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