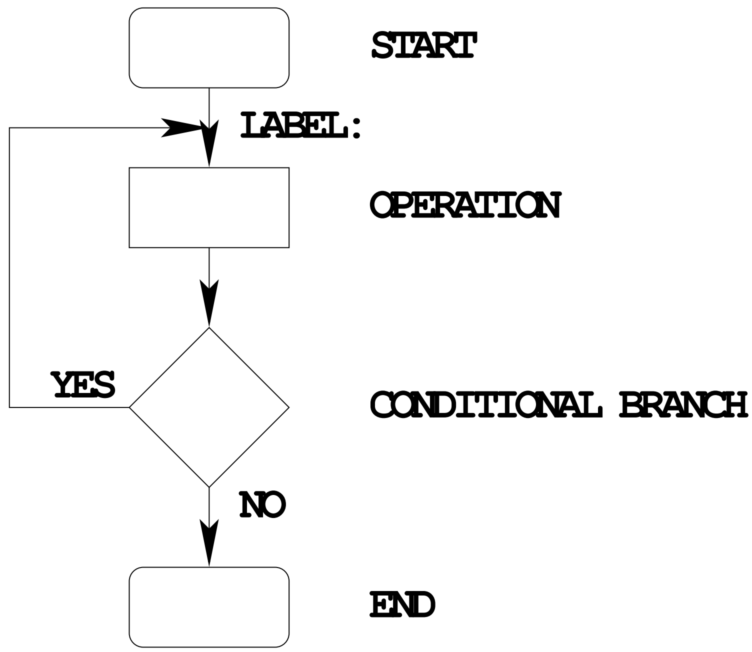
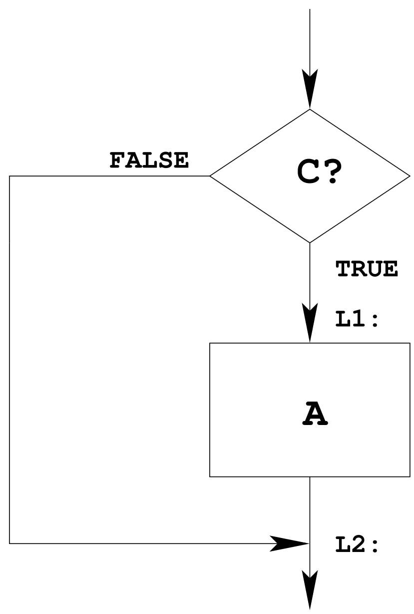
Writing Assembly Language Programs — Use Flowcharts to Help Plan Program Structure

Flow chart symbols:



IF-THEN Flow Structure

```
if (C)
{
  A;
}
```



EXAMPLE:

```
if (A<10)
{
    var = 5;
}
```

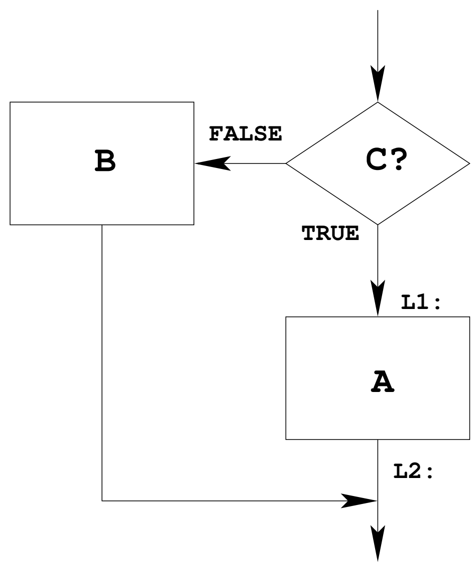
```
        CMPA    #10 ; if (A < 10)
        BLT     L1  ; signed numbers
        BRA     L2
L1:     LDAB    #5  ; var = 5;
        STAB    var
L2:     next instruction
```

OR:

```
        CMPA    #10 ; if (A < 10)
        BGE     L2  ; signed numbers
        LDAB    #5  ; var = 5
        STAB    var
L2:     next instruction
```

