BLUELIFE
LEVERAGE THE POWER OF AI

# Computer Vision

*Executive Briefing*

WHAT IS COMPUTER VISION?

# Hello!

## Welcome to the course!

*As you'll discover, computer vision (CV) is a powerful technology that has a variety of business applications.*
*This versatility-of-use makes CV a particularly exciting and fruitful area of artificial intelligence for multiple industries.*

The following study notes supplement the course's videos.
We'll revise and explore the **nuts and bolts** of this technology, the **two types of computer vision** (classic and deep learning), **why CV has been so disruptive** to so many industries (illustrated with an example), and **computer vision's potential applications**.
We will round off our analysis with **ten success stories** from companies that apply CV today.

# Table of Contents

PAGE

TUTORIAL

# 01

# What is computer vision?

Computer vision is a field of artificial intelligence that trains machines to **understand and interpret the visual world.** Appliances that use or manipulate images tend to use CV. This may sound futuristic, but CV has been around since the 1950s! The **barcode scanner** is one early example of CV in use.

Thanks to the technological advancements of the 21st century, computer vision's applications have entered many facets of our lives. As with many things we consume daily, we can take CV for granted. It is found in applications as varied as food sorting, image searches, and offsite monitoring. When your **camera identifies a face** and auto-focuses on it; when **Facebook auto-suggests** whom to tag in a photo; even when **a car drives automatically** – these are all examples of CV in action.


Due to the **increased capturing and processing capabilities** of computers, CV now means big bucks for businesses. Think about it: We process about 90% of data in visual form, so computer vision can tackle all the jobs that rely on human vision – from traffic inspectors to MRI scan-analysis experts, sports umpires to checkout assistants, truck drivers to equipment inspectors. By automating these tasks, computer vision can process them faster and with higher accuracy than human workers.

> **Businesses can, therefore, implement CV to increase efficiency and cut costs, freeing up their teams to carry out more creative tasks.**

TUTORIAL

02

# How does computer vision work?

# Two types of CV exist: Classic and deep learning

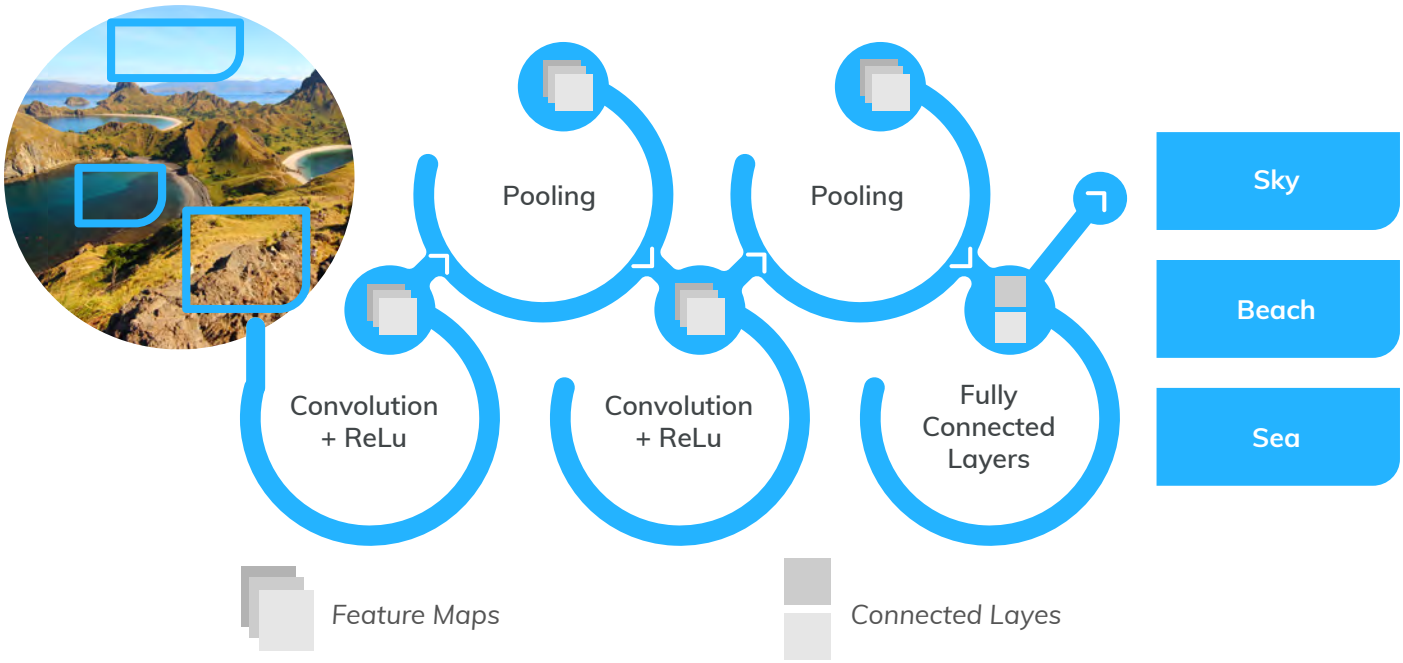
## Classic CV

relies on **pre-built libraries of features**.
It collects images, labels them according to similar characteristics, and groups them in a dataset, or library of features. We have to choose the right library for our purpose: To detect, say, a face in an image, a library of facial features will identify the eyes, nose, and mouth according to its preexisting trait sets. The beauty of classic CV is that it returns results quickly and accurately.

