Lecture 0: Introduction & Instructions

Fundamentals and Trends in Vision and Image Processing

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What is the purpose of this classes?

A complementary presentation of Deep Learning methods in the context of Vision and Image Processing.

Illustration by Justin Metz

Main Goals:

- To learn some of the theory and mathematics of the subject.
- To be able to apply the methods in practice.
- To view Deep Learning as a scientific tool, and understand what it can and cannot do for you.
- To be able to understand and critically evaluate current papers in the field.

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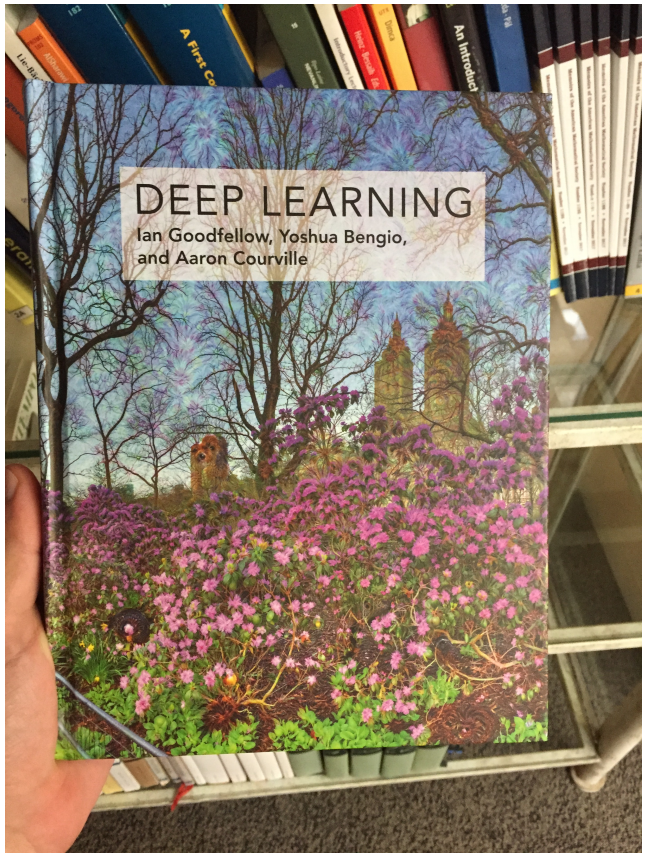
Provisional Lecture Schedule:

1. Introduction/Instructions (15/08)
2. Basic concepts of Machine Learning (ML) (22/08)
3. Neural Networks / Fundamentals (29/08)
4. The modular approach for designing NNs (05/09)
5. Training practices and Tensorflow (12/09)
6. Supervised applications (19/09)
7. Optimization and stability (26/09)
8. Unsupervised Learning I (03/10)
9. Unsupervised Learning II (10/10)
10. Working with Data (17/10)

References:

- **Deep Learning** by Goodfellow, Bengio, and Courville (link).
- Other references:
  - *Machine Learning: A Probabilistic Perspective* by Kevin Murphy
  - *Computer Age Statistical Inference* by Efron and Hastie
- Several papers which will appear during the course.
- (A compiled list of tutorials and references)



Todays Agenda

- Assignments
- Software Environment (Djalma)
- Topic Presentations

Assignments

1. Install Software Environment (instructions)
2. Linear Regression (due to 29/08)
3. Classification (due to 19/09)
4. Colorization (due to 26/09)
5. Image Synthesis (due to 17/10)

Preparing the Software Environment

Python:

- **Ubuntu:** (Ubuntu já possui o python instalado!)
  Para instalar `pip` e `virtualenv` execute o comando
  `sudo apt install python3-pip virtualenv`
- **Windows:**
  Para instalar o Python no Windows baixe o instalador que está disponível em:
  https://www.python.org/downloads/release/python-366/
  O instalador do Windows já vem com todas as ferramentas necessárias.

Preparing the Software Environment

Configurando o `virtualenv`

O virtualenv permite que o usuário tenha diversos ambientes Python isolados e evita que os pacotes instalados nestes ambientes não sobreponham os pacotes do sistema, além de não exigir direitos administrativos na máquina.

