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Introduction to Computer Vision

The workshop is part of EU co-funded Robo CO. - Robots and AI as future colleagues –project

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What is computer vision?

- **Computer vision** – includes 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; field of AI that enables machines to interpret and understand visual information from the world, mimicking human vision.
- By using algorithms and models, computers can process images and videos to recognize objects, detect patterns, and make intelligent decisions based on visual input.

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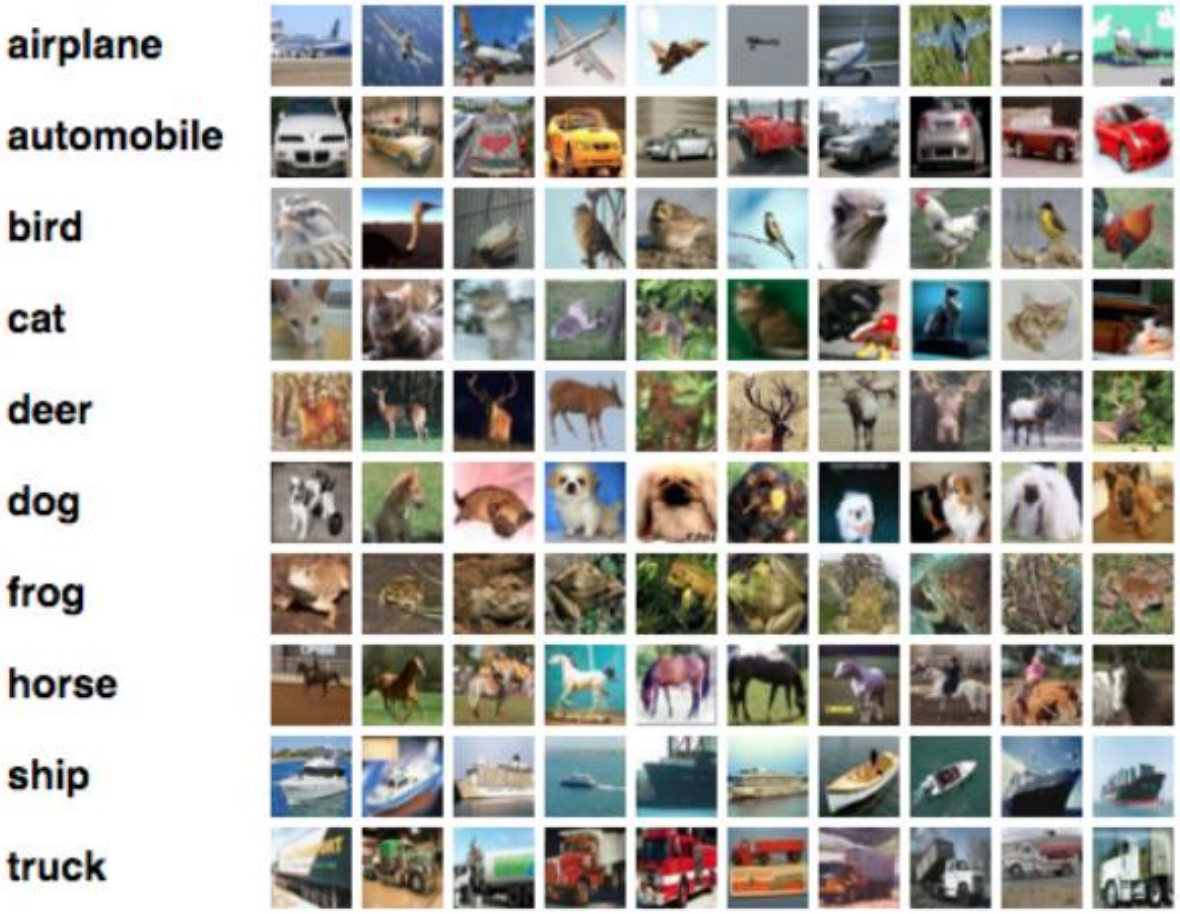
Introduction to object detection

- **Object detection** – computer vision task that involves identifying and locating objects within an image or video.
- Essential for various applications, including robotics, surveillance, and autonomous systems.

Linear classification and classification problem



- Similar to regression.
- The solution is learnt from training data.

x1 -> y1 (known class, ground truth)
x2 -> y2
x3 -> y3
….

