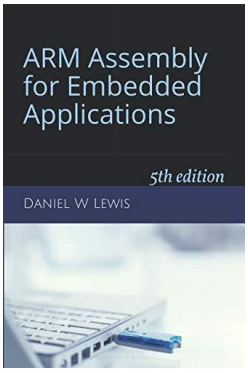

ARM Instructions Worksheet #6

Conditional Branch

Signed versus Unsigned

Prerequisite Reading: Chapter 6
Revised: March 25, 2020

Objectives: *To use the web-based simulator ("CPUlator") to better understand …*

1. Single versus unsigned conditional branch instructions.

To do offline: Answer the questions that follow the listing below. (Numbers at far left are memory addresses.)

```
                    .syntax     unified
                    .global     _start

00000000  _start:   LDR         R0,=0xFFFFFFFF      // *** EXECUTION STARTS HERE ***
00000004  loop:     LDR         R1,=0x11111         // Turn on all flags
00000008            CMP         R0,1
0000000C  test1:    BLO         test2               // Branch if R0 <  1 (unsigned)
00000010            SUB         R1,R1,0x10000       // Did not branch: Turn off LO flag
00000014  test2:    BHI         test3               // Branch if R0 >  1 (unsigned)
00000018            SUB         R1,R1,0x01000       // Did not branch: Turn off HI flag
0000001C  test3:    BLT         test4               // Branch if R0 < +1 (signed)
00000020            SUB         R1,R1,0x00100       // Did not branch: Turn off LT flag
00000024  test4:    BGT         test5               // Branch if R0 > +1 (signed)
00000028            SUB         R1,R1,0x00010       // Did not branch: Turn off GT flag
0000002C  test5:    BEQ         next                // Branch if R0 == 1
00000030            SUB         R1,R1,0x00001       // Did not branch: Turn off EQ flag
00000034  next:     ADD         R0,R0,1             // Increment R0
00000038            B           loop                //    and repeat.

                    .end
```

Note: The least-significant four hex digits of register `R1` will be used to indicate which conditions were satisfied according to the table shown at the right:

R1 contents	LO	HI	LT	GT	EQ
0x00010000	√				
0x00001000		√			
0x00000100			√		
0x00000010				√	
0x00000001					√

What is in `R0` the 1st time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): FFFFFFFF

R0 (as signed decimal): -1

Which conditions does `R1` indicate as true for `R0` compared to `1`?

LO [X] EQ [ ] HI [ ]

LT [X] EQ [ ] GT [ ]

What is in R0 the 2nd time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 0x111111

R0 (as signed decimal): 1

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☐ EQ ☒ HI ☐ LT ☐ EQ ☐ GT ☒

What is in R0 the 3rd time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 023c9061

R0 (as signed decimal): 37523553

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☐ EQ ☐ HI ☒ LT ☒ EQ ☐ GT ☐

What is in R0 the 4th time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 0024f00d

R0 (as signed decimal): 2420749

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☐ EQ ☐ HI ☒ LT ☐ EQ ☐ GT ☒

Getting ready: Now use the simulator to collect the following information and compare to your earlier answers.

1. Click here to open a browser for the ARM instruction simulator with pre-loaded code.
1. In the "Disassembly" window, click in the grey area left of the ADD instruction. The red dot (●) is a breakpoint where the simulation will pause *before* executing this instruction.

Notes:

1. The BLO instruction in the "Editor" window will appear as an equivalent BCC instruction in the "Disassembly window.
2. You can change the number format in the "Settings" window between hex, unsigned decimal and signed decimal as needed.

Step 1: *Press F3 exactly* ***once*** *to run the simulation and stop at the breakpoint.*

What is in R0 the 1st time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 0x111111

R0 (as signed decimal): 1

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☐ EQ ☐ HI ☐ LT ☐ EQ ☐ GT ☐

Step 2: *Press F3 exactly* ***once*** *to run the simulation and stop at the breakpoint.*

What is in R0 the 2nd time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 023c9061

R0 (as signed decimal): 37523553

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☐ EQ ☐ HI ☐ LT ☐ EQ ☐ GT ☐

Step 3: *Press F3 exactly* ***once*** *to run the simulation and stop at the breakpoint.*

What is in R0 the 3rd time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 0024f00d

R0 (as signed decimal): 2420749

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☐ EQ ☐ HI ☐ LT ☐ EQ ☐ GT ☐

Step 4: *Press F3 exactly* ***once*** *to run the simulation and stop at the breakpoint.*

What is in R0 the 4th time execution arrives at address 00000038_{16}?

R0 (as unsigned decimal): 60432ea6

R0 (as signed decimal): 4402854

Which conditions does R1 indicate as true for R0 compared to 1?

LO ☒ EQ ☐ HI ☐ LT ☒ EQ ☐ GT ☐