Program Analysis

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Constant Propagation

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Constant Propagation

- Replace expressions that evaluate to same constant “c” every time they are executed, by the value “c”

DF Framework for ConstProp

- Domain
  - For a single variable v of type t, all possible constant values of type t
  - $\top$ and $\bot$?
- Semilattice?

DFF for CP

- NAC: not a constant
  - If variable is inferred not to be a constant
  - Multiple (different valued) defs, non-const defs, assigned an “un-interpreted” value …
- UNDEF: No definition of the variable is seen yet – nothing known!

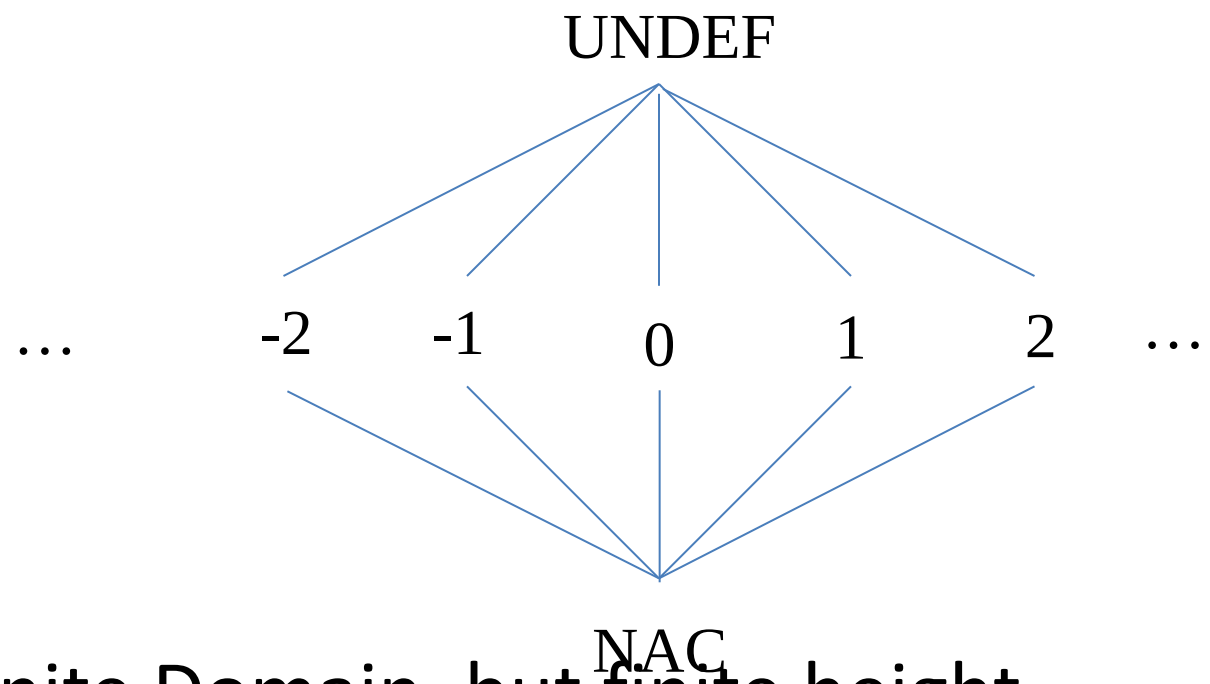
NAC vs UNDEF

- NAC ⇒ too many definitions seen to declare the variable is NOT constant
- UNDEF ⇒ too few definitions seen to declare anything about the variable
- $\top$ is UNDEF; $\bot$ is NAC

CP Meet (Λ)

- UNDEF Λ c = c NAC Λ c = NAC
  - Recall ⊤Λ x = x and ⊥ Λ x = ⊥
- c Λ c = c
- c1 Λ c2 = NAC

CP Semilattice



- Infinite Domain, but finite height

CP Semilattice

- Previous figure semilattice for one variable
- CP Semilattice = Product of all such semilattices
- Each semilattice has a finite height

OUT Information

(Informal Representation)

1. x = c // const
   - {x -> c}
2. x = y + z
   - If {y -> c1, z -> c2} in IN then {x -> c1+c2}
   - If {y -> NAC} in IN then {x -> NAC}
   - If {z -> NAC} in IN then {x -> NAC}
   - {x -> UNDEF} // y is UNDEF or z is UNDEF
3. x = <complicated unhandled expr>
   - {x = NAC}

Monotonicity of CP

- Case analysis on transfer function f
- NAC ≤ c ≤ UNDEF
- Case (1) and (3) has “constant” f
- Case (2):
  - Fix z (One of UNDEF, c2, NAC)
  - Vary y over UNDEF, c1, NAC
  - Confirm that x does not “increase”
  - Do this for all z’s.
  - Similarly, fix y and vary z.

Nondistributivity of CP

```
B0: …
if (…) {
B1:    x = 2;
       y = 3;
} else {
B2:    x = 3;
       y = 2;
}
B3: z = x + y;
…
```

All paths:
B0-B1-B3
B0-B2-B3
z is 5 along both paths
Meet Λ results in z = NAC
(Exercise)

MOP: z is a constant 5
MFP: z is NAC
MFP not equal to MOP