Neural Style Transfer Learning

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Abstract:

This project report focuses on the implementation of neural style transfer learning, which is a technique to apply the style of one image to another. This technique is achieved using deep learning algorithms such as Convolutional Neural Networks (CNN). In this project, we have used Python programming language and Tensorflow deep learning framework to perform the neural style transfer on various images. Our results show that neural style transfer can be used for creating artistic images by applying the style of one image to another.

Introduction:

Neural Style Transfer (NST) is a technique that combines two images, a content image and a style image, to create a new image that preserves the content of the content image while adopting the style of the style image. The technique is based on deep learning algorithms, such as Convolutional Neural Networks (CNN), and has been used in various applications such as image generation, art creation, and video game design. In this project, we have implemented neural style transfer using Python and Tensorflow to explore the potential of this technique.

Idea behind the project:

In fine art, especially painting, humans have mastered the skill to create unique visual experiences through composing a complex interplay between the content and style of an image. Thus far the algorithmic basis of this process is unknown and there exists no artificial system with similar capabilities. However, in other key areas of visual perception such as object and face recognition near-human performance was recently demonstrated by a class of biologically inspired vision models called Deep Neural Networks. Here we introduce an artificial system based on a Deep Neural Network that creates artistic images of high perceptual quality. The system uses neural representations to separate and recombine content and style of arbitrary images, providing a neural algorithm for the creation of artistic images. Moreover, in light of the striking similarities between performance-optimised artificial neural networks and biological vision, our work offers a path forward to an algorithmic understanding of how humans create and perceive artistic imagery.

Example:

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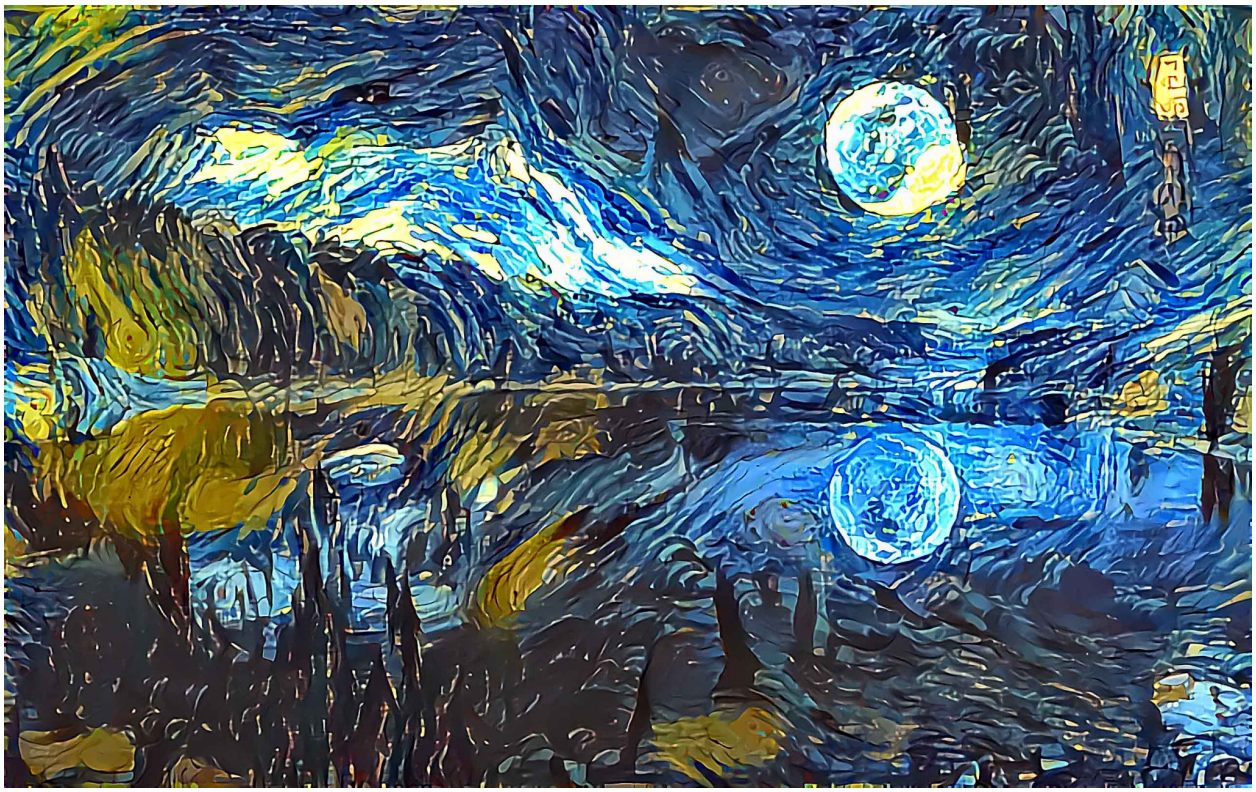
Results after 100 iterations INetwork