1. Para criar o ambiente usado no curso, execute o seguinte comando:
   `virtualenv -p python3 venv-ip2018`
2. Para ativar um ambiente basta executar o comando:
   `source venv-ip2018/bin/activate`
3. Para desativar um ambiente execute:
   `deactivate`

Preparing the Software Environment

Instalando NumPy e a SciPy Stack

Para ter todas as ferramentas necessárias disponíveis no ambiente execute o seguinte comando:

```
pip install numpy scipy matplotlib ipython jupyter pandas
sympy nose
```

Preparing the Software Environment

Instalando o TensorFlow

Para instalar o tensorflow basta executar o seguinte comando:

```
pip install tensorflow
```

Toda a documentação necessária para instalar o TensorFlow se encontra aqui:

- Ubuntu:
  https://www.tensorflow.org/install/install_linux#InstallingVirtualenv
- Windows:
  https://www.tensorflow.org/install/install_windows

Preparing the Software Environment

Instalando PyTorch

Para instalar o PyTorch com suporte somente à CPU execute os seguintes comandos

1. Ubuntu:

```
pip install http://download.pytorch.org/whl/cpu/
torch-0.4.1-cp36-cp36m-linux_x86_64.whl
pip install torchvision
```

2. Windows:

```
pip install http://download.pytorch.org/whl/cpu/
torch-0.4.1-cp36-cp36m-win_amd64.whl
pip install torchvision
```

Preparing the Software Environment

Instalando e executando jupyter

Para instalar o Jupyter execute o comando:

```
pip install jupyter
```

Para executar o Jupyter execute o comando:

```
jupyter notebook
```

Preparing the Software Environment

Anaconda

A distribuição Anaconda Python, além do Python, já possui, praticamente, todos os pacotes necessários para o desenvolvimento de projetos de ML, como o numpy, jupyter etc. Para realizar sua instalação, baixe o instalador em:

https://www.anaconda.com/download/

A documentação necessária para ativar e usar esta distribuição se encontra em:

https://conda.io/docs/user-guide/index.html

Preparing the Software Environment

Anaconda

Para instalar o PyTorch na distribuição Anaconda, execute o seguinte comando:

`conda install pytorch-cpu torchvision-cpu -c pytorch` Para instalar o TensorFlow na distribuição Anaconda siga a documentação disponível em:

- Ubuntu: https://www.tensorflow.org/install/install_linux#InstallingAnaconda
- Windows: https://www.tensorflow.org/install/install_windows

Topics Presentation/Final Project

Format:

- Choose a topic related to **Vision and Image Processing** which has been approached by **Deep Learning** techniques.
- Preference for **Generative** applications!
- **Option 1:** You can choose from our list of recommended topics:
  - Texture Synthesis
  - Art creation & Style Transfer
- **Option 2:** Suggest your own themes.
- Your choice should be accompanied by at least one paper that has its code available.
- The idea is to extend the results observed, taking the available code as base. You can apply it for some related task, or even try to improve the results.
- The project can be done individually or in groups.

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- Fase 3: Run tests on the available code
- Fase 4: Propose your idea of extension.
  - This should be presented and discussed at some point during the Lab classes -
- Fase 5: Implement the ideas and write a report on the problem, with a brief explanation on the subject and the methods of the original paper.
- Fase 6: Present your results in the end of the semester.

