Class 3

CSC 472 Software Security
X86 Assembly & Stack

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X86 ASM

MOV

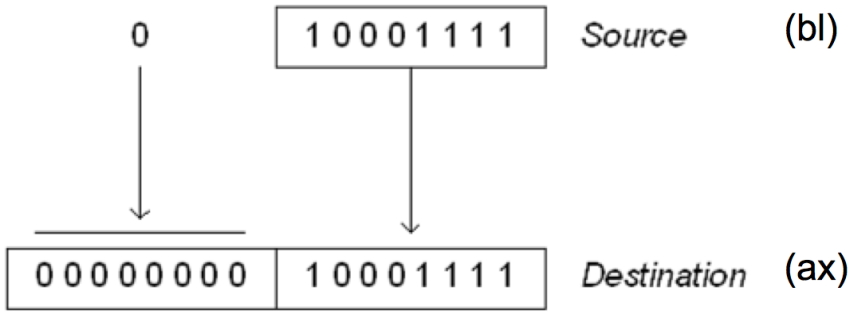
- Move **reg/mem** value to **reg/mem**
  - mov A, B is "Move B to A" (A=B)
  - Same data size

```
mov eax, 0x1337
mov bx, ax
mov [esp+4], bl
```

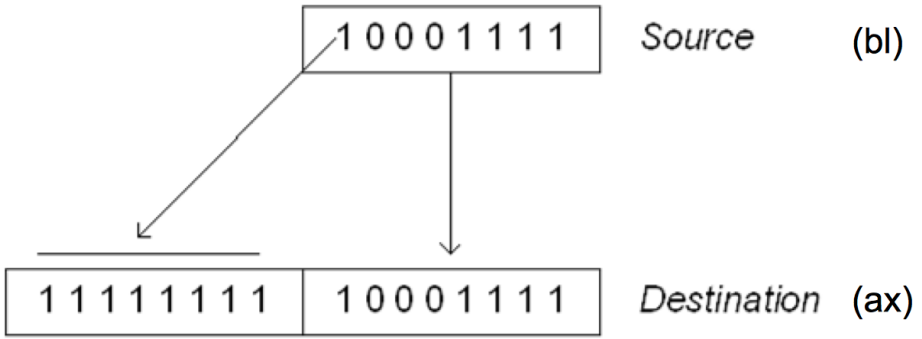
MOVZX / MOVSX

- From small register to large register
- Zero-extend (MOVZX) / sign-extend (MOVSX)
- Example: movzx ebx, al

When copy a smaller value into a larger destination, MOVZX instruction fills (extends) the upper half of the destination with zeros



MOVSX fills the upper half of the destination with a copy of the source operand's sign bit



More About Memory Access

- mov ebx, [esp + eax * 4] **Intel**
- mov (%esp, %eax, 4), %ebx **AT&T**
- mov BYTE [eax], 0x0f
  You must indicate the data size: BYTE/WORD/DWORD

ADD / SUB

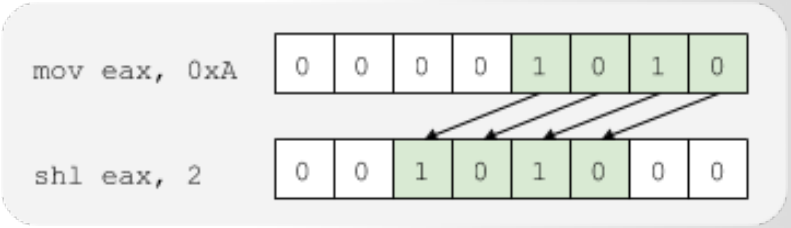
- ADD / SUB
- Normallly "reg += reg" or "reg += imm"
- Data size should be equal
  - ADD eax, ebx
  - sub eax, 123
  - sub eax, BL ; Illegal

INC / DEC

- **inc, dec** — Increment, Decrement
- The **inc** instruction increments the contents of its operand by one.
  The **dec** instruction decrements the contents of its operand by one.
- *Syntax*
  inc <reg>
  inc <mem>
  dec <reg>
  dec <mem>
- *Examples*
  DEC EAX — subtract one from the contents of EAX.
  INC DWORD PTR [var] — add one to the 32-bit integer stored at location *var*

SHL / SHR / SAR

- Shift logical left / right
- Shift arithmetic right
- Common usage: **SHL eax, 2** (when calculate memory address)