IF-THEN-ELSE Flow Structure

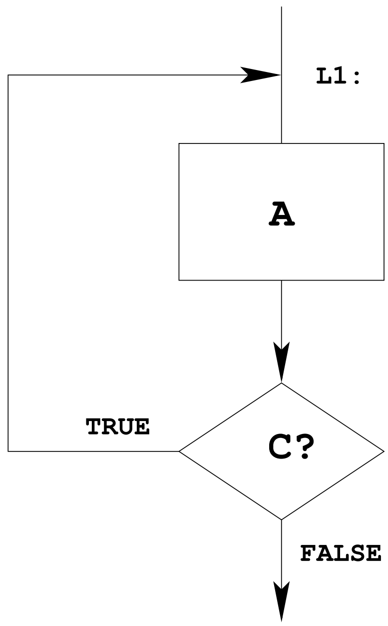
```
if (C)
{
  A;
}
else
{
  B;
}
```




```
if (A<10)                       CMPA   #10   ; if (A < 10)
{                               BLT    L1    ; signed numbers
   var = 5;                     CLR    VAR   ; var = 0
}                               BRA    L2
else                     L1:    LDAB   #5    ; var = 5
{                               STAB   var
   var = 0;              L2:    next instruction
}
```

DO WHILE Flow Structure

```
do
{
  A;
}
while (C);
```



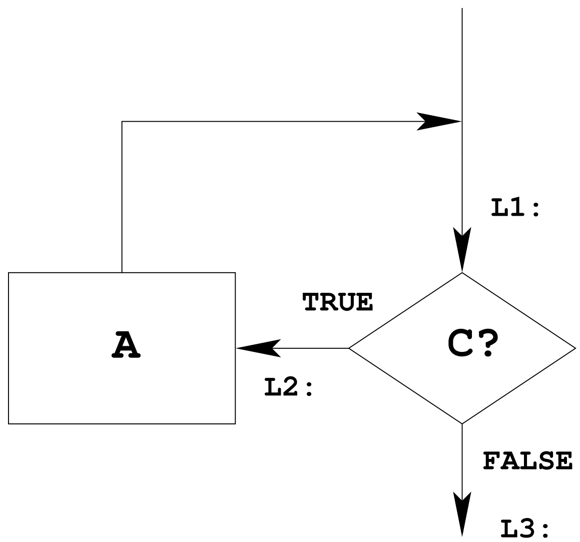
EXAMPLE:

```
i = 0;
do
{
   table[i] = table[i]/2;
   i = i+1;
}
while (i <= LEN);
```

```
      LDX    #table
      CLRA             ; i = 0
L1:   ASR    1,X+      ; table[i] /= 2
      INCA             ; i = i+1
      CMPA   #LEN      ; while (i <= 10)
      BLE    L1        ; unsigned numbers
```

