Research Article

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Various Deep Learning Techniques for Applications in Polymer, Polymer Composite Chemistry, Structures and Processing

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ABSTRACT

Polymers and polymer composites possess a wide range of applications in chemical, material, and biomedical fields. Although conventional techniques to the design and processing of these significant materials have been successful, they have faced critical problems. Their synthesis is not only time-consuming, but it is also costly for polymer industries. In recent years, there has been a regenerated hype regarding deep learning, as an approach based on artificial neural networks. Due to the importance of both polymer chemistry and artificial intelligence systems in the academic research and industry, it is a requirement to present approaches combining these two promising fields. This paper aims to categorize various deep learning approaches used in the field of the polymer science. We expect that this can expand the polymer chemistry community engagement with artificial intelligence, especially deep learning and accelerate the improvement in the data-driven techniques for the synthesis and application of polymers.

1. Introduction

Machine Learning (ML) is a technique that enables computers to address challenges via data learning [1]. Deep structural learning (deep learning), as a part of a larger machine learning family, is based on the artificial neural networks (ANN) with representation learning. The relationship between Artificial intelligence (AI), machine learning, and deep learning (DL) has been shown in Figure 1 [2].

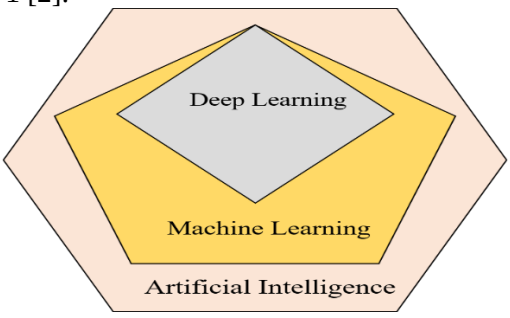

Figure 1. deep learning as a subset of machine learning and machine learning as a subset of artificial intelligence [2]

The majority of works in this area can be categorized into three main classifications (i.e., supervised, unsupervised, and semi-supervised) [3]–[5]. Figure 2 shows their architectures which apply in various fields such as speech and audio recognition, machine and computer vision, natural language processing, drug design, material inspection, medical image analysis, game programs, social network filtering, and bioinformatics. In these applications, DL produces results near to human expert performance and, surprisingly, the results in some examples are better than them [6], [7].

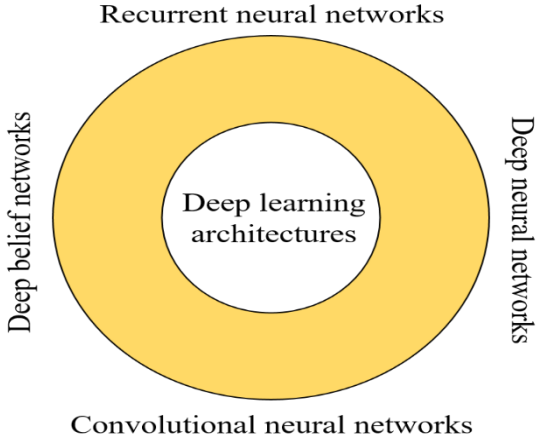

Figure 2. The architectures of deep learning [6], [7]

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