

Reference reading material:

- A Unified Approach to Global Program Optimization by Gary A. Kildall, POPL 1973. Gary's Ph.D. thesis at U.W. He is also known for the CP/M operating system that was an early competitor with MS-DOS (Microsoft).

Optimizations: \rightarrow run time $x = 10 * 5$
 \rightarrow $x = 50;$ $x = 50$
 \leftarrow $a = x;$ $a = 50;$ $msg, \$50, x$
 • common subexpression elimination \checkmark $a = b + c$
 • Similar to partial evaluator $d = (b+c) * 10$
 • live expression analysis \checkmark $b = a + 10$
 • Similar to liveness analysis in register allocation

\rightarrow
 for $i = 1 \dots 10$
 $x = 5 + 10;$
 Peel iteration

A: $a = 1$
 B: $c = 0$
 for $i = 1 \dots 10$ {
 C: $b = 2$
 D: $d = a + b$
 E: $e = b + c$
 F: $c = 4$
 }

A: $a = 1$
 B: $c = 0$
 $i = 1$
 C: $b = 2.$
 D: $d = 3$
 E: $e = 2$
 F: $c = 4$

for $i = 2 \dots 10$
 {
 E: $e = b + c$
 }
 $i = 2$
 E: $e = 6$

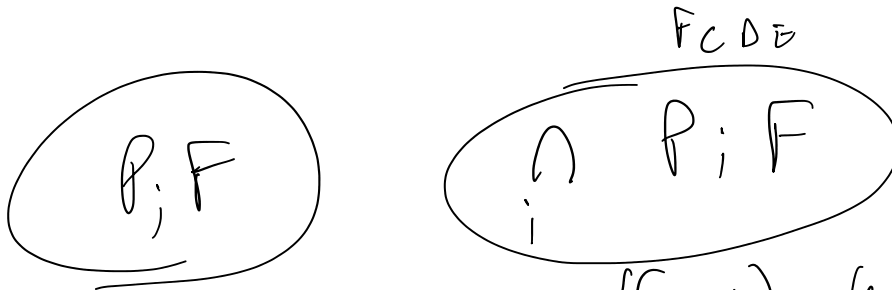
for $i = 1 \dots 10$
 $i = i + 1$

$i = 1$
 ~~$i = i + 1$~~
 $i = i + 1$

Path of execution

A: $a = 1$	A	{ }
B: $c = 0$	A \rightarrow B	{(a, 1)}
for $i = 1 \dots 10$ {	A \rightarrow B \rightarrow C	{(a, 1), (c, 0)}
C: $b = 2$	A \rightarrow B \rightarrow C \rightarrow D	{(a, 1), (c, 0), (b, 2)}
D: $d = a + b$	A \rightarrow D \rightarrow C \rightarrow D \rightarrow E	{(a, 1), (c, 0), (b, 2), (d, 3)}
E: $e = b + c$	A \rightarrow D \rightarrow C \rightarrow D \rightarrow E \rightarrow F	{(a, 1), (c, 0), (b, 2), (d, 3), (e, 2)}
F: $c = 4$		
}		
$b = c$		

ABCDEF C { ... (c, 4) ... }
 ABCDEF CD }
 ABCDEF CDE
 ABCDEF CDEF { (e, 6), (c, 4) }



$i=1$ ABCDEF
 $i=2$ ABCDEF CDEF
 $i=3$ ABCDEF CDEF CDEF
 \vdots
 10

$\{(a, 1), (b, 2), (c, 0), d, 3, e, \dots\}$
 $\{a, 1, b, 2, c, 4, d, 3, e, \dots\}$
 $\{ \dots \}$

$$\cap P; F = \underline{(a, 1) (b, 2) (d, 3)}$$

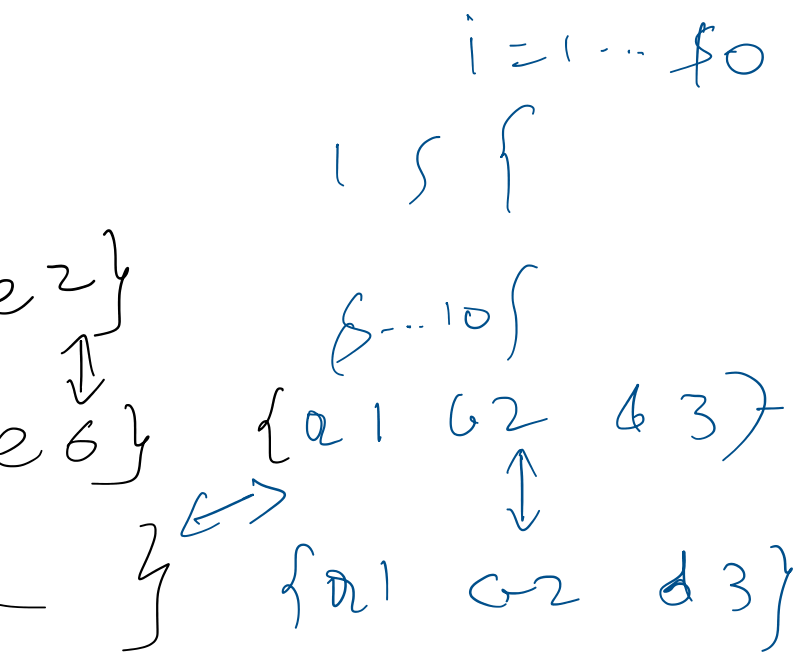
A: a=1
 B: c=0
 for i=1...10 {
 C: b=2
 D: d=a+b
 E: e=b+c
 F: c=4
 }

$$f(A, S) = \{ (a, 1) \}$$

$S) \cup \{ S - a \}$

Transfer func. \rightarrow monotonic, d
 $f(A, S) \Rightarrow$ next state
 \downarrow
 to execute
 state of current system

$X \leq Y$
 $f(X) \leq f(Y)$
 $f(X \wedge Y)$
 $\dots A$



istribution

$b(x)$

$= f(x) \wedge b(x)$

... ..

$$\cup \{s - a\}$$

$$f(B, s) = \{(c, 0)\} \cup \{s - c\}$$

$$f(C, s) = \{(b, 2)\} \cup \{s - b\}$$

$$f(D, s) = \text{if } \{(a, n) \in S\} \text{ and } \{(b, m) \in S\} \\ \{d = n + m\} \cup \{s - d\}$$

else

$$\{s - a\}$$

meet operation

intersection

T

meet c

$A \leq B$

$A \wedge B$

commutative
& associative

$$= A$$