



x86 Basics

Translation tools: C -> assembly <-> machine code

x86 registers, data movement instructions, memory addressing, arithmetic instructions

CSAPP book is **highly useful** and well-aligned with class for the remainder of the course.

Big picture: Turning C into *Actual* Machine Code



Real-world security &
performance implications

60-70%

of the world's servers/desktops!

```
void sumstore(long x, long y,  
              long *dest) {  
    long t = x + y;  
    *dest = t;  
}
```

sum.c

compiler (CS 301)

gcc -Og -S sum.c

Generated x86 Assembly Code

Human-readable language close to machine code.

```
sum:  
    addq %rdi,%rsi  
    movq %rsi,(%rdx)  
    retq
```

sum.s

assembler

Object Code

```
01010101100010011110010110  
00101101000101000011000000  
00110100010100001000100010  
01111011000101110111000011
```

sum.o

linker

Executable: sum

Resolve references between object files,
libraries, (re)locate data

Machine Instruction Example

```
*dest = t;
```

C Code

Store value t where indicated by dest

```
movq %rsi, (%rdx)
```

Assembly Code

Move 8-byte value to memory

t: Register %rsi

dest: Register %rdx

*dest: Memory **M**[%rdx]

```
0x400539:  48 89 32
```

Object Code

3-byte instruction encoding

Stored at address 0x400539

CISC vs. RISC

x86: real ISA, widespread

CISC: maximalism

Complex Instruction Set Computer

Many instructions, specialized.

Variable-size encoding,
complex/slow decode.

Gradual accumulation over time.

Original goal:

- humans program in assembly
- or simple compilers generate assembly by template
- hardware supports many patterns as single instructions
- fewer instructions per SLOC

Usually fewer registers.

We will stick to a small subset.

HW: toy, but based on real MIPS ISA

RISC: minimalism

Reduced Instruction Set Computer

Few instructions, general.

Regular encoding,
simple/fast decode.

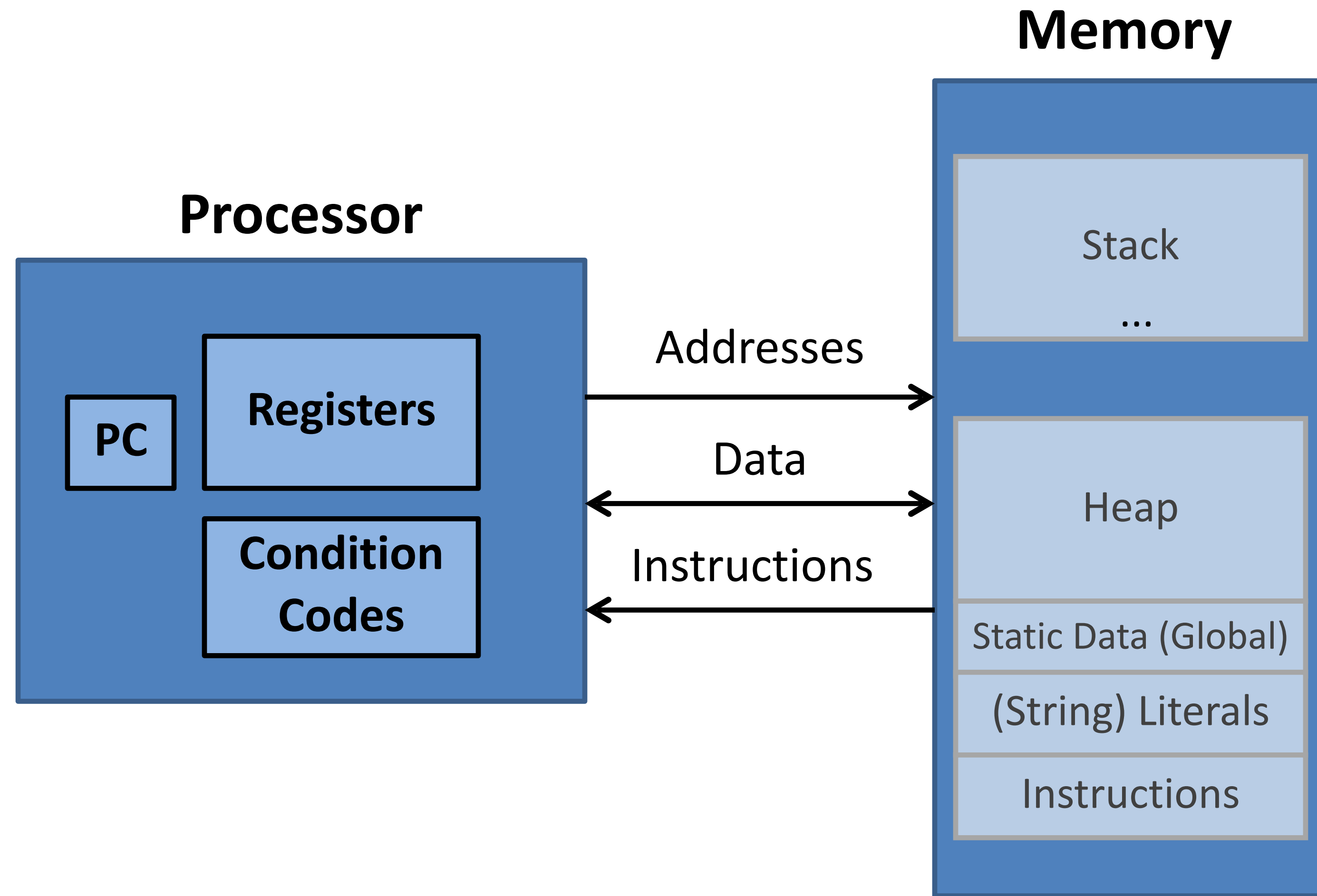
1980s+ reaction to bloated ISAs.

Original goal:

- humans use high-level languages
- smart compilers generate highly optimized assembly
- hardware supports fast basic instructions
- more instructions per SLOC

Usually many registers.

