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A Time Delay Line Neural Network for Modeling Ionospheric Disturbances Behavior

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Outlines

- Ionospheric disturbances
- Neural networks structures
- Time delay neural networks
- supervised training
- Adaptable mechanisms

Modeling Ionospheric Disturbances

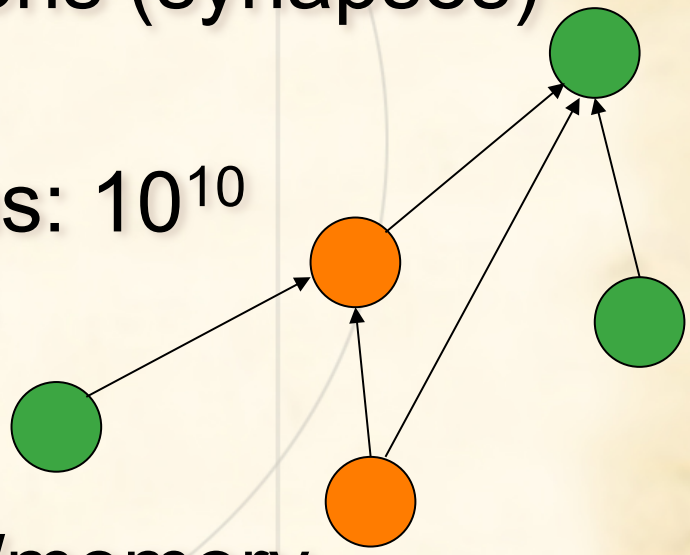
- This is a challenging research issue
  - t involves many dynamics, non-linearities and extrenal factors
- Such modeling is very importance in many applications,
  - efficient SAR signal processing through accurate noise modeling and removal,
  - monitoring of environmental evolution
  - geodynamics InSAR purposes.

Modeling High Dynamics

- The use of linear approaches lead to a failure due to the fact that the models are very simple
  - They cannot capture the complexity and the abrupt changes of the real data
- Neural networks
  - Highly non-linear classifiers and predictors
  - They relate inputs and (by implicitly extracted concepts through them) they map these inputs to outputs

Neural Networks

- Networks of processing units (neurons) with connections (synapses) between them
- Large number of neurons: 10^{10}
- Large connectitivity: 10^{5}
- Parallel processing
- Distributed computation/memory
- Robust to noise, failures

