

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.

- Has gain insights about the cloud and quantum computing and its applications

Learning Outcomes

After accomplishing this lesson, Students will be able to:

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



NANOTECHNOLOGY

The Nanotechnology as consisting of all of the following:

- *Research & technology development at the 1-to-100nm range.*
- *Creating & using structures that have novel properties because of their small size.*
- *Ability to control/manipulate at atomic scale.*

Fundamental concepts in Nanoscience & Nanotechnology

One nanometer is a billionth of a meter or 10^{-9} of meters

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 and nanotechnology

- It's hard to imagine just how small nanotechnology is.
- One nanometer is a billionth of a meter or 10^{-9} of meters.
- Here are a few illustrative examples:
 - There are 25,400,000 nanometers in an inch
 - A sheet of newspaper is about 100,000 nanometers thick
 - On a comparative scale, if a marble were a nanometer, then one meter would be the size of the Earth

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**

Fundamental concepts in Nanoscience & Nanotechnology

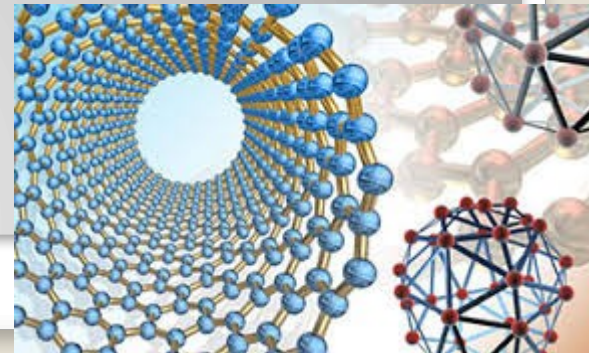
At the atomic scale, elements are at their most basic level

On the nanoscale, we can potentially put these atoms together to make almost anything

Fundamental concepts in Nanoscience & Nanotechnology

We define **nanoscience** as

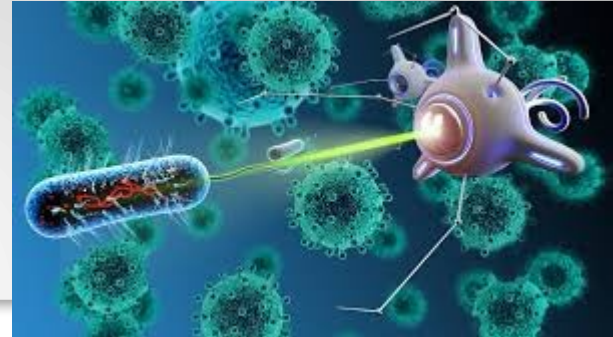
the study of phenomena and **manipulation of materials** at **atomic, molecular** and **macromolecular scales**, where properties differ significantly from those at a larger scale



Fundamental concepts in Nanoscience & Nanotechnology

We define **nanotechnologies** 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

The properties of materials can be different at the nanoscale for two main reasons:

First, **nanomaterials have a relatively larger surface area** when compared to the same mass of material produced in a larger form

This can make materials more chemically reactive (in some cases materials that are inert in their larger form are reactive when produced in their nanoscale form), and **affect their strength or electrical properties**

Fundamental concepts in Nanoscience & Nanotechnology

The properties of materials can be different at the nanoscale for two main reasons:

Second, **quantum effects can begin to dominate the behavior of matter at the nanoscale** particularly at the lower end – affecting the optical, electrical and magnetic behavior of materials

Materials can be produced that are nanoscale in **one dimension** (for example, nanowires, nanorods, and nanotubes), in **two dimensions** (plate-like shapes like nanocoating, nanolayers, and graphene) or in all **three dimensions** (for example, nanoparticles)

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

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NANOTECHNOLOGY (Continued)

KEY Elements of Nanotechnology:

- **Bucky ball-** A soccer-ball shaped molecule made of 60 carbon atoms. Applications: Composite reinforcement, drug delivery.
- **Carbon Nanotube:** A sheet of graphite rolled into a tube. Applications: Composite reinforcement, conductive wire, fuel cells, high-resolution displays.
- **Quantum Dot:** A semiconductor nanocrystal whose electrons show discrete energy levels, much like an atom. Applications: Medical imaging, energy-efficient light bulbs.
- **Nano shell:** A nanoparticle composed of a silica core surrounded by a gold coating. Applications: Medical imaging, cancer therapy.