WHILE Flow Structure

```
while (C)
{
  A;
}
```

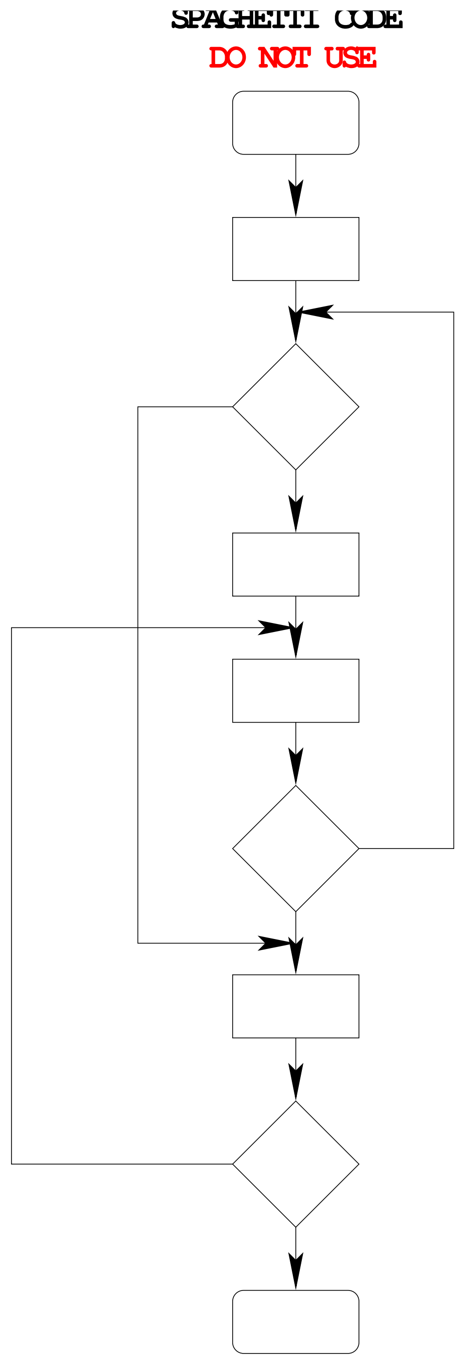


EXAMPLE:

```
i = 0;
while (i <= LEN)
{
   table[i] = table[i]*2;
   i = i + 1;
}
```

```
        LDX     #table
        CLRA                ; i = 0
L1:     CMPA    #LEN        ; while (i <= LEN)
        BLT     L2
        BRA     L3
L2:     ASL     1,X+        ; table[i] /= 2
        INCA                ; i = i + 1
        BRA     L1
L3:     next instruction
```

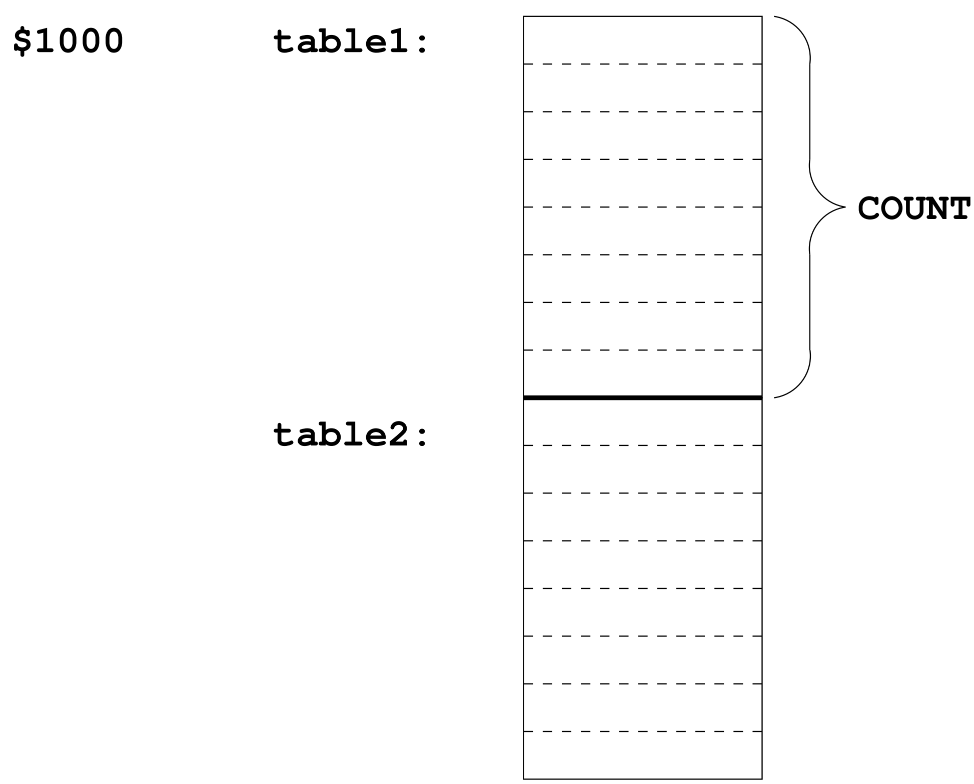
Use Good Structure When Writing Programs — Do Not Use Spaghetti Code



