
Other Emerging Technologies

— Chapter 7 —

Learning Outcomes

After accomplishing this lesson, Students will be able to:

- Explain **Nanotechnology** and its application in different sectors.
- Explain **Biotechnology** and its application in different sectors.
- Explain **Blockchain** technology and its application.
- Gain insights about the **Cloud computing** and its applications
- Gain insights about the **Quantum computing** and its applications
- Explain how **Computer Vision** works and its application
- Describe **Cybersecurity**, types of cyber security threat and its benefits

Nanotechnology

- **Nanotechnology** is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers
- **Nanoscience and nanotechnology** are the study and application of extremely **small things** and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering



Fundamental concepts in Nanoscience & Nanotechnology

- One nanometer is a billionth of a meter or 10^{-9} of meters (0.000000001)
- Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules
- As small as a nanometer is, it's still large compared to the atomic scale
 - An atom has a diameter of about 0.1 nm
 - An atom's nucleus is much smaller about 0.00001 nm

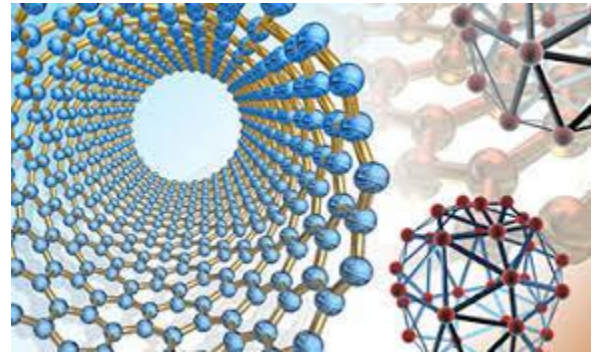
Fundamental concepts in Nanoscience & Nanotechnology

- You and everything around you are made of atoms
- Nature has perfected the science of manufacturing matter molecularly
 - For instance, our bodies are assembled in a specific manner from millions of living cells
- Cells are nature's **nanomachines**
- **At the atomic scale, elements are at their most basic level**
- **On the nanoscale, we can potentially put these atoms together to make almost anything**

Fundamental concepts in Nanoscience & Nanotechnology

Nanoscience is defined as:

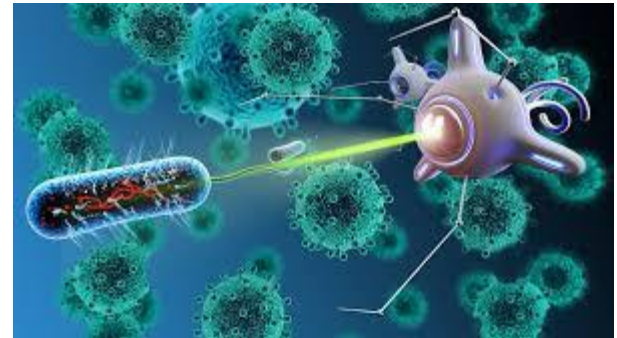
the **study** of phenomena and **manipulation of materials** at **atomic, molecular** and **macromolecular scales**, where properties differ significantly from those at a larger scale



Fundamental concepts in Nanoscience & Nanotechnology

Nanotechnology is defined as:

the **design**, **characterization**, **production**, and **application** of structures, devices, and systems by controlling shape and size at the **nanometer scale**



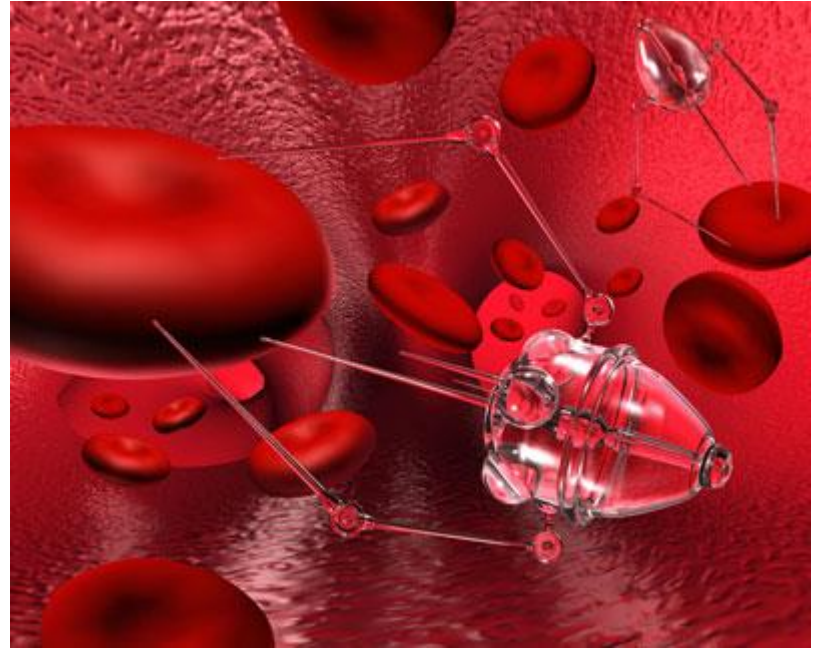
Fundamental concepts in Nanoscience & Nanotechnology

