



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

CS7GV1 Computer vision

Introduction

Dr. Martin Alain

What is Computer Vision?

https://en.wikipedia.org/wiki/Computer_vision

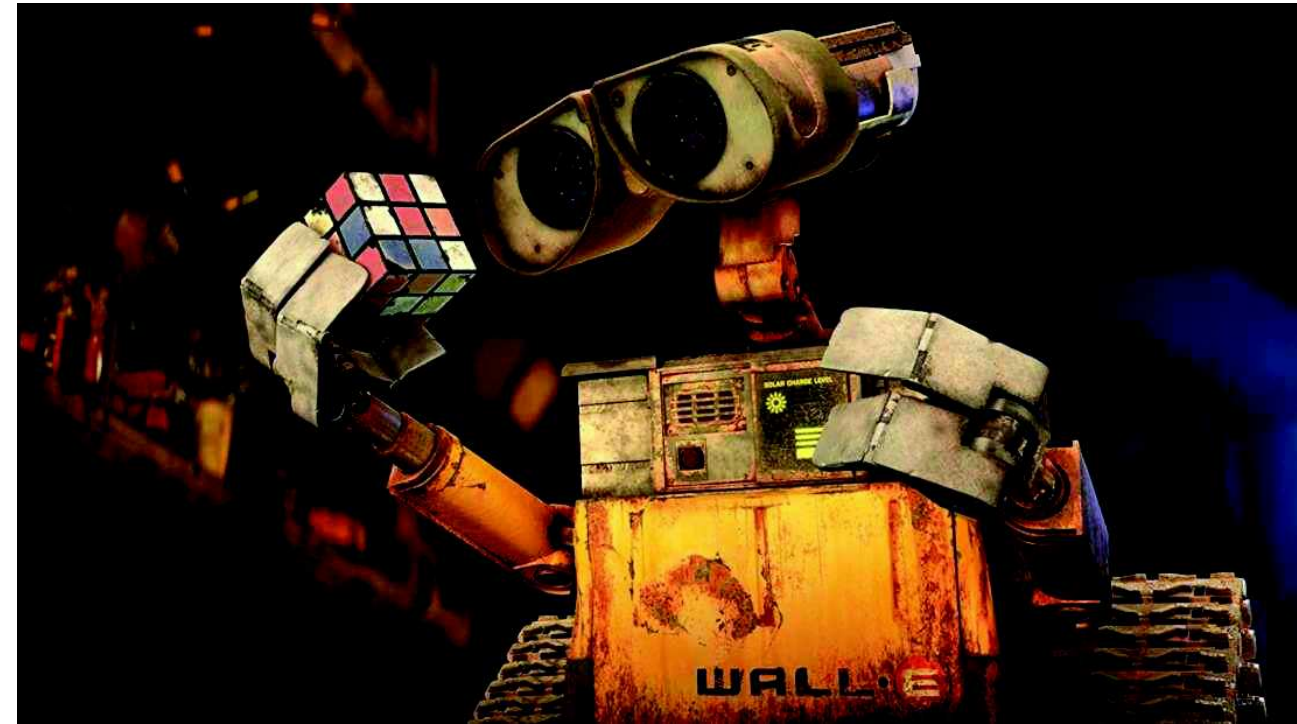
Computer vision originally aimed at computers mimicking what the human visual system can do in understanding images, as a stepping stone to endowing robots with intelligent behaviour.

