Astronomy Picture of the Day (Report)

Introduction

The year 2009 was the International Year of Astronomy (IYA). IYA marks a global effort initiated by the International Astronomical Union (IAU) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) to help the citizens of the world rediscover their place in the Universe through the day- and night-time sky, and thereby engage a personal sense of wonder and discovery. The fundamental goal for the initiative is to help people across societies realize the impact of astronomy and other fundamental sciences on our daily lives, and understand how scientific knowledge can contribute to a more equitable and peaceful society[6]. Therefore, strategies have to be put in place that helps humans learn about Space in a way that is both meaningful and interesting. One of the most influential and engaging approaches been incorporated in astronomy classroom, that employs popular media, is the power of digital visual media such as the Astronomy Picture of the Day (APOD).The Astronomy Picture of the Day (APOD) was founded in 1995 and is maintained by the brainchildren Robert Nemiroff and Jerry Bonnell. Robert Nemiroff is a professor at Michigan Technological University in Houghton, Michigan, USA. Jerry Bonnell is a scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, USA.

(APOD site: http://antwrp.gsfc.nasa.gov/apod/astropix.html)

The APOD is considered to be the largest collection of annotated astronomic digital media available on the Internet. The Astronomy Picture of the Day has also received the 2001 Scientific American Science and Technology Web Resource Award and continues to be a valuable resource for K-12 educators all over the world [4].

- **Proposed Model(ResNet50)**

ResNet is the short form for Residual Network (See fig.1). Over the years deep convolutional neural networks have made a series of breakthroughs in the field of image recognition and classification. Going deeper to solve more complex tasks and to improve classification or recognition accuracy has become a trend. But, training deeper neural networks has been difficult due to problems such as vanishing gradient problem [1] and degradation problem [2]. Residual learning tries to solve both these problems.

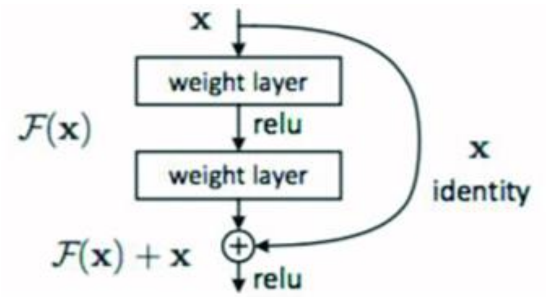


Fig. 1.
Residual learning: a building block

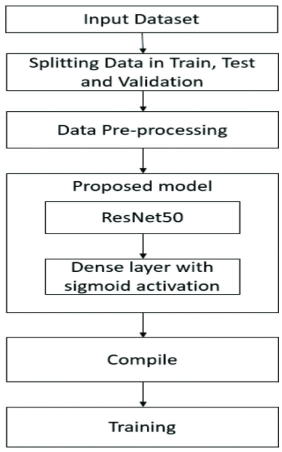
Transfer learning with ResNet50 has been used for "Astronomy Picture of Day" (APOD) dataset. Transfer learning is the process of using a pre-trained model on one task as the starting point on a second, related task. ResNet50 is a deep convolutional neural network that has been trained on a large dataset of images (ImageNet). Using transfer learning can save a lot of time and computational resources compare to training a model from scratch [3].

- **Data Pre-processing**

The input image for the ResNet50 layer should be of size 224*224. So, all the images have to be re-sized to the target size of 224*224. We've given the batch size to be 128 that makes 50 steps for each epoch of training. Steps per epoch for training are calculated by dividing the total objects in training with batch size. After Pre-processing and before training of the network the model has to be compiled. Few parameters such as optimizer, loss function and metrics to be calculated during the training has to be declared.

The optimizer along with loss function is the key elements that enable the network to work on the data. Optimizer, in simple terms, sets the learning rate of a neural network. The optimizer used for this model is Stochastic Gradient Descent (SGD). SGD optimizer has proven to be performing better than many other optimizers.

