## **Chapter 7 Assembly Language**

## 7.1 Assembly Language Programming - Moving Up a Level

**The purpose of assembly language** is to make the programming process more user-friendly than programming in machine language, while still providing the programmer with detailed control over the instructions that the computer can execute.

Before a program written in a high-level language can be executed, it **must be translated into a program in the ISA** of the computer on which it is expected to execute. It is often the case that each statement in the high-level language specifies **several instructions in the ISA** of the computer.

## 7.2 An Assembly Language Problem

#### 7.2.1 Instructions

LABEL Opcode Operands ; Comment

#### 7.2.1.1 Opcodes & Operands

These two parts are mandatory(强制的).

The **Opcode** is a symbolic name for opcode of the corresponding LC-3 instruction.

The number of **operands** depends on the operation being performed.

#### 7.2.1.2 Labels

**Labels** are symbolic names that are used to identify memory locations that are referred to explicitly in the program.

#### 2 reasons for using Labels:\*

- The location is the target of a branch instruction.
- The location contains a value that is loaded or stored.

#### **7.2.1.3 Comments**

Comments are messages intended only for human consumption.

## 7.2.2 Pseudo-Ops

#### 7.2.2.1 .ORIG

It tells the assembler where in the memory to place the LC-3 program.

#### 7.2.2.2 FILL

It tells the assembler to set aside the next location in the program and initialize it with the value of the operand.

#### 7.2.2.3 .BLKW

(a BLocK of Words)

It tells the assembler to set aside some number of sequential memory locations in the program.

#### **7.2.2.4 .STRINGZ**

It tells the assembler to initialize a sequence of n+1 memory locations. The first n words of memory are initialized with the zero-extended ASCII codes of the corresponding characters in the string. The final word of memory is initialized to 0.

#### 7.2.2.5 .END

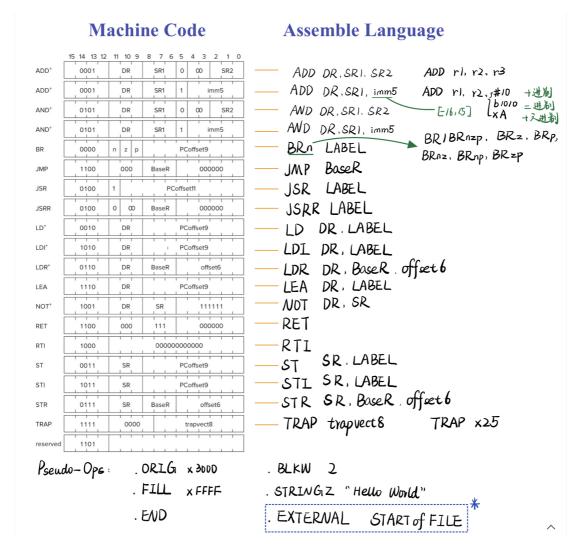
It tells the assembler it has reached the end of the program and need not even look at anything after it.

**HINT:** .END does not stop the program & it does not even exist at the time of execution.

#### \*(in 7.4.2) .EXTERNAL

It send a message to LC-3 assembler that the absence of the label corresponding to the pseudoops is not an error.

Used for multi-file programming.



## 7.3 The Assembly Process

### 7.3.2 A Two-Pass Process

The First Pass: Creating the Symbol Table

**The Second Pass:** Generating the Machine Language Program

# 7.4 Beyond the Assembly of a Single Assembly Language Program (*Recommend Reading*)

The concept of The Executable Image

Multi-file programming