Introduction to 8086 Assembly

Lecture 5

Jump, Conditional Jump, Looping, Compare instructions

Labels and jumping (the jmp instruction)


```
  mov eax, 1

  add eax, eax

  jmp label1

  xor eax, eax

label1:

  sub eax, 303
```

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```
   mov eax, 1

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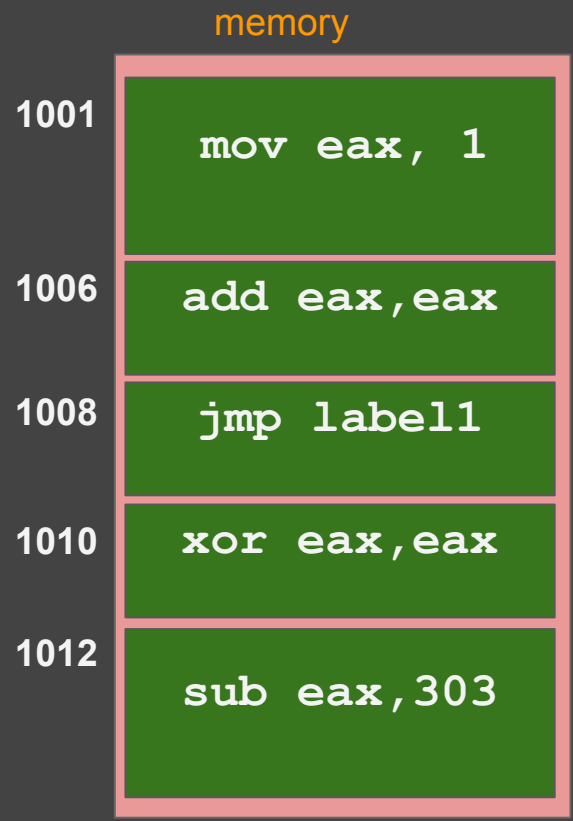

Labels and jumping (the jmp instruction)


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xor eax, eax

label1:

sub eax, 303
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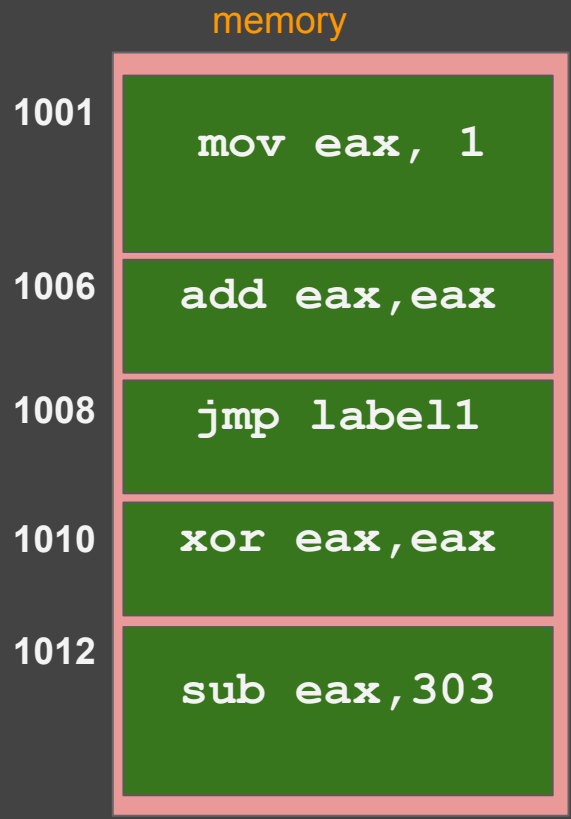


Labels and jumping (the jmp instruction)


```
mov eax, 1

add eax, eax

jmp label1

xor eax, eax

label1:

sub eax, 303
```

address of `sub eax,303`

Labels and jumping (the jmp instruction)


```
mov eax, 1

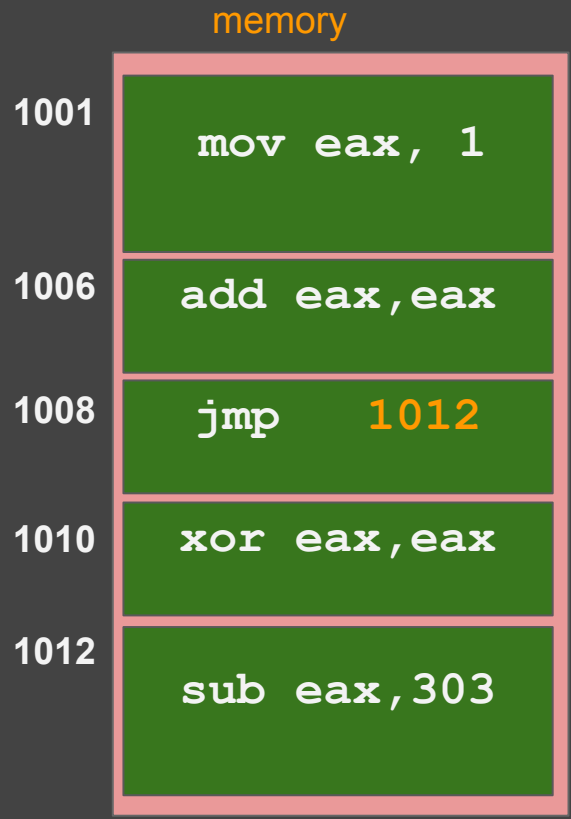
add eax, eax

jmp label1

xor eax, eax

label1:

sub eax, 303
```



Labels and jumping (the jmp instruction)


```
mov eax, 1

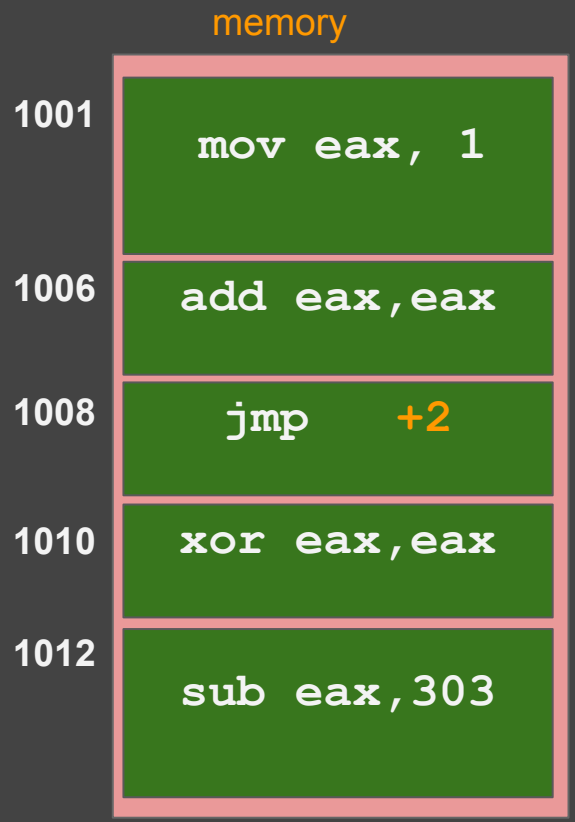
add eax, eax

jmp label1

xor eax, eax

label1:

sub eax, 303
```



