

Review Problem 5

❖ In assembly, replace the value in X0 with its absolute value.

```
CMP X0, X31  
B.GE WAS_POP_NEGATIVE // B.GE  
SUB X0, X31, X0 // X0 = -X0
```

WAS_POP_NEGATIVE:

Loop Example

Compute the sum of the values 0...N-1

```
int sum = 0;
for (int I = 0; I != N; I++) {
    sum += I;
}
```

// X0 = N, X1 = sum, X2 = I

① ADD X1, X31, X31 // sum=0
② ADD X2, X31, X31 // I=0

TOP:

CMP X2, X0 // check I us N
B.EQ END // end when ~~I~~ I == N
ADD X1, X1, X2 // sum += I
ADDI X2, X2, #1 // I++
B TOP // Next iteration

END:

① ADD X1, X31, X31
② ADD X2, X31, X31
B TEST

TOP:

① ADD X1, X1, X2
② ADDI X2, X2, #1

TEST:

CMP X2, X0
B.NE TOP

String to Upper

Convert a string to all upper case

```
char *index = string;
while (*index != 0) { /* C strings end in 0 */
    if (*index >= 'a' && *index <= 'z')
        *index = *index + ('A' - 'a');
    index++;
}
```

// string is a pointer held at Memory[80].
// X0=index, 'A' = 65, 'a' = 97, 'z' = 122

LDUR X0, [X31, #80] // index = string

Loop: LDURB X1, [X0, #0] // load byte *index

CBZ X1, END // exit loop if *index == 0

CMPI X1, #97 // is *index < 'a'?

// don't update if < 'a'

B.LT NEXT

// is *index > 'z'?

CBPI X1, #122 // don't update if > 'z'

// compute *index + ('A' - 'a')

SUBI X1, X1, #32 // *index = new value

STURB X1, [X0, #0]

NEXT:

ADDI X0, X0, #1

B Loop

// index++
// continue the loop



Machine Language vs. Assembly Language

Assembly Language	Machine language
mnemonics for easy reading	Completely numeric representation
labels instead of fixed addresses	format CPU actually uses
Easier for programmers	
Almost 1-to-1 with machine language	

SWAP:

LSL	X9, X1, #3		11010011011 00000 000011 00001 01001
ADD	X9, X0, X9	// Compute address of v[k]	100010111000 01001 000000 00000 01001
LDUR	X10, [X9, #0]	// get v[k]	11111000010 000000000 00 01001 01010
LDUR	X11, [X9, #8]	// get v[k+1]	11111000010 000001000 00 01001 01011
STUR	X11, [X9, #0]	// save new value to v[k]	11111000000 000000000 00 01001 01011
STUR	X10, [X9, #8]	// save new value to v[k+1]	11111000000 000001000 00 01001 01010
BR	X30	// return from subroutine	11010110000 00000 000000 00000 111110