شبکه‌های عصبی مصنوعی

درس ۲۳

مورد مطالعاتی ۱:
تقریب تابع

Case Study 1: Function Approximation

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Function Approximation Case Study: Smart Sensor

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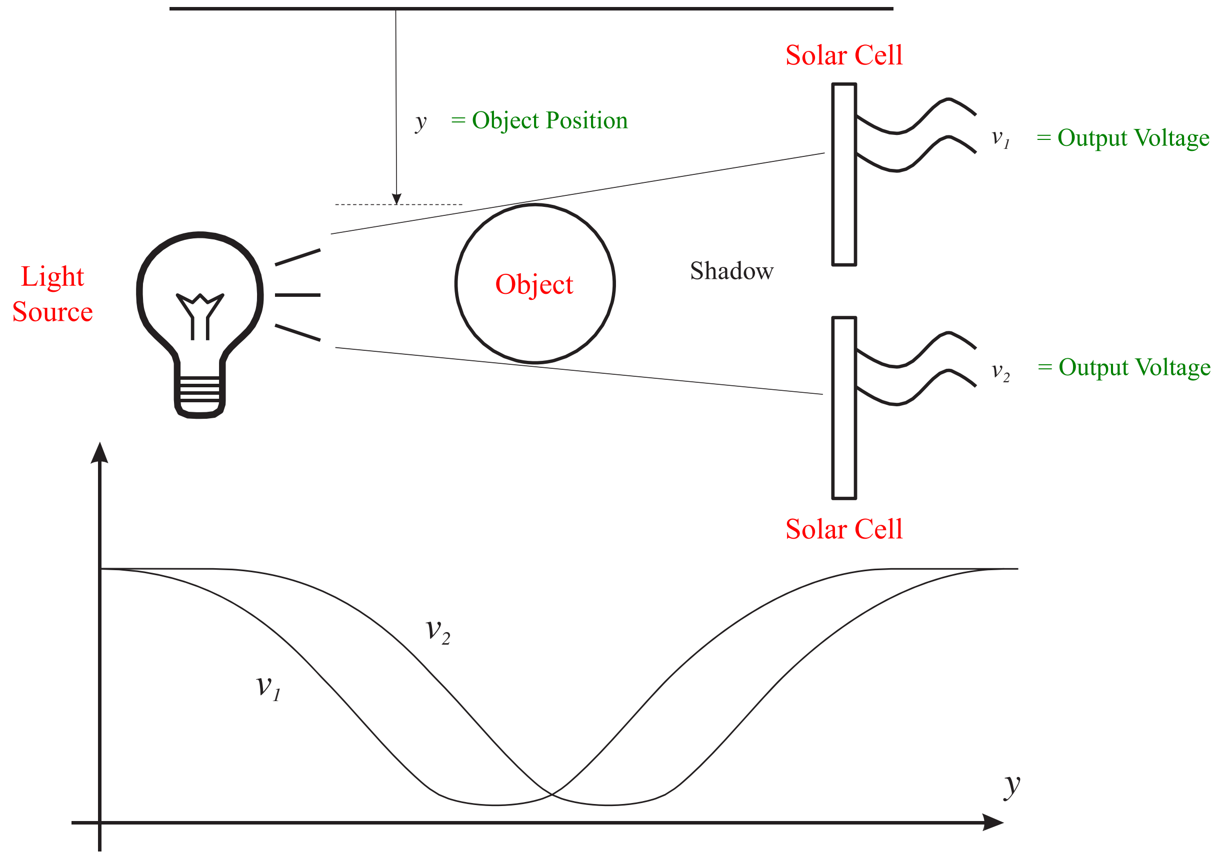
توصیف سیستم حسگر باهوش

Smart Sensor Diagram



Our objective is to determine the object position from measurements of the two voltages.

