Lecture 14:
Stack

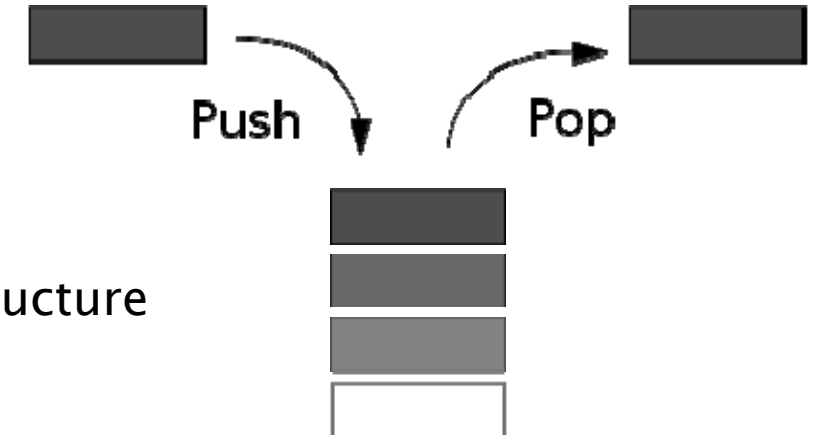
Today's Goals

- Learn how HCS12 stack functions

What is the Stack?

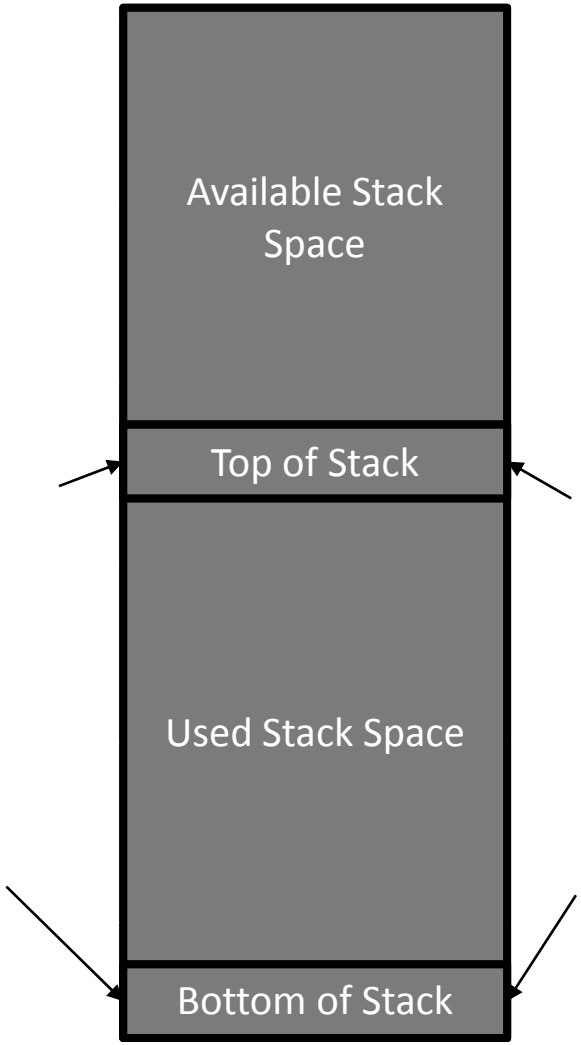
Last in, First out (LIFO)

- The stack is a last-in, first-out (LIFO) data structure.
- Two fundamental operations
  - Push: add to the top of the list
  - Pop/Pull: removes an item from the top of the list.
- Temporary variable storage
  - When subroutines are called.
- Think books stacked on a table
- c.f. Queue
  - First-in, first-out (FIFO) data structure



The Stack

Memory diagram of a stack



Important Concepts about Stacks

- A regular RAM section will be used. No hardware enforces this boundary.
- Much like variable-length array
- The stack grows toward lower addresses when a value is added.
- SP (Stack Pointer register) holds the address of the current index of the stack.
  - SP moves up (decrements) when an item is added
  - SP moves down (increments) when an item is removed
  - Note: Addition/Removal happens after SP moves up/down
  - All bytes in the stack space that are located at addresses lower than SP are considered unused

Important Concepts about Stacks

- Depth:
  - the number of bytes stored on the stack
- Empty:
  - If the depth is 0, we say the stack is **empty**.
- Underflow
  - Removing a byte from an empty stack
- Overflow
  - The depth is larger than the available stack space

Manipulating the Stack and SP

Adding/Removing an item to a stack

- PSHx
  - Push an item to the stack
  - X: A, B, C(CCR), D, X, Y
  1. S register is first decremented by the number of bytes to be pushed,
  2. then the value from the register is copied into the memory indicated by S.

