Empower AI through Computer Vision

Syllabus

A. Course Description

The whole purpose of this course is to enable the students to **explore** a data lake of images and to **engineer** meaningful **features** for generalisation models development such as **machine learning algorithms**. By the end of the course, students should be able to create **image based decision AIs** in any given field of work (i.e: space, automobile, biotech etc.).

B. Course Overview

1. Course Composition

6 sessions of 3 hours each (1/3 theory and 2/3 practice) and 1 exam of 3 hours for a total of 21 hours.

2. Target Skills and Learning Outcomes

The skills that should be acquired while taking this course are summarized in the following table

Skills	Learning outcomes
Numerical Image Understanding	• A numerical image: what is it ? • Spatial frequency and filtering • Mathematical morphology
Computer Vision Initiation	• Purposes and problematics • Algorithms • Tools • AI solution design
Image Processing for Computer Vision	• Normalisation • Dimensions reduction • Feature engineering • Data augmentation • Convolution
Computer Vision Modelisation	• Image classification • Image segmentation • Object detection • Object tracking • Using keras • Using pre-trained models (VGG16 & ResNet50) • Performances evaluation • Production ready

C. Assessment Model

Professional project achievement: Specifications will be given to students with 3 hours to respond to them. Within this time, they will need to create a documented jupyter notebook detailing all steps of their analysis / development strategy. During the 3 hours exam session, students can start working on the project and ask questions about the exam. At the end of the session, students will have 3 to 5 days to turn in their exam. If this is not possible, exams will be taken at the end of the 3 hours session and grades will be normalized based on the most advanced notebook. Notebooks will be evaluated according to the following criterias (in agreement with EPITA pedagogical team).

Criterias:

- Code documentation
- Technical steps justification
- Data cleaning relevance
- Feature engineering impact on modelisation
- Model choice and performances argumentation

D. References & Resources

- Online learning and books:
  - Kaggle course
  - Kaggle notebooks
  - PyImageSearch
  - Towards data science journal

As we live in a connected world, students are strongly encouraged to search for external resources that will help them cover the points that they feel particularly uneasy with. Feel free to report these resources so as to make them available to all for the next course session.

E. Hardware and Software

- Hardware:
  - Core I5 / I7
  - 8-16 GB RAM
  - Optional but very nice: GPU oriented ML training (ex: RTX 2000 series)
  - Internet access
- Software:
  - Optional: Unix/Linux distribution
  - Python3
  - Virtualenv (or equivalent)
  - Keras
  - Jupyter notebook (or equivalent)
  - Google colaboratory
  - OpenCV

F. Prerequisites

- Good understanding of programming in python3
- Able to search and read python3 documentation
- Intermediate skills in Algebra and Data visualization
- Intermediate skills in Algorithmic
- General understanding of machine learning models

G. Sessions Contents

1. Numerical Image Understanding

a. Description

In this session you will discover how images are built numerically with or without colors. Through exemples, you will study the principle of **image filtering** using a convolution kernel. Eventually, you will further learn about image modifications with **mathematical morphology operations**.

b. Milestones

- A numerical image: what is it ?
- Spatial frequency and filtering.
- Mathematical morphology.

c. Check your skills

- Define the notion of image sampling.
- Define what is the pixel quantification of an image.
- What frequential filters do you know ?
- What effect does this convolution kernel have on an image ?

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2. Computer Vision Initiation

a. Description

Computer vision is a branch of artificial intelligence which enables machines to “understand” an image content. This understanding comes through meaningful data extraction, processing and modeling. In this section, we will discuss the basic ideas and principles behind this concept. Through exemples, we will explore the importance of machine learning in the evolution of computer vision and its actual place in the development of AI solutions.

b. Milestones

- Purposes and problematics
- Algorithms
- Tools (python modules, frameworks and cloud API)
- AI solution design

c. Check your skills

- Define the potential of computer vision
- Did you select your favorite tools yet ?
- Solve the Digit Recognizer Kaggle competition

3. Data exploration (part 1)

a. Description

Using publicly available datasets of images, students will learn to clean and explore this type of data in order to select and create reasonable features for computer vision modelisation.

b. Milestones

- Normalisation
- Dimensions reduction
- Feature engineering

4. Data exploration (part 2)

a. Description

In this part, students will learn techniques to overcome the lack of training data which is a common issue in the field of computer vision. The session ends with a teacher / students discussion to insure a strong understanding of the data exploration analysis as this is the most important / difficult part of the course.

b. Milestones

- Video processing
- Data augmentation
- Convolution

c. Check your skills

- Apply your knowledge on this very popular dataset
- Kaggle competition: Dstl Satellite Image Feature Detection

5. Computer Vision Modelisation (part 1)

a. Description

This session will focus on the different algorithms available for image based automated decision making. By the end of the session, students will train their own models based on the algorithms previously discussed and evaluate their performances.

b. Milestones

- Image classification
- Image segmentation
- Object detection
- Object tracking
- Video classification
- Performances evaluation

6. Computer Vision Modelisation (part 2)

a. Description

Students will discover the tools to increase the efficiency of their model building strategy. The discussion will end on how to design an AI solution and bring it to the "production ready" status.

b. Milestones

- Keras
- OpenCV
- Using pre-trained models
- Production ready

c. Check your skills

Kaggle competitions:

- Simple image classification: Dogs vs Cats
- Cell nucleus detection
- Dog breed identification
- Help restaurant photo classification
- Distracted drivers detection
- Image background removal

H. Class Policies

- Behave as professional adults.
- Respect and honor others as yourself.