Please download Anaconda:

Anaconda.com

COMPUTER SCIENCE FOR MEDICINE: Computer Vision

Code MD

June 9, 2023

Module 2

AGENDA

1

INTRODUCTION

Code MD Project
CV Packages
Matrices
Pixels vs Channels
Types of CV
Medical Use Cases
Introduction to AI

2

BASICS NOTEBOOK

Review of Python basics
Importing images
Accessing Pixels
Changing color
Cropping
Increasing contrast
Rotating image
Thresholding
Count pixels
Saving image

3

PROJECT WALKTHROUGH

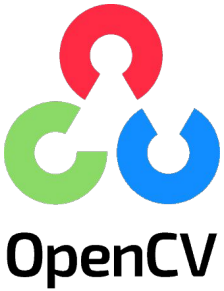
Diagnose Pneumonia
V/Q Scan Analysis
Classify Medical Images

Computer Vision

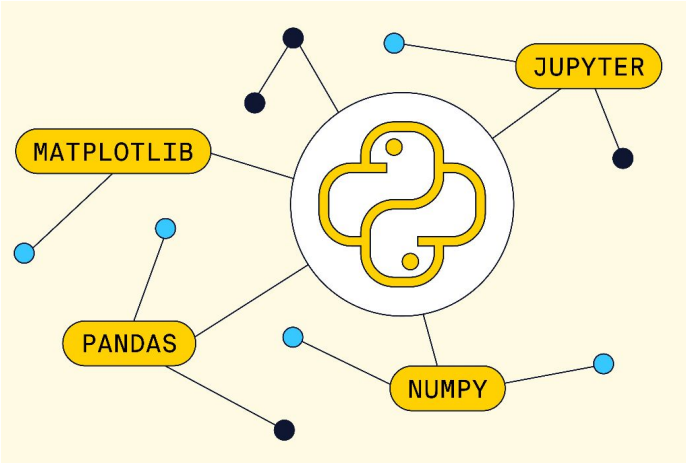
Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions.

wikipedia

Packages



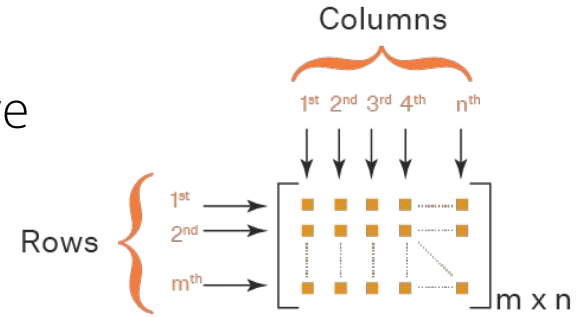
- **What is a package?**
  -
- **Open Computer Vision**
  - OpenCV
  - Powertool kit for computer vision
  - Whether you are doing AI or basic tasks, if you are using images you ***will*** use OpenCV
- **Numpy**
  - Debatably most important package for every computational task on the planet
  - Handles storage and manipulation of ***n*** dimensional arrays
  - Similar to a list, but just better…



codecademy

Matrices and why do we care?

