- Arithmetic average of execution time of all pgms?
  - But they vary by 4X in speed, so some would be more important than others in arithmetic average
- Could add a weights per program, but how pick weight?
  - Different companies want different weights for their products
- SPECRatio: Normalize execution times to reference computer, yielding a ratio proportional to performance =

$$\frac{\text{time on reference computer}}{\text{time on computer being rated}}$$

- If program SPECRatio on Computer A is 1.25 times bigger than Computer B, then

$$1.25 = \frac{SPECRatio_A}{SPECRatio_B} = \frac{\dfrac{ExecutionTime_{reference}}{ExecutionTime_A}}{\dfrac{ExecutionTime_{reference}}{ExecutionTime_B}}$$

$$= \frac{ExecutionTime_B}{ExecutionTime_A} = \frac{Performance_A}{Performance_B}$$

- Note that when comparing 2 computers as a ratio, execution times on the reference computer drop out, so choice of reference computer is irrelevant

- Since ratios, proper mean is geometric mean (SPECRatio unitless, so arithmetic mean meaningless)

$$GeometricMean = \sqrt[n]{\prod_{i=1}^{n} SPECRatio_i}$$

- 2 points make geometric mean of ratios attractive to summarize performance:

1. Geometric mean of the ratios is the same as the ratio of the geometric means
2. Ratio of geometric means
   = Geometric mean of performance ratios
   ⇒ choice of reference computer is irrelevant!

Weighted Arithmetic Mean. For many cases, computing an equal-weight arithmetic mean will give misleading results. Care must be taken when events occur at different fractions of the total events and each event requires a different amount of time. The weighted time per event is the weighted arithmetic mean, defined as

$$\text{weighted arithmetic mean} = \sum_{i=1}^{n} W_i T_i.$$

The weighted arithmetic mean is the central tendency of time per unit of work. W_i is the fraction that operation i is of the total operations, and T_i is the time consumed by each use. Note that $W_1 + W_2 + \cdots + W_n = 1$ and that W_i is not the fraction of time that the operation is in use.

EXAMPLE

A processor has two classes of instructions: class A instructions take two clocks to execute whereas class B instructions take three clocks to execute. Of all the instructions executed, 75% are class A instructions and 25% are class B instructions. What is the CPI of this processor?

Solution

The observations are in time and are weighted. Thus the CPI of the processor is determined by the weighted arithmetic mean:

$$\text{CPI} = W_{\text{A}}\,\text{CPI}_{\text{A}} + W_{\text{B}}\,\text{CPI}_{\text{B}},$$

$$\text{CPI} = (0.75 \times 2) + (0.25 \times 3) = 1.5 + 0.75 = 2.25 \text{ clocks per instruction}$$

Comment

When solving a problem such as this one, add the event probabilities together and verify that the sum is one; if the sum is not equal to one, there is some error in the solution. A good practice is to use a table, as shown in Table 2.1, for the solution of these problems rather than attempt to bind variables to an equation.