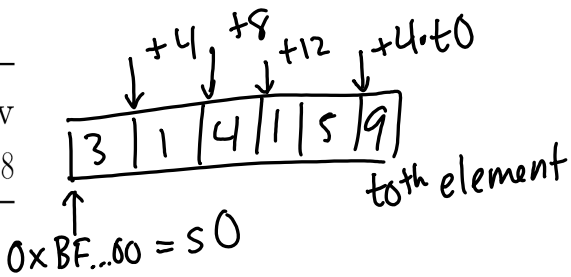
Jon 101 Dis 4

Monday, September 17, 2018 12:05 AM

CS 61C
Fall 2018

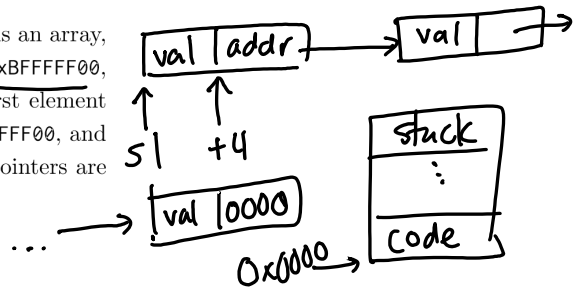
RISC-V Control Flow

Discussion 4: September 17, 2018



1 RISC-V with Arrays and Lists

Comment each snippet with what the snippet does. Assume that there is an array, `int arr[6] = {3, 1, 4, 1, 5, 9}`, which is starts at memory address `0xBFFFFF00`, and a linked list struct (as defined below), `struct ll* lst;`, whose first element is located at address `0xABCD0000`. `s0` then contains `arr`'s address, `0xBFFFFF00`, and `s1` contains `lst`'s address, `0xABCD0000`. You may assume integers and pointers are 4 bytes and that structs are tightly packed.



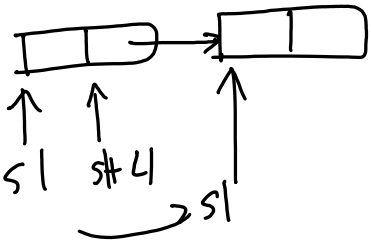

```
struct ll {
    int val;
    struct ll* next;
}
```

1.1
```
lw  t0, 0(s0)
lw  t1, 8(s0)
add t2, t0, t1
sw  t2, 4(s0)
```

arr[0] → t0
arr[2] → t1
t0+t1 → t2
t2 → arr[1]
→ arr[1] = arr[0] + arr[2]

1.2
```
loop: beq  s1, x0, end
      lw   t0, 0(s1)
      addi t0, t0, 1
      sw   t0, 0(s1)
      lw   s1, 4(s1)
      jal  x0, loop
end:
```

if (s1 == 0) → jump to end
MEM(s1) → t0
t0+1 → t0
t0 → MEM(s1)
s1 = s1→next
⇒ incr. all elems of ll by 1



1.3
```
      add  t0, x0, x0
loop: slti t1, t0, 6
      beq  t1, x0, end
      slli t2, t0, 2
      add  t3, s0, t2
      lw   t4, 0(t3)
      sub  t4, x0, t4
      sw   t4, 0(t3)
      addi t0, t0, 1
      jal  x0, loop
end:
```

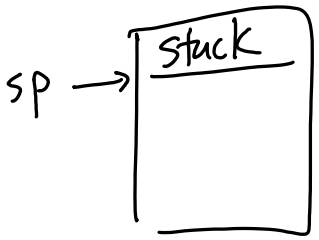
true / false

0 → t0
if t0 < 6 ⇒ 1 → t1, else 0 → t1
t1 == 0?
4·t0 → t2
t2 + s0 → t3
MEM(t3) → t4 ← get t0^th element
0 - t4 → t4
t4 → MEM(t3) ← put it back

negate 6 elems

lw t4, 0(s0+t2)
t3

2 RISC-V Calling Conventions



2.1 How do we pass arguments into functions?

arg registers: a0 – a7

2.2 How are values returned by functions?

a0, a1

2.3 What is `sp` and how should it be used in the context of RISC-V functions?

points to where we can save values

2.4 Which values need to saved by the caller, before jumping to a function using `jal`?

t0-t6, a0-a7, (ra)

2.5 Which values need to be restored by the callee, before using `jalr` to return from a function?

save s0-s11, sp, gp, tp, (ra)

3 Writing RISC-V Functions

3.1 Write a function `sumSquare` in RISC-V that, when given an integer `n`, returns the summation below. If `n` is not positive, then the function returns 0.

$$n^2 + (n-1)^2 + (n-2)^2 + \ldots + 1^2$$

For this problem, you are given a RISC-V function called `square` that takes in an integer and returns its square. Implement `sumSquare` using `square` as a subroutine.

s0, s1, ra

```
sumSquare: addi sp, sp, -12      ┐
           sw   s0, 0(sp)        │
           sw   s1, 4(sp)        │ prologue
           sw   ra, 8(sp)        ┘
              ⋮                  ┐
           jal  ra, square       │ body
              ⋮                  ┘
end:       add  a0, s1, x0       ← return value
           lw   s0, 0(sp)        ┐
           lw   s1, 4(sp)        │ epilogue
           lw   ra, 8(sp)        │
           addi sp, sp, 12       │
           jr   ra               ┘
```

4 More Translating between C and RISC-V

4.1 Translate between the C and RISC-V code. You may want to use the RISC-V Green Card as a reference. We show you how the different variables map to registers – you don't have to worry about the stack or any memory-related issues.

C	RISC-V

`// Nth_Fibonacci(n):`
`// s0 -> n, s1 -> fib`
`// t0 -> i, t1 -> j`
`// Assume fib, i, j init'd to:`
`int fib = 1, i = 1, j = 1;`
`if (n==0)`
`  return 0;`
`else if (n==1)`
`  return 1;`
`n -= 2;`
`while (n != 0) {`
`  fib = i + j;`
`  j = i;`
`  i = fib;`
`  n--;`
`}`
`return fib;`	