Homework 7 solution

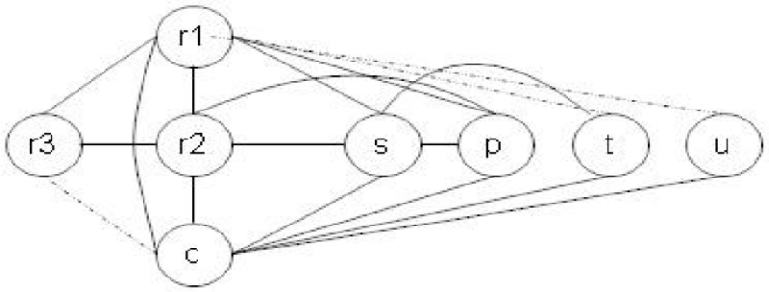
(30pts) Register Allocation

b. (20p) Exercise 11.1 in the textbook
c. (10p) Exercises 11.2 (a) in the textbook

a. 11.1

Iteration 1 Iteration 2 same as Iteration 1

Line	Use	Def	In	Out
15	r1,r3		r1,r3	
14	c	r3	c,r1	r1,r3
13	u	r1	u,c	c,r1
12		u	c	u,c
11			u,c	u,c
10	s,t	u	s,t,c	u,c
9	r1	t	r1,s,c	s,t,c
8	r1	r1,r2	r1,s,c	r1,s,c
7	p	r1	p,s,c	r1,s,c
6	r1	s	r1,p,c	p,s,c
5	r1	r1,r2	r1,p,c	r1,p,c
4	p	r1	p,c	p,c
3	p		p,c	p,c
2	r1	p	r1,c	p,c
1	r3	c	r3,r1	r1,c



Note that although r2 is not used in the original program. Interference edges about r2 must be inserted as long as it is a caller save register.

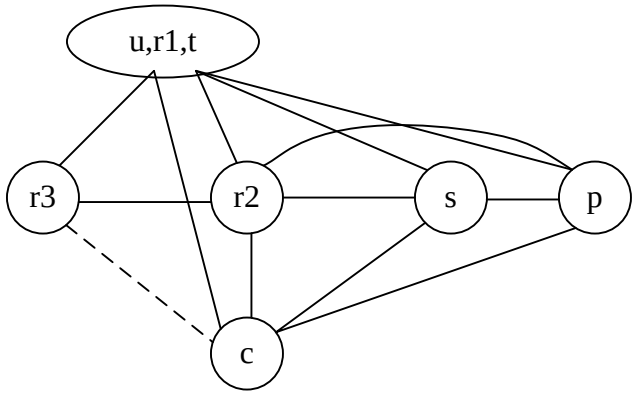
Cannot simplify any non-move relevant nodes.

Try to coalesce. According to Briggs, none of the pairs can be coalesced. Consider George, u and r1 can be merged. **Note that when applying George to pairs involving a pre-colored node, always pick the one that is not pre-colored to test the rule**. In this case, considering u, its neighbor c is also the neighbor of r1. So u and r1 can be merged.

Node “r1 & u” is further merged with t according to George.

c and r3 cannot be merged (when applying George on c).

We cannot proceed with the remaining graph, even after freezing the edge c-r3.



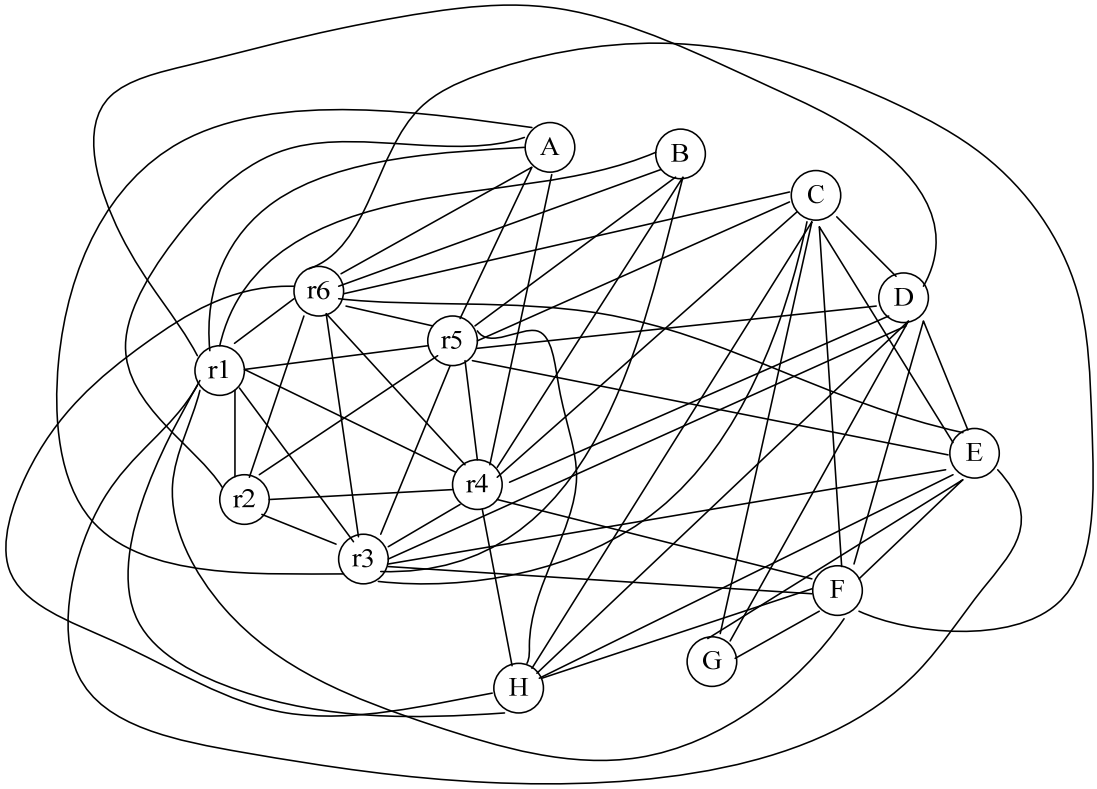
We hence look for a node to spill. According to the equation, node c has the lowest spill cost. After removing c, the remaining graph is still not colorable. We further spill s. Finally, p has r3, and u, t having r1.