Example Program: Divide a table of data by 2

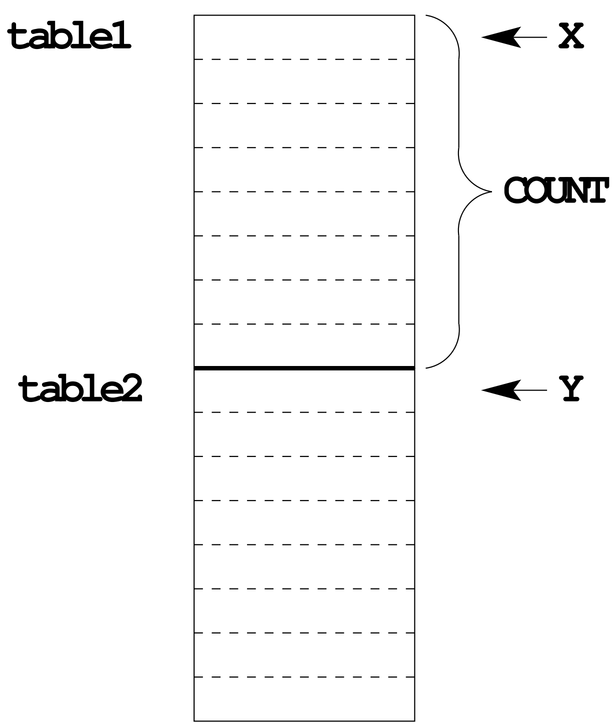
Problem: Start with a table of data. The table consists of 5 values. Each value is between 0 and 255. Create a new table whose contents are the original table divided by 2.

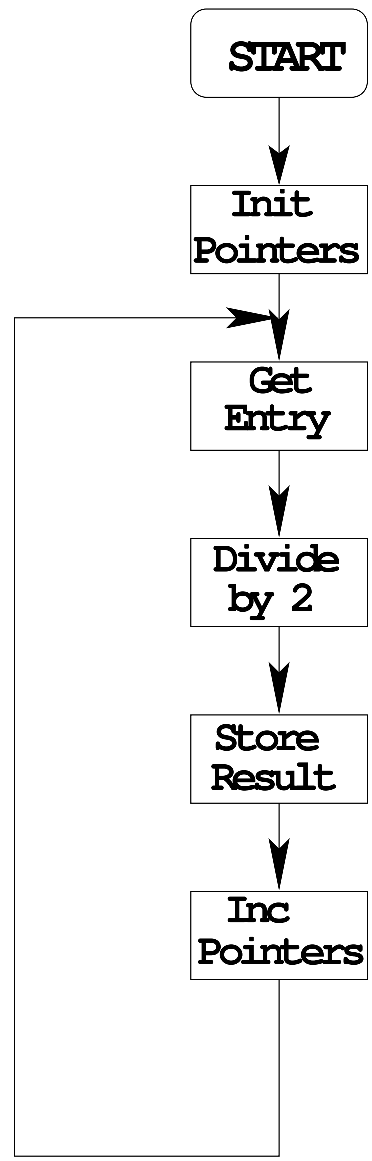
1. Determine where code and data will go in memory.
   Code at \$2000, data at \$1000.
2. Determine type of variables to use.
   Because data will be between 0 and 255, can use unsigned 8-bit numbers.
3. Draw a picture of the data structures in memory:



