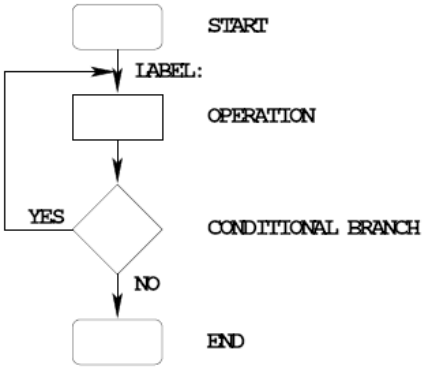
- **Disassembly of 9S12 op codes**
- **Writing an assembly language program**
- Huang Sections 2.4, 2.5, 2.6
  - Disassembly of 9S12 op codes
  - Use flow charts to lay out structure of program
  - Use common flow structures
    - if-then
    - if-then-else
    - do-while
    - while
  - Do not use spaghetti code
  - Plan structure of data in memory
  - Plan overall structure of program
  - Work down to more detailed program structure
  - Implement structure with instructions
  - Optimize program to make use of instruction efficiencies
  - Do not sacrifice clarity for efficiency

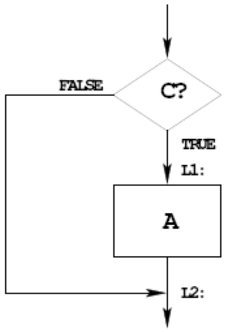
Writing Assembly Language Programs — Use Flowcharts to Help Plan Program Structure

Flow chart symbols:



IF-THEN Flow Structure

```
                                i
f (C)
                                {

A;
              }
```



EXAMPLE:

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

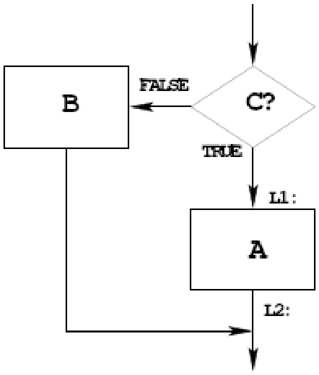
```
        CMPA        #10
        BLT         L1
        BRA         L2
L1:   LDAB    #5
        STAB        var
L2:   next instruction
```

OR:

```
        CMPA        #10
        BGE         L2
        LDAB        #5
        STAB        var
L2:   next instruction
```

IF-THEN-ELSE Flow Structure

```
if (C)

{

A;

}

else

{

B;

}
```

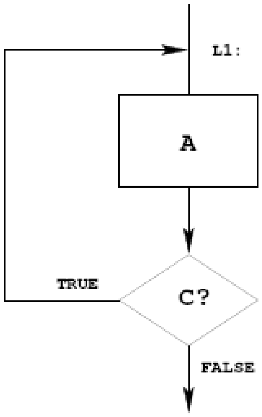


```
if(A < 10)
{
var = 5;
}
else
{
var = 0;
}
```

```
        CMPA      #10
        BLT       L1
        CLR       VAR
        BRA       L2
L1:     LDAB      #5
        STAB      var
L2:     next instruction
```

DO WHILE Flow Structure

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

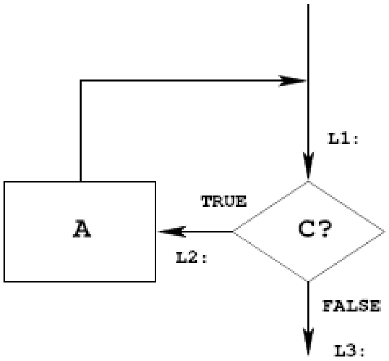


EXAMPLE:

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

WHILE Flow Structure

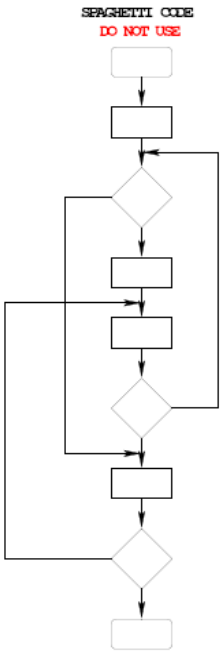
```
while ( C )

{

A;

}
```



EXAMPLE:

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

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



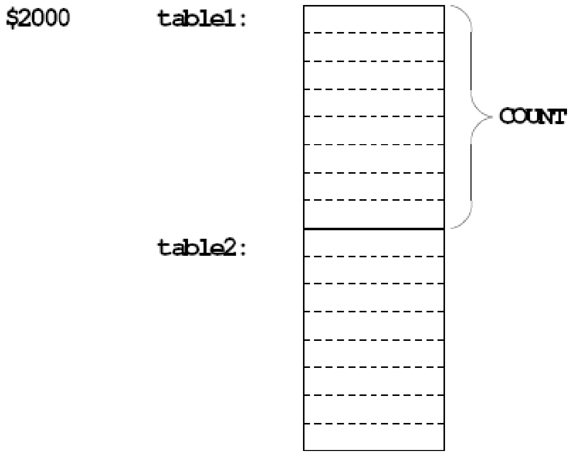
Example Program: Divide a table of data by 2

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 $1000, data at $2000.

