*Amdahl's Law*

## What is Amdahl's Law?

Amdahl's Law is an important concept in parallel computing. It relates to the parts of system which decrease the performance of the task, that is why it is used to calculate how much a computation can be sped up by running part of it in parallel. There are two parts of Amdahl's Law; one part is that can be parallelized and the other part is that cannot be parallelized.

## Mathematical Definition:

$$T = B + (T-B)$$

where $T$ is the total time of serial execution, $B$ is the total time of non-parallelized part, and $T-B$ is the total time of parallelized part.

T-B's speed depends on how many threads or processors are applied to parallelize it. The number of threads or processors used are represented with N. So, the formula becomes:

$$T(N) = B + (T-B) / N$$

This indicates the total execution time of program with respect to N i.e. number of threads/processors used.

## Formula:

$$speed = 1 / ( (1-p) + (p/s) )$$

where *speed* is the max amount of improvement in a system, $p$ is the part that can be improved (so *1-p* is the part that cannot be improved – performance is already efficient), $s$ is the performance improvement factor of $p$ after applying enhancements.

## Example #1:

Calculate the speed improvement if the part that can be improved is 25% of the overall system and it's performance is doubled.

*Solution:*

s = 2, p = 0.25

Speed = 1 / ( (1-0.25) + (0.25/2) ) = 1.14


## Example #2:

Calculate the speed improvement if the part that can be improved is 75% of the overall system and it's performance is doubled.


*Solution:*

s = 2, p = 0.75

Speed = 1 / ( (1-0.75) + (0.75/2) ) = 1.6


## Conclusion:

These two examples indicate that the more the parts that can be improved are improved, the more speed is seen i.e. performance improves. If the *p* is less i.e. the room for improvement is less, the less will be the overall maximum speed of the system.

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