ISA View



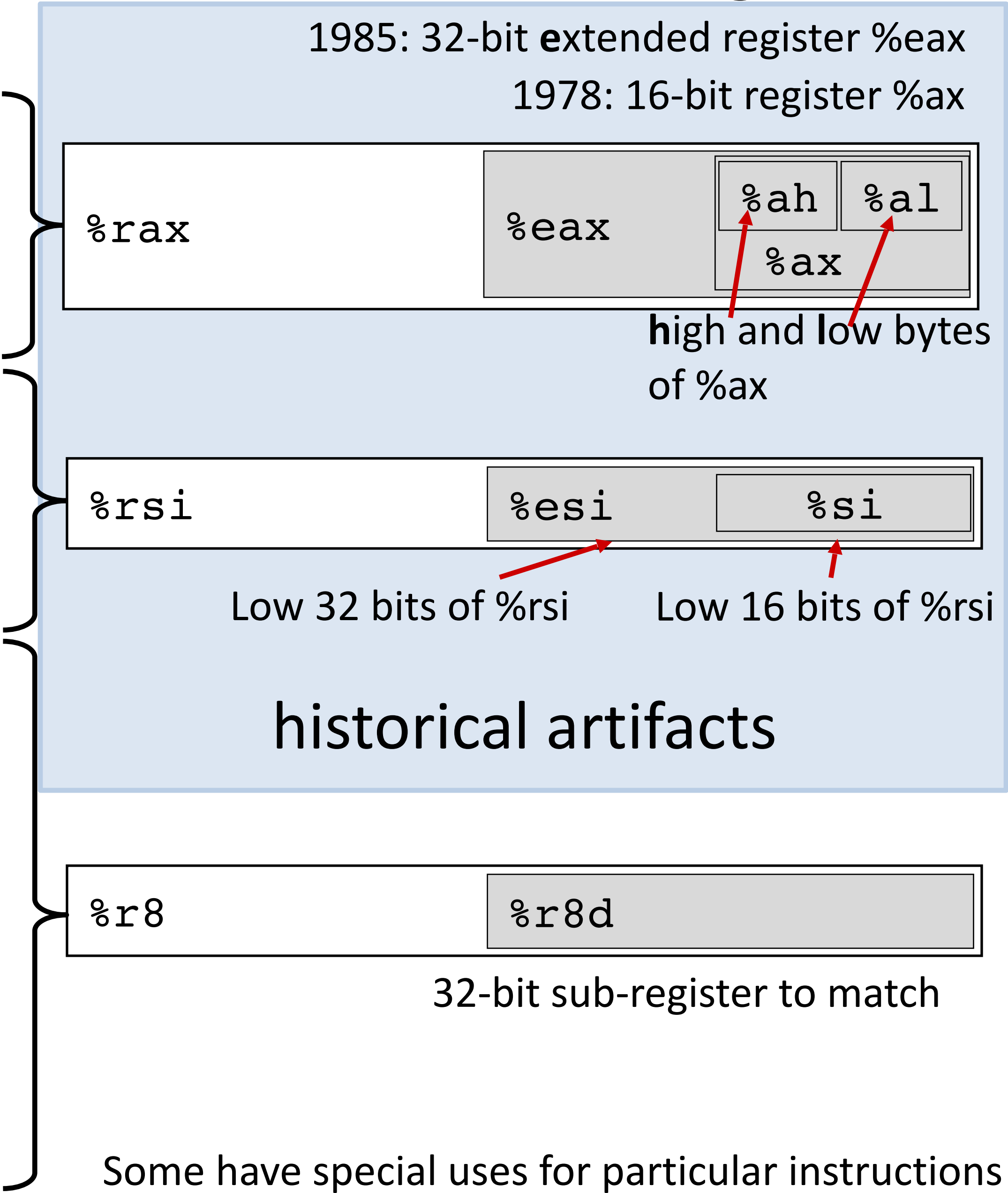
x86-64 registers

16 named registers

Each 64 bits (8 bytes)

%rax	Return Value
%rbx	
%rcx	Argument 4
%rdx	Argument 3
%rsi	Argument 2
%rdi	Argument 1
%rsp	Special Purpose: Stack Pointer
%rbp	Special Purpose: Base Pointer
%r8	Argument 5
%r9	Argument 6
%r10	
%r11	
%r12	
%r13	
%r14	
%r15	

64-bits / 8 bytes



x86-64 registers: function arguments and return value

%rax	Return Value	←
%rbx		
%rcx	Argument 4	←
%rdx	Argument 3	
%rsi	Argument 2	
%rdi	Argument 1	
%rsp	Special Purpose: Stack Pointer	
%rbp	Special Purpose: Base Pointer	
%r8	Argument 5	←
%r9	Argument 6	
%r10		
%r11		
%r12		
%r13		
%r14		
%r15		

64-bits / 8 bytes

Mnemonic:

	register
Diana's	%rdi
silk	%rsi
dress	%rdx
costs	%rcx
\$89	%r8
	%9

Arguments 7 and above are passed via stack, not in registers.

x86: Three Basic Kinds of Instructions

1. Data movement between memory and register

Load data from memory into register

$\%reg \leftarrow \text{Mem}[\text{address}]$

Store register data into memory

$\text{Mem}[\text{address}] \leftarrow \%reg$

Memory is conceptually
an array[] of bytes!

2. Arithmetic/logic on register or memory data

$c = a + b;$ $z = x \ll y;$ $i = h \& g;$

Next lecture:

3. Comparisons and Control flow to choose next instruction

Unconditional jumps to/from procedures

Conditional branches

Data movement instructions

(Like LW and SW in the HW ISA)

mov *Source, Dest*

*“copy the contents of **source** operand into **dest** operand”*

data size is one of {b, w, l, q}

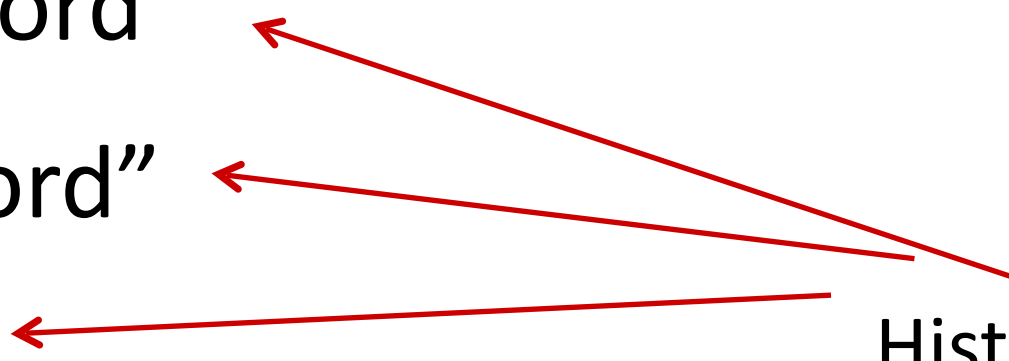
movq: move 8-byte “quad word”

movl: move 4-byte “long word”

movw: move 2-byte “word”

movb: move 1-byte “byte”

Historical terms based on the 16-bit days,
not the current machine word size (64 bits)



Source, Dest operand types:

Immediate: Literal integer data

Examples: \$0x400 \$-533

Register: One of 16 registers

Examples: %rax %rdx

Memory: consecutive bytes in memory, at address held by register

Direct addressing: (%rax)

With displacement/offset: 8(%rsp)

mov Operand Combinations

	Source	Dest	Src, Dest	C Analog
movq	Imm	Reg	movq \$0x4, %rax	a = 0x4;
		Mem	movq \$-147, (%rax)	*p = -147;
	Reg	Reg	movq %rax, %rdx	d = a;
		Mem	movq %rax, (%rdx)	*q = a;
	Mem	Reg	movq (%rax), %rdx	d = *p;

Cannot do memory-memory transfer with a single instruction.

How would you do it?

Memory Addressing Modes

Indirect **(R)** $\text{Mem}[\text{Reg}[R]]$

Register R specifies memory address: `movq (%rcx), %rax`

Displacement **D(R)** $\text{Mem}[\text{Reg}[R]+D]$

Register R specifies **base** memory address (e.g. base of an object)

Displacement D specifies literal **offset** (e.g. a field in the object)

`movq %rdx, 8(%rsp)`

General Form: **D(Rb,Ri,S)** $\text{Mem}[\text{Reg}[Rb] + S * \text{Reg}[Ri] + D]$

D: Literal “displacement” value represented in 1, 2, or 4 bytes

Rb: Base register: Any register

Ri: Index register: Any except `%rsp`

S: Scale: 1, 2, 4, or 8

Pointers and Memory Addressing

```
void swap(long* xp, long* yp){  
    long t0 = *xp;  
    long t1 = *yp;  
    *xp = t1;  
    *yp = t0;  
}
```

```
swap:  
    movq (%rdi),%rax  
    movq (%rsi),%rdx  
    movq %rdx,(%rdi)  
    movq %rax,(%rsi)  
    retq
```