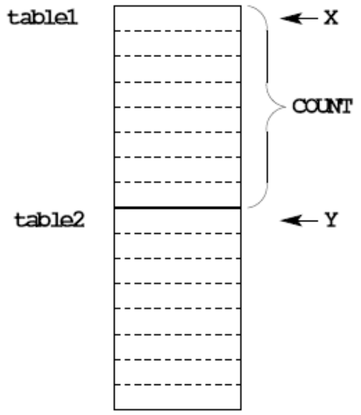
2. Determine type of variables to use.
Because data will be between 0 and 255, can use unsigned 8-bit numbers.

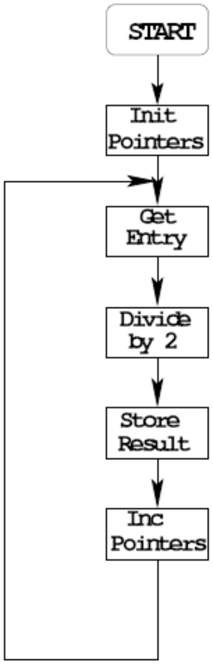
3. Draw a picture of the data structures in memory:



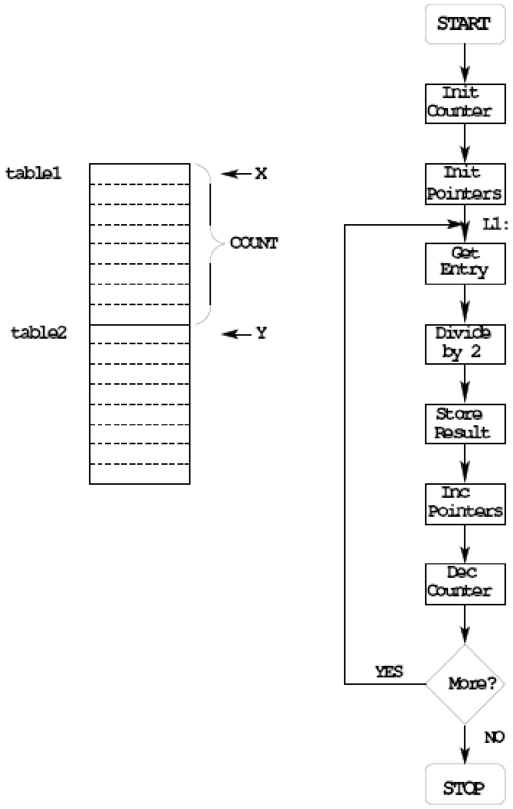
4. Strategy: Because we are using a table of data, we will need pointers to each table so we can keep track of which table element we are working on.
Use the X and Y registers as pointers to the tables.

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

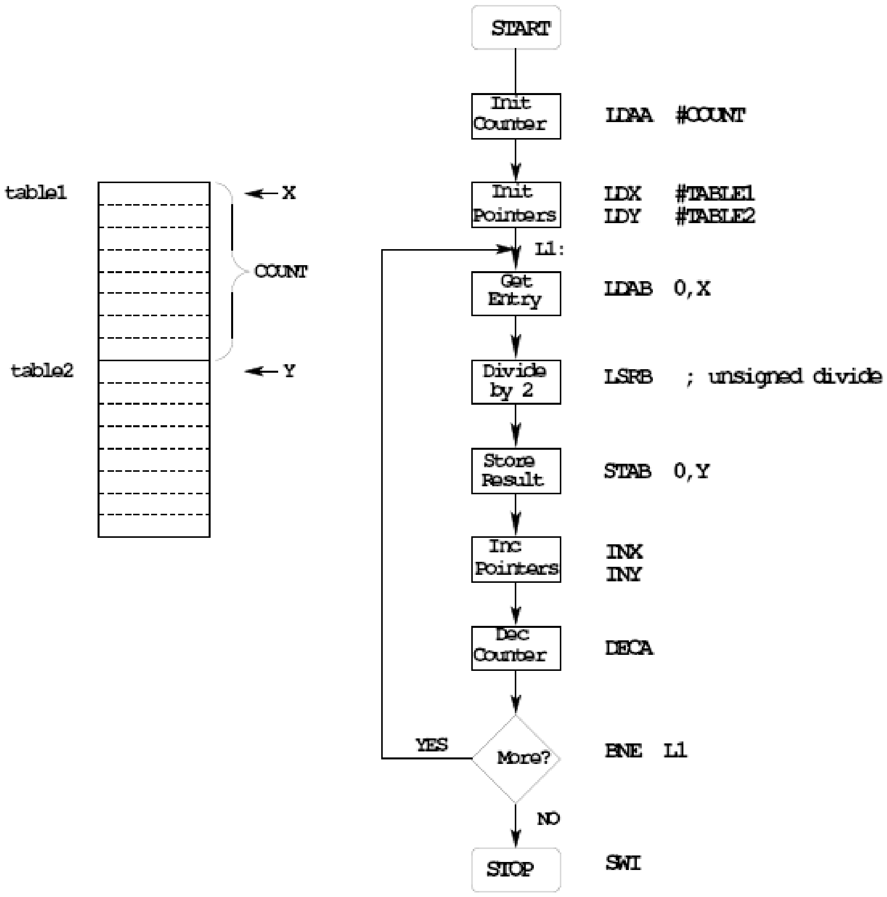




6. Need a way to determine when we reach the end of the table.
One way: Use a counter (say, register A) to keep track of how many Elements we have processed.



7. Add code to implement blocks:



8. Write program:

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

prog:   equ     $1000
data:   equ     $2000
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