

Global Register Allocation

(slides courtesy of Prof. Barbara Ryder, Virginia Tech)

- **Global register allocation through graph coloring**
 - **Live ranges**
 - **Interference graph**
 - **Coloring algorithm**

Global Register Allocation

- **Picks values to store in registers across groups of basic blocks in the control flow graph**
 - Choose using estimates of profitability (saved loads and stores) and availability of registers
- **Calculate *live ranges* (regions in which a value will stay in a register)**
 - *Live range* may not be entire program
 - A value can be in a register and then in memory or vice versa

Global Register Allocation

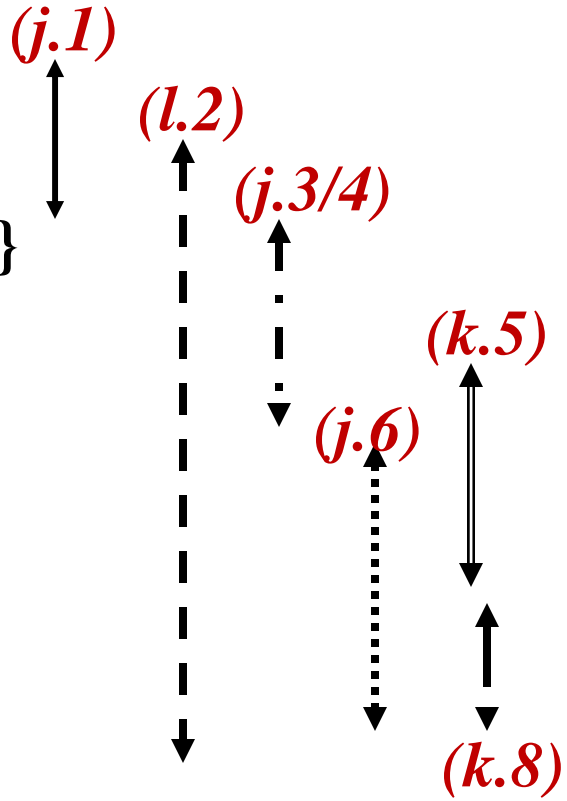
- **Map interference between live ranges**
 - Each live range is a node in an undirected graph
 - Two live ranges overlapping is shown by placing an edge between their corresponding nodes
 - For k registers, add a k -clique to the graph
 - *k -clique*: k nodes all connected to each other
- **Use graph coloring to map registers to ranges where each color represents a register**
 - Try to obtain a k -coloring of this graph
 - *Legal coloring*: assign colors to each node in the graph such that no adjacent nodes are the same color.

Example

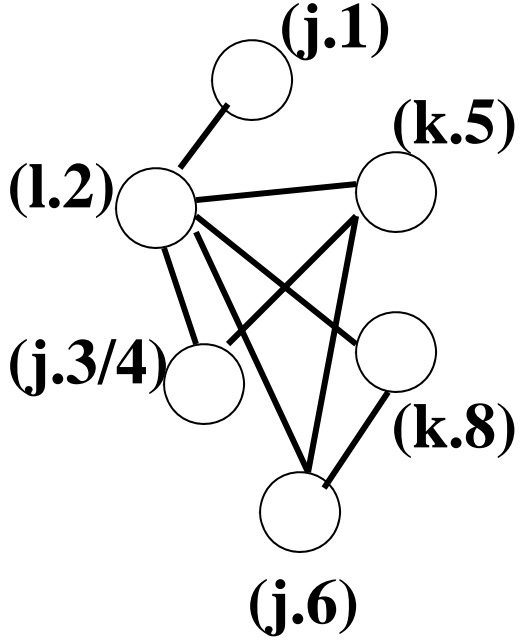
```

1. j :=
2. l := ...j...
3. if( ) then { j := }
4.   else {j := }
5. k := j ...
6. j :=
7. := j...k
8. k:=
9. := ...j...l..k...
    
```

