Deep Learning for Computer Vision

Going Beyond Explaining CNNs

Vineeth N Balasubramanian

Department of Computer Science and Engineering
Indian Institute of Technology, Hyderabad

Review: Axioms of Attribution[1]

Completeness

For any input x, the sum of the feature attributions equals $F(x) = \sum_i A_i^F(x)$

Sensitivity

If x has only one non-zero feature and $F(x) \neq 0$, then the attribution to that feature should be non-zero

Implementation Invariance

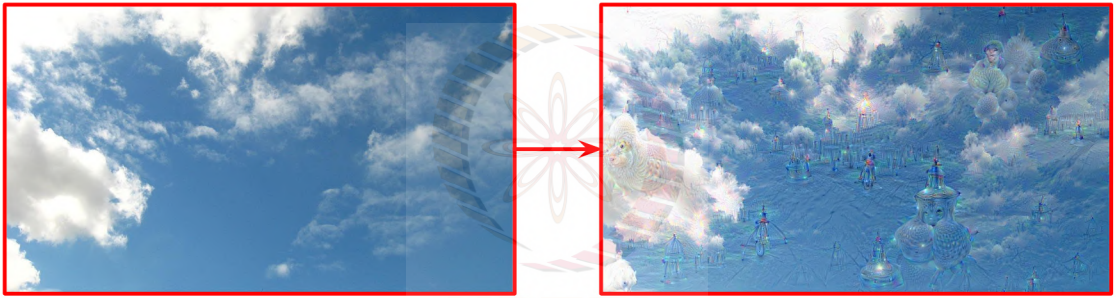
When two neural networks compute the same mathematical function $F(x)$, regardless of how differently they are implemented, the attributions to all features should always be identical.

Symmetry-Preserving

For any input x where the two values of two symmetric features are the same, their attributions should be identical as well.

[1] Sundararajan et al, Axiomatic Attribution for Deep Networks, ICML 2017

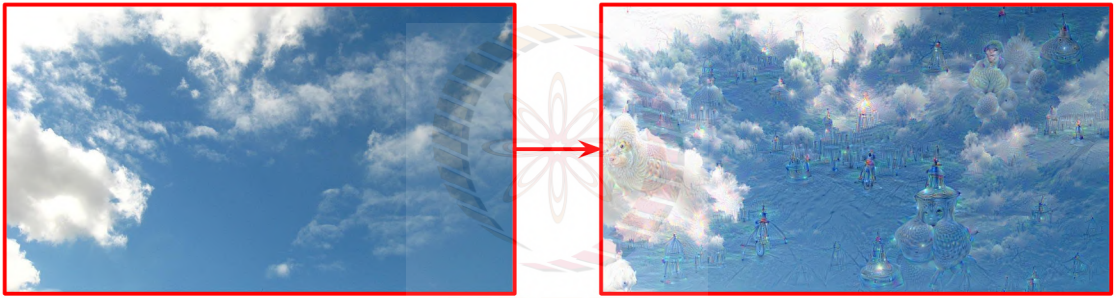
DeepDream[2]



- Modifies a given image in a way that **boosts** all activations at any layer, creating a feedback loop

[2] Mordvintsev et al, Deepdream - a code example for visualizing neural networks, 2015

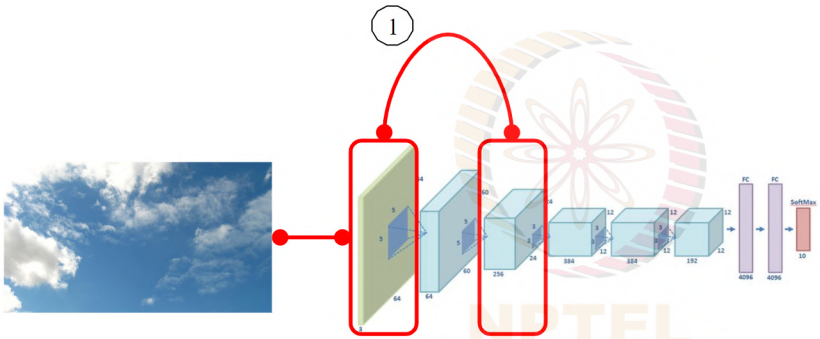
DeepDream[2]



