Stacks

October 13

CSC201 Section 002

Fall, 2000

Stack Uses

- Saving and restoring register values
- Saving return addresses for procedure calls
- Passing parameters to/from procedures
- Allocating memory dynamically

Stack Access

- Access is last-in-first-out (LIFO)
  - One use: reversing the order of an array of elements
  - Example: digits produced during base conversion
- Use "push" to store onto stack
- Use "pop" to retrieve and remove from stack

Stack Organization

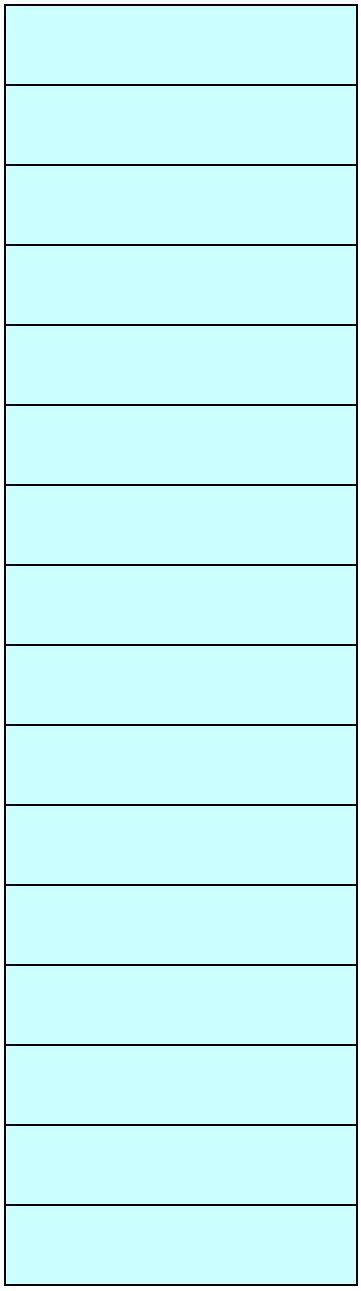
- The stack location in memory
  - allocated with the "stack" directive
- Direction of stack growth is "upwards" (towards lower-numbered addresses)
- The ESP register points to the "top" of stack
  - "points to" means "contains the address of"
  - initially, just below the start of the stack (i.e., there is no top)
  - this initialization is done by the linker/loader automatically
- The EBP register is also used to point to a portion of the stack
  - Usually, the location of subroutine parameters

The Push Operation

- Instruction: "push operand"
- First, decrements ESP by 4
- Then copies operand (doubleword or byte) to m(ESP)
  - This is a form of (implicit) register indirect addressing
- "operand" may be memory or register or immediate value

