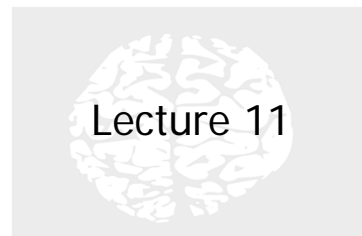
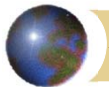


Modular Neural Networks



1



Modular Neural Networks

- ✦ **Different models** of neural networks combined into a **single system**. Each single network is made into a module that can be freely intermixed with modules of other types in that system.

2



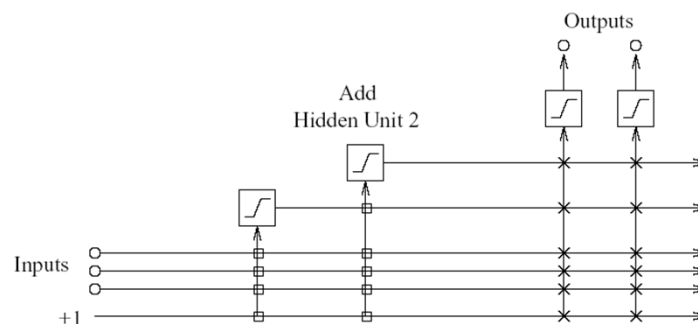
Definition

- ✦ A neural network is said to be modular if the computation performed by the network can be decomposed into **two or more modules (subsystems)** that **operate on distinct inputs without communicating with each other**.
- ✦ The outputs of the modules are mediated by an integrating unit that is not permitted to feed information back to the modules. In particular, the integrating unit decided both (1) how the modules are combined to form the final output of the system, and (2) which modules should learn which training patterns.

3



Cascade Correlation (CC): Diagram



The vertical lines sum all incoming activation. Boxed connections are frozen, X connections are trained repeatedly.

4



Committee Machines

- ✦ Universal Approximators
- ✦ Static Structures
- ✦ Dynamic Structures

5



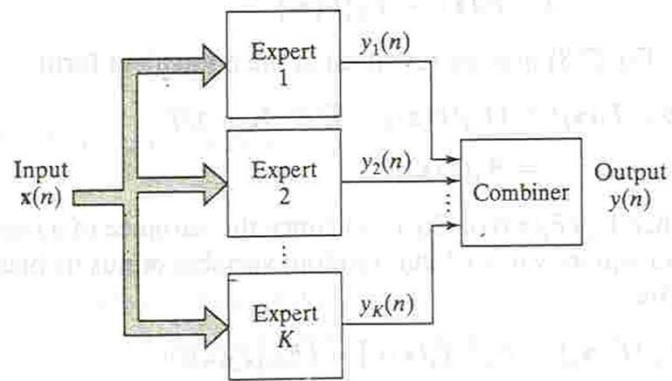
Static Structures

- ✦ The response of several predictors (experts) are combined by means of a mechanism that does not involve the input signal, hence the designation "static".
- ✦ **Ensemble Averaging:** Outputs of different predictors are linearly combined to produce an overall output
- ✦ **Boosting:** Weak algorithm is converted into one that achieves arbitrarily high accuracy.

