COT 5310: Assignment 4

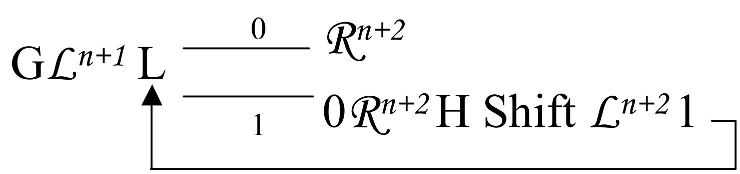
1. **Present a Turing Machine to do MAX of n non-zero arguments, n>=0. You know you've run out of arguments when you encounter the value 0, represented by two successive 0's (blanks). Use the machines we have already built up and others you build. Do NOT turn in Turing Tables. We won't pay any attention to them if you do.**

2. **Show that Turing Machines are closed under primitive recursion. This completes the equivalence proofs for our five models of computation.**

To prove the that Turing Machines are closed under primitive recursion, we must simulate some arbitrary primitive recursive function $F(x_1,x_2, \ldots, x_n,y)$ on a Turing Machine. To show this, we define $F(x_1,x_2, \ldots, x_n,y)$ recursively as:

$F(0, x_1,x_2, \ldots, x_n) = G(x_1,x_2, \ldots, x_n)$
$F(y+1, x_1,x_2, \ldots, x_n) = H(y, x, F(y,x_1,x_2, \ldots, x_n))$

Where, G and H are Standard Turing Computable. We define the function F for the Turing Machine as the following:




Since our Turing Machine simulator can produce the same value for any arbitrary PRF, F, we show that Turing Machines are closed under PRFs.

**3. Constructively (no proof required), show how a standard register machine can simulate a different register machine model with instructions of the form:**
**i. if even(r) goto j // goto j if value in register r is even**
**i. r = r+1 // increment contents of r**
**i. r = r-1 // decrement contents of r**

To simulate **i. r = r+1**:

| | |
|---|---|
| i. | INCr[i + 1] |

To simulate **i. r = r-1:**

| | |
|---|---|
| i. | DECr[i + 1, i + 1] |

To simulate **i. if even(r) goto j**, we'll use more than one instruction. If there are **m** lines in the machine we're simulating, these extra instructions must be located after the **m**th line to avoid any collisions. Let **t** be some temporary register not used in the original program and assume it's initially 0.

| | |
|---|---|
| i. | DECr [k, k + 3] |
| k. | INCt [k + 1] |
| k+1. | DECr [k + 2, k + 5] |
| k+2. | INCt [i] |
| k+3. | DECt [k + 4, j] |
| k+4. | INCr [k + 3] |
| k+5. | DECt [k + 6, i + 1] |
| k+6. | INCr [k + 5] |

Since we've used 7 extra lines, let k = m + 7i.