Université Constantine 2
جامعة قسنطينة 2

Artificial Vision

– Course 1 –

Chapter 1 : INTRODUCTION TO ARTIFICIAL VISION (1/1)

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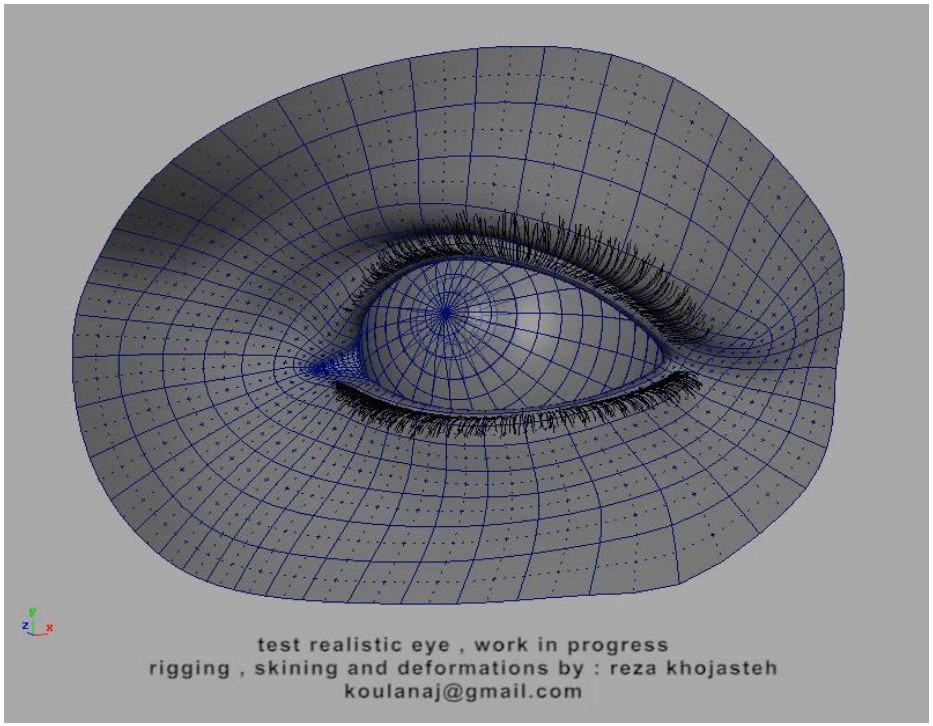
Etudiants concernés

Faculté/Institut	Département	Niveau	Spécialité
Nouvelles technologies	/	Master 2	Sciences de Données et Intelligence Artificielle (SDIA)

Summary

Prerequisites

- Mathematical Notions
- Algorithmic Notions



Course Objective

- A look into how machines see the world.

