


Administrative Matters

- Homework #3
 - due Monday, 10/22
 - Please read chapter 4 ahead of the lecture
- Midterm #1
 - Wednesday 10/24
 - Cumulative
 - Chapter 1-4
 - Homework 1-3
 - Quiz 1-2

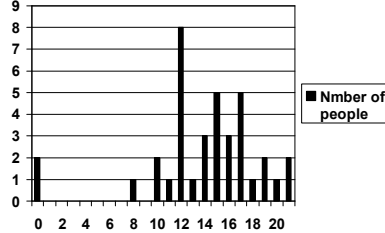


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Quiz 2

- Average: 14.74 (C)
- 21: 2
- 20: 1
- 19: 2
- 18: 1
- 17: 5
- 16: 3
- 15: 5
- 14: 3
- 13: 1
- 12: 8
- 11: 1
- 10: 2
- 9: 0
- 8: 1
- NC: 2



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Chapter 4

Assessing and Understanding Performance

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Performance

- Measure, Report, and Summarize
- Make intelligent choices
- See through the marketing hype
- Key to understanding underlying organizational motivation

Why is some hardware better than others for different programs?

What factors of system performance are hardware related? (e.g., Do we need a new machine, or a new operating system?)


How does the machine's instruction set affect performance?

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Which of these airplanes has the best performance?

Airplane	Passengers	Range (mi)	Speed (mph)
Boeing 737-100	101	630	598
Boeing 747	470	4150	610
BAC/Sud Concorde	132	4000	1350
Douglas DC-8-50	146	8720	544



- Which one is the fastest?
 - Concorde
- Which one is the fastest if we have 450 passengers?
 - 747
- How much faster is Concorde compared to the 747?
 - 1350/610
- How much bigger is the 747 than the Douglas DC-8?
 - 470/146

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Computer Performance

- Response Time (latency)
 - How long does it take for my job to run?
 - How long does it take to execute a job?
 - How long must I wait for the database query?
- Throughput
 - How many jobs can the machine run at once?
 - What is the average execution rate?
 - How much work is getting done?

- If we upgrade a machine with a new processor what do we increase?
 - Both
- If we add a new machine to the lab what do we increase?
 - Throughput
- What if the jobs are queued up?
 - Both

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Execution Time

- **Elapsed/Response time**
 - counts everything (disk and memory accesses, I/O, etc.)
 - what the user actually experiences
 - a useful number, but often not good for comparison purposes
- **CPU execution time**
 - doesn't count I/O or time spent running other programs
 - can be broken up into system time, and user time
 - But not what the user actually feels
- **Our focus: user CPU time**
 - time spent executing the lines of code that are "in" our program

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Definition of Performance

- For some program running on machine X,

$$\text{Performance}_x = 1 / \text{Execution time}_x$$
- "X is n times faster than Y"

$$\text{Performance}_x / \text{Performance}_y = n$$
- **Example:**
 - machine A runs a program in 20 seconds
 - machine B runs the same program in 25 seconds
 - A is 1.25 times faster
- **Improve execution time = decrease execution time**

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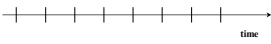
Quick Questions

- Suppose we know that an application that uses both a desktop client and a remote server is limited by network performance. For the following changes state whether only the throughput improves, both response time and throughput improve, or neither improves.
 - An extra network channel is added between the client and the server, increasing the total network throughput and reducing the delay to obtain network access (since there are now two channels)
 - The networking software is improved, thereby reducing the network communication delay, but not increasing throughput
 - More memory is added to the computer
- Computer C's performance is 4 times better than the performance of computer B, which runs a given application in 28 seconds. How long will computer C take to run that application?

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Clock Cycles

- Instead of reporting execution time in seconds, we often use cycles

$$\frac{\text{seconds}}{\text{program}} = \frac{\text{cycles}}{\text{program}} \times \frac{\text{seconds}}{\text{cycle}}$$
- Clock "ticks" indicate when to start activities:
 
- cycle time = time between ticks = seconds per cycle
- clock rate (frequency) = cycles per second (1 Hz = 1 cycle/sec)
- A 4 Ghz. clock has a $\frac{1}{4 \times 10^9} \times 10^{12} = 250$ picoseconds (ps) cycle time

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How to Improve Performance

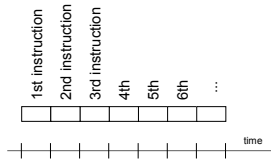
$$\frac{\text{seconds}}{\text{program}} = \frac{\text{cycles}}{\text{program}} \times \frac{\text{seconds}}{\text{cycle}}$$

- So, to improve performance (everything else being equal) you can either
 - ↓ the # of required cycles for a program, or
 - ↓ the clock cycle time or, said another way,
 - ↑ the clock rate.

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How many cycles are required for a program?

- Could assume that number of cycles equals number of instructions?

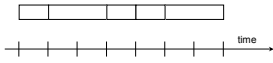


This assumption is incorrect, different instructions take different amounts of time on different machines.

Why?

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Different numbers of cycles for different instructions



- Multiplication may take more time than addition
- Floating point operations may take longer than integer ones
- Accessing memory may take more time than accessing registers
- *Changing the cycle time often changes the number of cycles required for various instructions*
 - *Longer cycle time can do more*