Materials made at nanoscale have enhanced properties such as

- **higher strength**
- **lighter weight**
- **increased control of light spectrum**, and
- **greater chemical reactivity** than their larger-scale counterparts

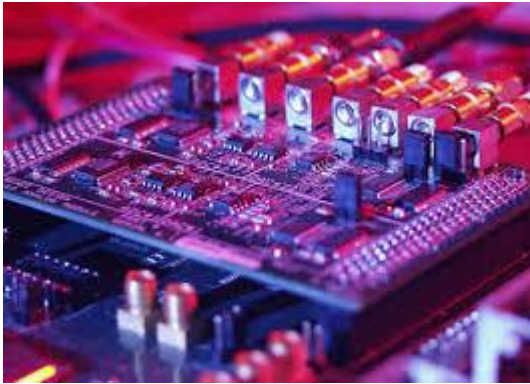
Applications of Nanotechnology in Medicine

- Customized nanoparticles the size of molecules that can deliver drugs directly to diseased cells in human body
- When it's perfected, this method should greatly reduce the damage treatment such as chemotherapy does to a patient's healthy cells



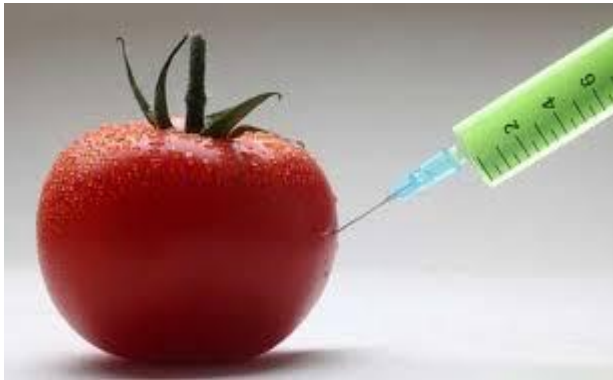
Applications of Nanotechnology in Electronics

- It has some answers for how we might increase the capabilities of electronics devices while we reduce their weight and power consumption



Applications of Nanotechnology in Food

- Companies are developing nanomaterials that will make a difference not only in the taste of food but also in food safety and the health benefits that food delivery



Applications of Nanotechnology in Agriculture

- Nanotechnology can possibly change the whole agriculture part and nourishment industry anchor from **generation to preservation, handling, bundling, transportation**, and even **waste treatment**



Applications of Nanotechnology in Vehicle Manufacturers

- Much like aviation, lighter and stronger materials will be valuable for making vehicles that are both quicker and more secure
- Burning motors will likewise profit from parts that are all the more hardwearing and higher temperature safe



Biotechnology

- It is the broad area of biology **involving living systems and organisms to develop or make products**, or
- Any **technological application** that **uses biological systems, living organisms, to make or modify products or processes for specific use**
- At its simplest, **biotechnology is technology based on biology** - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that **help improve our lives and the health of our planet**

Biotechnology

- Brewing and baking bread are examples of processes that fall within the concept of biotechnology:
 - use of yeast (= living organism) to produce the desired product



Biotechnology

- In **modern biotechnology**, researchers **modify DNA and proteins to shape the capabilities** of living cells, plants, and animals into something useful for humans
- Biotechnologists do the modification by sequencing or reading, the DNA found in nature, and then manipulating it in a test tube – or, more recently, inside of living cells.



Application of biotechnology: Agriculture

- **Genetically Modified Organisms** such as Crops, Animals, Plants, Fungi, Bacteria, etc have traits such as **pest resistance, insect resistance, weed resistance**, etc
- **Genetically modified crops** are formed by the manipulation of DNA to introduce a new trait into the crops.



Application of biotechnology: **Medicin**

- **Genetically modified insulin** known as **humulin** helps in the **treatment** of a large number of **diabetes patients**
- **Gene therapy** is a technique to remove the genetic defect in an embryo or child. This technique involves the **transfer of a normal gene that works over the non-functional gene**



Application of biotechnology: Aquaculture Fisheries

- Improving the quality and quantity of fishes
- Through biotechnology, fishes are induced to breed via gonadotropin releasing hormone