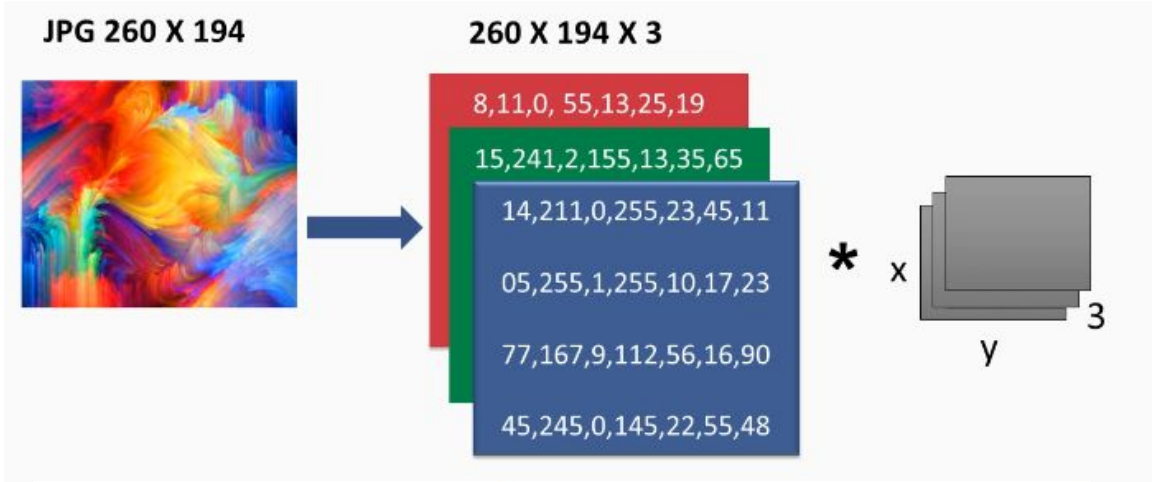
- **What is a matrix**
  - Table used to numerically represent an object
    - Linear algebra deals with these, but we **don't need to know linear algebra** to use them!
- **We need a way to represent images numerically → use matrices**
- **OpenCV reads image as numpy arrays (matrix representation of an image)**

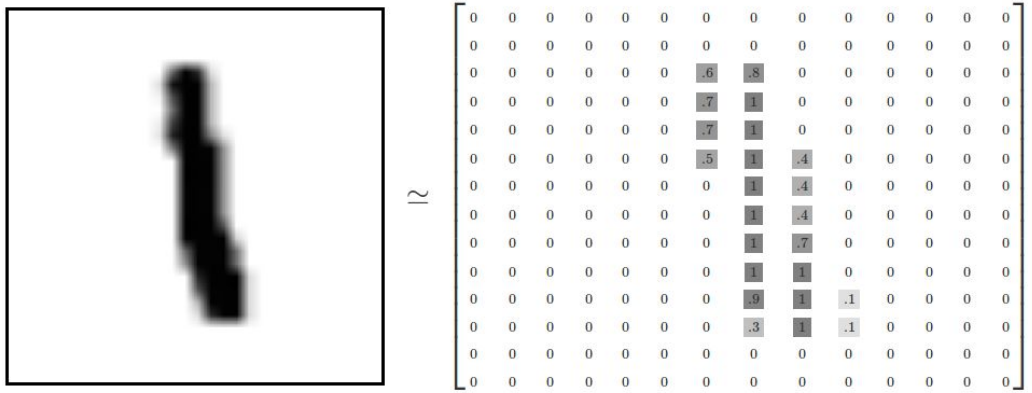


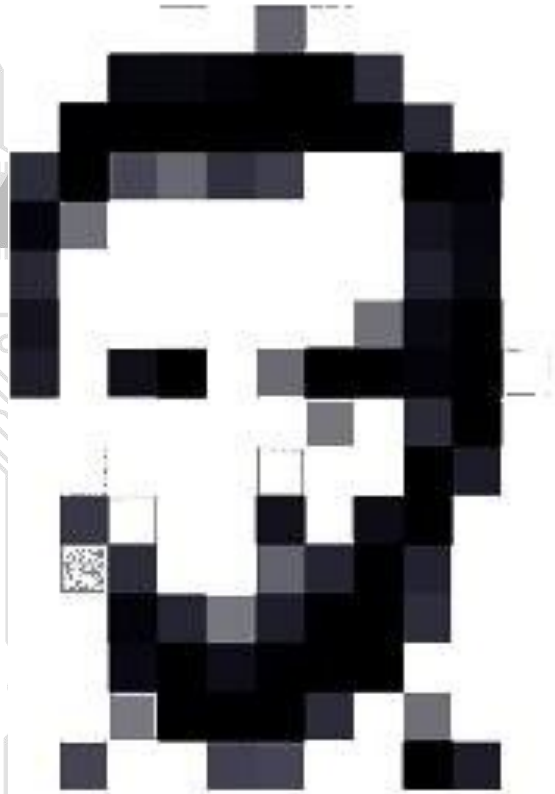
Pixels, channels, oh my!