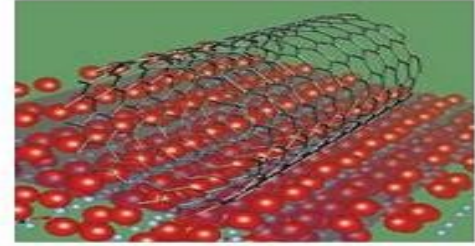
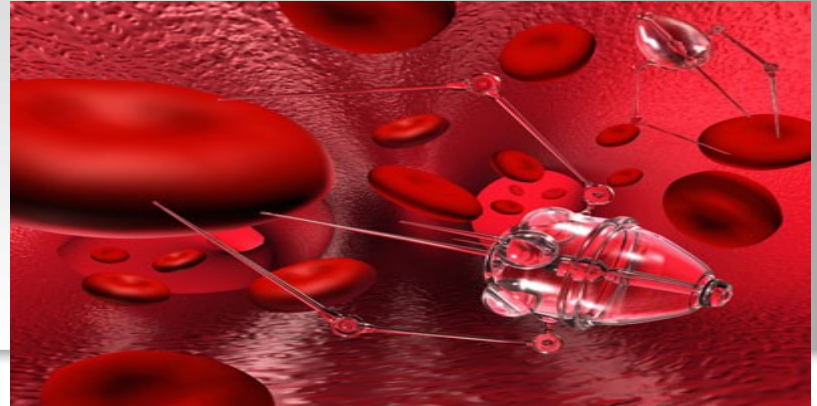


Figure representing nanowire synthesis

Applications of Nanotechnology in Medicine

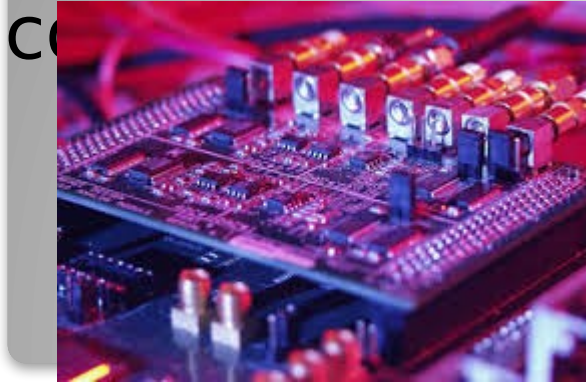
Customized nanoparticles (the size of molecules) that can deliver drugs directly to diseased cells in human body

When it's perfected, this method should greatly reduce the damage treatment such as **chemotherapy** does to a **patient's healthy cells**



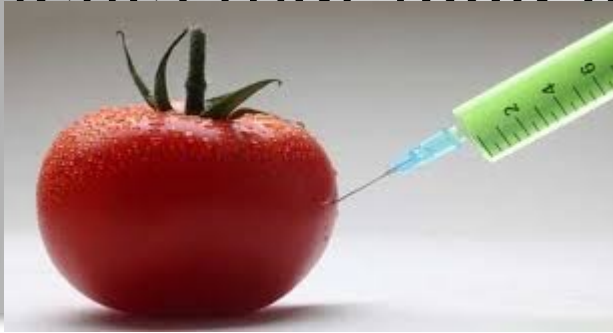
Applications of Nanotechnology in Electronics

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



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,** and even



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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 more hardware



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, or derivatives thereof, 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

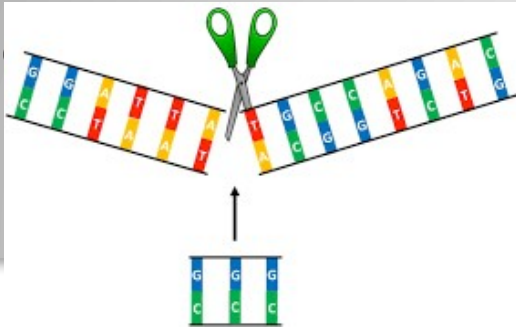
use of yeast (= living organism) to produce the product



