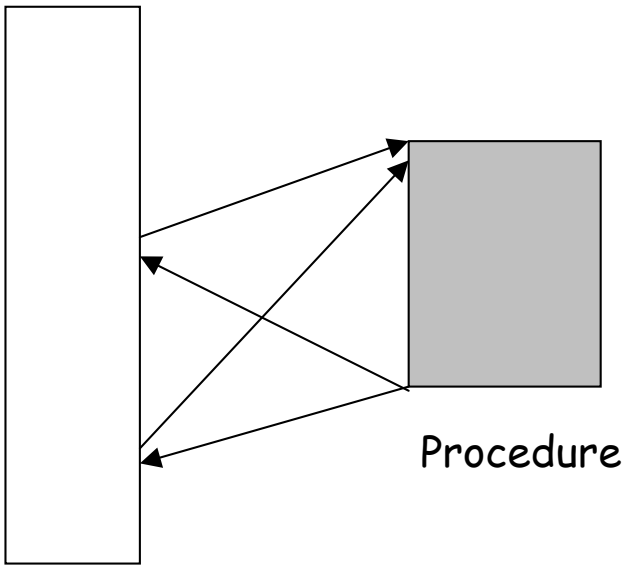
Procedure Call

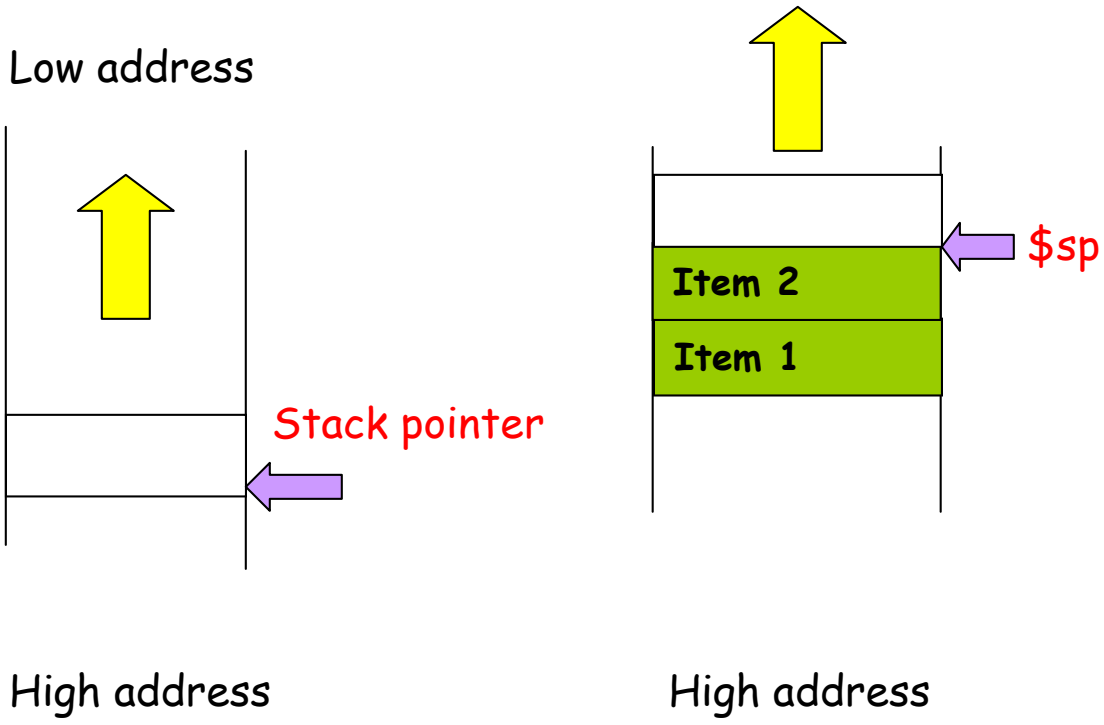


Typically procedure call uses a stack. What is a stack?

Question. Can't we use a jump instruction to implement a procedure call?

The stack

Occupies a part of the main memory. In MIPS, it grows from high address to low address as you push data on the stack. Consequently, the content of the stack pointer ($sp) decreases.



Use of the stack in procedure call

Before the subroutine executes, save registers (why?).

Jump to the subroutine using jump-and-link (jal address)

(**jal address** means **ra ← PC+4; PC ← address**) For MIPS, (ra=r31)

After the subroutine executes, restore the registers.

Return from the subroutine using jr (jump register)

(**jr ra** means **PC ← (ra)**)

Example of a function call

```
int leaf (int g, int h, int i, int j)
{
        int f;
        f = (g + h) - (i + j);
        return f;
}
```

The arguments g, h, i, j are put in $a0-$a3.

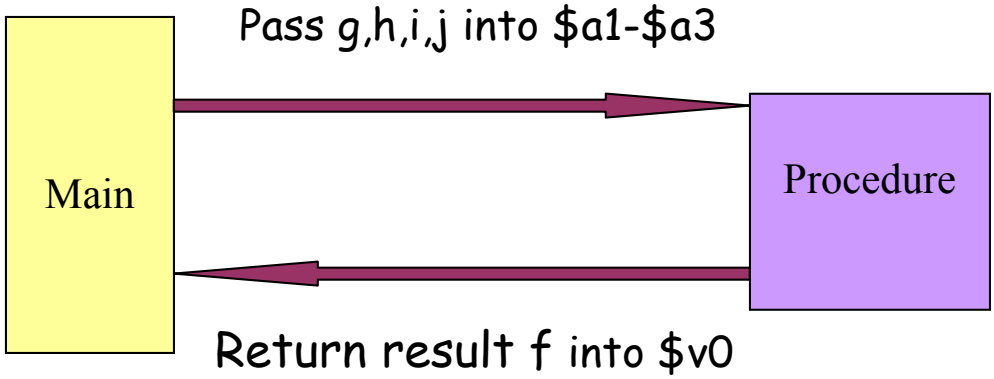
The result f will be put into $s0, and returned to $v0.

The structure of the procedure

```
Leaf:   addi $sp, $sp, -12   # $sp = $sp-12, make room
        sw $t1, 8($sp)       # save $t1 on stack
        sw $t0, 4($sp)       # save $t0 on stack
        sw $s0, 0($sp)       # save $s0 on stack
```

The contents of $t1, $t0, $s0 in the main program will not be overwritten. Now we can use them in the body of the function.

```
        add $t0, $a0, $a1    # $t0 = g + h
        add $ t1, $a2, $a3   # $t1 = i + j
        sub $s0, $t0, $t1    # $s0 = (g + h) – (i + j)
```



Return the result into the register $v0

```
add $v0, $s0, $zero      # returns f = (g+h)-(i+j) to $v0
```

Now restore the old values of the registers by popping the stack.

```
lw $s0, 0($sp)       # restore $s0
lw $t0, 4($sp)       # restore $t0
lw $t1, 8($sp)       # restore $t1
addi $sp, $sp, 12    # adjust $sp
```

Finally, return to the main program.

```
jr $ra               # return to caller.
```