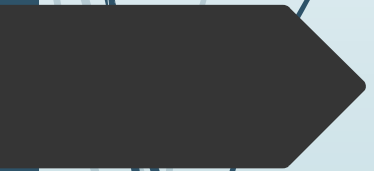


# Emerging issues in computer Science

## Week One: Introduction to Emerging issues in Computer Science

Lecturer: Ikwap Flavia Agatha





## Learning Out come

- At the End of Lecture one you will be able to:
- Define a computer
- Define computer science
- Define Trends
- You will be able to comprehend the history of computer science innovations
- You will be able to have an over view of the different technological trends
- Understand the application of different technologies
- Understand the benefits and limitations of the computer science technologies



## ► Introduction to emerging trends in Computer Science

### ► What is Computer?

A computer is an electronic device used to store retrieve and manipulate data.

A computer can also be defined as a programmable electromechanical device that accept instruction (program) to direct the operations of the computers.

### ► What is Computer Science?

Computer science is the study of processes that interact with data and that can be represented as data in the form of programs. It enables the use of algorithms to manipulate, store, and communicate digital information.



## ► What is a trend?

A **trend** refers to a course or pattern in which something is developing, changing, or moving over time. Trends happen in different settings and contexts like fashion, technology, economics, social behaviors, or culture. They portray shifts or tendencies that influence a group of people, industries, or societies over a period.

**Technology trends** involve innovations or advancements in technology, like the rise of smartphones or artificial intelligence.

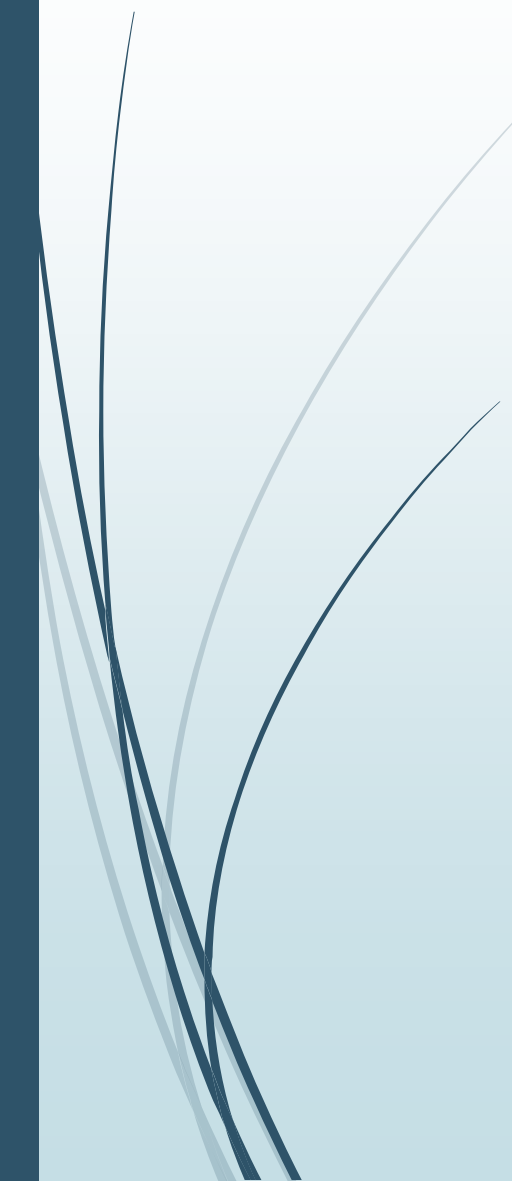


# Introduction to emerging trends in Computer Science

- ▶ Over the years the field of computer science has experienced new innovations which has resulted in to the development and implementation of new technologies and systems, greatly improving existing solutions, create new opportunities, and solve problems in a more efficient or effective ways. It involves the use of technology to drive advancements, enhance business operations, improve user experiences, or transform industries.
- ▶ **History of Computer Science Innovations**
- ▶ Computer science has experienced a journey of great discoveries thereby fostering breakthroughs that have transformed society



## Early Foundations (Pre-20th Century)

- Abacus (c. 2400 BC): One of the earliest known computing device, used for basic arithmetic operations. Kick started a trail for future innovations.
  - Charles Babbage's Analytical Engine (1837): regarded as the "father of the computer," Charles Babbage designed the Analytical Engine, a mechanical device that functioned like modern computer, it had components such as a control unit, memory, and arithmetic logic unit (ALU).
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# Computer Generations

## First Generation of Computer (1937 – 1946):

- In 1937 the first electronic digital computer was built by *Dr. John V. Atanasoff* and *Clifford Berry*. It was called the Atanasoff-Berry Computer (ABC). In 1943 an electronic computer name the Colossus was built for the military. Other developments continued until in 1946 the first general– purpose digital computer, the Electronic Numerical Integrator and Calculator (ENIAC) was built. It had 18,000 vacuum tubes which was used for processing.