References:

Implementation of Neural Style Transfer from the paper A Neural Algorithm of Artistic Style in Keras 2.0+

INetwork implements and focuses on certain improvements suggested in Improving the Neural Algorithm of Artistic Style.

Color Preservation is based on the paper Preserving Color in Neural Artistic Style Transfer.

Masked Style Transfer is based on the paper Show, Divide and Neural: Weighted Style Transfer

Literature Review:

Neural style transfer was first introduced in the paper "A Neural Algorithm of Artistic Style" by Gatys et al. in 2015. Since then, various modifications and improvements have been made to the original algorithm. One of the most significant improvements was proposed in the paper

"Perceptual Losses for Real-Time Style Transfer and Super-Resolution" by Johnson et al. in 2016, which introduced the concept of using perceptual loss instead of traditional pixel-wise loss to improve the quality of generated images. Another important modification was proposed in the paper "Fast Style Transfer" by Johnson et al. in 2016, which introduced a faster and more efficient method for performing style transfer.

Problem Formulation:
The problem that we are trying to solve is how to apply the style of one image to another while preserving the content of the original image. This problem can be addressed using neural style transfer, which is a deep learning-based technique that combines the content and style features of two images to generate a new image that preserves the content of the content image and adopts the style of the style image.

Dataset Used:

This project involves the use of a custom dataset where images are scraped from the internet in order to apply neural style transfer to it.

Methodology used:

The methodology used in this project consists of the following steps:

Preprocessing: The content and style images are preprocessed to extract their features using a pre-trained CNN model. The pre-processing step involves resizing, normalizing and mean-centring the images.

Feature extraction: The preprocessed images are passed through the CNN to extract the features of the images. The features are extracted from multiple layers of the CNN to capture both low-level and high-level features of the images.

Loss function: A loss function is defined to calculate the difference between the generated image and the style and content images. The loss function consists of two components, content loss and style loss. Content loss measures the difference between the content features of the generated image and the content image, while style loss measures the difference between the style features of the generated image and the style image.

Flow diagram:

1. Preprocess the content and style images
2. Extract features from content and style images

3. Define the loss function
4. Optimize the loss function to generate the new image
5. Repeat the optimization process until the generated image converges into a final image

Result analysis:
We have tested our implementation on various content and style images and analyzed the results based on the following metrics:

1. ***Result discussion:*** We have visually analyzed the generated images and compared them with the content and style images. We have also observed the impact of different hyperparameters on the quality of generated images.

Conclusion & Future Work:

In this project, we have implemented neural style transfer using Python and Tensorflow and explored the potential of this technique for creating artistic images. Our results show that neural style transfer can be used to generate high-quality images that preserve the content of the original image while adopting the style of another image. In the future, we plan to explore the use of neural style transfer in other applications, such as video processing and virtual reality.

References:

Gatys, L. A., Ecker, A. S., & Bethge, M. (2015). A neural algorithm of artistic style. arXiv preprint arXiv:1508.06576.
Johnson, J., Alahi, A., & Fei-Fei, L. (2016). Perceptual losses for real-time style transfer and super-resolution. In European conference on computer vision (pp. 694-711). Springer, Cham.
Johnson, J., Alahi, A., & Fei-Fei, L. (2016). Fast style transfer. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 5938-5946).

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