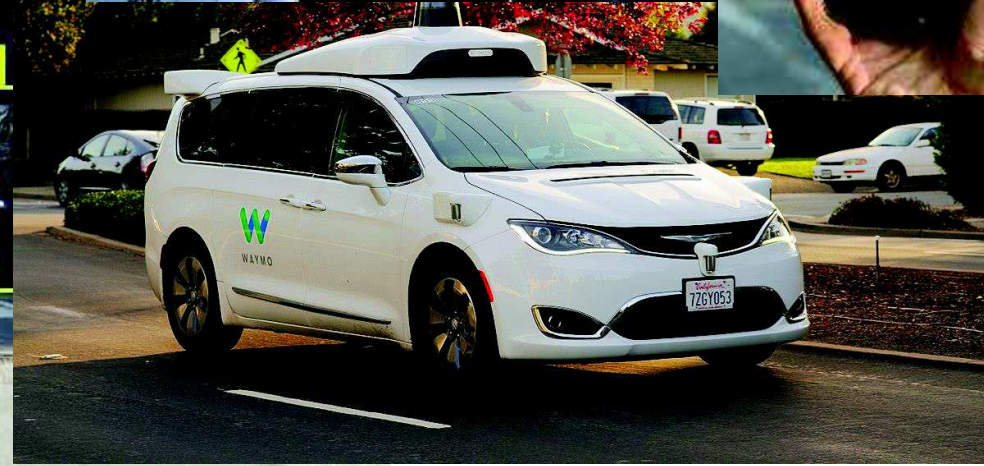
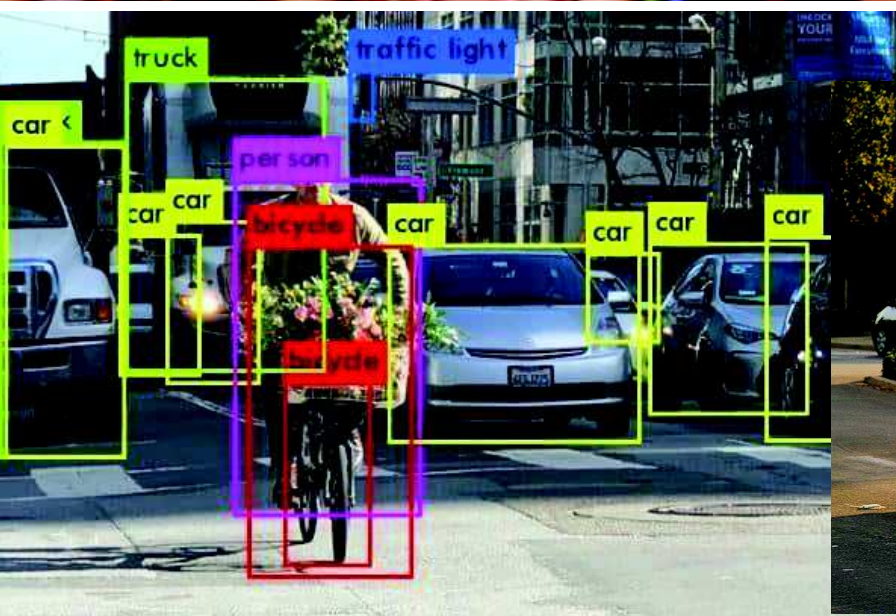


Animal visual system is also a source of inspiration for building intelligence

Computer vision Vs digital image processing:

CV originally aims to extract 3D structure from images with the goal of achieving full scene understanding.



