Optimal and Heuristic Global Code Motion for Minimal Spilling

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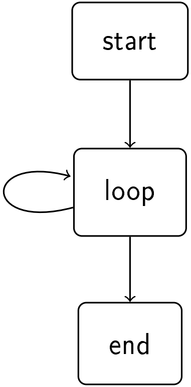
What?

Solve global code motion and register allocation as an integrated problem.

Global code motion

```
start:
   i0 := 0
   a := read()
loop:
   i1 := φ(i0, i2)
   b := a + 1
   i2 := i1 + b
   c := f(a)
   compare i2 < c
   d := i2 × 2
   blt loop
end:
   return d
```



Global code motion

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start:
   i0 := 0
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loop:
   i1 := φ(i0, i2)
   b := a + 1        loop invariant
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   b := a + 1          loop invariant
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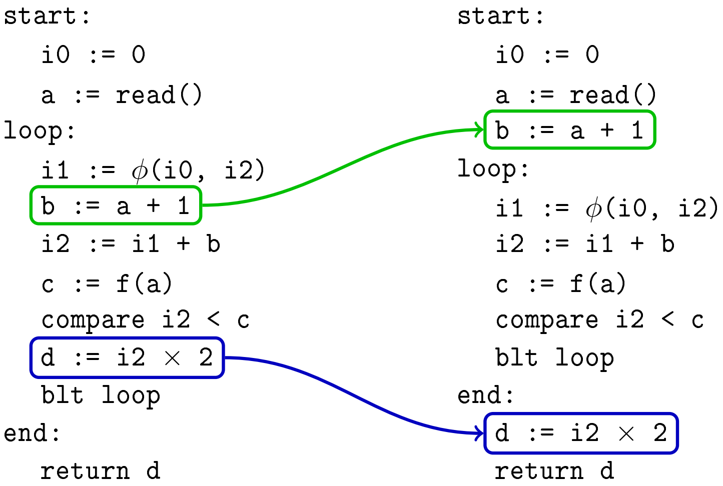
   c := f(a)
   compare i2 < c
   d := i2 × 2         partially dead
   blt loop
end:
   return d
```

Global code motion



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live range of b

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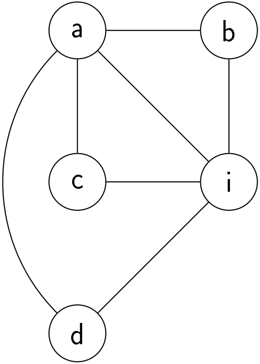
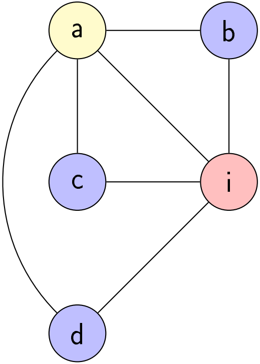
Register allocation: conflict graphs

original program



Register allocation: conflict graphs

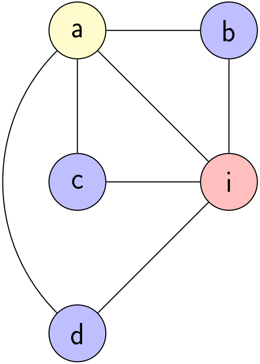
original program



allocation to 3 registers possible

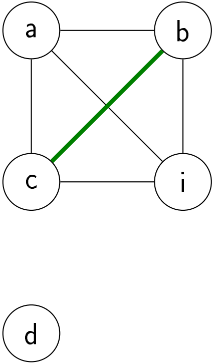
Register allocation: conflict graphs

original program



allocation to 3 registers possible

after global code motion



not 3-colorable!

Compute code motions and overlaps

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start:
0:  i0 := 0
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```

Avoidable overlaps

Pair	Overlapping placement
a, d	7 in loop
b, c	3 in start
b, d	3 in start, 7 in loop
b, i0	3 in start
b, i2	3 in start
c, d	7 in loop, 7 before 6
d, i2	7 in loop

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7 in loop: overlap!

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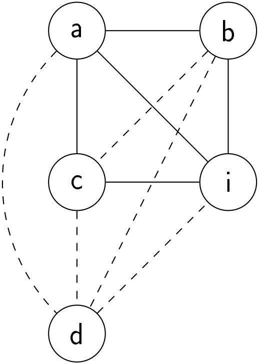
7 not in loop: no overlap

Register allocation

Conflict graph with special edges for avoidable overlaps. Allocate to different registers if possible.



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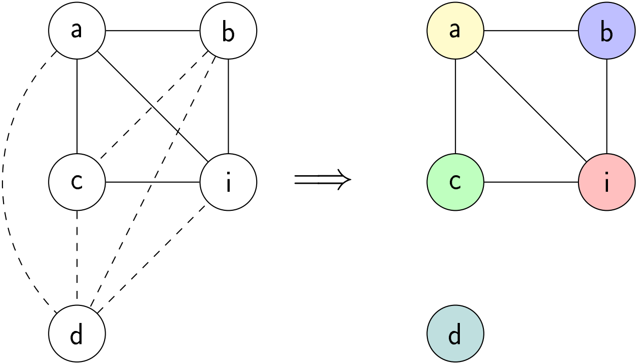
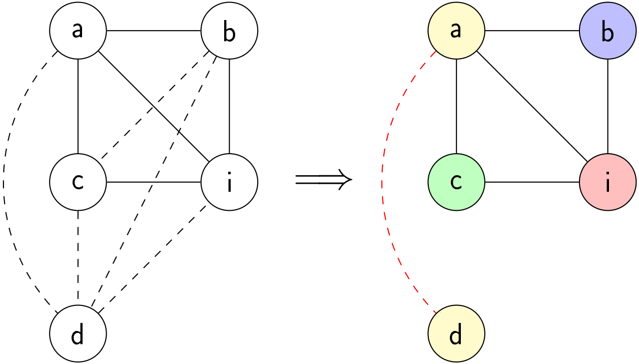


5 registers: easy allocation

Register allocation

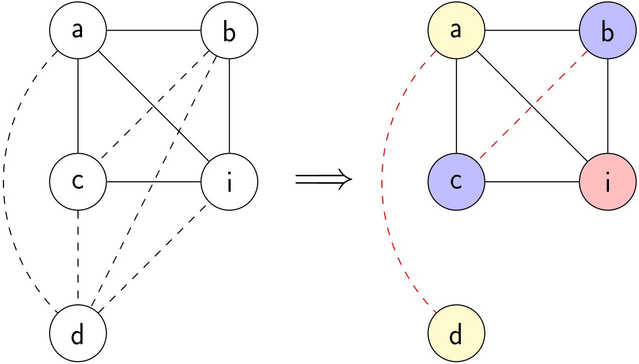
Conflict graph with special edges for avoidable overlaps. Allocate to different registers if possible.



4 registers: place instruction 7 in block end to avoid overlaps

Register allocation

Conflict graph with special edges for avoidable overlaps. Allocate to different registers if possible.



3 registers: place 3 in `loop` and 7 in `end`

Results

- Integrate code motion and register allocation by letting the allocator choose necessary code motions.
- Execution time improved by up to 4 % ☺
- . . . but no improvement on average ☹

Conclusion: Code motion is important, but simple heuristics suffice in practice.

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- Integrate code motion and register allocation by letting the allocator choose necessary code motions.
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Conclusion: Code motion is important, but simple heuristics suffice in practice.

Thank you!

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