
CS2100 Computer Organization

Tutorial #4: Datapath

16 – 20 September 2024

1. An ISA has 16-bit instructions and 5-bit addresses. There are two classes of instructions: class A instructions have one address, while class B instructions have two addresses. Both classes exist and the encoding space for the opcode is completely utilized. Please answer the questions below.

(a) What is the minimum total number of instructions?

(b) What is the maximum total number of instructions?

(Past year's exam question)

2. You have seen how the `blt` (“branch less than”) instruction can be implemented in the lecture slides. As we know, MIPS assembly also allows for *pseudo-instructions* which the assembler will expand to multiple instructions to implement the functionality. Show how the following pseudo-instructions are implemented using real MIPS instructions:

(a) `bgt $r1, $r2, L` (“branch greater than”)

(b) `bge $r1, $r2, L` (“branch greater than or equal”)

(c) `ble $r1, $r2, L` (“branch less than or equal”)

(d) `li $r, imm` (“load immediate” where the immediate can be any length up to 32-bits))

(e) `nop` (“no operation”, i.e. a null operation)

3. Convert the following MIPS instructions to its corresponding hexadecimal equivalent.

(a) `beq $1, $3, 12`

(b) `lw $24, 0($15)`

(c) `sub $25, $20, $5`

4. Draw the MIPS datapath for the following instruction. Make sure that you specify the necessary bits on any lines you draw.

`addi $15, $14, -50`

5. **For Fun** ☺: This question is all about some extra ‘fun’ learning, if you choose to ☺. We have heard a lot about GPUs (Graphics Processing Unit) in the news off late, especially in relation to the advancements in Machine Learning and AI. Given you are learning how to build a simple CPU, how are GPUs different to CPUs from an architecture perspective?