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论文与报告

一种基于能量人工神经元模型的自生长、自组织神经网络

班晓娟, 刘浩, 徐卓然

北京科技大学信息工程学院 北京 100083

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摘要
本文结合近年生物学中神经科学的发展, 针对神经胶质细胞对生物神经元网络的生长提供能量支持的特性, 将神经胶质细胞的能量模型引入到人工神经元的概念模型中, 提出了能量人工神经元(Energy artificial neuron, EAN)的概念模型,并给出了数学表述. 同时,在能量人工神经元模型的基础上, 实现了一种新型自生长、自组织人工神经元网络 (EAN based self-growing and self-organizing neural network, ESGSONN), ESGSONN将神经元中的能量、网络的熵增量及样本与神经元权值的相似度的竞争作为生长的条件, 并对最优生长点中的获胜神经元进行单位步长调整. ESGSONN实现了快速生长、精确的样本数据分布密度保持、死神经元少的特性. 本文使用经典的16种动物实验(Ritter and Kohonen, 1989)验证了ESGSONN的正确性,并通过同SOFM、GCS等自组织网络的对比实验验证ESGSONN网络的特性. 最后,本文对ESGSONN在高维空间中的本质进行了讨论.

关键词 自组织 生长网络 能量人工神经元 无监督学习 高维空间 熵 聚类

分类号

An Energy Artificial Neuron Model Based Self-growing and Self-organizing Neural Network

BAN Xiao-Juan, LIU Hao, XU Zhuo-Ran

Information School of Engineering, University of Science and Technology Beijing, Beijing 100083

Abstract
In this paper, we established a new artificial neuron model called EAN (energy artificial neuron) based on the energy concept from the glial cells according to the recent achievements in the neuroscience field. We suggested a way to demonstrate EAN model in mathematics. In addition, we realized a self-growing and self-organizing neural network based on the EAN model called ESGSONN (EAN based self-growing and self-organizing neural network). ESGSONN considers the energy in EAN, the entropy productions in the network and the similarity (between the sample and neurons' weights) as its conditions of growing and competitions. Its main features are described as below: rapid growing, probability density preserving and few superfluous neurons. A classical experiment of 16-kind animals (after Ritter and Kohonen, 1989) proved ESGSONN can work correctly. We showed the new features of ESGSONN by comparing it with the traditional self-organizing networks such as SOFM and GCS. Finally, we argued about the essence of this network in the high-dimensional space.

Key words Self-organizing growing network energy artificial neuron (EAN) unsupervised leaning high-dimensional space entropy clustering

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通讯作者 刘浩 liuhao520@gmail.com

作者个人主页 班晓娟; 刘浩; 徐卓然