- A **picture** is a **matrix** of **pixels**
  - Think about your screen size- 1920x1080
- **Channels** determine **number of colors** in a **picture**
  - Black and white image → **1 channel**
  - Colored image → **3 channels (Red, green, blue)**
- This means a **black and white** picture is a **2d matrix**
- It also means a **colored** picture is a **3d matrix**

Lets really understand that







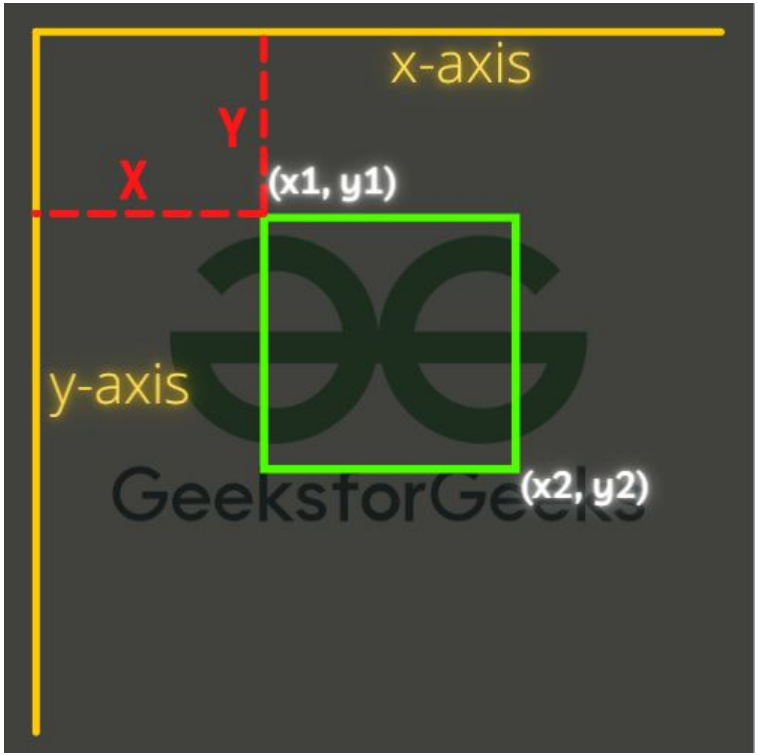
Minu et. al. 2019

What can you do to a picture computationally?

- Briefly, **basically anything you want**
  - Rotate
  - Change color scheme
  - Change size
  - Crop
  - Detect edges
  - Threshold based on colors
  - Measure distances

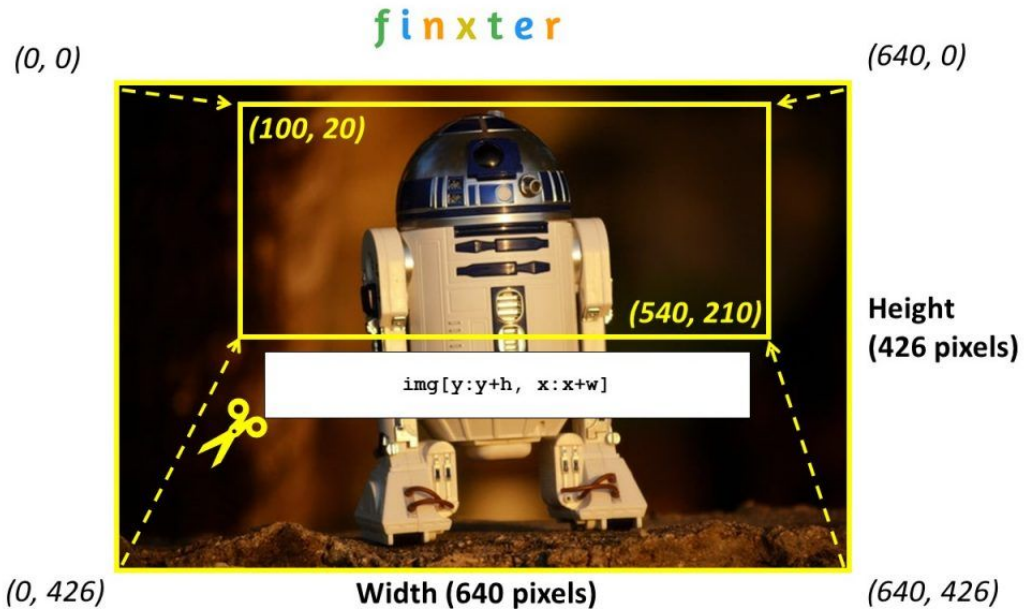
- **All of this is possible because pictures are represented as numbers to a computer**