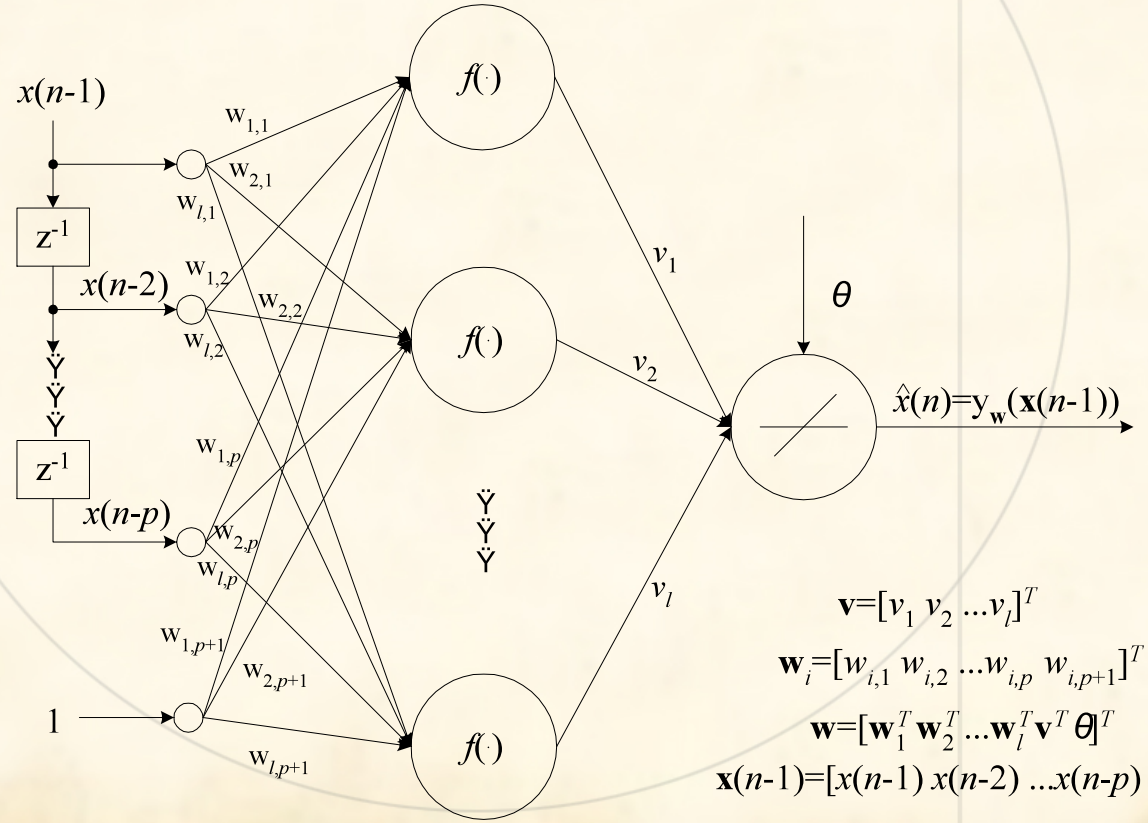


Understanding the Brain

- Levels of analysis (Marr, 1982)
  1. Computational theory
  2. Representation and algorithm
  3. Hardware implementation
- Reverse engineering: From hardware to theory
- Parallel processing:

Time Delay Neural networks

- Their inputs are time series instead of features



Learning a Network

- The procedure that consists in estimating the parameters of neurons so that the whole network can perform a specific task

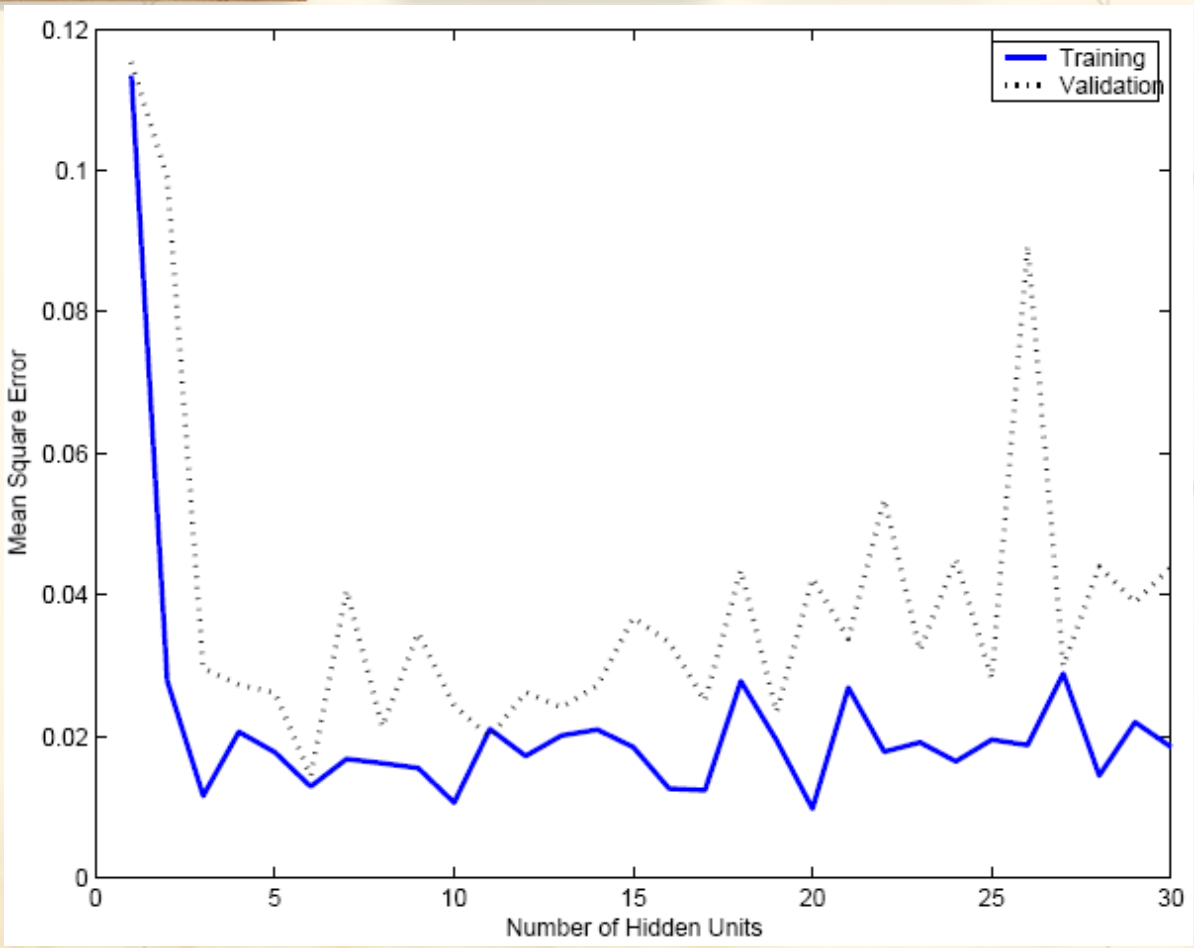
- 2 types of learning
  - The supervised learning
  - The unsupervised learning