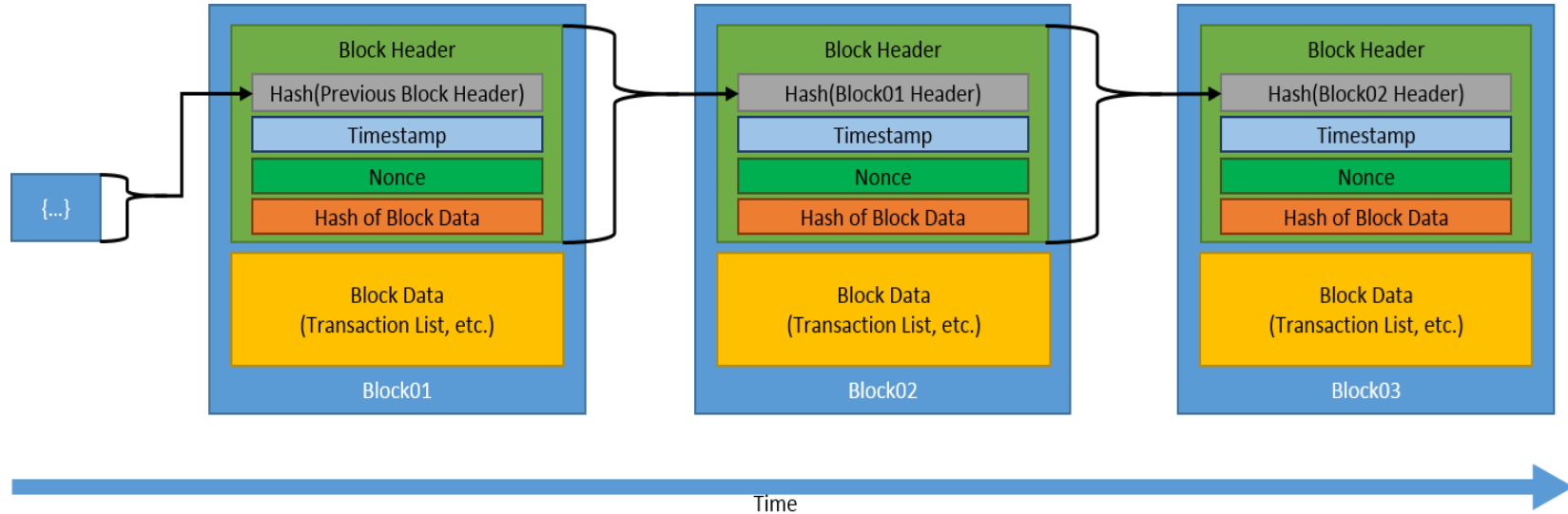
Application of biotechnology: Environment

- Used in waste treatment and pollution prevention
- Environmental biotechnology can more efficiently clean up many wastes than conventional methods and greatly reduce our dependence on methods for land-based disposal
- Some bacteria thrive on the chemical components of waste products

Blockchain Technology

- **Blockchain** is a growing list of records, called blocks, that are linked using cryptography
- A **blockchain** is, a **time-stamped series of immutable records of data** that is managed by a cluster of computers not owned by any single entity
- Each of these blocks of data (i.e. block) is secured and bound to each other using cryptographic principles (i.e. chain)
- Each block contains
 - a cryptography hash of the previous block,
 - a timestamp, and
 - transaction data (generally represented as a Merkle tree)

Blockchain technology



Blockchain technology

“**Blocks**” on the blockchain are made up of three digital pieces of information

1. Information about **transactions** like the date, time, and dollar amount of your most recent purchase, for example
2. Information about **who is participating in transactions.**

Instead of using your actual name, your purchase is recorded without any identifying information using a unique “digital signature”

1. Information that **distinguishes them from other blocks**

Blockchain technology

When a block stores new data it is added to the blockchain

- A transaction must **occur**
- That transaction must be **verified**
- That transaction must be **stored** in a block
- That block must be given a **hash**

Blockchain technology

- By design, a **blockchain** is resistant to modification of the data
- It is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way
- Once recorded, the data in any given block cannot be altered retroactively without the alteration of all subsequent blocks, which requires the consensus of the network majority

Blockchain technology

- The blockchain network has **no central authority**
 - it is the very definition of a democratized system
- Since it is a **shared and immutable ledger**, the information in it is open for anyone and everyone to see
- Anything that is built on the blockchain is by its very nature **transparent** and everyone involved is accountable for their actions

Application of blockchain: The sharing economy

- With companies like **Uber** and **Airbnb** flourishing, the **sharing economy** is already a proven success
- **By enabling peer-to-peer payments**, the blockchain opens the door to direct interaction between parties, without any intermediary
- Leading to a truly decentralized sharing economy



Application of blockchain: Crowdfunding

- Crowdfunding initiatives like **Kickstarter** and **GoFundMe** are doing the advance work for the emerging peer-to-peer economy
- Blockchains helps in **creating crowdsourced venture capital funds**

For example, the Ethereum-based DAO (Decentralized Autonomous Organization), raised an astonishing \$200 million USD in just over two months

