http://www.llnl.gov/computing/tutorials/parallel_comp/

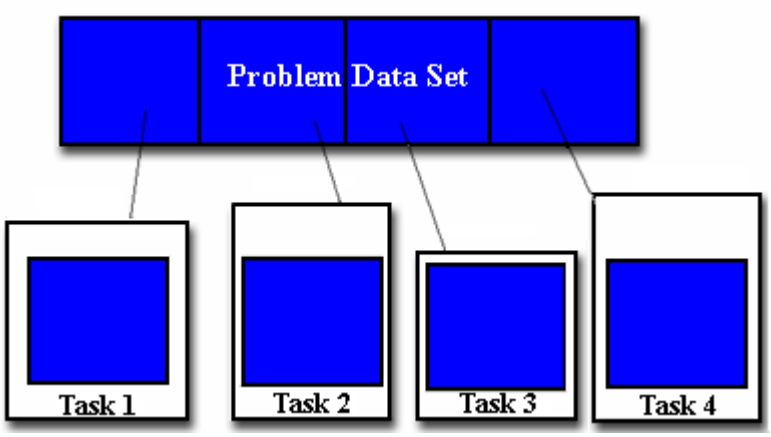
Designing Parallel Programs

Partitioning

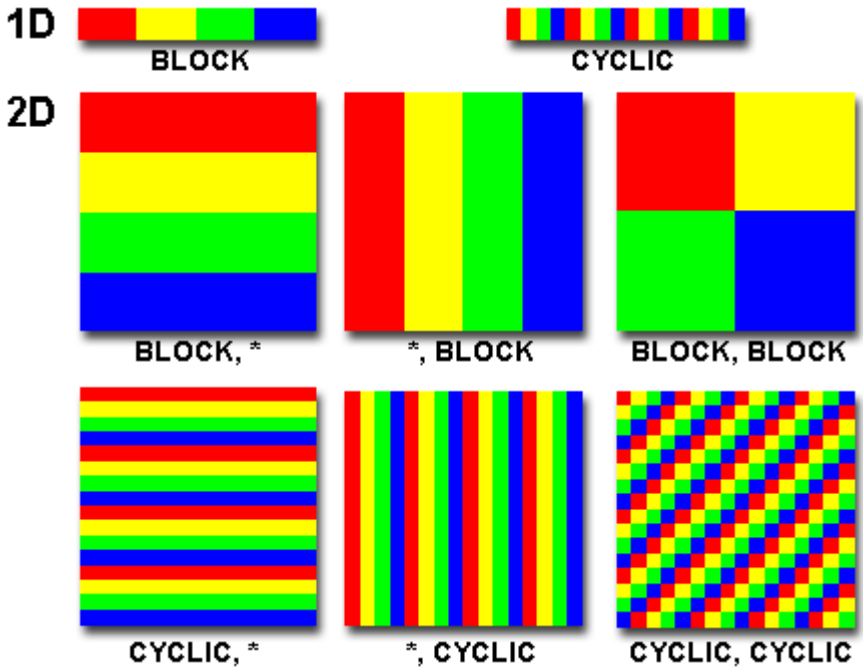
- One of the first steps in designing a parallel program is to break the problem into discreet "chunks" of work that can be distributed to multiple tasks. This is known as decomposition or partitioning.
- There are two basic ways to partition computational work among parallel tasks: ***domain decomposition*** and ***functional decomposition***.

Domain Decomposition:

- In this type of partitioning, the data associated with a problem is decomposed. Each parallel task then works on a portion of of the data.

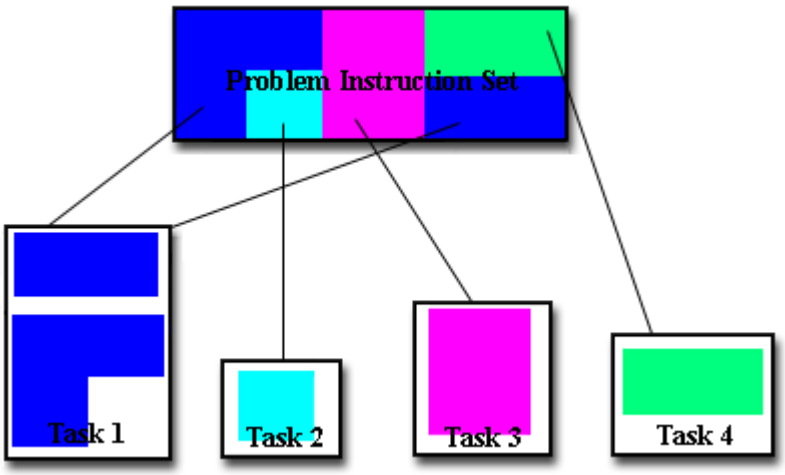


- There are different ways to partition data:



Functional Decomposition:

- In this approach, the focus is on the computation that is to be performed rather than on the data manipulated by the computation. The problem is decomposed according to the work that must be done. Each task then performs a portion of the overall work.



- Functional decomposition lends itself well to problems that can be split into different tasks. For example:
  - Ecosystem Modeling - This diagram shows five processes, each running a different program. Each program calculates the population of a given group, where each group's growth depends on that of its neighbors. As time progresses, each process calculates its current state, then exchanges information with the neighbor populations. All tasks then progress to calculate the state at the next time step.
  - Signal Processing - An audio signal data set is passed through three distinct computational filters. Each filter is a separate process. The first

segment of data must pass through the first filter before progressing to the second. When it does, the second segment of data passes through the first filter. By the time the third segment of data is in the first filter, all three tasks are busy.
    - Climate Modeling - Each model component can be thought of as a separate task. Arrows represent exchanges of data between components during computation: the atmosphere model generates wind velocity data that are used by the ocean model, the ocean model generates sea surface temperature data that are used by the atmosphere model, and so on.
- Combining these two types of problem decomposition is common and natural.