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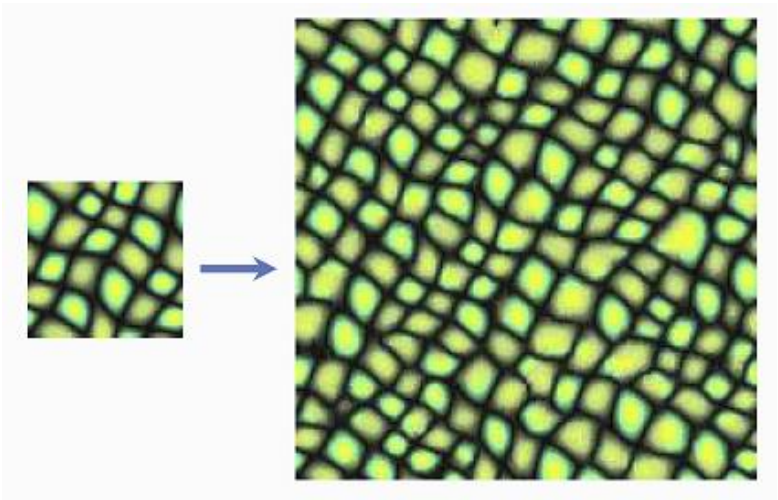
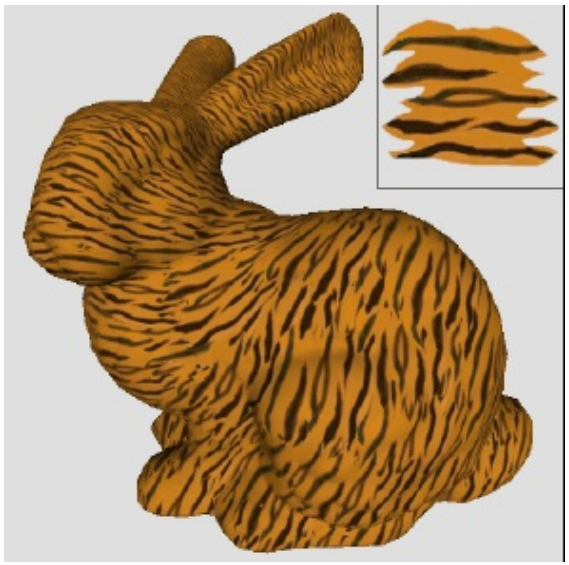
Texture Synthesis

Motivation:





- Texture Mapping is essential in many computer graphics applications.
- Texture synthesis can generate content on the fly, reducing memory consumption.
- Some surveys: [1], [2].

Texture Synthesis

Brief explanation:

- Given an exemplar, a image of fixed size, we want to generate a texture of arbitrary size that preserves the visual features present in the original picture.
- The problem can be seen in the generative framework as to sample from a *texture distribution*.

Texture Synthesis

Texture Synthesis with Spatial Generative Adversarial Networks

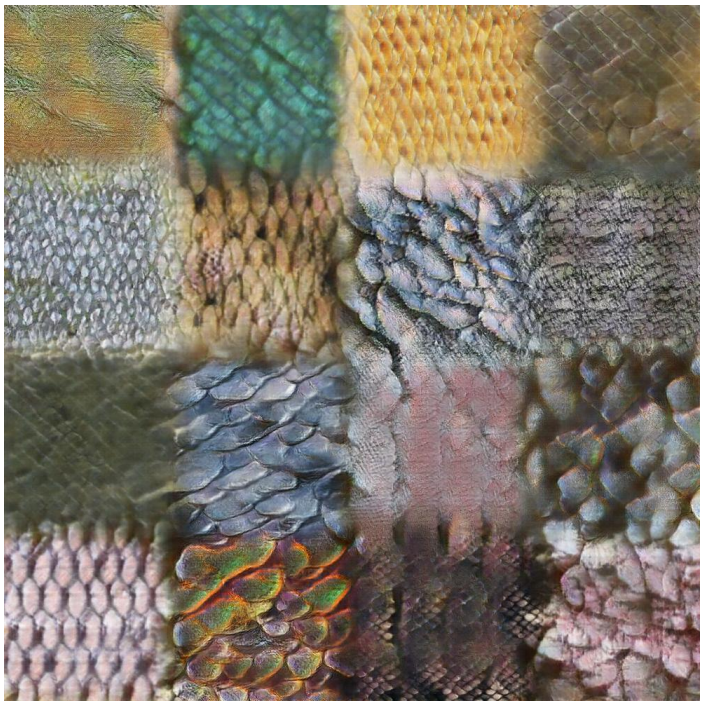
Jetchev, Bergmann, and Vollgraf. [code]

