

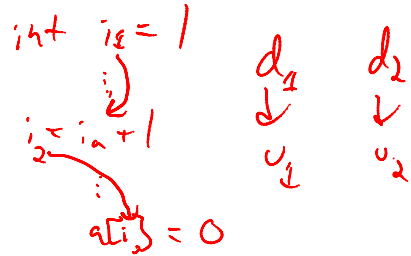


CS 4120  
Introduction to Compilers

Ross Tate  
Cornell University

Lecture 30: Reaching Definitions,  
Webs, and SSA

Reaching Definitions



Definition Preorder

For each var  $v$  and edge  $e$   
in CFG  
subsets of  $def_v$  of  $v$   
ordered by inclusion

Flow Function

Given a node  $n$   
with incoming set of  
 $def_v$  of  $v$  in  $\{n\}$   
what is  $out\{n\}$ ?  
if  $n$  redefines  $v$  with  $d_n$   
then  $= \{d_n\}$   
else  $= in\{n\}$

Def-Use Graph



Static Single Assignment

each variable to  
have a unique  
definition

### $\phi$ -nodes

$x = 0$   
 while ( $x < 100$ )  
 $x = x + 1$

```

    graph TD
      A["x0 = 0"] --> B["x2 = phi(x0, x2)  
x2 < 100"]
      B --> C[" "]
      B --> D["x1 = x2 + 1"]
      D --> B
  
```

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$x_2 = \phi d$   
 $x_0 = 0$     $x_1 = x_2 + 1$

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$x = 0$   
 $y = x + x$   
 $z = 5 \cdot y$

```

    graph TD
      A["z = 0"] --> B["5"]
      A --> C["y = x"]
      C --> D["( )  
x = 0"]
  
```

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List l = ...  
 $x = l.get(0) \Rightarrow \text{lookup}(l, get), l, 0$   
 $y = l.get(1)$   
 $z = l.get(2)$   
 return  $x + y + z$

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### Cons hashing

$0 \rightarrow \text{hash}(5+100+1)$

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