Application of blockchain: Governance

- By making the results fully transparent and publicly accessible, distributed database technology could bring full transparency to elections or any other kind of poll taking

Ethereum-based smart contracts help to automate the process

Application of blockchain: Supply chain auditing

- Distributed ledgers provide an easy way to certify that the backstories of the things we buy are genuine
- Transparency comes with blockchain-based timestamping of a date and location



Application of blockchain: File storage

- Decentralizing file storage on the internet brings clear benefits
- Distributing data throughout the network protects files from getting hacked or lost

Cloud Computing

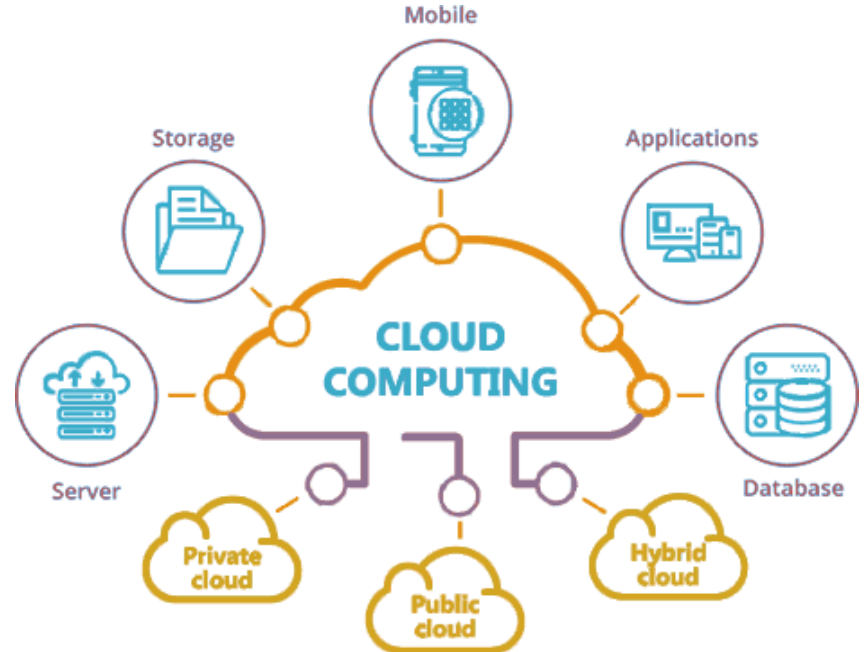
- Cloud computing is a **means of networking remote servers that are hosted on the Internet**

- **Types of cloud infrastructures**

Public Cloud

Private Cloud

Hybrid Cloud



Cloud computing: **Public Cloud**

- A third-party provider manages the servers, applications, and storage much like a public utility
- Anyone can subscribe to the provider's cloud service



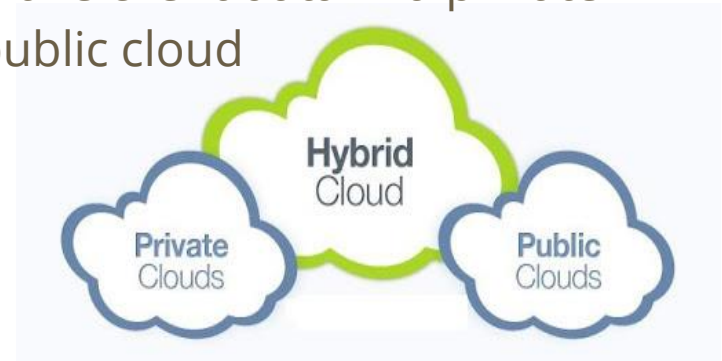
Cloud computing: Private Cloud

- The computing infrastructure exists as a private network accessible over the Internet
- A business or organization would typically use a private cloud
- The network might be hosted on their on-site data center, or through a third-party provider



Cloud computing: Hybrid Cloud

- Here **private clouds are connected to public clouds**, allowing data and applications to be shared between them
- **Hybrids** can **offer more computing capacity for a business application** when the need for its spikes
- Hybrids also enable applications to keep sensitive client data in a private cloud but connect to end-user software in a public cloud



Cloud computing services

- Cloud computing services can focus on **infrastructure**, **web development** or a **cloud-based app**
- These are often regarded as a stack; all are **on-demand, pay-as-you-go**

Cloud computing services

- **Infrastructure as a Service (IaaS)**

gives you management of the whole deal: **servers, web development tools, applications**

- **Platform as a Service (PaaS)**

offers a **complete web development environment**, without the worry of the hardware that runs it

