



PHENIKAA UNIVERSITY
Faculty of Computer Science

COMPUTER VISION

Introduction to Computer Vision

Lecturer: PhD. Dang Thi Thuy An



1. What is Computer Vision?
2. What can Computer Vision do?
3. What will we learn in this course?
4. Classical Computer Vision
5. Deep Learning Computer Vision
6. What make Computer Vision hard?
7. Evaluation

1. Introduction to Computer Vision

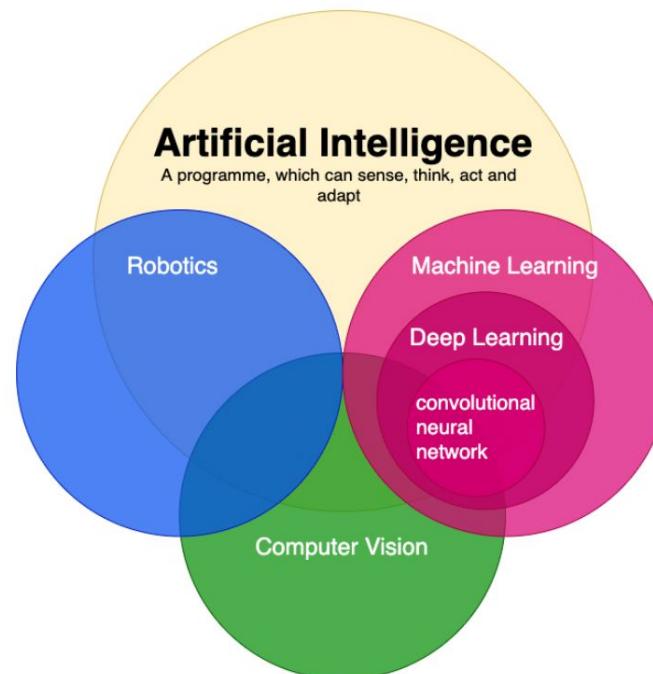


So what exactly is Computer Vision?

*“An interdisciplinary field that aims to enable computers to gain **understanding of what is being seen in** images and videos.”*



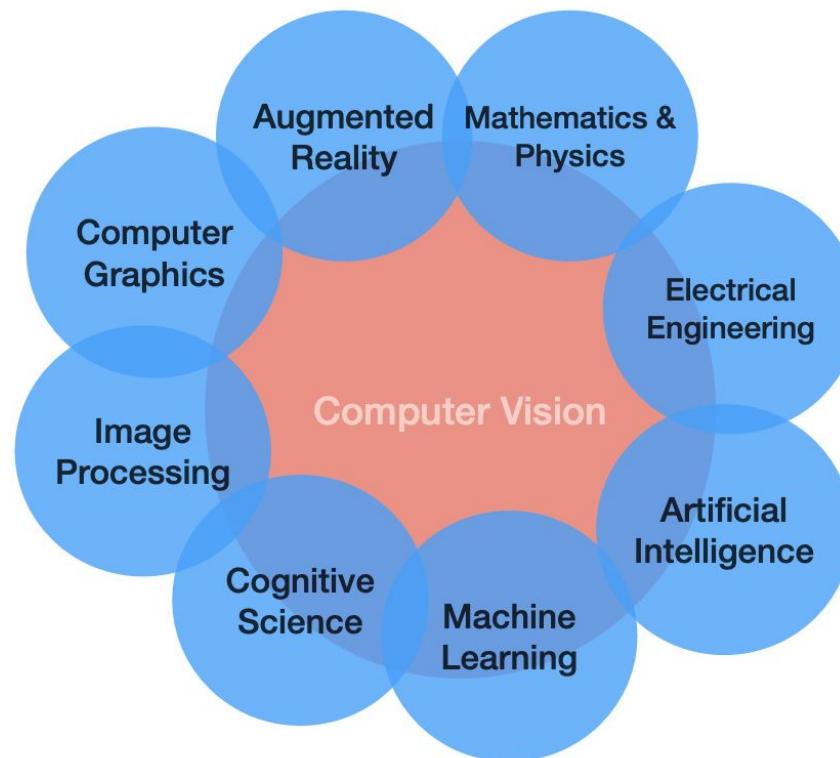
Is Computer Vision Artificial Intelligence?



Relation between Artificial Intelligence, Machine Learning and Deep Learning, Computer Vision.
https://www.researchgate.net/figure/Relation-between-Artificial-Intelligence-Machine-Learning-and-Deep-Learning-Computer_fig1_342978934



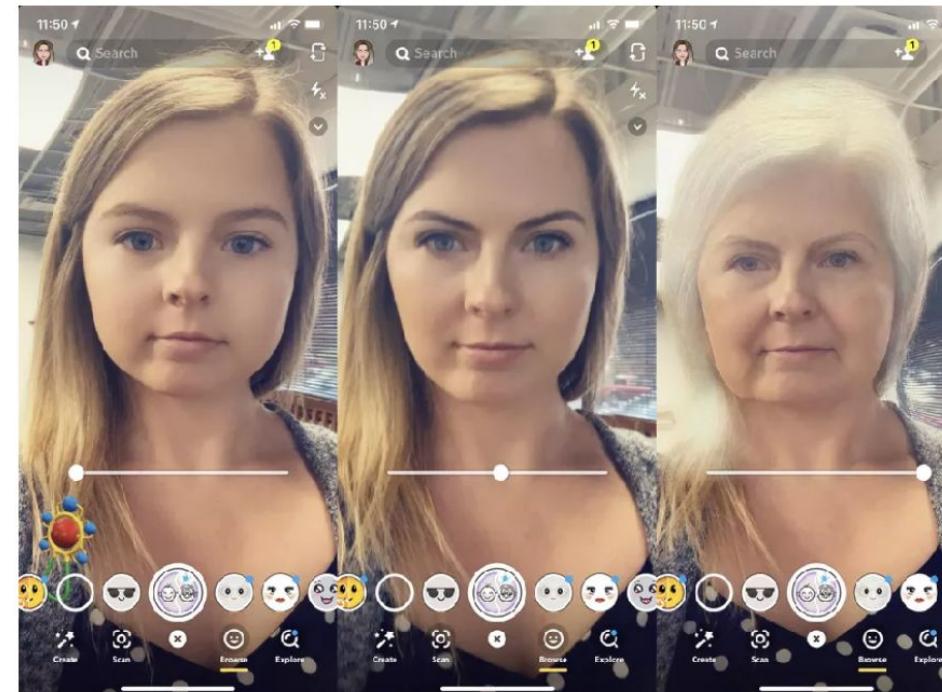
Computer Vision is an amalgamation of many fields



2. So what can Computer Vision do?

You might be familiar with these...