- **Characteristics:**

Sizes of these computers were as large as the size of a room.

Used of Vacuum Tubes to perform calculation.

They used an internally stored instruction called program.

# Characteristics and Examples of computers in the First Generation

Use capacitors to store binary data and information.

They use punched card for communication of input and output data and information

They generated a lot of heat.

They have about One Thousand 1000 circuits per cubic foot.

## Examples

- Mark I developed by Aiken in 1944.
- Electronic Numerical Integrator and Calculator (ENIAC) built at the Moore School for Engineering of the University of Pennsylvania in 1946 by *J. Presper Eckert and William Mauchley.*
- Electronic Discrete Variable Automatic Computer (EDVAC) also developed in 1947 by *Eckert and Mauchley.*

## Second Generation of Computer (1947 – 1962):

- Second generation of computers used transistors instead of vacuum tubes which were more reliable. In 1951 the first computer for commercial use was introduced to the public; the Universal Automatic Computer (UNIVAC 1). In 1953 the International Business Machine (IBM) 650 and 700 series were introduced. During this generation of computers over 100 computer programming languages were developed, computers had memory and operating systems. Storage media such as tape and disk were in use also were printers for output.
- **Characteristics:**
  - The computers were still large, but smaller than the first generation of computers.
  - They used a transistor in place of Vacuum Tubes to perform calculations.
  - They were produced at a reduced cost compared to the first generation of computers.



## Characteristics and examples

- Used magnetic tapes for data storage.
- They were using punch cards as input and output of data and information.
- They have about one thousand circuits per cubic foot.
- **Example:**
- Leprechaun, IBM built by Bell Laboratories in 1947
- Transis produced by philco, GE and RCA.
- UNIVAC 1107, UNIVAC III.
- RCA 501.
- IBM 7030 stretch.

## Third Generation of Computer (1963 – 1975):

- The invention of integrated circuit introduced the third generation of computers. With this invention computers became smaller, more powerful more reliable and they are able to run many different programs at the same time.
- **Characteristics:**
- They used large-scale integrated circuits, which were used for both data processing and storage.
- Keyboard and mouse were used for input while the monitor was used as output device.
- Use of programming language like COBOL and FORTRAN were developed.
- They have hundred thousand circuits per cubic foot.
- **Examples:**
- Burroughs 6700, Mini computers
- Honeywell 200
- IBM system 360
- UNIVAC 9000 series.

## Fourth Generation of Computer (PC 1975 – Current)

- **Personal computers took a center stage in this generation**, the size of computer was re-divided. This was the time the first Microprocessor was created by Intel. The microprocessor was a very large-scale, that is, VLS integrated circuit which contained thousands of transistors.
- Transistors on one chip were capable performing all the functions of a computer's central processing unit.
- **Characteristics:**
- Possession of microprocessor which performs all the task of a computer system use today.
- The size of computers and cost was reduced.
- Increase in speed of computers.
- Very large scale (VLS) integrated circuits were used.
- They have millions of circuits per cubic foot.



## Examples:

- ▶ IBM system 3090, IBM RISC6000, IBM RT.
- ▶ ILLIAC IV.
- ▶ Cray 2 XMP.
- ▶ HP 9000.
- ▶ Apple Computers.

## Fifth Generation of Computers (Present and Beyond)

- Fifth generations computing devices, based on artificial intelligence (AI) are still in development, although there are some application such as voice recognition, facial face detector and thumb print that are used today.
- **Characteristics:**
- Consist of extremely large scale integration.
- Parallel processing
- Possession of high speed logic and memory chip.
- High performance, micro-miniaturization.
- Ability of computers to mimic human intelligence, e.g. voice recognition, facial face detector, thumb print.
- Satellite links, virtual reality.
- They have billions of circuits per cubic and large storage.
- **Examples:**
- Super computers, Robots, Facial face detector, Thumb print.

