Example (2.3, pag 60)

- **Our favorite program runs in 10 seconds on computer A, which has a 400 Mhz. clock. We are trying to help a computer designer build a new machine B, that will run this program in 6 seconds. The designer can use new (or perhaps more expensive) technology to substantially increase the clock rate, but has informed us that this increase will affect the rest of the CPU design, causing machine B to require 1.2 times as many clock cycles as machine A for the same program. What clock rate should we tell the designer to target?"**

t_{CPU-A} = (Nº de períodos)$_A$ / f_{CK-A}

10 s = (Nº de períodos) $_A$ / 400 MHz ⇒ (Nº de períodos) $_A$ = 4 E+09

t_{CPU-B} = (Nº de períodos)$_B$ / f_{CK-B}

6 s = 1.2 * (Nº de períodos) $_A$ / f_{CK-B} = 4.8 E+09 / f_{CK-B}

f_{CK-B} = 4.8 E+09 / 6 s = 0.8 GHz = 800 MHz ⇒ f_{CK-B} = 2* f_{CK-A}

of Instructions Example (pag 64)

A compiler designer is trying to decide between two code sequences for a particular machine. Based on the hardware implementation, there are three different classes of instructions: Class A, Class B, and Class C, and they require one, two, and three cycles (respectively).

The first code sequence has 5 instructions: 2 of A, 1 of B, and 2 of C
The second sequence has 6 instructions: 4 of A, 1 of B, and 1 of C.

Which sequence will be faster? How much?

Nº de períodos = $\sum_{i=1}^{n} (CPI_i \ x \ C_i)$

- Nº de períodos1 = (2*1)+(1*2)+(2*3) = 2+2+6 = 10 ciclos
- Nº de períodos2 = (4*1)+(1*2)+(1*3) = 4+2+3 = 9 ciclos ⇐ mais rápida

What is the CPI (average) for each sequence? $CPI_{ave} = \frac{(N^o \ de \ ciclos)}{IC}$

CPI1 = 10/5 = 2 CPI2 = 9 / 6 = 1.5

Lei de Amdhal (2.7, pag 75)

- "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?"**

  $Comp_A$ e $Comp_M$ (melhorias na multiplicação por fator k)

  T_{CPU-M} = (tempo operações afetadas)/k + (tempo operações não afetadas)

  T_{CPU-A} = 100 s dos quais 80 s em multiplicação

  $T_{CPU-M} = (80)/k + (20) = 100 / 4 = 25 \Rightarrow (80)/k = 5 \Rightarrow \mathbf{k = 16}$

- How about making it 5 times faster?

  $T_{CPU-M} = (80)/k + (20) = 100 / \mathbf{5} = \mathbf{20} \Rightarrow (80)/k = \mathbf{0} \Rightarrow \mathbf{k =} \infty$ (impossível)

Example

- Suppose we enhance a machine making all floating-point instructions run five times faster. If the execution time of some benchmark before the floating-point enhancement is 10 seconds, what will the speedup be if half of the 10 seconds is spent executing floating-point instructions?

  Tm= 5/5 + 1 = 6 $\Rightarrow$ Tm/T = 0.6 $\Rightarrow$ redução de 40%

- We are looking for a benchmark to show off the new floating-point unit described above, and want the overall benchmark to show a speedup of 3. One benchmark we are considering runs for 100 seconds with the old floating-point hardware. How much of the execution time would floating-point instructions have to account for in this program in order to yield our desired speedup on this benchmark?

  100/3 = 33.3 = (100 * p) / 5 + 100 * (1-p) = 20p + 100 - 100p = 100 - 80p

  p = 100 * (2/3) / 80 = 20 / 24 = 5/6