Basics: Parameters and Performance Metrics

Parameters: Number of processors, p and problem size, n.

Metrics:

- For the problem itself
  - (Sequential) complexity, $T_S(n)$
- For a given parallel program
  - Execution time, $T(n,p)$
  - Cost (or Work) $W(n,p) = pT(n,p)$
  - Speedup, $S(n,p) = \frac{T_S(n)}{T(n,p)}$
  - Efficiency, $E(n,p) = \frac{S(n,p)}{p} = \frac{T_S(n)}{pT(n,p)}$

Properties

- $T_S(n) \leq T(n, 1)$
- $S(n, p) \leq p$, or $E(n, p) \leq 1$

Amdahl's Law

Let sequential time be T which consists of an inherently sequential fraction α, the remaining $1-\alpha$ fraction being perfectly parallelizable. Then

$$
\begin{aligned}
T &= \alpha T + (1-\alpha)T \\
T(n,p) &= T\left(\alpha + \frac{1-\alpha}{p}\right) \\
S(n,p) &= \frac{T}{T(n,p)} = \frac{1}{\alpha + \frac{1-\alpha}{p}} \\
\lim_{p \longrightarrow \infty} S(n,p) &= \frac{1}{\alpha}
\end{aligned}
$$

Example: Sieve of Eratosthenes

```
int primes[n], i, j, this;

primes[0] = primes[1] = 0;
for (i=2; i<sqrt(n); i++) {
    if (!primes[i]) continue;
    this = i;
    for (j=this*this; j<n; j += this)
        primes[i] = 0;
}
```