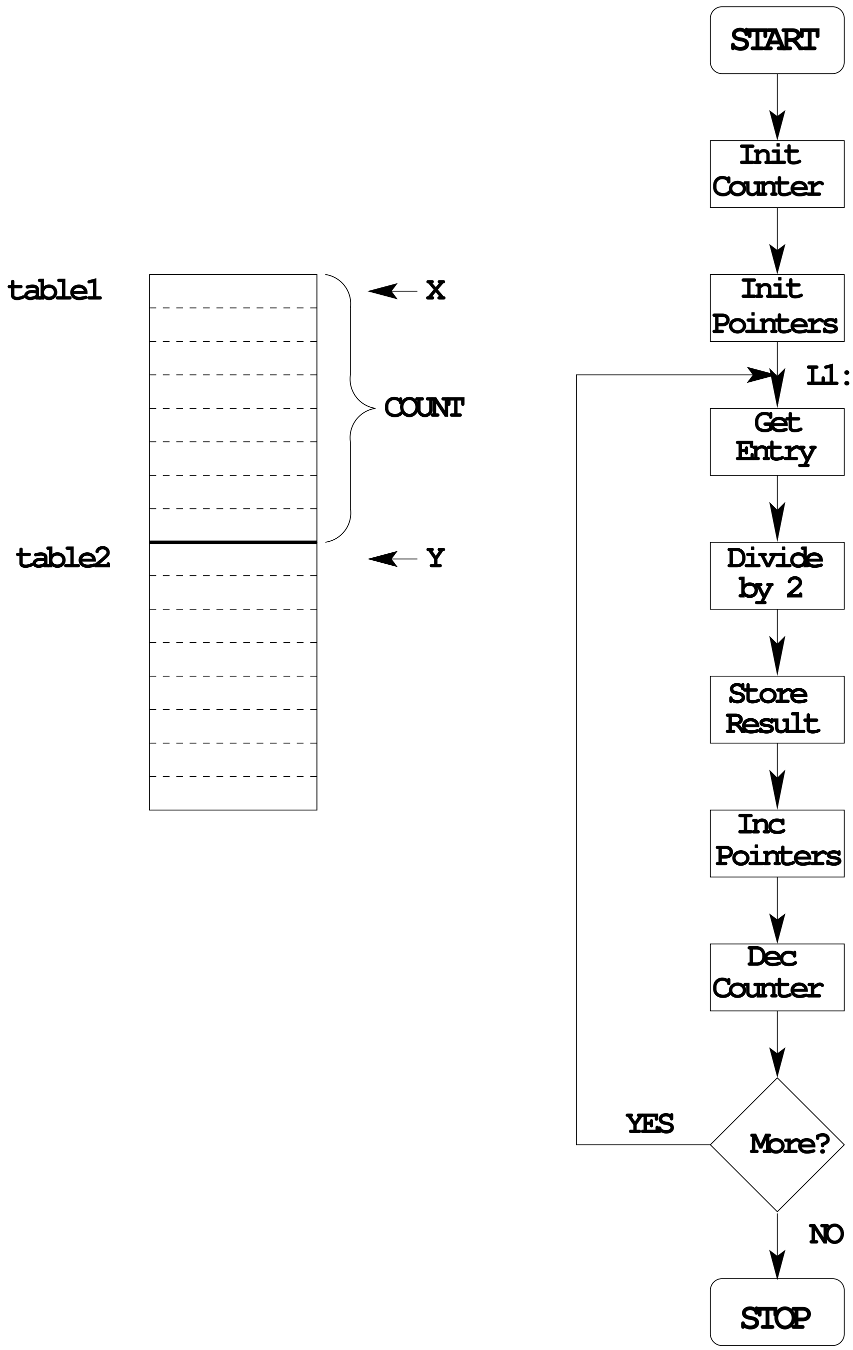
4. Strategy: Because we are using a table of data, we will need pointers to each table so we can keep track of which table element we are working on.
   Use the X and Y registers as pointers to the tables.

