Introduction to Computer Vision

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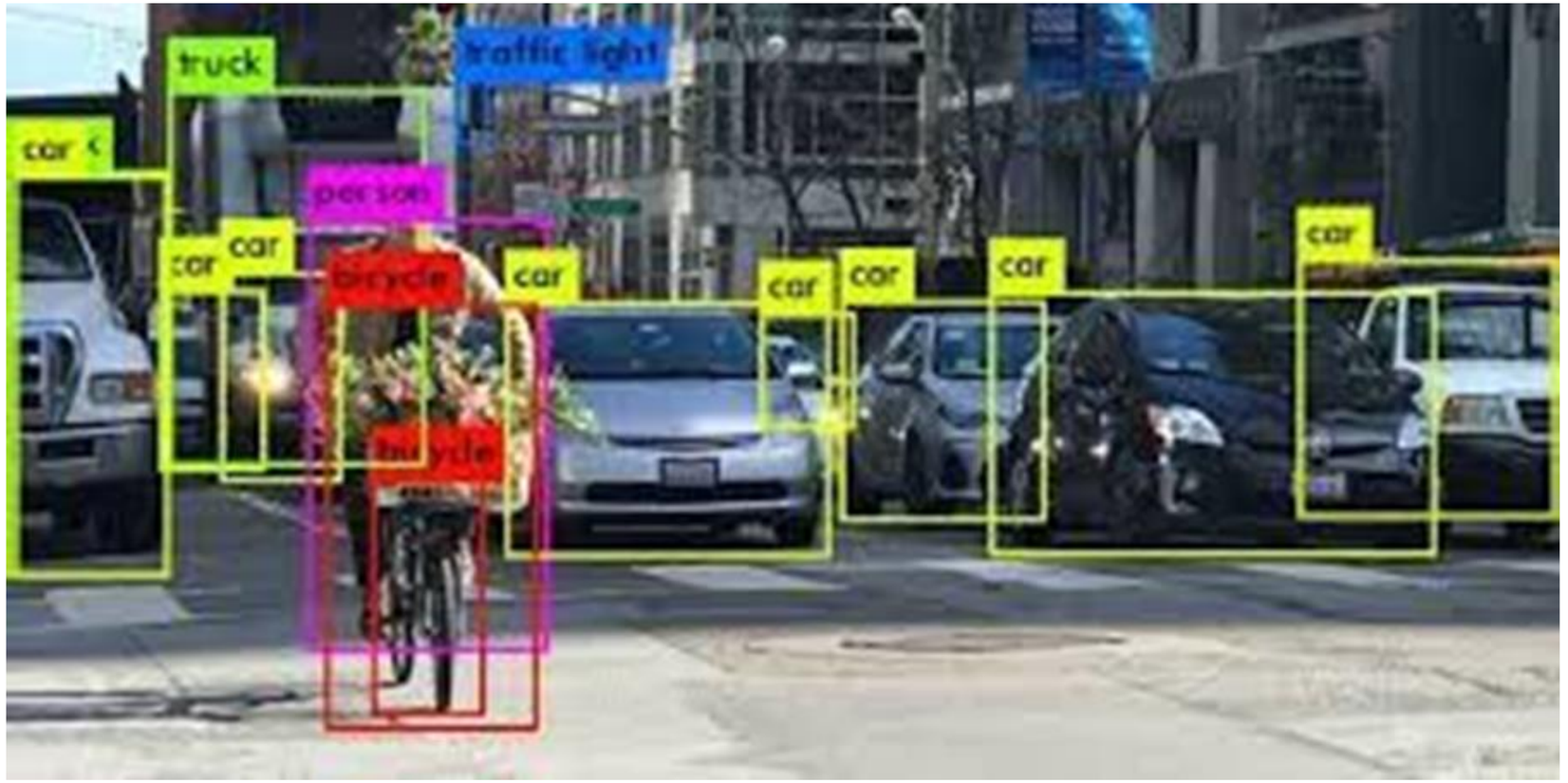
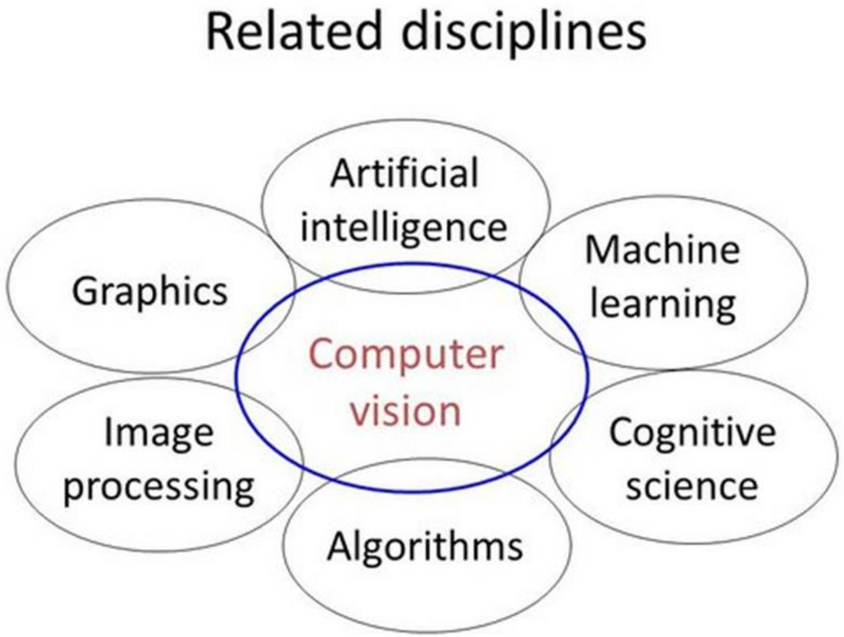
What is computer vision?