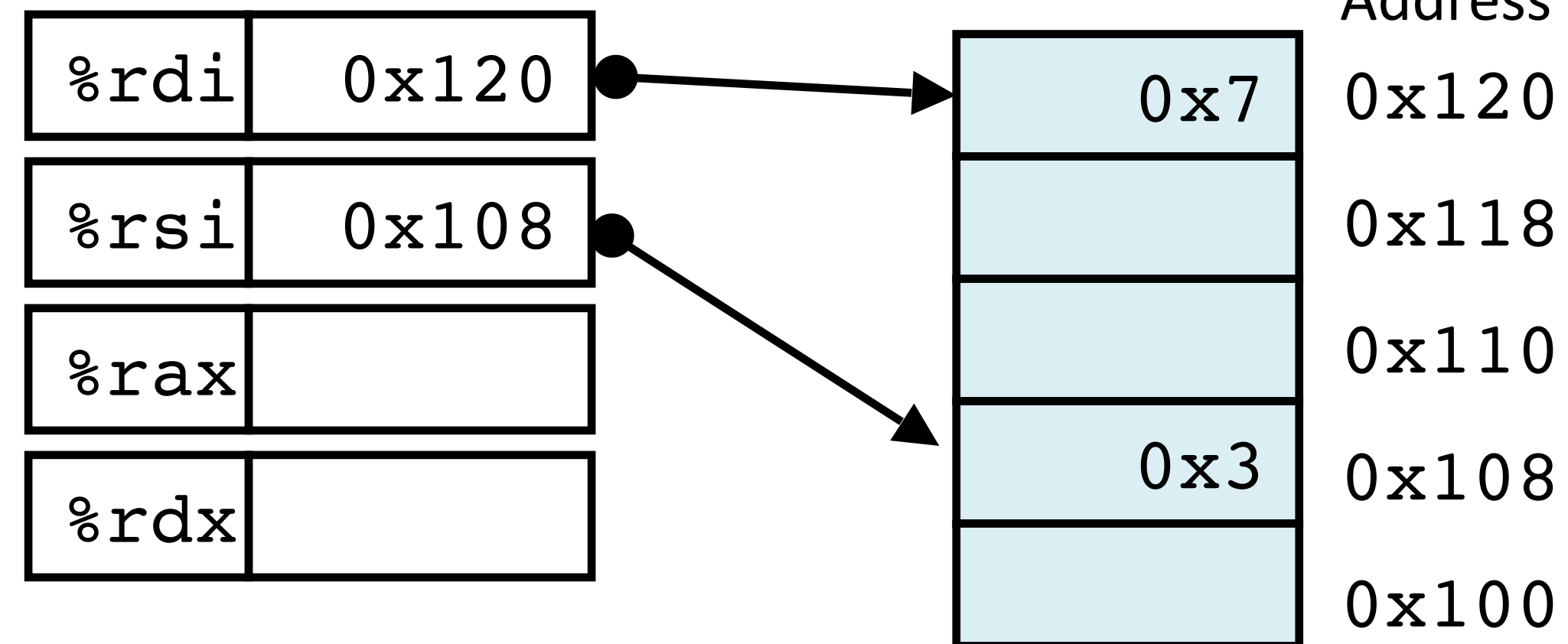
<u>Register</u>		<u>Variable</u>
%rdi	↔	xp
%rsi	↔	yp
%rax	↔	t0
%rdx	↔	t1

Registers

%rdi	0x120
%rsi	0x108
%rax	
%rdx	

Memory

Address
0x120
0x118
0x110
0x108
0x100



Pointers and Memory Addressing

```
void swap(long* xp, long* yp){  
    long t0 = *xp;  
    long t1 = *yp;  
    *xp = t1;  
    *yp = t0;  
}
```

```
swap:  
    movq (%rdi),%rax  
    movq (%rsi),%rdx  
    movq %rdx,(%rdi)  
    movq %rax,(%rsi)  
    retq
```

<u>Register</u>		<u>Variable</u>
%rdi	↔	xp
%rsi	↔	yp
%rax	↔	t0
%rdx	↔	t1

Registers

%rdi	0x120
%rsi	0x108
%rax	0x7
%rdx	

Memory

Address
0x120
0x118
0x110
0x108
0x100

Pointers and Memory Addressing

```
void swap(long* xp, long* yp){  
    long t0 = *xp;  
    long t1 = *yp;  
    *xp = t1;  
    *yp = t0;  
}
```

```
swap:  
    movq (%rdi),%rax  
    movq (%rsi),%rdx  
    movq %rdx,(%rdi)  
    movq %rax,(%rsi)  
    retq
```

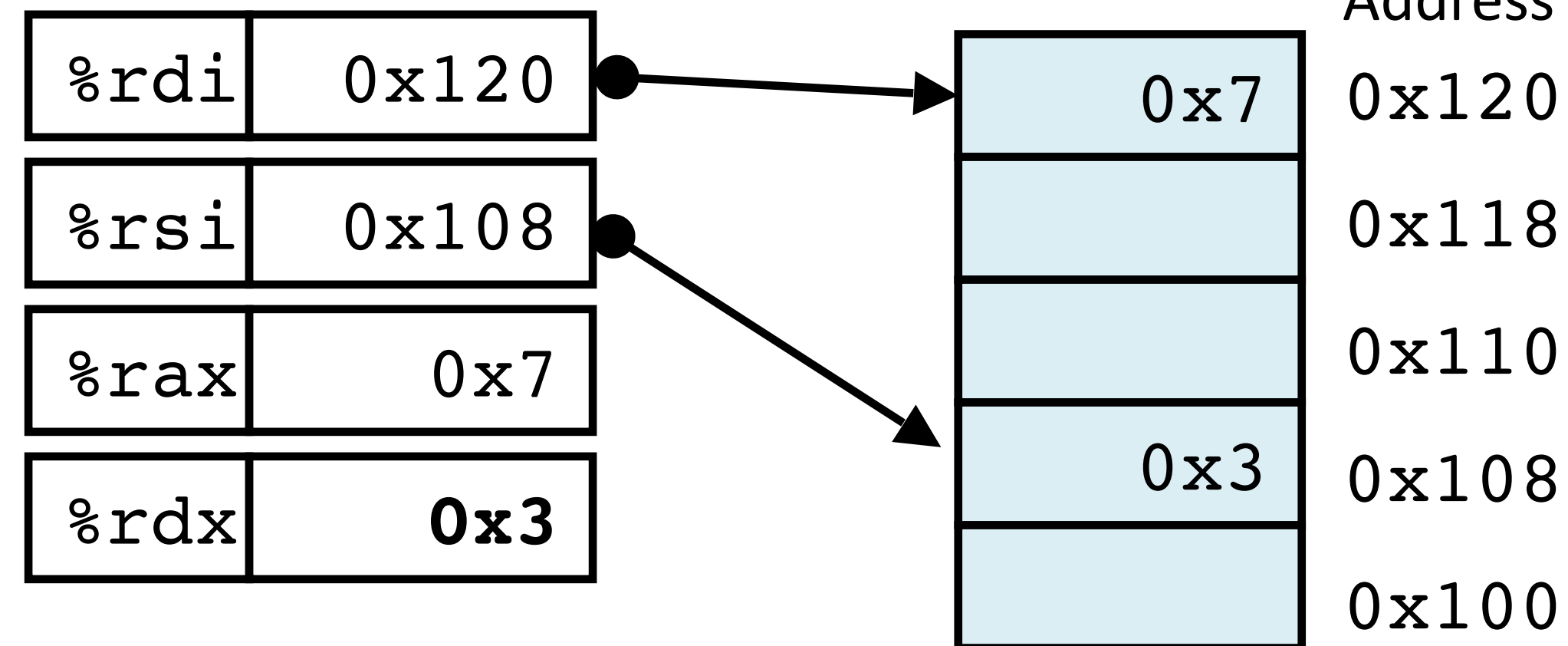
<u>Register</u>		<u>Variable</u>
%rdi	↔	xp
%rsi	↔	yp
%rax	↔	t0
%rdx	↔	t1

Registers

%rdi	0x120
%rsi	0x108
%rax	0x7
%rdx	0x3

Memory

Address
0x120
0x118
0x110
0x108
0x100



Pointers and Memory Addressing

```
void swap(long* xp, long* yp){  
    long t0 = *xp;  
    long t1 = *yp;  
    *xp = t1;  
    *yp = t0;  
}
```

```
swap:  
    movq (%rdi),%rax  
    movq (%rsi),%rdx  
    movq %rdx, (%rdi)  
    movq %rax, (%rsi)  
    retq
```