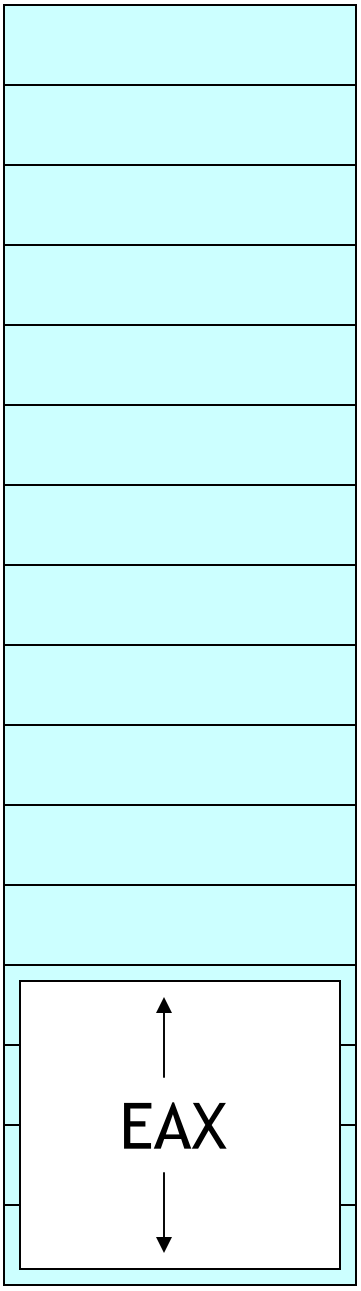
Example

Stack area
in memory



SP →

Empty

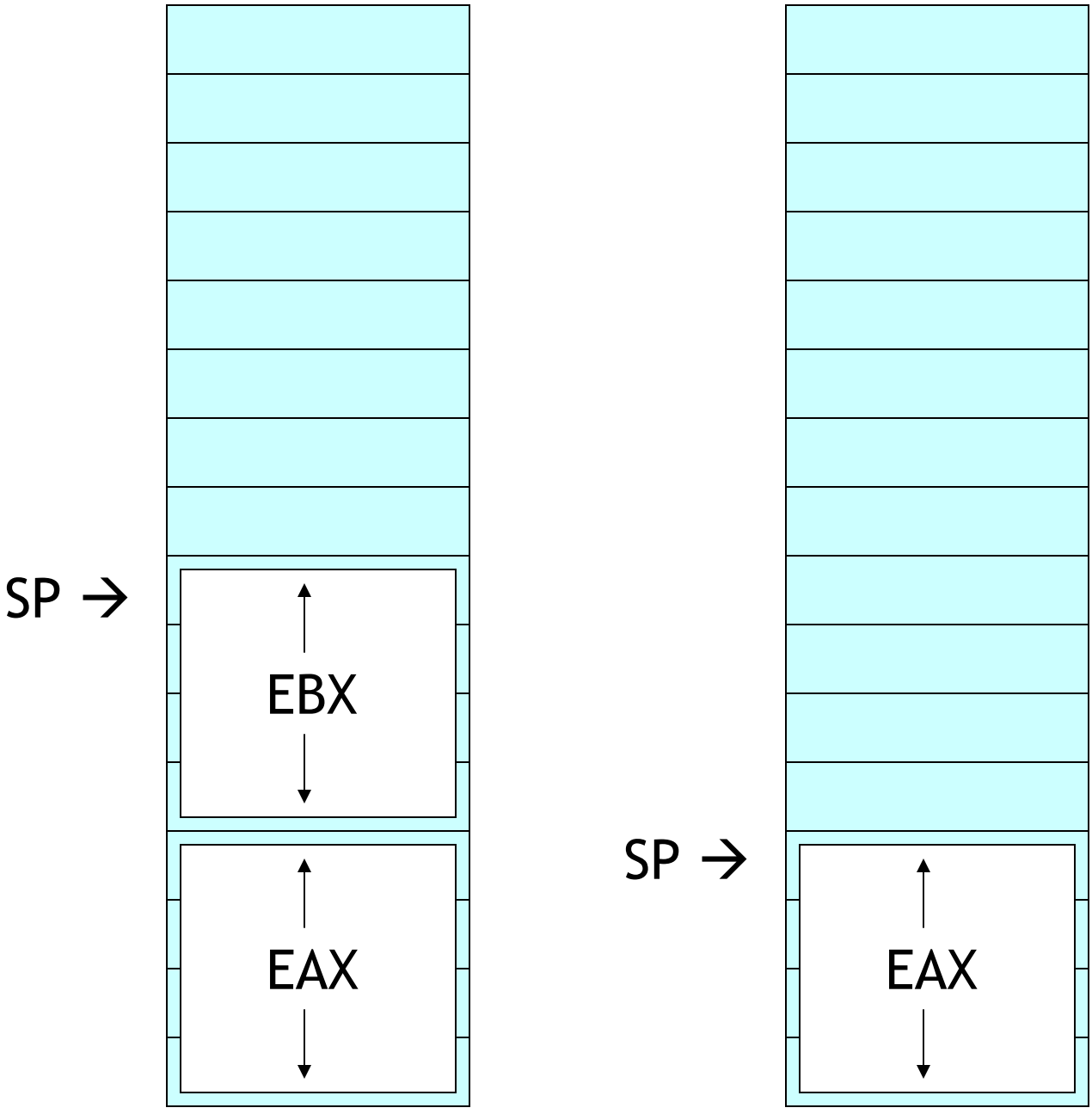


after “push EAX”

The POP Operation

- Instruction: "pop operand"
- First, copies doubleword (or byte) at m(ESP) into operand
- Then increments ESP by 4

Example



After 2 pushes

after “pop oper1”

Details (PUSH and POP)

- No effect on flags
- Little-endian ordering of bytes within a doubleword on the stack
- There must be a POP for every PUSH
  - Make sure they are in reverse order!