## Deep learning CV

requires **neural networks** to function, specifically convolutional neural networks (CNN).
The key difference between the two types is that classic CV uses features that we have already input into the library, while deep learning CV **generates its own library of characteristics** by using its CNN.

*Convolutional Neural Networks (CNN)*




Imagine deep learning CV as a black box, inside which sits a neural network – we input the data, but we don't control how it learns to recognize characteristics. Let's say we want to trial the accuracy of our CNN in a project to identify types of weevil, because we don't yet know what distinguishing features each species has. We first feed the CNN thousands of relevant images.

These pictures are labelled and, over time, the network will have seen enough to extract features that it thinks are distinguishing for each species.

The system stores these features for future identification, **so the more data we give it, the more accurate it will become.** When we later feed our CNN a previously unseen image of a weevil, it can apply prior information to identify the species correctly.

But why restrict ourselves to beetles? We can teach deep learning CV to identify anything. Today, libraries exist for cancerous cells, recyclable waste, weather patterns. If we can gather ample visual data, then we can run a CV algorithm.

> CV now means **big bucks** for businesses.
> We process about 90% of data in visual form.

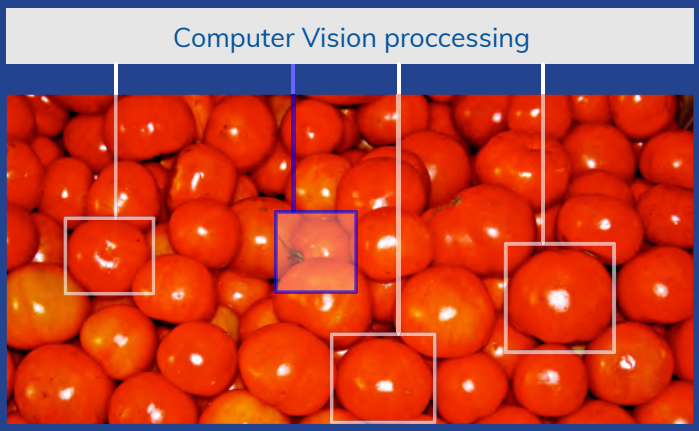
TUTORIAL

# 03

# Tomato sorting with computer vision

**Computer vision can automate any task that requires the visual analysis of data,**

from tomato sorting to driving a car. We'll use the former example to illustrate how easy it is to innovate with CV.
In this instance, you are the CEO of a company that wholesales tomatoes to grocery stores. You designate three workers to quality-check the tomatoes on a conveyor belt, and you ask them to remove any unripe or rotten fruit.




This manual process is hardly efficient for your business. For one, you need to **budget for three full-time employees.** Also, human workers...

... will make mistakes
... are **slower than computers when carrying out repetitive tasks**
... might **get sick or take days off**, causing the process to break down
... will likely not **find the work enjoyable**

## A deep learning CV algorithm can help!

First, **gather data** by installing a camera in the sorting room and letting the algorithm watch your workers' actions. The **collected images** of tomatoes that pass along the belt will be classified as "good," while pictures of discarded fruit will be classified as "bad."

A week of observations should be enough to **train the algorithm to make autonomous decisions**. All that remains is to install a mechanism that can automatically remove the bad tomatoes.