- **Software as a Service (SaaS)**

allows **access to cloud-based apps**, usually through a web browser interface

Advantages of cloud computing

- Much like with any utility, a business **benefits from economy of scale**, which means cheap computing power
- Because a cloud provider's hardware and software are shared, **there's no need for the initial costly capital investment**
- Businesses **save on the electricity** required 24/7 to power and cool that computing infrastructure
- **Cloud providers** have vast resources of computing power, they can **allocate** these **resource whenever required** with just a few mouse clicks

Advantages of cloud computing

- **Cloud providers** source on a global scale, so they **can deliver the precise bandwidth, storage and power** business needs when it needs it
- The cloud allows you and multiple users to **access your data from any location and at any time**
- With cloud computing a business **processes its data more efficiently, increasing productivity.**
- **Maintenance is much cheaper**, often free, so reliability is rarely a worry
- Cloud computing allows CEOs to focus on running their business

QUANTUM COMPUTING

- Unlike classic computers, **quantum computers** derive their computing power by harnessing the **power of quantum physics**
- Give clients access to a quantum computer over the internet, and you have **quantum cloud computing**



Quantum Computing

- Currently, the only organization which provides a quantum computer in the cloud is IBM. They allow free access to anyone who wishes to use their 5-qubit machine
- Google provided the fastest quantum computer with 53 qubits and speed of 200 seconds computation while the supercomputer took 10000 years



Quantum computing

- What is qubit and how many do you need?

Qubit is short for a sequence of **q**uantum **b**its

- With a **classic computer**, **data is stored** in tiny transistors that hold a **single bit** of information, **either** the binary value of **1 or 0**
- With a quantum computer, the data is stored in qubits
- A qubit can exist in **two states** at the **same time**

This phenomenon is called **superposition**

Quantum computing

- A **qubit** can have a value of **1, 0, or some value between**
- Two qubits can hold even more values
- Before long, you are building yourself an **exponentially more powerful computer the more qubits you add**

Advantages of quantum computing

- Quantum computers will be able to **make complex calculations** that would only overwhelm classic computers
- Quantum computing could **help in the discovery of new drugs**
by unlocking the complex structure of chemical molecules
- Other uses include **financial trading, risk management, and supply chain optimization**
- With its ability to handle more complex numbers, **data could be transferred over the internet with much safer encryption**

COMPUTER VISION

- It is an interdisciplinary scientific field that deals with **how computers can be made to gain a high-level understanding of digital images or videos**
- From the perspective of engineering, it seeks to **automate tasks that the human visual system can do**



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

Computer vision

- **Understanding digital images** means the **transformation of visual images (the input of the retina) into descriptions of the world** that can interface with other thought processes and elicit appropriate action
- This **image understanding** can be seen as the **disentangling of symbolic information from image data** using models constructed with the aid of geometry, physics, statistics, and learning theory
- Computer vision is building **algorithms that can understand the content of images and use it for other applications**

How computer vision works

- **Acquiring an image**

Images, even large sets, can be acquired in real-time through video, photos or 3D technology for analysis

- **Processing the image**

Deep learning models automate much of this process, but the models are often trained by first being fed thousands of labeled or pre-identified images

- **Understanding the image**

The final step is the interpretative step, where an object is identified or classified

Types of computer vision

Image segmentation

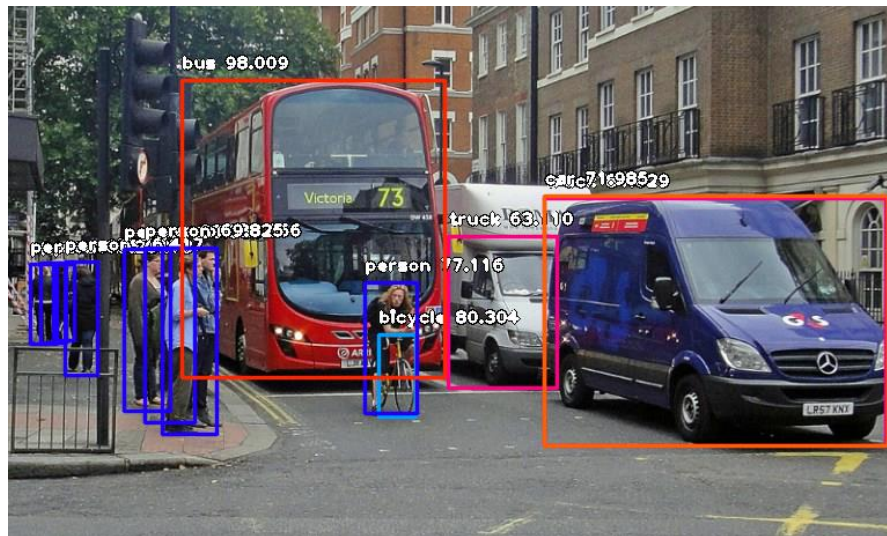
partitions an image into multiple regions or pieces to be examined separately