- Snapchat and Instagram filters
- Optical Character Recognition (OCR)
- Licence Plate Reading
- Self-driving cars
- Sporting Analysis
- Facial Recognition



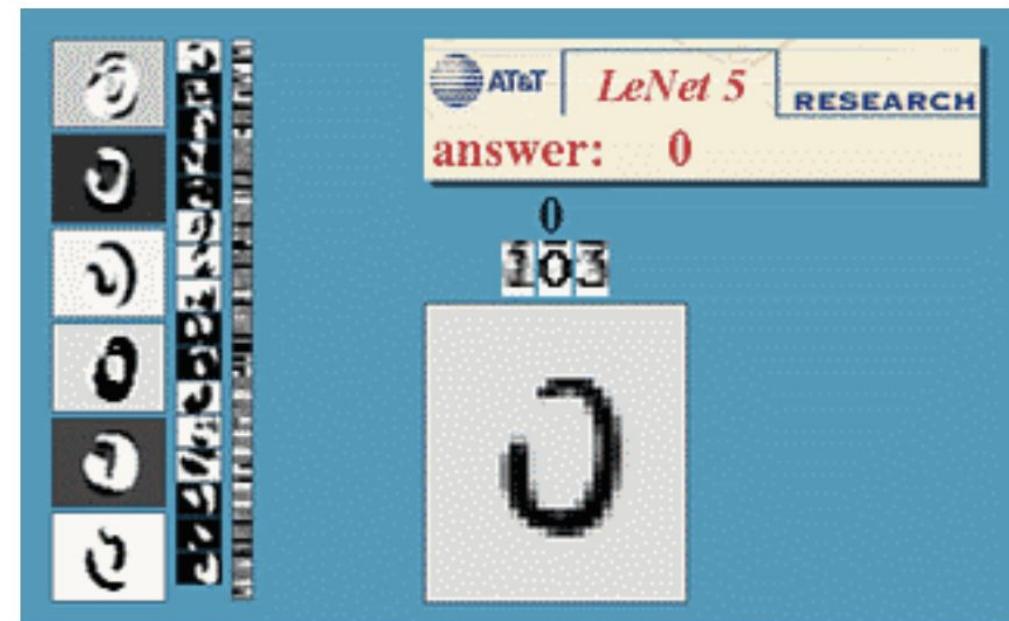
Source - Cnet - Snapchat's Time Machine AR lens creepily shows what you'll look like ol



2. So what can Computer Vision do?

You might be familiar with these...

- Snapchat and Instagram filters
- **Optical Character Recognition (OCR)**
- Licence Plate Reading
- Self-driving cars
- Sporting Analysis
- Facial Recognition



Source -AT&T's LeNet OCR for Handwritten Digits

2. So what can Computer Vision do?

You might be familiar with these...

- Snapchat and Instagram filters
- Optical Character Recognition (OCR)
- **Licence Plate Reading**
- Self-driving cars
- Sporting Analysis
- Facial Recognition



2. So what can Computer Vision do?

You might be familiar with these...

- Snapchat and Instagram filters
- Optical Character Recognition (OCR)
- Licence Plate Reading
- **Self-driving cars**
- Sporting Analysis
- Facial Recognition



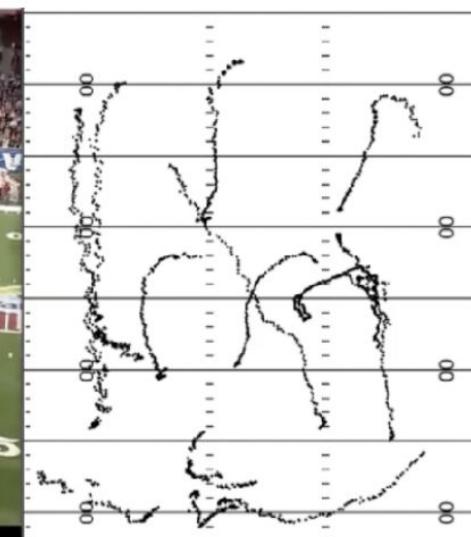
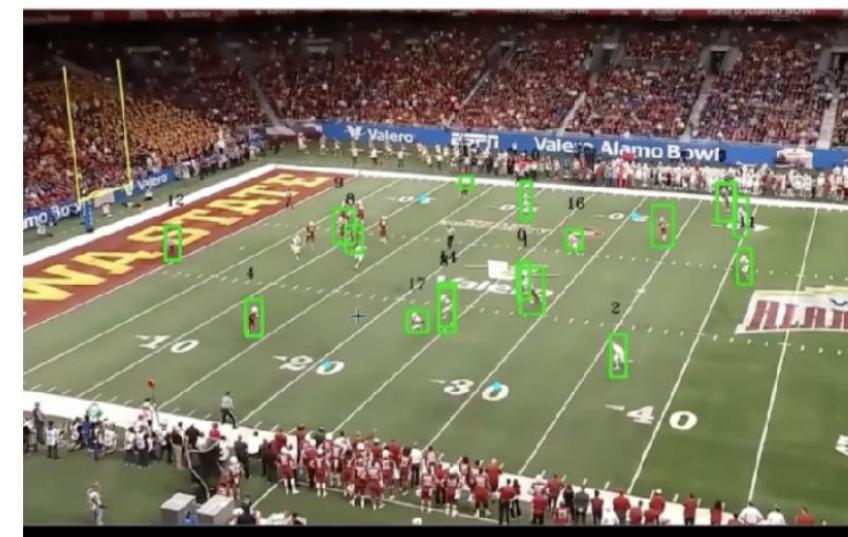
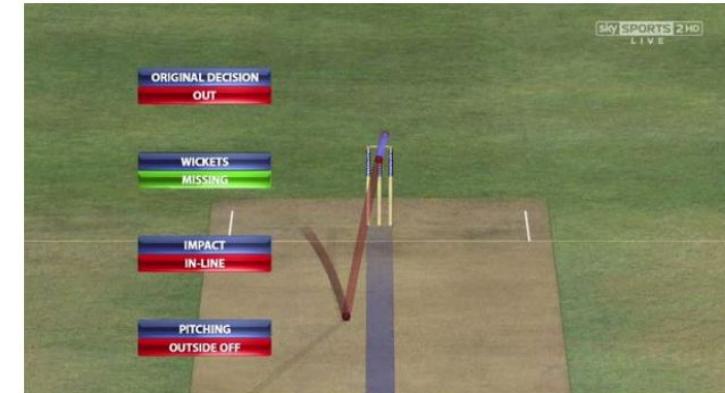
Source Inc. - The Tech That Powers Your Self-Driving Car Might
Be Built Using People Playing Games on Their Phones

2. So what can Computer Vision do?

You might be familiar with these...

