

```
// File: disassembler.c
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// Assignment: Project 1
// Course: MET CS472 (FALL 2014)

#include <stdio.h>
#include <string.h>

int main()
{
    // the first instruction begins at address 0x0007A060;
    // the rest follow in 4 byte intervals;
    // this program will output the address and assembly instruction translation
    // (e.g., 0x0007A060 lw $t0, 12($t0))

    // rs: first register source operand
    // rt: second register source operand
    // rd: register destination operand
    // shamt: shift amount

    unsigned int memory_address = 0x0007A060; // will be incremented

    unsigned int instructions[] = { 0x022DA822,
                                    0x8EF30018,
                                    0x12A70004,
                                    0x02689820,
                                    0xAD930018,
                                    0x02697824,
                                    0xAD8FFFF4,
                                    0x018C6020,
                                    0x02A4A825,
                                    0x158FFFF6,
                                    0x8E59FFF0 };

    // loop through instructions
    for (int instr_index = 0; instr_index < 11; instr_index++) {

        // display machine instruction in hex
        printf("\n<--- Machine instruction (in hex): 0x%x --->\n\n",
            instructions[instr_index]);
    }
}
```

//////// R & I FORMATS //////////

```
/****** ADDRESS *****/
```

```
printf("Memory Address: 0x%x\n", memory_address);
```

```
/****** OPCODE [6 bits] *****/
```

```
// properly positioned mask for opcode
// 11111 11100 0000 0000 0000 0000 0000 0000
unsigned int opcode_mask = 0xFC000000;
// proper shift amount for opcode
int opcode_right_shift = 26;
// (logical AND) then perform bit shift to the right
unsigned int opcode = (instructions[instr_index] & opcode_mask)
    >> opcode_right_shift;
```

```
// display opcode value in hex
printf("Opcode hex value: 0x%x\n", opcode);
// display instruction type
char opcode_type = ' ';
if (opcode == 0) {
    opcode_type = 'R';
}
else {
    opcode_type = 'I';
}
printf("Instruction type: %c Format\n", opcode_type);
```

```
/****** FIRST REGISTER (source) [5 bits] *****/
```

```
// properly positioned mask for first register
// 0000 00111 11110 0000 0000 0000 0000 0000
unsigned int rs_mask = 0x03E00000;
// proper shift amount for first register
int rs_right_shift = 21;
// (logical AND) then perform bit shift to the right
unsigned int rs = (instructions[instr_index] & rs_mask)
    >> rs_right_shift;
// display first register value in hex
printf("First register (source) hex value: 0x%x\n", rs);
```

```
/****** SECOND REGISTER (R: source | I: source/dest) [5 bits] *****/
```

```
// properly positioned mask for second register
// 0000 0000 000|1 1111| 0000 0000 0000 0000
unsigned int rt_mask = 0x001F0000;
// proper shift amount for second register
int rt_right_shift = 16;
// (logical AND) then perform bit shift to the right
unsigned int rt = (instructions[instr_index] & rt_mask)
                  >> rt_right_shift;
// based on opcode, follow R or I format,
// and display second register value in hex
char rt_type[20];
if (opcode == 0) {
    strcpy(rt_type, "source");
}
else {
    strcpy(rt_type, "source/dest");
}
printf("Second register (%s) hex value: 0x%x\n", rt_type, rt);
```

```
// based on opcode, follow R or I format
if (opcode == 0) {
    ////////// R FORMAT //////////
```

```
/****** THIRD REGISTER (destination) [5 bits] *****/
```

```
// properly positioned mask for third register
// 0000 0000 0000 0000 |1111 1|000 0000 0000
unsigned int rd_mask = 0x0000F800;
// proper shift amount for third register
int rd_right_shift = 11;
// (logical AND) then perform bit shift to the right
unsigned int rd = (instructions[instr_index] & rd_mask)
                  >> rd_right_shift;
// display third register value in hex
printf("Third register (destination) hex value: 0x%x\n", rd);
```

```
// ignore shamt
```

```
/********* FUNCTION [6 bits] *****/
```

```
// properly positioned mask for function
// 0000 0000 0000 0000 0000 0000 00111 11111
unsigned int funct_mask = 0x0000003F;
// logical AND (no need to shift)
unsigned int funct = (instructions[instr_index] & funct_mask);
// display function value in hex
printf("Function value: 0x%x\n", funct);
```

```
// IRI add: 0x00000020 IRI sub: 0x00000022
// IRI and: 0x00000024 IRI or: 0x00000025
// IRI slt: 0x0000002A
```

```
char funct_name[30];
switch (funct) {
    case 0x00000020:
        strcpy(funct_name, "add");
        break;
    case 0x00000022:
        strcpy(funct_name, "sub");
        break;
    case 0x00000024:
        strcpy(funct_name, "and");
        break;
    case 0x00000025:
        strcpy(funct_name, "or");
        break;
    case 0x0000002A:
        strcpy(funct_name, "slt");
        break;
    default:
        strcpy(funct_name, "ERROR! Something went wrong!");
        break;
}
```

```
printf("Function name: %s\n", funct_name);
```

```
/****** FINAL OUTPUT *****/
```

```
printf("\n---> Assembly instruction: ");
printf("0x%x: %s $%d, $%d, $%d <---\n\n",
       memory_address, funct_name, rd, rs, rt);
```

```
} // end: if (opcode == 0)
else {
```

```
//////// I FORMAT //////////
```

```
/****** CONSTANT/OFFSET [16 bits] *****/
```

```
// properly positioned mask for constant/offset
// 0000 0000 0000 0000 |1111 1111 1111 1111|
unsigned int constant_offset_mask = 0x0000FFFF;
// logical AND (no need to shift, but do need a short for negative
values)
short constant_offset = (instructions[instr_index] &
constant_offset_mask);
// display constant/offset value in hex
printf("Constant/Offset hex value: 0x%x\n", constant_offset);
```

```
/****** OPERATION NAME (OPCODE) [6 bits] *****/
```

```
// |I| lw: 0x00000023 |I| sw: 0x0000002B
// |I| beq: 0x00000004 |I| bne: 0x00000005
```

```
char operation_name[30];
switch (opcode) {
    case 0x00000023:
        strcpy(operation_name, "lw");
        break;
    case 0x0000002B:
        strcpy(operation_name, "sw");
        break;
    case 0x00000004:
        strcpy(operation_name, "beq");
        break;
    case 0x00000005:
        strcpy(operation_name, "bne");
        break;
```

```
        default:
            strcpy(operation_name, "ERROR! Something went wrong!");
            break;
    }

    printf("Operation name: %s\n", operation_name);

    /***** FINAL OUTPUT *****/

    printf("\n---> Assembly instruction: ");
    // if a branch:
    // program counter (PC) / instruction pointer (IP) would be pointed
    // at next instruction
    int instruction_pointer = (memory_address + 4);
    // branch_to instruction is based on IP,
    // with the constant/offset shifted right by two bits,
    // so shift left the constant/offset to recover actual byte offset
    int branch_to = (instruction_pointer + (constant_offset << 2));
    if (opcode == 0x00000004 || opcode == 0x00000005) {
        printf("0x%x: %s %d,%d (branch to: 0x%x) <---\n\n",
            memory_address, operation_name, rs,
            rt, branch_to);
    }
    else {
        printf("0x%x: %s %d,%d($%d) <---\n\n",
            memory_address, operation_name, rt,
            constant_offset, rs);
    }

} // end: else (i.e., opcode != 0)

// increment memory address before next loop
memory_address += 4;

} // end: for (int instr_index = 0; instr_index < 11; instr_index++)

return 0;
}
```