Finding a pixel...



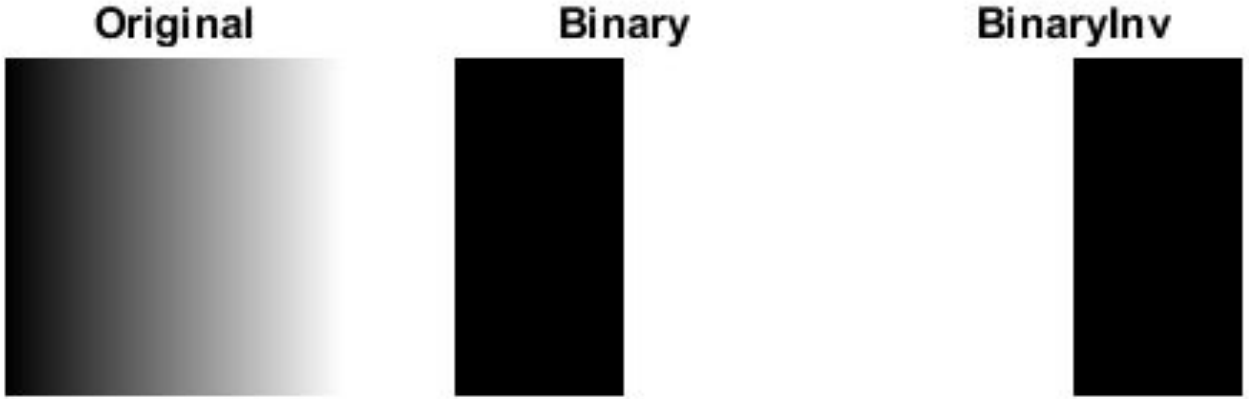
https://www.geeksforgeeks.org/python-opencv-selectroi-function/

Cropping...



https://blog.finxter.com/how-to-crop-an-image-using-opencv/

Threshold...



http://amroamroamro.github.io/mexopencv/opencv/thresholding_demo.html

Buzzwords of Computer Vision

Classification

Is this a dog?

Image Classification

Medical Applications of Computer Vision

- Anywhere a human looks at and analyzes image data is a place where computer vision can be (theoretically) implemented
- **Radiology, pathology, surgery, ophthalmology, hematology, basic science research, pulmonology, oncology, etc…**
- The technology is becoming sufficiently advanced to have real world clinical utility

Science Translational Medicine

Current Issue First release papers

Using deep learning for dermatologist-level detection of suspicious pigmented skin lesions from wide-field images

LUIS R. SOENKSEN, TIMOTHY KASSIS, SUSAN T. CONOVER, BERTA MARTI-FUSTER, JI
ROBERT R. STAVERT, CAROLINE C. KIM, MARYANNE M. SENNA, JOSÉ AVILÉS-IZQUIER
fewer Authors Info & Affiliations

Sybil: A Validated Deep Learning Model to Predict Future Lung Cancer Risk From a Single Low-Dose Chest Computed Tomography

Peter G. Mikhael, BSc[1,2]; Jeremy Wohlwend, ME[1,2]; Adam Yala, PhD[1,2]; Ludvig Karstens, MSc[1,2]; Justin Xiang, ME[1,2]; Angelo K. Takigami, MD[3,4]; ...