- Snapchat and Instagram filters
- Optical Character Recognition (OCR)
- Licence Plate Reading
- Self-driving cars
- **Sporting Analysis**
- Facial Recognition

HawkEye in Cricket



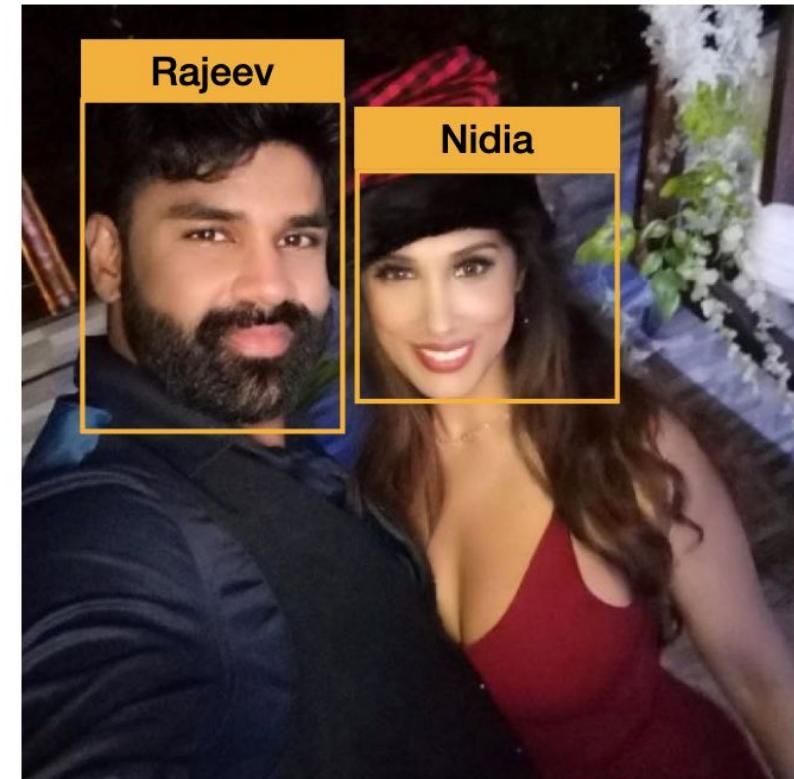
Source -Roboflow - AI Coach



2. So what can Computer Vision do?

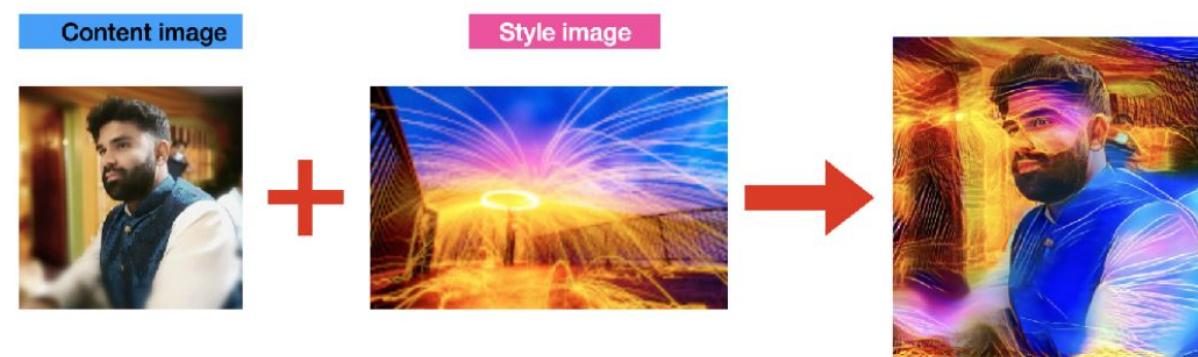
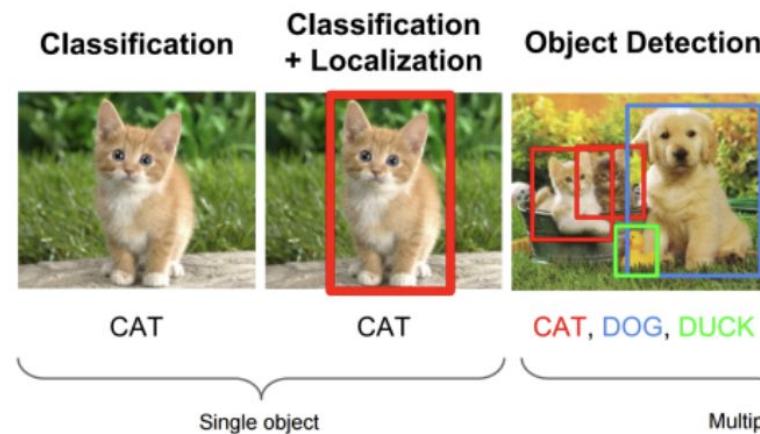
You might be familiar with these...

- Snapchat and Instagram filters
- Optical Character Recognition (OCR)
- Licence Plate Reading
- Self-driving cars
- Sporting Analysis
- **Facial Recognition**



But there's so much more!

- **Image Recognition**
 - **Object Detection**
 - **Segmentation**
 - **AI Art**
 - Image Similarity
 - Deep Fakes
 - Body Pose Detection
 - Image Generation



But there's so much more!

- Image Recognition
- Object Detection
- Segmentation
- AI Art
- **Image Similarity**
- **Deep Fakes**
- Body Pose Detection
- Image Generation



But there's so much more!

- Image Recognition
- Object Detection
- Segmentation
- AI Art
- Image Similarity
- Deep Fakes
- **Body Pose Detection**
- **Image Generation**





Computer Vision Applications are endless!

