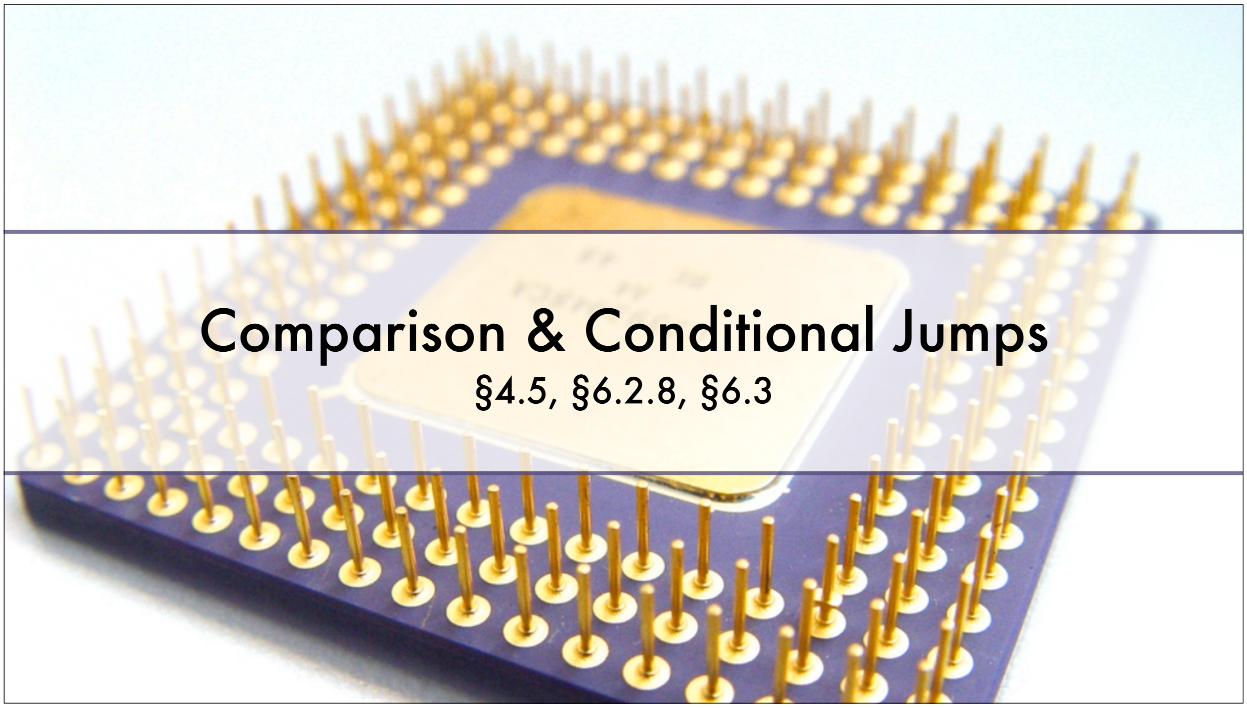


Comparison & Conditional Jumps

§4.5, §6.2.8, §6.3

Conditional Jumps... For Real This Time

- You have seen one conditional jump instruction
  - How to implement *if* (ECX == 0) { ... } *else* { ... }
  - How to implement *while* (ECX == 0) { ... }
  - How to implement *do* { ... } *while* (ECX == 0)
  - And the same with the condition ECX ≠ 0
- **How do you perform comparisons other than "ECX == 0" and "ECX ≠ 0"?**
  - Perform a CMP (Compare) to set flags
  - Then perform a conditional jump

Example 1: Comparison, Jumps

```
        ; Read a signed integer into EAX
        call ReadInt
        cmp eax, 100
        jge big
        ; If we reach here, eax < 100
        jmp done
big:    ; If we reach here, eax ≥ 100
done:   exit
```

JGE = Jump if Greater or Equal
(based on flags set by cmp)

Example 2: Comparison, Jumps

```
        ; Read a signed integer into EAX
        call ReadInt
        cmp eax, 10
        jle small
        ; If we reach here, eax > 10
        jmp done
small:  ; If we reach here, eax ≤ 10
done:   exit
```

JLE = Jump if Less or Equal
(based on flags set by cmp)

Subtraction & Comparison

- How does the SUB instruction affect the flags?

