

# EMERGING TECHNOLOGIES & SOCIETAL IMPACT

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# The Pace of Change

- Technology is evolving at an unprecedented speed.
- New innovations emerge constantly, transforming how we live, work, and interact.
- Think about:
  - How quickly smartphones became ubiquitous.
  - The recent surge in AI capabilities (e.g., ChatGPT, image generators).
- **Key takeaway:** Staying informed is crucial in this fast-paced digital era.

# What are "Emerging Technologies"

- **Definition:** These are new innovations that are still developing but are expected to have a significant and transformative impact on society, the economy, and our daily lives.
- They often build upon existing technologies but push boundaries in novel ways.
- **Not just gadgets:** They represent new ways of solving problems, creating value, and even defining human experience.

# Key Characteristics of Emerging Technologies

- **Rapid Evolution:** They change quickly, often with exponential growth in capability.
- **Potentially Disruptive:** They can overturn existing industries, business models, and social norms.
- **Wide-Ranging Applications:** Their impact extends across many sectors (healthcare, finance, education, entertainment).
- **Interconnected:** Often, the power of one emerging technology is amplified by its connection to others.
- **Uncertainty:** Their full impact and ethical implications are often still being understood.

# Artificial Intelligence (AI) - The Brain of the Machine

- **What is AI?** The ability of computer systems to perform tasks that typically require human intelligence.
- **Core Idea:** Making machines "smart" enough to learn, reason, problem-solve, perceive, and understand language.
- **It's not magic:** It's built on complex algorithms and vast amounts of data.

# How AI "Thinks" (Simply)

- **Learning from Data:** AI systems are "trained" by feeding them huge datasets. They identify patterns and relationships within this data.
- **Pattern Recognition:** Once trained, they can recognize similar patterns in new, unseen data.
- **Prediction & Action:** Based on these patterns, they can make predictions (e.g., what movie you'll like) or take actions (e.g., steer a car).
- **Analogy:** Imagine teaching a child by showing them many examples, rather than giving explicit instructions for every single possibility.

# Types of AI: From Narrow to Super

- **Artificial Narrow Intelligence (ANI) / Weak AI:**
- Designed for a specific task.
- Most AI we encounter today falls into this category.
- *Examples:* Voice assistants (Siri, Alexa), spam filters, recommendation algorithms, chess-playing computers.

# Types of AI: From Narrow to Super

- **Artificial General Intelligence (AGI) / Strong AI:**
- Hypothetical AI that possesses human-level cognitive abilities across a wide range of tasks.
- Can learn, understand, and apply knowledge flexibly like a human.
- *Currently theoretical.*



# Types of AI: From Narrow to Super

- **Artificial Super Intelligence (ASI):**
- Hypothetical AI that surpasses human intelligence in virtually every field.
- Would be vastly smarter than the best human minds.
- *Purely speculative at this point.*

# AI in Our Daily Life: Examples You Use

- **Voice Assistants:** Siri, Google Assistant, Alexa – helping with reminders, searches, smart home control.
- **Recommendation Systems:** Netflix, Spotify, Amazon – suggesting content or products based on your past behavior.
- **Email Spam Filters:** Automatically identifying and isolating unwanted emails.
- **GPS Navigation:** Real-time traffic updates and optimal route suggestions.
- **Facial Recognition:** Unlocking phones, tagging photos on social media.

# AI's Impact on Healthcare

- **Diagnosis:** Analyzing medical images (X-rays, MRIs) to detect diseases like cancer with high accuracy.
- **Drug Discovery:** Accelerating the research and development of new medicines.
- **Personalized Treatment:** Tailoring treatment plans based on a patient's genetic makeup and medical history.
- **Robotic Surgery:** Assisting surgeons with precision and minimally invasive procedures.

What's one major benefit you see from AI in healthcare? Are there any concerns that come to mind?

# AI in Creative Fields (Generative AI)

- **Generative AI:** A type of AI that can create new, original content.
- **Text Generation:** Writing articles, stories, poems, or even code (e.g., ChatGPT).
- **Image Generation:** Creating realistic or artistic images from text descriptions (e.g., DALL-E, Midjourney).
- **Music Composition:** Generating new melodies and compositions.
- **Challenges:** Ethical questions around originality, copyright, and potential misuse (e.g., deepfakes).

Do you think AI-generated art or music is "real" art? What are the implications for human artists?

# Machine Learning (ML) - AI's Learning Engine

- **ML is a subset of AI.** It's how AI systems learn without being explicitly programmed for every scenario.
- **How it learns:** By analyzing vast amounts of data and identifying patterns.
- **Think of it like:** Teaching a child to recognize a cat by showing them many pictures of cats, rather than giving them a list of rules.
- **Key Idea:** The more data, the "smarter" the ML model can become.