Labels and jumping (the jmp instruction)


```
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jmp label1

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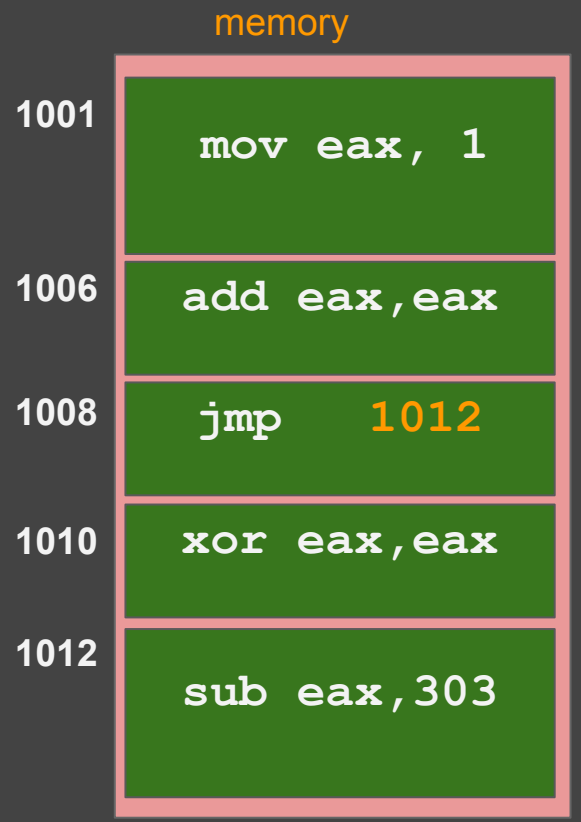
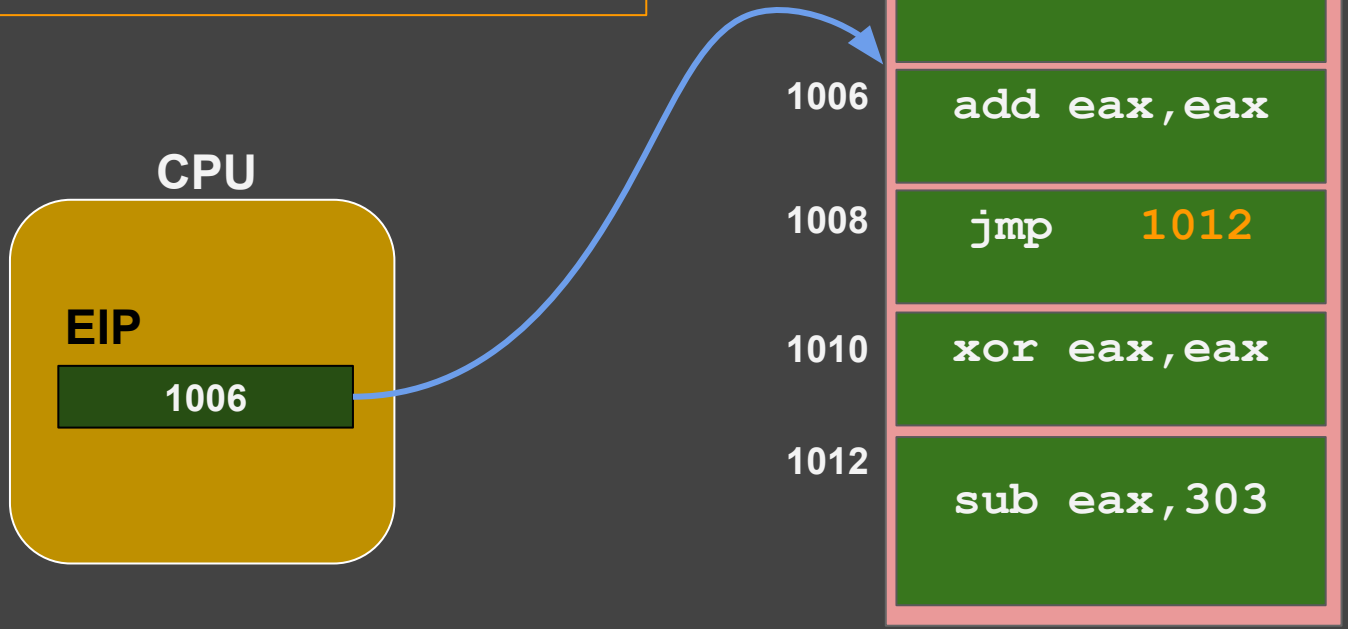
label1:

sub eax, 303
```