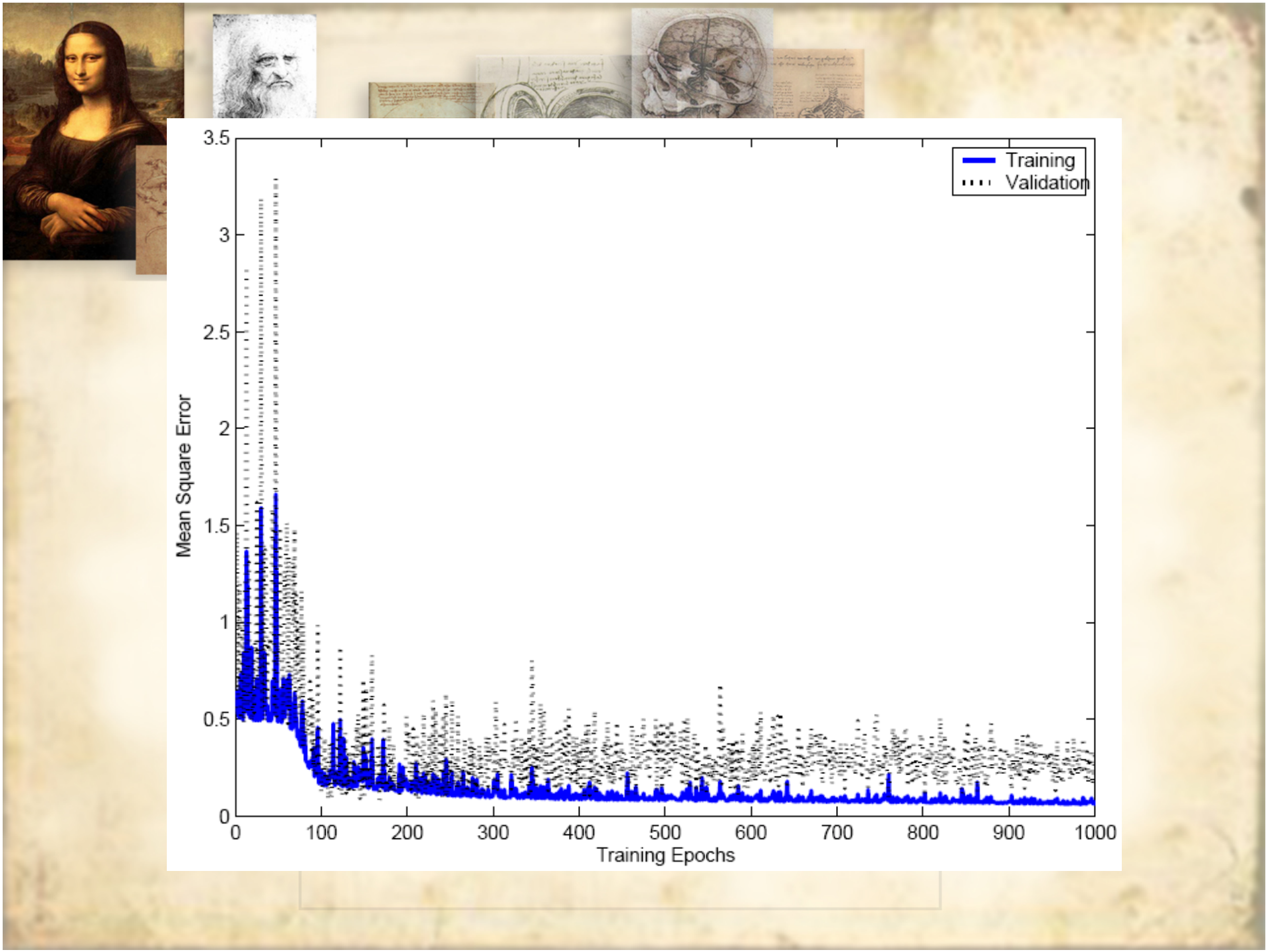
- The Learning process (supervised)
  - Present the network a number of inputs and their corresponding outputs
  - See how closely the actual outputs match the desired ones
  - Modify the parameters to better approximate the desired outputs

Supervised learning

- The desired response of the neural network in function of particular inputs is well known.
- A “Professor” may provide examples and teach the neural network how to fulfill a certain task

Overfitting/Overtraining




Training
Validation
Mean Square Error
Training Epochs
0
0.5
1
1.5
2
2.5
3
3.5
0
100
200
300
400
500
600
700
800
900
1000

Network Adaptation

- A time delay neural networks present static (constant) weights)
- We modify the weights of the network whenever the environmental conditions are changed
- For the adaptation, we re-initialize the training using the given a priori weights
- We trust more the current data sets rather than the old ones, without however forgetting them

Conclusions

- Dynamic modeling of ionospheric disturbances
- Time delay neural networks
- supervised training with validation data to avoid over fitting
- Adaptable mechanisms so that the weights of the network are adapted with respect to the environmental conditions