Unsigned	ZF	CF
Dest < Src		
Dest = Src		
Dest > Src		

Signed	Flags
Dest < Src	SF $^{?}=^{?}$ OF
Dest = Src	ZF = ?
Dest > Src	SF $^{?}=^{?}$ OF

Subtraction & Comparison

- How does the SUB instruction affect the flags?

Unsigned	ZF	CF
Dest < Src	0	1
Dest = Src	1	0
Dest > Src	0	0

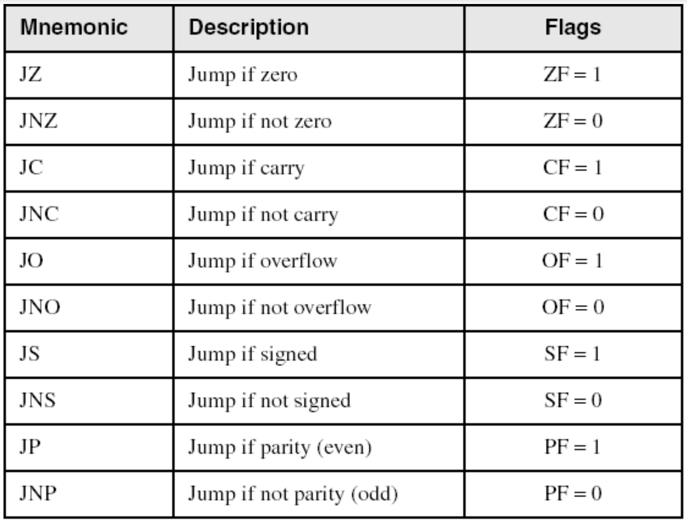
Signed	Flags
Dest < Src	SF ≠ OF
Dest = Src	ZF = 1
Dest > Src	SF = OF

- Integer values can be compared by subtracting the values and then looking at the flags!
- The CMP (Compare) instruction subtracts values but does **not** store the result; it only sets flags

Topics Covered in Notes:

- CMP instruction

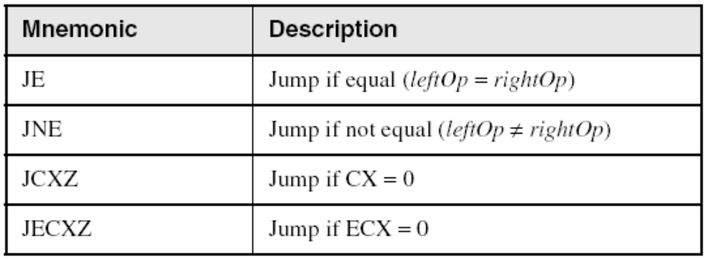
Jumps Based on Specific Flags



Mnemonic	Description	Flags
JZ	Jump if zero	ZF = 1
JNZ	Jump if not zero	ZF = 0
JC	Jump if carry	CF = 1
JNC	Jump if not carry	CF = 0
JO	Jump if overflow	OF = 1
JNO	Jump if not overflow	OF = 0
JS	Jump if signed	SF = 1
JNS	Jump if not signed	SF = 0
JP	Jump if parity (even)	PF = 1
JNP	Jump if not parity (odd)	PF = 0