- Modifies a given image in a way that **boosts** all activations at any layer, creating a feedback loop
- Any slightly detected dog face will be made more and more dog-like over time

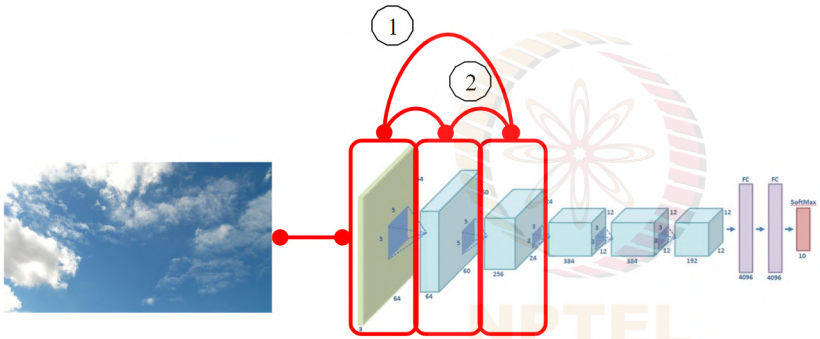
[2]Mordvintsev et al, Deepdream - a code example for visualizing neural networks, 2015

DeepDream



1) Choose a layer/filter.

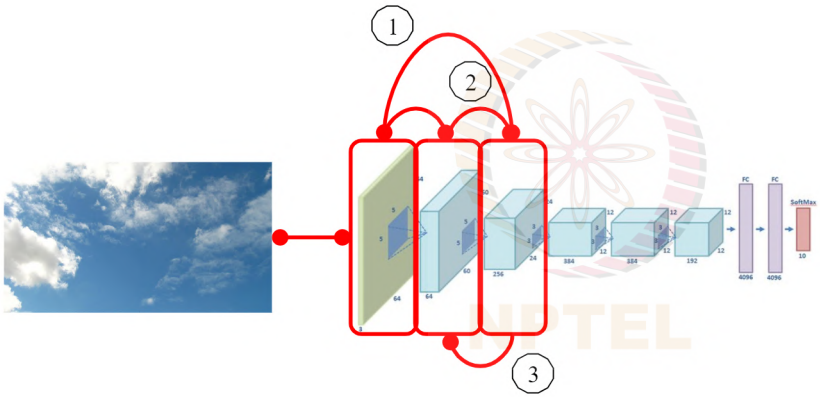
DeepDream



1) Choose a layer/filter.

2) Compute the activations for your image up to that layer.

DeepDream

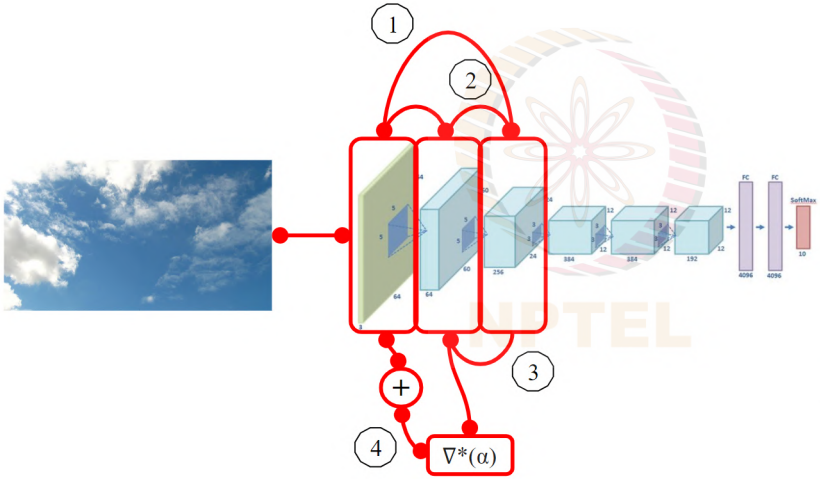


1) Choose a layer/filter.