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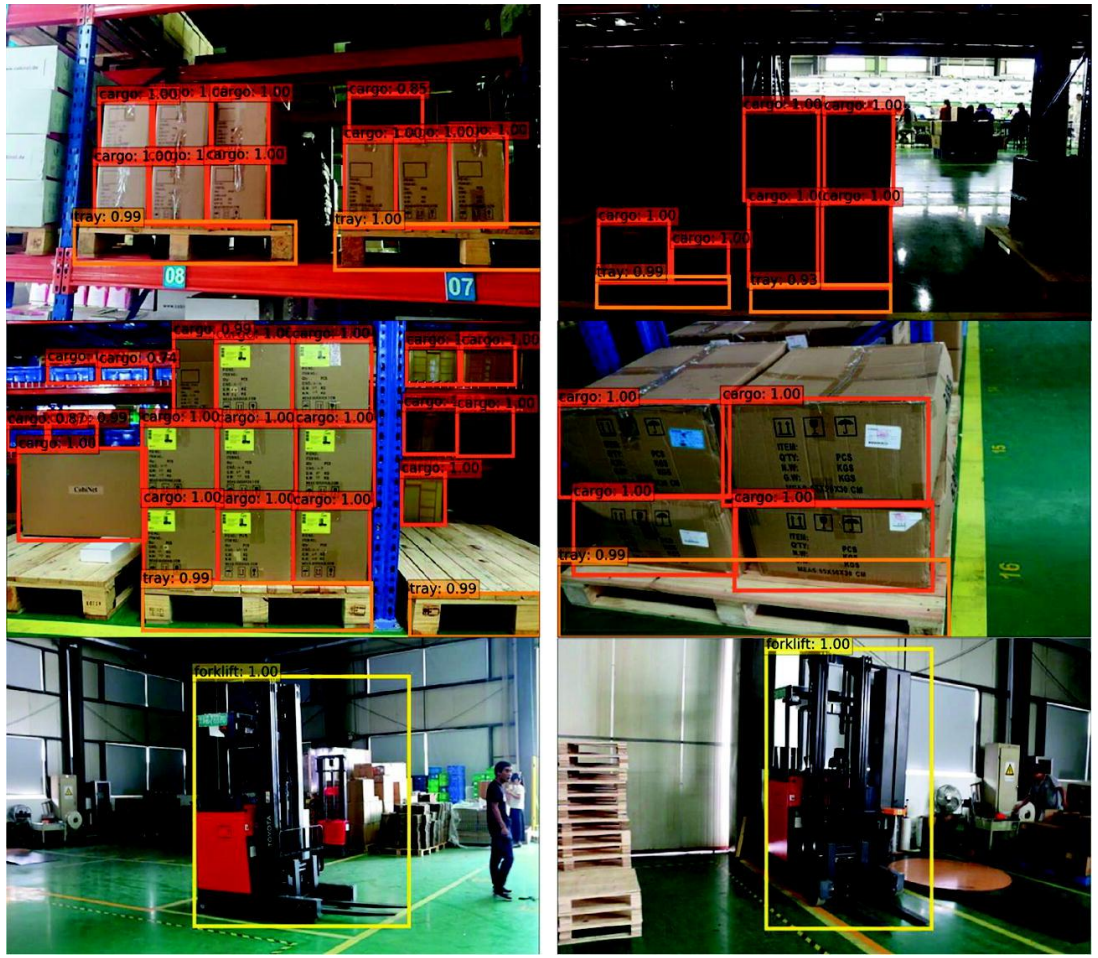
Applications of computer vision

- Object tracking, object recognition for inventory management.
- Industrial inspection.
- Facial recognition and security.
- Autonomous vehicles, driver assistance systems.
- Medical image analysis, disease diagnosis.
- Agriculture.
- Entertainment, augmented reality.



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Why Computer Vision?

- **Automation:** reduces the need for human intervention, increasing efficiency and accuracy.
- **Speed**: processes large amounts of visual data rapidly.
- **Scalability**: can be deployed across various industries with minimal customization.
- **Cost-effectiveness**: reduces labor costs and improves operational efficiency.
- **Adaptability**: can be trained to handle various types of visual data and evolving conditions.

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OpenCV (Open Source Computer Vision)

- **OpenCV**: computer vision library developed by Intel to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in commercial products.
- **Key Features of OpenCV:**
  - **Image processing**: provides wide range of functions for image processing such as filtering, transformation, edge detection, etc.
  - **Video analysis**: tools for analyzing videos including object detection, tracking, and motion analysis.
  - **Machine learning:** integration with machine learning algorithms for object detection, recognition, and other tasks.
  - **GUI support:** for GUI elements to display images and create simple user interfaces.
  - **Interoperability:** compatibility with other libraries like numpy, which allows easy integration and efficient processing.

