Neural Computing and Applications (2023) 35:14093–14107
https://doi.org/10.1007/s00521-023-08448-6

ORIGINAL ARTICLE

Incremental learning without looking back: a neural connection relocation approach

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Received: 12 November 2022 / Accepted: 24 February 2023 / Published online: 22 March 2023

Abstract
Nowadays, artificial intelligence methods need to face more and more open application scenarios. They need to have the ability to continuously develop new skills and knowledge to respond to changes over time. However, how the learning system learns new tasks without affecting performance on old tasks remains a big challenge. In this work, we develop a learning system based on convolutional neural network (CNN) to implement the incremental learning mode for image classification tasks. Inspired by the way human learns, which includes abstracting learning experiences, keeping only key information in mind and forgetting trivial details, our proposed method contains a neural connection relocation mechanism to remove unimportant information from learned memory. And a mechanism composed of knowledge distillation and fine-tuning is also included to consolidate the learned knowledge using associations with the new task. To demonstrate the performance of our method, two pairs of image classification tasks are conducted with different CNN architectures. The experimental results show that our method performs better than the state of the art incremental learning methods.

Keywords Neural connection relocation · Incremental learning · Convolutional neural network · Filter pruning · Distillation

1 Introduction

Nowadays, there is an increased demand for computer vision applications that can incrementally learn new skills while maintaining the performance of learned ones. For example, a monitor system can identify whether a driver in a vehicle is wearing a seat belt properly, but administrators may want to add the ability to detect whether the driver is using a mobile phone during driving. However, how the learning agent learns new tasks without catastrophic forgetting (decline in performance on old tasks, [1–3]) remains a big challenge. To solve this problem, we refer to the way human learns incrementally without forgetting old knowledge.

When learning new skills, humans can maintain old skills, even the rarely used ones. Because humans can abstract learning experiences and keep the crucial information in mind as the knowledge, then use the learned knowledge to help learn new knowledge. For example, when we learn English words, it will be easier for us to learn the word "pencil" after we learn the word "pen". Because the first three letters of the "pencil" are the same

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