Electric Scooter ID

Gas Leak Detection

Document Digitization

Plant Phenotyping

Flare Stack Monitoring

Resume Parsing

Augmented Reality

Weed Detection

Microscopy

Bean Counting

Garbage Cleanup

Drone Video Analysis

Conveyer Belt Debris

Traffic Counter

Pothole Identification

Soccer Player Tracker

Steelyard Throughput

Security Cam Analysis

Self Driving Cars

Fish Measuring

Remote Tech Support

Tennis Line Tracking

Know Your Customer

Endangered Species Tracking

Inventory Management

Hard Hat Detection

Pest Identification

OCR Math

Basketball Shot Tracking

Logo Identification

Satellite Imagery

Traffic Cone Finder

Airplane Maintenance

Tumor Detection

D&D Dice Counter

Plant Disease Finder

X-Ray Analysis

Roof Damage Estimator

City Bus Tracking

Board Game Helpers

Dental Cavity Detection

Drought Tracking

Hog Confinements

Sushi Identifier

Oil Storage Estimator

Car Wheel Finder

License Plate Reader

Exercise Counter

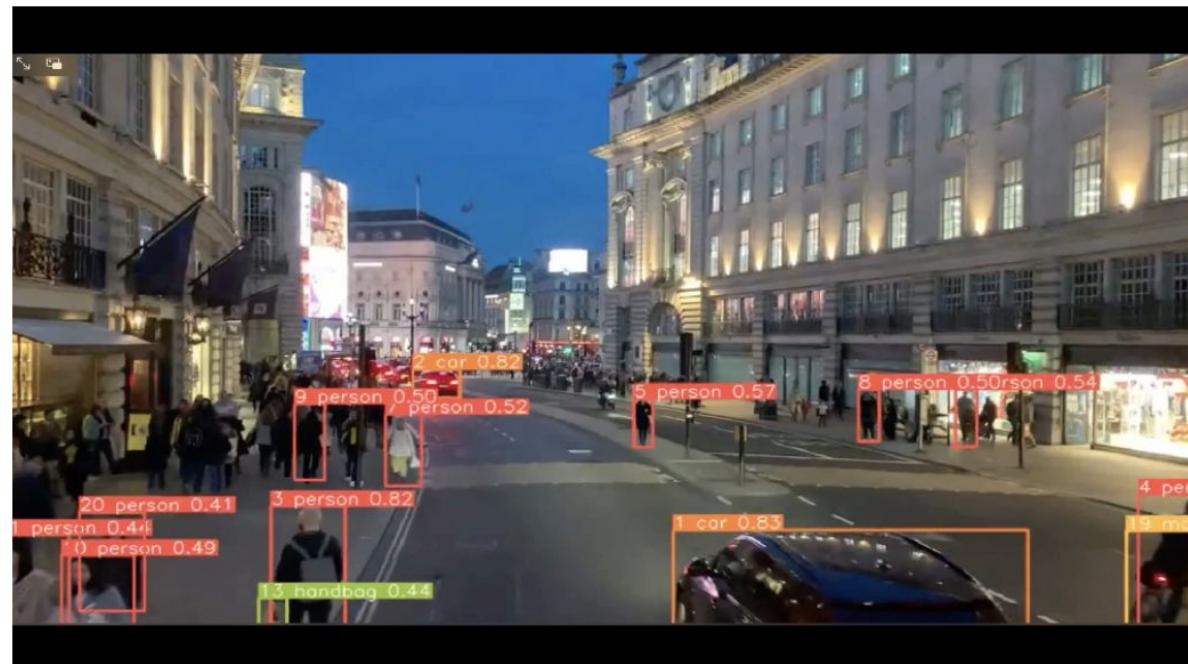
roboflow



3. Why do this course?

What are you going to learn exactly?

- Foundation in **Classical Computer Vision** with **OpenCV**
- **Deep Learning** applied to Computer Vision
 - PyTorch
 - TensorFlow Keras





So how do we do Computer Vision?

What makes it possible?

- We need tools! Namely a programming language
- Many exist such as:
 - Matlab
 - C++ & Java
 - Python

```
require File.expand_path('../spec_helper', __FILE__)
# Prevent database truncation if the database needs
# clearing for testing (http://www.rubydoc.info/gems/rspec-rails/0.10.0/Spec/Helper/Rails)
abort("The Rails environment is running in production mode!
       Run `rake db:test:prepare` to create the test databases.") if ActiveRecord::Base.connection.adapter_name == 'Production'

require 'rspec'
require 'rspec/rails'

require 'capybara/rspec'
require 'capybara/rails'

Capybara.javascript_driver = :webkit
Category.delete_all; Category.create!
Shoulda::Matchers.configure do |config|
  config.integrate do |t|
    t.with.test_framework :rspec
    t.with.library :rails
  end
end

# Add additional requires below this line if you need them
# require 'spec_helper'
# require 'factory_girl_rails'
# require 'shoulda-matchers'

# Requires supporting files with custom matchers and helpers
# in spec/support/ and its subdirectories
# require 'spec/support/factories'
# require 'spec/support/matchers'

# run as spec files by default. This can be changed to
# require 'spec/spec' or 'spec/runner' if desired
# $LOAD_PATH.unshift(File.join(File.dirname(__FILE__), '..', 'spec'))
# $LOAD_PATH.unshift(File.join(File.dirname(__FILE__), '..', 'spec', 'support'))

# If you're not using ActiveRecord, or don't want to use
# ActiveRecord in your tests, uncomment these lines.
# require 'rspec/rails'
# require 'rspec/autorun'

# If you're using devise, uncomment these lines
# require 'devise/test_helpers'
# require 'rspec/devise'
```



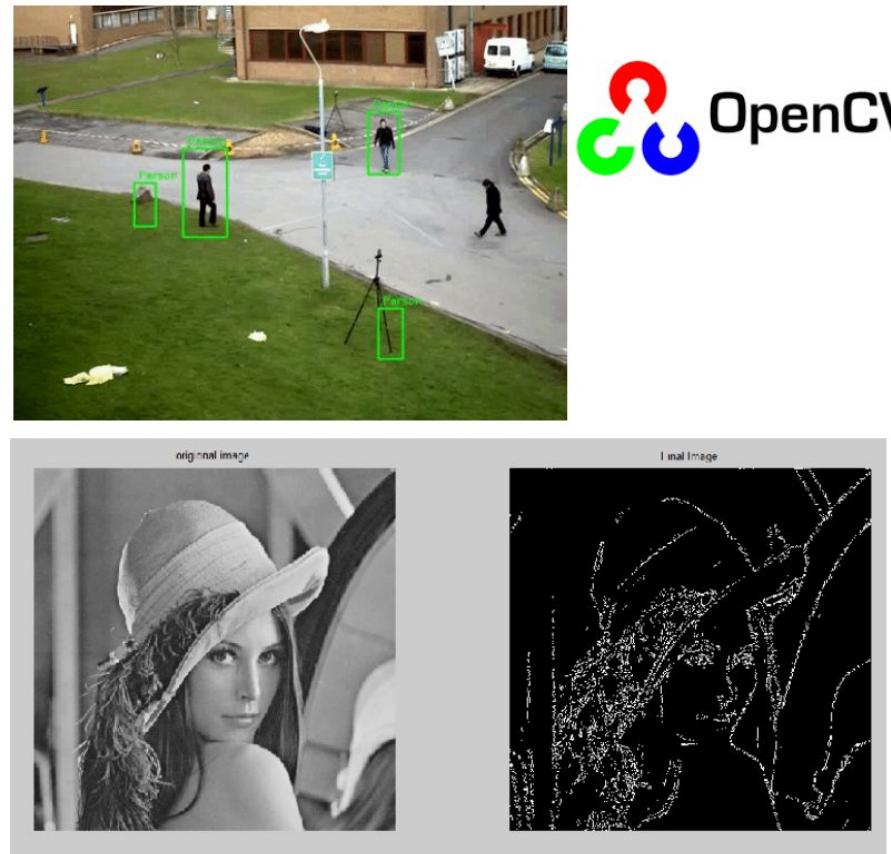
What makes Python so great for Computer Vision?