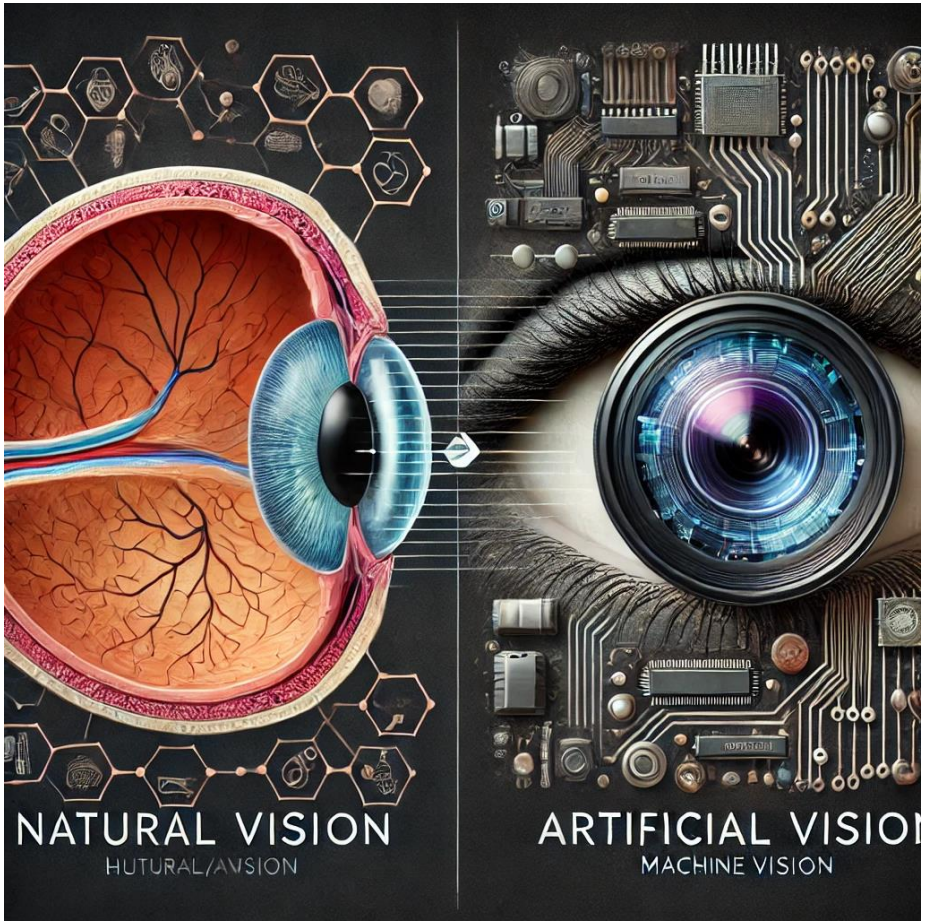
OUTLINE

- ✓ Definition
- ✓ History of Artificial Vision
- ✓ How Artificial Vision Works
  - Step 1: Image Capture (Camera)
  - Step 2: Preprocessing (Filtering, Resizing)
  - Step 3: Feature Extraction (Edges, Corners, Textures)
  - Step 4: Analysis and Interpretation (Classification, Object Detection)
- ✓ Applications of Artificial Vision
  - (exhaustive list of 20 application domains)
  - Self-driving cars
  - Medical imaging (X-ray, MRI)
  - Face recognition
  - Robotics
  - …
- ✓ Key Challenges in Artificial Vision

DEFINITION

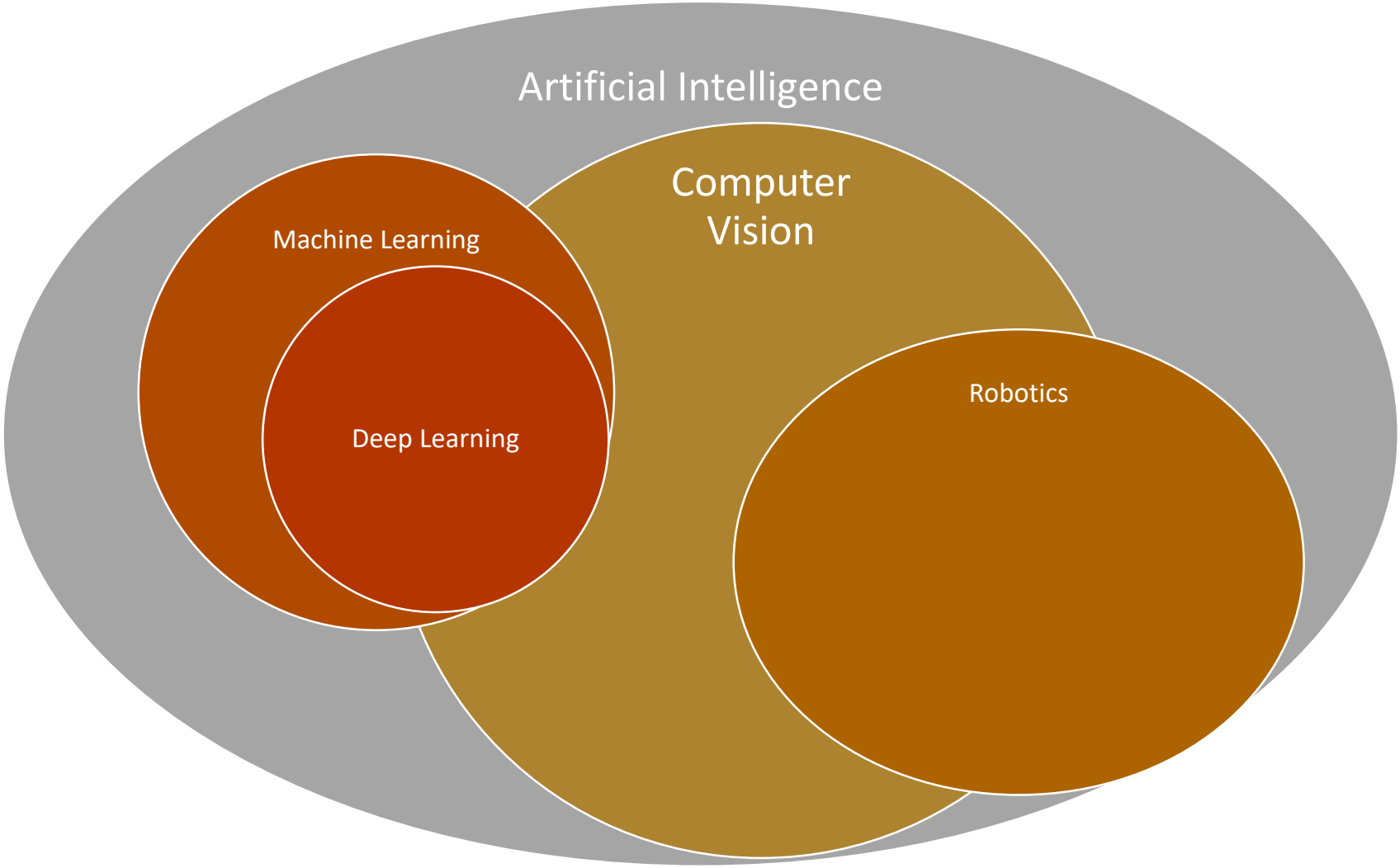
What is Artificial Vision?

