Example: Sign Analysis - example program

```
def select(c : Boolean): Int = {
                                   ⟨a → ⊥, b → ⊥, x → ⊥⟩
    val a = 42
                                   ⟨+, ⊥, ⊥⟩
    val b = 333
                                   ⟨+, +, ⊥⟩
    var x = 0;
                                   ⟨+, +, 0⟩
    if (c)
        x = a + b;
                                   ⟨+, +, +⟩
    else                                          ⊔ ⇒ ⊤
        x = a - b;
                                   ⟨+, +, ⊤⟩
    x
}
```

Example: Constant Propagation - example program

$x \to \bot, y \to \bot, z \to \bot$

```
val z = 3
var x = 1
while(x > 0) {
  if(x == 1) {
    y = 7
  } else {
    y = z + 4
  }
  x = 3
}
```

$\langle \bot, \bot, 3 \rangle$

$\langle 1, \bot, 3 \rangle \sqcup \to$ $\langle \top, 7, 3 \rangle$

$\langle 1, 7, 3 \rangle$

$\langle 1, 7, 3 \rangle$

$\langle 3, 7, 3 \rangle$

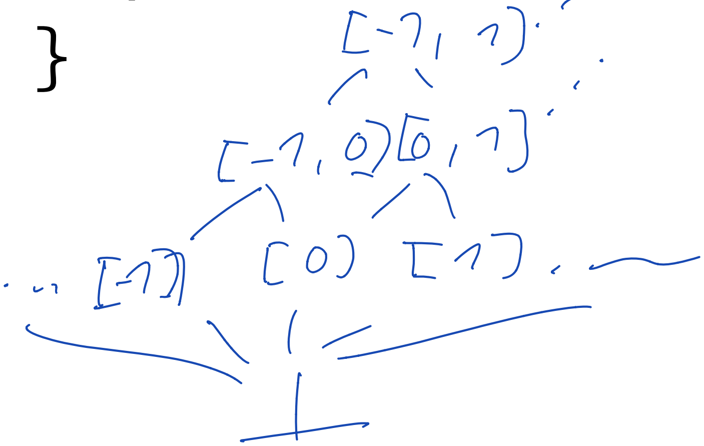
$\langle \top, 7, 3 \rangle$ ✓

Interval analysis - example

```
var x = 0
while (true) {
  x = x + 1
  println(x)
}
```

[0]

[0,1] [0,2] [0,3] ...



Kill

∅

∅

∅

Gen

{a+b}

{a*b}

{a+b}

$\{a+b, a*b, a+1\}$ $\{\}$

$\emptyset$ $\{a+b\}$

Available Expressions - Example

```
          def m(initialA: Int, b: Int): Int = {
/*pc 0*/    var a = initialA

/*pc 1*/    var x = a + b;

/*pc 2*/    val y = a * b;

/*pc 3*/    while (y > a + b) {

/*pc 4*/      a = a + 1

/*pc 5*/      x = a + b

            }
/*pc 6*/    a + x
          }
```

$AE_{Entry}(pc1) = \emptyset$

$AE_{Entry}(pc3) = AE_{exit}(pc2) \cap AE_{Exit}(pc5)$

$AE_{Exit}(pc3) = AE_{entry}(pc3) \cup \{a+b\}$