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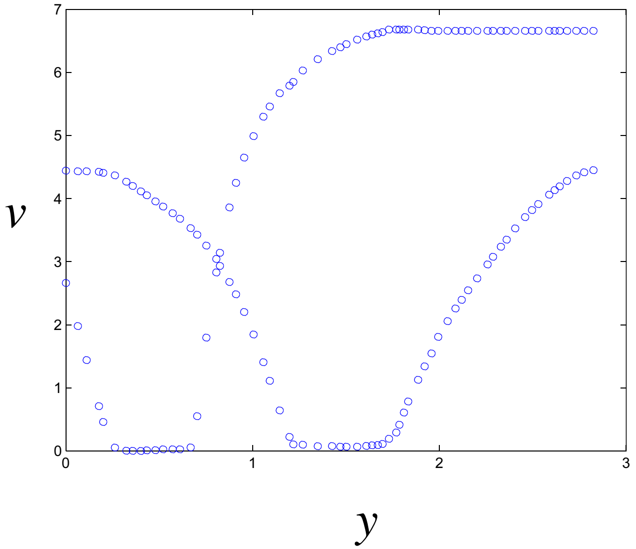
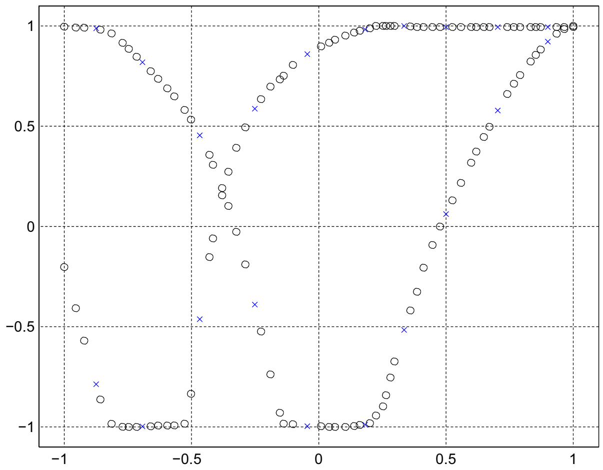
گردآوری داده‌ها و پیش‌پردازش

Collected Data

Raw Data



Normalized Data



$$\mathbf{p} = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} \qquad t = y$$

There are a total of 67 sets of measurements

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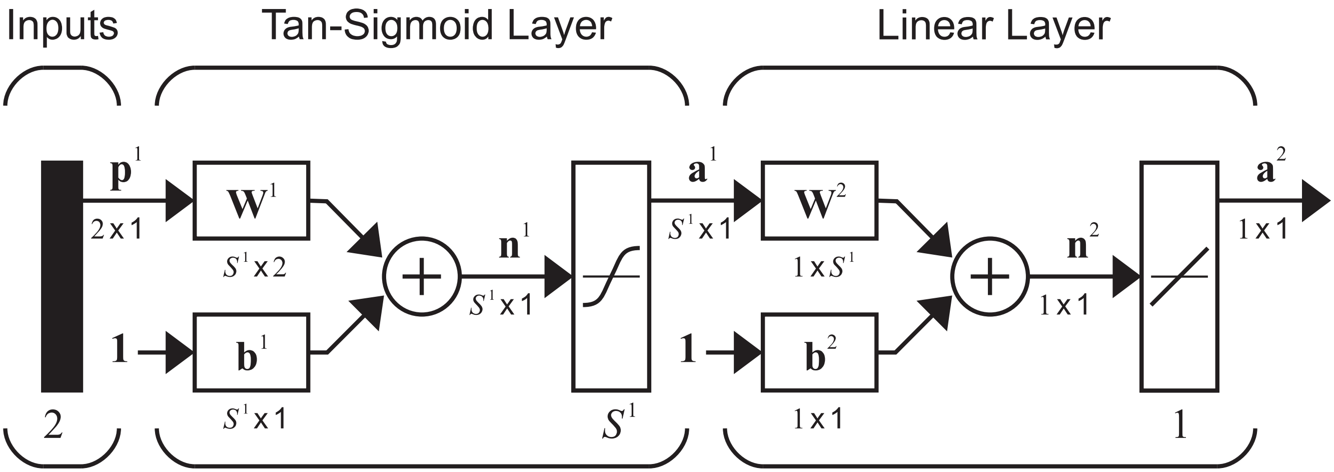
انتخاب معماری