Definition: Artificial vision (or computer vision) is a field of artificial intelligence focused on enabling machines to interpret and understand visual information from the world.

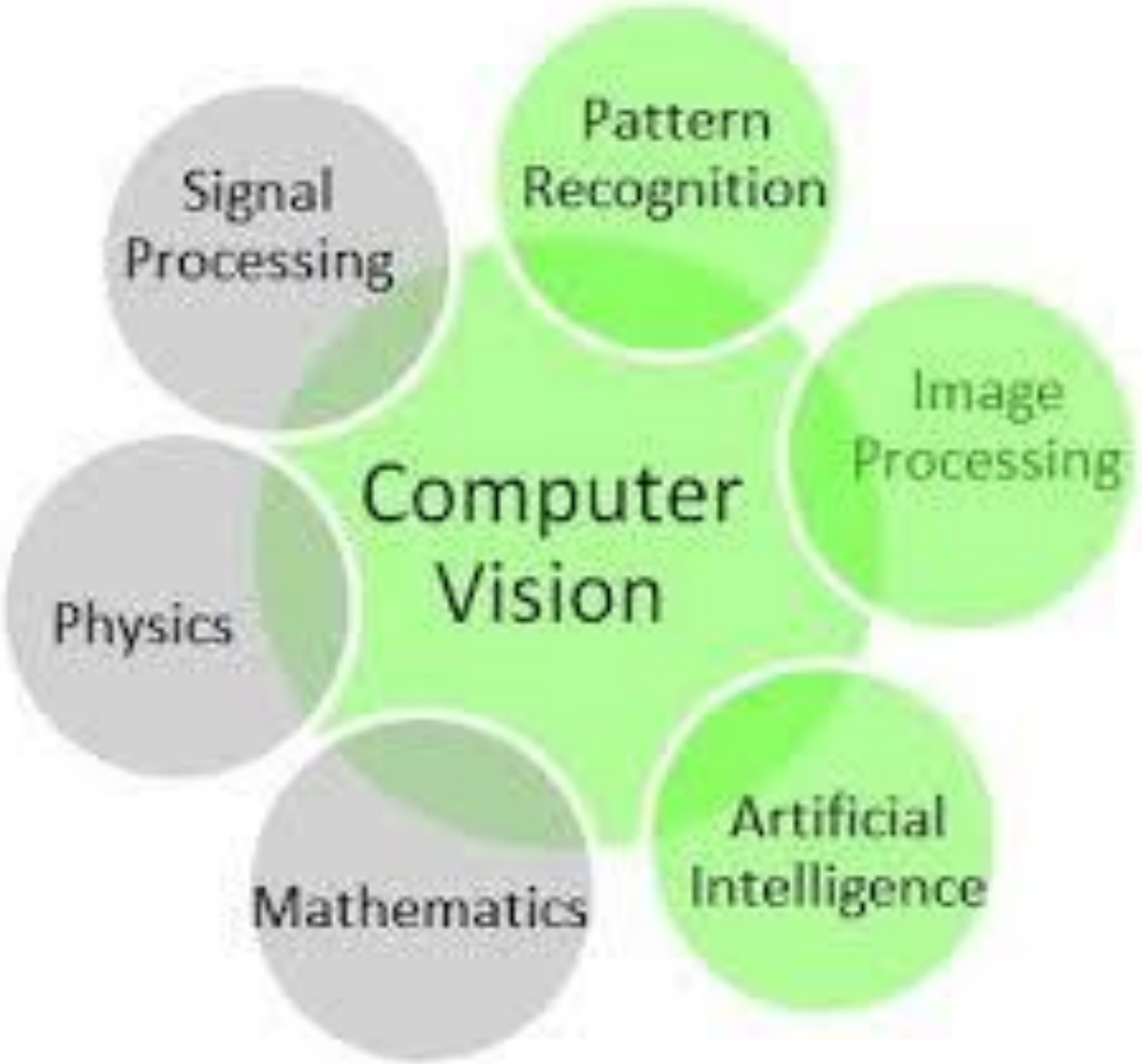


Comparison: Natural vision (human/animal) vs. artificial vision (machine).