The final program is

```
f:  M[address for c]<- r3
    r3<-r1
    if (r3=0) goto L1
    r1<- M[r3]
   call f
   M[address for s]<-r1
```

```
        r1<-M[r3+4]
        call f
        r1<-M[address for s]+r1
      goto L2
L1:   r1<-1
      r3<-M[addr of c]
      return
```

c.



Exercise 11.2 (a)
Simplify:
Remove A
Remove B
Remove G
All the remaining nodes have degree of at least 8.
Randomly pick up the node for potential spill.
Spill
Remove H
Simplify
Remove D
Remove E
Remove F
Remove C
Select:
Add C with color 1
Add F with color 5
Add E with color 4
Add D with color 2
Add H with color 3
Add G with color 3

Add B with color 2

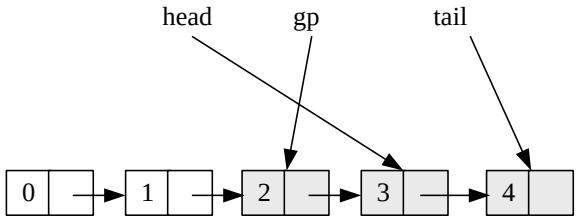
Add A with color 7

The nodes are 8 colorable. No actual spill is required.

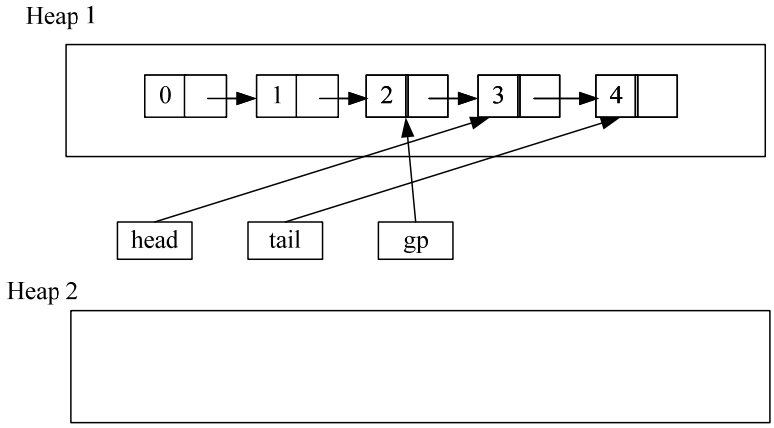
(30p) Garbage collection.

Apply the Mark-Sweep (10p) and Copying (20p) GC algorithms to the following program at the end of the execution

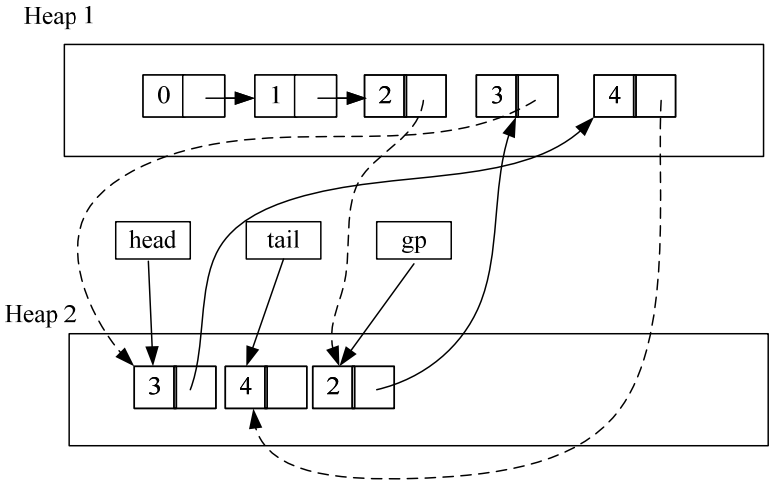
```
class B{
   int val;
   B next;
   static B gp;
}
…
F () {
   B head= new B(0, nil);
   B tail = head;
   for (int i=1; i< 5; i++) {
      tail.next=new B(i, nil);
      tail=tail.next;
   }
   head=head->next->next;
   gp=head;
   head=head->next;
```



Mark and Sweep: The plain nodes are garbage collected.



After forwarding all roots



After scanning and forwarding all the pointers in Heap2, the entire Heap1 will be discarded.