Performance

We say that a computer has better performance than another if the **response time**/**execution time** is smaller than the other. The **response time** is the time which a computer needs in order to finish a task.

We also say that a computer has better performance if a computer has more **throughput**/**bandwidth** which refers to the total amount of work done in a given time.

So, we can define performance as: $Performance = \frac{1}{Execution\ time}$

So, if we have to computers X and Y we say that "X is **n** times faster than Y" with this formula: $\frac{Performance_X}{Performance_Y} = \boldsymbol{n}$.

How do we measure performance in computers? First, we need to know the execution time of a program. The CPU does a lot of tasks at the same time, so if we want to measure a specific time, we need to check the **CPU time**, which is the time that the CPU spends in that task.

We measure this time with the next formulas:

$$\text{CPU execution time for a program} = \text{CPU clock cycles for a program} \times \text{Clock cycle time}$$

$$\text{CPU execution time for a program} = \frac{\text{CPU clock cycles for a program}}{\text{Clock rate}}$$

These formulas say how much time spends a computer with a task, but we can be more specific trying to know the **instructions** it does per clock cycle, the **clock cycles per instruction CPI**.

$$\text{CPU clock cycles} = \text{Instructions for a program} \times \text{Average clock cycles per instruction}$$

Having the CPI, we can take the CPU time with the next formula:

$$\text{CPU time} = \text{Instruction count} \times \text{CPI} \times \text{Clock cycle time}$$

Instruction count refers to the number of instructions done.

$$\text{CPU time} = \frac{\text{Instruction count} \times \text{CPI}}{\text{Clock rate}}$$

Amdahl's law

With the amdahl's law we can see the overall improvement in a given machine:

$$Speedup_{Overall} = \frac{Execution\ time_{old}}{Execution\ time_{new}}$$

$$Speedup_{Overall} = \frac{1}{(1 - Fraction_{enhanced}) + \frac{Fraction_{enhanced}}{Speedup_{enhanced}}}$$

The amdahl's law states that the performance enhancement possible with a given improvement is limited by the amount that the improved feature is used.

There are more metrics used in order to measure the performance of a computer.

MIPS, millions of instructions per seconds:

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

MFLOPS, millions of floating-point operations per second.

$$\text{MFLOPS} = \frac{\text{Floating point instruction count}}{\text{Execution time} \leftrightarrow 10^6}$$

Info Adicional: Fórmulas y relaciones útiles para los ejercicios

T_{CPU} = NI x CPI x T_{CICLO} =
= NroCiclosReloj / FreqReloj

$$\text{Rendimiento}(X) = 1 / T_{EJEC}(X)$$

X es n veces más rápido que Y significa:

$$n = \frac{\text{Rendimiento}(X)}{\text{Rendimiento}(Y)} = \frac{T_{EJEC}(Y)}{T_{EJEC}(X)}$$

Una mejora en el sistema se mide con la:

$$\textit{Aceleración} = \frac{T_{EJ}(\text{sin mejora})}{T_{EJ}(\text{con mejora})} = \frac{R(\text{con m.})}{R(\text{sin m.})}$$

La ***ley de Amdahl*** mide la mejora del rendimiento global de un sistema. Donde:

F_m: Fracción de tiempo mejorada y Acc_m: Aceleración mejorada

$$Acc_{global} = \frac{1}{(1 - F_m) + \frac{F_m}{Acc_m}}$$

La ***ley de Amdahl*** para varias mejoras:

$$Acc_{global} = \frac{1}{1 - \sum_{i=1}^{n} F_{m,i} + \sum_{i=1}^{n} \frac{F_{m,i}}{Acc_{m,i}}}$$

$$\text{MIPS} = \text{NI} / (T_{CPU} \times 10^6) = \text{NI} / (\text{NI} \times \text{CPI} \times T_{Ciclo} \times 10^6) = \text{Frec} / (\text{CPI} \times 10^6)$$