Types of computer vision

Object detection

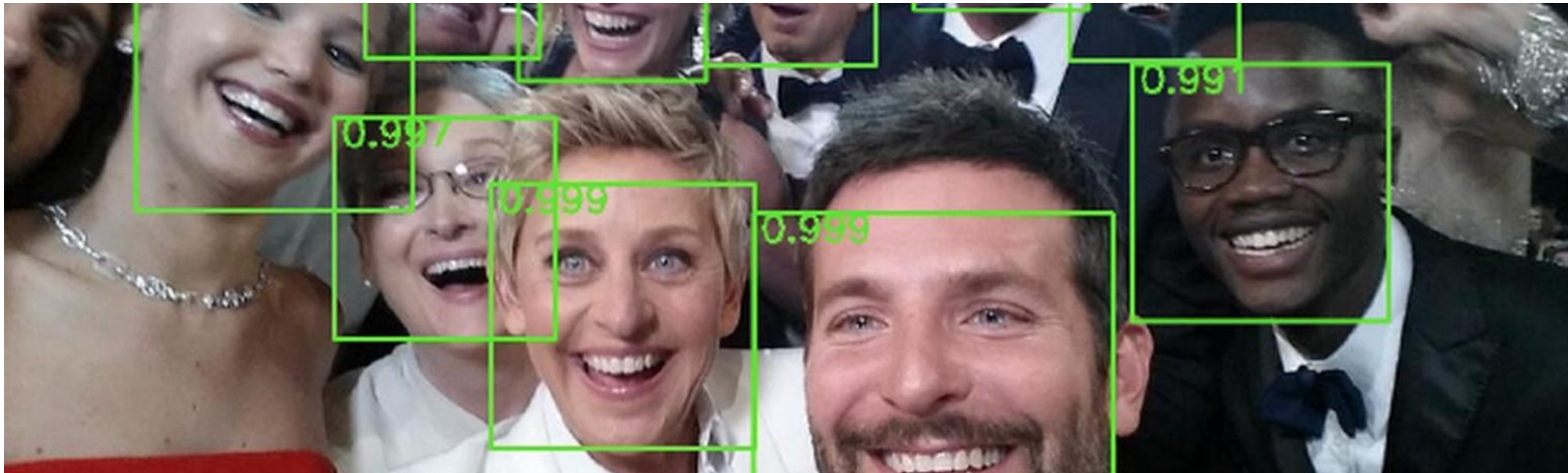
identifies a specific object in an image



Types of computer vision

Facial recognition

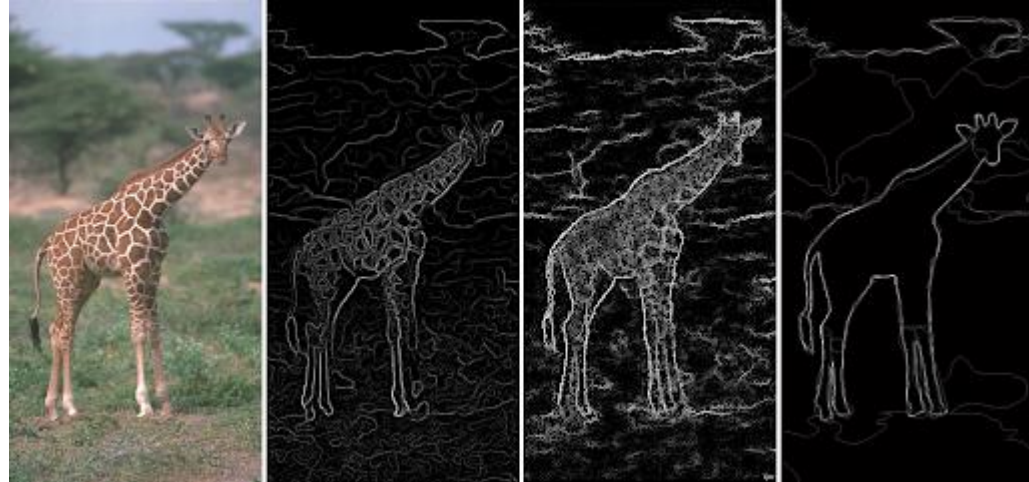
is an advanced type of object detection that not only recognizes a human face in an image but identifies a specific individual