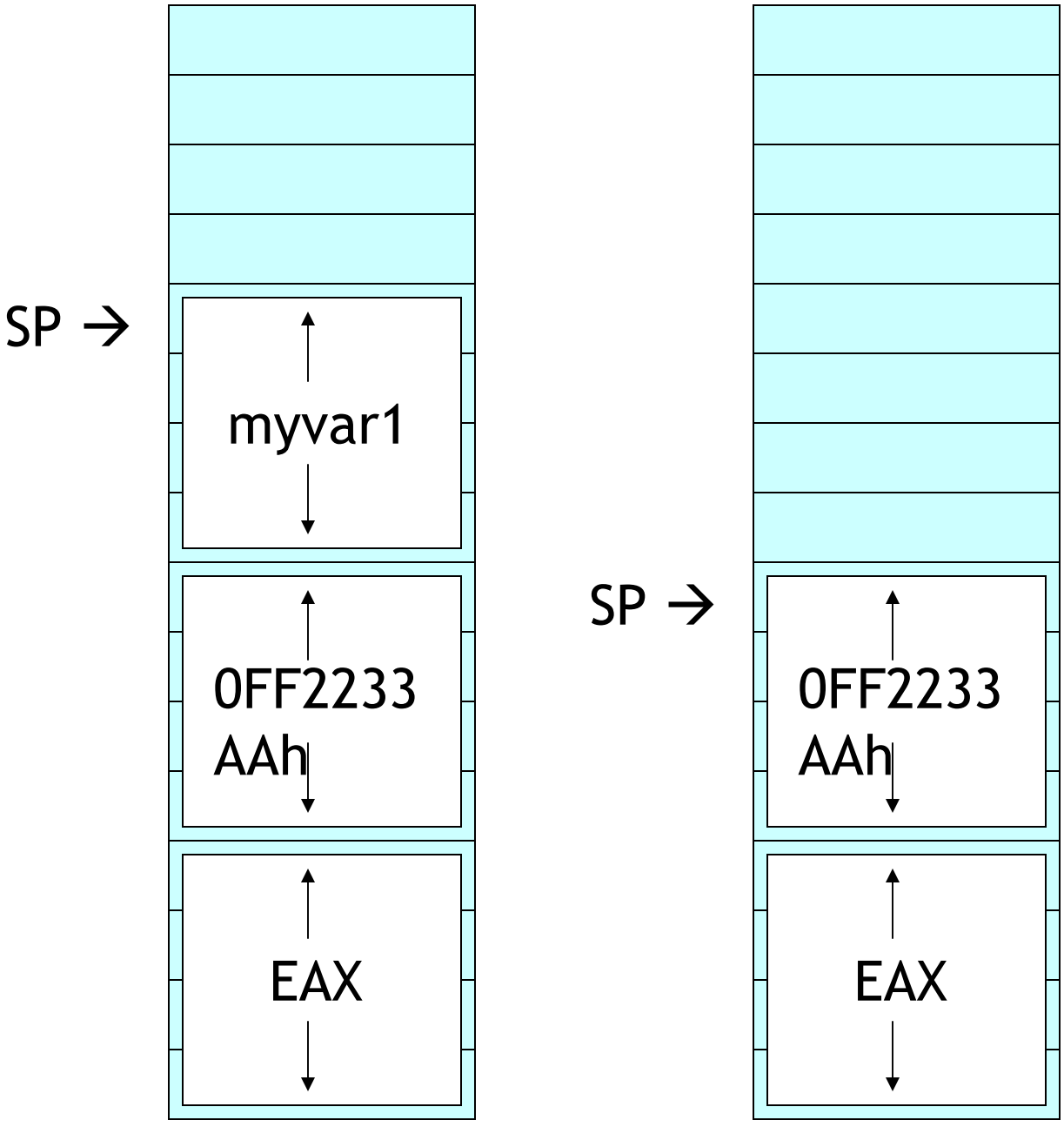
"Empty" and "Full" Stacks

- Empty stack: ESP points just below the first element of the stack
  - POP is an error on empty stack; check first!
- Full stack: ESP points to the top (lowest-numbered) storage location allocated for the stack
  - PUSH is an error on a full stack; check first!

Examples of Stack Use

```
.stack          1000h           ; 4096 bytes =
                                ; 1024 doublewords
...
        push    EAX
        push    0FF2233AAh
        push    myvar1
...
        pop     EBX
        pop     [dword myvar4]
        pop     EAX
```

Example



after 3 pushes

after first pop

Checking for Full and Empty

```
Bottom_of_stack     dd      ?
Top_of_stack        dd      ?
…
        mov     bottom_of_stack, ESP
        mov     top_of_stack, ESP
        iadd    top_of_stack, 1000h
        …
        compare         ESP, bottom_of_stack
        bgez            stack_empty_dont_pop
        …
```

Checking (cont.)