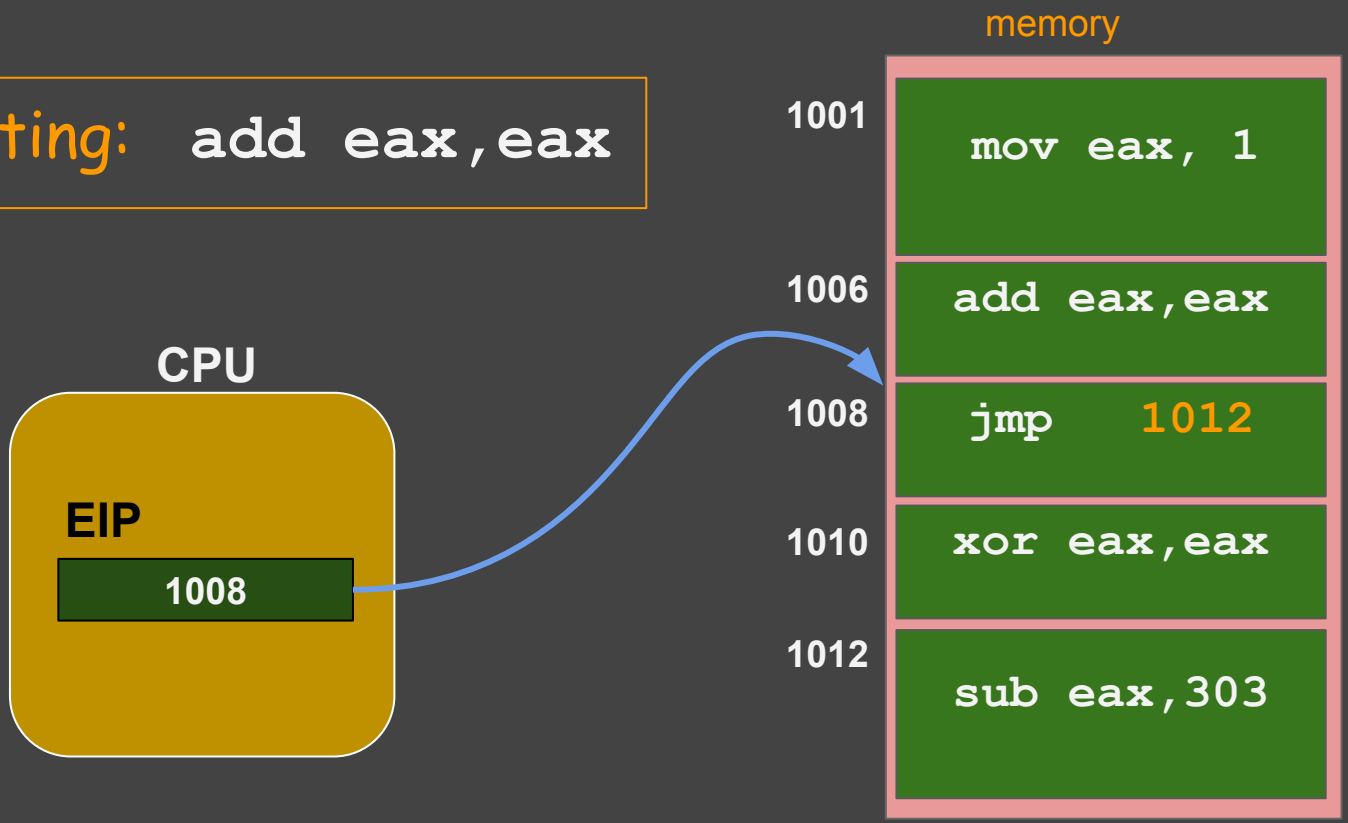
Labels and jumping (the jmp instruction)

Executing: `mov eax, 1`



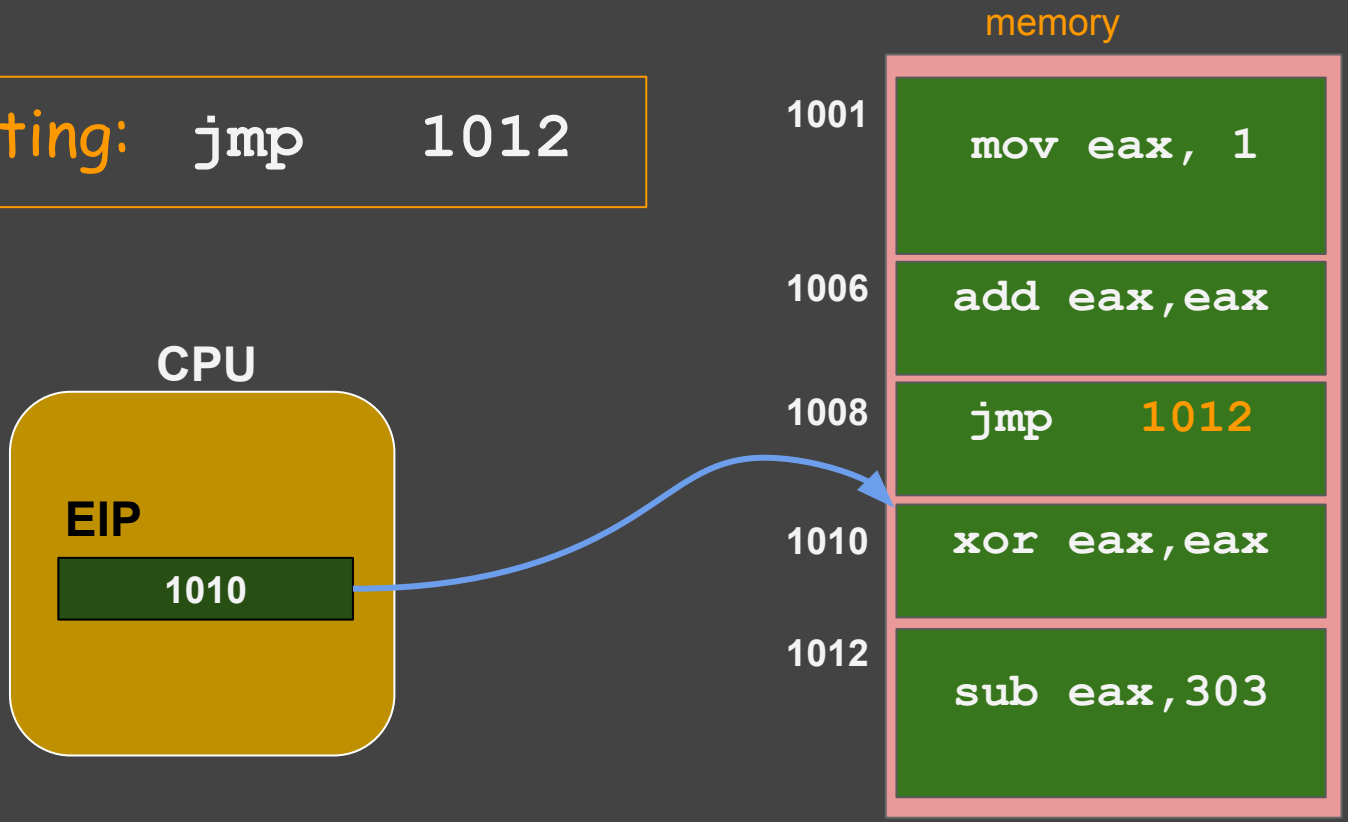
Labels and jumping (the jmp instruction)

