Models: What is the computational environment?

Algorithm design is an interplay between a given problem and the computational environment.

Multiple processors are available so that one can speed up execution. Multicore architecture.

Suppose we have $p > 1$ processors available, then ideally we should aim for a $p$-fold speedup.

If $T(n)$ is the sequential running time then we should target $\frac{T(n)}{p}$ parallel running time.

When $p$ is also large, $\sim \sqrt{n}$.
Parallel RAM model (PRAM)

- Each process can communicate its data to a neighboring process in unit time.
- All processes communicate concurrently on a cycle.
- These steps are synchronized (global clock)

Basic step is compare-exchange

Odd-even transposition sort

Compare odd-even and even-odd pairs

for \( k \) iterations

\[ k = \frac{n}{2} \]

Overall we have sorted \( n \) elements in \( n \) parallel steps using \( n \) processors

0-1 principle: If any sorting algorithm sorts all combinations of \( \{0,1\}^n \) correctly, then it sorts any arbitrary input correctly (contaminated input)
If we can show that all the $2^n$ possibilities are sorted correctly then the algorithm works for any input.

A sorted 0-1 output looks like

```
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1
2 5 20 1
D D D D D D
6 1 2 3 4
```

$\sqrt{n}$