

CMSC 430 - 15 June 2023

Inductive data and allocating memory

Announcements:

- (Graded) Survey out after class, due before class tomorrow
- Folks are still taking the midterm; we will discuss later

Revisiting stack alignment in Fraud

Hustle: heaps and lists

- inductive data
- allocating memory

Invariants (Fraud)

Various facts about the Fraud compiler

Registers:

`rax` - return value

`rsp` - stack pointer

`rdi` - first param when calling run-time system

Stack is 8-byte (64-bit) aligned,
i.e. divisible by 8,
i.e. ends in `#b000`

(Must align to 16-bytes to call)

`(compile-e e c)` - leaves stack initial state

Length of compile time environment =
Number of elements on stack at RT

Stack-alignment in Fraud

Always 8-byte, sometimes 16-byte aligned

Stack is 8-byte aligned,
i.e. divisible by 8,
i.e. ends in #b000

Must align to 16-bytes to call,
i.e. divisible by 16,
i.e. ends in #b0000

```
Mov r15 rsp
And r15 #b1000
Sub rsp r15
Call f
Add rsp r15
```

r15 is 0 when rsp ends in #b0000

r15 is 8 when rsp ends in #b1000

r15 is a “callee-saved” or
“non-volatile” register

The registers RAX, RCX, RDX, R8, R9, R10, R11 are considered volatile (caller-saved).
The registers RBX, RBP, RDI, RSI, RSP, R12, R13, R14, and R15 are considered nonvolatile (callee-saved).

How to represent pointers?

Addressing memory

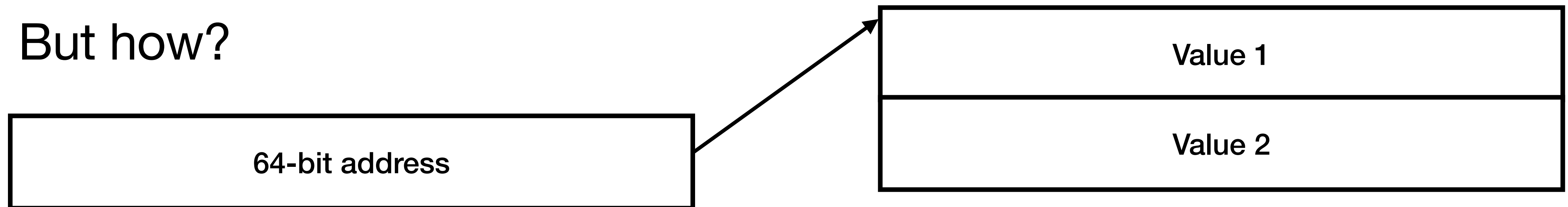
Basic idea:

A pair is allocated as two words in memory

The pair *value* will be represented by the address

+ something indicating the value is a pair

But how?



Hint: we'll always allocate memory in multiples of 8-bytes (64-bits)

Encoding immediate values (Hustle)

Type tag in least significant bits

60-bits for number	0	0	0	0	0	0	Integers
59-bits for code point (only need 21)	0	1	0	0	0	0	Characters
	0	1	1	0	0	0	#t
	1	1	1	0	0	0	#f
	1	0	1	1	0	0	eof
	1	1	1	1	0	0	void

Immediate tag

Encoding pointer values (Hustle)

Type tag in least significant bits

61-bits for address	0	0	1	Box
61-bits for address	0	1	0	Cons

Invariants (Hustle)

Various facts about the Hustle compiler

Registers:

`rax` - return value

`rsp` - stack pointer

`rdi` - first param when calling run-time system

`rbx` - heap pointer

`(compile-time c)`

- leaves stack in initial state

Length of compile time environment =
Number of elements on stack at RT

Stack is 8-byte (64-bit) aligned,
i.e. divisible by 8,
i.e. ends in `#b000`
(Must align to 16-bytes to call)

Heap is 8-byte (64-bit) aligned,
i.e. divisible by 8,
i.e. ends in `#b000`

↑
Key to our tagging scheme for pointer types

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Functions

Announcements:

- Assignment 4 due tonight; A5 out tonight
- Quiz out today, due before class Thursday
- M1 grades out; regrade form due by Friday

Finishing Hustle: string literals and string operations

Adding (recursive) functions

- inductive data + recursive functions = real computing power

Invariants (Fraud)

Various facts about the Fraud compiler

Registers:

`rax` - return value

`rsp` - stack pointer

`rdi` - first param when calling run-time system

Stack is 8-byte (64-bit) aligned,
i.e. divisible by 8,
i.e. ends in `#b000`

(Must align to 16-bytes to call)

`(compile-e e c)` - leaves stack initial state

Length of compile time environment =
Number of elements on stack at RT