Jump

- Unconditional jump: jmp
- Conditional jump: je/jne
  and ja/jae/jb/jbe/jg/jge/jl/jle ...
- Sometime with ”cmp A, B” -- compare these two values and set eflags
- Conditional jump is decided by some of the eflags bits.

ref

The JMP Instruction

- JMP (jump) instruction causes an **unconditional jump**
- Syntax is:

JMP destination/target_label

- JMP can be used to get around the range restriction [126/127 byte]
- Flags – no change

```
TOP:

; body of the loop, say 2 instructions
DEC     CX      ; decrement counter
JNZ     TOP     ; keep looping if CX > 0
MOV     AX, BX
```

```
TOP:

; the loop body contains so many instructions
; that label TOP is out of range for JNZ. Solution is-
        DEC     CX
        JNZ     BOTTOM
        JMP     EXIT
BOTTOM:
        JMP     TOP
EXIT:
        MOV     AX, BX
```

Section 6-3: Assembly Language Programming

Unsigned and Signed Jumps.

Condition	Unsigned	Signed
source< dst	JB	JL
source<=dst	JBE	JLE
source≠dst	JNE(JNZ)	JNE(JNZ)
source= dst	JE(JZ)	JE(JZ)
source>=dst	JAE	JCE
source> dst	JA	JG

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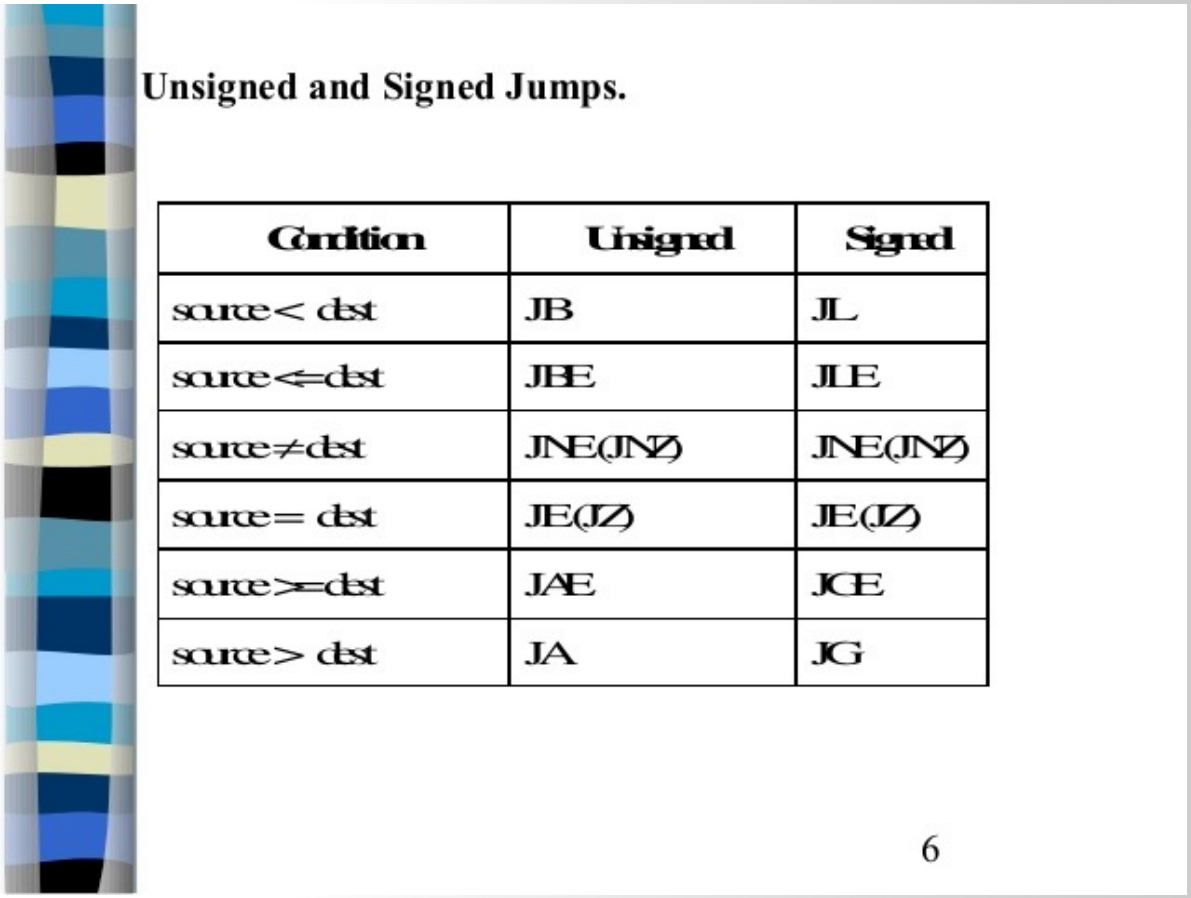
Jump

