Outline

•Measuring Performance

Measuring Performance 1/5

CPU clock cycles = Instructions count * CPI

CPU time = CPU clock cycles * clock cycle time

CPU time = Instruction count * CPI * clock cycle time

CPU time = Instruction count * CPI/clock rate

$$Time = \frac{Instructions}{Program} * \frac{Clockcycles}{Instruction} * \frac{Seconds}{clockcycle}$$

Basic Performance Components

- CPU execution time
- Instruction count
- CPI
- Clock cycle time

Measuring Performance 2/5

How to determine values of performance components

- CPU execution time: measurement (i.e. using *time* utility)
- Clock cycle time: published as part of documentation for a machine
- Instruction count:
  - Software tools to profile execution, or use a simulator of the architecture
  - Hardware counters if available to measure the # of instructions executed
- CPI: varies by application , as well as among implementations within the same instruction set. Obtained through a detailed simulation or by combining HW counters and simulation

CPI Can be calculated if different types of instructions and individual clock cycle counts are known

Measuring Performance 3/5

$$\text{CPU clock cycles} = \sum_{i=1}^{n} (CPI_i * C_i)$$

C_i: number of instructions of class i executed

CPI_i: average number of cycles per instruction for that instruction class

***n*: number of instruction classes**

Overall program CPI dependent on

- Number of cycles for each instruction type
- Frequency of each instruction type in the program execution

Measuring Performance 4/5

$$Performance = \frac{1}{ExecutionTime}$$

CPU time = CPU clock cycles * clock cycle time

CPU time = CPU clock cycles for a program / clock rate

CPU clock cycles = Instructions for a program * CPI

CPU time = Instruction count * CPI * clock cycle time

CPU time = Instruction count * CPI/clock rate

$$\text{CPU clock cycles} = \sum_{i=1}^{n} (CPI_i * C_i)$$

Measuring Performance

A compiler designer is trying to decide between two code sequences for a particular computer. The hardware designers have supplied the following facts:

	CPI for this instruction class		
	A	B	C
CPI	1	2	3

Code sequence	Instruction counts for instruction class		
	A	B	C
1	2	1	2
2	4	1	1

Which code sequence executes the most instructions? Which will be faster? What is the CPI for each sequence?

Which code sequence (program) executes the most instructions?

Sequence 1 executes 2 + 1 + 2 = 5 instructions

Sequence 2 executes 4 + 1 + 1 = 6 instructions

Hence, sequence 2 executes the most instructions **Ans.**

Which will be faster?

$$\text{CPU clock cycles} = \sum_{i=1}^{n} (\text{CPI}_i \times \text{C}_i)$$

$$\text{CPU clock cycles}_1 = (2 \times 1) + (1 \times 2) + (2 \times 3) = 2 + 2 + 6 = 10 \text{ cycles}$$

$$\text{CPU clock cycles}_2 = (4 \times 1) + (1 \times 2) + (1 \times 3) = 4 + 2 + 3 = 9 \text{ cycles}$$

Hence, sequence 2 is faster **Ans.**

What is the CPI for each sequence?

CPI for sequence 1 = 10 cycles / 5 instructions = 2.0

CPI for sequence 2 = 9 cycles / 6 instructions = 1.5