6



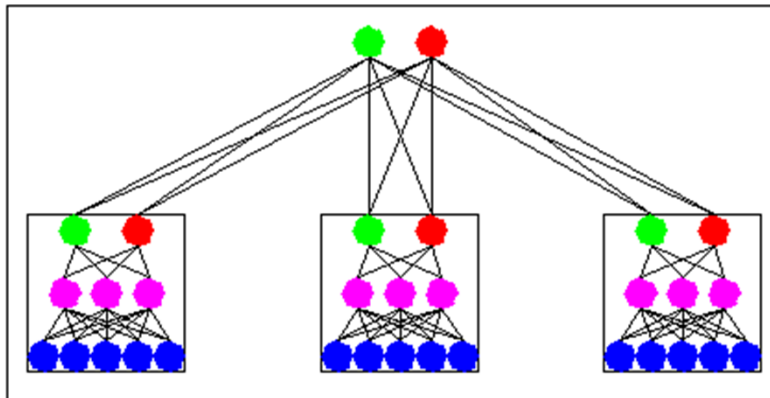
Ensemble Averaging



7



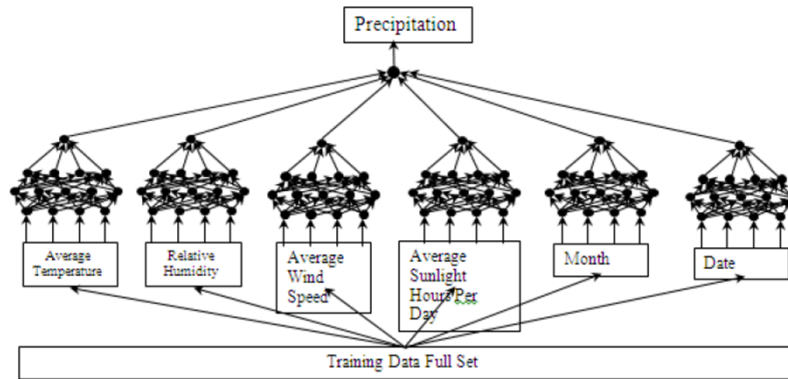
Example



8



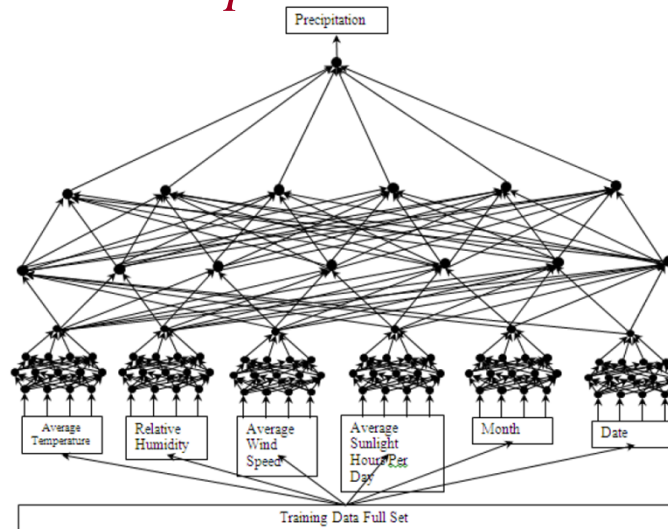
Example - Precipitation



9



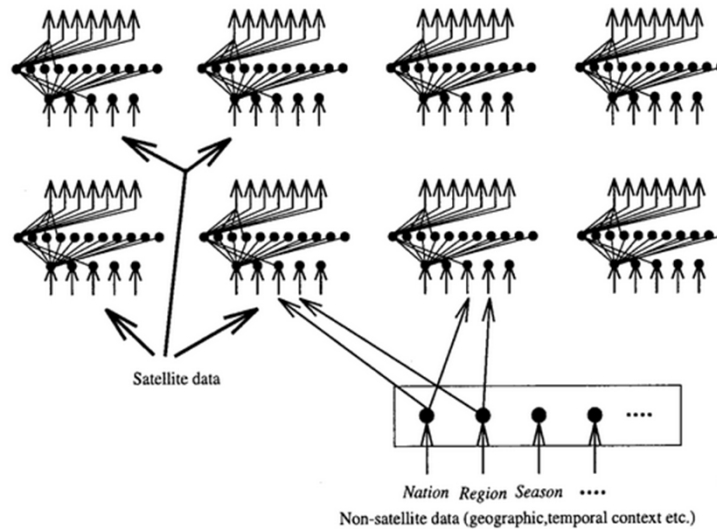
Precipitation- Hidden Layer



10



Remote Sensing Example



11



Example: Cheque Data

JAMES C. MORRISON
MARY A. MORRISON
1785 SHERIDAN DRIVE
YOUR CITY, STATE 12345
M.I.T. TEST SAMPLES