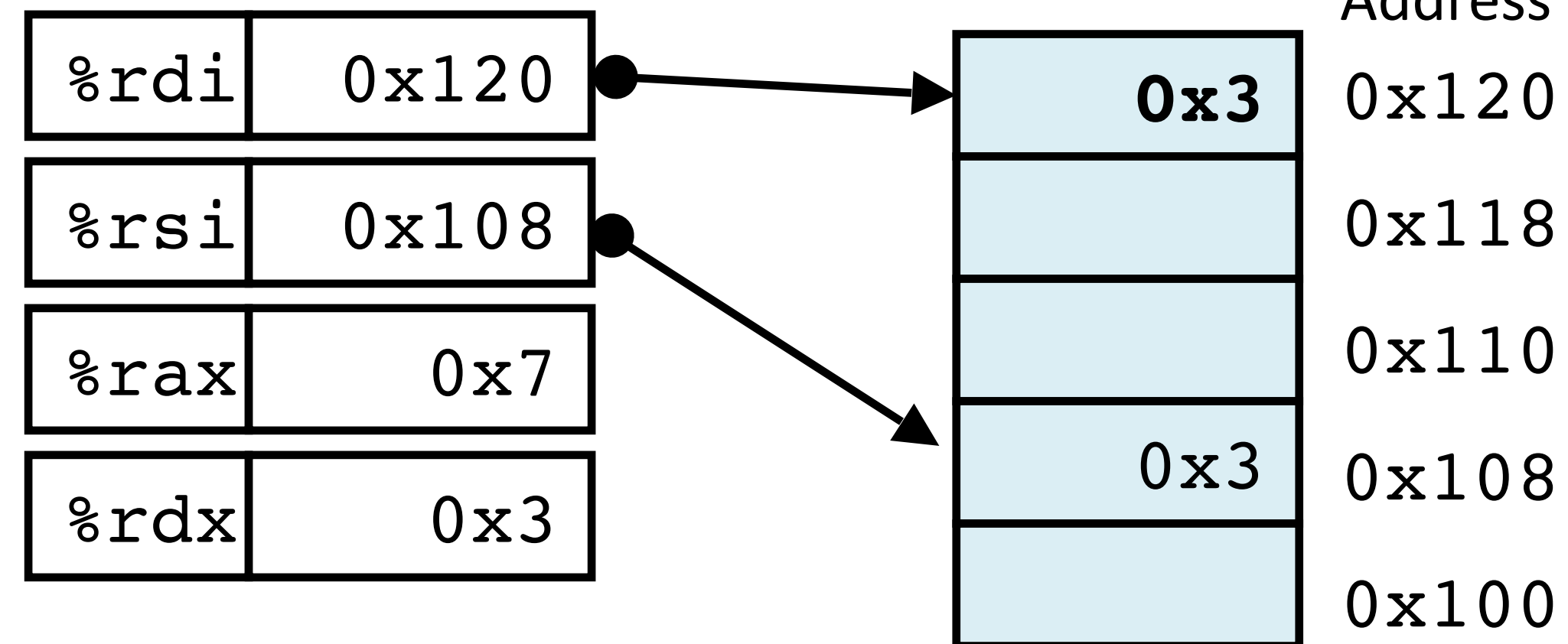
<u>Register</u>		<u>Variable</u>
%rdi	↔	xp
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%rax	↔	t0
%rdx	↔	t1

Registers

%rdi	0x120
%rsi	0x108
%rax	0x7
%rdx	0x3

Memory

Address
0x120
0x118
0x110
0x108
0x100



Pointers and Memory Addressing

```
void swap(long* xp, long* yp){  
    long t0 = *xp;  
    long t1 = *yp;  
    *xp = t1;  
    *yp = t0;  
}
```

```
swap:  
    movq (%rdi),%rax  
    movq (%rsi),%rdx  
    movq %rdx,(%rdi)  
    movq %rax,(%rsi)  
    retq
```

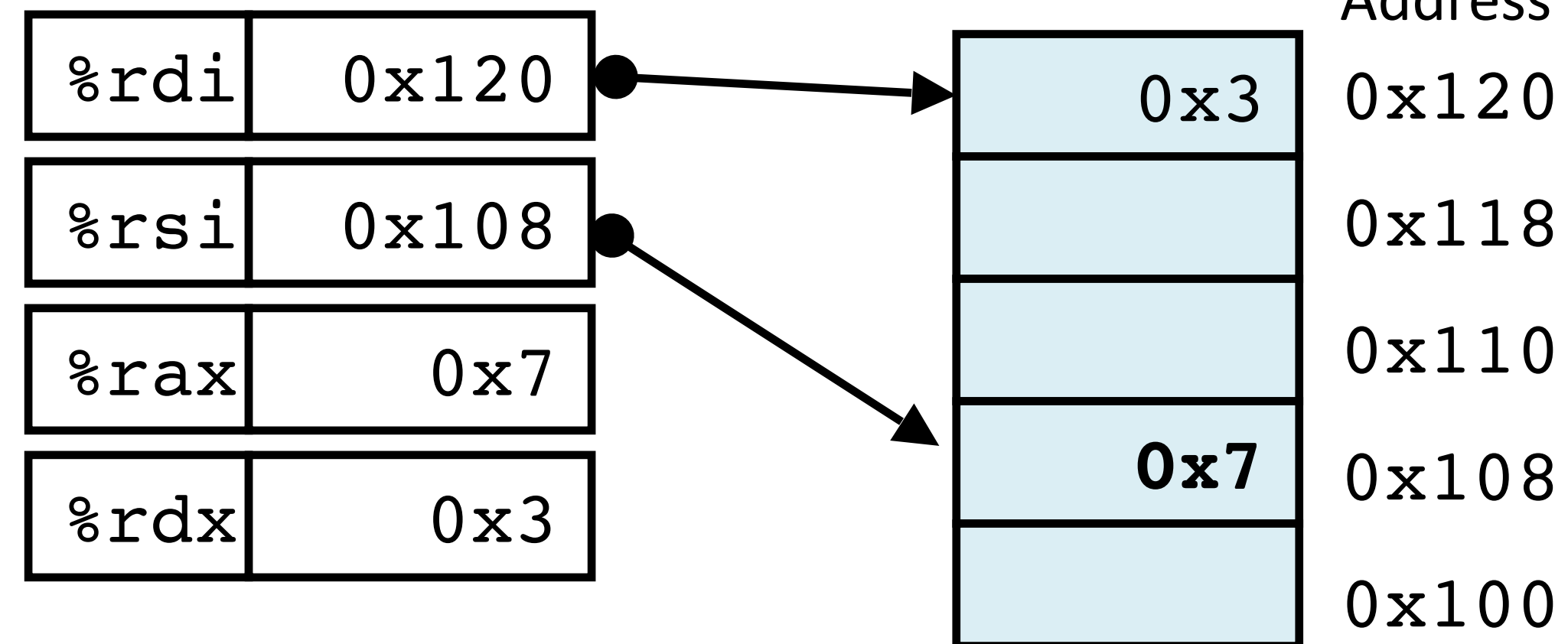
<u>Register</u>		<u>Variable</u>
%rdi	↔	xp
%rsi	↔	yp
%rax	↔	t0
%rdx	↔	t1

Registers

%rdi	0x120
%rsi	0x108
%rax	0x7
%rdx	0x3

Memory

Address
0x120
0x118
0x110
0x108
0x100



Address Computation Examples



General Addressing Modes

Register contents

<code>%rdx</code>	<code>0x6000</code>
<code>%rcx</code>	<code>0x100</code>

$D(Rb, Ri, S) \quad \text{Mem}[\text{Reg}[Rb] + S * \text{Reg}[Ri] + D]$

Special Cases:

(Rb, Ri)	$\text{Mem}[\text{Reg}[Rb] + \text{Reg}[Ri]]$	Implicitly: $(S=1, D=0)$
$D(Rb, Ri)$	$\text{Mem}[\text{Reg}[Rb] + \text{Reg}[Ri] + D]$	$(S=1)$
(Rb, Ri, S)	$\text{Mem}[\text{Reg}[Rb] + S * \text{Reg}[Ri]]$	$(D=0)$

Address Expression	Address Computation	Address
<code>0x8 (%rdx)</code>	<code>0x8 + 0x6000</code>	
<code>(%rdx , %rcx)</code>		
<code>(%rdx , %rcx , 4)</code>		
<code>0x80 (, %rdx , 2)</code>		

Address Computation Examples



General Addressing Modes

Register contents

<code>%rdx</code>	<code>0x6000</code>
<code>%rcx</code>	<code>0x100</code>

$$D(Rb,Ri,S) \quad \text{Mem}[\text{Reg}[Rb]+S*\text{Reg}[Ri] + D]$$

Special Cases:		Implicitly:
(Rb,Ri)	$\text{Mem}[\text{Reg}[Rb]+\text{Reg}[Ri]]$	$(S=1,D=0)$
$D(Rb,Ri)$	$\text{Mem}[\text{Reg}[Rb]+\text{Reg}[Ri]+D]$	$(S=1)$
(Rb,Ri,S)	$\text{Mem}[\text{Reg}[Rb]+S*\text{Reg}[Ri]]$	$(D=0)$