Executing: `add eax,eax`



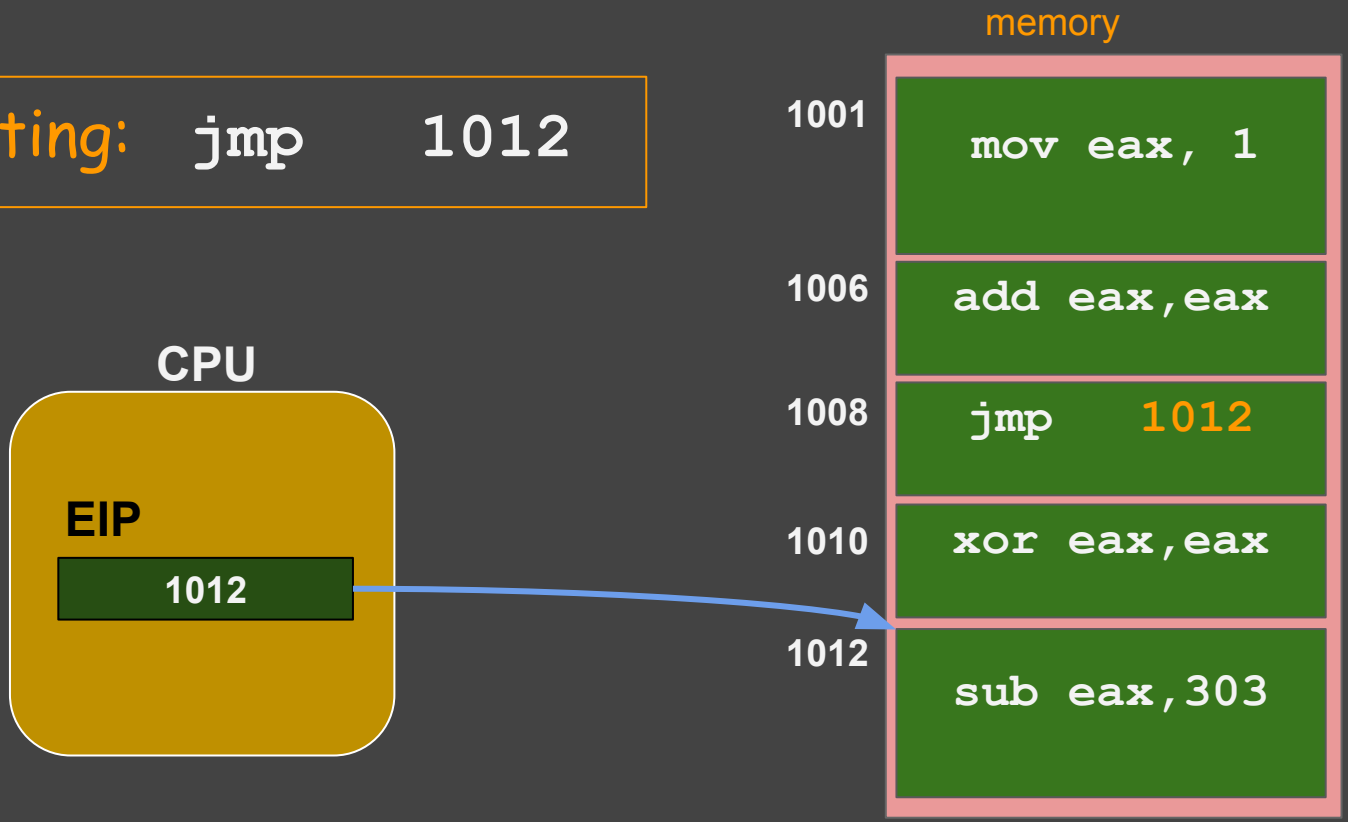
Labels and jumping (the jmp instruction)

Executing: `jmp 1012`



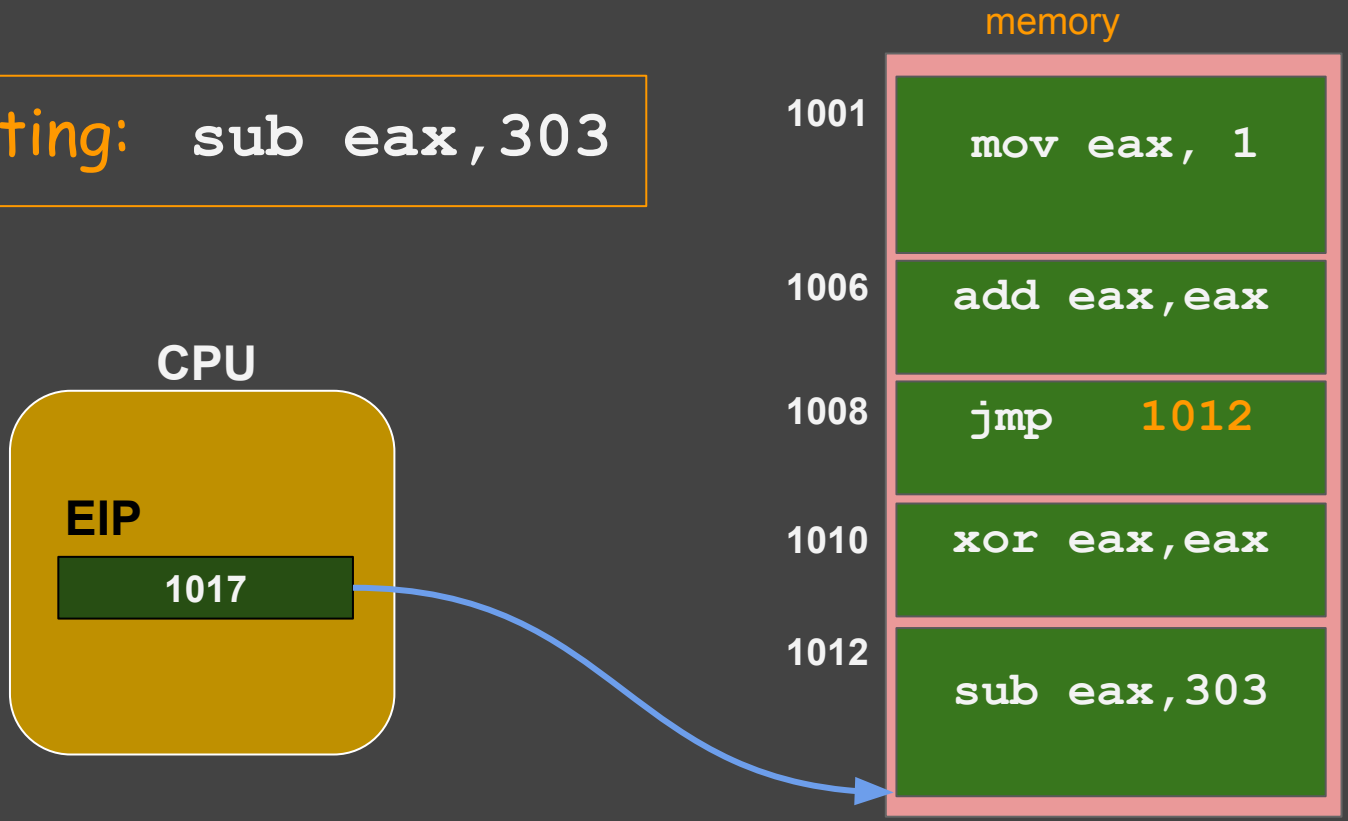
Labels and jumping (the jmp instruction)

