

Pairs

$\langle \text{expr} \rangle ::=$
 $(\langle \text{expr} \rangle, \langle \text{expr} \rangle)$
 $\text{fst}(\langle \text{expr} \rangle)$
 $\text{snd}(\langle \text{expr} \rangle)$
 $\text{ispair}(\langle \text{expr} \rangle)$

~~~~~ 0 integers  
 ~~~~~ 11 booleans  
 ~~~~~ 01 pointers

size of a common value in the processor

all bird values are one machine word (64-bit values)

all <sup>machine</sup> ptrs are to addresses which are "8-byte aligned"  
 all ptrs have lower 3 bits as zeroes

to point to addr  $0xc39850$   
 use value  $0xc39851$

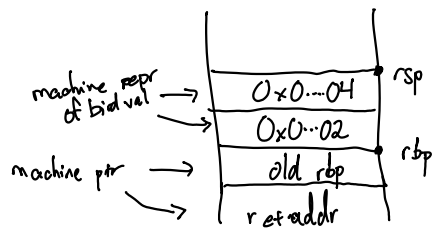
Bird Code: (false, 7)

Result:  $0xc39851$

$0xc39850$



| Bird Value        | Machine Value    |
|-------------------|------------------|
| false             | $0x7ff \dots ff$ |
| 7                 | $0x000 \dots 0e$ |
| ptr to $0xc39850$ | $0x0-c39851$     |



1 + 2

In driver.c: `int64_t* heap = malloc( ... );`  
pass heap to bird\_main

At top of bird\_main:

`mov [heap-cursor], rdi`

section .data  
heap-cursor:  
dq 0

~~`mov [heap-cursor], 5`~~

To load into memory address described by heap cursor:

`mov r10, [heap-cursor]`

`mov r11, 5`

`mov [r10], r11`

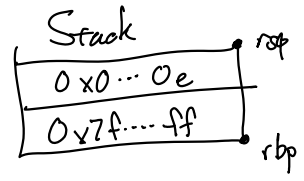
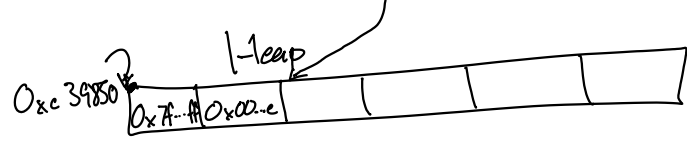
## Exercise:

write complete assembly for (false, 7)

ignoring typechecks, write asm for `snd x`

Code: (false, 7)

heap\_cursor 0xc39860



```

mov rax, 0x7fff...fff
mov [rbp-8], rax
mov rax, 14
mov [rbp-16], rax
mov r10, [heap_cursor]
mov rax, r10
mov r11, [rbp-8]
mov [r10], r11
mov r11, [rbp-16]
mov [r10+8], r11
add r10, 16
mov [heap_cursor], r10
add rax, 1

```

; store in r10 value 0xc39850  
; 0xc39850

; 0xc39851

### Eagle: tuples

$\langle \text{expr} \rangle ::= \dots$   
 $\quad | (\langle \text{expr} \rangle, \langle \text{expr}_{-list} \rangle)$   
 $\quad | \langle \text{expr} \rangle [\langle \text{expr} \rangle]$

Heap example: 3-tuple (triple) (1, false, 2)

|                |           |               |           |
|----------------|-----------|---------------|-----------|
| machine<br>0x3 | bird<br>1 | bird<br>false | bird<br>2 |
|----------------|-----------|---------------|-----------|