## The Start of Programming (1950s-1960s)

- In the start programming was done using machine or low-level languages, Later, high-level languages were developed, which made programming simpler since these high-level languages were simple to understand, less portable and required less memory, one of the first programming language was Fortran created to simplify programming for scientific calculations. The invention of Computers like UNIVAC, allowed programs to be stored in memory and executed, providing greater flexibility.
- LISP: was one of the oldest high-level programming languages, developed to support in artificial intelligence

## Networking (1970s-1980s)

- The Internet's Origins (1960s-1980s): Early networking technologies like ARPANET (1969) laid the foundation for the modern Internet. ARPANET connected several research institutions and evolved into what we now know as the internet. The penetration of the Internet into the commercial phase (1984-1989), facilitated by the upgrading of backbone links, the writing of new software programs and the growing number of interconnected international networks; the massive expansion of the Internet into a global network happened during the 1990s when business and personal computers with different operating systems joined the universal network.

## The Growth of Software and the Internet (1990s-2000s)

- **The World Wide Web (1991):** Tim Berners-Lee created the World Wide Web, enabling global access to information.
- **The Emergence of Web Browsers:** Web browsers made the internet more accessible and user-friendly, with Mosaic (1993) and Netscape Navigator (1994) being among the earliest browsers.
- **Search Engines for Information Retrieval (1990s):** Search engines like Yahoo! (1994) and Google (1998) played a crucial role in simplifying the process of searching and retrieving information from vast amounts of data.
- **E-commerce and Social Media:** During the 1990s, platforms like Amazon and eBay in e-commerce, and social media networks like Facebook and MySpace, significantly enhanced communication and human interactions.

# The Mobile phones and Cloud Computing (2000s-Present)

- ▶ **Smartphones and Mobile Computing (2000s):** The launch of Apple's iPhone in 2007 was a pivotal moment in mobile computing, further driven by the development of mobile apps and operating systems like iOS and Android.
- ▶ **Cloud Computing (2000s-Present):** The advent of cloud computing has allowed individuals and businesses to move from on-site computing to cloud services provided by companies like Amazon Web Services (AWS) and Microsoft Azure, promoting the growth of technologies such as big data and machine learning.
- ▶ **Social Networks and Big Data (2000s-Present):** The expansion of social media platforms like Facebook, Twitter, and Instagram has led to the collection of large-scale data, sparking the rise of big data analytics.



# Artificial Intelligence and Machine Learning (2010s-Present)

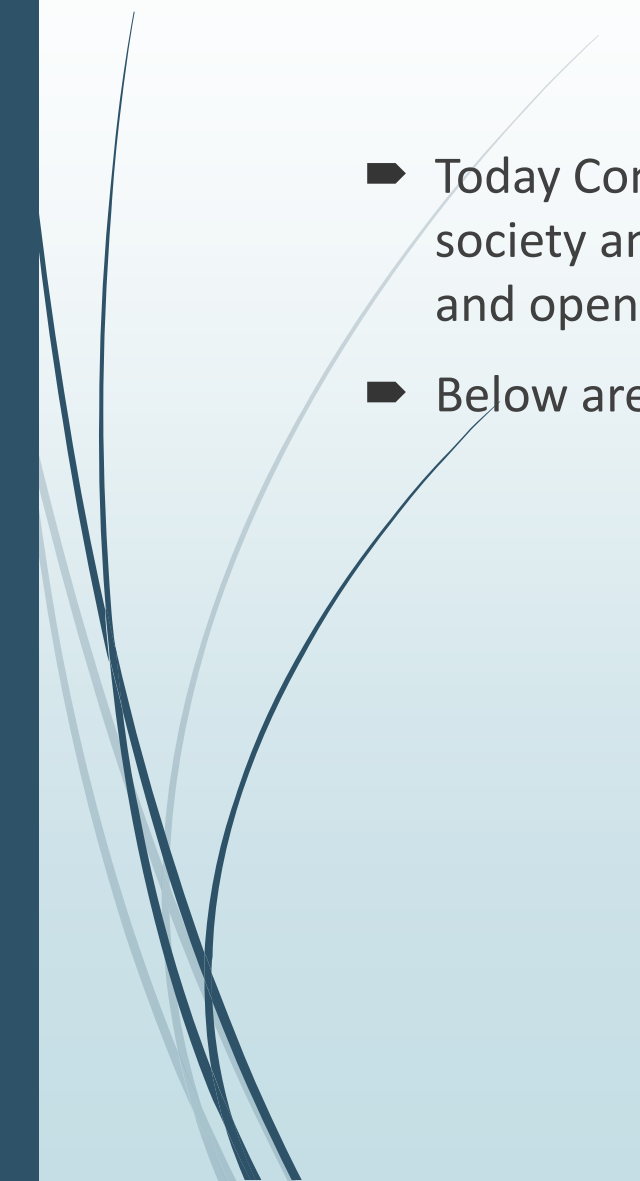
- ▶ **Deep Learning and AI (2010s):** Innovations in AI and machine learning have profoundly transformed operations across various sectors such as healthcare, transportation, education, banking, agriculture, and entertainment. Technologies like natural language processing (NLP) and computer vision have driven major progress in AI applications.