Executing: `jmp 1012`



Labels and jumping (the jmp instruction)

Executing: `sub eax,303`



Infinite loop


```
  mov eax, 0

loop1:

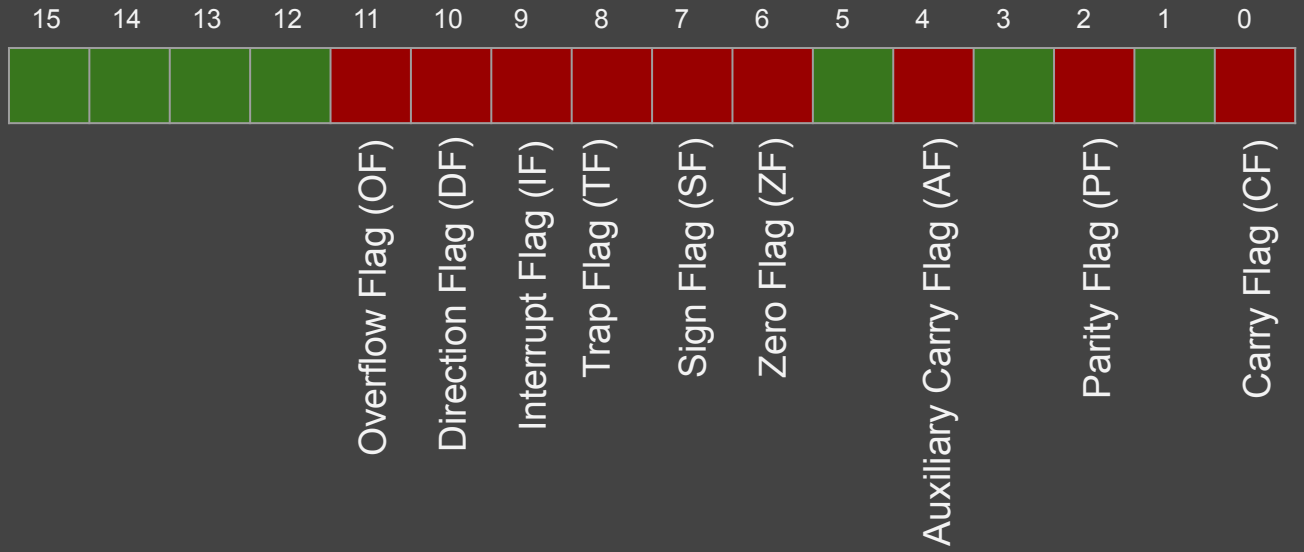
  call print_int
  call print_nl

  inc eax

  jmp loop1
```

infinite_loop.asm

Remember: the FLAGS Register



CF: carry flag
OF: overflow flag
SF: sign flag
ZF: zero flag

PF: parity flag
DF: direction flag
IF: interrupt flag

Conditional jumps

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

unsigned integer:

```
if (eax == ebx)
    esi = 0
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

unsigned integer:

```
if (eax == ebx)
    esi = 0
```

```
sub eax, ebx
jnz next

mov esi, 0

next:
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

signed integer:

```
if (eax == ebx)
    esi = 0
```

```
sub eax, ebx
jnz next

mov esi, 0

next:
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

signed integer:

```
if (eax == - ebx)
    edi = 4
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

signed integer:

```
if (eax == - ebx)
    edi = 4

add eax, ebx
jnz next

mov edi, 4

next:
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

unsigned integer:

```
if (eax >= ebx)
    esp -= 4
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

unsigned integer:

```
if (eax >= ebx)
    esp -= 4
```

```
sub eax, ebx
jc next

sub esp, 4

next:
```

JZ	Jump if ZF=1
JNZ	Jump if ZF=0
JO	Jump if OF=1
JNO	Jump if OF=0
JS	Jump if SF=1
JNS	Jump if SF=0
JC	Jump if CF=1
JNC	Jump if CF=0
JP	Jump if PF=1
JNP	Jump if PF=0

Practice

signed integer:

```
if (eax < ebx)
    ebp += 8
```

```
x - y
```

x < y	=>	SF = 1
x >= y	=>	SF = 0

Practice

signed integer:

```
if (eax < ebx)
    ebp += 8
```

```
x - y
```

OF=0	x < y => SF = 1 x >= y => SF = 0

Practice

signed integer:

```
if (eax < ebx)
    ebp += 8
```

`x - y`

`OF=0`	x < y => SF = 1 x >= y => SF = 0
`OF=1`	x < 0 < y => SF = 0 x > 0 > y => SF = 1

Practice

signed integer:

```
if (eax < ebx) ebp += 8
```

```
   sub eax, ebx
   jo  ovflow
   jns endl
if_cond:
   add ebp, 8
   jmp endl
ovflow:
   jns if_cond
endl:
```

x - y

OF=0	x < y => SF = 1 x >= y => SF = 0
OF=1	x < 0 < y => SF = 0 x > 0 > y => SF = 1

