

TER 2021 – 033 – Type: Research

Deep Learning to paint like Van Gogh

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1. Executive summary

The objective of the project is to transfer the artistic style from artworks, such as paintings, to real images to transform them into new artworks. The principle is to start from real photos and apply the style of Van Gogh to transform the initial photo into a painting-like picture. In this way, new data can be generated when real data is missing, and the dataset containing all Van Gogh's paintings can be augmented.

There have been several techniques proposed to transfer artistic style, but this project will mainly focus on three main approaches: Generative Adversarial Networks, Variational Auto-Encoders, and Convolutional Neural Networks.

Hence, the project will be composed of two parts:

1. Implement and evaluate existing algorithms for artistic style transfer
2. Improve the state-of-the-art results to provide a brand-new approach involving semantic segmentation

The first outcome of this work will be a comparison of current solutions for artistic style transfer under different point of views, such as accuracy of the model, speed, resources required, and quality of the fake generated artworks.

A second outcome will instead be a new model that combines aspects of the current approaches with semantic segmentation. So far, the usage of segmentation has been poorly investigated for the field of artistic style transfer, hence this outcome constitutes the main challenge of the whole project.

The overall result of this project will hopefully be a deep learning architecture able to generate fake paintings starting from real images, as if they had been painted by Van Gogh in person.

2. Project description

Technological context

- Virtual Machine
- Github repository
- Google Colab

Motivations

Problems to solve:

- Obtain a strong model using only few samples (Van Gogh's paintings) for training
- A painter does not use the same style when painting different objects, so generated artworks should preserve this principle
- Segmenting a painting is more difficult than segmenting real photos, because sometimes shapes are not very distinguishable

Part of science that will advance thanks to this project:

- Artistic Style Transfer
- Painting segmentation

Use of the project:

- Exhibitions
- Fake detection
- Digital commerce in NFT marketplaces
- Studies on Van Gogh's painting style

Objectives to achieve

- Generating new data to augment Van Gogh's paintings dataset
- Compare existing solutions each other
- Improve state-of-the-art algorithms exploiting image segmentation

Identified risks (and countermeasures)

- Risk: Too few style images may lead to poor performances
Countermeasure: Augment the dataset with similar paintings (e.g.: from other impressionist artists)
- Risk: Paintings become textures when applied to real images
Countermeasure: Use semantic segmentation to transfer style class-wise

Scenarios

Scenario 1 – Exhibitions

A first scenario could consist in an exhibition where immersive installations are placed in a museum or in a generic space. Screens will show animations of the evolution process of each image, from the real photo to the fake artwork. People coming to see the exhibition will then put themselves in Van Gogh's shoes to have a likely idea of what his mental process was while he painted. This can be done by extracting the features learned by the model in each step, so that it can be created a logic flow in the fake artwork creation process. This scenario can always run because, by definition, neural networks build their own feature representation during training.

Scenario 2 – Fake detection

Dataset containing Van Gogh's artworks can be augmented by adding the artworks generated by the model. Every image will be labelled as "real" or "fake". Then anybody can implement a new model that distinguishes original Van Gogh's paintings from fake ones. To achieve this goal, in principle the dataset should look homogeneous, thus the system should test the quality of generated paintings with a discriminator beforehand. If the discriminator turns out to be weak in distinguishing real from fake artworks, then this scenario can be run.

3. Implementation

List of activities already completed before full-time weeks:

1. Read all papers related to state-of-the-art models already used or that may be used for style transfer
2. Read some papers regarding the semantic style transfer

Lists of activities planned for each full-time week:

1. Implement current state-of-the-art models
2. Compare current state-of-the-art-models
3. Build new model
4. Compare new model with current state-of-the-art