DEFINITION


Artificial Intelligence
Computer Vision
Machine Learning
Deep Learning
Robotics

DEFINITION



Section 1 : History

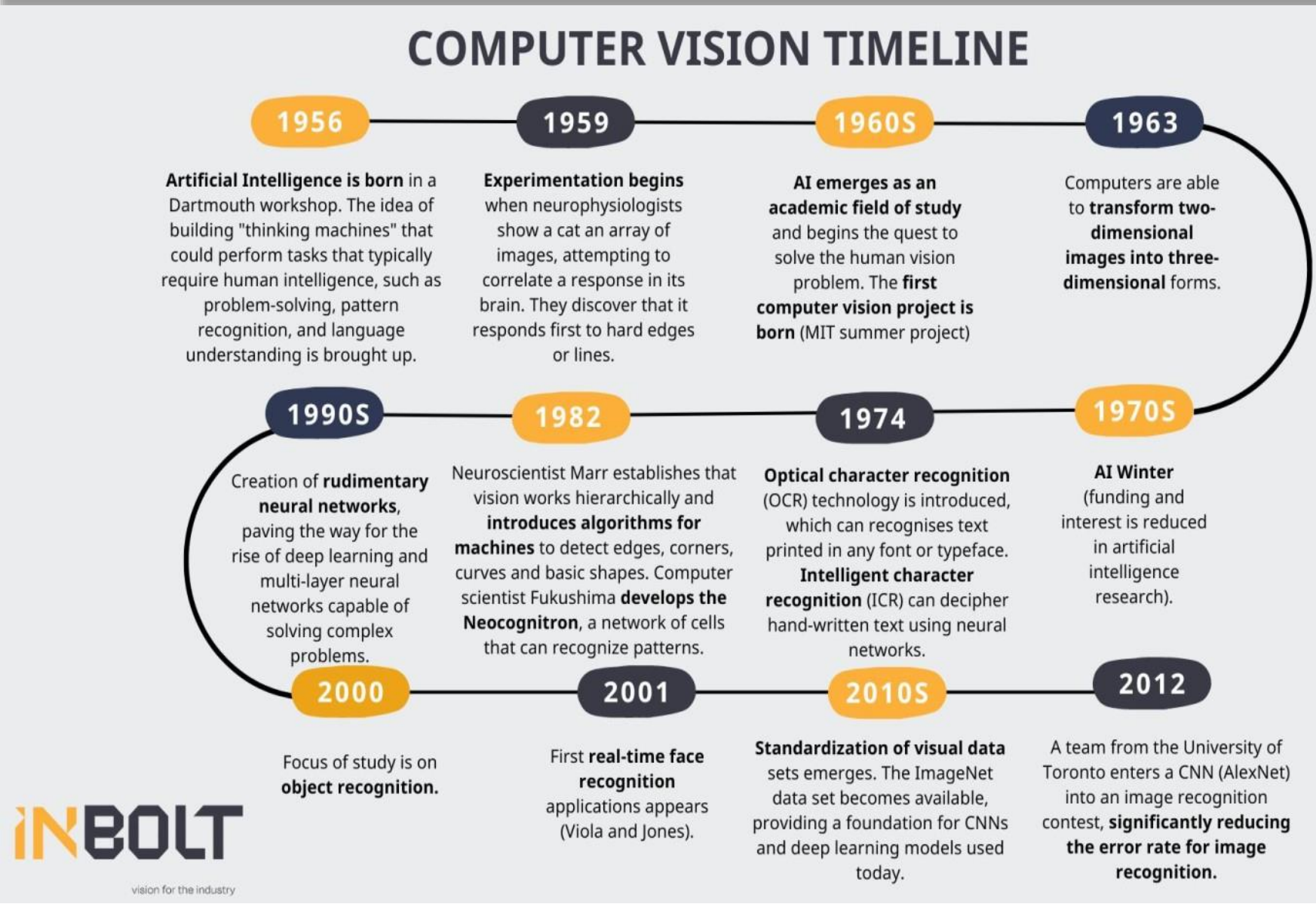
- History of Artificial Vision

Origins in the 1960s, early research in pattern recognition.
Key milestones:
object recognition
image segmentation
machine learning integration.