# Types of Machine Learning

- **Supervised Learning:**
- **Concept:** Learning from labeled data (input-output pairs). The AI is given examples of "questions" and their "correct answers."
- **Example:** Training an AI to distinguish between cat and dog images by showing it thousands of labeled pictures of each.
- **Uses:** Image recognition, spam detection, predictive analytics.



# Types of Machine Learning (Cont.)

- **Unsupervised Learning:**
- **Concept:** Finding patterns and structures in unlabeled data. The AI explores the data on its own to find relationships.
- **Example:** Grouping customers into segments based on their purchasing behavior without predefined categories.
- **Uses:** Customer segmentation, anomaly detection, data compression.

# Types of Machine Learning (Cont.)

- **Reinforcement Learning:**
- **Concept:** Learning by trial and error, similar to how humans or animals learn. The AI receives "rewards" for desired actions and "penalties" for undesirable ones.
- **Example:** Training an AI to play a game, where it gets points for winning and loses points for bad moves.
- **Uses:** Robotics, game playing (e.g., AlphaGo), autonomous navigation.

If you had a huge collection of songs without genres, which type of ML could help you group them into similar-sounding categories? Why?

# Big Data - The Fuel for Modern Tech

- Extremely large datasets that can be analyzed computationally to reveal patterns, trends, and associations.
- **Where does it come from?**
  - Social media activity
  - Online transactions
  - Sensors (like in smart devices)
  - Scientific research

# The Importance of Big Data

- **Enhanced Decision-Making:** Provides a more complete picture for informed choices.
- **Personalization:** Enables customized experiences (e.g., marketing, education).
- **Innovation:** Fuels new products, services, and business models.
- **Problem Solving:** Helps identify and address complex issues (e.g., disease outbreaks, climate patterns).
- **Example:** Retailers using purchase data to predict trends and optimize inventory.

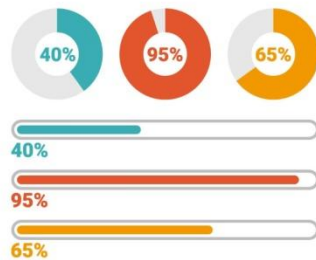
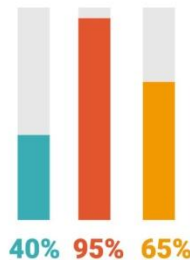
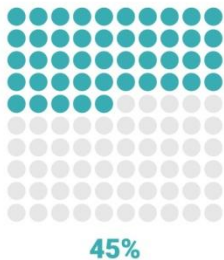
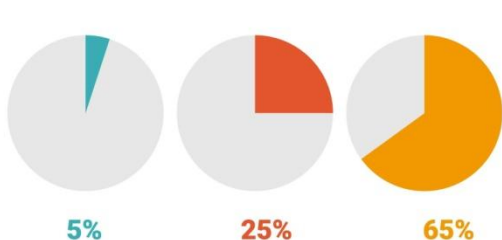
# 5 Vs in Big Data

- **Volume:** Enormous quantities of data.
- **Velocity:** Data generated and processed at high speed (real-time).
- **Variety:** Data comes in many forms (structured, unstructured, text, images, video).
- **Veracity:** The quality and accuracy of the data.
- **Value:** The insights and benefits derived from the data.

Give me some sources of "big data" that impacts your life?

# Data Visualization

## PERCENTAGES DATA VISUALIZATION





# Internet of Things (IoT) - Connecting the Physical World

- **Definition:** A vast network of physical objects ("things") embedded with sensors, software, and other technologies that allow them to connect and exchange data over the internet.
- **The "Things" Can Be Anything:** From smart home appliances and cars to industrial machinery and even agricultural sensors.
- **Goal:** To make everyday objects "smart" and interactive, collecting data and automating tasks.

# How IoT Works: Simple Components

1. **Sensors:** Collect data from the environment (temperature, light, motion, pressure, location).
2. **Connectivity:** Devices transmit data via Wi-Fi, Bluetooth, cellular, etc.
3. **Cloud Processing:** Data is sent to the cloud (internet servers) for storage and analysis.
4. **User Interface/Application:** Users interact with the data and control devices via apps on their smartphones or computers.
5. **Actuators:** Devices that can perform actions based on received commands (e.g., turning off a light).

# IoT in Action: Use Cases

- **Smart Homes:** Automated lighting, smart thermostats, security cameras, smart appliances.
- **Wearable Technology:** Fitness trackers, smartwatches monitoring health data.
- **Smart Cities:** Managing traffic, monitoring air quality, optimizing waste collection.
- **Industrial IoT (IIoT):** Sensors on factory equipment for predictive maintenance, optimizing production lines.
- **Healthcare:** Remote patient monitoring, smart hospitals.