- ja/jae/jb/jbe are unsigned comparison
- jg/jge/jl/jle are signed comparison



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source≥dst	JAE	JGE
source> dst	JA	JG

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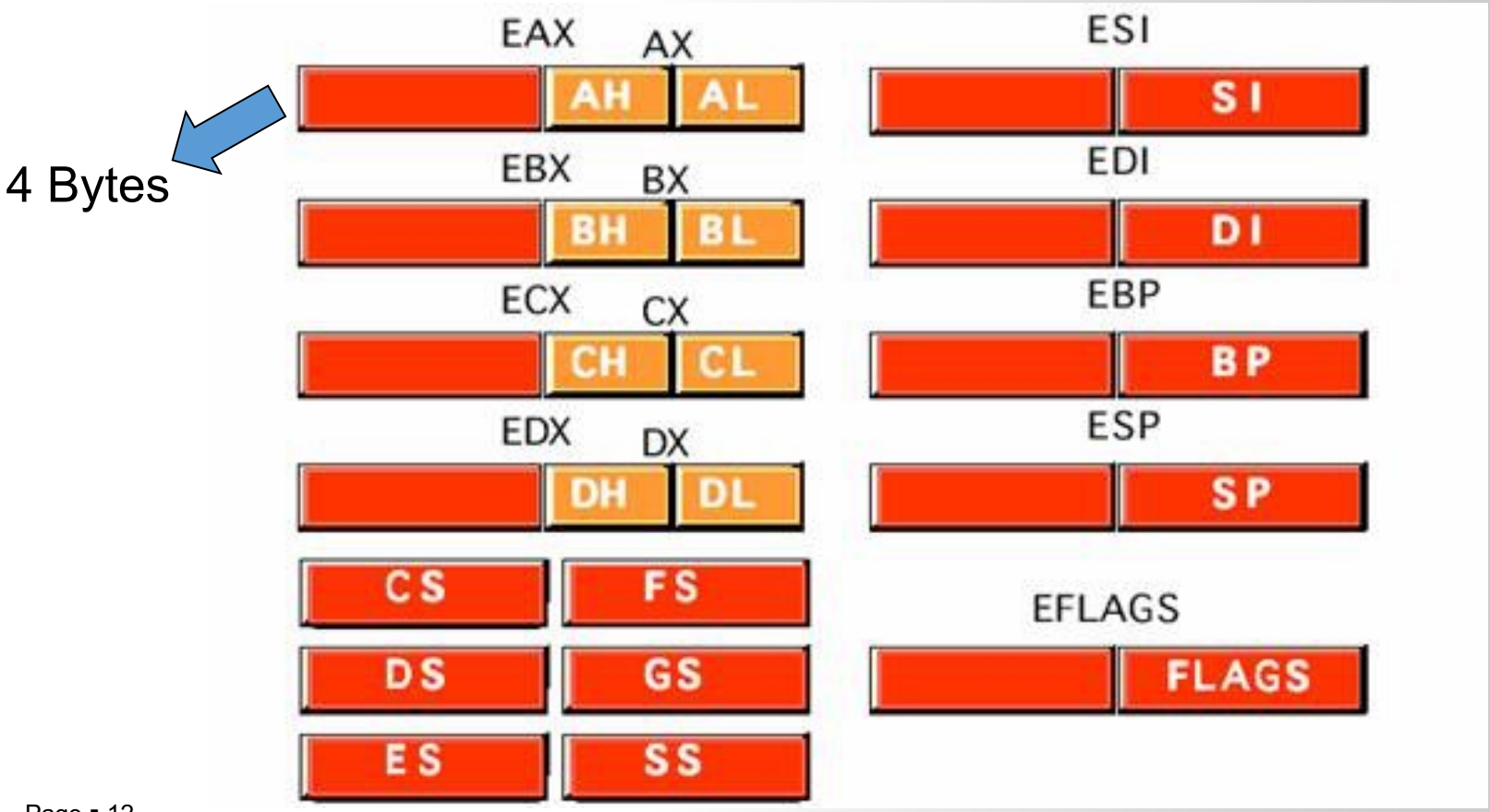
CMP