Network Architecture



$\mathbf{a}^1 = \mathrm{tansig}(\mathbf{W}^1\mathbf{p} + \mathbf{b}^1)$

$\mathbf{a}^2 = \mathrm{purelin}(\mathbf{W}^2\mathbf{a}^1 + \mathbf{b}^2)$

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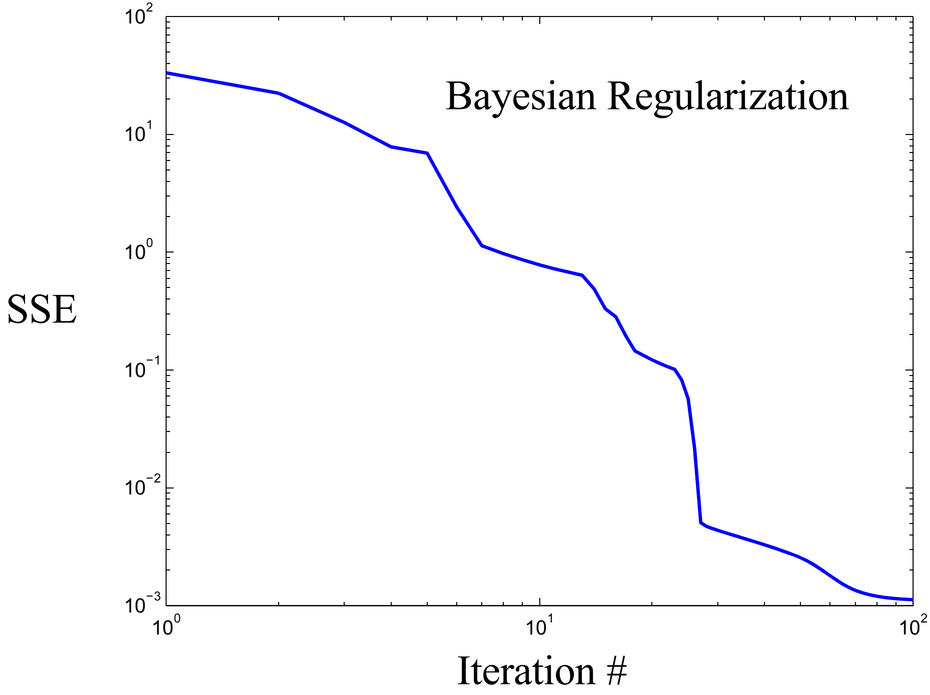
آموزش شبکه

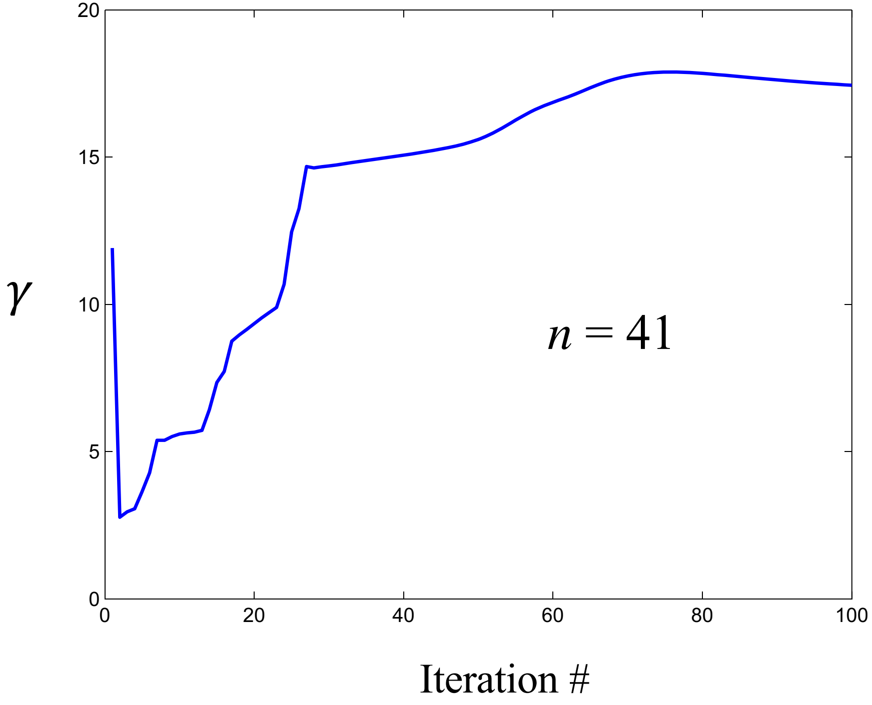
Training Performance (S^1=10)



Final performance using five random initial weights.