The benefit of this approach is that, comparative to manual labor,

**Computer Vision :**

01 **Minimizes costs**

02 **Reduces errors**

03 **Increases processing speeds**

04 **Obliterates days off/ sick days**

05 **Frees human employees to carry out more meaningful tasks**

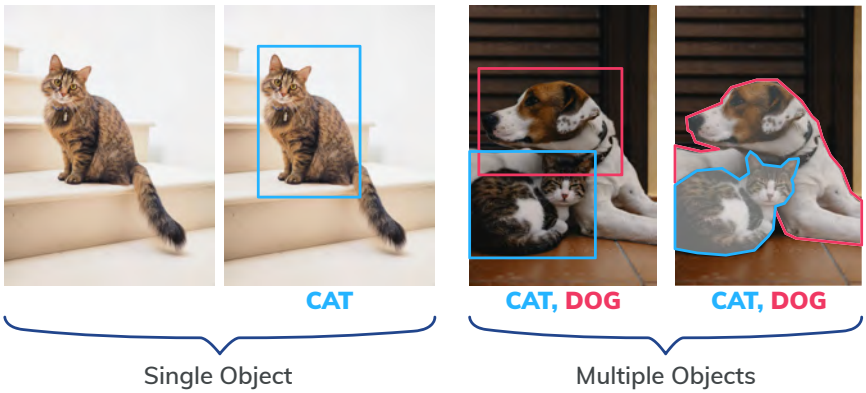
TUTORIAL

# 04

# Applications of computer vision

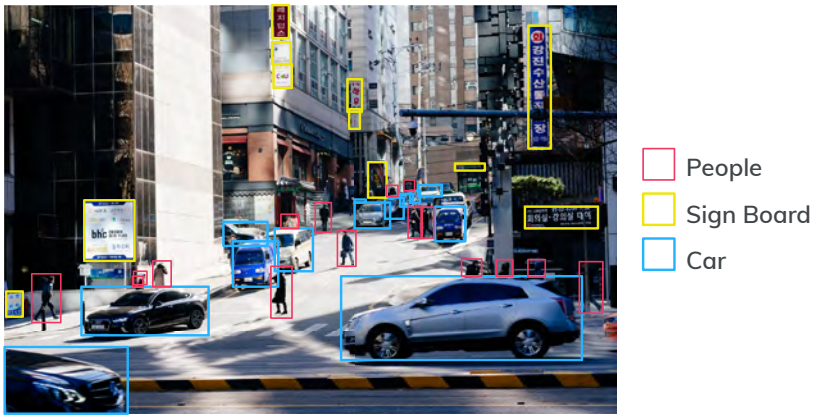
## Image classification

groups visual files into categories. It helps us to identify and categorize objects. E.g., pictures of dogs and cats; images of defective and working parts.




## Object detection

helps to identify important parts of an image. Advanced object detection can recognize multiple objects in an image and draw identification boxes around them. E.g., identifying human life; oil spills.




## Image segmentation

partitions an image into multiple regions which can be examined/ manipulated separately. E.g., Skype can now blur out the background behind a person on a call.

## Object tracking

monitors movement – a Tesla car was recently able to apply breaks on a highway seconds before a collision happened ahead of it. E.g., tracking pedestrian routes; monitoring car speeds.

## Image generation

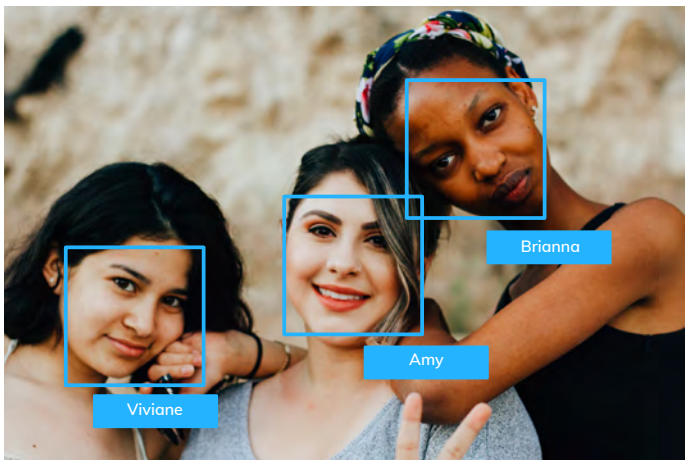
enables us to generate 3D-renders from 2D-images. E.g., Google Maps; transferring clothing patterns.

## Edge detection

finds the outside edges of an object to identify image content accurately. E.g., night vision.

## Face recognition

identifies specific individuals. E.g., automating the process of photo tagging.




## Face detection

facilitates applications to recognize facial features. E.g., camera focus; identifying the number of faces in an image.

## Optical character recognition (OCR)

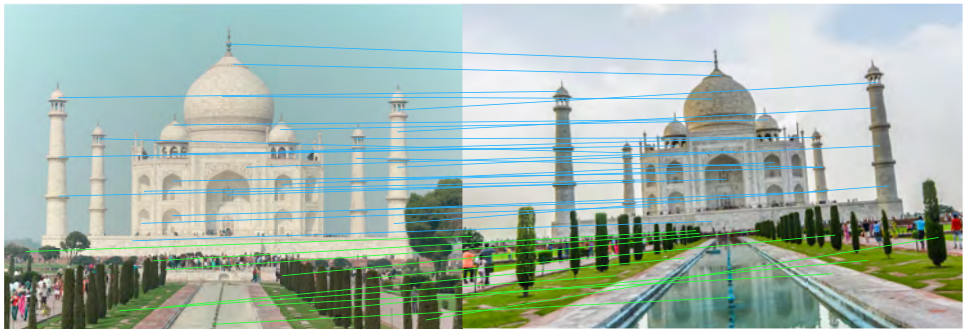
Optical character recognition (OCR) recognizes words and numbers in scanned printed and hand-written documents, with accuracy rates of over 99%. E.g., manuscript study; note-taking.