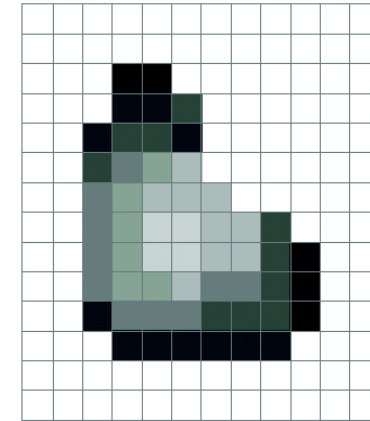
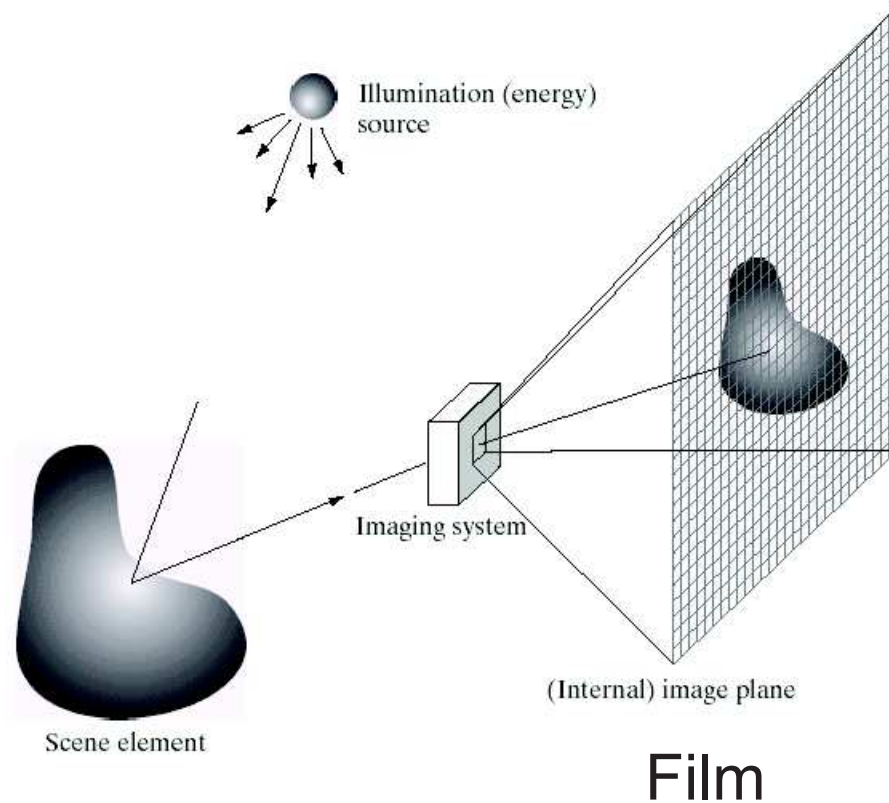


Underpinning fields of Computer Vision

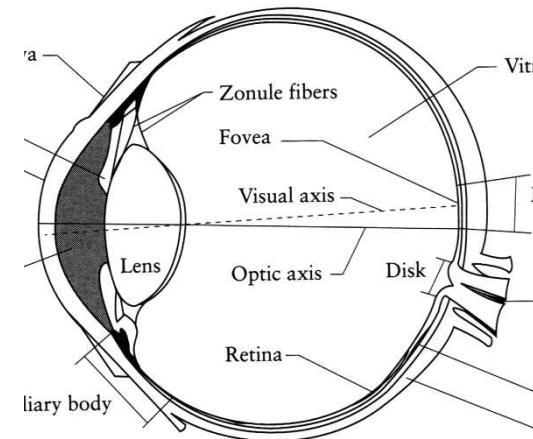
- Mathematics
- Statistics
- Electronics
- Physics
- Computer science
- Psychology (Perception)
- ...