Address Expression	Address Computation	Address
<code>0x8(%rdx)</code>	<code>0x8 + 0x6000</code>	<code>6008</code>
<code>(%rdx,%rcx)</code>	<code>0x6000 + 0x100 * 1</code>	<code>6100</code>
<code>(%rdx,%rcx,4)</code>	<code>0x6000 + 0x100 * 4</code>	<code>6400</code>
<code>0x80(,%rdx,2)</code>	<code>0x80 + 0x0 + 0x6000 * 2</code>	<code>C080</code>

What memory address will the following access? `0x1(%rdx,%rcx,2)`

Register contents

<code>%rdx</code>	0x03
<code>%rcx</code>	0x04

General Addressing Modes

$D(Rb, Ri, S) \quad \text{Mem}[\text{Reg}[Rb] + S * \text{Reg}[Ri] + D]$

Special Cases:

(Rb, Ri)	$\text{Mem}[\text{Reg}[Rb] + \text{Reg}[Ri]]$	Implicitly: $(S=1, D=0)$
$D(Rb, Ri)$	$\text{Mem}[\text{Reg}[Rb] + \text{Reg}[Ri] + D]$	$(S=1)$
(Rb, Ri, S)	$\text{Mem}[\text{Reg}[Rb] + S * \text{Reg}[Ri]]$	$(D=0)$

0x8 (8)

0xA (10)

0xB (11)

0xC (12)

0xD (13)

0xE (14)

Compute address given by
this addressing mode expression
and store it here.

`leaq Src, Dest`

Load effective address



DOES NOT ACCESS MEMORY

Uses: "address of" "Lovely Efficient Arithmetic"

`p = &x[i];` $x + k * I$, where $k = 1, 2, 4, \text{ or } 8$

leaq vs. movq

Registers		Memory	Address	Assembly Code
%rax		0x400	0x120	leaq (%rdx,%rcx,4), %rax movq (%rdx,%rcx,4), %rbx leaq (%rdx), %rdi movq (%rdx), %rsi
%rbx		0xf	0x118	
%rcx	0x4	0x8	0x110	
%rdx	0x100	0x10	0x108	
%rdi		0x1	0x100	
%rsi				

Compute address given by
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leaq vs. movq

Registers		Memory	Address	Assembly Code
%rax	0x110	0x400	0x120	leaq (%rdx,%rcx,4), %rax
%rbx		0xf	0x118	movq (%rdx,%rcx,4), %rbx
%rcx	0x4	0x8	0x110	leaq (%rdx), %rdi
%rdx	0x100	0x10	0x108	movq (%rdx), %rsi
%rdi		0x1	0x100	
%rsi				

Compute address given by
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leaq vs. movq

Registers		Memory	Address	Assembly Code
%rax	0x110	0x400	0x120	<code>leaq (%rdx,%rcx,4), %rax</code>
%rbx	0x8	0xf	0x118	<code>movq (%rdx,%rcx,4), %rbx</code>
%rcx	0x4	0x8	0x110	<code>leaq (%rdx), %rdi</code>
%rdx	0x100	0x10	0x108	<code>movq (%rdx), %rsi</code>
%rdi		0x1	0x100	
%rsi				

Compute address given by
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`leaq Src, Dest`

Load effective address



DOES NOT ACCESS MEMORY

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`p = &x[i];` $x + k * I$, where $k = 1, 2, 4, \text{ or } 8$

leaq vs. movq

Registers		Memory	Address	Assembly Code
%rax	0x110	0x400	0x120	<code>leaq (%rdx,%rcx,4), %rax</code>
%rbx	0x8	0xf	0x118	<code>movq (%rdx,%rcx,4), %rbx</code>
%rcx	0x4	0x8	0x110	<code>leaq (%rdx), %rdi</code>
%rdx	0x100	0x10	0x108	<code>movq (%rdx), %rsi</code>
%rdi	0x100	0x1	0x100	
%rsi				

Compute address given by
this addressing mode expression
and store it here.

`leaq Src, Dest`

Load effective address



DOES NOT ACCESS MEMORY

Uses: "address of" "Lovely Efficient Arithmetic"

`p = &x[i];` $x + k * l$, where $k = 1, 2, 4, \text{ or } 8$

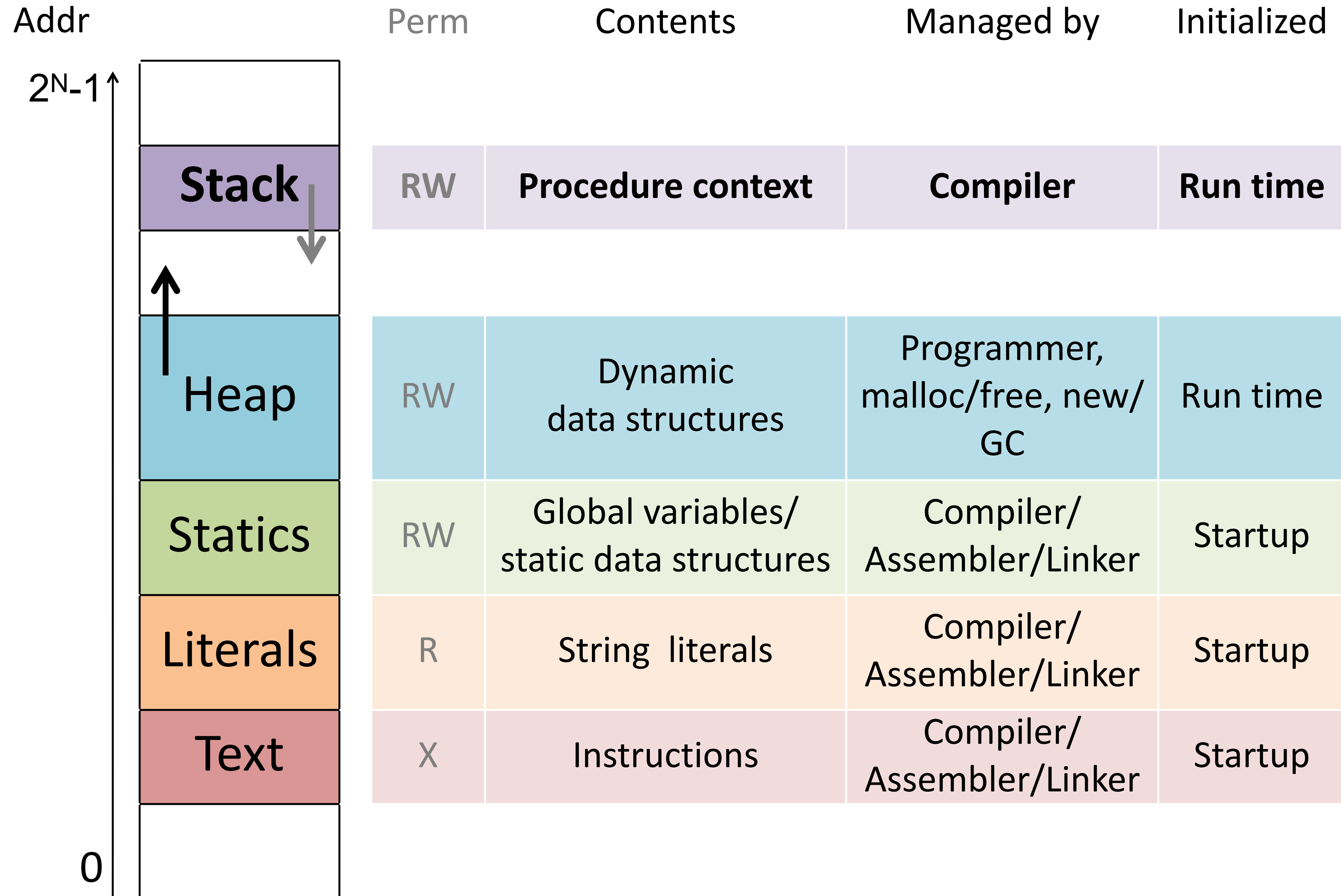
leaq vs. movq

Registers	
<code>%rax</code>	<code>0x110</code>
<code>%rbx</code>	<code>0x8</code>
<code>%rcx</code>	<code>0x4</code>
<code>%rdx</code>	<code>0x100</code>
<code>%rdi</code>	<code>0x100</code>
<code>%rsi</code>	<code>0x1</code>