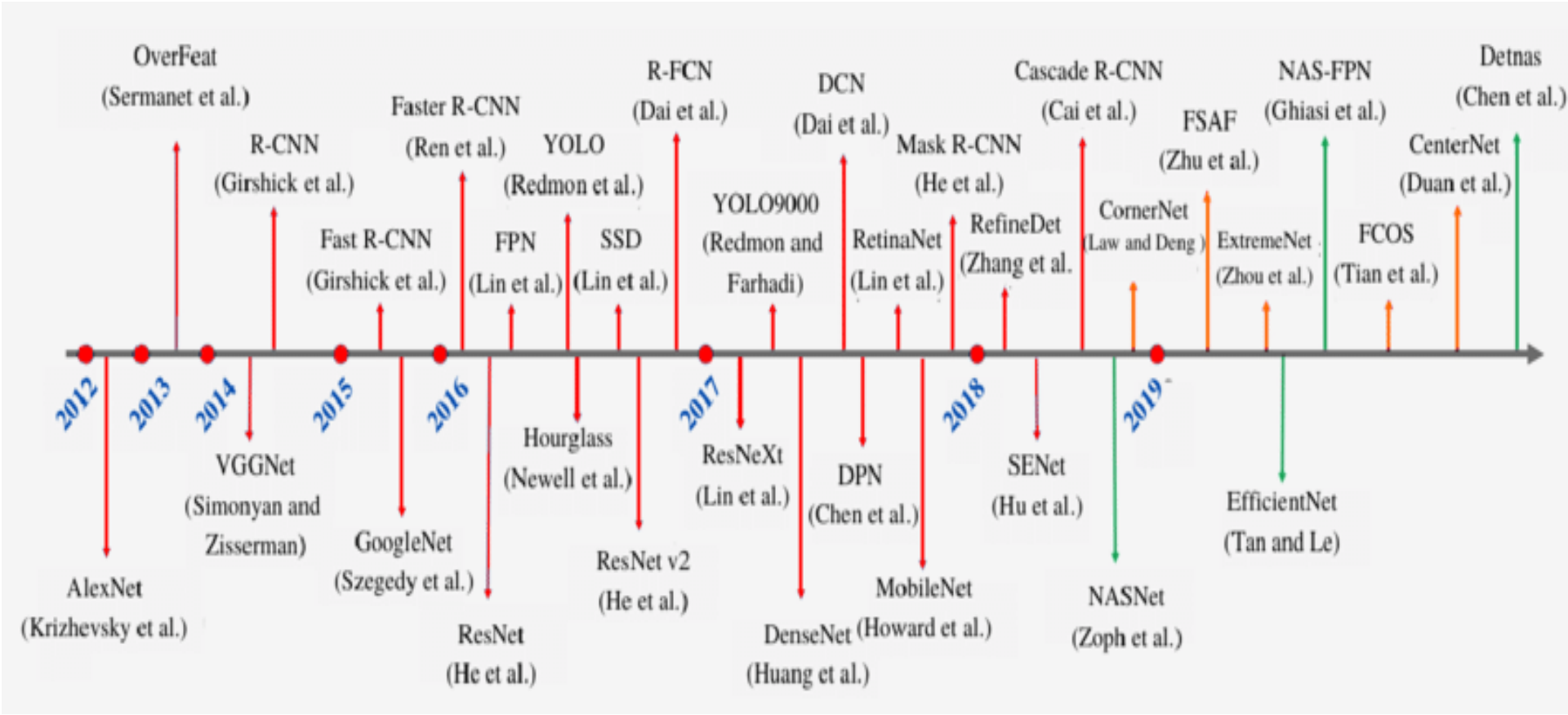
- History of Artificial Vision

Early work focused on simple tasks like edge detection and object recognition, relying on basic pattern recognition and geometry. In the 1970s and 1980s, advancements in image processing allowed for more complex analyses, though limited by computational power. In the 1990s, statistical approaches, especially machine learning, began to enhance object and facial recognition capabilities. The real breakthrough came in the 2010s with the rise of deep learning and neural networks, allowing models to recognize and classify objects with high accuracy by training on vast datasets. Today, artificial vision powers applications across healthcare, autonomous driving, security, and more, evolving rapidly with advances in neural networks and AI.

Timeline of key advancements in computer vision.



Timeline of key advancements in computer vision.



Section 2:
How Artificial Vision Works

How Artificial vision works

Here is a flowchart illustrating the steps involved in artificial vision from **Image Acquisition** to **Recognition**:

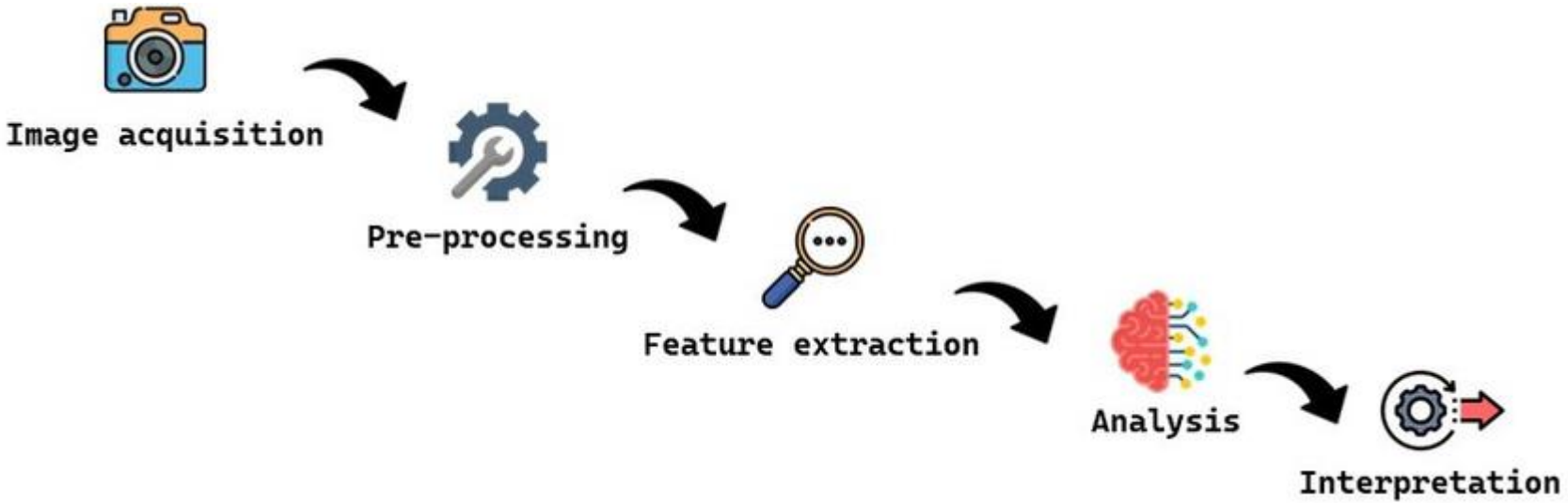
1.Image Acquisition: The process begins with capturing images through sensors or cameras.

2.Preprocessing: The captured image is enhanced by reducing noise and adjusting brightness or contrast for clearer analysis.

3.Feature Extraction: Key features like edges, corners, or textures are detected and extracted for further analysis.

4.Recognition: The system then classifies or identifies objects within the image using algorithms (like machine learning or deep learning).

This flow helps visualize how an image is processed in stages leading up to recognition



Section 3:
AV APPLICATIONS

ARTIFICIAL VISION APPLICATIONS

- 1. Autonomous Vehicles
- Self-driving cars: Detecting pedestrians, lane markers, traffic signals, and other vehicles for autonomous navigation.
- Drones: Object detection and terrain analysis for autonomous flight.
- Robotics: Visual perception in industrial or domestic robots to navigate environments.

ARTIFICIAL VISION APPLICATIONS

- 2. Healthcare & Medicine
- Medical imaging: Analysis of X-rays, MRIs, CT scans, and ultrasound images for diagnostics (e.g., tumor detection, organ segmentation).
- Telemedicine: Remote diagnostics through visual inspections using computer vision.
- Surgical assistance: Augmented reality and image-guided surgery for precision.
- Retinal analysis: Detecting diabetic retinopathy and other eye conditions.

ARTIFICIAL VISION APPLICATIONS

- 4. Security & Surveillance

Product recommendations	Inventory management	Cashier-less stores
Visual search engines where customers upload images to find similar products.	Using cameras and vision systems to track stock levels automatically.	Monitoring customers' actions (e.g., picking items from shelves) for automated billing.

ARTIFICIAL VISION APPLICATIONS

- 3. Retail & E-commerce

Face recognition	Anomaly detection	License plate recognition
Identifying individuals in public spaces, airports, or security checkpoints.	Identifying suspicious activities or security breaches in real-time through video feeds.	Tracking vehicles at tolls or in parking management systems.

ARTIFICIAL VISION APPLICATIONS

- 5. Agriculture
- Precision farming: Monitoring crop health, growth, and soil quality using drones and satellite imagery.
- Harvesting robots: Identifying ripe produce and automating the picking process.
- Livestock monitoring: Detecting health and movement patterns in animals for disease prevention.

ARTIFICIAL VISION APPLICATIONS

- 6. Manufacturing & Industrial
- Quality control: Detecting defects in products during production using automated vision systems.
- Object sorting: Automating the sorting of products or components in factories.
- Robotic guidance: Vision-guided robots to assemble components or inspect machinery.

ARTIFICIAL VISION APPLICATIONS

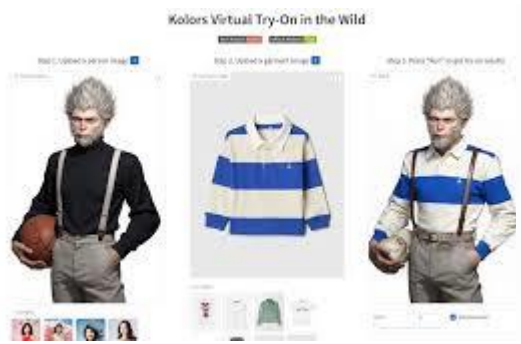
- 7. Education & Research
- Augmented reality learning: Enhancing textbooks and real-world objects with visual overlays for an interactive learning experience.
- Data visualization: Automatically processing images and videos for academic research in various fields.