Biotechnology

The agriculturalist Karl Ereky (who coined the term Biotechnology) described it as

all lines of **work** by which **products are produced from raw materials with the aid of living organisms**



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**



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

Application of biotechnology: Environment

Environmental engineers use **bioremediation**, the broadest application of environmental biotechnology, in two basic ways

- They introduce nutrients to stimulate the activity of bacteria already present in the soil at a waste site or add new bacteria to the soil

- The bacteria digest the waste at the site and turn it into harmless byproducts

- After the bacteria consume the waste materials, they die off or return to their normal population levels in the environment

Blockchain technology

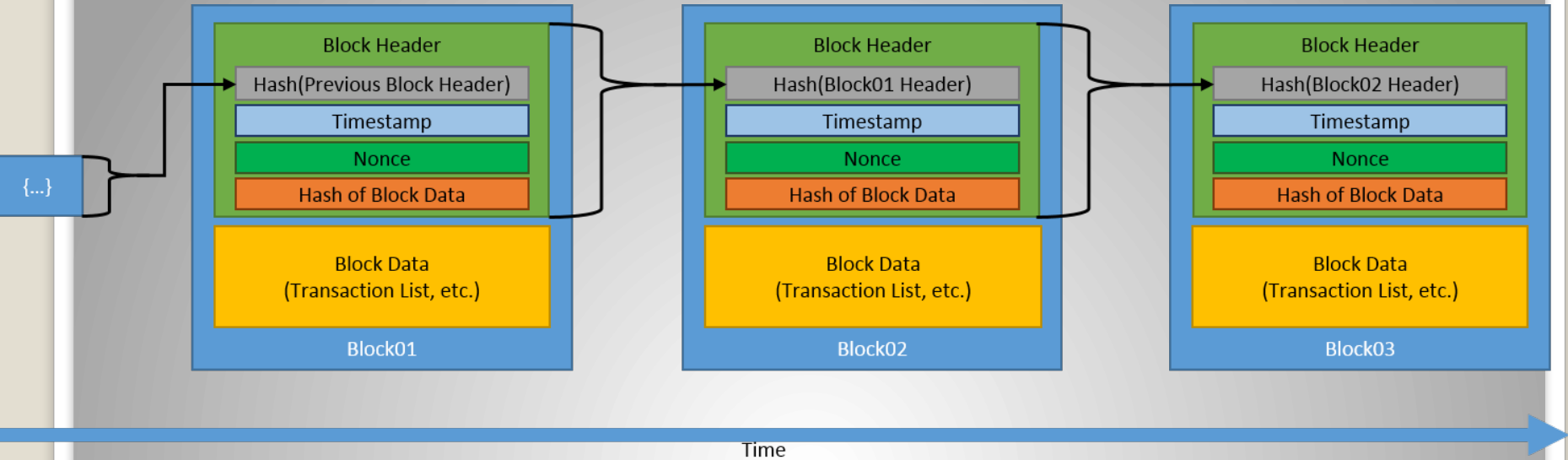
Blockchain is a growing list of records, called blocks, that are linked using cryptography

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

A **blockchain** is, in the simplest of terms, 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)

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”
3. 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

Let's see how blockchain is already decelerating the 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 block timestamping of a date and lo



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

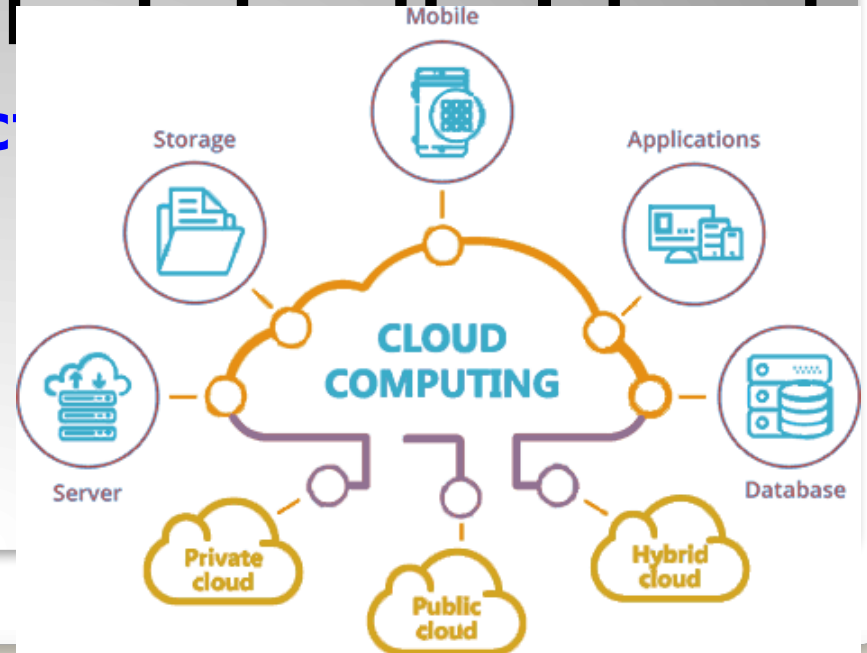
Cloud computing is a **means of networking remote servers that are**