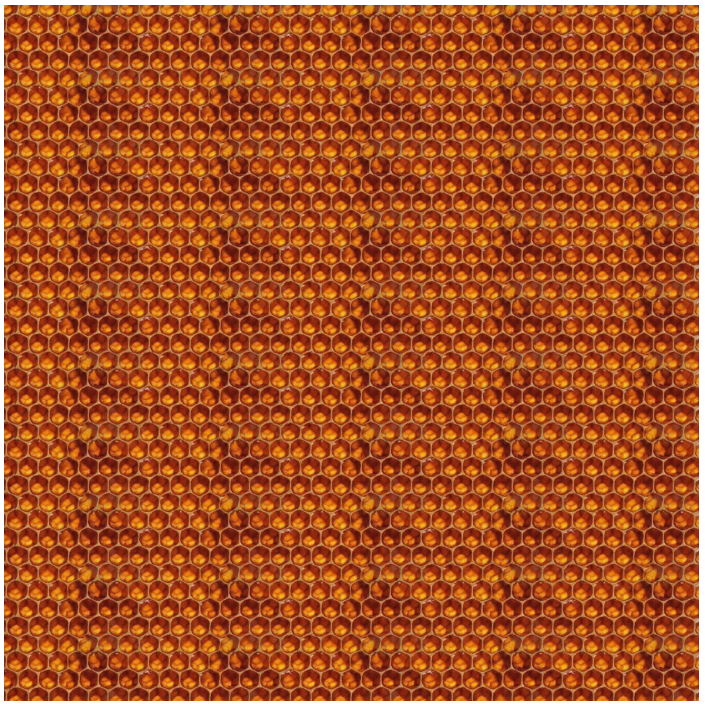
SGAN4 SGAN5 SGAN6

Texture Synthesis

Learning Texture Manifolds with the Periodic Spatial GAN

Jetchev, Bergmann, and Vollgraf. [code]





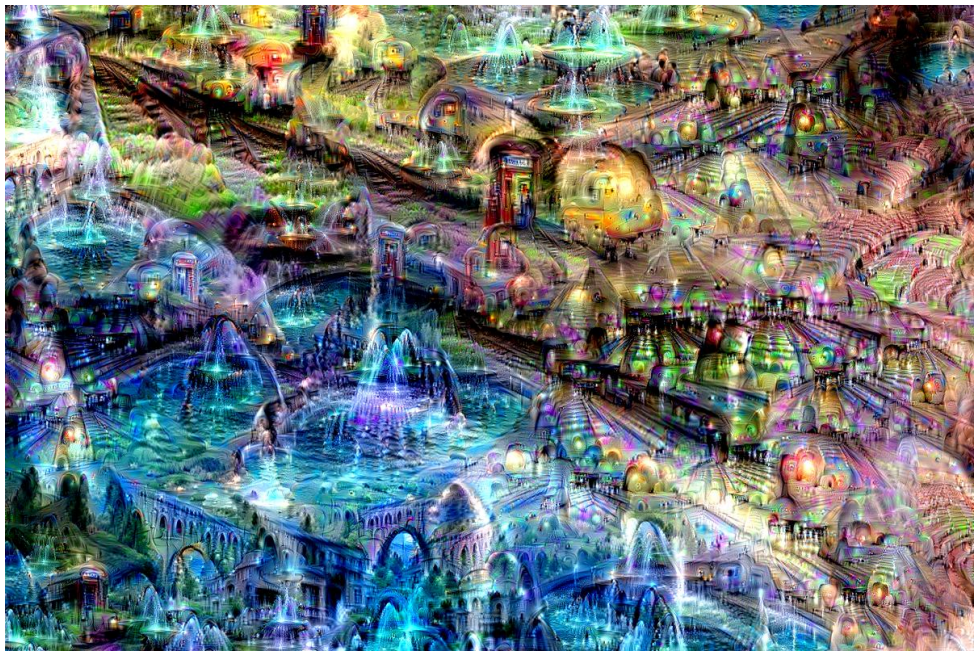
Texture Synthesis

Non-Stationary Texture Synthesis by Adversarial Expansion

Zhou, Zhu, Bai, Lischinski, Cohen-Or, Huang. [code]

Art creation & Style Transfer

Generative artwork



Left: From Google's DeepDream [album] - Right: GANGogh experiment [link]

Art creation & Style Transfer

ArtGAN: Artwork Synthesis with Conditional Categorical GANs

Tan, Chan, Aguirre, Tanaka. [code]

Art creation & Style Transfer

CAN: Creative Adversarial Networks Generating "Art" by ...