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JAMA Ophthalmology Search All

Original Investigation

January 13, 2022

Evaluation of Artificial Intelligence–Based Intraoperative Guidance Tools for Phacoemulsification Cataract Surgery

Rogerio Garcia Nespolo, MSc[1,2]; Darvin Yi, PhD[1,2]; Emily Cole, MD, MPH[1]; Nita Valikodath, MD[1]; Cristian Luciano, PhD[2]; Yannek I. Leiderman, MD, PhD[1,2]

nature › npj digital medicine › brief communications › article

Brief Communication | Open Access | Published: 01 March 2019

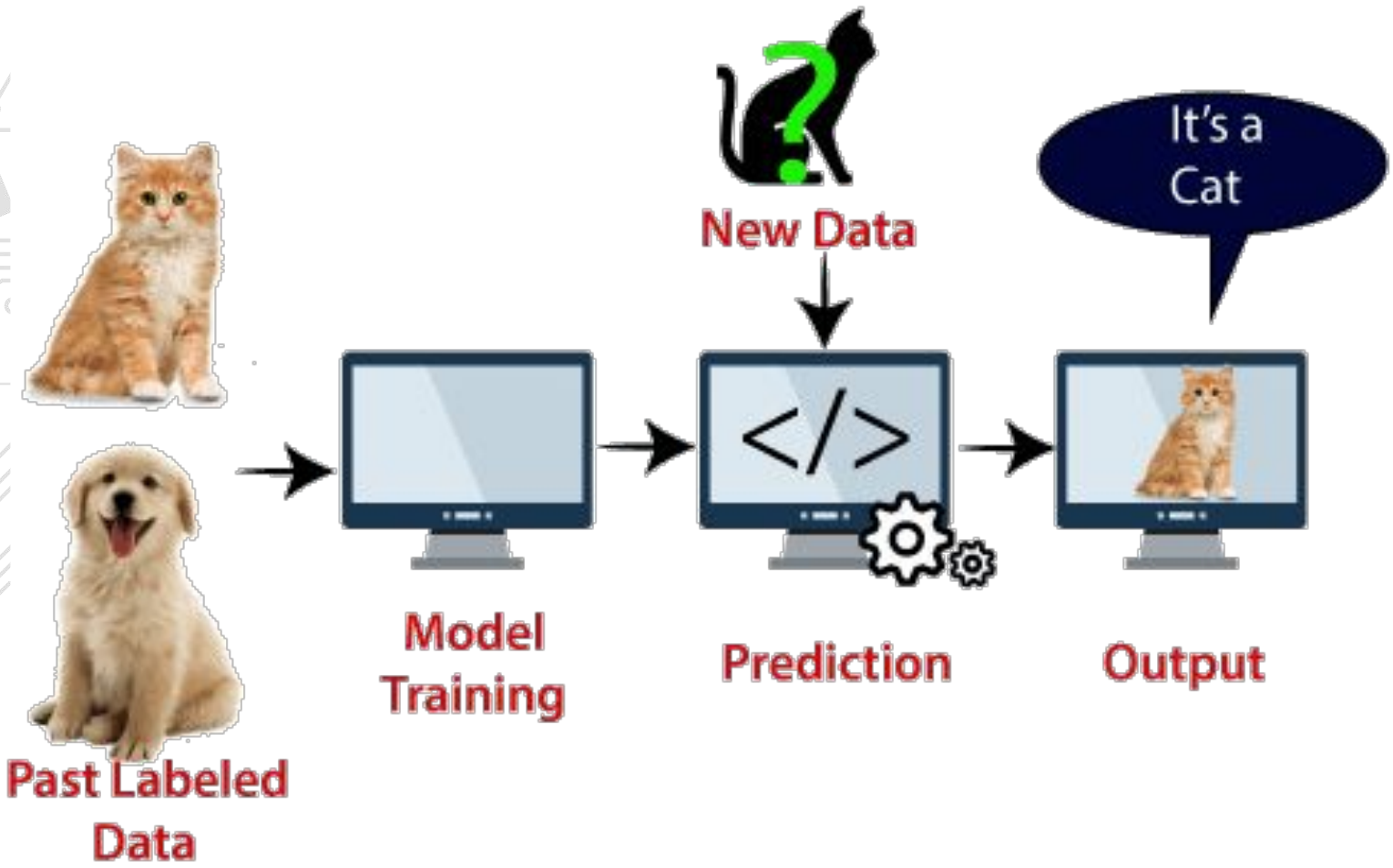
A computer vision system for deep learning-based detection of patient mobilization activities in the ICU

