شبکه‌های عصبی مصنوعی

درس ۱

مقدمه‌ای بر شبکه‌های عصبی

Introduction to Neural Networks

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دانشگاه تهران

http://courses.fouladi.ir/nn

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Introduction

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Course Objectives

This course gives an introduction to basic neural network architectures and learning rules.

Emphasis is placed on the mathematical analysis of these networks, on methods of training them and on their application to practical engineering problems in such areas as pattern recognition, signal processing and control systems.

What Will Not Be Covered

- Review of all architectures and learning rules
- Implementation
  - VLSI
  - Optical
  - Parallel Computers
- Biology
- Psychology

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تاریخچه

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Historical Sketch

- Pre-1940: von Hemholtz, Mach, Pavlov, etc.
  - General theories of learning, vision, conditioning
  - No specific mathematical models of neuron operation
- 1940s: Hebb, McCulloch and Pitts
  - Mechanism for learning in biological neurons
  - Neural-like networks can compute any arithmetic function
- 1950s: Rosenblatt, Widrow and Hoff
  - First practical networks and learning rules
- 1960s: Minsky and Papert
  - Demonstrated limitations of existing neural networks, new learning algorithms are not forthcoming, some research suspended
- 1970s: Amari, Anderson, Fukushima, Grossberg, Kohonen
  - Progress continues, although at a slower pace
- 1980s: Grossberg, Hopfield, Kohonen, Rumelhart, etc.
  - Important new developments cause a resurgence in the field

شبکه‌های عصبی مصنوعی

مقدمه‌ای بر شبکه‌های عصبی

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کاربردها

کاربردهای شبکه‌های عصبی مصنوعی

نمونه‌هایی از کاربردها

پردازش سیگنال
Signal Processing
- حذف نویز از صدا
- حذف پژواک (اکو)

کنترل
Control
- کنترل دمای اتاق
- مسیر حرکت ضد موشک

بازشناسی الگو
Pattern Recognition
- بازشناسی دست‌نوشته
- OCR

پزشکی
Medicine
- سیستم تشخیص پزشکی

پیش‌بینی
Prediction
- مصرف برق در ماه بعد
- وضعیت آب و هوا
- سود سهام

تولید گفتار
Speech Generation
- تبدیل متن به گفتار

بازشناسی گفتار
Speech Recognition
- دستورهای گفتاری

بازشناسی چهره
Face Recognition
- هویت مبتنی بر چهره

تحلیل مالی
Financial Analysis
- میزان ریسک وام‌دهی

تقریب تابع
Function Approximation
- توابع پیچیده غیرخطی

Applications

- Aerospace
  - High performance aircraft autopilots, flight path simulations, aircraft control systems, autopilot enhancements, aircraft component simulations, aircraft component fault detectors
- Automotive
  - Automobile automatic guidance systems, warranty activity analyzers
- Banking
  - Check and other document readers, credit application evaluators
- Defense
  - Weapon steering, target tracking, object discrimination, facial recognition, new kinds of sensors, sonar, radar and image signal processing including data compression, feature extraction and noise suppression, signal/image identification
- Electronics
  - Code sequence prediction, integrated circuit chip layout, process control, chip failure analysis, machine vision, voice synthesis, nonlinear modeling

Applications

- Financial
  - Real estate appraisal, loan advisor, mortgage screening, corporate bond rating, credit line use analysis, portfolio trading program, corporate financial analysis, currency price prediction
- Manufacturing
  - Manufacturing process control, product design and analysis, process and machine diagnosis, real-time particle identification, visual quality inspection systems, beer testing, welding quality analysis, paper quality prediction, computer chip quality analysis, analysis of grinding operations, chemical product design analysis, machine maintenance analysis, project bidding, planning and management, dynamic modeling of chemical process systems
- Medical
  - Breast cancer cell analysis, EEG and ECG analysis, prosthesis design, optimization of transplant times, hospital expense reduction, hospital quality improvement, emergency room test advisement

Applications

- Robotics
  - Trajectory control, forklift robot, manipulator controllers, vision systems
- Speech
  - Speech recognition, speech compression, vowel classification, text to speech synthesis
- Securities
  - Market analysis, automatic bond rating, stock trading advisory systems
- Telecommunications
  - Image and data compression, automated information services, real- time translation of spoken language, customer payment processing systems
- Transportation
  - Truck brake diagnosis systems, vehicle scheduling, routing systems