Memory	Address
<code>0x400</code>	<code>0x120</code>
<code>0xf</code>	<code>0x118</code>
<code>0x8</code>	<code>0x110</code>
<code>0x10</code>	<code>0x108</code>
<code>0x1</code>	<code>0x100</code>

```
leaq (%rdx,%rcx,4), %rax
movq (%rdx,%rcx,4), %rbx
leaq (%rdx), %rdi
movq (%rdx), %rsi
```

Memory address-space layout

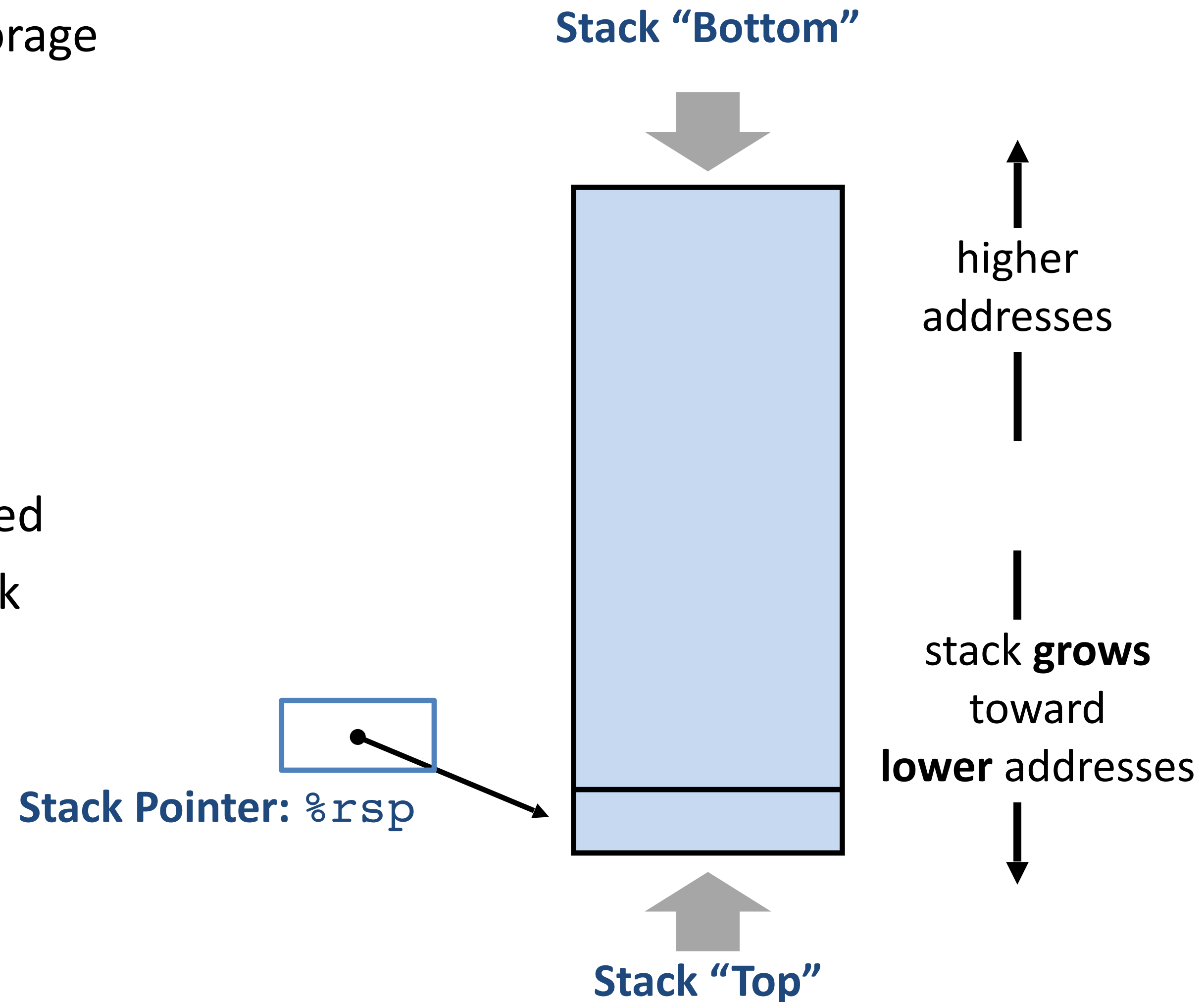


Call Stack

Memory region for temporary storage managed with stack discipline.

`%rsp` holds lowest stack address (address of "top" element)

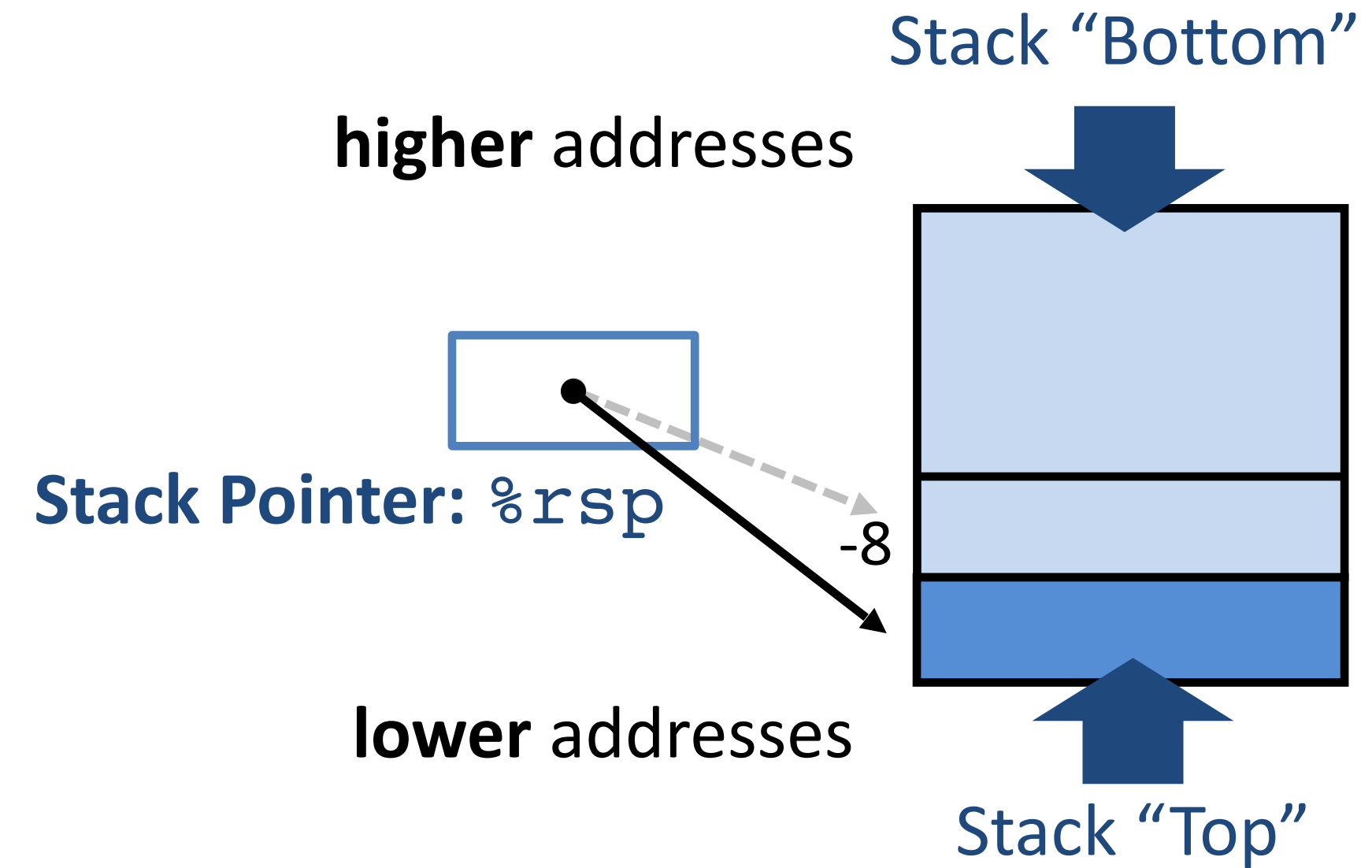
Local variables (that can't be stored in registers) are stored in the stack frame for their function.



