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SPECIAL DEEP CNN DESIGN FOR FACIAL EXPRESSION CLASSIFICATION WITH A SMALL AMOUNT OF DATA

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Abstract

Since artificial intelligence is becoming an important part of our lives providing incredible facilities, researchers around the world are suggesting better and better applications. Researchers working on various subfields of Artificial Intelligence, including Natural language processing, Expert systems, Speech recognition, and Computer vision are trying to make life easier for humankind. Within those, computer vision is one of the most important fields, since cameras are installed in many places nowadays and installed in more and more places. One of the trending topics would be facial analysisFromIn this point of view, facial expression recognition has been one of the hot topics among computer vision researchers in recent decades. Surely, many approaches are proposed to tackle the issue. It can be argued that learning the small dataset with Deep CNN has an overfitting problem compared to that with the big dataset. The reason is that smaller images have a small number of features or not clear features, so deeper models would learn a limited number of features, possibly causing overfitting later. Thus, a more reliable model that works well for face images with low resolution is necessary. In this end, we propose our method, which we believe, is more reliable for low-resolution images. We show experimental results on FER2013 and FERPlus datasets to prove how well our architecture classifies low-resolution images. The proposed method is well generalized while having 69.32% and 85.35% accuracies on FER2013 and FERPlus datasets respectively. While other models are good for particular datasets, our model shows good performance for both datasets.

Introduction

Many computer vision tasks are solved by applying Deep Learning algorithms in recent years. However, it has one drawback; it needs lots of data for learning given images. If images are fewer, then the deep learning model might not learn well enough to make good predictions. However, the datasets we made experiments on have enough data to train, thus data will not be an issue for our case. Deep Learning (DL) is showing promising performances recently and becoming the main tool of AI, thus, we use it to build our model. A traditional way of tackling some issues is by applying the Neural Network model. However, we utilized a specific type of Neural Network called Convolutional Neural Network (CNN), which became the main architecture of utilizing DL and showing reliable results over the years, we build our model with the help of CNNs.

Related Work

Artificial Intelligence

The concept of Artificial Intelligence

The concept of artificial intelligence was initially revealed in 1956, yet artificial intelligence became more mainstream nowadays because of expanded data volumes, progressed algorithms, and enhancements in storage and computing power.

Initial research on artificial intelligence during the 1950s explored themes such as symbolic methods and problem-solving. The US Department of Defense, during the 1960s, checked out this kind of work and started performing training on computers in order to emulate fundamental human reasoning. As an example, the Defense Advanced Research Projects Agency (DARPA) finished road-planning work in the 1970s. Besides, sometime before Cortana, Alexa, or Siri were easily recognized names, Defense Advanced Research Projects Agency invented, in 2003, intelligent personal assistants.

The term artificial intelligence means the capacity of a computer or computer-controlled robot to do activities usually connected with smart creatures. This concept is often used in the venture of creating architectures blessed with human intellectual processes characteristics, for instance, gaining experience, summing up, choosing a more important item, or the ability of reasoning.

Algorithms of artificial intelligence intended to make decisions, frequently utilizing real-time data. One might think like maybe they are just a machine that responds mechanically, but it is more than that. Remote inputs, digital information, or utilizing sensors, concatenate different types of data, analyze the data instantly, as well as analyzing insights derived from those data. Thus, they are planned by people with

deliberateness and arrive at conclusions dependent on their instant analysis.
In any case, despite continuing advances in computer processing speed and capacity of memory, there are no programs until now which could mimic a person's flexibility in various broad areas or in tasks remanding much conventional information. Some programs achieved the demonstration levels of experts and professionals in specific particular assignments, with the goal that AI in this restricted function found in employments as different as handwriting or voice recognition, computer search engines, and sometimes even medical diagnosis.
There are three fundamental concepts in AI, this first is machine learning, the next is deep learning, and finally neural networks. Maybe artificial intelligence with machine learning might seem interchangeable concepts; artificial intelligence is typically viewed as the more extensive, while ML, DP, and NN are a subset of AI.

Concept of Machine Learning

We communicated with some kind of AI everyday routine. Using Gmail, for instance, you might appreciate the future automated email filtering. You have a cell phone; you perhaps connect a calendar with the assistance of Bixby, Cortana, or Siri. You have the latest vehicle, maybe while driving you profited feature of driver-assist.
As accommodating as those software applications seem to be, they come up short on the aptitude to adapt freely. They only think about what is in the code. ML (Machine learning) is a part of artificial intelligence, which plans to enable mechanisms to get familiar with an assignment without using a code that already exists.

Concept of Deep Learning

This (Deep Learning) is a subfield of AI that manages the algorithms enlivened by the arrangement along with the capacity of the mind name ANN or artificial neural networks.
DL is a critical innovation in the base of driverless vehicles, empowering those to perceive signs, or to recognize a walker from a light post. Moreover, it would be the key to voice responses in consumer devices such as TVs, tablets, hands-free speakers, and phones. DL is obtaining bunches of consideration recently for some reasons. It is accomplishing an achievement that was impractical previously before.
In DL, an architecture figures out how to accomplish classification/ detection/ segmentation assignments straightforwardly from pictures, text, or even sound. DL models may accomplish cutting-edge correctness, in some situations even surpassing the execution of a human. A model is normally trained by utilizing a large set of labeled data and neural network architectures that contain many layers.