Practice

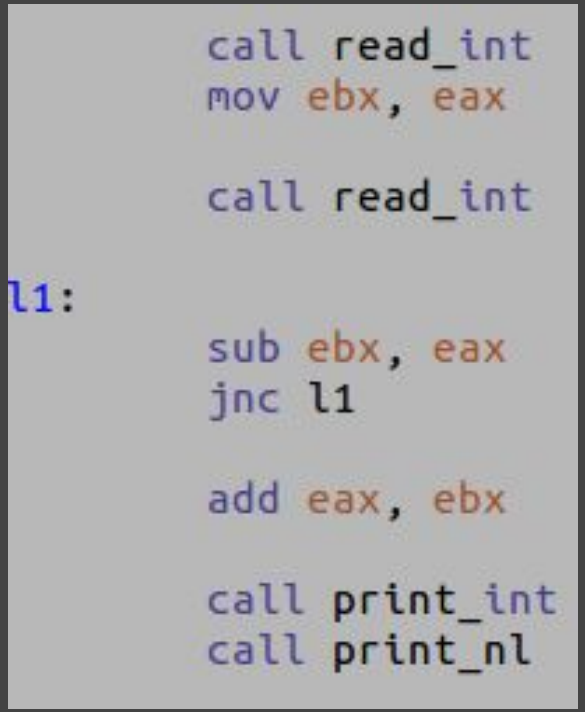
signed integer:

```
if (eax < ebx)
    ebp += 8
else
    ebp -= 8
```

x - y

OF=0	x < y => SF = 1 x >= y => SF = 0
OF=1	x < 0 < y => SF = 0 x > 0 > y => SF = 1

Practice:



```
        call read_int
        mov ebx, eax

        call read_int

l1:

        sub ebx, eax
        jnc l1

        add eax, ebx

        call print_int
        call print_nl
```

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Practice:

```
        call read_int
        mov ebx, eax

        call read_int

l1:
        sub ebx, eax
        jnc l1

        add eax, ebx

        call print_int
        call print_nl
```

32 bits

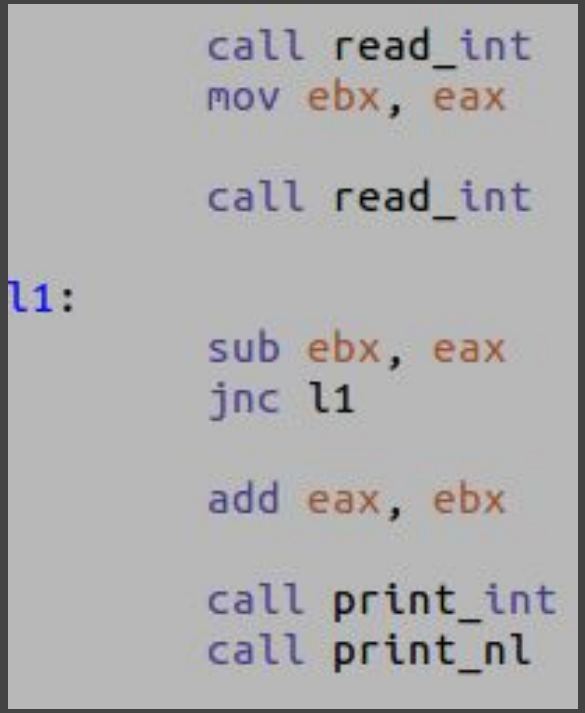
	binary
0	00000000000000000000000000000000
1	00000000000000000000000000000001
2	00000000000000000000000000000010
:	:
:	:
2^{32}-3	11111111111111111111111111111101
2^{32}-2	11111111111111111111111111111110
2^{32}-1	11111111111111111111111111111111

Other conditional jump commands

`sub x, y`

unsigned		signed	
`JE label`	jump if x == y (same as `JZ`)	`JE label`	jump if x == y (same as `JZ`)
`JNE label`	jump if x != y (same as `JNZ`)	`JNE label`	jump if x != y (same as `JNZ`)
`JA label` `JNBE label`	jump if x > y	`JG label` `JNLE label`	jump if x > y
`JB label` `JNAE label`	jump if x < y	`JL label` `JNGE label`	jump if x < y
`JAE label` `JNB label`	jump if x >= y	`JGE label` `JNL label`	jump if x >= y
`JBE label` `JNA label`	jump if x <= y	`JLE label` `JNG label`	jump if x <= y

Practice:



```
        call read_int
        mov ebx, eax

        call read_int

l1:

        sub ebx, eax
        jnc l1

        add eax, ebx

        call print_int
        call print_nl
```

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Practice:


```
        call read_int
        mov ebx, eax

        call read_int

l1:

        sub ebx, eax
        jnc l1

        add eax, ebx

        call print_int
        call print_nl
```

rem.asm

```
        call read_int
        mov ebx, eax

        call read_int

l1:

        sub ebx, eax
        jae l1

        add eax, ebx

        call print_int
        call print_nl
```

rem2.asm

Practice:


```
        call read_int
        mov ebx, eax

        call read_int

l1:

        sub ebx, eax
        jnc l1

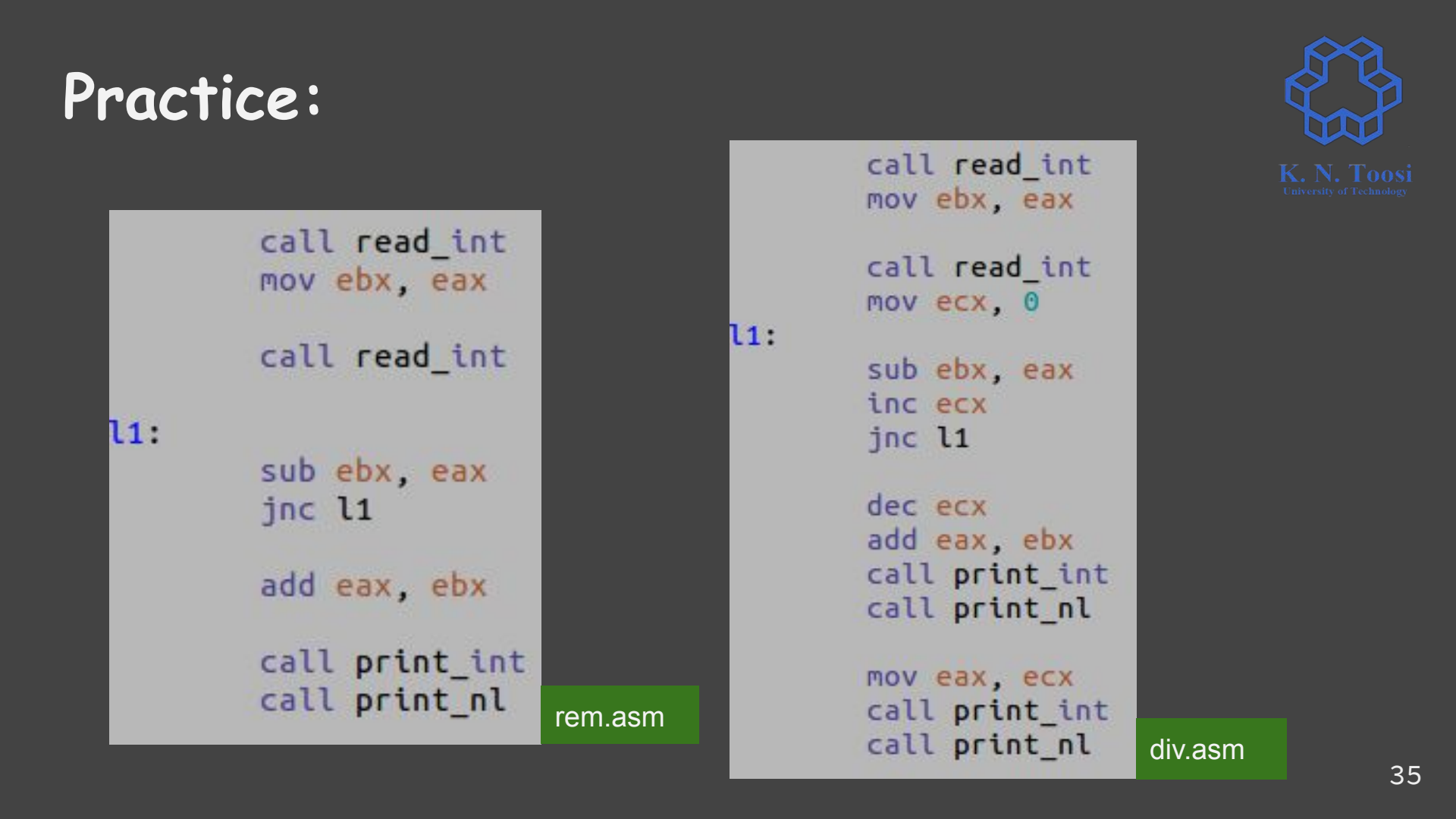
        add eax, ebx

        call print_int
        call print_nl
```