- **cmp** — Compare
- Compare the values of the two specified operands, setting the condition codes in the machine status word appropriately. This instruction is equivalent to the sub instruction, except the result of the subtraction is discarded instead of replacing the first operand. *Syntax*
  cmp <reg>,<reg>
  cmp <reg>,<mem>
  cmp <mem>,<reg>
  cmp <reg>,<con>
- *Example*
  cmp DWORD PTR [var], 10
  jeq loop
- If the 4 bytes stored at location *var* are equal to the 4-byte integer constant 10, jump to the location labeled *loop*.

General-purpose Registers

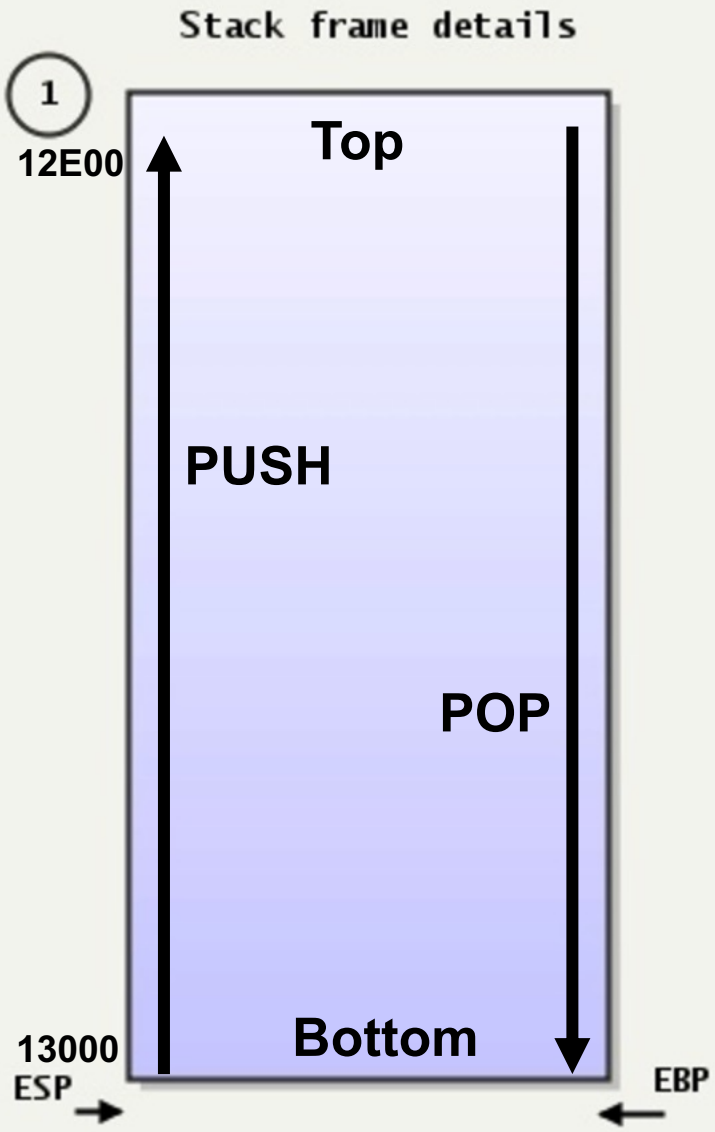
- The **eight** 32-bit general-purpose data registers are used to hold operands for logical and arithmetic operations, operands for address calculations and memory pointers



- ## Register
- + `esp` `ebp` `esi` `edi` - *DWORD (32-bit)*
- + `sp` `bp` `si` `di` - WORD (16-bit) - *rarely used*
- + \[esp, ebp\] - *mark the range of stack frame*
- + esi, edi - *used as buffer pointer, some instruction will directly handle esi, edi*

- ## Other Register
- + `eip` - *Program counter, pointing to the current line*
- + `eflags` - *cannot change the value directly, store the instruction result*
- + `cs` `ss` `ds` `es` `fs` `gs` - *segment register*

The Stack



Stack:

- A special region of your computer's memory that **stores temporary variables** created by each functions
- The stack is a "**LIFO**" (last in, first out) data structure
- Once a stack variable is freed, that region of memory becomes available for other stack variables.

