Lecture 17:
More on Subroutines

Today’s Goals

- Return subroutine output using the stack
- Review the full structure of stack frames

Returning Data by Value using the Stack

- In the previous subroutine examples, the subroutines returned a single value in a register.
- The stack can be used to return a value.

Example

Returning data by value using the stack

- Write a subroutine that meets the following requirements.
  - The subroutine adds two 2-byte signed numbers
  - If the sum is less than -2000, the subroutine returns -2000.
  - If the sum is greater than 3000, the subroutine returns 3000.
  - The numbers to add and the result are all passed on the stack.

Example

Returning data by value using the stack

Returning Data by Reference

- Usually, subroutines only return one object when they need to do.
- The returning object may have multiple pieces.
- The result is passed by reference.
  - The subroutine still only returns one item.
- The caller is responsible for creating space for the result.
  - The caller makes space.
  - The caller then passes the address of the result as an input.
  - The subroutine changes values in the allocated space.
  - Hum… the subroutine doesn't technically return something. Right?

Example

Return data by reference

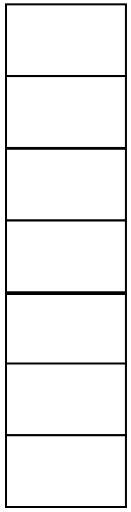
- Write a subroutine that meets the following requirements.
  - The subroutine finds the minimum and maximum values in an array of unsigned numbers.
  - The address of the array is the first item passed on the stack.
  - The length of the array is a one byte value passed as the second parameter on the stack.
  - The subroutine returns a two-byte array on the stack where the first byte is the minimum value and the second byte is the maximum value.
  - The subroutine passed a minimum value higher that the maximum value if the length is zero.

Example

Returning data by value using the stack

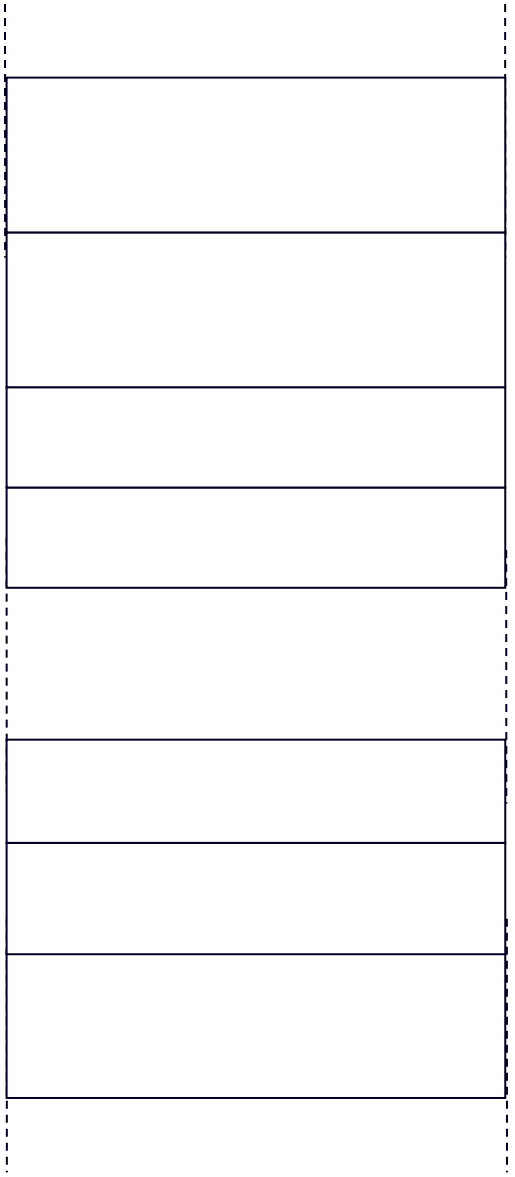
```
        ORG     $3000
Array   DC.B    $34, $98, $11, $DF
Length  DC.B 4
Result  DS.B    ; minimum value
        DS.B    ; maximum value

        ORG     $2000
        LDS     #$3600
        LDD     #Result
        PSHD
        LDAB    Length
        PSHB
        LDD     #Array
        PSHD
        JSR     MinMax
        LEAS    3,SP
        PULX
        SWI
```

Stack Frame



Stack Frames

- This diagram shows the relative position of items in a stack frame.



Questions?

Wrap-up

What we've learned

What to Come