ARTIFICIAL VISION APPLICATIONS

- 8. Entertainment & Media
- Special effects: Generating and enhancing visual effects for films and video games.
- Gesture recognition: Interfacing with devices using gestures for immersive gaming or virtual reality experiences.
- Image/video search: Content indexing and retrieval for large media databases (e.g., YouTube, Netflix).

ARTIFICIAL VISION APPLICATIONS

- 9. Retail & Fashion
- Virtual try-ons: Letting customers try clothes, accessories, or makeup using augmented reality.
- Style suggestions: Automated outfit recommendations based on personal preferences or uploaded images.
- Fabric defect detection: Identifying flaws in textiles during manufacturing.



ARTIFICIAL VISION APPLICATIONS

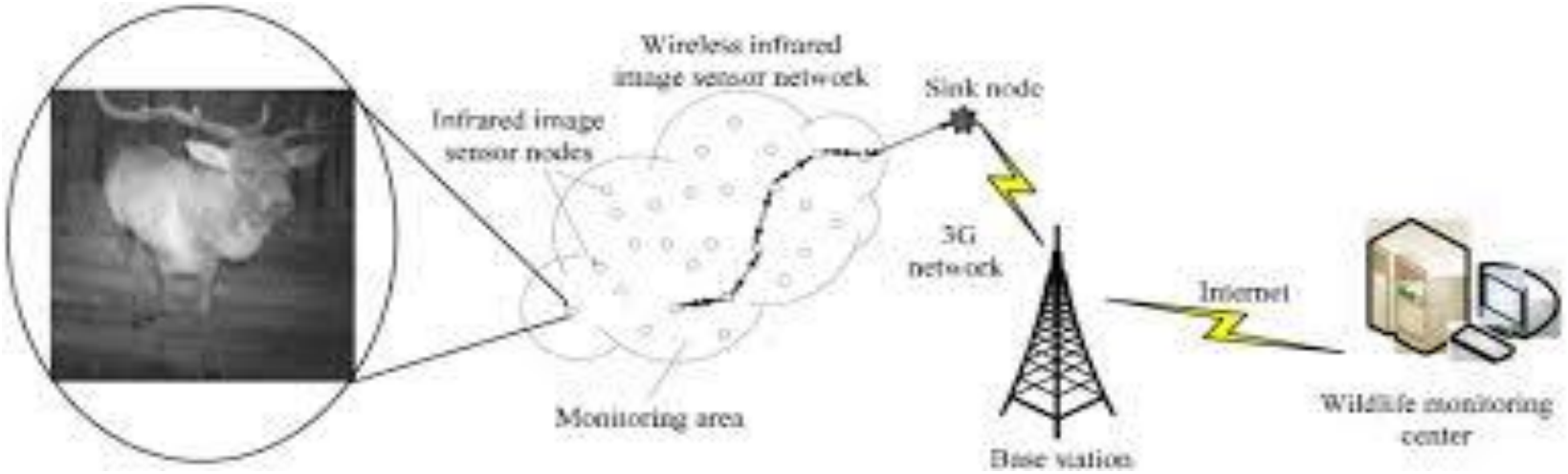
- 10. Finance & Banking
- Customer verification: Biometric face recognition for secure login or identity verification in banking apps.
- Document scanning: Processing checks, invoices, or contracts through OCR (Optical Character Recognition).

ARTIFICIAL VISION APPLICATIONS

- 11. Construction & Architecture
- Site inspection: Drones with computer vision to monitor construction progress and detect structural issues.
- Safety monitoring: Detecting unsafe worker behaviors, like not wearing helmets or protective gear.

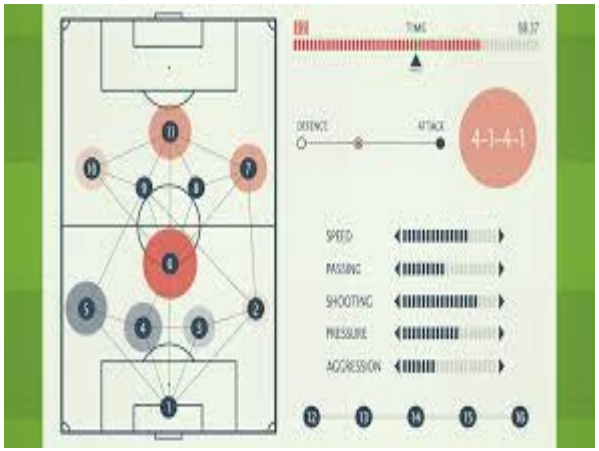
ARTIFICIAL VISION APPLICATIONS

- 12. Environmental Monitoring
- Wildlife tracking: Monitoring animal species and their habitats using drones or satellite imagery.
- Pollution detection: Identifying pollution levels in air or water through real-time image analysis.
- Forest fire detection: Early detection of wildfires using thermal and visual sensors in forests.