Image Formation



Digital Camera



The Eye

Digital camera



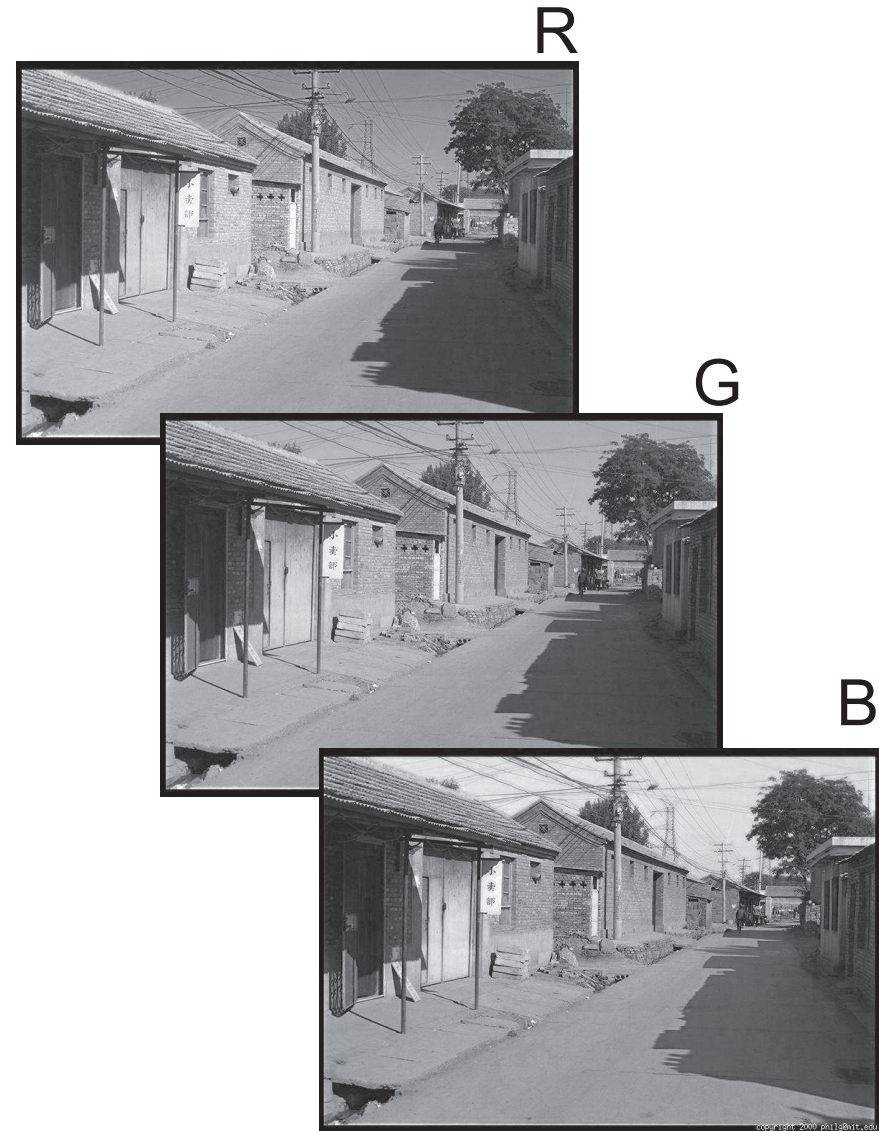
- A digital camera replaces film with a sensor array
 - Each cell in the array is light-sensitive diode that converts photons to electrons
 - Two common types
 - Charge Coupled Device (CCD)
 - CMOS
- <http://electronics.howstuffworks.com/digital-camera.htm>

