

Worksheet 5B

Quiz 1: *Frame Allocation*

How many stack slots do the following functions need to allocate for their frames?

Program

Stack Slots

```
(fun (incr n)
  (let (x1 (add1 n))
    (let (x2 (add1 x1))
      x2)))
```

```
(fun (incr n)
  (let (x1 (add1 n))
    (if (= n 99)
      x1
      (let (x2 (add1 x1))
        (+ x1 x2)))))
```

Quiz 2: *How many stack frames?*

How many stack frames are created when we run (sum 1000000)? _____

Quiz 3: *Tail calls*

Circle the calls that are tail calls.

```
(fun (fac n acc)
  (if (= n 0)
    acc
    (if (= n 2)
      (* 2 (fac (sub1 n) (* acc n)))
      (fac (sub1 n) (* acc n)))
    )
  )
)
```

Quiz 4: *Which expressions can have tail calls?*

- **Circle** the expression that *can have* tail calls
- **Cross out** the expressions that *cannot have* tail calls

```
e ::= n | true | false | input | x | (add1 e) | (print e)
    | (+ e1 e2) | (= e1 e2)
    | (let (x e1) e2) | (if e1 e2 e3)
    | (set x e) | (block e1...en)
    | (loop e) | (break e)
    | (f e1) | (f e1 e2)
```

Quiz 5: Modify assembly to reuse stack frame

Given the source:

```
(fun (helper n acc)
  (if (= n 0)
    acc
    (helper (sub1 n) (+ acc n))))
```

Original Assembly

```
fun_start_helper:
push rbp                ; SETUP FRAME
mov rbp, rsp
sub rsp, 8*3

mov rax, [rbp - 8*-2]   ; IF (= n 0)
mov [rbp - 8*1], rax
mov rax, 0
cmp rax, [rbp - 8*1]
mov rcx, 3
mov rdx, 1
cmovne rax, rcx
cmovne rax, rdx
cmp rax, 1
je if_false_0         ; THEN BRANCH
if_true_0:
mov rax, [rbp - 8*-3]
jmp if_exit_0
if_false_0:           ; ELSE BRANCH
mov rax, [rbp - 8*-2]
sub rax, 2
mov [rbp - 8*1], rax   ; (sub1 n)
mov rax, [rbp - 8*-3]
mov [rbp - 8*2], rax
mov rax, [rbp - 8*-2]
add rax, [rbp - 8*2]   ; (+ acc n)

push rax               ; (helper ..)
mov rax, [rbp - 8*1]
push rax
call fun_start_helper
add rsp, 16
if_exit_0:

mov rsp, rbp          ; TEARDOWN FRAME
pop rbp
ret
```

Optimized Assembly

; here?

? here?

Quiz 6: Your turn!

What is something you found confusing in today's lecture (or earlier)?