Code

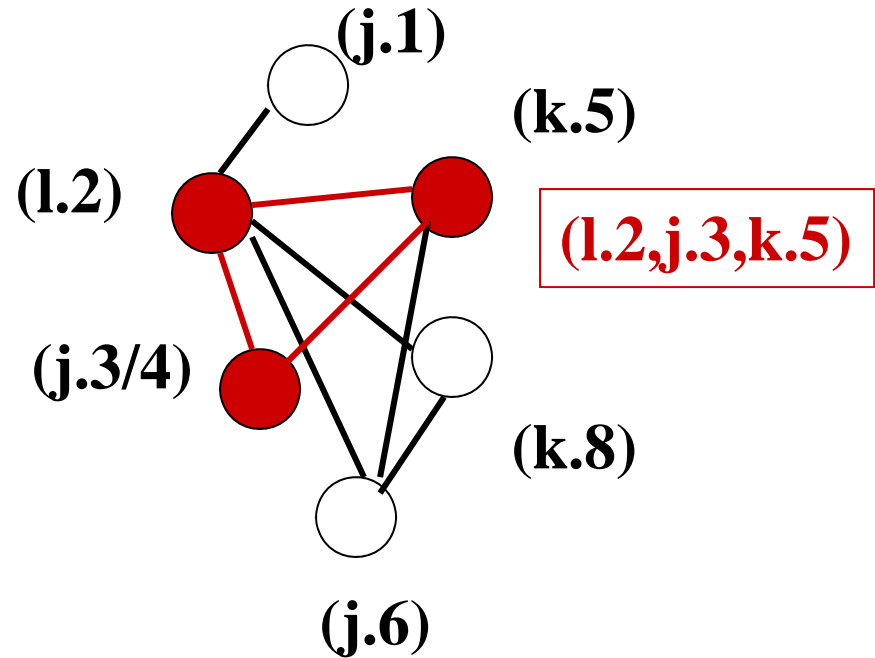
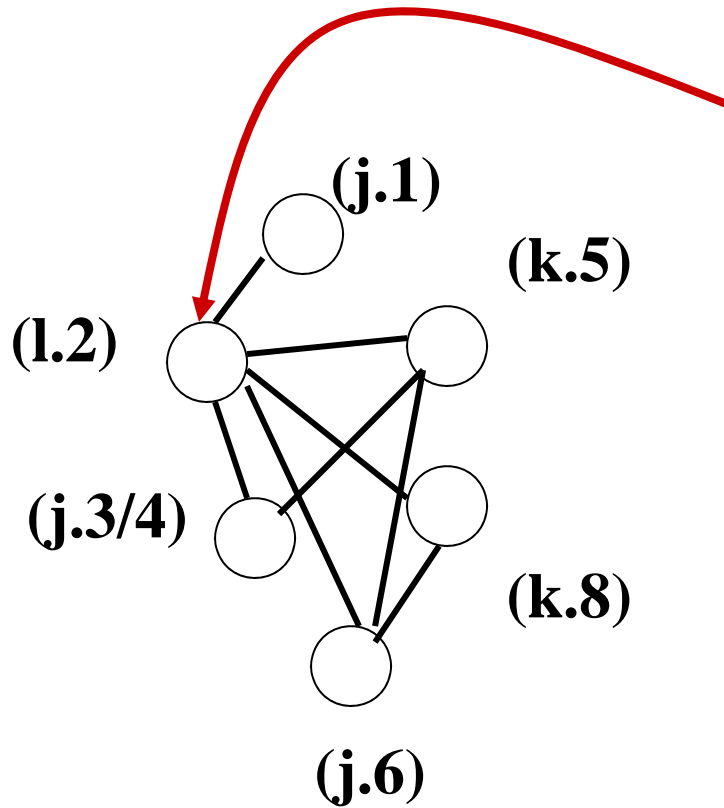


Live Ranges

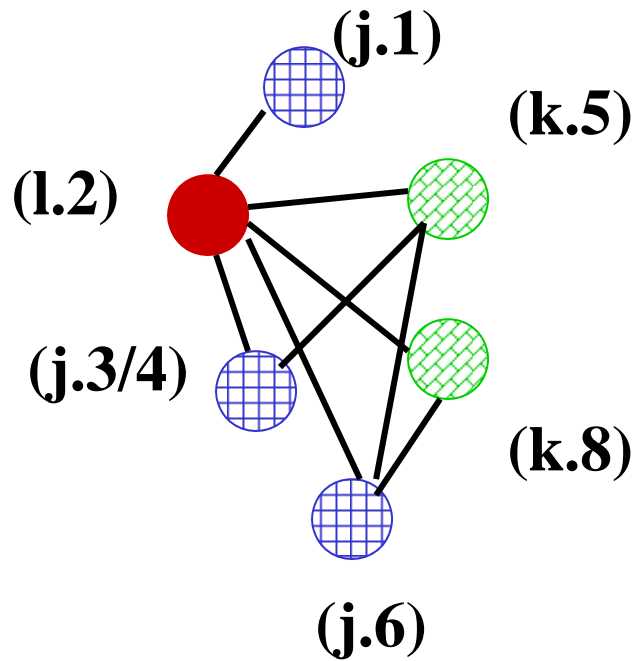


Interference Graph

With one node having 5 neighbors, we may need lots of colors, if neighbors are interconnected. Find 3-cliques: (l.2,j.3/4,k.5) (l.2,k.5,j.6) (l.2,j.6,k.8) so need at least 3 registers to color this graph!