rem.asm

Practice: Also print quotient

Practice:




```
        call read_int
        mov ebx, eax

        call read_int

l1:

        sub ebx, eax
        jnc l1

        add eax, ebx

        call print_int
        call print_nl
```

rem.asm

```
        call read_int
        mov ebx, eax

        call read_int
        mov ecx, 0
l1:
        sub ebx, eax
        inc ecx
        jnc l1

        dec ecx
        add eax, ebx
        call print_int
        call print_nl

        mov eax, ecx
        call print_int
        call print_nl
```

div.asm

Practice:

```
        call read_int
        mov ecx, eax

        call read_int

        mov ebx, 0
l1:
        add ebx, eax

        dec ecx
        jnz l1

        mov eax, ebx
        call print_int
        call print_nl
```

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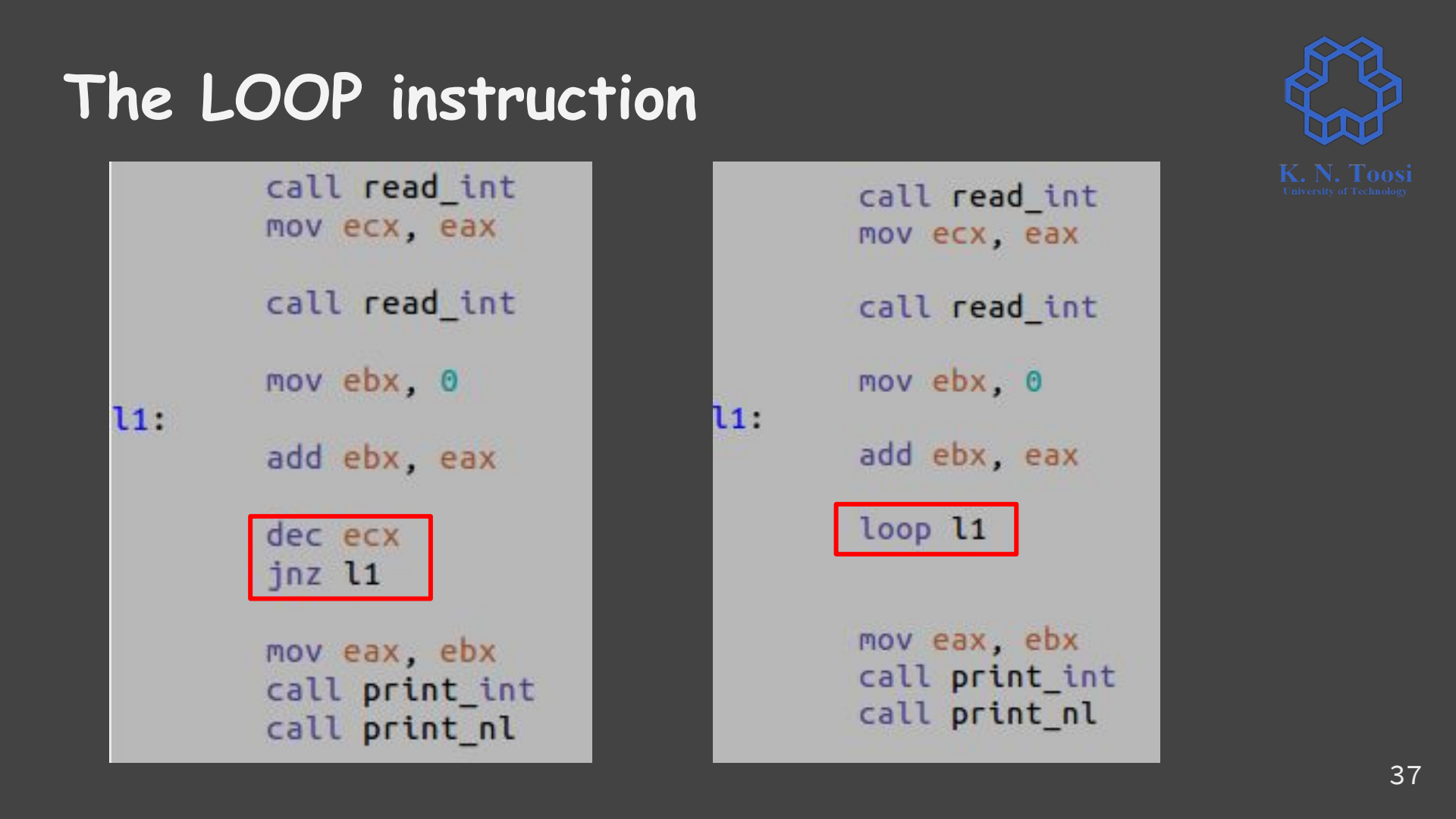
The LOOP instruction




```
        call read_int
        mov ecx, eax

        call read_int

        mov ebx, 0
l1:
        add ebx, eax

        dec ecx
        jnz l1

        mov eax, ebx
        call print_int
        call print_nl
```

```
        call read_int
        mov ecx, eax

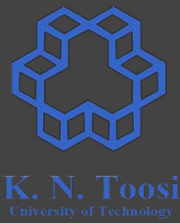
        call read_int

        mov ebx, 0
l1:
        add ebx, eax

        loop l1


        mov eax, ebx
        call print_int
        call print_nl
```