Types of computer vision

Edge detection

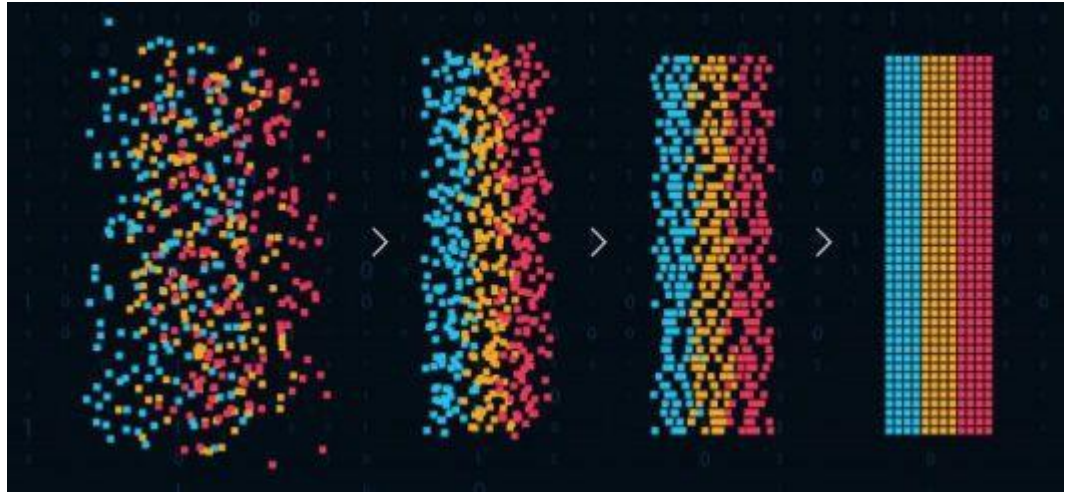
is a technique used to identify the outside edge of an object or landscape to better identify what is in the image



Types of computer vision

Pattern detection

is a process of recognizing repeated shapes, colors and other visual indicators in images



Types of computer vision

Image classification

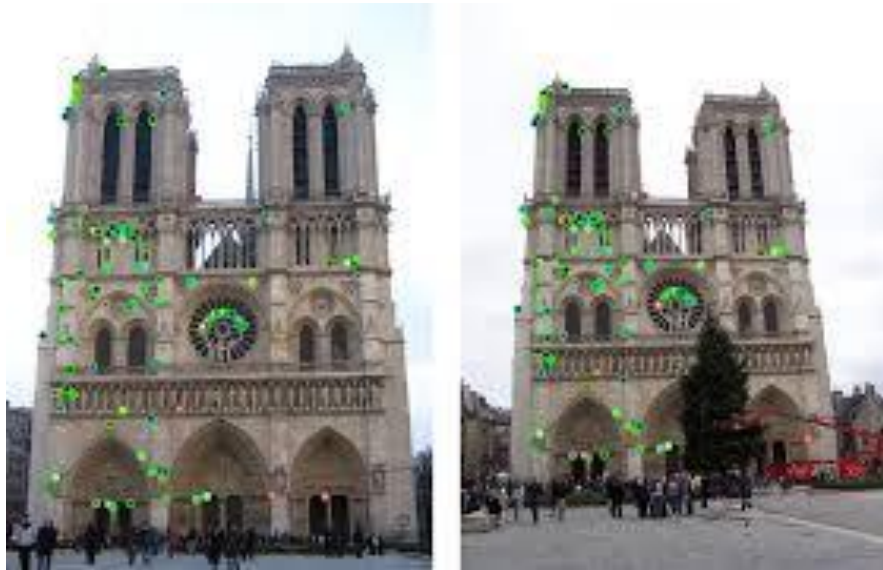
groups images into different categories



Types of computer vision

Feature matching

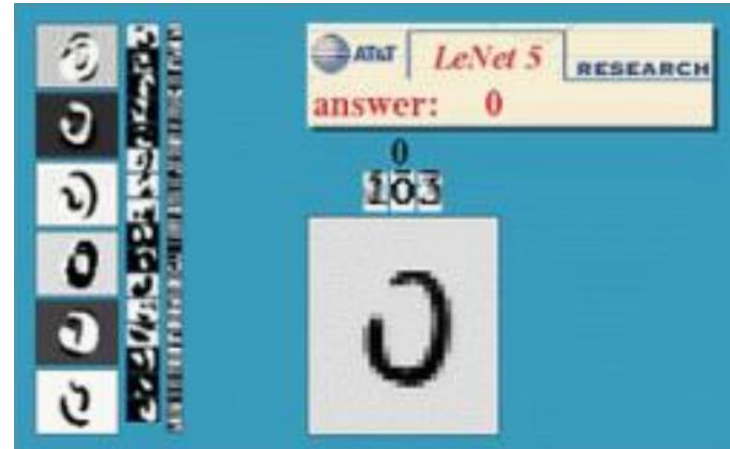
is a type of pattern detection that matches similarities in images to help classify them



Applications of computer vision

Optical character recognition (OCR)

reading handwritten postal codes on letters and automatic number plate recognition (ANPR)



Applications of computer vision

Machine inspection

- rapid parts inspection for quality assurance using stereo vision with specialized illumination to measure tolerances on aircraft wings or auto body parts
- looking for defects in steel castings using X-ray vision



