9.3   Flynn's Taxonomy
- Many attempts have been made to come up with a way to categorize computer architectures.
- *Flynn's Taxonomy* has been the most enduring of these, despite having some limitations.
- Flynn's Taxonomy takes into consideration the number of processors and the number of data paths incorporated into an architecture.
- A machine can have one or many processors that operate on one or many data streams
- The four combinations of multiple processors and multiple data paths are described by Flynn as:
    - SISD: Single instruction stream, single data stream. These are classic uniprocessor systems.
    - SIMD: Single instruction stream, multiple data streams. Execute the same instruction on multiple data values, as in vector processors.
    - MIMD: Multiple instruction streams, multiple data streams. These are today's parallel architectures.
    - MISD: Multiple instruction streams, single data stream.
- Flynn's Taxonomy falls short in a number of ways:
    - First, there appears to be no need for MISD machines.
    - Second, parallelism is not homogeneous. This assumption ignores the contribution of specialized processors.
    - Third, it provides no straightforward way to distinguish architectures of the MIMD category.
        - One idea is to divide these systems into those that share memory, and those that don't, as well as whether the interconnections are bus-based or switch-based.
- Symmetric multiprocessors (SMP) and massively parallel processors (MPP) are MIMD architectures that differ in how they use memory.
- SMP systems share the same memory and MPP do not.
- An easy way to distinguish SMP from MPP is:
    - MPP $\Rightarrow$ many processors + distributed memory + communication via network
    - SMP $\Rightarrow$ fewer processors + shared memory +   communication via memory
- Other examples of MIMD architectures are found in distributed computing, where processing takes place collaboratively among networked computers.
    - A **network of workstations** (NOW) uses otherwise idle systems to solve a problem.
    - A **collection of workstations** (COW) is a NOW where one workstation coordinates the actions of the others.
    - A **dedicated cluster parallel computer** (DCPC) is a group of workstations brought together to solve a specific problem.
    - A **pile of PCs** (POPC) is a cluster of (usually) heterogeneous systems that form a dedicated parallel system.
- Flynn's Taxonomy has been expanded to include SPMD (single program, multiple data) architectures.

- Each SPMD processor has its own data set and program memory. Different nodes can execute different instructions within the same program using instructions similar to:
    If myNodeNum = 1 do this, else do that
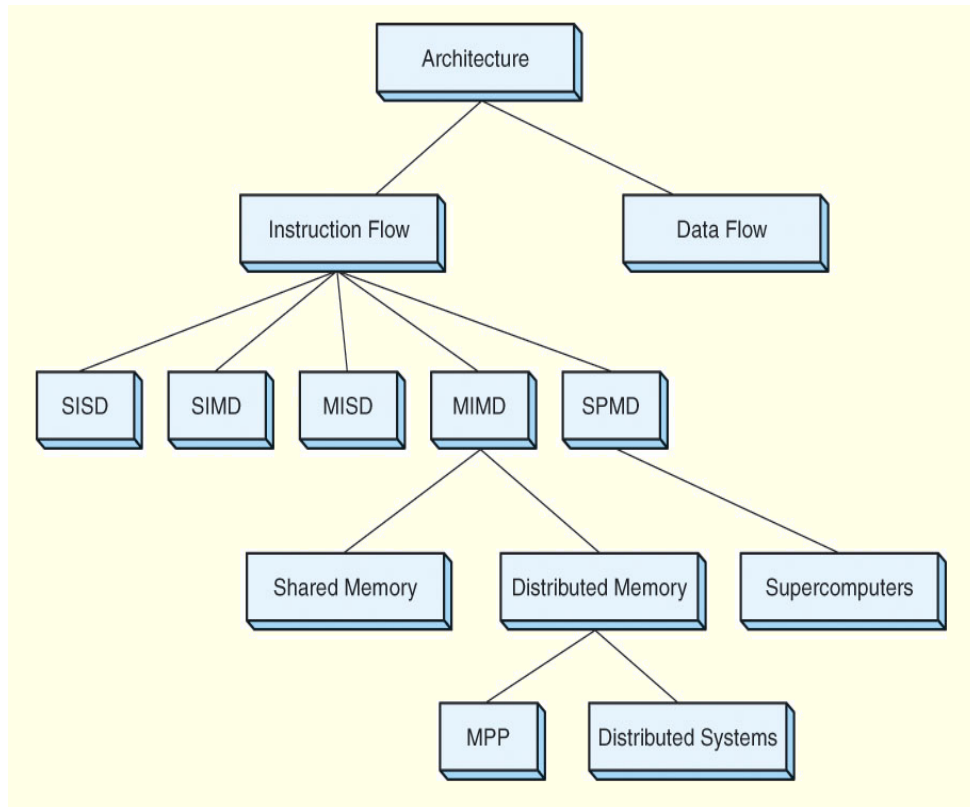- Yet another idea missing from Flynn's is whether the architecture is instruction driven or data driven

Figure 9.2 A Taxonomy of Computer Architectures
- SISD – Single Instruction Single Data – Flynn
- SIMD – Single Instruction Multiple Data – Flynn
- MISD – Multiple Instruction Single Data – Flynn
- MIMD – Multiple Instruction Multiple Data – Flynn
- SPMD – Single Program Multiple Data – Flynn expanded
- MPP – Massively Parallel Processors
- SMP – Symmetric Multiprocessors