206

53-235/110

DATE 12/12/11

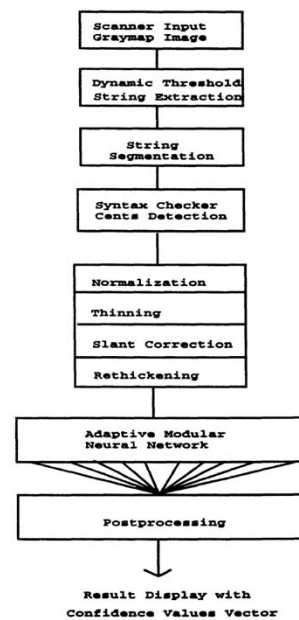
AMOUNT \$ 3,469.00

Pay to the order of

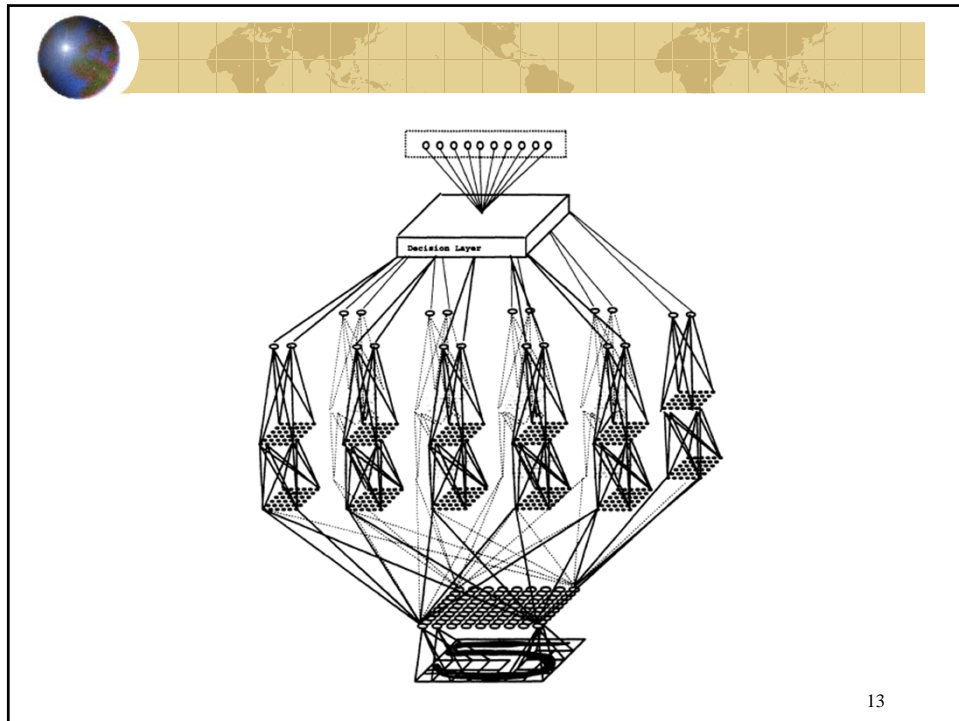
BayBank
BayBank Middlesex
Massachusetts

SAMPLE VOID DELUXE CHECK PRINTERS

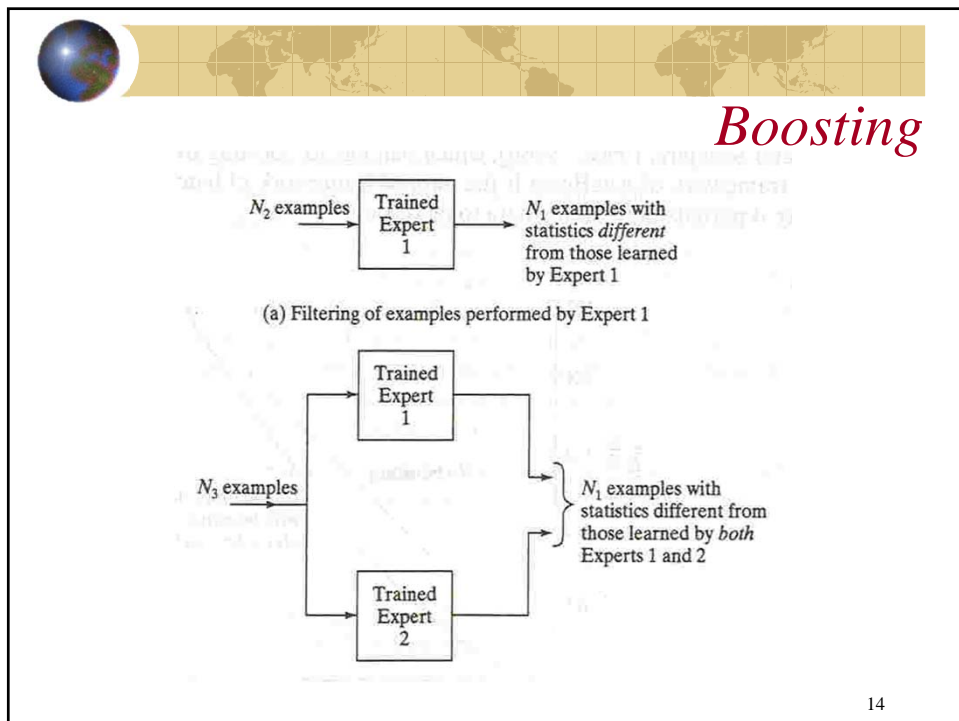
1:0 113023571: 123 456789 0206



12



13



14



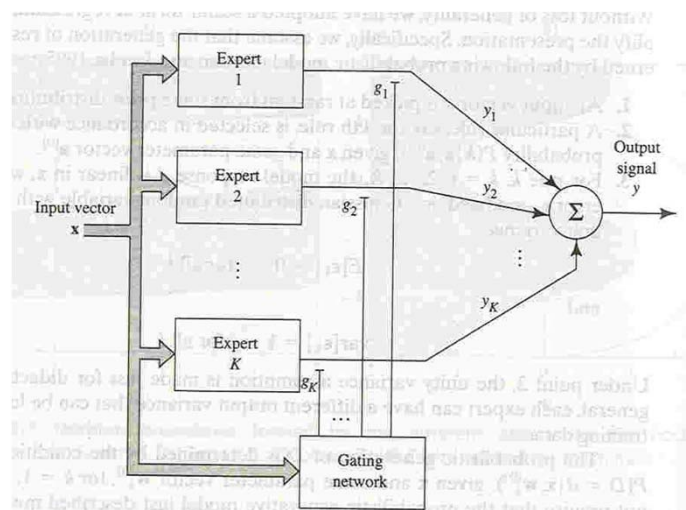
Dynamic Structures

- ✦ The input signal is directly involved in actuating the mechanism that integrates the outputs of the individual experts into an overall output, hence the designation "dynamic".
- ✦ **Mixture of experts**- Individual response of experts are nonlinearly combined by means of single gating network
- ✦ **Hierarchical mixture of experts** - Individual response of experts are nonlinearly combined by means of several gating networks arranged in hierarchical fashion