2) Compute the activations for your image up to that layer.

3) Backpropagate the activations of your filter back to the input image.

DeepDream



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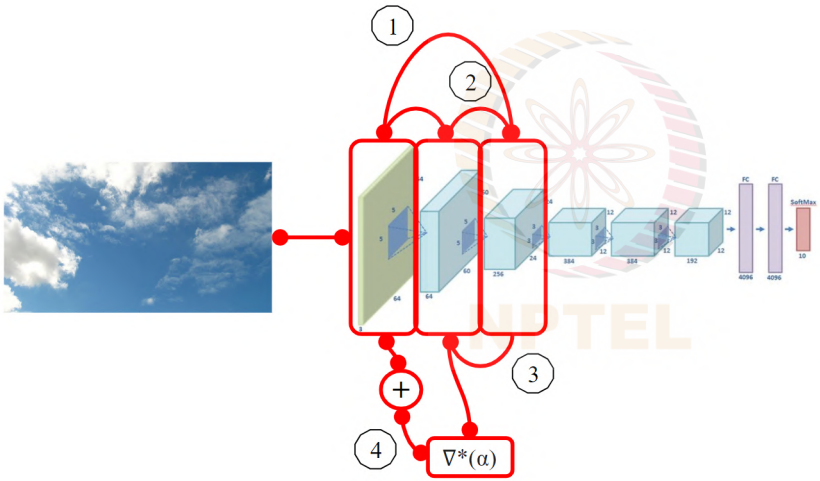
2) Compute the activations for your image up to that layer.

3) Backpropagate the activations of your filter back to the input image.

4) Multiply the gradients (∇) with your learning rate (α) and add them to your input image

DeepDream



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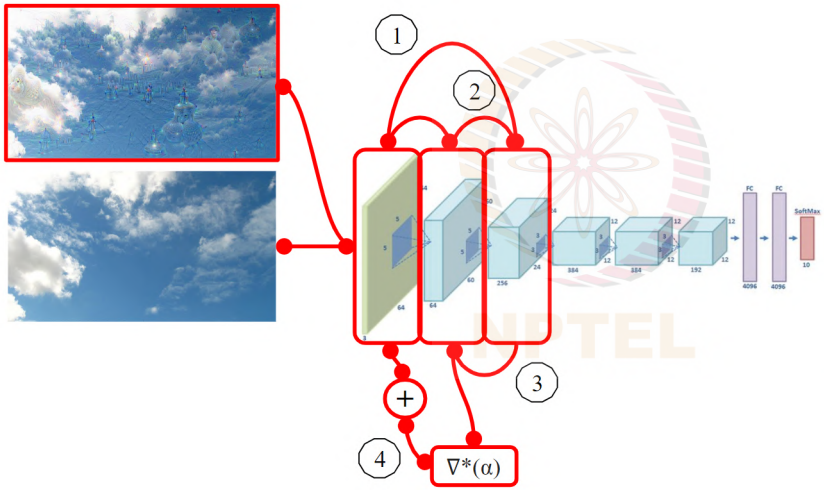
5) Go back to 2.