## Technologies (2020s and Beyond)

- ▶ **Quantum Computing:** Although still in its early stages, quantum computing has the potential to address problems in fields like cryptography and drug discovery that traditional computers are unable to solve.
- ▶ **Block\_chain and Cryptocurrency:** Originally popularized by Bitcoin, blockchain technology is now being applied in various other systems, including supply chain management, secure voting systems, and digital identity verification.
- ▶ **Edge Computing and 5G:** As the Internet of Things (IoT) expands and the need for real-time data processing grows, edge computing and 5G technologies are being developed to enable faster, decentralized computing that processes data closer to its source.



## Sectors That Have Adopted Computer Science Innovations

- ▶ Today Computer science innovations have spread and transformed nearly every sector of society and business operations, hence fostering productivity, improving customer experience, and opening new opportunities for growth and development.
  - ▶ Below are key sectors that have widely adopted computer science innovations:
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# Healthcare

- ▶ **Healthcare digitalization** has transformed how people interact with healthcare professionals, enabling quicker decision-making regarding treatments, outcomes, and the sharing of medical data. Electronic Health Records (EHR) and other technological tools are becoming standard practice. EHRs enhance doctors' ability to access and share patient medical histories, with devices like computers and tablets now as common in hospitals as stethoscopes.
- ▶ **Remote Patient Monitoring (RPM)** allows healthcare providers to track patients' conditions even when they are not physically present.
- ▶ **Artificial Intelligence (AI)** is also playing a significant role in healthcare, with machine learning being utilized to analyze patient data.
- ▶ **Wearables** like smartwatches and fitness trackers (e.g., Apple Watch, Fitbit) help monitor health metrics such as heart rate, sleep, and physical activity, providing essential data for preventive care.