Applications of computer vision

Retail

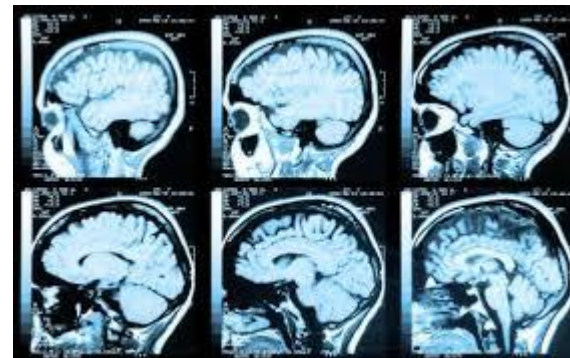
object recognition for automated checkout lanes



Applications of computer vision

Medical imaging

- registering preoperative and intraoperative imagery or performing long-term studies of people's brain morphology as they age



Applications of computer vision

Automotive safety

- detecting unexpected obstacles such as pedestrians on the street, under conditions where active vision techniques such as radar or lidar do not work well



Applications of computer vision

Surveillance

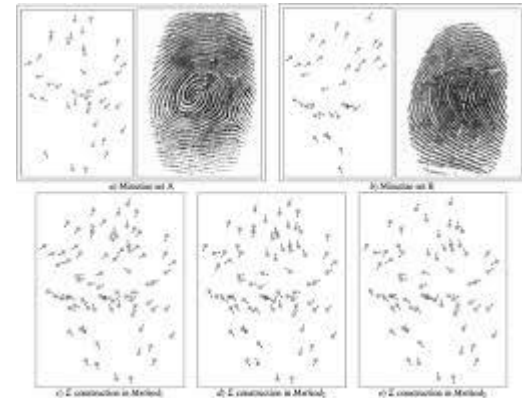
- monitoring for intruders, analyzing highway traffic, and monitoring pools for drowning victims



Applications of computer vision

Fingerprint recognition and biometrics

for automatic access authentication as well as forensic applications



Cybersecurity

- It is the protection of **computer systems** from the theft of or damage to their hardware, software, or electronic data, as well as from the disruption or misdirection of the services they provide
- The field is becoming more important due to increased reliance on computer systems, the Internet and wireless network standards such as Bluetooth and Wi-Fi, and due to the growth of smart devices, including smartphones, televisions, and the various devices that constitute the Internet of Things

Cybersecurity vs Information Security

Cybersecurity is often confused with information security

- **Cybersecurity** focuses on **protecting computer systems** from unauthorized access or being otherwise damaged or made inaccessible
- **Information security** is a broader category that looks to **protect all information assets**, whether in hard copy or in digital form

Cybercrime

- The term **cybercrime** is used to describe an unlawful activity in which computer or computing devices such as smartphones, tablets, Personal Digital Assistants (PDAs), etc are used as a tool or/and target of criminal activity



Cybersecurity measures

Staff awareness training

- Human error is the leading cause of data breaches, so you need to equip staff with the knowledge to deal with the threats they face
- Training courses will show staff how security threats affect them and help them apply best-practice advice to real-world situations

Application security

- Web application vulnerabilities are a common point of intrusion for cybercriminals
- As applications play an increasingly critical role in business, it is vital to focus on web application security

Cybersecurity measures

Network security

- Network security is the process of protecting the usability and integrity of your network and data
- This is achieved by conducting a network penetration test, which scans your network for vulnerabilities and security issues

Leadership commitment

- Leadership commitment is the key to cyber resilience. Without it, it is very difficult to establish or enforce effective processes
- Top management must be prepared to invest in appropriate cybersecurity resources, such as awareness training

Password management

- You should implement a password management policy that provides guidance to ensure staff create strong passwords and keep them secure

Types of cybersecurity threats

Ransomware

- It is a type of malicious software
- It is designed to extort money by blocking access to files or the computer system until the ransom is paid
- Paying the ransom does not guarantee that the files will be recovered or the system restored

Malware

- It is a type of software designed to gain unauthorized access or to cause damage to a computer

Types of cybersecurity threats

Social engineering

- it is a tactic that adversaries use to trick you into revealing sensitive information
- They can solicit a monetary payment or gain access to your confidential data
- Social engineering can be combined with any of the threats listed before to make you more likely to click on links, download malware, or trust a malicious source

Types of cybersecurity threats

Phishing



- it is the practice of sending fraudulent emails that resemble emails from reputable sources
- The aim is to steal sensitive data like credit card numbers and login information
- It's the most common type of cyber-attack
- You can help protect yourself through education or a technology solution that filters malicious emails

Benefits of cybersecurity

- Business protection against malware, ransomware, phishing, and social engineering
- Protection for data and networks
- Prevention of unauthorized users
- Improves recovery time after a breach
- Protection for end-users
- Improved confidence in the product for both developers and customers