1.121e-003	8.313e-004	1.068e-003	8.672e-004	8.271e-004

Effective Number of Parameters



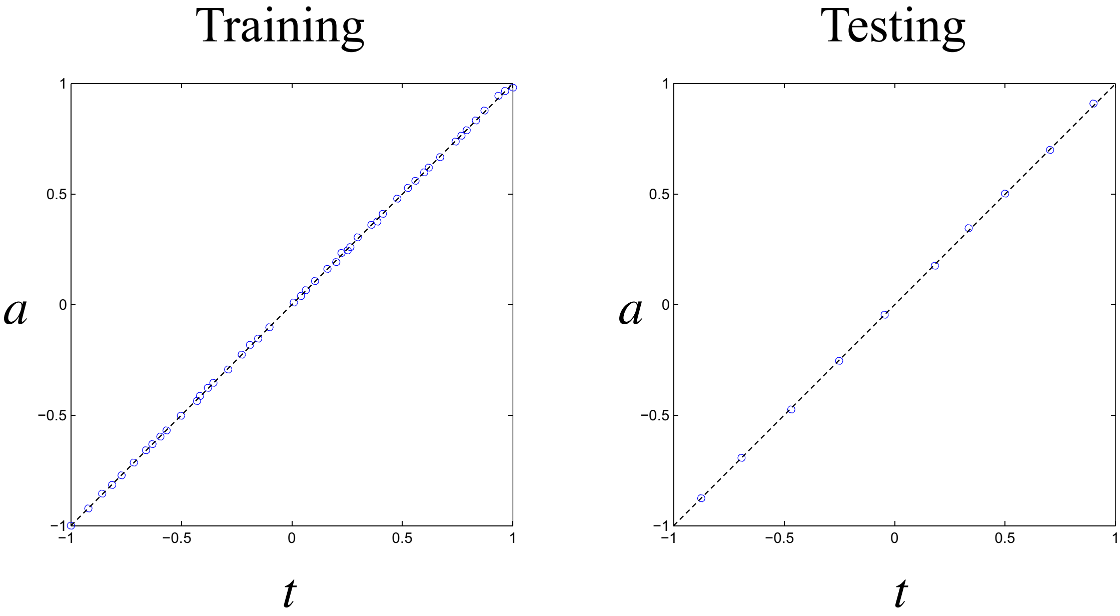
Number of Hidden Layer Neurons

Sum Squared Error

$S^1 = 3$	$S^1 = 5$	$S^1 = 8$	$S^1 = 10$	$S^1 = 20$
4.406e-003	9.227e-004	8.088e-004	8.672e-004	8.096e-004

After a sufficient number of neurons is reached (~5) the error does not go down, if Bayesian regularization is used.

