Homework 3

Due February 10, 2020

(1) Calculate the numbers of memory fetches and stores (in the accumulator cum RAM model) of the following code snippets. An input / output counts as a memory fetch / store.

Take this code snippet:

```
print(a*2+1).
```

We need to fetch a, 2, and 1 and we need to store the result in the output register, which gives us 4 operations.

Take another code snippet:

```
n = 0
for i in range(1…10):  #includes 1 and 10
     n += i
print(n)
```

We need to translate this code into an assembly style code. First, we break up the instructions.

```
n = 0
i = 0
loop:  if i > 10:
           break
       i = i+1
       n = n + i
       goto loop
       print(n)
```

Now we can generate accumulator based pseudo-assembly code:

```
       ACC = 0
       n <— ACC
       ACC <— i
loop:  CMP_GT ACC            #compare greater than
       IF FLAG SET:          #comparison yielded TRUE
            JUMP EXIT
       ACC +=  1             #not a memory fetch
       ACC —> i
       ACC <— n
       ACC += i              #but this one is
       ACC —> n
       ACC <— i
       JUMP LOOP
EXIT:  ACC <— N
       N —> OUTPUT
```

We now can count the fetch operations. Outside the loop, we have two fetch/store operations before and two after. Within the loop, we have five such operations. Therefore, we have $5n + 4$ fetch / store operations.

Use this process to calculate the number of fetch/store operations to calculate the sum of an array of *n* element. The array elements are stored contiguous in memory at incrementing memory locations. The first array element is stored at a location $m + 0$, the second at $m + 1$, etc.

You will have to make many assumptions. It is imperative that you make your reasoning very clear.

(2) Use limits in order to compare the asymptotic growth of the following pair of functions (given as expressions in the variable *n*). Show all your work. Use o, Θ, and Ω to express the relationship. You can check your derivations using Mathematica, Maple, or Matlab.

(1) $\log(n)^2, \quad \sqrt{n}$

(2) $\dfrac{n^2 + 5}{n + 4}, \quad n$

(3) $e^n, \quad 3^n$

(4) $n^n, 2^n$

(5) $n^2, 2^n$

(6) $n \log(n)^2, \; n \log(n^2)$