Types of cloud infrastructure

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 in a data center, or through a third party



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

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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 **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 **quantum bits**

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
to **automate tasks that a**
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

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

How computer vision works

Understanding the image

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

Types of computer vision

Image segmentation

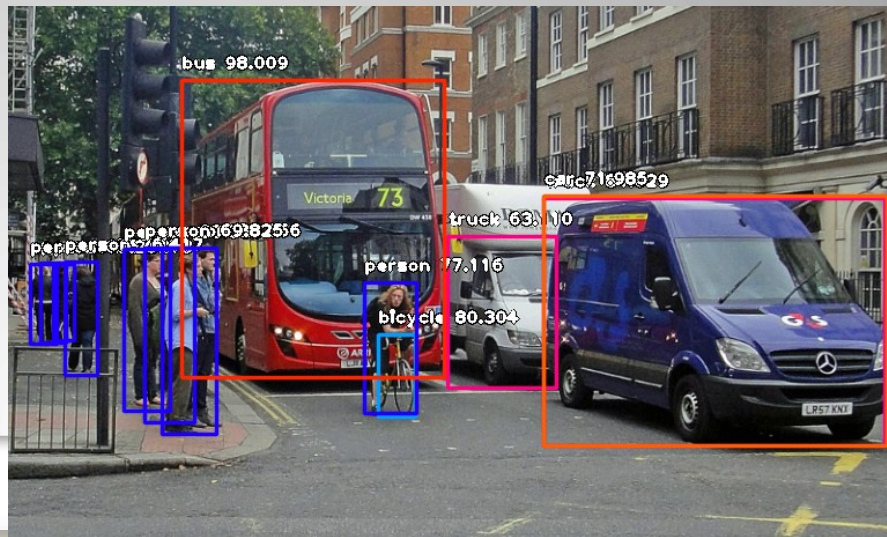
partitions an image into multiple regions or pieces to be examined



Types of computer vision

Object detection

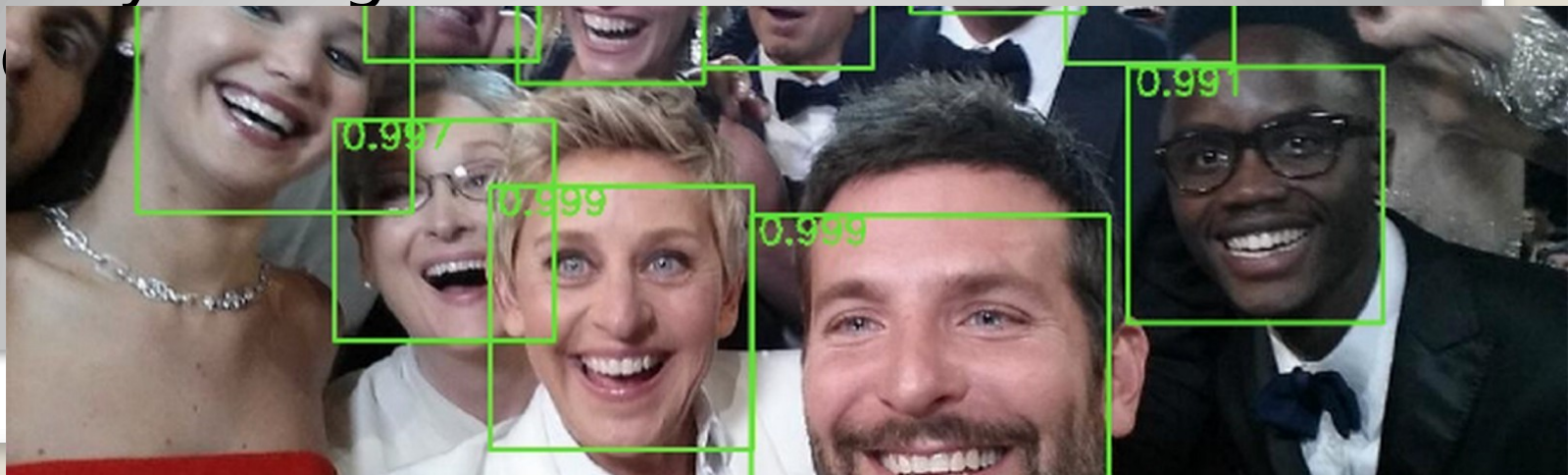
identifies a specific object in an image