- Easy to learn and accessible
- Language of Artificial Intelligence
- The best and easiest to use Libraries, such as:
 - **OpenCV** for Classical Computer Vision
 - **PyTorch** (Facebook) and **TensorFlow with Keras** (Google)



4. Classical Computer Vision?

- What is meant by **Classical Computer Vision?**
- It encompasses Computer Vision algorithms that **do not involve Machine Learning**
- Before the advent of Machine Learning and Deep Learning, Computer Vision was a deeply explored field and many useful algorithms were developed for things like **feature extraction, OCR, Segmentation and simple transformations.**
- **OpenCV** is the Classical Computer Vision library of choice!





5. Deep Learning Computer Vision

- Deep Learning was used in Computer Vision since the 1990s, however due to the computational requirements and intricate design, it remained on the sidelines for decades.
- Until the mid 2010s...which brought **two important building blocks** together.
 - **Mature Deep Learning libraries** (TensorFlow, Keras, Theano, Caffe)
 - **Accessible GPU processing** (NVIDIA's CUDA)



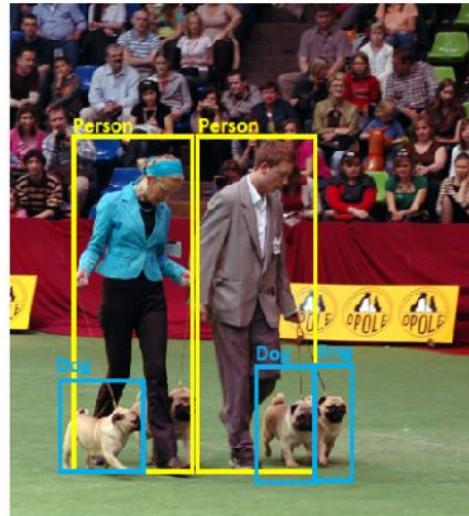
Deep Learning Examples

Image Classification



{Dog}

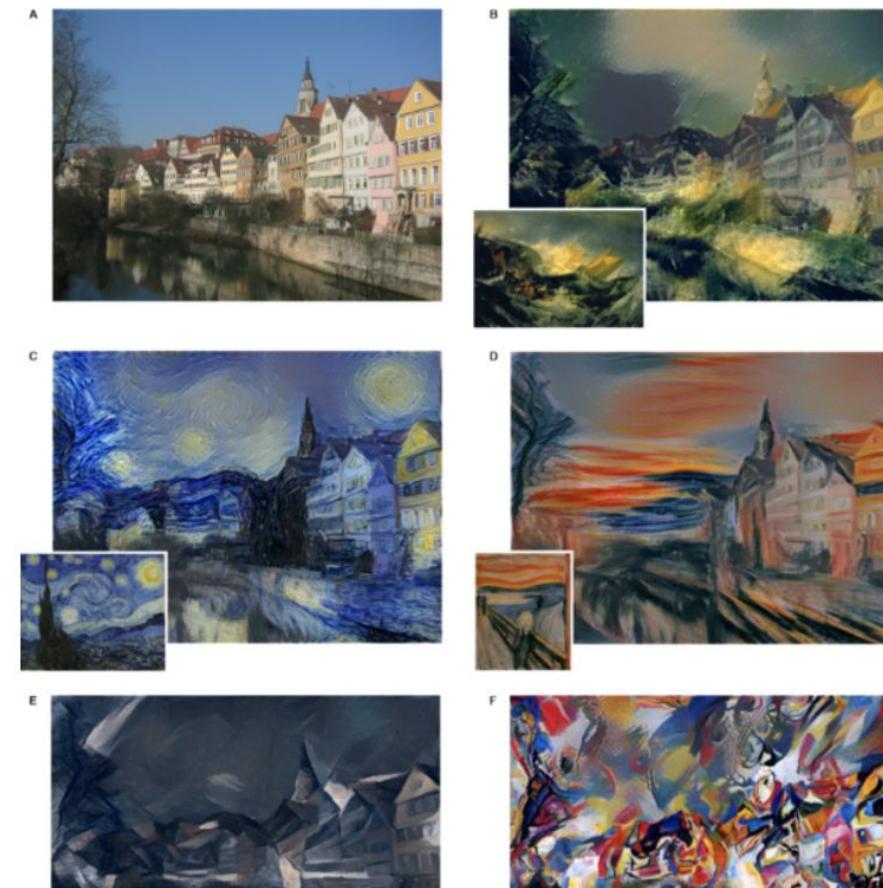
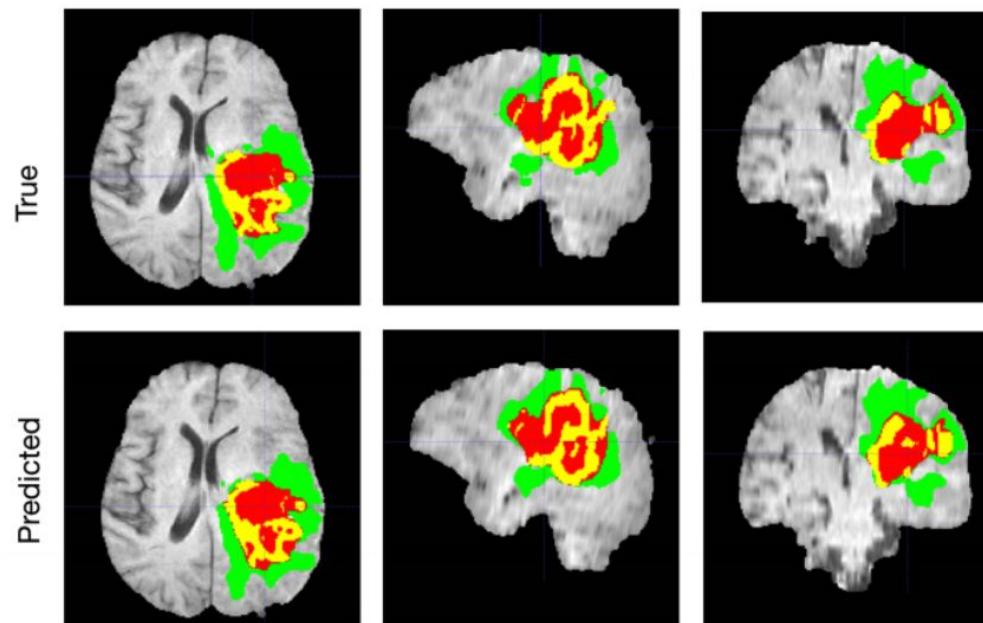
Object Detection



