B2:
t2 = t2+4
t3 = a[t2]
if t3<v goto B2
B3:
t4 = t4-4
t5 = a[t4]
if t5>v goto B3
B4:
if t2>=t4 goto B6
B5:
a[t2] = t5
a[t4] = t3
goto B2
B6:
t14 = a[t1]
a[t2] = t14
a[t1] = t3

Summary

Redundancy but preserve semantics!

- Global Common Subexpressions.
- Copy Propagation.
- Dead-code Elimination.
- Code Motion.
- Induction Variables/Strength Reduction.

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  - Final is May 12.
  - pr3 will be due week of May 19.

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