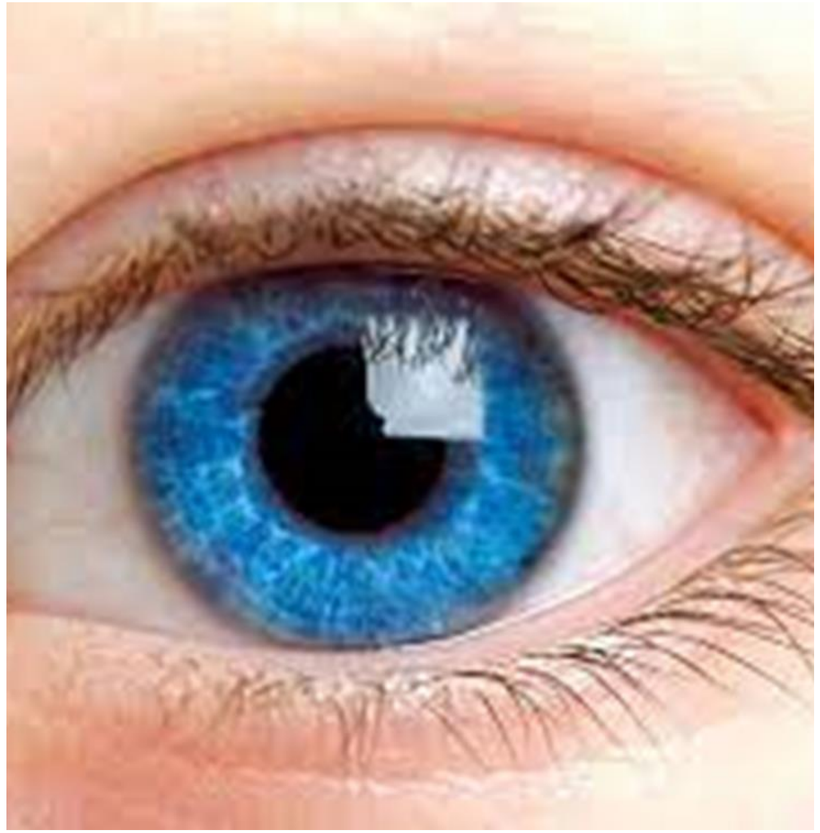
What is Computer Vision?

Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs — and take actions or make recommendations based on that information. If AI enables computers to think, computer vision enables them to see, observe and understand.



Computer Vision?

Computer vision trains machines to perform these functions, but it has to do it in much less time with cameras, data and algorithms rather than retinas, optic nerves and a visual cortex.



How does computer vision work?

- Computer vision needs lots of data. It runs analyses of data over and over until it discerns distinctions and ultimately recognize images.
- Two essential technologies are used to accomplish this: a type of machine learning called deep learning and a convolutional neural network (CNN).
- Machine learning uses algorithmic models that enable a computer to teach itself about the context of visual data.
- A CNN helps a machine learning or deep learning model “look” by breaking images down into pixels that are given tags or labels.

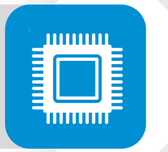
The History of Computer Vision

1959

Neurophysiologists showed a cat an array of images, attempting to correlate a response in its brain.

1963

Computers were able to transform two-dimensional images into three-dimensional forms.



1974

The introduction of optical character recognition (OCR) technology, which could recognize text printed in any font or typeface.

1982

Introduced algorithms for machines to detect edges, corners, curves and similar basic shapes.

The History of Computer Vision

2001

The first real-time face recognition applications appeared.

2010

The ImageNet data set became available which it contained millions of tagged images across a thousand object classes and provides a foundation for CNNs and deep learning models used today

2012

AlexNet, model from University of Toronto, significantly reduced the error rate for image recognition.

Computer Vision Application

Automatic inspection, e.g., in manufacturing applications

Assisting humans in identification tasks, e.g., a species identification system

Controlling processes, e.g., an industrial robot

Detecting events, e.g., for visual surveillance or people counting, e.g., in the restaurant industry

Interaction, e.g., as the input to a device for computer-human interaction

Modeling objects or environments, e.g., medical image analysis or topographical modeling

Navigation, e.g., by an autonomous vehicle or mobile robot

Organizing information, e.g., for indexing databases of images and image sequences.

Tracking surfaces or planes in 3D coordinates for allowing Augmented Reality experiences.

Typical Tasks in Computer Vision

RECOGNITION

- Content-based image retrieval
- Pose estimation
- Optical character recognition (OCR)

MOTION ANALYSIS

- Egomotion
- Tracking
- Optical flow

SCENE RECONSTRUCTION

IMAGE RESTORATION

System Methods

IMAGE ACQUISITION

the action of retrieving an image from a source.

PRE-PROCESSING

process the data in order to assure that it satisfies certain assumptions implied by the method.

FEATURE EXTRACTION

image features at various levels of complexity are extracted from the image data.

DETECTION / SEGMENTATION

at some point the processing a decision is made to find relevant for further processing.

System Methods

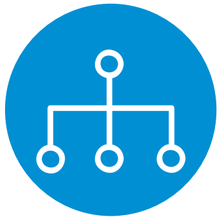
HIGH-LEVEL PROCESSING

basically for specific purpose with the small scope of data.

DECISION MAKING

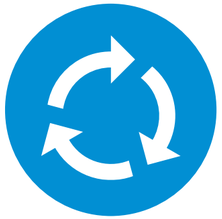
making the final decision required for the application.

Numpy



NumPyis a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications.



NumPy is open-source software and has many contributors.

Example of Numpy

Array creation

Basic operations

Universal functions

Linear algebra

Tensors

Incorporation with OpenCV

Nearest Neighbor Search

F2PY (Fortran to Python)


jupyter