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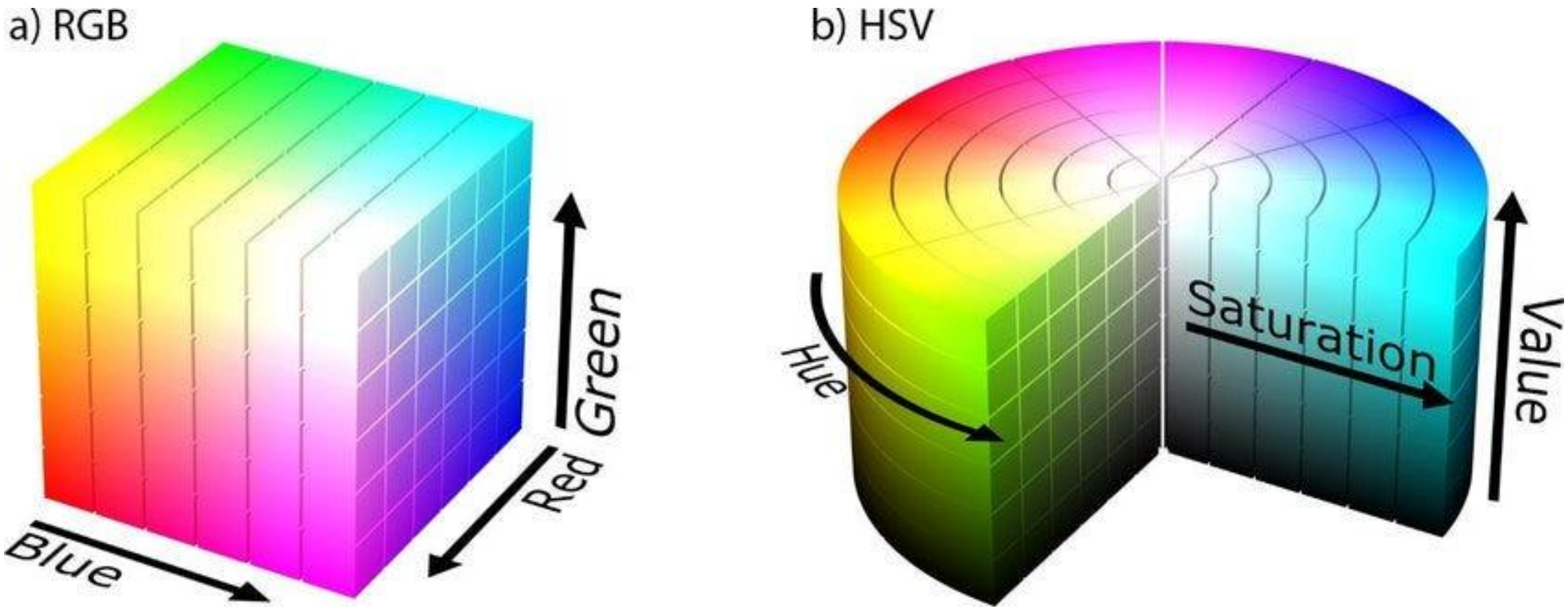
RGB & HSV color spaces



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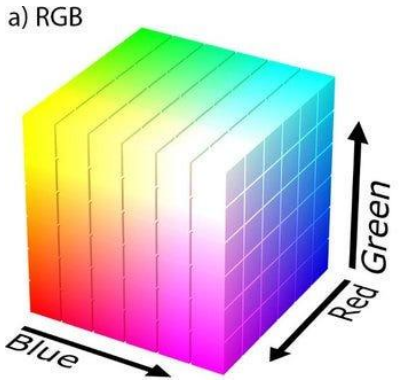

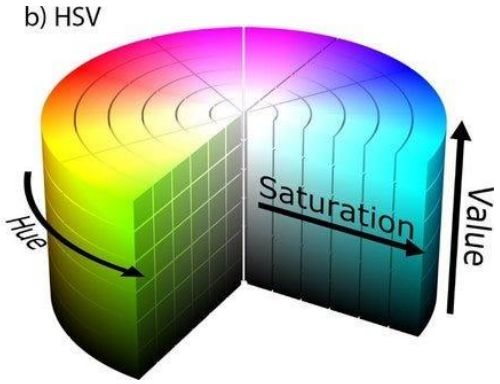

RGB & HSV color spaces

- Color spaces are essential in computer vision for tasks like object tracking and image segmentation.
- **RGB (Red, Green, Blue):** color model where colors are represented as a combination of red, green, and blue intensities.
  - Used for digital images but is sensitive to lighting variations.
- **HSV (Hue, Saturation, Value):** represents colors based on human perception, where:
  - **Hue:** represents the color type (e.g. red, blue, yellow).
  - **Saturation**: defines the intensity of the color.
  - **Value**: represents brightness.

Color-based object detection

- Perform color detection based on HSV color values.
- **HSV (Hue, Saturation, Value) Color Space**: commonly used in computer vision for color-based image processing.
- Assigning HSV values to define a specific color range for object detection.
- Advantages:
  - More intuitive representation of colors compared to RGB.
  - Separates color information, making it easier to work with specific color ranges.