Properties:

- the stack grows and shrinks as functions **push and pop** local **variables**
- there is no need to manage the memory yourself, variables are allocated and freed **automatically**
- the **stack has size limits**
- stack variables only exist while the function that created them, is running

EBP—Pointer to data on the stack
ESP—Stack pointer

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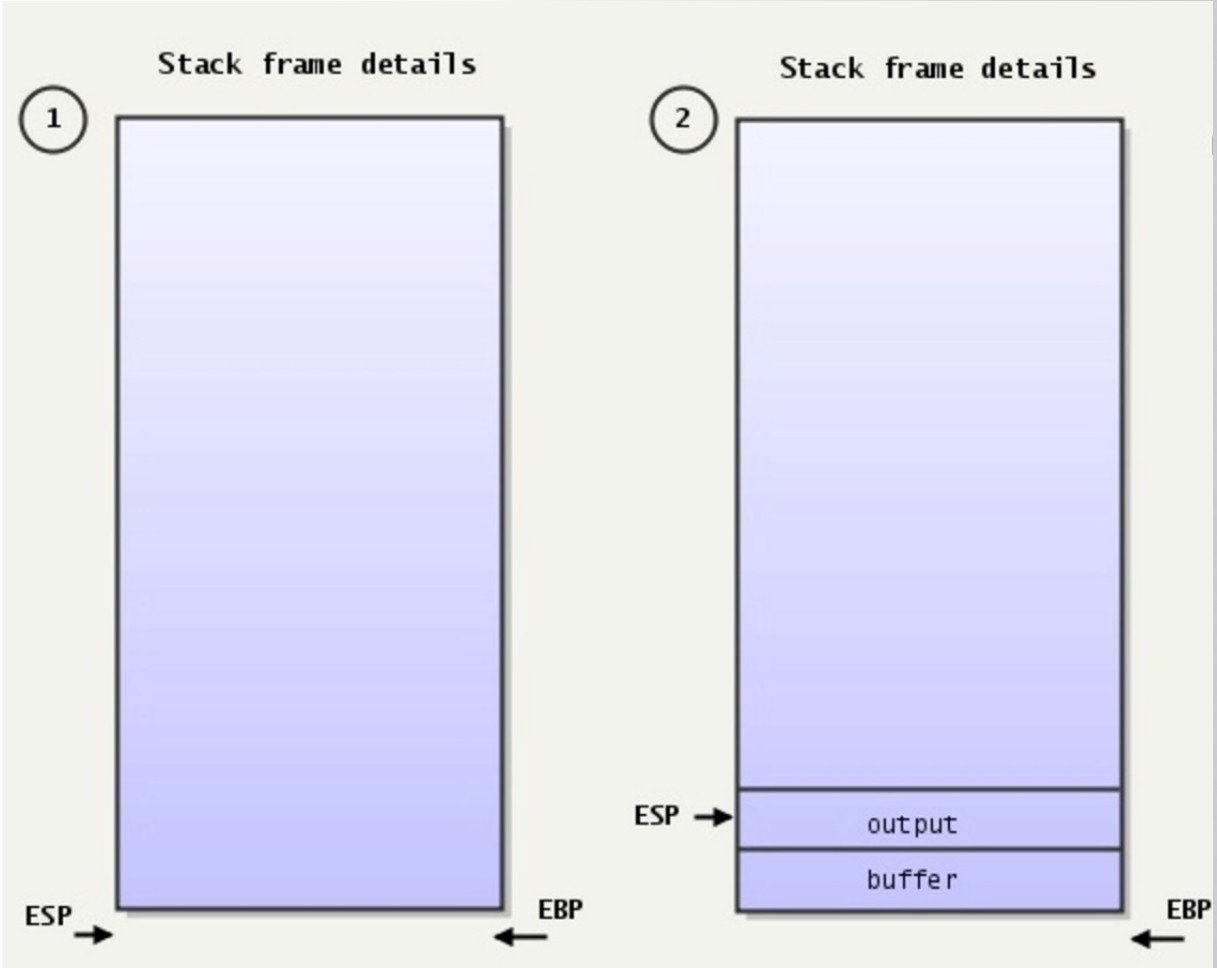

Q & A