EMERGING TECHNOLOGIES & SOCIAL 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

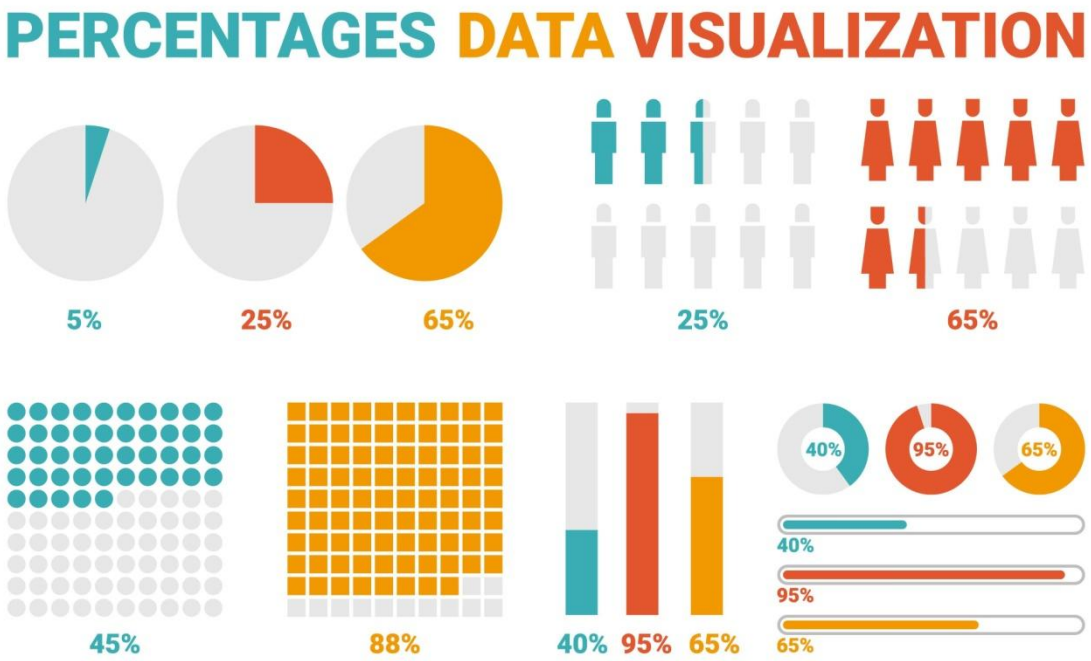
- **Enhanced Decision-Making:** Provides a more complete picture for informed choices.
- **Personalization:** Enables customized experiences (e.g., marketing, education).
- **Innovation:** Fuels new products, services, and business models.
- **Problem Solving:** Helps identify and address complex issues (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



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.