The loop commands




```
loop     lbl      ecx--; if (ecx!=0) goto lbl
loopz    lbl      ecx--; if (ecx!=0 && ZF=1) goto lbl
loopnz   lbl      ecx--; if (ecx!=0 && ZF=0) goto lbl
```

The loop commands


```
loop     lbl      ecx--; if (ecx!=0) goto lbl
loopz    lbl      ecx--; if (ecx!=0 && ZF=1) goto lbl
loopnz   lbl      ecx--; if (ecx!=0 && ZF=0) goto lbl

loope  ≡ loopz
loopne ≡ loopnz
```

Example: Count up to N


```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jnc l1
```

Example: Count up to N


```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jnc l1
```

```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jae l1
```

Example: Count up to N


```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jnc l1
```

```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jae l1
```

```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jge l1
```

using sub before jump; what's wrong?

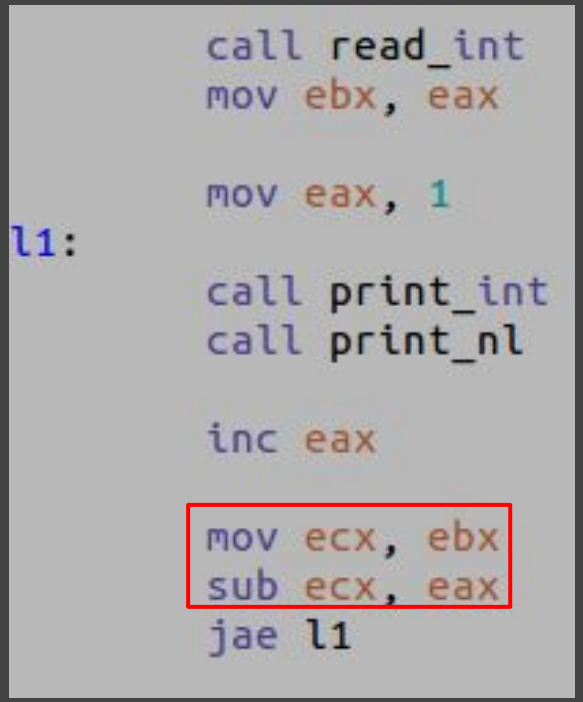

```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jae l1
```

the cmp instruction

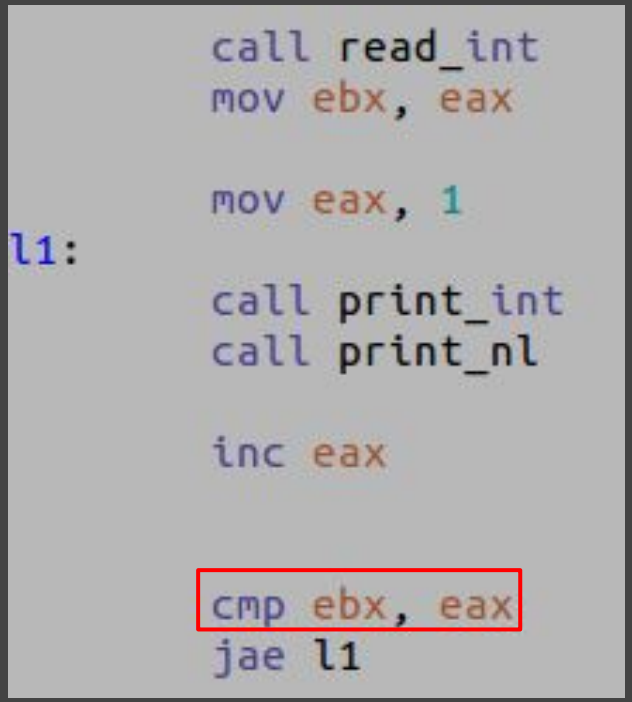


```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax

        mov ecx, ebx
        sub ecx, eax
        jae l1
```



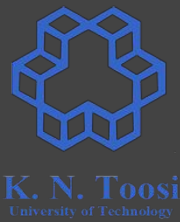
```
        call read_int
        mov ebx, eax

        mov eax, 1
l1:
        call print_int
        call print_nl

        inc eax


        cmp ebx, eax
        jae l1
```

The cmp instruction




```
sub eax, ebx
cmp eax, ebx
```

- `cmp x, y`
- subtracts y from x (like `sub x,y`)
- does not store the result (x is not changed)
- flags are set (as though a subtraction has taken place)

The cmp instruction

`cmp x, y`

unsigned		signed	
`JE label`	jump if x == y	`JE label`	jump if x == y
`JNE label`	jump if x != y	`JNE label`	jump if x != y
`JA label` `JNBE label`	jump if x > y	`JG label` `JNLE label`	jump if x > y
`JB label` `JNAE label`	jump if x < y	`JL label` `JNGE label`	jump if x < y
`JAE label` `JNB label`	jump if x >= y	`JGE label` `JNL label`	jump if x >= y
`JBE label` `JNA label`	jump if x <= y	`JLE label` `JNG label`	jump if x <= y

Practice

(signed)

```
if (eax > ebx)
    edi=1
else
    edi=2
```

Practice

(signed)

```
if (eax > ebx)
    edi=1
else
    edi=2
```

```
cmp eax, ebx
jle else_lbl
mov edi, 1
jmp endif

else_lbl:
  mov edi, 2

endif:
```

Practice

(signed)

```
if (eax > ebx)
    edi=1
else
    edi=2
```

```
cmp eax, ebx
jle else_lbl
mov edi, 1
jmp endif

else_lbl:
   mov edi, 2

endif:
```

executed at the same time?