Computer Organization (IS F242)

Lect 22: MIPS Architecture

Amdahl's Law

- Improving an aspect of a computer and expecting a proportional improvement in overall performance

$$T_{\text{improved}} = \frac{T_{\text{affected}}}{\text{improvement factor}} + T_{\text{unaffected}}$$

Suppose a program runs in 100 seconds on a machine, with multiply responsible for 80 seconds of this time.

How much do we have to improve the speed of multiplication if we want the program to run 4 times faster?

  - How much improvement in multiply performance to get 5× overall?

$$20 = \frac{80}{n} + 20$$

  - Can't be done!

- Corollary: make the common case fast

MIPS as a Performance Metric

- MIPS: Millions of Instructions Per Second
  - Doesn't account for
    - Differences in ISAs between computers
    - Differences in complexity between instructions

$$\text{MIPS} = \frac{\text{Instruction count}}{\text{Execution time} \times 10^6}$$

$$= \frac{\text{Instruction count}}{\frac{\text{Instruction count} \times \text{CPI}}{\text{Clock rate}} \times 10^6} = \frac{\text{Clock rate}}{\text{CPI} \times 10^6}$$

- CPI varies between programs on a given CPU

MIPS Architecture

Microprocessor without
Interlocked Pipeline Stages

Registers and their Uses in MIPS

$zero	0	The constant value 0
$at	1	Assembler Temporary
$v0 - $v1	2-3	Values for function results and Expression evaluation
$a0 - $a3	4-7	Arguments
$t0 - $t7	8-15	Temporaries
$s0 - $s7	16-23	Saved temporaries
$t8 - $t9	24-25	Temporaries
$k0 - $k1	26-27	Reserved for OS Kernel
$gp	28	Global Pointer
$sp	29	Stack Pointer
$fp	30	Frame Pointer
$ra	31	Return Address

Registers in MIPS

Preserved	Not Preserved
Saved Registers: \$s0 - \$s7	Temporary registers: \$t0 - \$t9
Stack pointer register: \$sp	Argument registers: \$a0 - \$a3
Return address register: \$ra	Return value registers: \$v0, \$v1
Stack above the stack pointer	Stack below the stack pointer