ARTIFICIAL VISION APPLICATIONS

- 13. Sports Analytics
- Player tracking: Real-time tracking of athletes' positions and movements during games.
- Performance analysis: Analyzing game footage to optimize player tactics and training regimes.
- Referee assistance: Assisting referees with goal-line technology, offside decisions, and more.



ARTIFICIAL VISION APPLICATIONS

- 14. Retail and Customer Experience
- Self-checkout systems: Automating product recognition during checkout without scanning barcodes.
- Foot traffic analysis: Monitoring customer movement and patterns in stores to optimize layouts.

ARTIFICIAL VISION APPLICATIONS

- 15. Transportation & Logistics
- Cargo inspection: Automated detection of damage or anomalies in shipping containers.
- Driver assistance: Monitoring driver behavior (e.g., detecting drowsiness or distractions).

ARTIFICIAL VISION APPLICATIONS

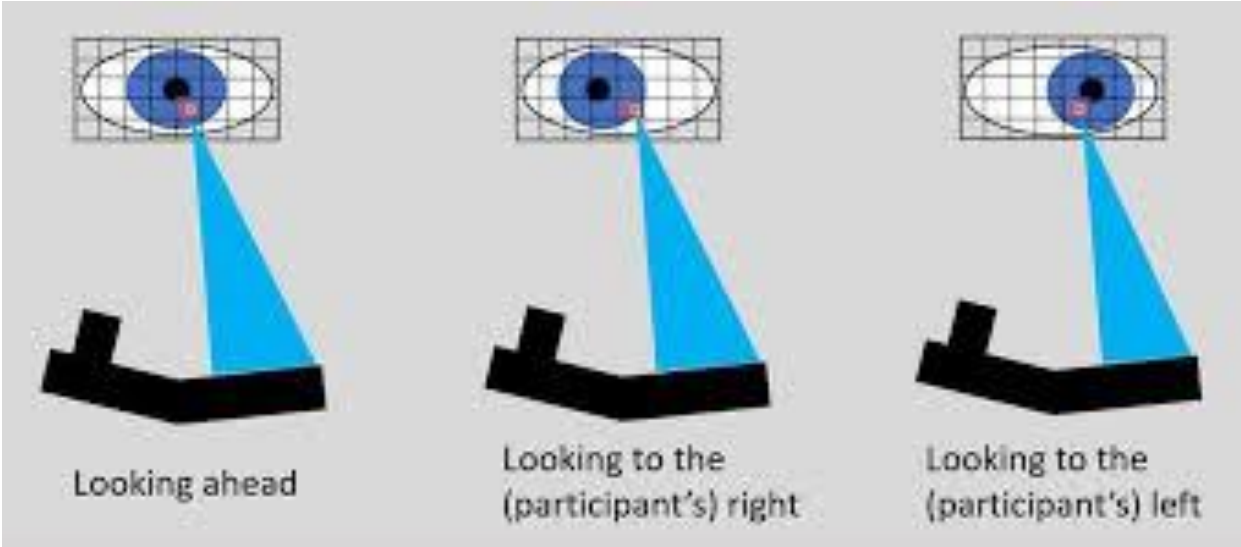
- 16. Real Estate & Property Management
- 3D property tours: Using computer vision to create virtual tours of real estate properties.
- Property maintenance: Automated detection of damage, mold, or leaks in buildings using drones or cameras.

ARTIFICIAL VISION APPLICATIONS

- 17. Mining and Extraction
- Resource detection: Identifying minerals and other resources using aerial or satellite imagery.
- Safety monitoring: Detecting hazardous conditions in mines through real-time video analysis.

ARTIFICIAL VISION APPLICATIONS

- 18. Human-Computer Interaction
- Eye-tracking: Understanding where users focus their attention on screens, useful in UX/UI design.
- Gesture-based control: Hands-free control of devices through visual recognition of hand gestures.



ARTIFICIAL VISION APPLICATIONS

- 19. Art and Culture
- Art restoration: Using image processing to restore damaged or faded works of art.
- Cultural heritage preservation: Digitizing and analyzing historical artifacts or documents.

ARTIFICIAL VISION APPLICATIONS

- 20. Logistics and Supply Chain
- Warehouse automation: Robots using computer vision to identify and pick items from shelves.
- Shipment tracking: Real-time package tracking using cameras and computer vision systems.

SECTION 4

Key Challenges in Artificial Vision

Key Challenges in Artificial Vision

Despite its impressive capabilities, artificial vision still faces challenges:

- **Lighting variations**: Changes in lighting conditions can affect image quality and accuracy.
- **Occlusions**: Objects that are partially hidden or obscured by other objects.
- **Complex backgrounds**: Difficulty distinguishing between objects and cluttered or dynamic backgrounds.
- **Real-time processing**: The need for fast algorithms that can process images and video in real-time, especially for autonomous systems.

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