Twitter @RDahyot

Color Image

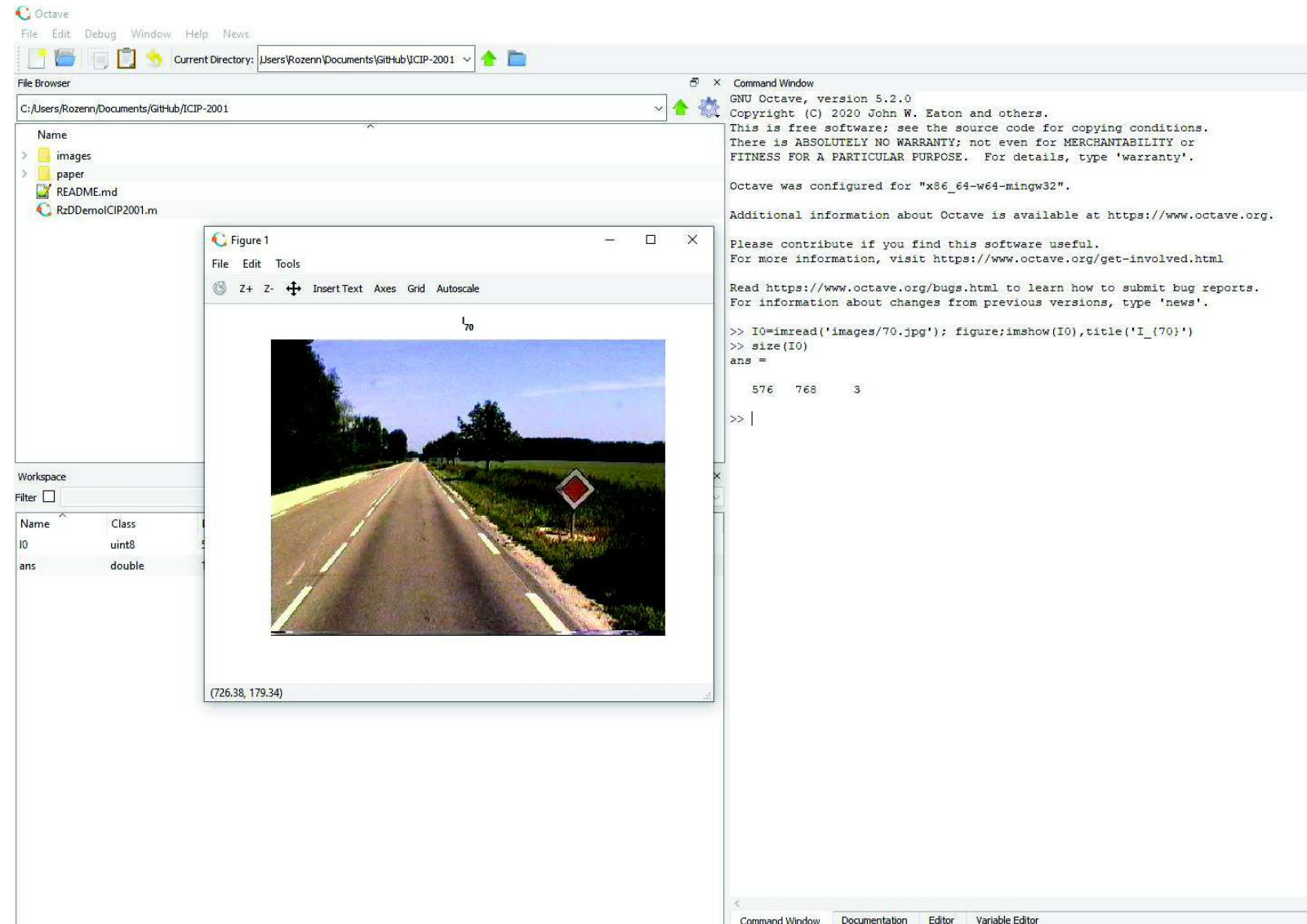


Pixel = Picture element



Octave-Matlab

```
I0=imread('images/70.jpg');  
figure;imshow(I0),title('I_{70}')
```



Octave-Matlab

Red channel

```
figure;imshow(I0(:, :, 1))
```

```
I0(1:10, 1:20, 3)
```

```
imshow(I0(1:10, 1:20, 3))
```