{Dog, Dog, Dog, Person, Person}



Deep Learning Examples





Deep Learning Examples





Deep Learning CV vs Classical CV

Deep Learning	Classical Computer Vision
Adapts to new images well (assuming it's similar to the data it was trained on)	Small changes can have big negative impacts
Requires Models to be trained	Doesn't require training and can be used once coded
Model weights learn to adapt to varying image conditions	Relies on hardcoded features and parameters
Requires GPU hardware (most times)	Can be run on CPU



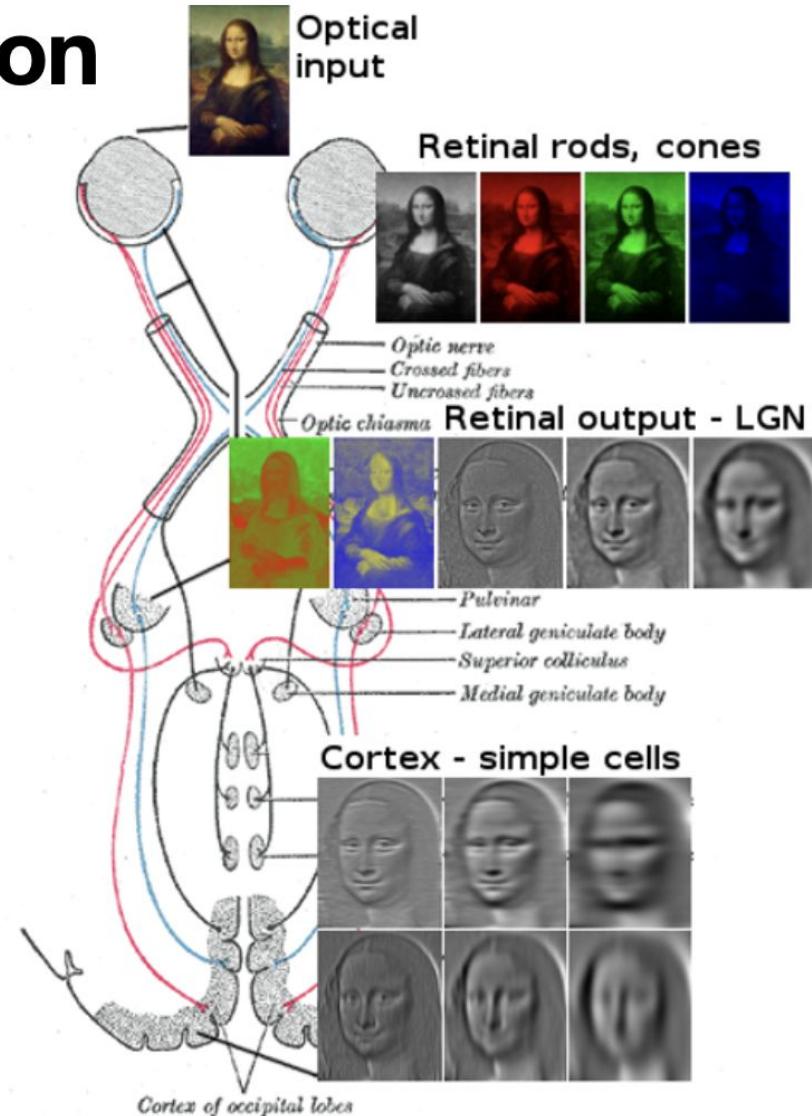
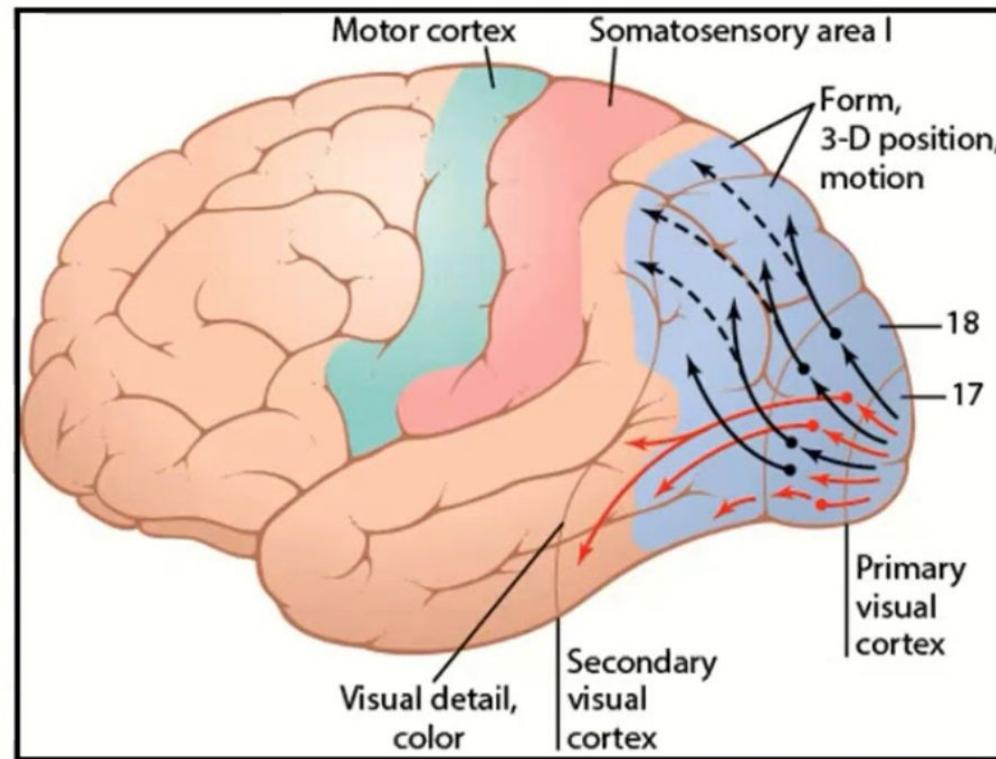
6.