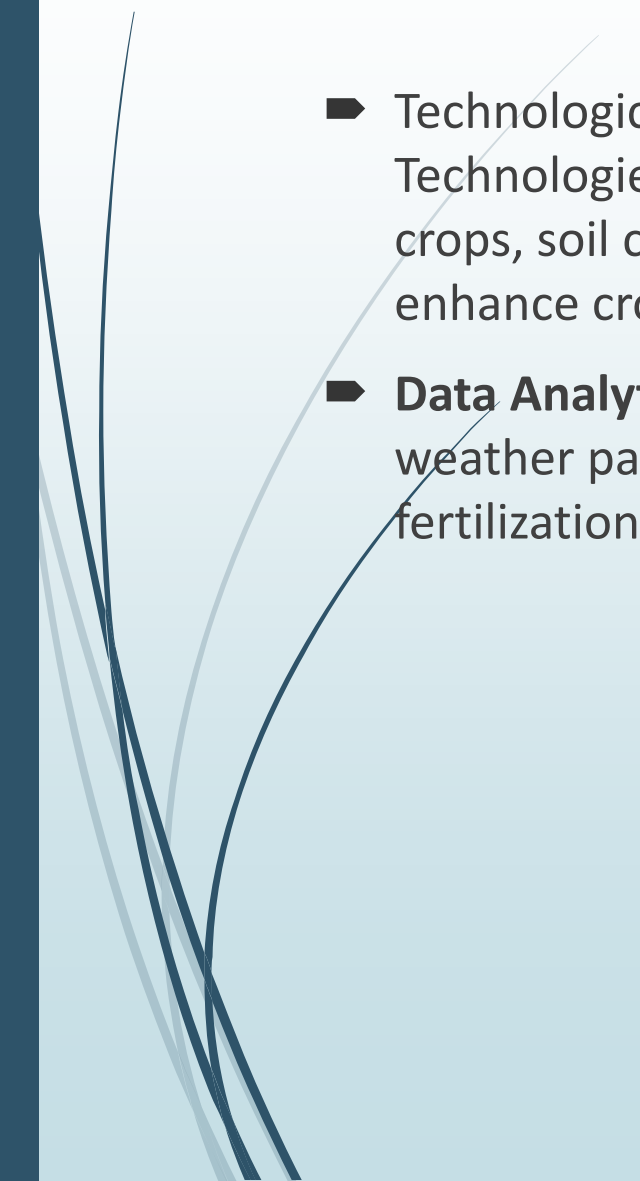


# Education

- ▶ **E-Learning Platforms:** Platforms such as Moodle, Blackboard, Khan Academy, and video conferencing tools have revolutionized education, transitioning from traditional classrooms to virtual environments, making learning more convenient and accessible.
- ▶ **Artificial Intelligence in Learning:** AI-powered systems adjust to the learner's pace, offering tailored learning experiences and delivering immediate feedback.
- ▶ **Smart Classrooms:** **IoT-integrated smart classrooms, equipped with interactive whiteboards, projectors, and sensors, create engaging and effective learning spaces.**




# Agriculture

- ▶ Technological advancements in agriculture are considered a crucial way to combat poverty. Technologies such as IoT devices, drones, and satellite imaging are employed to monitor crops, soil conditions, and weather patterns, enabling farmers to optimize resources and enhance crop production.
  - ▶ **Data Analytics:** Farmers are leveraging large agricultural data sets to analyze and forecast weather patterns, predict crop yields, and make better decisions regarding irrigation and fertilization.
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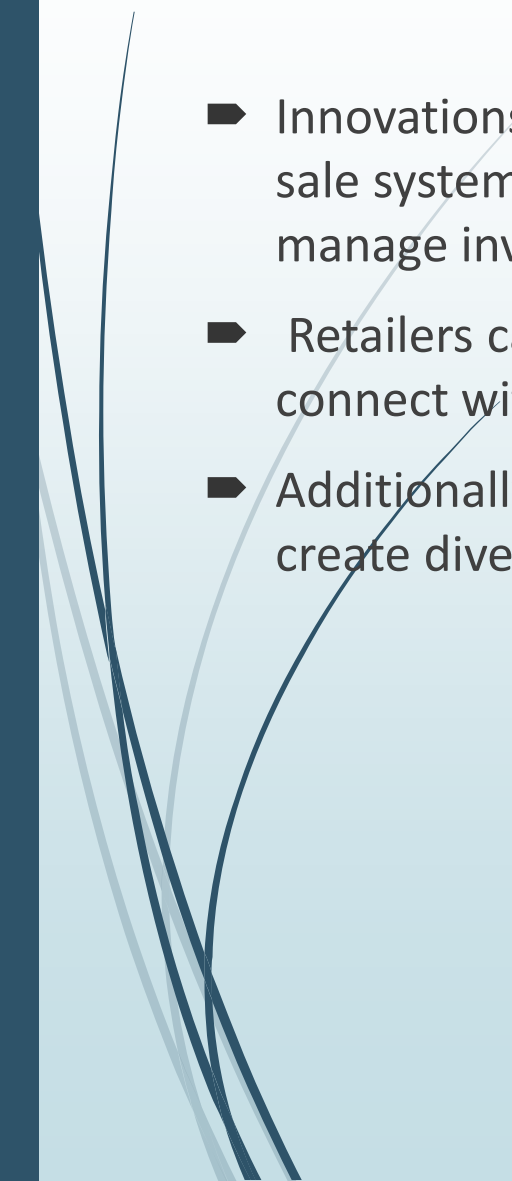