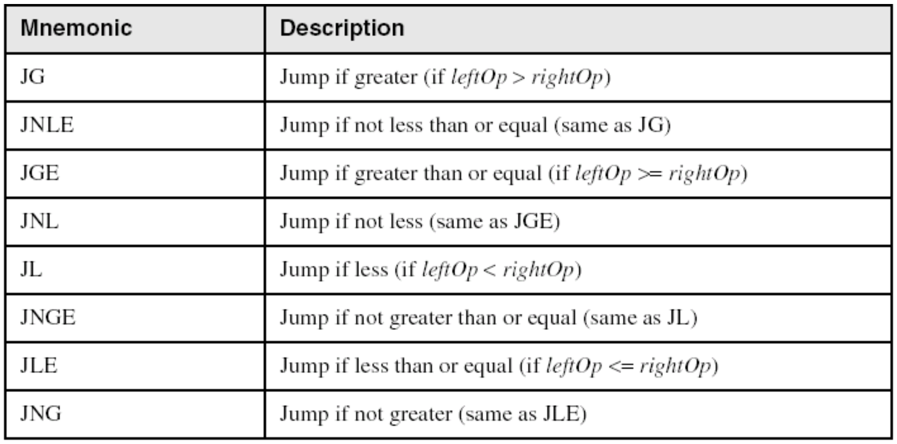
Activity 10 #1

Jumps Based on Equality



Mnemonic	Description
JE	Jump if equal (*leftOp* = *rightOp*)
JNE	Jump if not equal (*leftOp* ≠ *rightOp*)
JCXZ	Jump if CX = 0
JECXZ	Jump if ECX = 0

Jumps Based on Signed Comparisons



Mnemonic	Description
JG	Jump if greater (if *leftOp* > *rightOp*)
JNLE	Jump if not less than or equal (same as JG)
JGE	Jump if greater than or equal (if *leftOp* >= *rightOp*)
JNL	Jump if not less (same as JGE)
JL	Jump if less (if *leftOp* < *rightOp*)
JNGE	Jump if not greater than or equal (same as JL)
JLE	Jump if less than or equal (if *leftOp* <= *rightOp*)
JNG	Jump if not greater (same as JLE)

Activity 10

Jumps Based on Unsigned Comparisons

Mnemonic	Description
JA	Jump if above (if *leftOp* > *rightOp*)
JNBE	Jump if not below or equal (same as JA)
JAE	Jump if above or equal (if *leftOp* >= *rightOp*)
JNB	Jump if not below (same as JAE)
JB	Jump if below (if *leftOp* < *rightOp*)
JNAE	Jump if not above or equal (same as JB)
JBE	Jump if below or equal (if *leftOp* <= *rightOp*)
JNA	Jump if not above (same as JBE)

Activity 10

Jumps Based on Comparisons

Signed Comparisons ("Greater/Less")

Mnemonic	Description
JG	Jump if greater (if *leftOp* > *rightOp*)
JNLE	Jump if not less than or equal (same as JG)
JGE	Jump if greater than or equal (if *leftOp* >= *rightOp*)
JNL	Jump if not less (same as JGE)
JL	Jump if less (if *leftOp* < *rightOp*)
JNGE	Jump if not greater than or equal (same as JL)
JLE	Jump if less than or equal (if *leftOp* <= *rightOp*)
JNG	Jump if not greater (same as JLE)

Unsigned Comparisons ("Above/Below")

Mnemonic	Description
JA	Jump if above (if *leftOp* > *rightOp*)
JNBE	Jump if not below or equal (same as JA)
JAE	Jump if above or equal (if *leftOp* >= *rightOp*)
JNB	Jump if not below (same as JAE)
JB	Jump if below (if *leftOp* < *rightOp*)
JNAE	Jump if not above or equal (same as JB)
JBE	Jump if below or equal (if *leftOp* <= *rightOp*)
JNA	Jump if not above (same as JBE)

Activity 10 #2

Conditional Jumps and Flags

- Remember: JA, JB, JL, JG, etc. are based on **flags**
  - It's *conventional* to use `cmp` to set the flags
  - But if some other instruction changes the flags, the jump will be be based on its flags

```
.data
msg BYTE "3 < 5", 0
```

```
      mov ah, 3                     mov ah, 3
      mov al, 5                     mov al, 5
      cmp ah, al                    sub ah, al
      jnl done                      jnl done

      mov edx, OFFSET msg           mov edx, OFFSET msg
      call WriteString              call WriteString

done: exit                    done: exit
```