DeepDream



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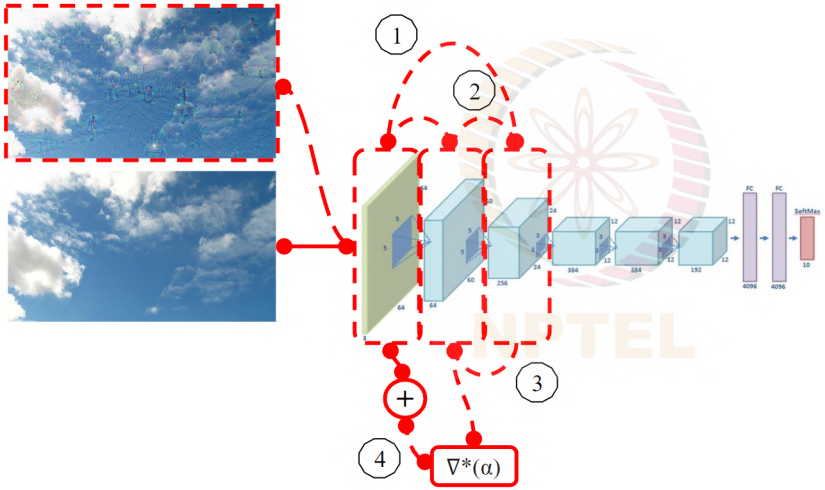

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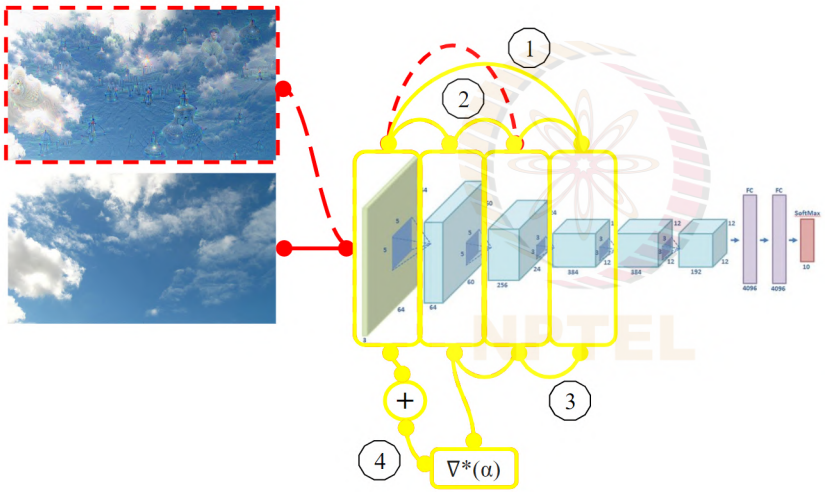

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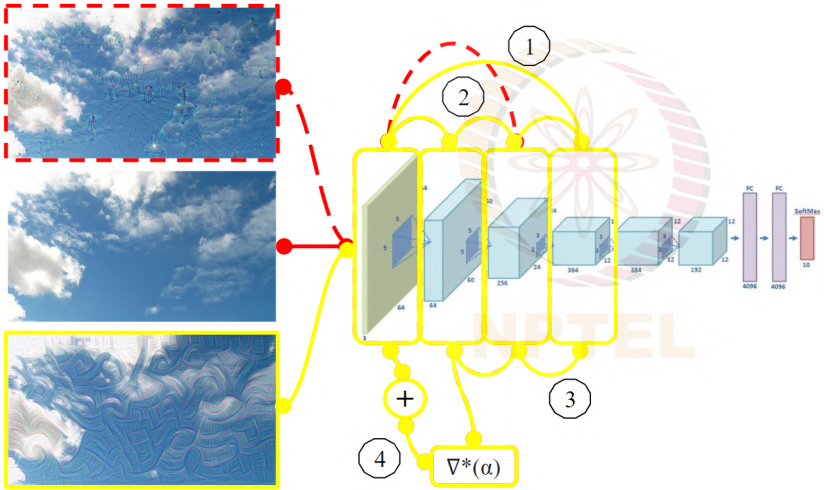
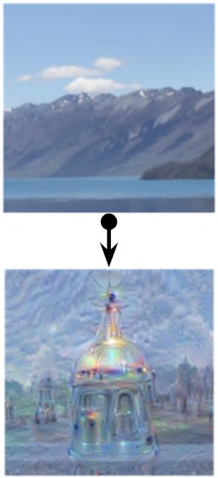


Higher layers produce complex features, while lower ones enhance edges and textures.