What Makes Computer Vision Hard?

Nothing worth having comes easy

6. Our Brains are amazing at Vision

The **visual cortex** (located in the occipital lobe) is the primary cortical region of the brain that receives, integrates, and processes visual information relayed from the retinas



6. Can Artificial Intelligence Come Close?

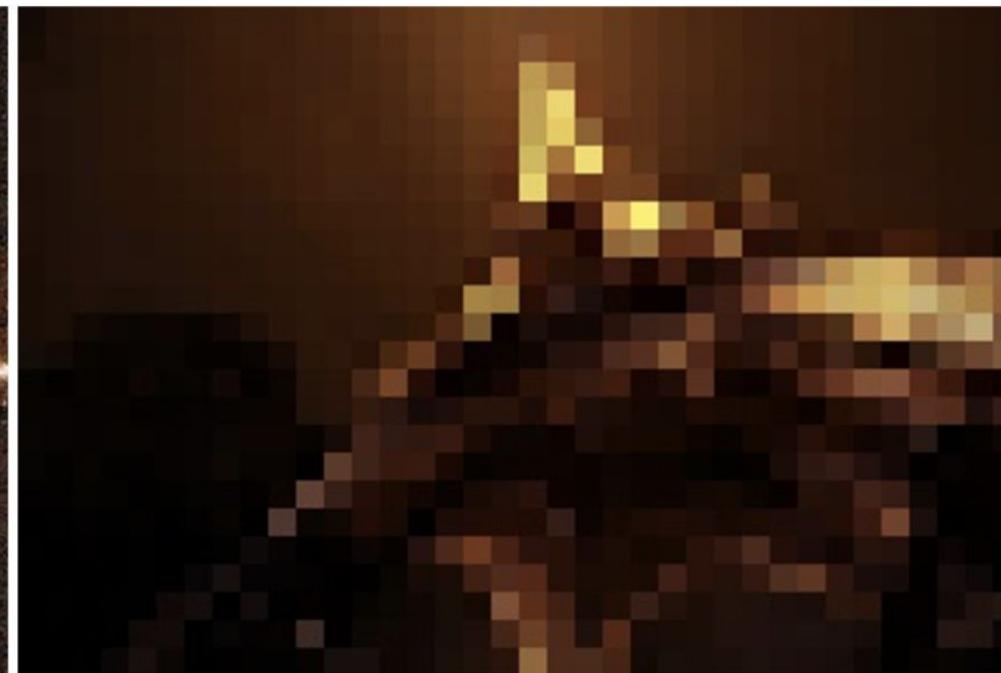
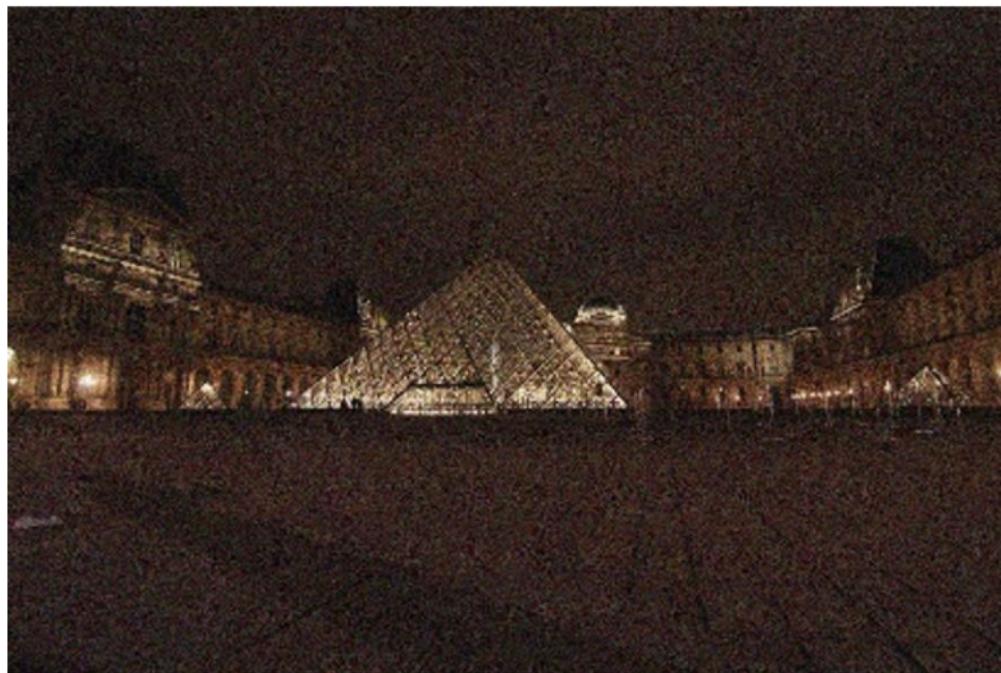
The AI Dream, a machine that can see and understand better than humans.



Source - Terminator 2: Judgement Day (1991)

