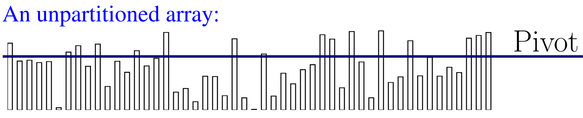
What is The Partition Problem?

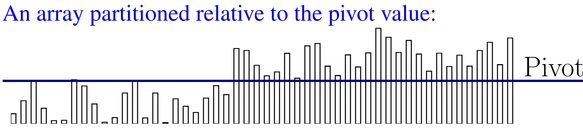
Explanation: The *Partition Problem* is to reorder the elements in a list so that elements in the same group occur in the same part of the list.

Example: A common way of grouping elements is based on whether they exceed or fall short of a certain "pivot" value.

An unpartitioned array:



An array partitioned relative to the pivot value:

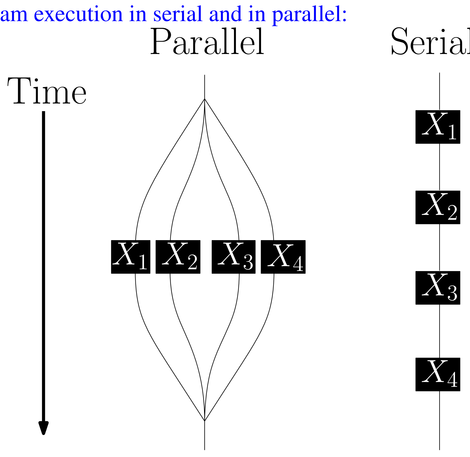


What is A Parallel Algorithm?

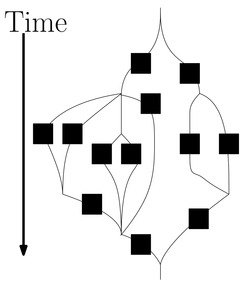
Explanation: Whereas a typical (i.e. serial) algorithm runs on a single processor, a *parallel algorithm* runs on $p \geq 1$ processors. In our model of parallelism, the only concurrency mechanism that we use is parallel-for-loops; in particular we do not use locks or atomic variables. We chose this model of parallelism because it makes our algorithms Exclusive Read Exclusive Write (EREW).

Example: Many tasks have parts that can be performed concurrently; such tasks can be performed faster with parallel computing.

Program execution in serial and in parallel:



Performance Metrics for Parallel Algorithms



Important extreme cases:

Work: T_1
- time to run in serial
- "sum of all work"

Span: T_∞
- time to run on infinitely many processors
- "height of the graph"

What is Cache Efficiency?

Explanation: *Cache* is a small part of memory that can be accessed much faster than ordinary RAM. When data is already loaded into Cache a program can rapidly access it; this is called a *cache hit*. When data needed by a program isn't in cache it must be loaded into cache; this is called a *cache miss*, and takes time.

Remark: An algorithm with very few cache misses is *Cache Efficient*; cache efficiency leads to faster performance in practice.

Factors in Cache-Efficiency:
- Perform low number of passes over the data
- Don't use extra memory, i.e. are *In-Place*
- Deal with elements that are close in memory together

Previous Work on the Partition Problem

The "Standard Algorithm" is theoretically optimal with span $O(\log n)$, but slow in practice due to poor cache behavior.

The fastest algorithms in practice lack theoretical guarantees

- Lock-based and atomic-variable based algorithms

  [Michael Axtmann, Sascha Witt, Daniel Ferizovic, and Peter Sanders, 2017; Philip Heidelberger, Alan Norton, and John T. Robinson, 1990; Philippas Tsigas and Yi Zhang, 2003]

  Not Exclusive Read/Write Memory
- The Strided Algorithm

  [Francis and Pannan, 92; Frias and Petit, 08]

  No locks or atomic-variables, but no bound on span