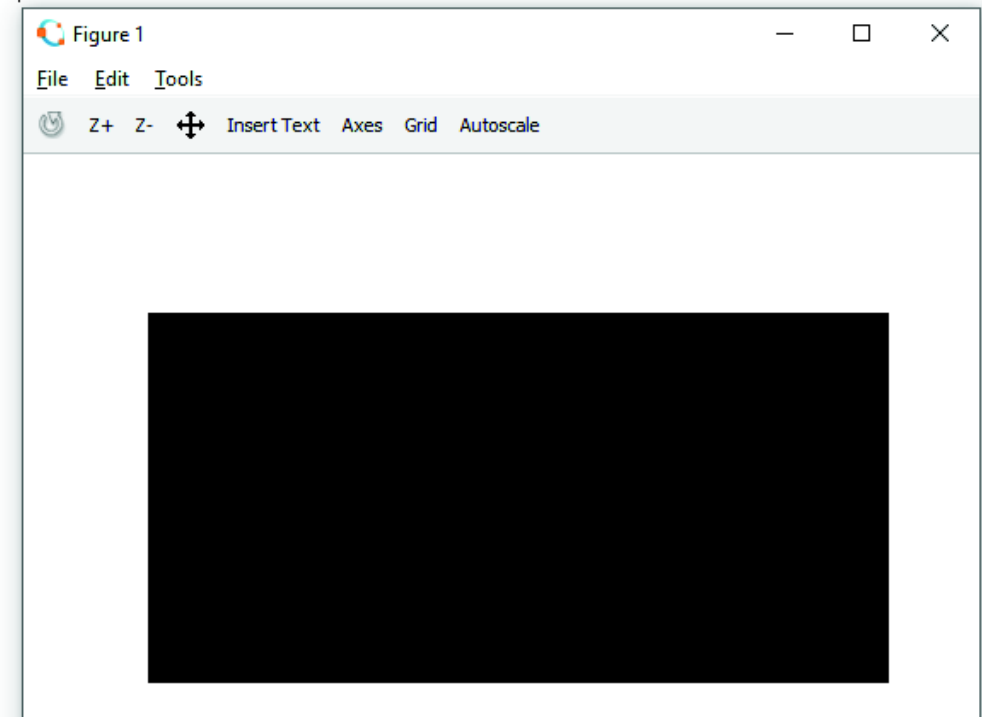
Blue channel

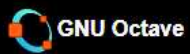
```
>> I0(1:10, 1:20, 3)
ans =
```

43	56	64	60	57	58	60	58	55	67	65	48	39	47	57	58	71	64	59	56
54	62	66	60	60	64	63	60	48	56	55	41	36	47	59	62	63	57	53	51
35	35	34	32	34	40	40	33	44	50	47	39	41	53	65	67	51	46	44	46
37	34	30	31	35	41	41	37	37	38	36	35	40	53	59	58	37	33	35	41
47	44	42	46	50	52	50	51	28	24	22	25	33	42	42	35	26	26	28	35
34	37	44	48	44	36	37	43	31	22	16	20	33	39	33	23	17	20	25	30
32	42	56	59	46	28	29	40	45	29	16	18	32	38	32	22	10	15	19	22
29	44	61	62	42	20	19	33	51	28	9	12	25	33	28	19	5	12	16	16
16	31	49	51	35	19	21	32	66	53	31	19	24	35	39	34	34	30	24	18
17	31	47	50	35	20	22	33	44	43	36	28	27	31	33	29	33	31	27	23

```
>> imshow(I0(1:10, 1:20, 3))
```

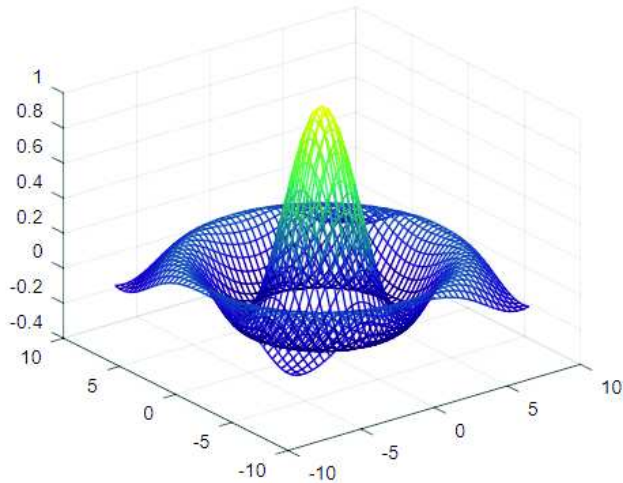
```
>> |
```





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Need help? Try out our new user and developer forum [Octave Discourse](#).



Scientific Programming Language

- Powerful mathematics-oriented syntax with built-in 2D/3D plotting visualization tools
- Free software, runs on GNU/Linux, macOS, BSD, and Microsoft Windows
- Drop-in compatible with many Matlab scripts

[Download](#)

[Documentation](#)

Syntax Examples

The Octave syntax is largely compatible with Matlab. The Octave interpreter can be run in [GUI mode](#), as a console, or invoked as part of a shell script. examples can be found in [the Octave wiki](#).

Solve systems of equations with linear algebra operations on **vectors** and **matrices**.

```
b = [4; 9; 2] # Column vector
A = [ 3 4 5;
      1 3 1;
      3 5 9 ]
x = A \ b     # Solve the system Ax = b
```



Octave Forge

[Home](#) [Packages](#) [Developers](#) [Support/Help](#) [Documentation](#)

Packages

Community packages

These packages are maintained by a community of Octave Forge and Octave developers in a spirit of collaboration. The main repository for development is located at Octave Forge and the packages share Octave's [bug and patch tracker](#). Community packages are coordinated between each other and with Octave regarding compatibility, naming of functions, and location of individual functions or groups of functions.