Translating Do-While Loops

```
do {
   // body
} while (eax < ebx)
```

⬇

```
start:  ; body
        cmp eax, ebx
        jl start  or  jb start
          (signed)      (unsigned)
```

Translating While Loops

```
while (eax < ebx) {
    // body
}
```

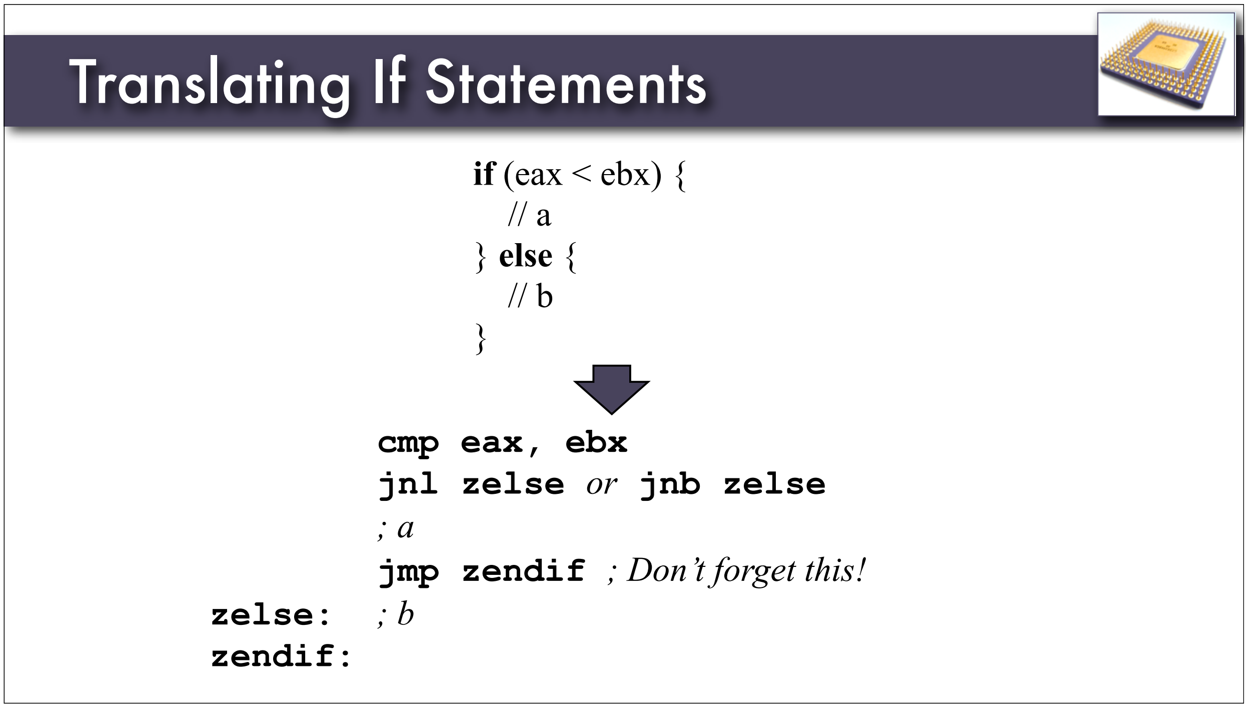
```
start:  cmp eax, ebx
        jnl finish or jnb finish
        ; body
        jmp start
finish:
```

Translating Counted Loops

```
for (eax = 0; eax < 10; eax++) {
    // body
}
```

```
eax = 0
while (eax < 10) {
    // body
    eax++
}
```