Call Stack: Push, Pop

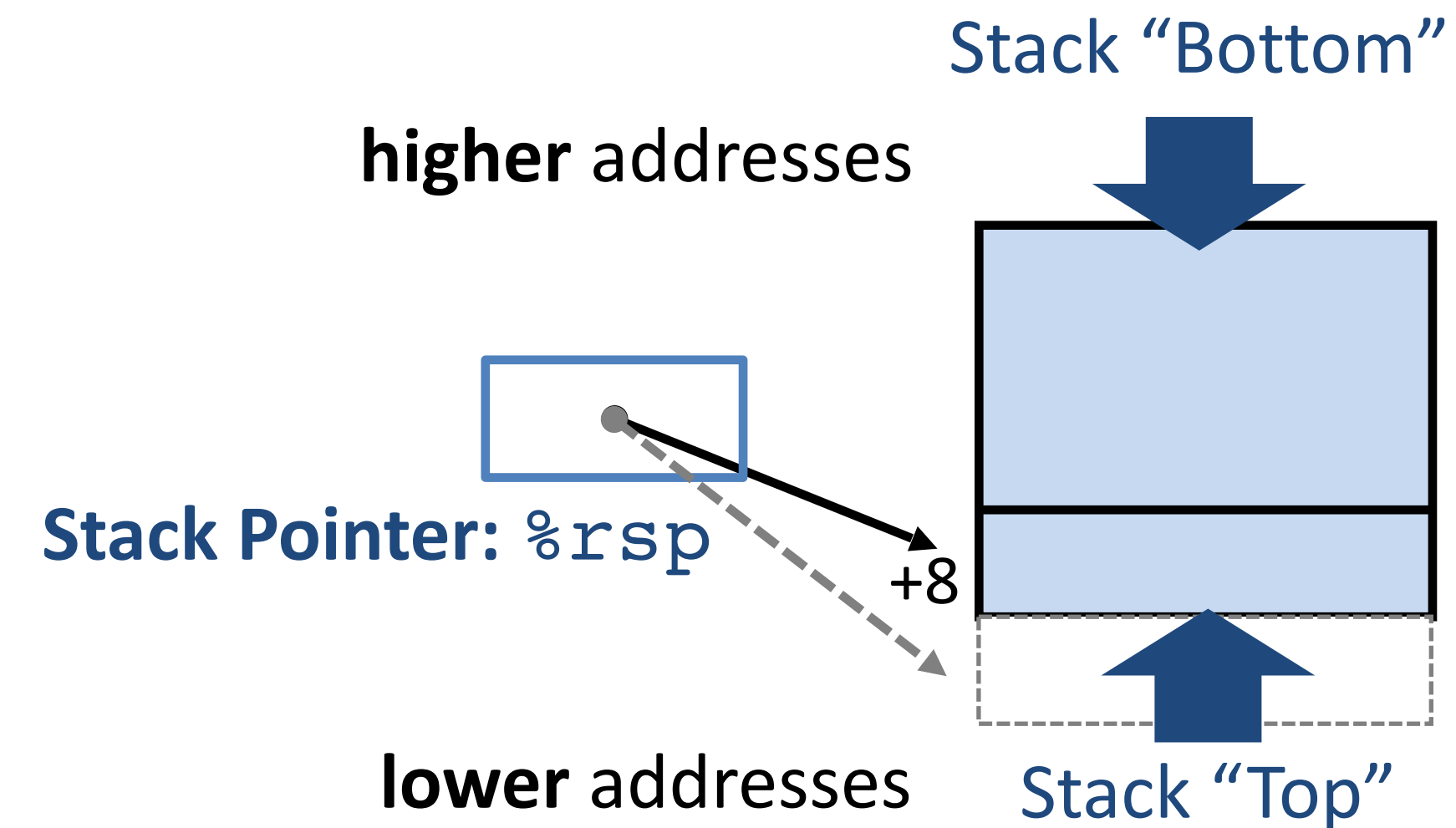
`pushq Src`

1. Fetch value from *Src*
2. Decrement `%rsp` by 8 (*why 8?*)
3. Store value at new address given by `%rsp`



`popq Dest`

1. Load value from address `%rsp`
2. Write value to *Dest*
3. Increment `%rsp` by 8



Assume the current stack pointer is at 0x00000000ffffff08 and %rdi is 0x0000000000000010. What is %rsp after the x86 instruction "pushq %rdi"?



0x0000000000000010

0x00000000ffffff18

0x00000000ffffff10

0x00000000ffffff00

None of the above

Procedure Preview (more soon)

call, ret, push, pop

Procedure arguments passed in 6 registers:

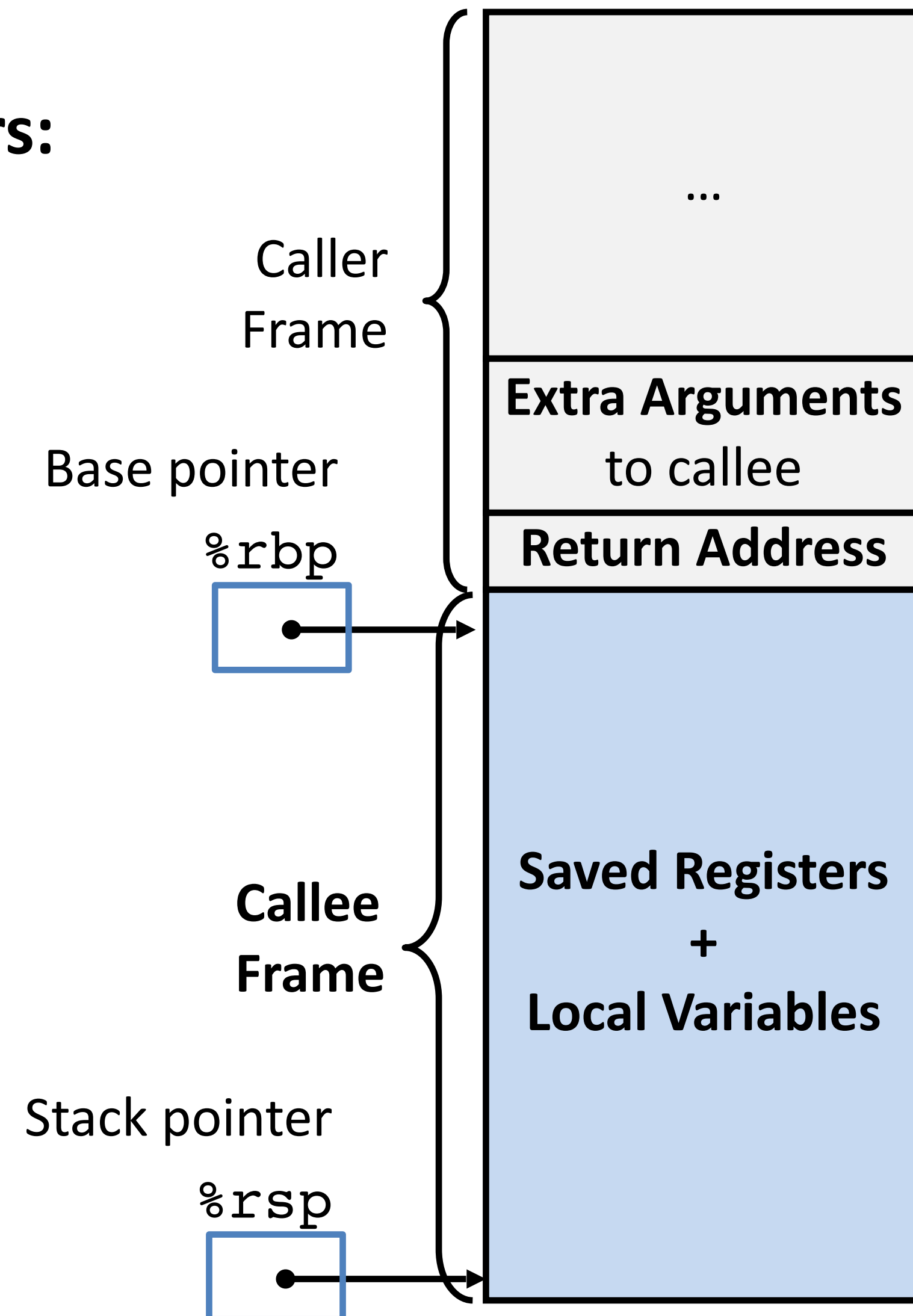
%rax	Return Value	%r8	Argument 5
%rbx		%r9	Argument 6
%rcx	Argument 4	%r10	
%rdx	Argument 3	%r11	
%rsi	Argument 2	%r12	
%rdi	Argument 1	%r13	
%rsp	Stack pointer	%r14	
%rbp	Base pointer	%r15	

Return value in %rax.