Serena Yeung, Francesca Rinaldo, Jeffrey Jopling, Bingbin Liu, Rishab Mehra, N. Lance Downing, Michelle Guo, Gabriel M. Bianconi, Alexandre Alahi, Julia Lee, Brandi Campbell, Kayla Deru, William Beninati, Li Fei-Fei & Arnold Milstein

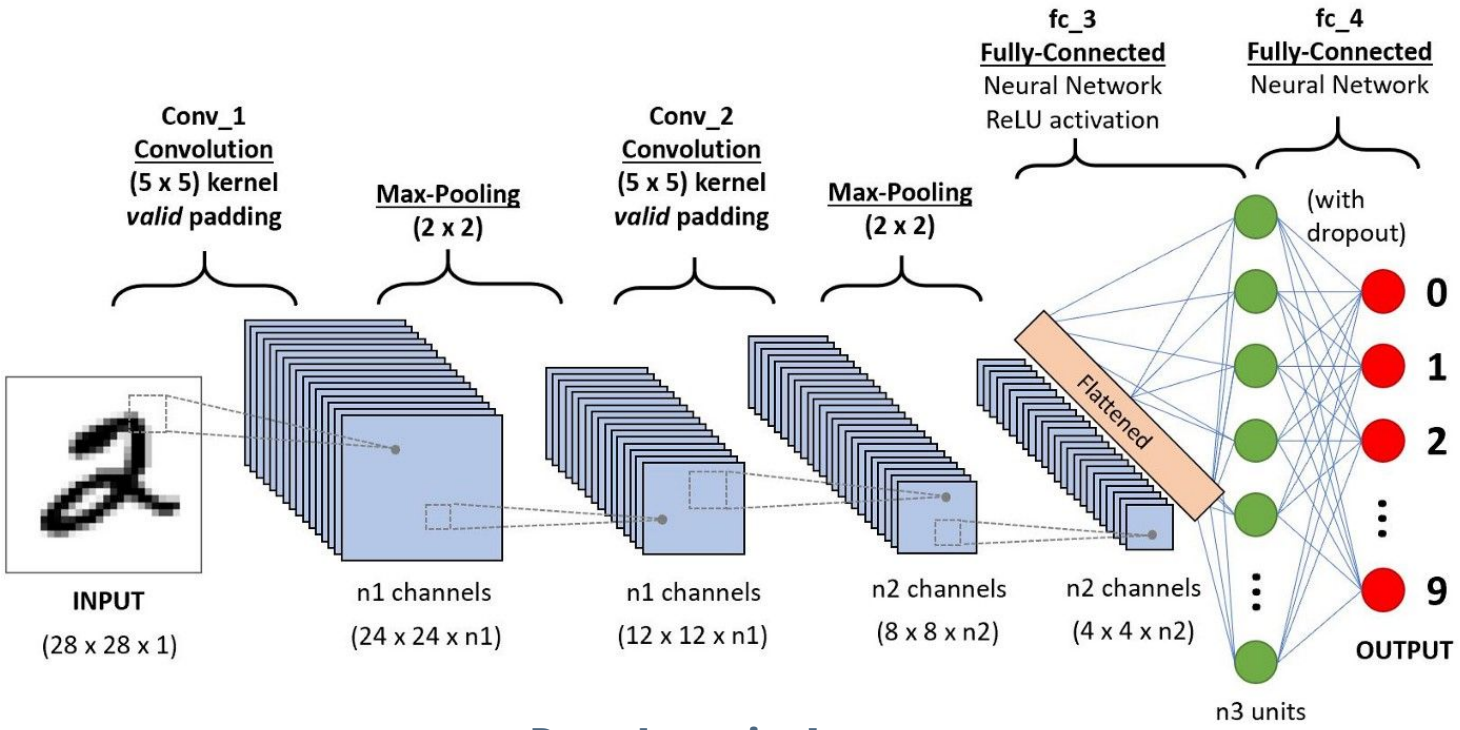
Introduction to Artificial Intelligence

- ***Most*** of the on the ground use cases of computer vision involve AI
- Artificial intelligence is the ability of a **program** to **approximate** an outcome given exposure to numerous prior examples

- **At a high level:**
  - **1. Training** → showing the algorithm many examples of inputs and **known outputs**
    - The algorithm starts from knowing nothing and makes a guess about the output
    - **It compares its performance to the known outputs**
    - 'Teaches' itself by using math on its internal decision making functions to try and do better
  - **2. Testing** →Showing the algorithm many examples of inputs with **no known outputs**
    - The algorithm then evaluates its performance by comparing with the correct answer
- This process is repeated many many times until the algorithm **converges** to a point at which it can see new data and make a good approximation on the outcome


It's a Cat