- PULx
  - Pull or Pop an item from the stack
  - X: A, B, C(CCR), D, X, Y
  - One or two bytes (depends on the size of the register) at the top of the stack is/are copied into the specified register,
  - then S is incremented

- Note: PSHx and PULx (except for PULC) do not affect on CCR bits

- Again, there is no separate space for the stack. The stack is just a chunk of RAM. S register holds the current position.

Manipulating the Stack and SP

- LDS
  - Load the stack pointer
  - Typically use only immediate addressing mode.
  - Typically initialize the pointer at the beginning of a program.
- LEAS
  - Remember LEAX and LEAY?
  - Load Effective Address into S register
  - This is useful to manipulate stack pointer without pushing/popping values.
  - With negative offsets, create space on the top of the stack
  - With positive offsets, removes data from the top of the stack

Examples

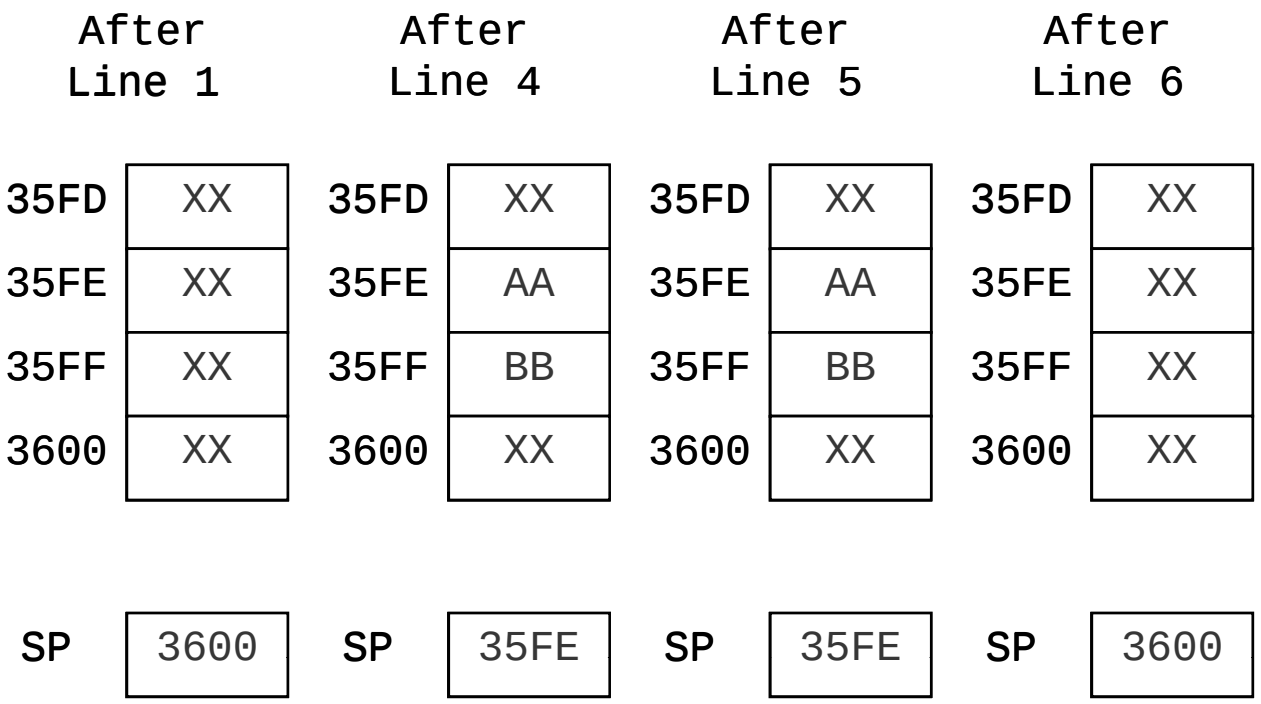
Example 1

```
1:  LDS   #$3600
2:  LDAA  #$AA
3:  LDAB  #$BB
4:  PSHA
5:  PSHB
6:  PULA
7:  PULB
```

Examples

Example 2

```
1: LDS  #$3600
2: LDAA #$AA
3: LDAB #$BB
4: PSHD
5: LDD  #$CCDD
6: LEAS 2,SP
```



Questions?

Wrap-up

What we've learned

- Stack
- PUSx, PULx, LDS, LEAS

What to Come

- Subroutines