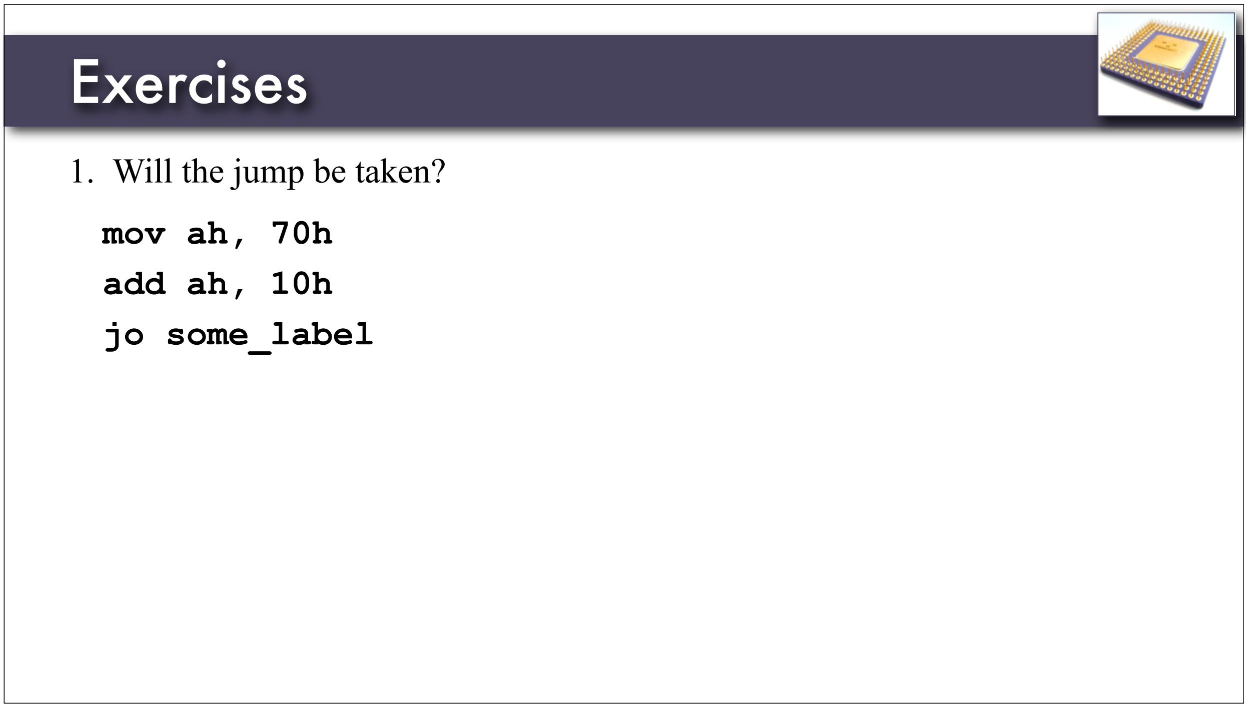
```
        mov eax, 0
start:  cmp eax, 10
        jnl finish or jnb finish
        ; body
        inc eax
        jmp start
finish:
```



Translating If Statements

```
if (eax < ebx) {
   // a
} else {
   // b
}
```

```
         cmp eax, ebx
         jnl zelse or jnb zelse
         ; a
         jmp zendif  ; Don't forget this!
zelse:   ; b
zendif:
```



Exercises

1. Will the jump be taken?

```
mov ah, 70h
add ah, 10h
jo some_label
```

Exercises

2. Will the jump be taken?

```
mov ah, -1
cmp ah, 5
jl some_label
```

Exercises

3. Will the jump be taken?

```
mov ah, -1
cmp ah, 5
jb some_label
```

Exercises

4. Will the jump be taken?

```
mov ah, 0FFh
cmp ah, -1
je some_label
```

Exercises

5. Will the jump be taken?

```
mov eax, 0FFh
cmp eax, -1
je some_label
```

Exercises

6. Will the jump be taken?

```
mov al, 100

mov ah, 25
add ah, 75

cmp ah, al
je some_label
```

Exercises

7. Will the jump be taken?

```
mov al, 100
add al, 50
cmp al, 100
jg some_label
```