## Retail and E-Commerce

- **Online Shopping:** E-commerce platforms like Amazon, eBay, and Alibaba have greatly improved the shopping experience, offering customers the flexibility to shop at any time and from any location.
  - **Personalized Marketing:** AI and big data analytics allow retailers to develop tailored marketing campaigns, targeting consumers based on their browsing patterns, preferences, and purchasing habits.
  - **Payment Solutions:** The integration of cryptocurrencies and mobile wallets (e.g., Apple Pay, Google Pay) provides secure, cashless payment methods, making transactions easier for both customers and merchants.
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## Retail business

- ▶ Innovations in computer science have driven significant progress in the retail industry: Point of sale systems are now integrated with databases, enabling retailers to monitor sales in real time, manage inventory, and process payments all at once.
  - ▶ Retailers can also leverage ICT tools such as social media, email marketing, and targeted ads to connect with customers.
  - ▶ Additionally, digital advancements allow retailers to analyse data, track customer behaviour, and create diverse marketing strategies, leading to more successful campaigns.
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## Transportation and Logistics

- ▶ **Automated Booking Systems:** Automated booking platforms have made travel planning more convenient for clients. Additionally, sensors are being utilized in self-driving cars, trucks, and drones, revolutionizing the transportation and delivery industries.
- ▶ **Smart Traffic Systems:** Smart traffic systems have significantly helped reduce congestion in busy cities, enhancing urban mobility.
- ▶ **Fleet Management:** IoT and GPS technologies enable real-time tracking of delivery trucks and fleets, optimizing route planning, improving fuel efficiency, and boosting customer satisfaction.




## Banking and Finance

- ▶ Online banking: Mobile banking applications that enable Payments and banking services outside the banking building e.g., PayPal, school pay, have made financial services more accessible and convenient.
- ▶ **Manufacturing and Industry**
- ▶ IoT for Predictive Maintenance: IoT devices are employed to monitor machinery and equipment, ensuring they remain in optimal condition, minimizing downtime, and boosting operational efficiency.
- ▶ Supply Chain: Innovations such as GPS tracking and automated warehousing have enhanced inventory management, improved data accessibility, and lowered operational costs.



## ► **Energy Sector**

- The energy sector is no exception, having widely embraced computer science innovations and incorporated them into its systems and operations, resulting in to significant improvements in production and service delivery. Technologies such as smart grids rely on IT advancements to efficiently distribute electricity to cities and homes. This is achieved by integrating digital sensors, real-time data analytics, and automation, which optimize electricity flow, detect faults, and minimize power outages.
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# Entertainment

- The entertainment and media industries have embraced the latest advancements in computer science. Technologies such as Virtual Reality (VR) and Augmented Reality (AR) have played a significant role in creating fully interactive environments in video games and simulations, as well as enhancing live experiences like sports broadcasts and interactive ads.
- Various digital tools, including high-definition cameras, editing software, and 3D animation, have become integral to the industry. These tools allow filmmakers, game developers, and musicians to produce high-quality content more efficiently. Programs like Adobe Premiere, Final Cut Pro, and Blender are commonly used for video editing, special effects, and animation.
- Online streaming platforms, such as Netflix and YouTube, heavily rely on technologies to deliver content to millions of users worldwide. These platforms utilize cloud computing, content delivery networks (CDNs), and video compression to stream high-quality media to users on-demand.

## Government and Public Services

- ▶ Almost every nation relies on computer science innovations to effectively govern and manage various branches of government and public projects. The national identification and authentication processes have become highly digitalized, enabling citizens to be identified and access services at different levels. These systems incorporate biometrics, digital signatures, and multi-factor authentication to ensure secure and authorized access to services.
- ▶ In democratic nations, the voting process is essential for electing leaders, and to maintain integrity, transparency, and confidentiality, e-voting systems have proven invaluable. They increase accessibility, particularly for people with disabilities or those living abroad, while also reducing the high costs associated with traditional manual elections.



## ICT at Home

- ▶ ICTs have greatly enhanced comfort in many households, allowing homeowners to manage various systems (such as lighting, temperature, and security) remotely using smartphones, tablets, or voice assistants like Amazon Alexa. Automation can be programmed for tasks like adjusting the thermostat, turning lights on and off, or locking doors at set times.
- ▶ Additionally, household appliances such as refrigerators, washing machines, ovens, and vacuum cleaners are now internet-connected. These "smart appliances" can be controlled remotely and provide features like energy consumption tracking, maintenance alerts, and remote operation.