New Data
Past Labeled Data
Model Training
Prediction
Output

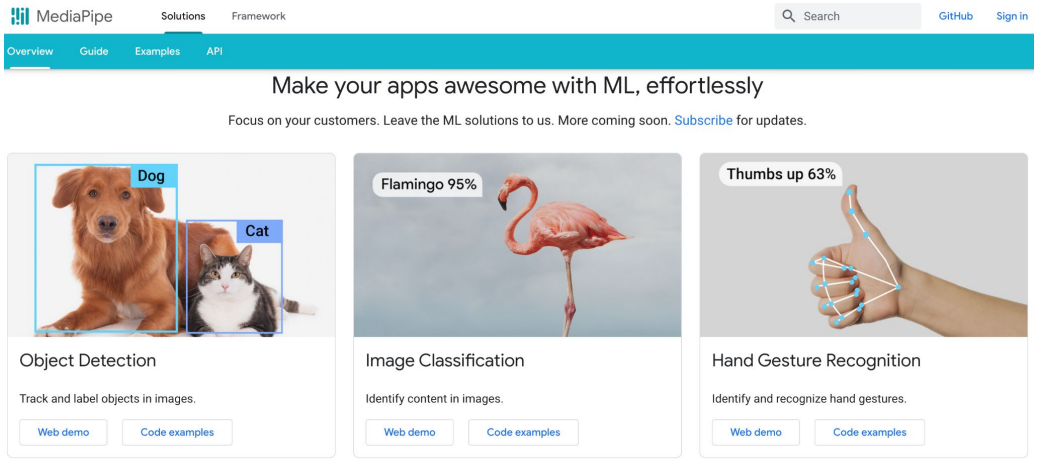
Convolutional Neural Networks
(just an fyi so you recognize the word)



Deep Learning!

Do I have to do this whole process if I want to analyze some of my data using AI?

- NO! Not necessarily at least…
- Pretrained models are a very quick and easy way to get started with some of your data! Some of this is no code even…
- Can also finetune an existing model for your problem



Just because it's 'pretrained' doesn't mean it will work with your data!!!

- **Need to be cognizant of:**
  - **Bias in training data**
  - **Variation in your data**
  - **Relevance of pretrained model to your data (domain knowledge)**

SOME USEFUL LIBRARIES

- **Data Science and Statistics**
  - Pandas
  - SciPy
  - Numpy
  - Statsmodels
  - Matplotlib/Plotly/Seaborn
- **Software Development**
  - Tkinter/PyQT (user interfaces)
  - Django/Flask (application backends)
- **Biological Computation**
  - BioPython
- **Machine Learning**
  - OpenCV (also computer vision)
  - Scikit-learn
  - Tensorflow
  - Keras
  - PyTorch
- **Miscellaneous**
  - os
  - sys
  - re
  - datetime

Whatever you want to do, there's probably a library to help you do it!