Note Title

Subroutines and loops in assembly

Revision: instructions so far:

opcode	mnemonic
1	Load X
2	Store X
3	Add X
4	Subt X
5	Input
6	Output
7	Halt
8	Skipcond
9	Jump X

Skipcond →
- Skipcond 000 - skip if $AC<0$
- skipcond 400 - skip if $AC=0$
- skipcond 800 - skip if $AC>0$

Revision: if-else statements:

e.g. "if $X>2$ then $Y=3$ else $Y=4$"
becomes

```
          load X
          subt two
          skipcond 800   /skip if X>2
          jump else
if,       load three
          jump endif
else,     load four
endif,    store Y
```

Today's topics: 1 while loops
2 Some new instructions
3 subroutines

1 While loops (or equivalently, for loops)

These are easy using skipcond.

Example:

```
for counter = 1 to 5
    Y = Y + X
end
```

See loopDemo.mas for the assembly version fill in this column interactively

② New instructions

[see table 4.6]

opcode	mnemonic	pseudocode
0	JnS X	$M[X] = PC$ $PC = X+1$
A	Clear	$AC = 0$
B	AddI X	$AC = AC + M[M[X]]$
C	JumpI X	$PC = M[X]$
D	LoadI X	$AC = M[M[X]]$
E	StoreI X	$M[M[X]] = AC$

used for subroutines – see later in this lecture

Show demos of JnS, AddI, JumpI, Clear

See example 4.1 for a more practical use of AddI

(3) Subroutines

subroutine (assembly) ≡ function (C, C++) ≡ method (Java)

Basic idea: - jump somewhere else, do some useful work, then return to where you were before

- the return address is the location to return to after the subroutine has finished its work.

- in MARIE, its best to store the return address at the start of the subroutine. (Use JnS for that).

- after doing the required job, use JumpI to return to the return address

example: see subroutineDemo.mas

Minilab:

1. Step through subroutineDemo.mas, make sure you understand it.

2. Alter subroutineDemo.mas to achieve the result

$$X = (4 * X - 1) * 4 * 4$$

3. Write a subroutine that multiplies two positive integers X and Y, storing the result in Z.

4. Use your answer to write an assembly program that computes the product of a list of five numbers.

5. Can one subroutine call another subroutine? Give examples or counterexamples.

6. Can a subroutine call itself?