Lec 18 Dominator Graph & Mem Optimisation

Dominator Graph

$\ell > \ell'$ ≈ ℓ dominates ℓ'
≈ every path to ℓ' goes through ℓ

1. Compute $\ell > \ell'$ on control flow graph
   - Lengauer - Tarjan alg ← asymptotically faster
   - Cooper et al alg ← simpler & faster in practice

Alg Cooper et al — make dominator tree
$V = \{$ lines $\}$ ← generalises to $\{$ nodes in control flow graph $\}$
$E = \{ \ell \to \ell$'s immediate dominator $\}$

$\ell > \ell'$ iff going up from ℓ' in tree doesn't find ℓ

Ex. while (e, s)

$\ell_0 : \hat{e} \ldots$
$\ell_0' :$ if $(\check{e} = 0)$ then ℓ_2 else ℓ_1
$\ell_1 : \hat{s} \ldots$
$\ell_1' :$ goto ℓ_0
$\ell_2 :$

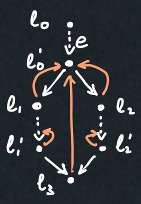
Then, solve data flow equation

$$Dom(\ell) = \begin{cases} \{\ell\} & \text{if at entrypoint} \\ \{\ell\} \cup \left(\bigcap_{\ell' \in pred(\ell)} Dom(\ell') \right) \end{cases}$$

Note: Dom tree can be done while translating

Ex. if (e, s_1, s_2)

$\ell_0 : \hat{e} \ldots$
$\ell_0' :$ if $(\check{e} \mathrel{!}= 0)$ then ℓ_1 else ℓ_2
$\ell_1 : \hat{s}_1 \cdots$; goto ℓ_3
$\ell_2 : \hat{s}_2 \cdots$; goto ℓ_3
$\ell_3 :$



Memory Optimisation

$M[q] \leftarrow 4$
$M[p] \leftarrow 8128$
$x \leftarrow M[q]$

if $p \neq q$ ⇝

$M[q] \leftarrow 4$
$M[p] \leftarrow 8128$
$x \leftarrow 4$

→ Need Alias Analysis
may-alias(a, b) ≈ temps a and b can have same address

$\left.\begin{array}{l} \ell : t \leftarrow M[a] \\ \vdots \;\; t \text{ not redefined, } a \text{ not changed, } M[a] \text{ still available} \\ \ell' : t' \leftarrow M[a] \end{array}\right\} \rightarrow \left\{\begin{array}{l} \ell : t \leftarrow M[a] \\ \vdots \\ \ell' : t' \leftarrow t \end{array}\right.$

• SSA will have these

if t still defined at this point

→ Availability Analysis
unavail(ℓ, ℓ') ≈ $\ell : t \leftarrow M[a]$, $M[a]$ is potentially defined on a path from ℓ to ℓ' and $\ell > \ell'$

only for efficiency — we only care about availability when $\ell > \ell'$

$$\frac{\ell : t \leftarrow M[a] \quad \ell > \ell' \quad \ell' : M[b] \leftarrow s \quad \text{may-alias}(a, b) \quad succ(\ell', k)}{unavail(\ell, k)}$$

$$\frac{unavail(\ell, k) \quad succ(k, k') \quad \ell > k'}{unavail(\ell, k')}$$