See also: [external packages](#), [unmaintained packages](#)



arduino

Basic Octave implementation of the matlab arduino extension, allowing communication to a programmed arduino board to control its hardware

[details](#) [download](#) [repository](#)



audio

Audio and MIDI Toolbox for GNU Octave

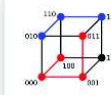
[details](#) [download](#) [repository](#)



cgi

Common Gateway Interface for Octave

[details](#) [download](#) [repository](#)



communications

Digital Communications, Error Correcting Codes (Channel Code), Source Code functions,



control

Computer-Aided Control System Design (CACSD) Tools for GNU Octave, based on the proven SLICOT Library



data-smoothing

Algorithms for smoothing noisy data



```
1 import cv2
2 import numpy as np
3 import os
4 from random import shuffle
5 from tqdm import tqdm
6 import tensorflow as tf
7 import matplotlib.pyplot as plt
8 %matplotlib inline
9
10 train_data = '/TensorFlow/ImageData/Vehicles/train'
11 test_data = '/TensorFlow/ImageData/Vehicles/test'
12
13 def one_hot_label(img):
14     label = img.split('.')[0]
15     if label == 'car':
16         ohl = np.array([1,0])
17     elif label == 'truck':
18         ohl = np.array([0,1])
19     return ohl
20 def train_data_with_label():
21     train_images = []
22     for i in tqdm(os.listdir(train_data)):
23         path = os.path.join(train_data, i)
24         img = cv2.imread(path, cv2.IMREAD_GRAYSCALE)
25         img = cv2.resize(img, (64, 64))
26         train_images.append([np.array(img), one_hot_label(i)])
27     shuffle(train_images)
28     return train_images
29
30 def test_data_with_label():
31     test_images = []
32     for i in tqdm(os.listdir(test_data)):
33         path = os.path.join(test_data, i)
34         img = cv2.imread(path, cv2.IMREAD_GRAYSCALE)
35         img = cv2.resize(img, (64, 64))
36         test_images.append([np.array(img), one_hot_label(i)])
37     return test_images
```



TensorFlow

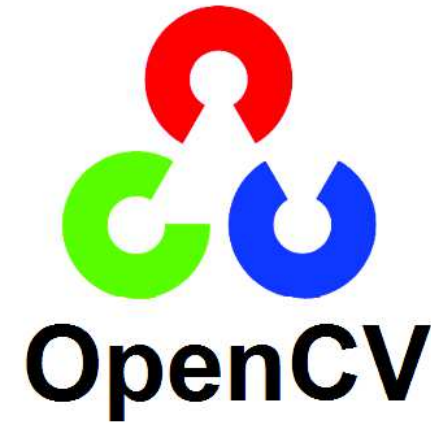
 PyTorch

The PyTorch logo, featuring a red flame-like icon to the left of the word "PyTorch" in a sans-serif font.



TensorFlow

 PyTorch



```
29 //Opencv C++ Example of Operation on Arrays:absdiff
30 #include "opencv2/highgui/highgui.hpp"
31 #include "opencv2/imgproc/imgproc.hpp"
32 #include <iostream>
33
34 using namespace cv;
35 using namespace std;
36
37 int main( )
38 {
39
40     Mat image1,image2,dst;
41     image1 = imread("C:\\Users\\shourya\\Desktop\\opencv-logo1.jpg",CV_LOAD_IMAGE_COLOR);
42     if( !image1.data ) { printf("Error loading image1 \n"); return -1;}
43     image2 = imread("C:\\Users\\shourya\\Desktop\\opencv-testing.png",CV_LOAD_IMAGE_COLOR);
44     if( !image2.data ) { printf("Error loading image2 \n"); return -1;}
45
46     absdiff( image1, image2, dst);
47
48     namedWindow( "Display window", CV_WINDOW_AUTOSIZE );
49     imshow( "Display window", image2 );
50
51     namedWindow( "Display windo", CV_WINDOW_AUTOSIZE );
52     imshow( "Display windo", image1 );
53
54     namedWindow( "Result window", CV_WINDOW_AUTOSIZE );
55     imshow( "Result window", dst );
56
57     //imwrite("C:\\Users\\shourya\\Desktop\\opencv-dst.jpg",dst);
58     waitKey(0);
59     return 0;
60 }
```



- Share / archive code
- Essential for teamwork