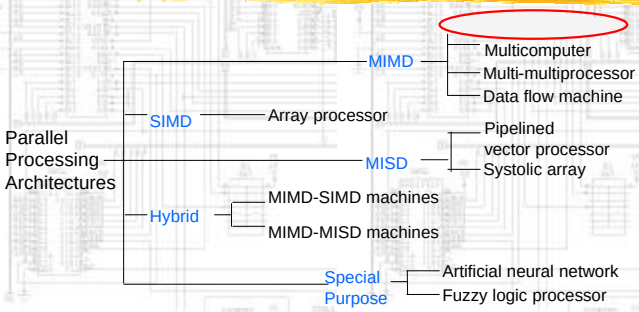
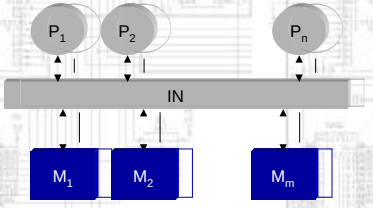
Parallel Processing Architectures

MIMD - Multiprocessor



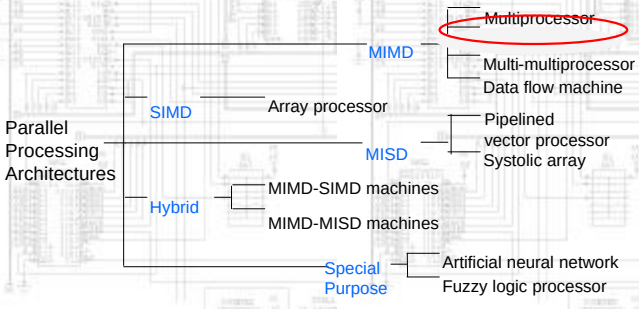
MIMD Varieties

Multiprocessor-Shared Memory



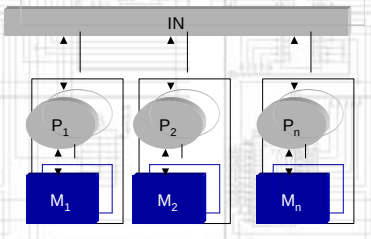
Parallel Processing Architectures

MIMD - Multicomputer



MIMD Varieties

Multicomputer - Passes Messages



Parallel Processing Architectures

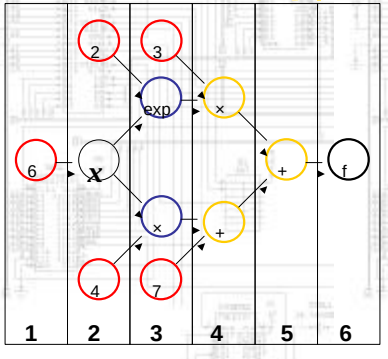
MIMD – Dataflow Machine

- Parallel Processing Architectures
  - MIMD
    - Multiprocessor
    - Multicomputer
    - Multi-multiprocessor
  - SIMD
    - Array processor
  - MISD
    - Pipelined vector processor
    - Systolic array
  - Hybrid
    - MIMD-SIMD machines
    - MIMD-MISD machines
  - Special Purpose
    - Artificial neural network
    - Fuzzy logic processor

Dataflow Machine

- Dataflow attempts to solve the "von Neumann Bottleneck" problem by:
  - Linking data to instructions
  - Issuing the instructions to execute as soon as all the necessary data binding is complete

Dataflow Machine - Example

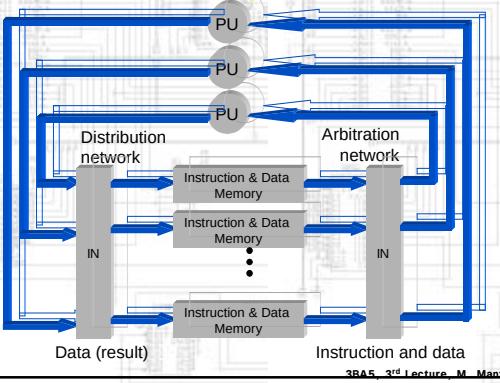


$f \neg 3x^2+4x+7$

$x \neg 6$

Dataflow Machines

Classified as MIMD in the Flynn taxonomy



Dataflow - Conclusions

The pseudo-random character of program assignments makes the efficient design of the arbitration and distribution networks a formidable task.

