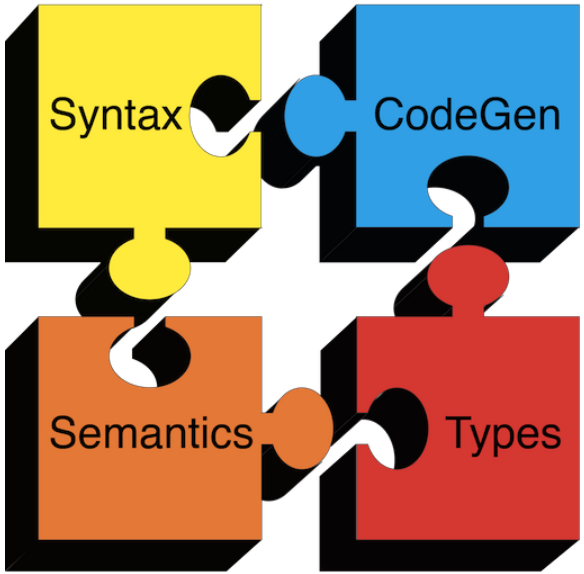


Compilers

Temporaries

Temporaries

- Idea: Keep temporaries in the AR

- The code generator must assign a fixed location in the AR for each temporary

Temporaries

```
def fib(x) = if x = 1 then 0 else
    if x = 2 then 1 else
      fib(x - 1) + fib(x - 2)
```

2 temporaries

Temporaries

- Let NT(e) = # of temps needed to evaluate e
- NT(e_1 + e_2)
  - Needs at least as many temporaries as NT(e_1)
  - Needs at least as many temporaries as NT(e_2) + 1

  ] Max
- Space used for temporaries in e_1 can be reused for temporaries in e_2

Temporaries

$$NT(e_1 + e_2) = \max(NT(e_1), 1 + NT(e_2))$$

$$NT(e_1 - e_2) = \max(NT(e_1), 1 + NT(e_2))$$

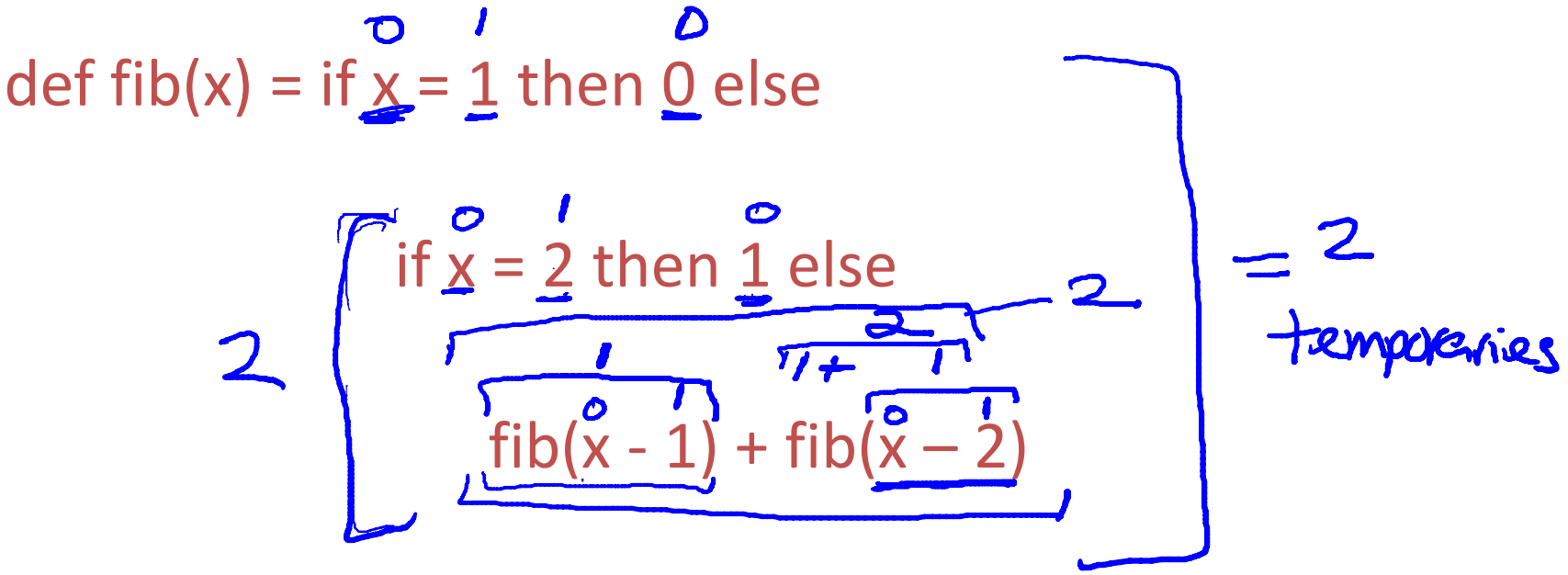
$$NT(\text{if } e_1 = e_2 \text{ then } e_3 \text{ else } e_4) = \max(NT(e_1), 1 + NT(e_2), NT(e_3), NT(e_4))$$