Elgammal, Liu, Elhoseiny, Mazzone. [code]

Art creation & Style Transfer

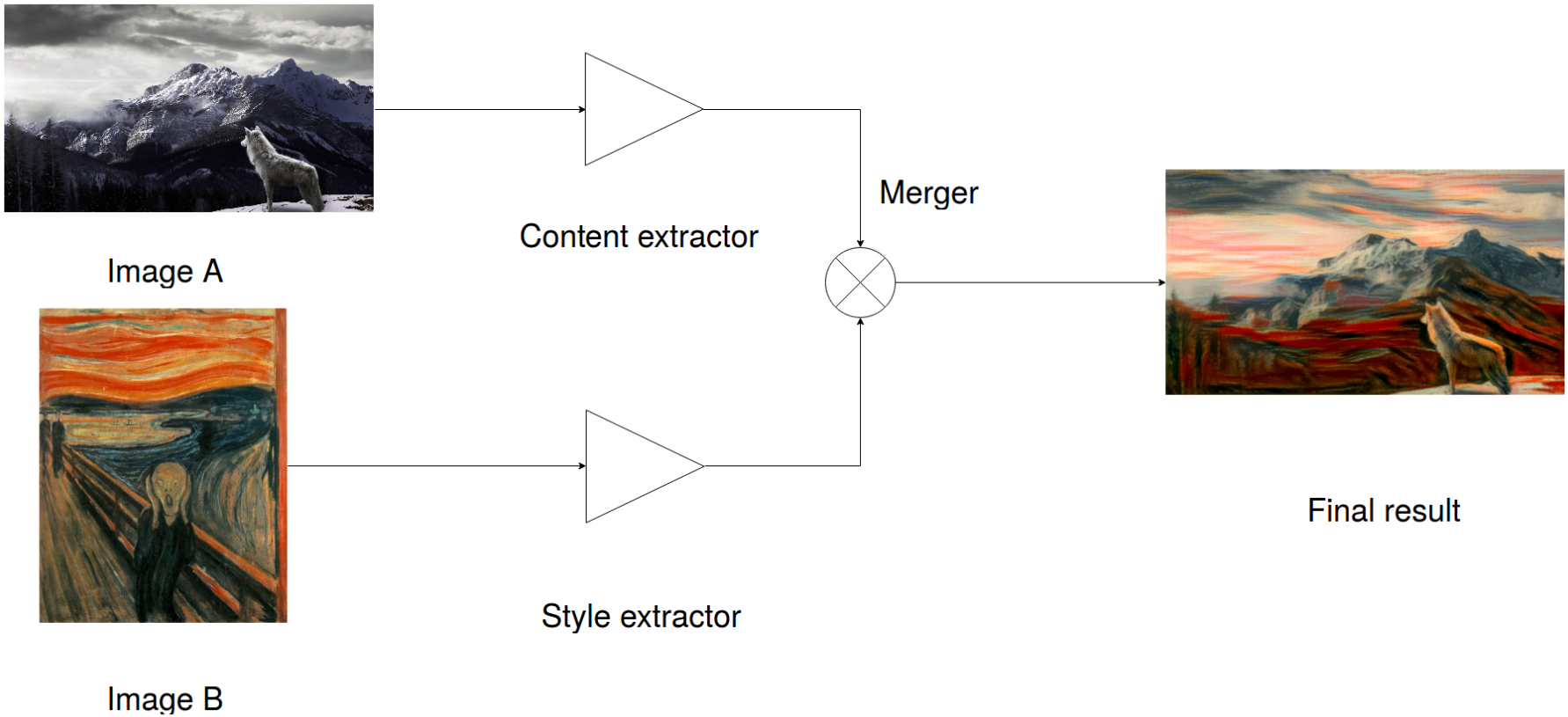
Neural Style Transfer:

Original work: *A Neural Algorithm of Artistic Style* by Gatys, Ecker, Bethge - [paper]

Art creation & Style Transfer

Neural Style Transfer:

Neural Style Transfer: A Review - [paper] (see also [link] for some codes)



Art creation & Style Transfer

Deep Painterly Harmonization

Luan, Paris, Shechtman, Bala, [code]