A Study to Find Facts Behind Preprocessing on Deep Learning Algorithms

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Abstract: In the near future, deep learning algorithms will be incorporated in several applications for assisting the human beings. The deep learning algorithms have the tendency to allow a computer to work on its assumption. Most of the deep learning algorithms mimic the human brain’s neuron connection to leverage an artificial intelligence to the computer system. This helps to improve the operational speed and accuracy on several critical tasks. This paper projects the blocks, which are required for the incorporation of deep learning based algorithm. Also, the paper attempts to deeply analyze the necessity of the preprocessing step over several deep learning based applications.

Keywords: Preprocessing, image, data, signal, text, classification, EEG, ECG, EMG.

Introduction

Computers perform some specific task based on the user command. However, due to the improvement of science and technology the researchers were made a computer system to autonomously perform some analytic and arithmetic processes. The applications are getting increased day-by-day due to its compatibility/size reduction of both the hardware and software components required for a computer system. The accuracy and speed of the computer systems are really incomparable to a human speed and accuracy. A computer never gets tired; never do mistake when sleepy and never take leave. These are the reasons for employing an automated system everywhere instead of human beings.
As of now, the computers are made to do the prescribed work. In recent trends, the researchers attempt to give artificial intelligence to a computer machine in order to analyze and work on its own. Many robotic applications are utilizing the artificial intelligence for addressing certain issues. For example, a line following robot is trained to analyze and identify a line, which was drawn in-front of it. Similarly, several medical application robots are trained to visualize the changes occurred over a scanned image and regular image. Figure 1 shows the broad classification of deep learning algorithms input for a reference.

![Image of deep learning algorithm](image)

**Figure 1. Inputs of deep learning algorithm**

The deep learning algorithm requires input for analyzing. Same as like of human vision the images are taken into account for several analysis applications. Similarly numerical data, voice, digital signals and sensor outputs are considered as an input for deep learning based algorithms. Figure 2 indicates the application wise classification of input data on deep learning process. However, the inputs are different form the deep learning algorithm, which requires proper preprocessing step for removing the noise. So that, the accuracy of the algorithm gets
increased. Apart from noise removal, the preprocessing step is utilized for marking the area of interest. Therefore, the works are concentrated more on the particular region without any disturbances.

**Figure 2.** Application and outcome of deep learning algorithms

The outcome from deep learning algorithms can be divided into three major categories like classification, prediction and estimation. The classification works are employed to classify two or more categorized images based on the information collected during training process. The prediction kinds of applications on deep learning algorithms that are mostly used for analysis process are obtained from a numerical data. The estimation type of applications is working from the sensor and further the signal data gets transferred to the deep learning architectures.
Literature Survey

The workflow process of deep learning algorithms on several applications are almost same as like shown in figure 3. Whereas, the dataset splitting and neural network training process will be available for all kind of applications. Also, the feature selection and preprocessing steps are not employed everywhere. The deep learning algorithms can be trained directly with a training data without any preprocessing, when the sample data are clear and noise free. The deep learning algorithms are having the ability to be trained with noisy information. However, it may affect the accuracy on most of the applications. In order to improve the accuracy, the preprocessing steps are widely used for classification and prediction process.

![Figure 3. Work Flow of Deep Learning Algorithm](image)

Similarly, the feature selection process is also not mandatory for training a deep learning network. However, it is employed in the workflow for concentrating over some important information, which lies over the training samples. Table 1 show the research works, which are employed with a preprocessing step on their workflow. At the same time table 2 indicates the algorithms, which are implemented without any preprocessing work.
### Table 1. Deep learning based Applications with Preprocessing Techniques