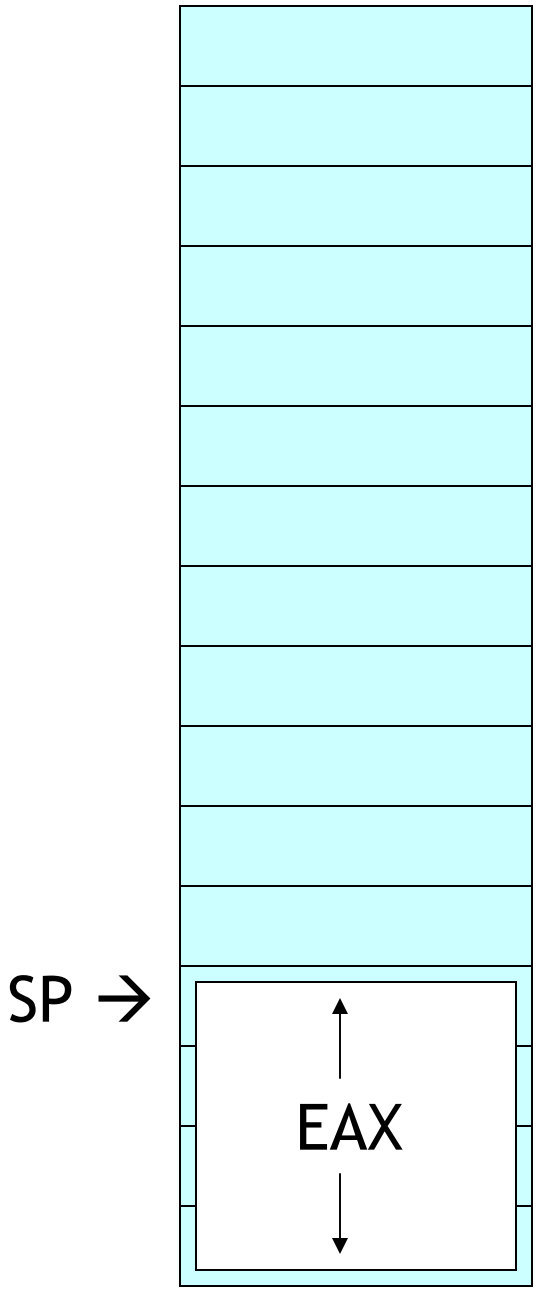
```
        …
        compare     ESP, top_of_stack
        blez        stack_full_dont_push
        …
```

Dynamic Memory Allocation

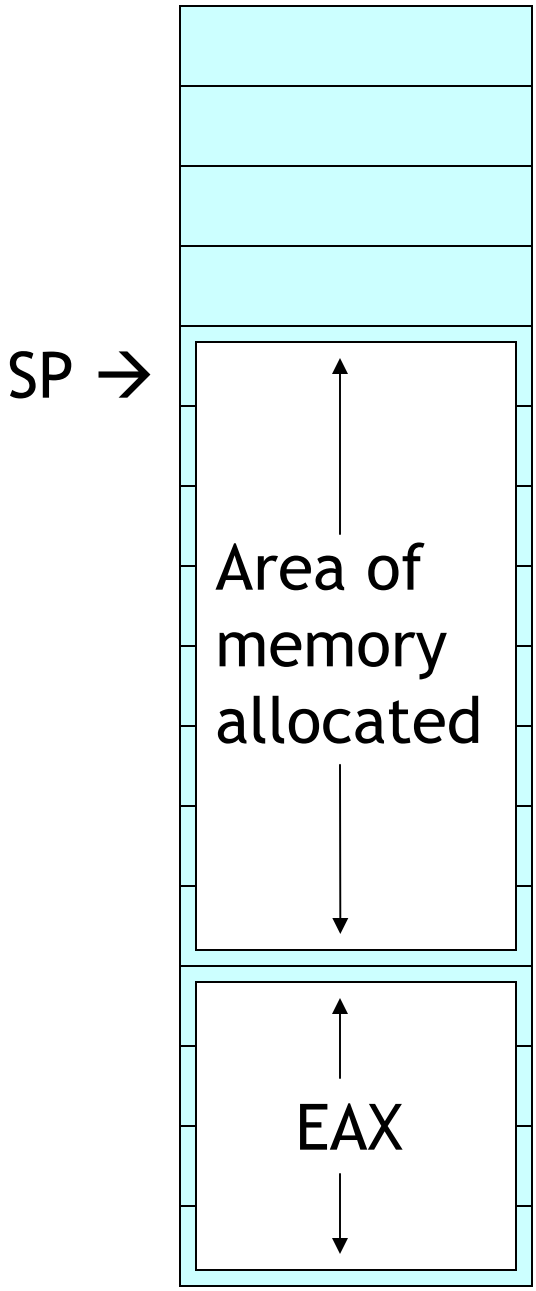
- Goal: set aside "n" bytes of storage for temporary use...
- First copy ESP into EBP
- Then subtract "n" from ESP
- Refer to (I.e., address) an element in this area of memory using...
  - based-indexed (or based-displacement) addressing mode
  - with EBP as the base register
  - displacement will be negative!

Dynamic Allocation Example

```
mov    EBP, ESP
isub   ESP, num_bytes_to_allocate
```



Before dynamic allocation



after dynamic allocation

Warning!

- After "popping" an element from the stack, don't count on it's value still being there later!

Some Clarifications

- Push
  - Can push a byte-length immediate value
  - (Can push from a word-length register, or a word from memory, or a word-length immediate value)
  - Can push from a double-word length register, or a double-word from memory, or a double-word length immediate value
- Pop
  - Cannot pop byte-length operands
  - (Can pop to a word-length register, or a word to memory)
  - Can pop to a double-word length register, or a double-word to memory