## Benefits of Computer Science Innovations and Trends

### Supported in Achieving Sustainable Development Goals

- ▶ The rapid growth of technology has significantly contributed to achieving the Sustainable Development Goals (SDGs). These advancements have offered innovative solutions that have addressed various global challenges, promoted sustainable development, and enhanced the quality of life around the world.

- ▶ **Increased Efficiency and Productivity**

The adoption of these technologies has boosted productivity by automating operational processes, improving project management, and saving valuable time that would otherwise be lost due to delays in production and service delivery.



## ► **Cost Savings**

In the long term, organizations can reduce operational costs by adopting technologies such as cloud computing. With cloud computing, the expenses related to managing and maintaining IT infrastructure are handled entirely by the cloud service provider, allowing organizations to focus on their core business activities.

## ► **Improved Customer Experience**

By leveraging technologies such as AI and Machine Learning, businesses can tailor customer interactions by recommending products and services based on personal preferences and browsing history (e.g., Netflix, Amazon). Additionally, e-commerce websites and mobile apps allow customers to browse products, place orders, and make payments online.



## ➤ **Better Decision-Making**

Access to real-time data and the use of predictive tools have enabled organizations to make more informed and proactive, data-driven decisions.

## ➤ **Enhanced Communication and Collaboration**

One of the greatest achievements of communication technologies is its ability to facilitate quick and highly reliable communication. It has also enhanced collaboration through tools like video conferencing (Zoom, Microsoft Teams) and platforms for teamwork (Slack, Google Workspace), allowing teams to work together without physical barriers.



## ► **Access to Data and Information**

IT applications have become a major source of vast amounts of data, generated at high speeds. This data, coming from ERPs, databases, and social media platforms, can now be analyzed by organizations to gain insights into customer behavior, market trends, and operational performance, ultimately aiding in making well-informed decisions.

## ► **Scalability and Flexibility**

Cloud computing services enable clients to pay only for what they use at any given time, with the ability to scale up or down according to demand. This offers greater flexibility and cost-efficiency compared to traditional IT models.



- **Increased Security and Risk Management**

- Advanced security systems such as cryptography, multi-factor authentication, intrusion detection systems, virtual private networks, and access control systems have played a key role in reducing crime rates, creating a safer environment for both businesses and individuals.



## Challenges in Computer Science Innovations

- **Security and Privacy Concerns**

- Many of these technologies are vulnerable to external and internal attacks like Phishing, Social Engineering and SQL injection attacks among so many others, this can lead to data breaches and very huge loses or enterprises. Organizations must invest a lot to curb some of these security risks

- **High Costs of Implementation**

- The adoption of innovations such as biometric systems and smart homes comes with significant costs, requiring organizations and individuals to allocate funds that could have otherwise been used to expand their core business.



- **Skill Shortages**

- These innovations have created a strong demand for skilled professionals, such as cybersecurity and forensics experts, data scientists, and highly trained programmers, making it expensive for organizations to hire and continuously train their IT staff.

- **Integration with old Systems**

- Integrating new systems with old ones can be quite complex, and transitioning entirely from old systems to new ones is even more challenging. This often requires temporarily halting existing procedures and systems, which can incur significant costs.



## ➤ **Ethical Considerations**

- Many technologies have brought about ethical challenges, as AI and machine learning algorithms can inherit biases from the datasets they are trained on, resulting in false positives or misleading information.

## ➤ **Regulatory and Legal Challenges**

- Different countries have distinct laws, regulations, and rules concerning data usage, access, and distribution. Cloud providers also adhere to the regulations of their home countries, which can lead to conflicts when addressing various issues.



## ► **Adoption Barriers**

- Despite significant investments in these technologies, their adoption remains slow in many regions, particularly in developing countries. This is due to several challenges, including inadequate infrastructure, negative attitudes toward technology, limited awareness, and concerns about security and privacy.

## ► **Environmental Impact**

- Waste management remains a significant challenge, as improper disposal of old devices can harm the environment. Additionally, many IT infrastructures consume substantial amounts of energy, and the environmental impact of this energy usage, along with the carbon footprint of large-scale IT operations, is becoming an increasing concern.



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# Next Lecture

- ▶ Artificial Intelligence and Machine Learning
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