

Homework 1

CS 540
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- 1 Consider the following fragment of a high-level program (which counts prime numbers between 2 and n):

```
for  $i := 2$  to  $n$  do
   $a[i] := \text{true}$ ;
   $count := 0$ ;
  for  $i := 2$  to  $\sqrt{n}$  do
    if  $a[i]$  then
      begin
         $count := count + 1$ ;
        for  $j := 2i$  to  $n$  by  $i$  do
           $a[j] := \text{false}$ 
        end
      end
```

- Translate the fragment into a three-address program.
- Construct the flow graph which corresponds to the three-address program.

- 2 Consider the following three-address program:

```
(1)  $a := 1$ 
(2)  $b := 2$ 
(3)  $c := a + b$ 
(4)  $d := c - a$ 
(5) if  $c > d$  goto (13)
(6)  $d := b * d$ 
(7) if  $a = d$  goto (13)
(8)  $d := a + b$ 
(9)  $e := e + 1$ 
(10) goto (6)
(11)  $a := 3$ 
(12)  $b := 4$ 
(13)  $b := a + b$ 
(14)  $e := c - a$ 
(15) if  $b \neq e$  goto (3)
(16)  $a := b * d$ 
(17)  $b := a - d$ 
```

2 continued,

- a) Construct the flow graph which corresponds to the three-address program.
- b) For each definition, give (in table form) the blocks which it reaches the beginning of, and the blocks which it reaches the end of.
- c) For each variable, identify the points (if any) at which it becomes dead.

3 Consider the following basic block:

$a := 2$
$b := a * 4$
$c := a + b$
$d := e[c]$
$b := 3$
$a := e[c]$
$c := a + b$
$d := e[c]$

Apply the four optimizations as defined in class (common subexpression elimination, constant folding, copy propagation, dead-code elimination) until no further applications can be made. The optimizations can be applied in any order. Show the resulting basic block after each application.

4 Prove or disprove the following conjecture:

Conjecture. For every basic block, if the four optimizations in problem 3 are applied until no more applications can be made, the same block results from any order of application.