Neural Networks

An artificial neural network (ANN) is a structure that is actually based on a biological neural network, such as the brain. Our brain has around 100 billion neurons, which exchange information through electrochemical signals. Those neurons are connected through junctions named synapses. Each neuron receives thousands of connections with other neurons, continually accepting incoming signals to reach the cell body. In case the resulting quantity of the signals exceeds a specified threshold, a response is sent through by axon. The ANN strives to recreate the computational template of the biological neural network, although it is not exactly the same since the amount and complexity of neurons and the usage in a biological neural network is way too larger for those in an artificial neural network.

ANNs are comprised of a network of artificial neurons (sometimes called "nodes"). Those nodes are associated with each other, and the level of their relationships to one another is specified at a rate based on their energy: restraint (maximum being -1.0) or excitation (maximum being +1.0). If the rate of the relationship is high, then it symbolizes that there is a strong relationship. Within every node's perspective, a transfer function is built in. Three types of neurons exist in any ANN, input nodes, hidden nodes, and output nodes. Figure 1 demonstrates a simple Neural Network.

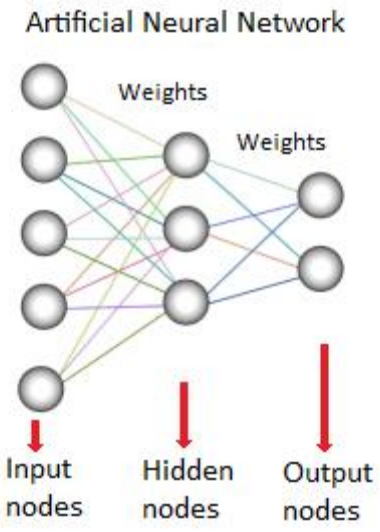

Fig. 1. Example for neural network

An input node receives information, in a form that can be numerically represented. The information is shown as activation values, where every node is given a value, the bigger the value, the higher the activation. The information is later passed throughout the rest of the network.

Based on the relationship strengths (weights), restraint or excitation, and transfer functions, the value of activation is transferred from node to node. Every node sums the activation values it takes; then changes the value according to its transfer function. The activation passes through the network, by hidden layers, until it comes to output nodes. The output layer represents the input layer. The distinction between the predicted value and output value (error) is propagated backward by distributing them to every node's weights based on the quantity of this error a certain node is accountable for (e.g., gradient descent algorithm).

Previous Related Works

Proposing CNN models was a huge breakthrough in the Computer Vision field enabling and encouraging researchers to dig into this area deeper and explore more possibilities. From this point of view, we assume that mentioning the first CNN model would be appropriate. The first CNN model Alex Krizhevsky et al. [1], is often called AlexNet airs nod popular with this name. Demonstrated how effective CNNs are. It was proposed on 30 September 2012 and achieved a top-5 error of 15.3% in the Image Net 2012 Challenge, more than 10.8 percentage points lower than that of the runner-up. This was made feasible due to the use of Graphics processing units (GPUs) during training, an essential ingredient of the deep learning revolution. According to The Economist, "Suddenly people started to pay attention, not just within the AI community but across the technology industry as a whole. It has 60M parameters, 8 layers - 5 convolutional and 3 fully connected and they were the first to implement Rectified Linear Units (ReLUs) as activation functions. AlexNet [1] is published on the Imagenet dataset and was the CNN model to win the ImageNet competition. Followed by AlexNet [1] many other CNN models are proposed later: ZFNet [101], which won the Image net in 2013, and Inception (GoogLeNet) [102] which won the Imagenet in 2014. And, other successful architectures over the next years are VGG [103], ResNet [104], ResNeXt [105], SENet [106], Deargen [107], SENet [108], PNASNet-5 [109], The model proposed in 2018 called SE-ResNet architecture proposed by Jie Hu [2] is considered as the state of the model so far to tackle the VGG-face dataset. However, these models that depicted promising results on Imagenet (224x224 input size) and VGG-face (224x224 input size) datasets are not good enough to achieve high performance on FER2013 and FERPlus datasets, as both contain 48x48 images. The reason is, above-mentioned datasets contain low-resolution images compared to Imagenet and VGG-face datasets. Furthermore, FER2013 contains many bad images such as wrongly labeled, invalid images, etc. Therefore, building a model for this dataset is not an easy task to achieve.

State-of-the-art CNN-based work on the FER2013 dataset is fine-tuned VGG-face referred to in [3], showing accuracy (72.11%) regardless of many invalid images on the dataset. Meanwhile, the latest works with very promising results on the FERPlus dataset are Kai Wang et al. [4], Samuel Albanie et al. [5], and Emad Barsoum et al. [6]. We will be diving into these proposals later and will be compared them with respect to our method.

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