Types of computer vision

Facial recognition

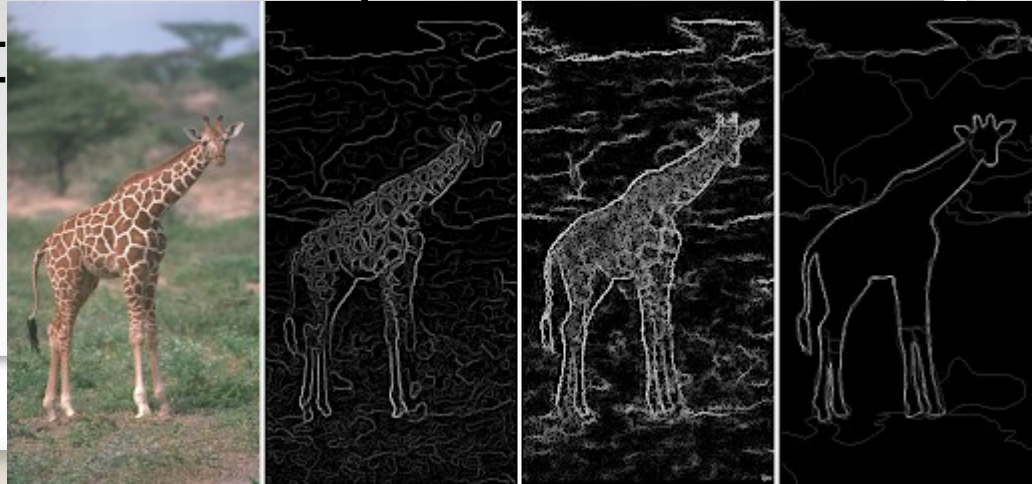
is an advanced type of object detection that not only recognizes a human face in an image



Types of computer vision

Edge detection

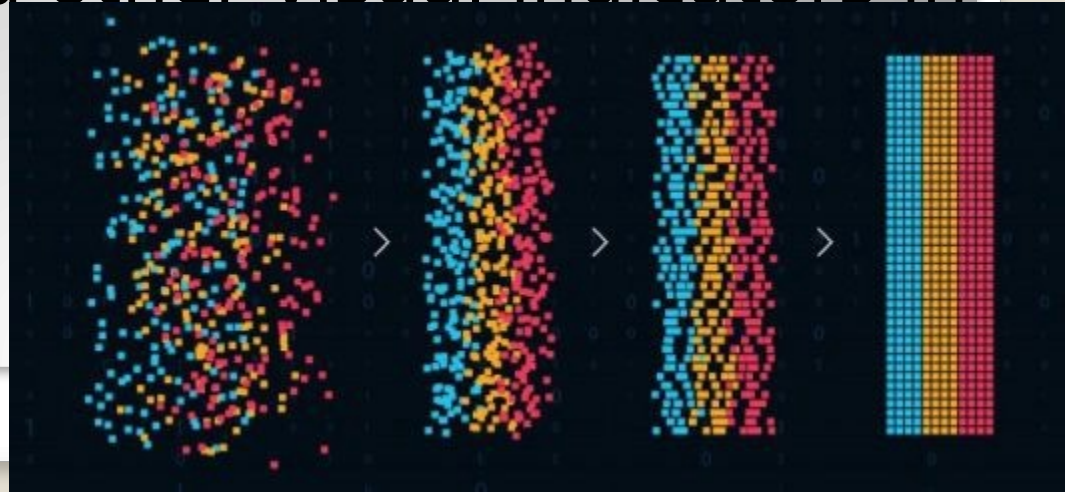
is a technique used to identify the outside edge of an object or landscape to better identify what is in t



