CSSE 132 – Introduction to Computer Systems
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ARM vs. C — Some examples

1 Simplified Examples

These examples assume all the variable data are stored in registers. This is not usually the case, but this helps illustrate basic C structures.

1.1 `main` function

```c
int main() {
  int x = 13;
  int y = 14;
  return x + y;
}
```

```
main:
  mov r2, #13
  mov r3, #14
  add r0, r2, r3
  bx lr
```

1.2 `if` statement

```c
x = 10;

if ( x > 0 ) {

   x = x - 1;
}
```

```
  mov r3, #10     @ r3 holds 'x'
.BEGINIF:
  cmp r3, #0
  ble .ENDIF      @ x>0 = !(x<=0)
  sub r3, r3, #1
.ENDIF:
```

1.3 `if/else` statement

```c
x = 10;

if ( x > 0 ) {

   x = x - 1;

} else {
   x = x + 1;
}
```

```
  mov r3, #10     @ r3 holds 'x'
.BEGINIF:
  cmp r3, #0
  ble .ELSE       @ x>0 = !(x<=0)
  sub r3, r3, #1
  b .ENDIF
.ELSE:
  add r3, r3, #1
.ENDIF:
```

1.4 `do/while` loop

```
1 x = 10;
2 do {
3    x = x - 1;
4 }
5 while ( x > 0 );
```

```
1   mov r3, #10     @ r3 holds 'x'
2 .LOOP:
3   sub r3, r3, #1
4   cmp r3, #0
5   bgt .LOOP
6 .ENDLOOP:
```

1.5 `while` loop

```
1 x = 10;
2
3 while ( x > 0 ) {
4
5    x = x - 1;
6 }
```

```
1   mov r3, #10     @ r3 holds 'x'
2 .LOOP:
3   cmp r3, #0
4   ble .ENDLOOP
5   sub r3, r3, #1
6   b .LOOP
7 .ENDLOOP:
```

There's another way to compile the same while loop. This way looks more like the do-while translation to assembly:

```
1   mov r3, #10     @ r3 holds 'x'
2   b .TEST
3 .LOOP:
4   sub r3, r3, #1
5 .TEST:
6   cmp r3, #0
7   bgt .LOOP
8 .ENDLOOP:
```

1.6 `for` loop

There's lots of extra space in this for loop. Usually you'd write the for statement like this:
`for (x = 10; x > 0; x--) {...}` but to better see how the bits of C map to ARM, spaces are added:

```
1 y = 0;
2 for ( x = 10;
3
4       x > 0 ;
5
6       x--     ) {
7    y = y + x;
8 }
```

```
1   mov r2, #0      @ r2 holds 'y'
2   mov r3, #10     @ r3 holds 'x'
3 .LOOP:
4   cmp r3, #0
5   ble .ENDLOOP    @ stop if !(x>0)
6   add r2, r2, r3  @ y=y+x
7   sub r3, r3, #1  @ x--
8   b .LOOP
9 .ENDLOOP:
```

2 Load/Store Examples

These examples now assume variables are assigned a memory location. This means they are loaded and stored as necessary.

2.1 set elements in array

Assume `x` is an array and its address is stored in `r4`:

```
1  x[0] = 40;
2
3
4  x[1] = 30;
5
6
7  x[2] = x[0] + x[1];
```

```
1   mov r0, #40
2   str r0, [r4] @ r4 is addr of x
3
4   mov r0, #30
5   str r0, [r4, #4]
6
7   ldr r0, [r4]      @ x[0]
8   ldr r1, [r4, #4]  @ x[1]
9   add r0, r0, r1    @ x[0]+x[1]
10  str r0, [r4, #8]
```

2.2 Local variables stored on the stack

When you declare variables in a C function, it makes space on the stack by moving `sp`, then assigns the variables locations there (much like entries in an array). Notice that `x = y;` requires both a load from memory and a store into memory since both variables are stored in memory!

In this example `x, y` and `tmp` are local variables stored on the stack:

```
1  void swap()
2  {
3
4    int x = 1;
5
6
7    int y = 16;
8
9
10   int tmp = x;
11
12
13   x = y;
14
15
16   y = tmp;
17
18
19 }
```

```
1  swap:
2    sub sp, sp, #12     @ make space
3
4    mov  r3, #1
5    str  r3, [sp, #0]   @ x is sp+0
6
7    mov  r3, #16
8    str  r3, [sp, #4]   @ y is sp+4
9
10   ldr  r3, [sp, #0]
11   str  r3, [sp, #8]   @ tmp is sp+8
12
13   ldr  r3, [sp, #4]   @ put y into x
14   str  r3, [sp, #0]
15
16   ldr  r3, [sp, #8]
17   str  r3, [sp, #4]
18
19   add  sp, sp, #12    @ shrink stack
20   bx  lr
```