$$NT(id(e_1,\ldots,e_n) = \max(NT(e_1),\ldots,NT(e_n))$$

$$NT(int) = 0$$

$$NT(id) = 0$$

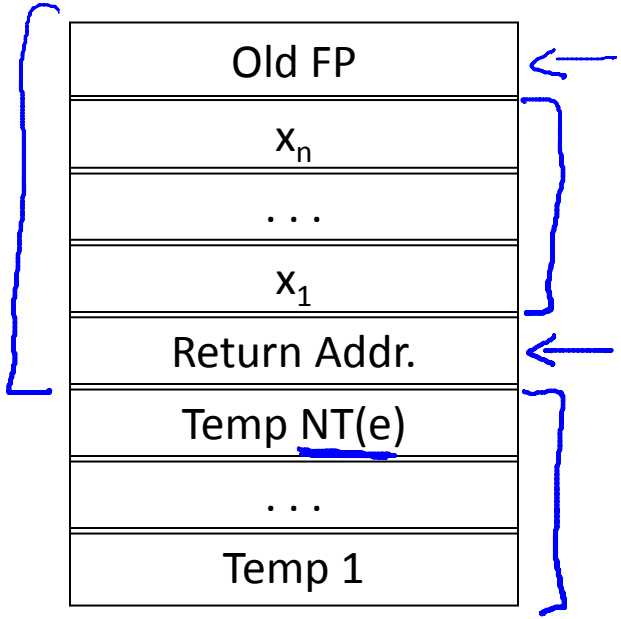
Temporaries



Temporaries

- For a function definition $f(x_1,\ldots,x_n) = e$ the AR has 2 + n + NT(e) elements
  - Return address
  - Frame pointer
  - n arguments
  - NT(e) locations for intermediate results

Temporaries



Temporaries

For the powerOfTwo() function at right, what are the numbers of temporaries required to evaluate each sub-expression, and the total number of temporaries required for powerOfTwo()?

```
def powerOfTwo(x) =
    if x % 2 == 0
    then powerOfTwo(x / 2)
    else x == 1
```

	x % 2 == 0	powerOfTwo(x / 2)	x == 1	Total
○	1	2	2	3
○	1	1	1	1
○	2	1	0	2
○	2	1	0	3

Temporaries

- Code generation must know how many temporaries are in use at each point
- Add a new argument to code generation
  - the position of the next available temporary
- The temporary area is used like a small, fixed-size stack

Temporaries

$cgen(e_1 + e_2)$ =

cgen(e_1)

sw $a0 0($sp)

addiu $sp $sp -4

cgen(e_2)

lw $t1 4($sp)

add $a0 $t1 $a0

addiu $sp $sp 4

Temporaries

cgen(e_1 + e_2, nt) =

    cgen(e_1, nt)
    sw $a0 nt($fp)
    cgen(e_2, nt + 4)
    lw $t1 nt($fp)
    add $a0 $t1 $a0