DeepDream: Examples



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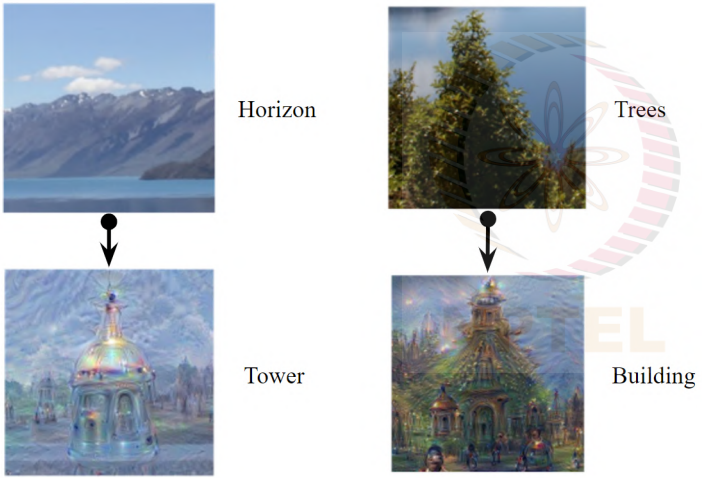


DeepDream: Examples

Horizon

Tower

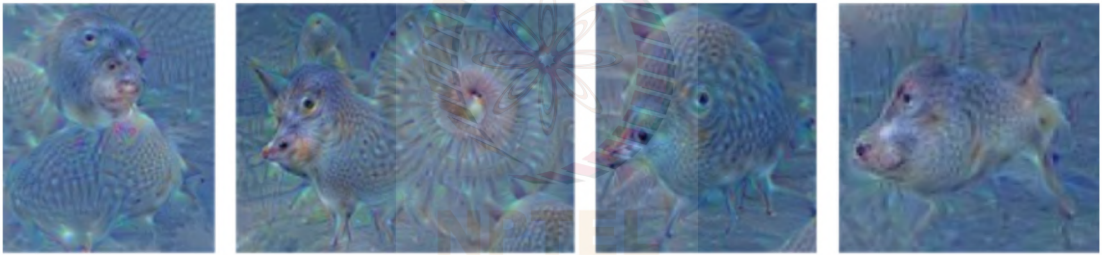
Trees

Building

Leaves

Birds & Insects

DeepDream: Examples



Admiral-Dog Pig-Snail Camel-Bird Dog-Fish

Credit: Fei-Fei Li and Andrej Karpathy, CS231n course, Stanford, Winter 2016

Neural Style

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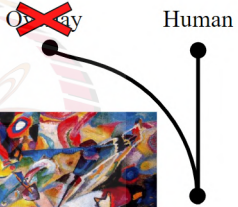
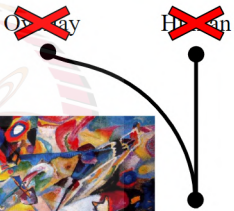
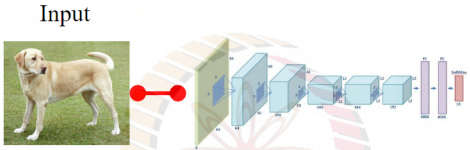


Neural Style



[3] Gatys et al, A Neural Algorithm of Artistic Style, 2015

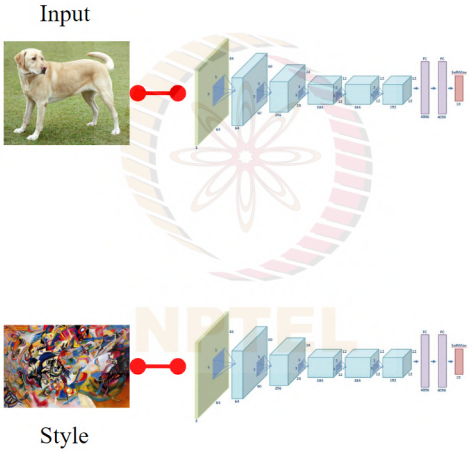
Neural Style[4]



1) Extract **input targets** :
ConvNet activations of all layers for the given input image.

