Computer Organization and Assembly Language - Lab
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Branching

Branching is a basic concept in computer science. It means an instruction that tells a computer to begin executing a different part of a program rather than executing statements one-by-one.

Unconditional Jumps:

Unconditional jumps are taken when no comparison is done or is not needed but still still a jump is required.

Example: JMP [label]

CMP:

CMP is used in an instruction when we want to compare Destination with Source. In CMP, subtraction takes place. Source (SRC) is subtracted from Destination (DEST). It is mainly used when we want to take a jump based on the result.
Example: CMP DEST, SRC

Conditional Jumps:

The jumps taken on the basis of CMP instructions are known as Conditional Jumps. They are taken right after CMP instructions.

(in unsigned integers JUMP ABOVE (JA) or JUMP BELOW (JB) is used)
(in signed integers, JUMP GREATER (JG) or JUMP LESS (JL) is used)
(UDEST = unsigned destination, USRC = unsigned source, SDEST = signed destination, SSRC = signed source)

1. **JA/JNBE:**
   Jump if Above/Jump if Not Below or Equal

If the UDEST is greater than USRC, JA works.

Example:
mov ax, 10
CMP ax, 5
JA [label]

Because 10 is greater than 5 so jump is taken.

2. **JB/JNAE/JC:**
   Jump if Below/Jump if Not Above or Equal/Jump if Carry (if Carry Flag is set)
   If the UDEST is less than USRC, jump is taken.

   Example:
   mov ax, 5
   CMP ax, 10
   JB [label]

   Because 5 is less than 10 so jump is taken.

3. **JE/JZ:**
   Jump if Equal/Jump if Zero (if Zero Flag is set)
   If the DEST is equal to SRC, jump is taken.

   Example:
   mov ax, 10
   CMP ax, 10
   JE [label]

4. **JG/JNLE:**
   Jump if Greater/Jump if Not Less or Equal
   If the SDEST is greater than SSRC, a jump is taken.

   Example:
   mov ax, -5
   CMP ax, -10
   JG [label]

   Because -5 is greater than -10 so jump is taken.

5. **JL/JNGE:**
   Jump if Less/Jump if Not Greater or Equal
   If the SDEST is less than UDEST, jump is taken.

   Example:
   mov ax, -10
   CMP ax, -5
   JL [label]

   Because -10 is less than -5 so jump is taken.

6. **JC:**
   Jump if Carry
   If Carry Flag is set i.e. CF = 1, jump is taken.

7. **JZ:**
   Jump if Zero
   If Zero Flag is set i.e. ZF = 1, jump is taken.

8. **JO:**
   Jump if Overflow
   If Overflow Flag is set i.e. OF = 1, jump is taken.

9. **JS:**
   Jump if Sign
   If the last arithmetic operation produced some negative integer as a result, Sign Flag is set i.e. SF = 1 so a jump is taken on the basis of that.

10. **JP/JPE:**
    Jump if Parity/Jump if Parity Even
    If the last arithmetic operation produced some result that has even parity then Parity Flag is set i.e. PF = 1, so a jump is taken on the basis if that.

11. **JCXZ:**
    Jump if CX is Zero
    If the CX register has 0 in it, a jump is taken.

NOTE: There are more conditional jumps than covered above so explore this world yourself.

Flags

UDEST/SDEST = USRC/SSRC If UDEST/SDEST and USRC/SSRC are the same the result is zero so Zero Flag is set.

Example:
move ax, 5
CMP ax, 5 ZF = 1

UDEST < USRC If UDEST is less than USRC then a borrow is needed which sets Carry Flag.

Example:
mov ax, 2
CMP ax, 5 CF = 1

UDEST > USRC If UDEST is greater than USRC then Carry Flag will be 0 because no borrow is needed.

Example:
mov ax, 10
CMP ax, 5 CF = 0

SDEST < SSRC If SSRC is subtracted from a SDEST and the result is negative with no overflow then the destination is smaller than the source. If however there is an overflow meaning that the sign has changed unexpectedly, the meanings are reversed and a positive number signals that the destination is smaller.

Example:

mov ax, -5
CMP ax, -2 SF != CF

SDEST > SSRC If SDEST is greater than SSRC then Overflow Flag will be equal to Sign Flag and Zero Flag will be 0.

Example:
mov ax, 10
CMP ax, 5 OF = SF AND ZF = 0

NOTE: There are some other conditions as well. For example UDEST <= USRC. Read them yourself.