| Citation                  | Area                  | Approach         | Preprocessing                          | Application                      | Accuracy  |
|---------------------------|-----------------------|------------------|----------------------------------------|-----------------------------------|-----------|
| Poloni et al., (2021)     | Image classification  | SVM              | Non-Local Means technique              | Alzheimer’s disease diagnosis     | 69.44%    |
| Beeravolu et al., (2021) | Image classification  | Deep CNN         | Sobel filter                           | Breast cancer classification      | 99.06%    |
| Wang et al., (2021)       | Image classification  | Random Implication Image Classifier | Median filter                        | Iris disease detection            | 96.7%     |
| Akhter et al., (2021)     | Data classification   | Multisize Filters CNN | Stemming                              | Document classification           | 95.4%     |
| Lichouri et al., (2021)   | Data Classification   | BiLSTM           | Lemmatization, stemming and POS tagging | Sentiment detection               | 88.29%    |
| Lichouri et al., (2021)   | Data Classification   | LSVC             | Lemmatization, stemming and POS tagging | Sentiment detection               | 98.46%    |
| Vijayakumar et al., (2020)| Data classification   | Capsule network  | Tokenization                           | Text classification               | 96.15%    |
| Mitra (2020)              | Data classification   | SVM, KNN, and NLP| Stemming and tokenization               | Sentiment analysis                | 94.61%    |
| Diker et al., (2020)      | Signal classification | Extreme learning machine | Baseline-wandering and 60 Hz noise removal | ECG signal classification          | 97.5%     |
| Ergün et al., (2020)      | Signal classification | KNN              | Fusion based preprocessing              | EEG classification               | 88.71%    |
| Heidari et al., (2020)    | Image Classification  | CNN              | Contrast normalization, bilateral and Gaussian low-pass filter | X-Ray classification on COVID 19 | 94.5%     |
| HaCohen-Kerner et al., (2020)| Data Classification | SMO              | Spelling correction, lowercasing, and removal of html tags, punctuation, stopwords, & R–repeated characters. | WebKB text classification         | 95.74%    |
| HaCohen-Kerner et al., (2020)| Data Classification | SMO              | Spelling correction, lowercasing, and removal of html tags, punctuation, stopwords, & R–repeated characters. | R8 text classification            | 95.75%    |
| HaCohen-Kerner et al., (2020)| Data Classification | RF               | Spelling correction, lowercasing, and removal of html tags, punctuation, stopwords, & R–repeated characters. | SMS spam classification           | 98.34%    |
| HaCohen-Kerner et al., (2020)| Data Classification | RF               | Spelling correction, lowercasing, and removal of html tags, | Sentiment text classification     | 78.78%    |
Table 2. Deep Learning based Applications without Preprocessing Techniques

| Citation                        | Area          | Approach | Application                  | Attainments |
|---------------------------------|---------------|----------|------------------------------|-------------|
| Lichouri et al., (2021)         | Data Classification | BiLSTM | Sentiment detection         | 86.05%      |
| Lichouri et al., (2021)         | Data Classification | LSVC   | Sentiment detection         | 98.83%      |
| HaCohen-Kerner et al., (2020)   | Data Classification | SMO    | WebKB text classification    | 94.1%       |
| HaCohen-Kerner et al., (2020)   | Data Classification | SMO    | R8 text classification      | 94.98%      |
| HaCohen-Kerner et al., (2020)   | Data Classification | RF     | SMS spam classification     | 97.62%      |
| HaCohen-Kerner et al., (2020)   | Data Classification | RF     | Sentiment text classification| 75.99%      |
| Heidari et al., (2020)          | Image Classification | CNN   | X-Ray classification on COVID 19 | 88%         |
| Ergün et al., (2020)            | Signal classification | KNN   | EEG classification          | 84.8%       |
| Rodrigues et al., (2020)        | Image Classification | CNN   | HEp-2 cell classification   | 98.28%      |
| Fujita et al., (2019)           | Signal classification | CNN   | ECG arrhythmia prediction   | 97.78%      |
| Camps (2018)                    | Image Classification | FDA   | Tomato variety classification| 45%         |

Discussion

The performances of classification techniques applied to image, data and signal classification techniques are analyzed in table 1 and 2. Based on the accuracy outcome of the classification processes, figure 4 graph has been plotted to observe the performance difference among techniques with preprocessing and without preprocessing. The comparison work that has
been carried out from figure 4 exposes the betterment of the preprocessing technique involved in all kind of applications. A slight performance reduction is observed only on LSVC based sentiment detection process. In remaining approaches, the performances of techniques implemented with preprocessing achieves its betterment.

![Comparison Analysis of Accuracy on Techniques with Preprocessing and Without Preprocessing](image)

**Figure 4.** Comparison Analysis of Accuracy on Techniques with Preprocessing and Without Preprocessing

**Conclusion**

The deep learning algorithms are having the ability to get trained without utilizing any preprocessing techniques. However, to improve the accuracy efficiency, it requires a preprocessing step. The paper discusses about the importance of preprocessing techniques on deep learning applications. The literature work summarizes the techniques, which are implemented with and without preprocessing step. It projects that, the approaches which are equipped with preprocessing module are comparatively giving better outcome for image, data and signal classification algorithms.
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