[4] Gatys et al, A Neural Algorithm of Artistic Style, 2015

Neural Style[4]

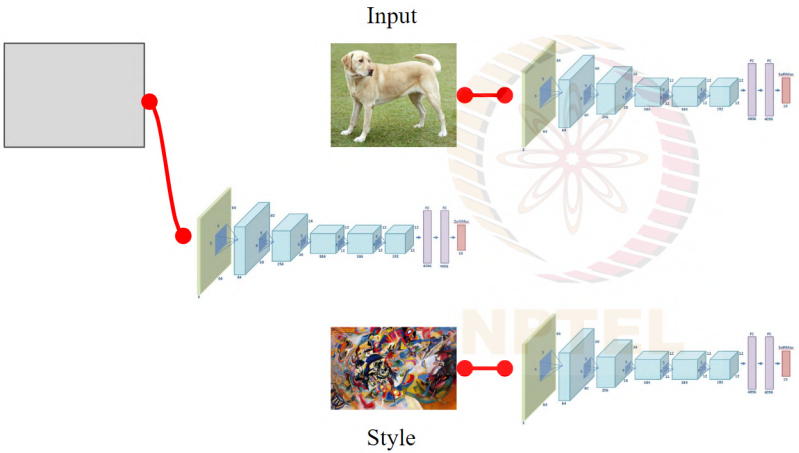


1) Extract **input targets** : ConvNet activations of all layers for the given input image.

2) Extract **style targets** : Gram matrix of ConvNet activations of all layers for the given style image.

[4] Gatys et al, A Neural Algorithm of Artistic Style, 2015

Neural Style[4]



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3) Initialize a new network.

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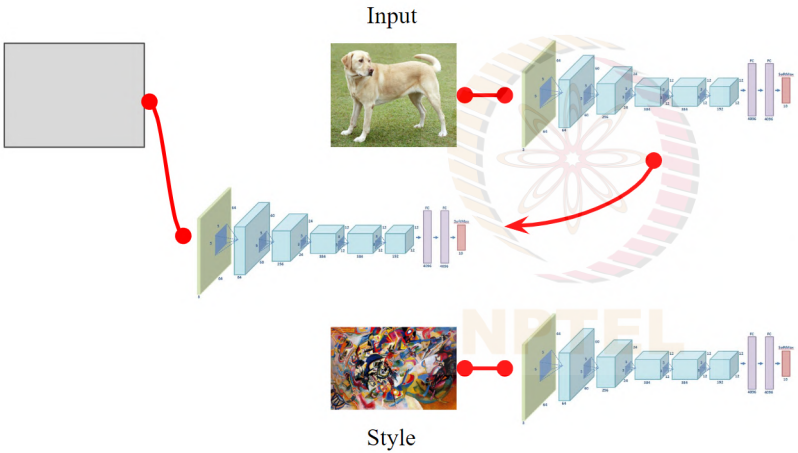

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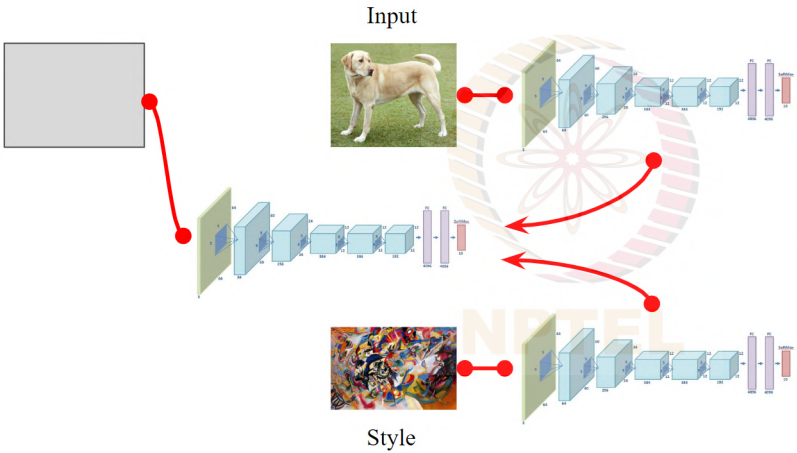