The loss function used to find the loss for this model is Categorical-Cross Entropy. During the training of model top layers in ResNet50 are not frozen because these layers learn from back propagation while other layers are frozen except last bottom layer (see fig.2 for model Architecture) [5].



- **Results and Discussion**

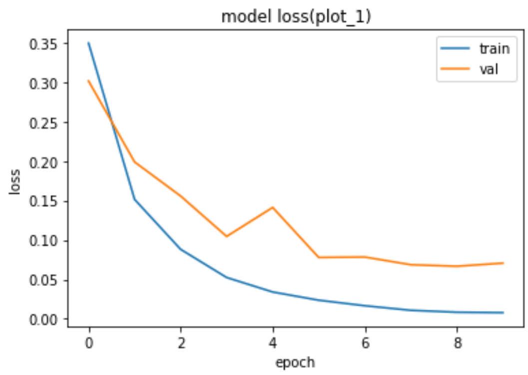
The metrics measured during the training of the dataset were accuracy and Loss. The accuracy and loss of training and validation data as well as test accuracy are tabulated in Table below.

Metrics	Value
Training Accuracy	99%
Validation Accuracy	97%
Test Accuracy	95%
Training Loss	0.007
Validation Loss	0.070

Performance Table

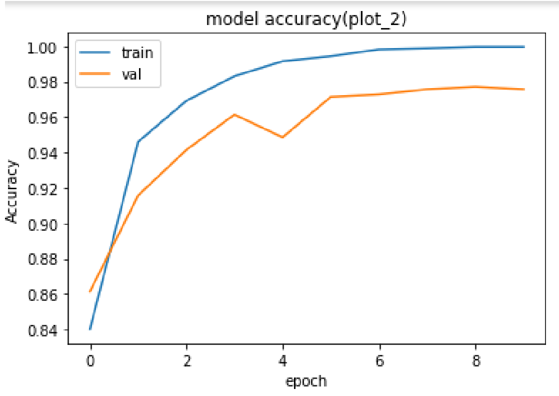
- **Loss and Accuracy Curves**

Loss curves seems to be convergent after 6 epochs, it can be seen in plot_1 below.



Accuracy curves can be seen below in plot_2. Exceptionally good curves have been monitored during training of model.

Hyper parameters have been tuned to get good combination to prevent over fitting for good plots.



- **Conclusion**

The use of Transfer learning for APOD image classification has brought good results. Accuracies has encountered really good for the datasets. A classification accuracy of 96% on APOD dataset suggests model is able to correctly classify 96 images out of 100 on average.

References

1. Habibzadeh, M., Jannesari, M., Rezaei, Z., Baharvand, H. and Totonchi, M., 2018, April. Automatic white blood cell classification using pre-trained deep learning models: Resnet and inception. In *Tenth international conference on machine vision (ICMV 2017)* (Vol. 10696, pp. 274-281). SPIE.
2. Wichrowska, O., Maheswaranathan, N., Hoffman, M.W., Colmenarejo, S.G., Denil, M., Freitas, N. and Sohl-Dickstein, J., 2017, July. Learned optimizers that scale and generalize. In *International Conference on Machine Learning* (pp. 3751-3760). PMLR.
3. Yosinski, J., Clune, J., Bengio, Y. and Lipson, H., 2014. How transferable are features in deep neural networks?. *Advances in neural information processing systems*, *27*.
4. Bonnell, J.T. and Nemiroff, R.J., 2000, December. Astronomy Picture of the Day in the Classroom. In *American Astronomical Society Meeting Abstracts* (Vol. 197, pp. 54-04).
5. Reddy, A.S.B. and Juliet, D.S., 2019, April. Transfer learning with ResNet-50 for malaria cell-image classification. In *2019 International Conference on Communication and Signal Processing (ICCSP)* (pp. 0945-0949). IEEE.
6. International Astronomical Union. (2009). Retrieved November 18, 2009, from http://www.astronomy2009.org/