5. Use a simple flow chart to plan structure of program.

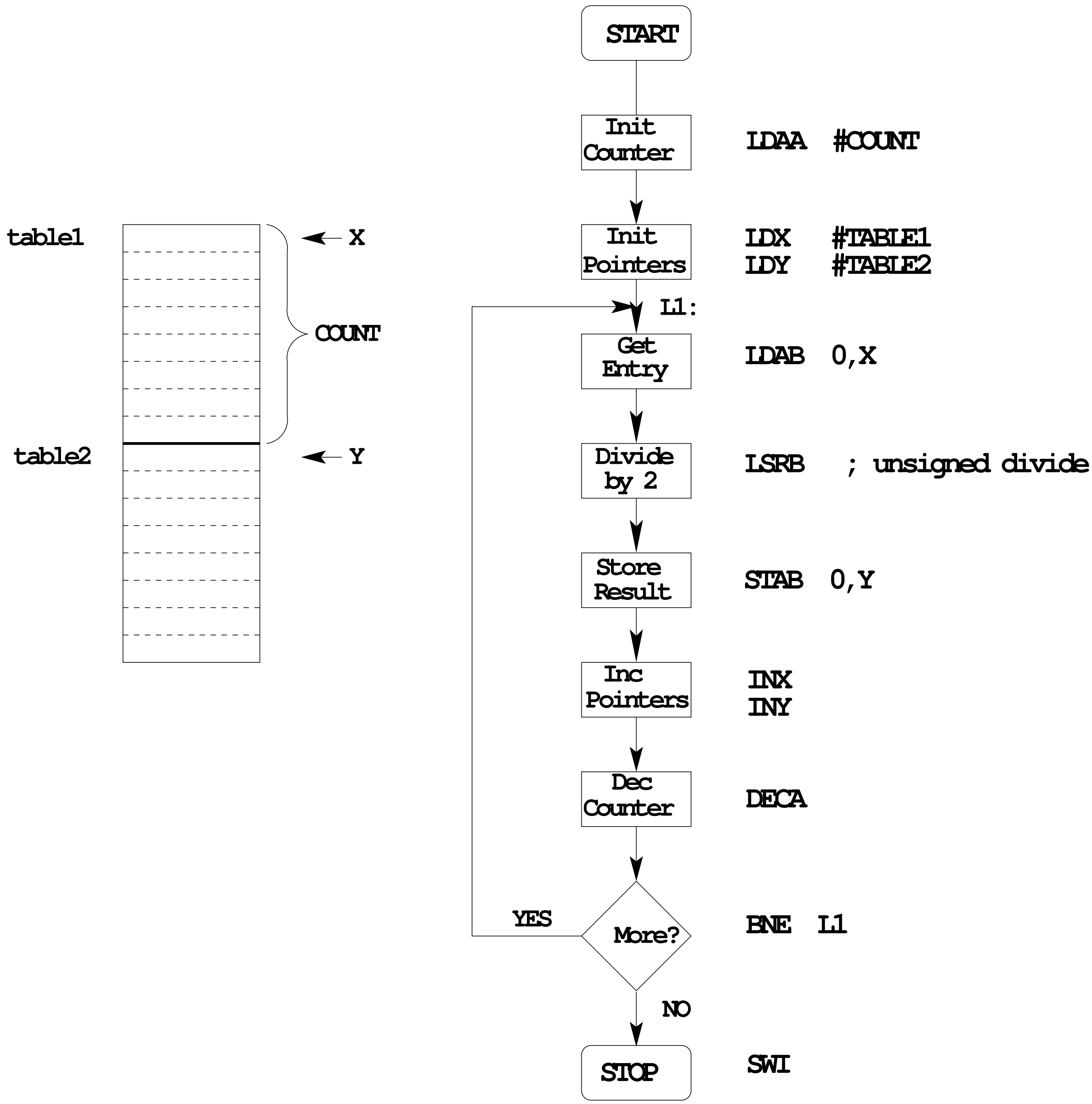




6. Need a way to determine when we reach the end of the table.
   One way: Use a counter (say, register A) to keep track of how many elements we have processed.



7. Add code to implement blocks:



8. Write program:

```
; Program to divide a table by two
; and store the results in memory

prog:    equ     $2000
data:    equ     $1000

count:   equ     5

         org     prog     ;set program counter to 0x1000
         ldaa    #count   ;Use A as counter
         ldx     #table1  ;Use X as data pointer to table1
         ldy     #table2  ;Use Y as data pointer to table2
l1:      ldab    0,x      ;Get entry from table1
         lsrb             ;Divide by two (unsigned)
         stab    0,y      ;Save in table2
         inx              ;Increment table1 pointer
         iny              ;Increment table2 pointer
         deca             ;Decrement counter
         bne     l1       ;counter != 0 => more entries to divide
         swi              ;Done


         org     data
table1:  dc.b    $07,$c2,$3a,$68,$F3
table2:  ds.b    count
```

9. Advanced: Optimize program to make use of instructions set efficiencies:

```
; Program to divide a table by two
; and store the results in memory

prog:    equ     $1000
data:    equ     $2000

count:   equ     5

         org     prog     ;set program counter to 0x1000
         ldaa    #count   ;Use B as counter
         ldx     #table1  ;Use X as data pointer to table1
         ldy     #table2  ;Use Y as data pointer to table2
l1:      ldab    1,x+     ;Get entry from table1; then inc pointer
         lsrb             ;Divide by two (unsigned)
         stab    1,y+     ;Save in table2; then inc pointer
         dbne    a,l1     ;Decrement counter; if not 0, more to do
         swi              ;Done


         org     data
table1:  dc.b    $07,$c2,$3a,$68,$F3
table2:  ds.b    count
```

TOP-DOWN PROGRAM DESIGN

- PLAN DATA STRUCTURES IN MEMORY
- START WITH A LARGE PICTURE OF PROGRAM STRUCTURE
- WORK DOWN TO MORE DETAILED STRUCTURE
- TRANSLATE STRUCTURE INTO CODE
- OPTIMIZE FOR EFFICENCY —
  DO NOT SACRIFICE CLARITY FOR EFFICIENCY