CS061 - Lab 4

More Arrays

1 High Level Description

In today's lab you will play around with arrays and loops a bit more, get some more practice with LDR, do some doubling down, and further explore the mysteries of console output.

2 Our Targets for This Week

1. Lab 3 review – Exercise 1
2. What a character! Exercise 2
3. Bits and pieces – Exercises 3 - 4
4. I rock!

3 Ok, let's hit these targets!

3.1 Lab 3 review

You will be building on the skills you learned last week: prompts, sentinel-controlled loops, and arrays, so let's start with a variation on last week's array – this time storing the results of a calculation, rather than user input.

Remember to always open the Text Window of your simpl LC-3 emulator!

Exercise 1

Use .BLKW to set up an array of 10 values, starting at memory location x4000, as in lab 3.
Now *programmatically* populate the array with the numbers 0 through 9 *(note - NOT the characters '0' through '9'!)* – i.e. hard-code just the first value (0), then calculate the rest one at a time, storing them in the array as you go. *Remember the proper way of setting a register to 0!*
After you've stored them all, grab the *seventh* value (i.e. 6) and store it in R2.
Clearly, you can't access this location via a label, so you'll need it's actual address.
How will you obtain that? And how will you use that address to get the value stored there?

As always, step through your program and examine the values as they are stored in the array, and examine the final value stored in R2, to make sure your program works as expected.

3.2 What a character!

Exercise 2

You'll notice that Exercise 1 didn't ask you to output to console the array you built.
Why not?
Because as you know by now, numbers are not characters!

So now go and add an *output loop*, making it output the *characters* corresponding to the *numbers* stored in your array, just as you learned to do in assignment 2.

3.3 Bits and pieces ...

Exercise 3

Let's try another modification of our well-used array program from Exercise 1:

This time, instead of calculating and storing the numbers from 0 to 9 in the array, calculate and store the first ten powers of 2, starting with 2^0 = 1 in array index 0.
Finally, grab the seventh value (2^6) from the array, and store it in R2.

In order to do this, you will have to figure out how to calculate powers of 2.
Some hints:

- Mathematically speaking: How do I obtain 2^{n+1} if I have 2^n?
- What LC-3 operation could I use to multiply a number by 2?

As always, place a breakpoint in your program, and step through it, examining the values as they are being stored in the array, and examine the final value stored in R2, to make sure your program works as expected.

You already understand that you can't simply output the values in the array to the console “as is”, so we have to manipulate them somehow to turn them into characters.
But this time all but the first four are _multi-digit numbers_ when represented as decimal values, so our trick from the last exercise won't work – it can only convert the numbers from 0 to 9 into the single-digit ascii characters '0' through '9'.

This is going to take some more effort to solve, so we'll spread it out over a couple of labs & assignments.

Exercise 4
For now, we will just observe what happens if we attempt to output the contents of the array as if they were ascii codes.

Copy your exercise 3 code into your lab4_ex4.asm file, and add a display loop that loads the content of each element of the array into R0 and outputs it to the console (i.e. the same structure as your array builing loop, but in the opposite direction).

Now place a breakpoint at the start of your display loop and step through it:
Observe the result carefully for as many iterations as the program will perform
(why won't it perform all 10? What is happening??).
You will need to keep an eye on the Text Window to understand what is going on!!

When you demo to your TA, you will have to explain the output from this loop.

3.4 Submission

Demo your lab exercises to your TA ***before you leave lab*** - and explain the output of ex. 4.
If you are unable to complete all exercises in lab, show your TA how far you got, and request permission to complete it after lab. Your TA will usually give you partial credit for what you have done, and allow you to complete & demo the rest later for full credit, so long as you have worked at it seriously. When you're done, demo it to any TA or instructor in office hours ***before your next lab***.
Office hours are posted on Piazza, under the "Staff" tab.

4 So what do I know now?

- You should be able to do counter and sentinel controlled loops in your sleep :)
- Ditto for multi-way branches (the AL version of if statements)
- The difference between a *number* (an abstract concept) and its various *representations* – in different bases (2, 10, 16), and as ascii character(s) (specifically, decimal numeric digits)
- Output values from 0 to 9 as their corresponding ascii characters