Allocate/push new *stack frame*
for each procedure call.

Some local variables,
saved register values, extra arguments

Deallocate/pop frame before return.



x86: Three Basic Kinds of Instructions

1. Data movement between memory and register

Load data from memory into register

$\%reg \leftarrow \text{Mem}[\text{address}]$

Store register data into memory

$\text{Mem}[\text{address}] \leftarrow \%reg$

Memory is an
array[] of bytes!

2. Arithmetic/logic on register or memory data

$c = a + b;$ $z = x \ll y;$ $i = h \& g;$

3. Comparisons and Control flow to choose next instruction

Unconditional jumps to/from procedures

Conditional branches

Arithmetic Operations

(Unlike the HW ISA, combines 1 operand and the destination)

Two-operand instructions:

Format

`addq Src, Dest`

`subq Src, Dest`

`imulq Src, Dest`

`shlq Src, Dest`

`sarq Src, Dest`

`shrq Src, Dest`

`xorq Src, Dest`

`andq Src, Dest`

`orq Src, Dest`

Computation

$Dest = Dest + Src$

$Dest = Dest - Src$

$Dest = Dest * Src$

$Dest = Dest \ll Src$

$Dest = Dest \gg Src$

$Dest = Dest \gg Src$

$Dest = Dest \wedge Src$

$Dest = Dest \& Src$

$Dest = Dest \mid Src$

note the unexpected argument order

a.k.a salq

Arithmetic

Logical

One-operand (unary) instructions

`incq Dest`

$Dest = Dest + 1$

increment

`decq Dest`

$Dest = Dest - 1$

decrement

`negq Dest`

$Dest = -Dest$

negate

`notq Dest`

$Dest = \sim Dest$

bitwise complement

See CSAPP 3.5.5 for: `mulq`, `cqto`, `idivq`, `divq`

leaq for arithmetic

```
long arith(long x, long y,
           long z){
    long t1 = x+y;
    long t2 = z+t1;
    long t3 = x+4;
    long t4 = y * 48;
    long t5 = t3 + t4;
    long rval = t2 * t5;
    return rval;
}
```

```
arith:
    leaq    (%rdi,%rsi), %rax
    addq    %rdx, %rax
    leaq    (%rsi,%rsi,2), %rdx
    salq    $4, %rdx
    leaq    4(%rdi,%rdx), %rcx
    imulq    %rcx, %rax
    ret
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z
%rax	
%rcx	

leaq for arithmetic

```
long arith(long x, long y,
           long z){
    long t1 = x+y;
    long t2 = z+t1;
    long t3 = x+4;
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    long t5 = t3 + t4;
    long rval = t2 * t5;
    return rval;
}
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z
%rax	t1
%rcx	

```
arith:
    leaq    (%rdi,%rsi), %rax
    addq    %rdx, %rax
    leaq    (%rsi,%rsi,2), %rdx
    salq    $4, %rdx
    leaq    4(%rdi,%rdx), %rcx
    imulq    %rcx, %rax
    ret
```

leaq for arithmetic

```
long arith(long x, long y,
           long z){
    long t1 = x+y;
    long t2 = z+t1;
    long t3 = x+4;
    long t4 = y * 48;
    long t5 = t3 + t4;
    long rval = t2 * t5;
    return rval;
}
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z
%rax	t1 t2
%rcx	

```
arith:
    leaq    (%rdi,%rsi), %rax
    addq    %rdx, %rax
    leaq    (%rsi,%rsi,2), %rdx
    salq    $4, %rdx
    leaq    4(%rdi,%rdx), %rcx
    imulq    %rcx, %rax
    ret
```

leaq for arithmetic

```
long arith(long x, long y,
           long z){
    long t1 = x+y;
    long t2 = z+t1;
    long t3 = x+4;
    long t4 = y * 48;
    long t5 = t3 + t4;
    long rval = t2 * t5;
    return rval;
}
```

```
arith:
    leaq    (%rdi,%rsi), %rax
    addq    %rdx, %rax
    leaq    (%rsi,%rsi,2), %rdx
    salq    $4, %rdx
    leaq    4(%rdi,%rdx), %rcx
    imulq    %rcx, %rax
    ret
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z 3*y
%rax	t1 t2
%rcx	

leaq for arithmetic

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%rdi	Argument x
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```
arith:
    leaq    (%rdi,%rsi), %rax
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    salq    $4, %rdx
    leaq    4(%rdi,%rdx), %rcx
    imulq   %rcx, %rax
    ret
```

== %rdx << 4
== %rdx * 2⁴
== %rdx * 16
== (3*y) * 16
== y * 48

leaq for arithmetic

```
long arith(long x, long y,
           long z){
    long t1 = x+y;
    long t2 = z+t1;
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    long t4 = y * 48;
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    leaq    (%rsi,%rsi,2), %rdx
    salq    $4, %rdx
    leaq    4(%rdi,%rdx), %rcx
    imulq    %rcx, %rax
    ret
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z 3*y t4
%rax	t1 t2
%rcx	4+x+t4 = t5

leaq for arithmetic

```
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Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z 3*y t4
%rax	t1 t2 rval
%rcx	4+x+t4 = t5

```
arith:
    leaq    (%rdi,%rsi), %rax
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leaq for arithmetic

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```
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    leaq    (%rdi,%rsi), %rax
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    leaq    4(%rdi,%rdx), %rcx
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```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rdx	Argument z 3*y t4
%rax	t1 t2 rval
%rcx	4+x+t4 = t5

- Instructions in different order from C code
- Some expressions require multiple instructions
- Some instructions cover multiple expressions
- Same x86 code as compiling:

$(x+y+z) * (x+4+48*y)$

Compiler optimization example

```
long logical(long x, long y){
    long t1 = x^y;
    long t2 = t1 >> 17;
    long mask = (1<<13) - 7;
    long rval = t2 & mask;
    return rval;
}
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rax	

```
logical:
    movq %rdi,%rax
    xorq %rsi,%rax
    sarq $17,%rax
    andq $8185,%rax
    retq
```

Compiler optimization example

```
long logical(long x, long y){
    long t1 = x^y;
    long t2 = t1 >> 17;
    long mask = (1<<13) - 7;
    long rval = t2 & mask;
    return rval;
}
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rax	x

logical:

```
    movq %rdi,%rax
    xorq %rsi,%rax
    sarq $17,%rax
    andq $8185,%rax
    retq
```

Compiler optimization example

```
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    long t1 = x^y;
    long t2 = t1 >> 17;
    long mask = (1<<13) - 7;
    long rval = t2 & mask;
    return rval;
}
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rax	* t1

```
logical:
    movq %rdi,%rax
    xorq %rsi,%rax
    sarq $17,%rax
    andq $8185,%rax
    retq
```

Compiler optimization example

```
long logical(long x, long y){
    long t1 = x^y;
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}
```

Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rax	* t1 t2

```
logical:
    movq %rdi,%rax
    xorq %rsi,%rax
    sarq $17,%rax
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Register	Use(s)
%rdi	Argument x
%rsi	Argument y
%rax	* t1 t2 rval

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    movq %rdi,%rax
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