# The Fourth Industrial Revolution (4IR) - A Deeper Dive

- **Historical Context:**
  - **1st IR:** Steam power, mechanization (late 1700s).
  - **2nd IR:** Electricity, mass production (late 1800s).
  - **3rd IR:** Electronics, IT, automation (mid-1900s - Digital Revolution).
- **4IR (Current Era):** Building on the 3rd IR, it's characterized by a **fusion of technologies** blurring the lines between the physical, digital, and biological spheres.
- **Core Idea:** Intelligent, interconnected systems that can communicate, analyze, and act with minimal human intervention.

# Key Pillars of 4IR

- **Cyber-Physical Systems (CPS):** Integration of computation, networking, and physical processes (e.g., smart factories).
- **Internet of Things (IoT):** Ubiquitous connectivity of devices.
- **Artificial Intelligence (AI) & Machine Learning (ML):** Intelligent automation and decision-making.
- **Big Data & Analytics:** Extracting insights from massive datasets.
- **Other enabling technologies:** Robotics, Additive Manufacturing (3D printing), Blockchain, Augmented Reality (AR) & Virtual Reality (VR), Quantum Computing.

# Societal Impact: Ethical Considerations - Privacy

- **The Challenge:** Massive data collection by AI and IoT devices raises significant privacy concerns.
- **Who owns your data?** You, the company, or both?
- **What data is being collected?** Location, health, spending habits, online behavior.
- **Risks:** Data breaches, unauthorized sharing, misuse of personal information, surveillance.
- **Thinking Point:** How much privacy are we willing to trade for convenience or personalized services?

# Societal Impact: Ethical Considerations - Bias & Fairness

- **Source of Bias:** AI systems learn from data, and if the data reflects existing societal biases (e.g., historical discrimination, underrepresentation), the AI can reproduce or even amplify those biases.
- **Consequences:**
  - Discriminatory outcomes in hiring, lending, or criminal justice.
  - Unfair treatment based on demographics.
- **Importance:** Developing "fair" AI requires careful data curation, transparent algorithms, and diverse development teams.

# Societal Impact: Ethical Considerations - Automation & Jobs

- **The Transformation of Work:** While some jobs will be automated (especially repetitive or manual tasks), new jobs will also emerge.
- **Skills Shift:** There will be a greater demand for skills that complement AI and automation (e.g., creativity, critical thinking, problem-solving, emotional intelligence, technology management).
- **The Need for Reskilling & Upskilling:** Lifelong learning becomes critical for individuals and workforces to adapt.
- **Policy Challenges:** How do societies support workers through this transition (e.g., retraining programs, social safety nets)?



What skills do you think will become *more* valuable in a world with increasing automation and AI?

# Societal Impact: Ethical Considerations - The Digital Divide

- **Definition:** The gap between those who have access to information and communication technologies (ICTs) and those who do not.
- **Factors:** Socioeconomic status, geographic location (rural vs. urban), age, disability, education level.
- **Consequences:** Limits opportunities for education, employment, healthcare, and civic participation for those on the "wrong side" of the divide.
- **Ethical Imperative:** Ensuring equitable access and digital literacy for all to prevent widening inequalities.

# The Future of Computing: Beyond Current Horizons

- **Neurotechnology & Brain-Computer Interfaces (BCI):** Direct communication pathways between the brain and external devices.
  - *Potential:* Restoring movement for paralyzed individuals, enhancing human capabilities.
- **Digital Twins:** Virtual replicas of physical objects, processes, or systems, constantly updated with real-time data.
  - *Uses:* Virtual Reality (VR), Augmented Reality (AR), Predictive maintenance, simulation, product design.
- **Blockchain Technology:** A decentralized, distributed ledger system that records transactions across many computers, making them secure and transparent.
  - *Beyond Cryptocurrency:* Supply chain management, digital identity, voting systems.

Can you think of any potential ethical concerns that might arise from the development of **Brain-Computer Interfaces (BCI)**?

# Responsible Technology Use - A Call to Action

- **Digital Citizenship:** Being a respectful, responsible, and safe participant in online communities.
- **Critical Thinking & Media Literacy:** Evaluating information critically, identifying misinformation, and understanding digital narratives.
- **Privacy Awareness:** Protecting personal data and understanding online tracking.
- **Ethical Design:** Encouraging developers to build technology with human well-being and societal impact in mind.
- **Mindful Consumption:** Managing screen time, preventing addiction, and promoting digital well-being.