Further, dataflow architecture has no inherent ability to avail of the efficiencies possible in executing vector assignments, such as

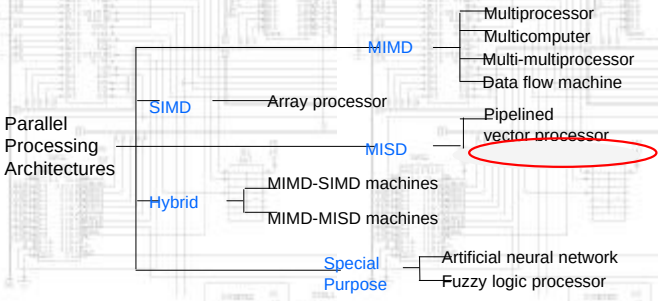
y ? x + 3.7, where x and y are vectors

which are frequent and execute very efficiently on a SISD and more efficiently on a vector processor

So far, a number of dataflow machines have been constructed, but none have been marketed

Parallel Processing Architectures

MISD – Systolic Array



Systolic Array

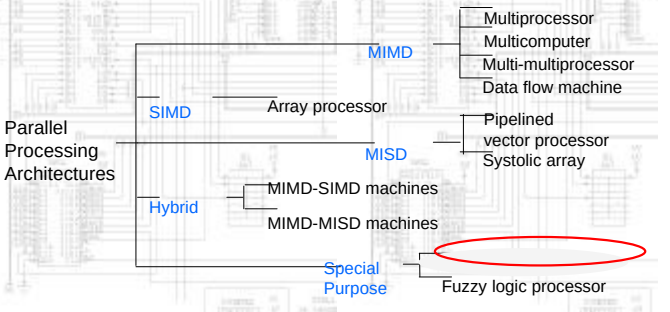
Systolic, pertaining to or marked by systole, the regular contraction of the heart and arteries that drives the blood outward

These are two or three dimensional pipelines, suitable only for applications with very regular data movement.

For example, matrix multiplication

Parallel Processing Architectures

Special Purpose – ANN

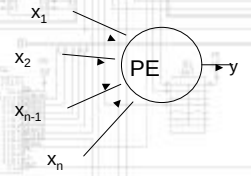


Non "Flynn-Classifiable" Parallel Systems

- Artificial Neural Networks
  - These use a processing element which implements a threshold function

Artificial Neural Networks

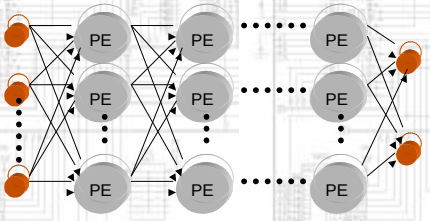
Computes:



$$s = \sum_{i=1}^{n} a_a \times x_i = [\text{Arithmetic}]$$

$$y = \begin{Bmatrix} 0 \text{ if } s < 1 \\ 1 \text{ if } s \geq 1 \end{Bmatrix} = [\text{logic if}]$$

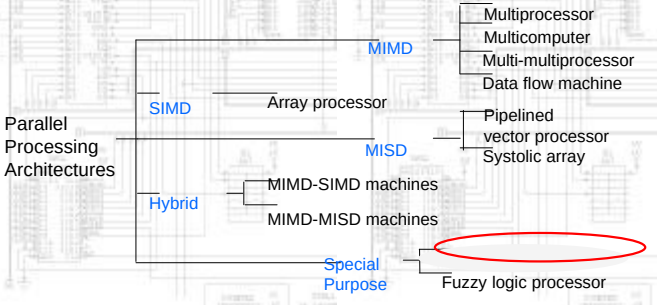
Block diagram of an artificial neural network



"Programming" consists of selecting the weight a_i for each PE_i and designing the interconnect between them

Parallel Processing Architectures

Special Purpose – Fuzzy Logic



Fuzzy Logic

- The objective of Fuzzy logic, like ANNs, is to deal with noise and uncertainty
  - Deductive logic uses {TRUE, FALSE}
  - Fuzzy logic uses truth values between completely true and completely false and defines functions over these