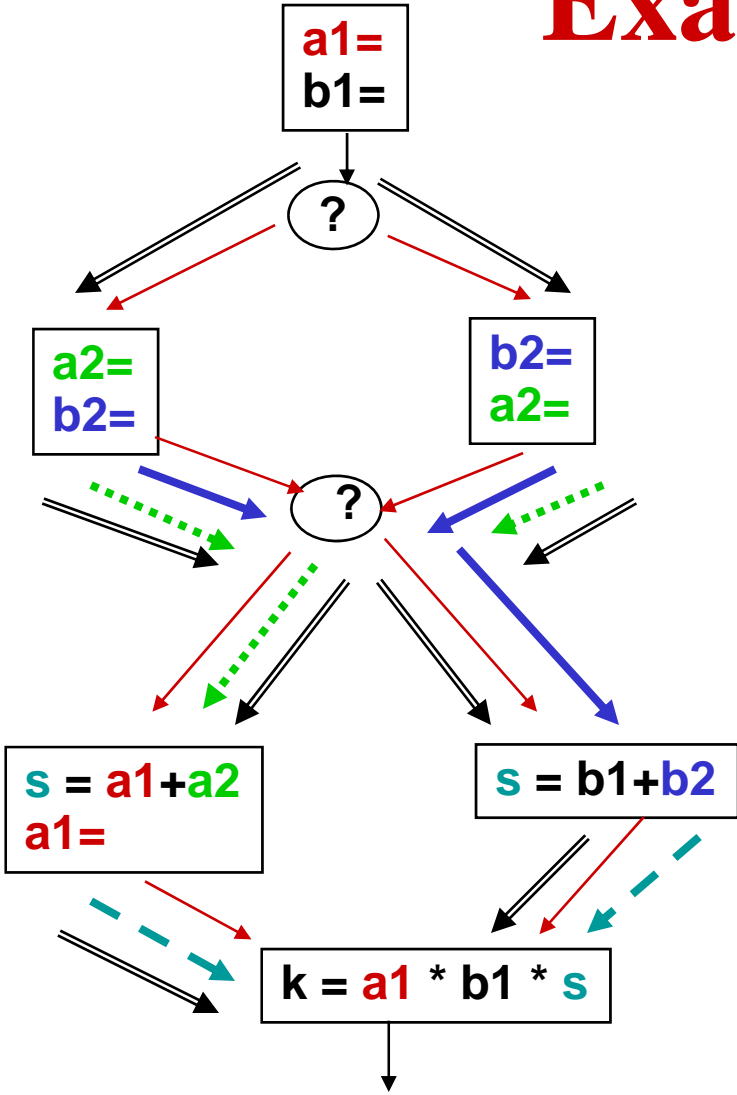


Example



A possible 3 coloring.

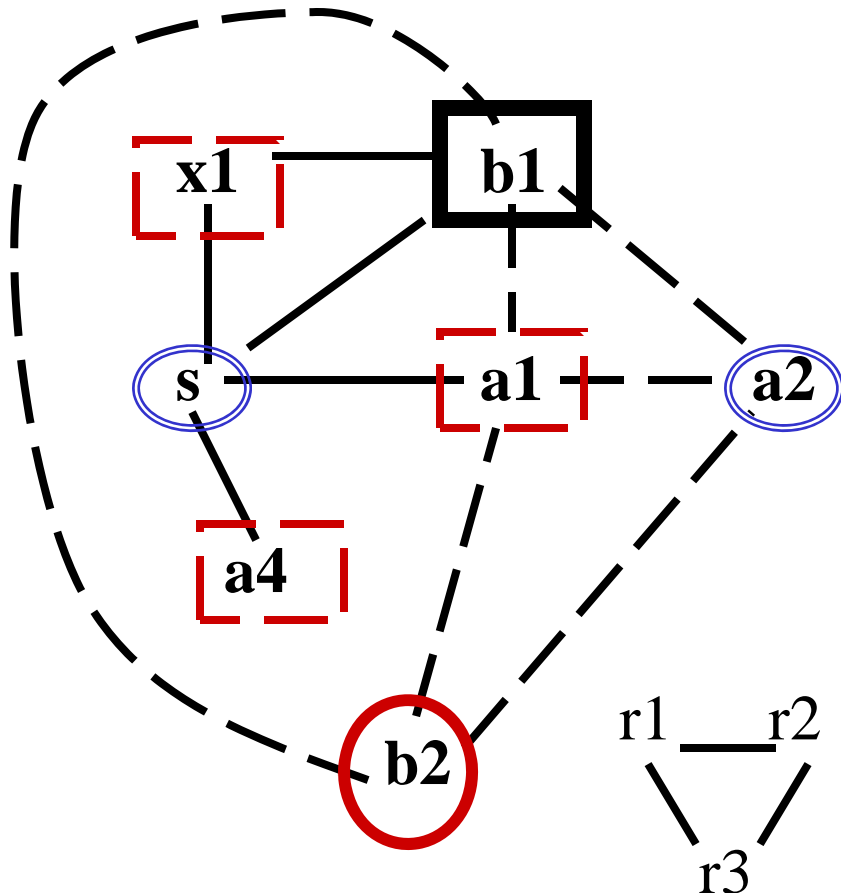
Example



live range for a1
live range for b2
live range for a2
live range for b1
live range for s

Interference in this figure
shown by overlap of live
ranges in shared nodes

Example



- Interference graph contains a 4-clique so can't find a 3 coloring
- Means have to spill something to find a 3 coloring
- But a 4 coloring is possible as shown

Interference graph