## Pattern detection

matches repeated shapes, colors and other visual indicators in images. E.g., handwriting recognition, fingerprint analysis.

## Feature matching

finds similar characteristics and groups them together. E.g., similar objects in photographs.



**Note:** We can apply each of the above applications to videos as well as images. This is because videos comprise frames that a machine can analyze individually.

TUTORIAL

# 05

# Case examples of computer vision in practice

## Skanska USA

Construction company Skanska found their workers walked an astonishing average of 6 miles per day.

**Using CV, Skanska tracke their movements and compared the activity data.**

This action enabled the company to optimize its operations, smartly positioning workers and resources. **The project saved each worker 2 miles of walking per day**, which boosted their productivity by 12%.

## Tesla

Self-driving cars use multiple scanners to analyze their surroundings, but **CV is crucial for a safe driving experience** because the vehicle must "see" where it is going. Since 2016, all of Tesla's cars have hardware that includes eight cameras, allowing a vehicle to visualize its environment at centimeter precision.

This move seems to mark Tesla's **growth in revenue**, which exploded by around 450% in the years following the announcement.

## eBay

In 2019, global sales reached 3 trillion USD online. Online retailers continue to explore new ways to improve the shopping experience and increase revenues.

With eBay's image search, you can upload to the platform photos of products you want to purchase.

**Its CV program analyzes your pictures and searches its inventory** of over 100 million items to find similar products.

## Harvest CROO Robotics

In Florida, 10-11,000 acres of strawberries are handpicked each year. By 2024, the number of agriculture workers is predicted to decrease by 6%, making automation essential for this industry.

Harvest CROO Robotics **developed a robot that uses CV** to inspect strawberries, determine ripeness, and pick the fruit, all in 8 seconds per plant.

**One machine can harvest 8 acres per day,** the equivalent of 30 human workers.

## AiCure

To increase the chance of making a successful recovery, patients must adhere to their prescribed medication. But around half of patients do not take their medicine as prescribed.

AiCure developed **smartphone CV software that can determine if a patient took the right medication at the right time and in the right quantity**.

They achieved 95% adherence on initial samples, which will be a significant aid to vulnerable and at-risk groups.

## RoAF

Every year, 11 billion USD of recyclable packaging is thrown away in the US alone. Even top-performing countries like Switzerland, Australia and Germany only recycle about half of their waste. This isn't just bad for the environment; it's also a colossal waste of money.

RoAF, the first fully automated sorting plant for municipal waste, opened in Norway in 2016.

With CV, it could **sort waste automatically**. RoAF's process **sorts 40 tons of waste per hour, serves 190,000 inhabitants, and is up to 97% accurate**.

## Osprey Informatics

Monitoring large numbers of production facilities costs time and money.

When startup Osprey applied **CV algorithms to monitor remote oil wells, they eliminated unnecessary visits to functioning sites and reacted more quickly to malfunctions**.

This project **halved monitoring costs**, and oil giant Shell invested several million USD into the startup.

## Cortexica

Businesses that use industrial machinery must consider workplace safety. An average company in construction will experience 27 worker injuries per year. Almost half of these are due to human error – an astonishing 30% are due to workers not wearing protective gear.

Cortexica's CV software **allows businesses to monitor the workplace and issue alerts** when a worker is not complying with safety rules.

They predict that **full adoption of their system could prevent 16,000 accidents**, saving millions for a company.

## Swiss Federal Institute of Technology

Every year, 15 million people worldwide suffer from strokes, and though mortality rates are low, it remains the leading cause of serious, long-term disabilities in developed countries. The reason? Recovery is expensive, with US rehabilitation services costing patients an average of 11,000 USD in the first year.

Swiss researchers have developed **CV software that monitors coordination, dexterity and reflex recovery, reducing the need for expensive medical services**.

Initial tests show full recovery, meaning that **implementation of the software could improve the lives of millions of affected people**.

## TOMRA

The mining industry consumes around 3% of the world's energy. This is mainly due to small quantities of precious materials being present in the ore. An average gold-bearing ore, for example, contains about 5 grams of gold per ton.

TOMRA-developed automatic sorting machines use **CV to identify particles containing large volumes of valuable materials** and separate them from the waste.

This system **reduces energy costs by 15%.**

# Hungry for **more**?

Find us at **www.bluelife.ai**,
where you can join us on our other courses
that deconstruct exponential technologies
in under 30 minutes!