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

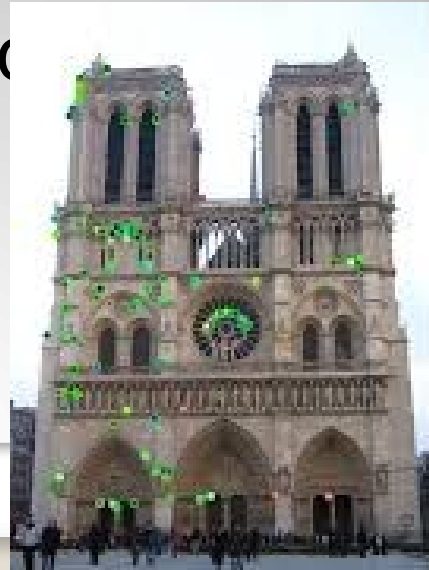
groups images into different categories



Types of computer vision

Feature matching

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



Applications of computer vision

Optical character recognition (OCR)

reading handwritten postal codes on letters, automatic number plate recognition (ANPR), Automatic Braille Recognition (ABR)



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 u
X-ray vision



Applications of computer vision

Retail

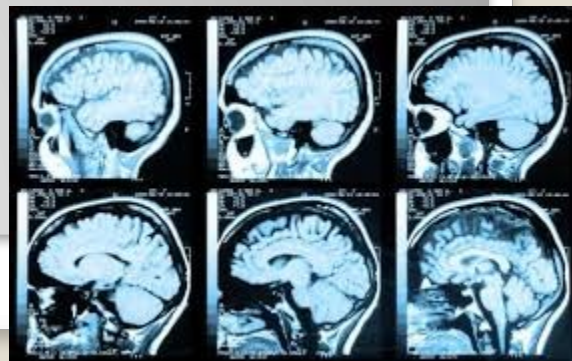
object recognition for automated checkout lanes



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

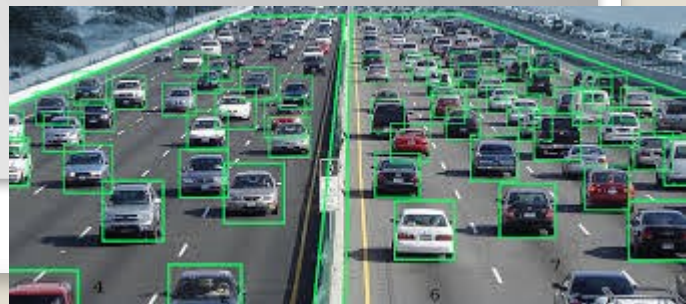
detecting unexpected obstacles such as pedestrians on the street, under conditions where active vision techniques such as radar or lidar do not work well



Applications of computer vision

Surveillance

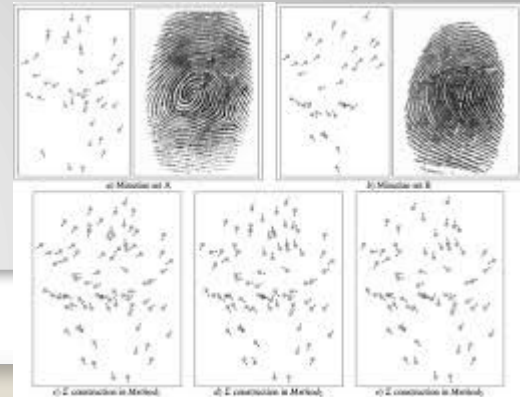
monitoring for intruders, analyzing highway traffic, and monitoring pools for drowning victims



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



Cybersecurity

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

Cybersecurity measures

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

Cybersecurity measures

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

Cybersecurity measures

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

Types of cybersecurity threats

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

End of Chapter 7 & The Course
Good Luck