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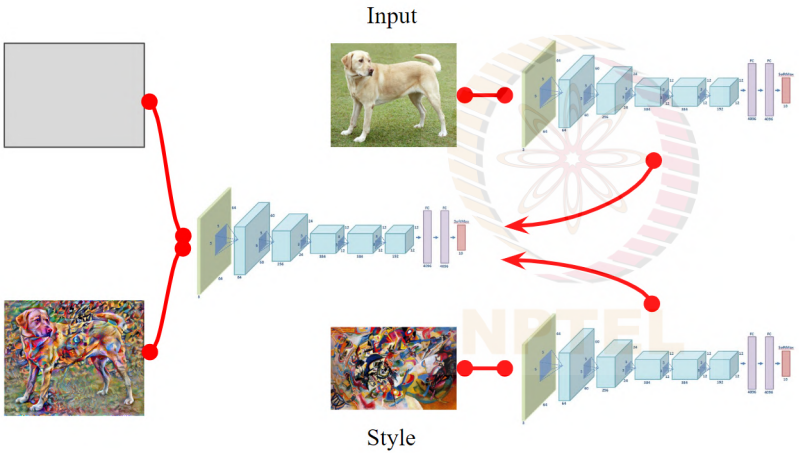

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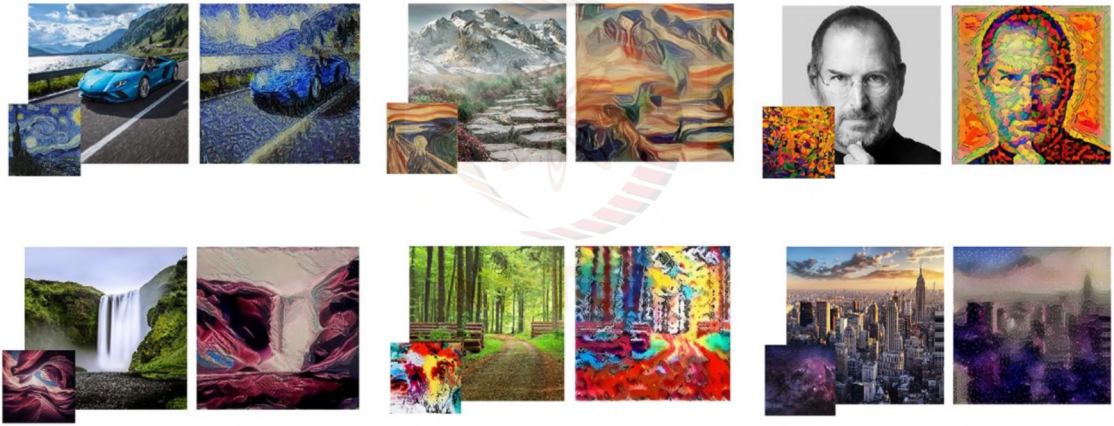
Neural Style: Examples



Credit: *Thushan Ganegedara, Intuitive Guide to Neural Style Transfer, TowardsDataScience*

Neural Style: Examples

Credit: *Artistic Style Transfer with TensorFlow Lite*

Homework

Readings

- Sarthak Gupta, DeepDream with Code, HackerNoon
- Thushan Ganegedara, Intuitive Guide to Neural Style Transfer, Towards Data Science
- (Optional) Another good tutorial on Neural Style Transfer on Towards Data Science

Exercises

- Watch this fun video on YouTube of using DeepDream on videos, try to figure out how this was done!