Amdahl’s law

- Amdahl's law states that the performance improvement to be gained from using some faster mode of execution is limited by the fraction of the time the faster mode can be used. Also known as speedup, which can be defined as the maximum expected improvement to an overall system when only part of the system, is improved.

Amdahl’s law

- The performance gain that can be obtained by improving some portion of a computer can be calculated using Amdahl’s Law.
- Amdahl’s Law states that the performance improvement to be gained from using some faster mode of execution is limited by the fraction of time the faster mode can be used.
- defines the speedup that can be gained by using a particular feature.

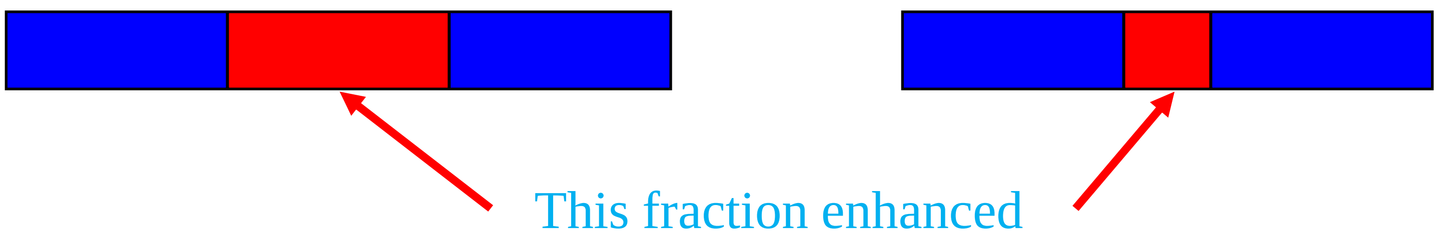
Amdahl's Law (1/5)

- Speedup is the ratio

$$\text{Speedup} = \frac{\text{Performance for entire task using enhancement when possible}}{\text{Performance for entire task without using the enhancement}}$$

  – Alternatively,

$$\text{Speedup} = \frac{\text{Execution time for entire task without using the enhancement}}{\text{Execution time for entire task using enhancement when possible}}$$



  – Two major reasons of Speedup enhancement
    - $\text{Fraction}_{\text{enhanced}}$: the fraction of the execution time in the original machine that can be converted to take advantage of the enhancement (≦1).
    - $\text{Speedup}_{\text{enhanced}}$: the improvement gained by the enhanced execution mode (≧1).

Amdahl’s law

$$Speedup = \frac{Execution\ time\ for\ task\ without\ enhancement}{Execution\ time\ for\ task\ with\ enhancement}$$

- Execution time using the enhancement can be thought of as the amount of time the unenhanced fraction takes (which is 1 − $Fraction^{enhanced}$) plus the length of time the enhanced fraction takes.

$$Speedup = \frac{Execution\ time\ old}{Execution\ time_{\ new}} = \frac{1}{(1 - Fraction_{enhanced}) + \frac{Fraction_{enhanced}}{Speedup_{enhanced}}}$$

Example 1

- We are considering an enhancement to the processor of a web server. The new CPU is 20 times faster on search queries than the old processor. The old processor is busy with search queries 70% of the time, what is the speedup gained by integrating the enhanced CPU?

Solution

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

$Fraction_{enhanced} = 70\ \% = 0.70$

$Speedup_{enhanced} = 20$

$$Speedup = \frac{1}{(1 - 0.70) + \frac{0.70}{20}} = \frac{1}{0.335} = 2.985$$

Example #2

- Suppose that we want to enhance the processor used for Web server. The new processor is 10 times faster on computation in the Web serving application than the original processor. Assuming that the original processor is busy with computation 40% of the time and is waiting for I/O 60% of the time, what is the overall speedup gained by incorporating the enhancement?

Example #2:Solution

$\text{Fraction}_{\text{enhanced}}$ = 40% = 0.4

$\text{Speedup}_{\text{enhanced}}$ = 10

$$\text{Speedup}_{\text{overall}} = \frac{1}{(1-0.4)+\frac{0.4}{10}} = \frac{1}{0.6+0.04} = \frac{1}{0.64} \approx 1.56$$

Amdahl's Law can serve as a guide to how much an enhancement will improve performance and how to distribute resources to improve cost-performance.