6. What Makes Computer Vision Hard?

Camera and Sensor Limitations



6. What Makes Computer Vision Hard?

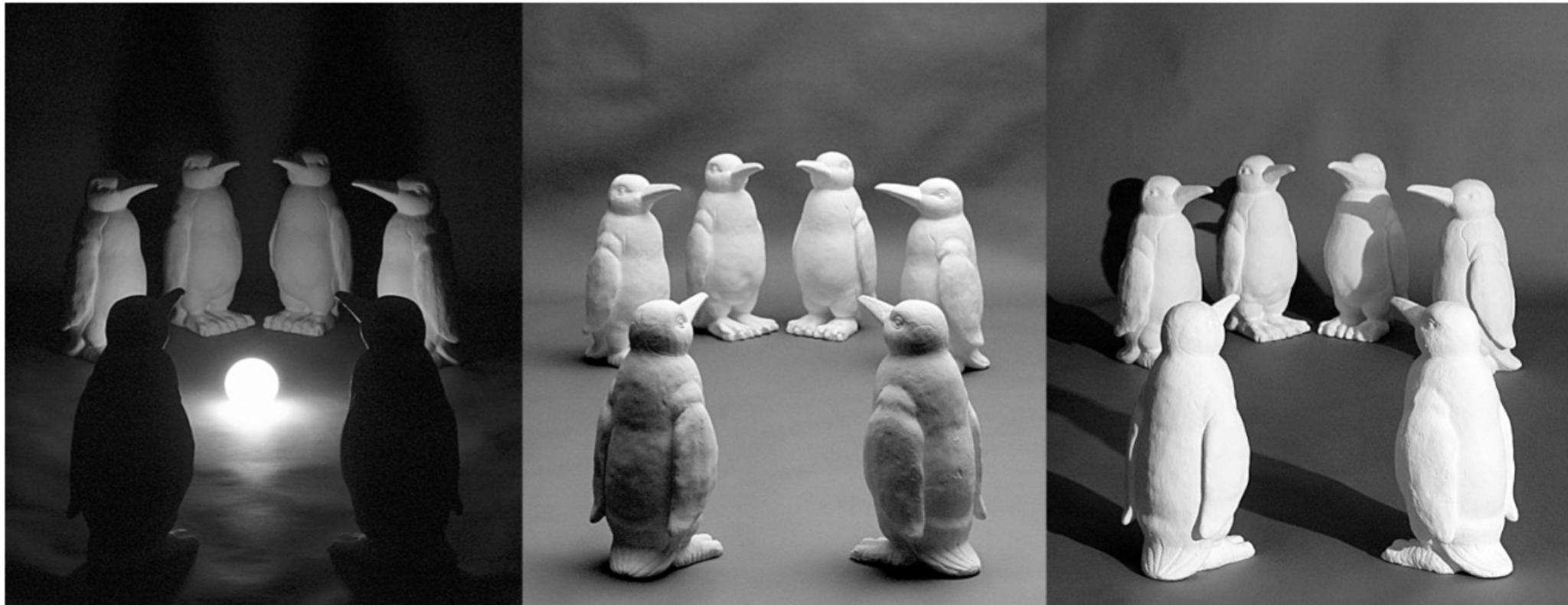
Viewpoint Variations





6. What Makes Computer Vision Hard?

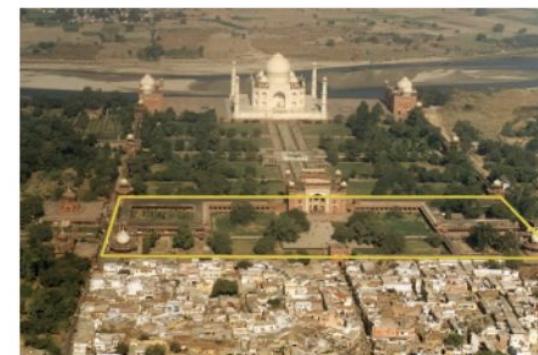
Changing Lighting Conditions





6. What Makes Computer Vision Hard?

Scaling Issues



6. What Makes Computer Vision Hard?

Non-rigid Deformations





What Makes Computer Vision Hard?

Occlusion





What Makes Computer Vision Hard?

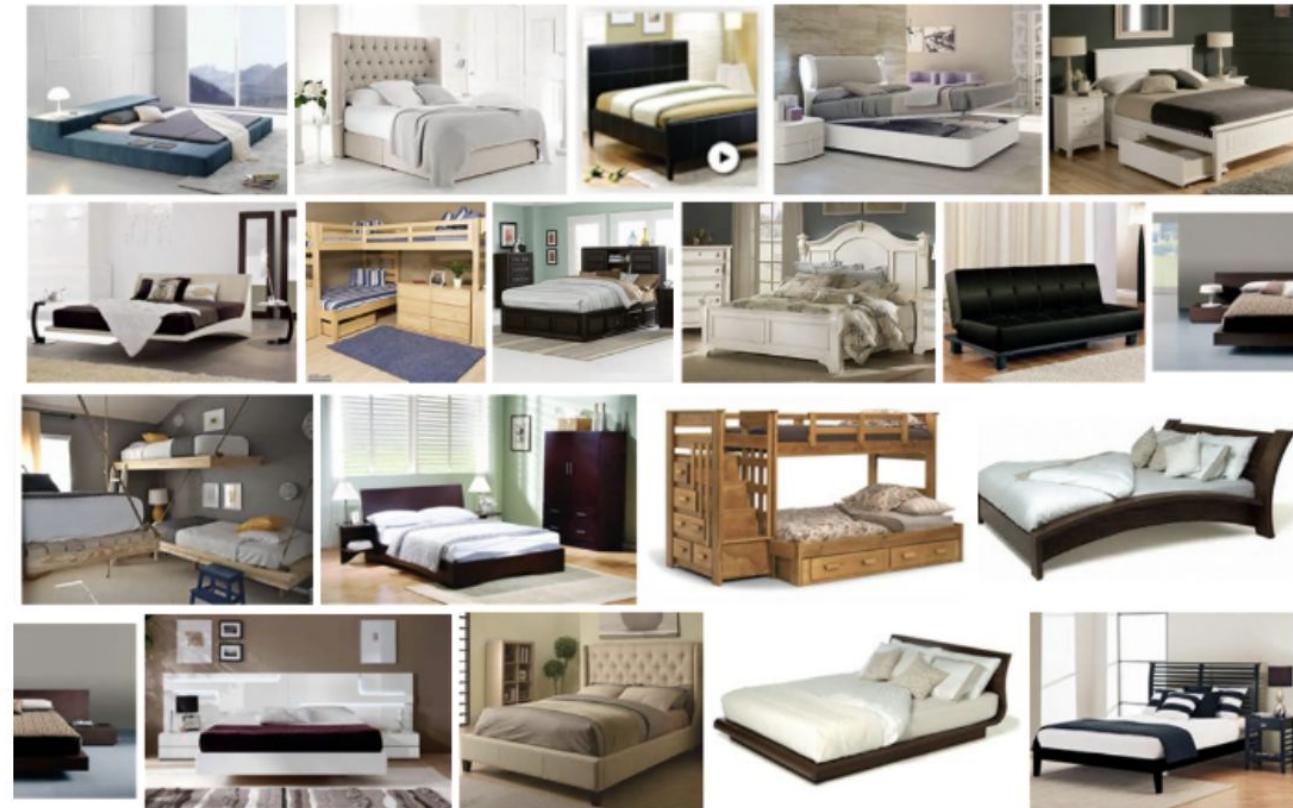
Clutter





What Makes Computer Vision Hard?

Object Class Variation



What Makes Computer Vision Hard?

Ambiguous Optical Illusions



6. Evaluation



- Attendance : 5%
- Exercises: 5%
- Mid-term test: 30%
- Final exam: 60% : Deep learning Project



PHENIKAA UNIVERSITY

Faculty of Computer Science

Q&A