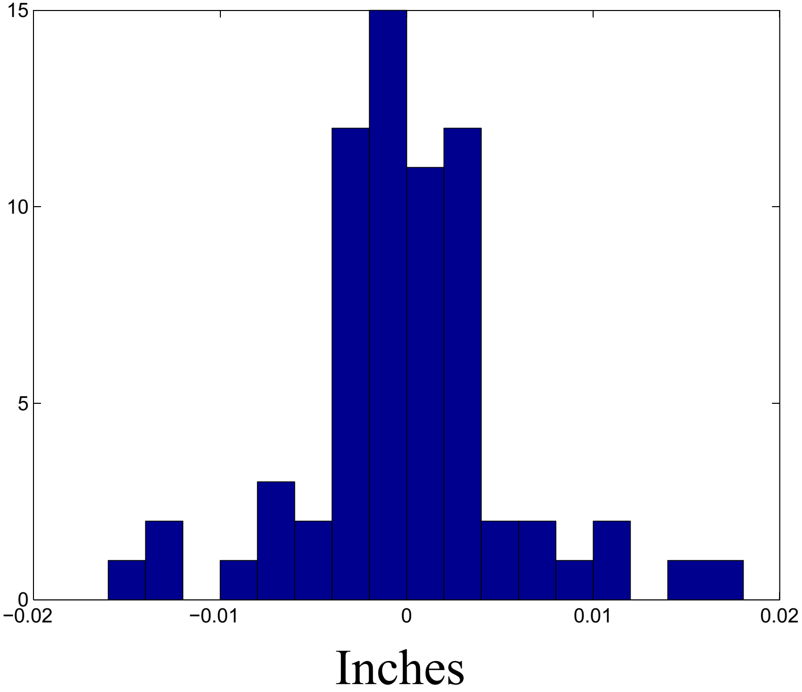
Scatter Plots



Training

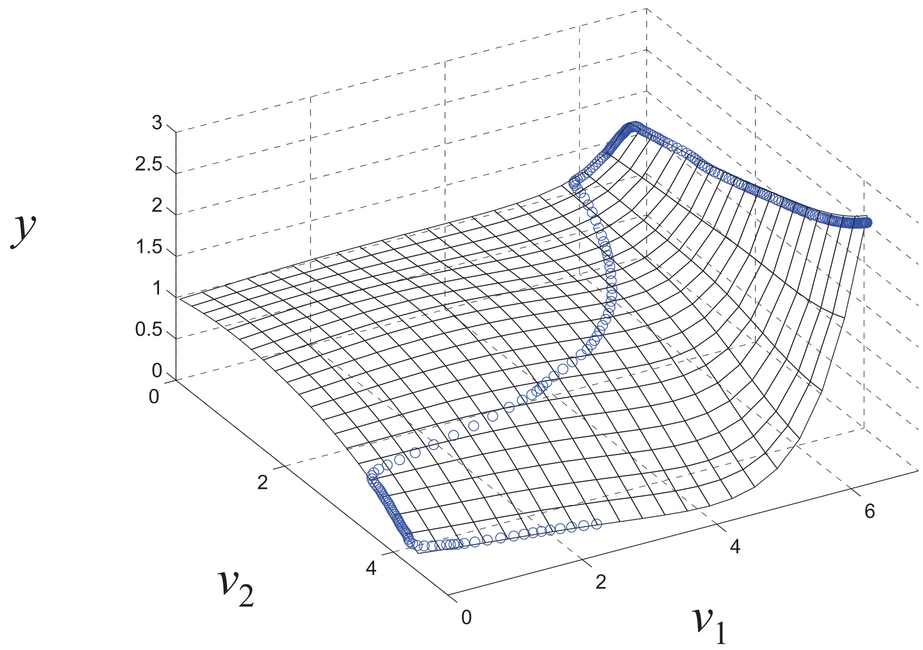
Testing

Error Histogram



$$\mathbf{a} = (\mathbf{a}^{n} + 1) .* \frac{(\mathbf{t}^{max} - \mathbf{t}^{min})}{2} + \mathbf{t}^{min}$$

Trained Network Response



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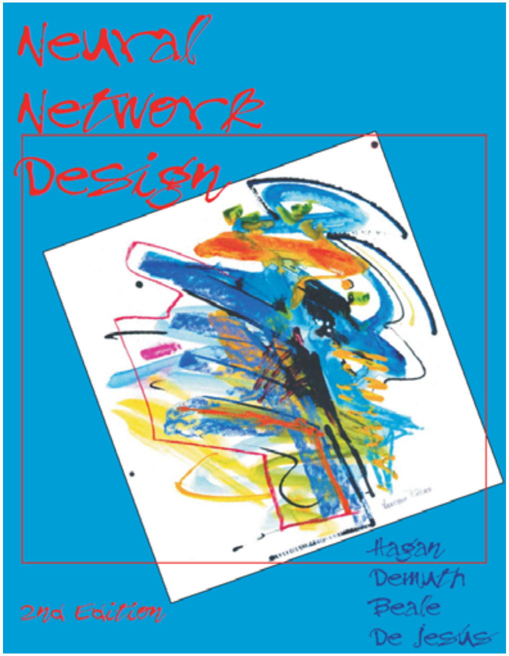
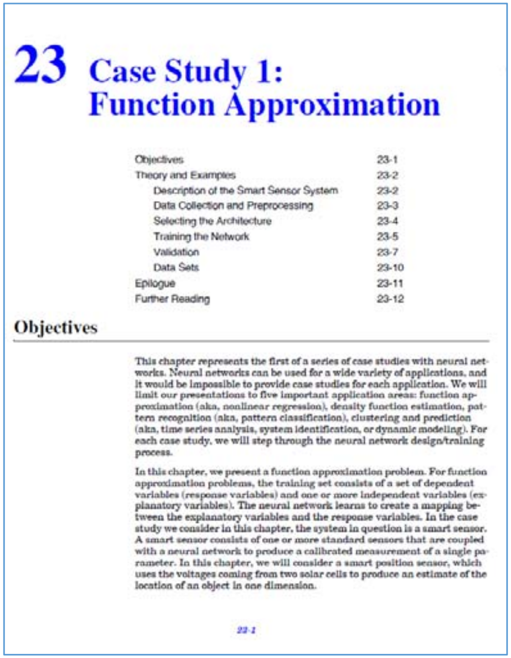
منابع

منبع اصلی





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Objectives

This chapter represents the first of a series of case studies with neural networks. Neural networks can be used for a wide variety of applications, and it would be impossible to provide case studies for each application. We will limit our presentations to five important application areas: function approximation (aka, nonlinear regression), density function estimation, pattern recognition (aka, pattern classification), clustering and prediction (aka, time series analysis, system identification, or dynamic modeling). For each case study, we will step through the neural network design/training process.

In this chapter, we present a function approximation problem. For function approximation problems, the training set consists of a set of dependent variables (response variables) and one or more independent variables (explanatory variables). The neural network learns to create a mapping between the explanatory variables and the response variables. In the case study we consider in this chapter, the system in question is a smart sensor. A smart sensor consists of one or more standard sensors that are coupled with a neural network to produce a calibrated measurement of a single parameter. In this chapter, we will consider a smart position sensor, which uses the voltages coming from two solar cells to produce an estimate of the location of an object in one dimension.

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Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Orlando De Jesus,
Neural Network Design,
2nd Edition, Martin Hagan, 2014.
Chapter 23

Online version can be downloaded from: http://hagan.okstate.edu/nnd.html