

CS1356 Introduction to Information Engineering

Homework 3

Due: Nov 4, 2009 in class

Remember to write your name and student ID

1. Translate the following C program into the machine language of the textbook (Appendix C).

Suppose the translated program is loaded into memory started at address **A0**, and variable a, b, c are assigned to main memory with address **6E**, **6D**, and **6C** respectively. Give a short explanation for each instruction.

(No credit will be given without explanation.) **30%**

```
int main(){
    char a, b=5, c=3;

    if (b==c) a = b+10;
    else a = c|0x13;
}
```

Ans:

[A0] 11 6E 12 6D 10 6C B2 D0 24 13 71 04 31 6E C0 00

[D0] 23 0A 51 23 31 6E C0 00

[6C] 03 05 00

[PC] A0

11 6E LOAD 6E -> R1

12 6D LOAD 6D -> R2

10 6C LOAD 6C -> R3

B2 D0 比較 R0 = R2 ? 若相等 PC 跳到 D0 執行

24 13 若不相等繼續執行 LOAD 13(VALUE) -> R4

71 04 R0 OR R4 結果存至 R1

31 6E STORE R1 到 6E

C0 00 終止

23 0A LOAD 10(VALUE) -> R3

51 23 ADD R2 和 R3 結果放到 R1

31 6E STORE R1 到 6E

C0 00 終止

2. Suppose the following program, written in the machine language of the textbook (Appendix C), is stored in main memory beginning at address **30** (hexadecimal).

| |
|------|
| 2003 |
| 2101 |
| 2200 |
| 2310 |
| 1400 |
| 3410 |
| 5221 |
| 5331 |
| 3239 |
| 333B |
| B248 |
| B038 |
| C000 |

(a) If you trace the program, you will find out this program modifies itself. Self-modifying program, though not encouraged in ordinary use, is an important feature of the stored-program concept. Please indicate which instructions are modified during the program execution? And how are they changed? **20%**

Ans: the 5th and 6th instruction will be changed.

1400 → 1401 → 1402 → 1403

3410 → 3411 → 3412 → 3413

因為 5221 5331 3239 333B 改動了 R2、R3 的值 並存入 MEMORY CELL 39、3B

(b) A disassembler is a computer program that translates machine language into assembly language. Your job is to disassemble the code into a C program. First, use a sentence to describe what task the program performs? And then write a C program to perform the same function as this code does. Use integer arrays A[?] and B[?] for the memory location 00-03 and 10-13. **20%**

Ans:

此程式為複製一個陣列到另一個陣列

```
for (int i=0; i<3; i++){
    A[i]=B[i];
}
```

(c) If we want to place the program in main memory beginning at address **A0** (hexadecimal), how should the program be modified? Please write down the modified program with explanations. **30%**

Ans: 直接把 PC 換成 A0, 若把全部存至 A0~B8, 其中有關聯到 self-modified 的位址和 JUMP 的位址都要改變

[PC] A0

[A0] 20 03

21 01

22 00

23 10

14 00

34 10

52 21

53 31

32 A9

33 AB

B2 B8

B0 A8

C0 00

(d) **BONUS QUESTION:** Memory operations (load/store) are slower than arithmetic/logic operations. Can you rewrite this program to perform the same action with faster instructions? The program size should be less than 15 instructions.

Explain the correctness of your program. **20%**

Ans:

1400

3410

1401

3411

1402

3412

C000

The number of memory accesses (load/store) is 8. The original program has 16 memory accesses.