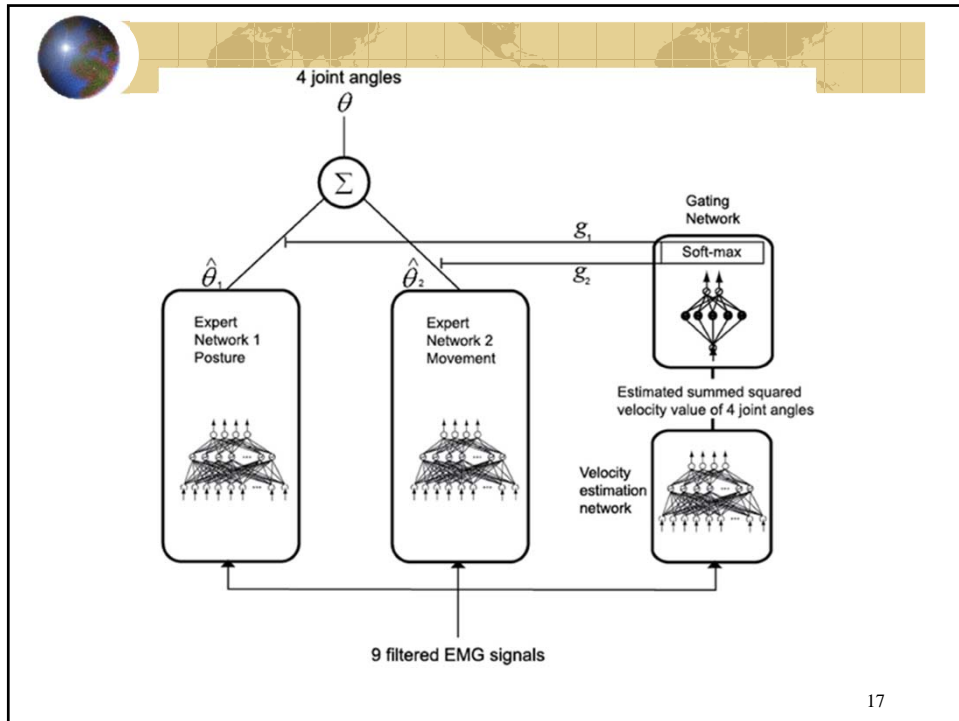
15



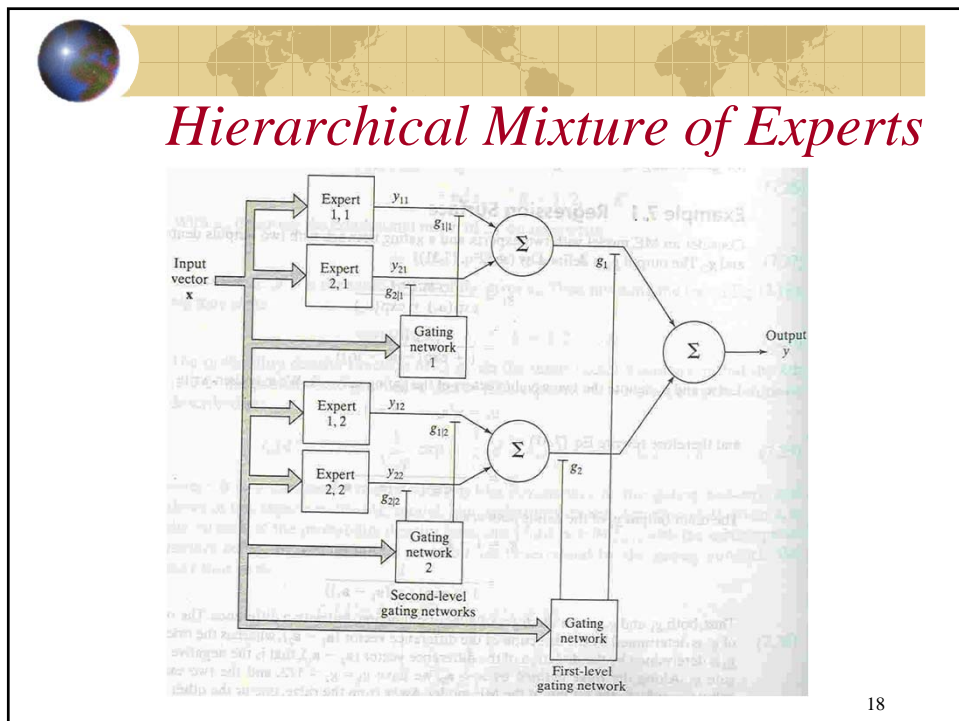
Mixture of Experts



16



17



18