مقدمه‌ای بر شبکه‌های عصبی

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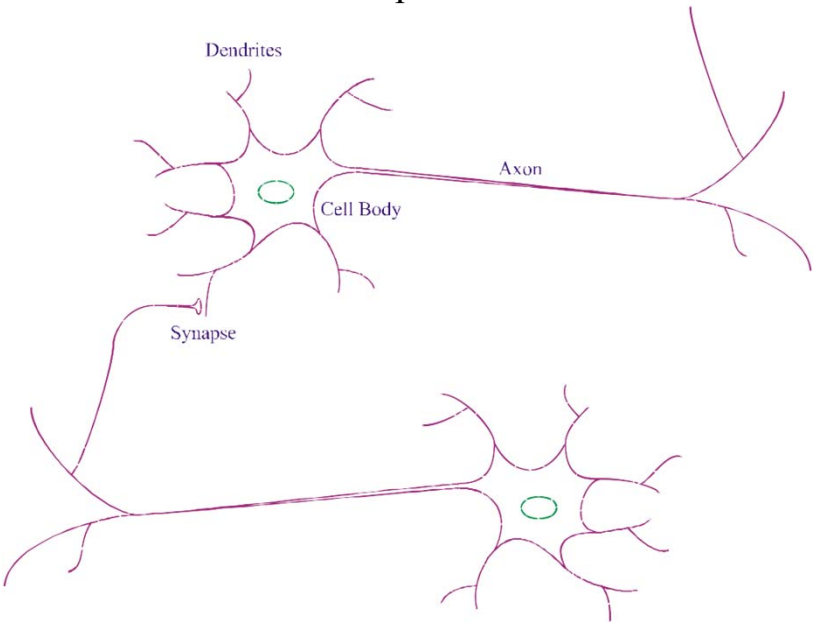
الهام از طبیعت

Biology

- Neurons respond slowly
  - 10^{-3} s compared to 10^{-9} s for electrical circuits
- The brain uses massively parallel computation
  - $\approx 10^{11}$ neurons in the brain
  - $\approx 10^{4}$ connections per neuron



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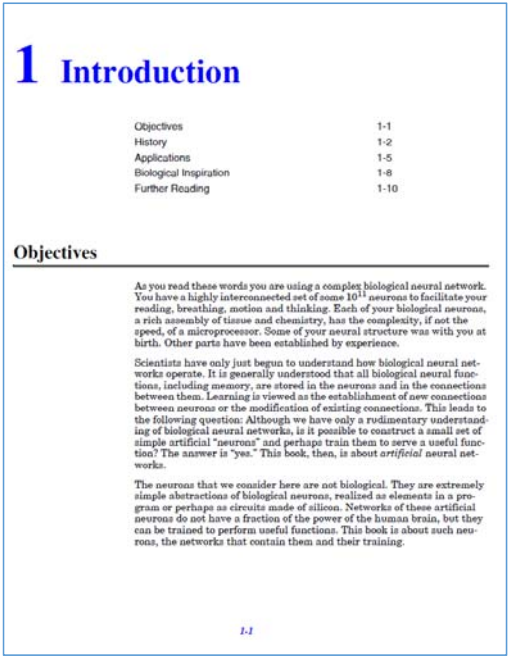
منابع

منبع اصلی



1 Introduction

Objectives

As you read these words you are using a complex biological neural network. You have a highly interconnected set of some 10^{11} neurons to facilitate your reading, breathing, motion and thinking. Each of your biological neurons, a rich assembly of tissue and chemistry, has the complexity, if not the speed, of a microprocessor. Some of your neural structure was with you at birth. Other parts have been established by experience.

Scientists have only just begun to understand how biological neural networks operate. It is generally understood that all biological neural functions, including memory, are stored in the neurons and in the connections between them. Learning is viewed as the establishment of new connections between neurons or the modification of existing connections. This leads to the following question: Although we have only a rudimentary understanding of biological neural networks, is it possible to construct a small set of simple artificial "neurons" and perhaps train them to serve a useful function? The answer is "yes." This book, then, is about *artificial* neural networks.

The neurons that we consider here are not biological. They are extremely simple abstractions of biological neurons, realized as elements in a program or perhaps as circuits made of silicon. Networks of these artificial neurons do not have a fraction of the power of the human brain, but they can be trained to perform useful functions. This book is about such neurons, the networks that contain them and their training.

1-1

Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Orlando De Jesus,
Neural Network Design,
2nd Edition, Martin Hagan, 2014.
Chapter 1

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