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YOLO (You Only Look Once)

- Deep learning-based approach to object detection.
- YOLO is a popular real-time object detection algorithm.
- Divides the image into a grid and predicts bounding boxes and class probabilities simultaneously.
- Single forward pass through the NN for the entire image:
  - Predicts bounding boxes and class probabilities directly from the full image at once, rather than proposing regions and then classifying them separately.
- Benefits:
  - High accuracy
  - Efficient and fast

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Object detection with YOLO

- Clone Darknet github repo that includes pretrained YOLO model.
- Load and read input image where we want to detect objects.
- Class names.
- Set input blob for the network.
- Draw bounding boxes around the detected object and labels it with the class name.
- Run YOLO Model.
- Display the result image.

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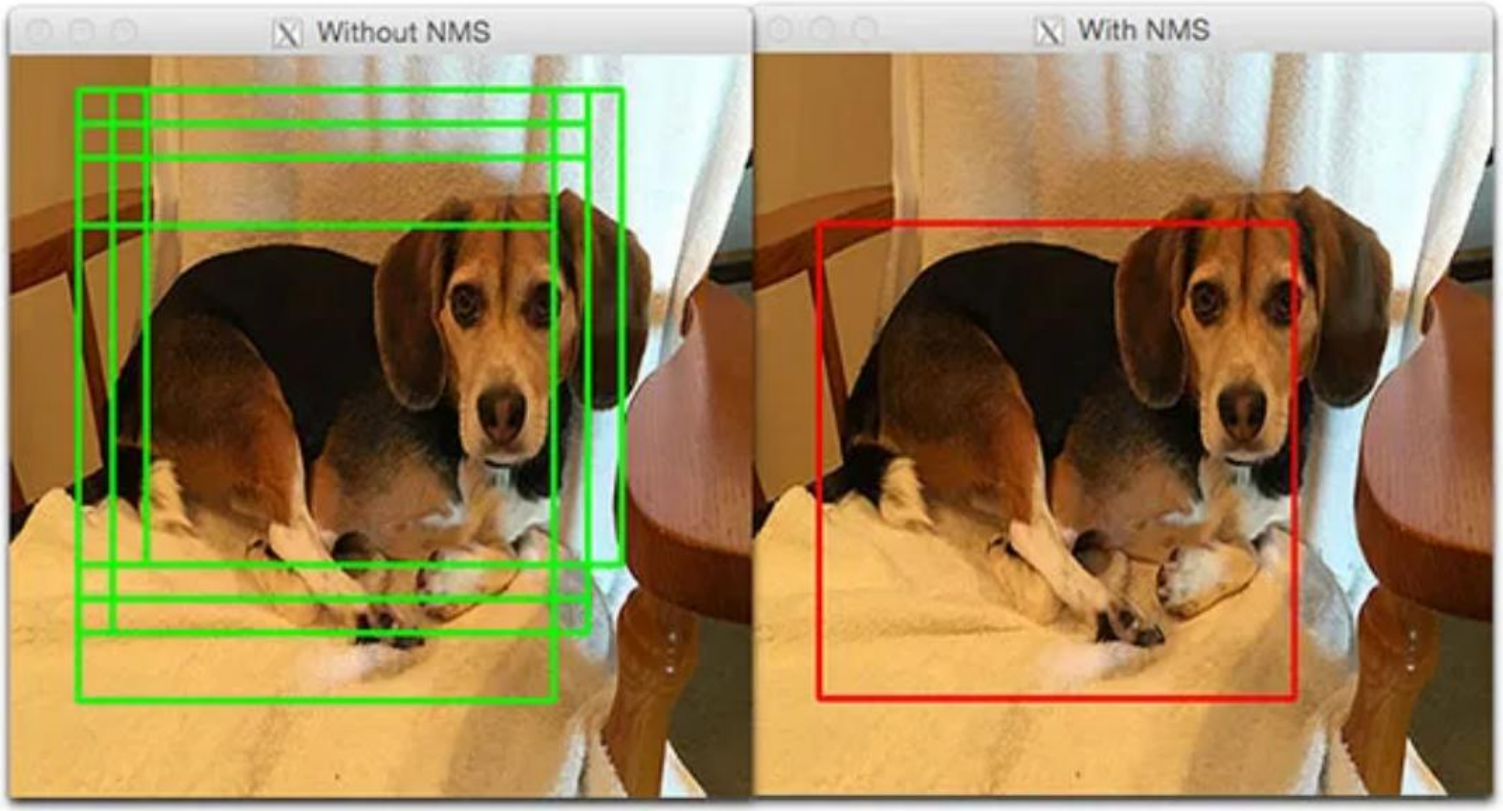
Non-max suppression: remove boxes with high overlapping



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Conclusions

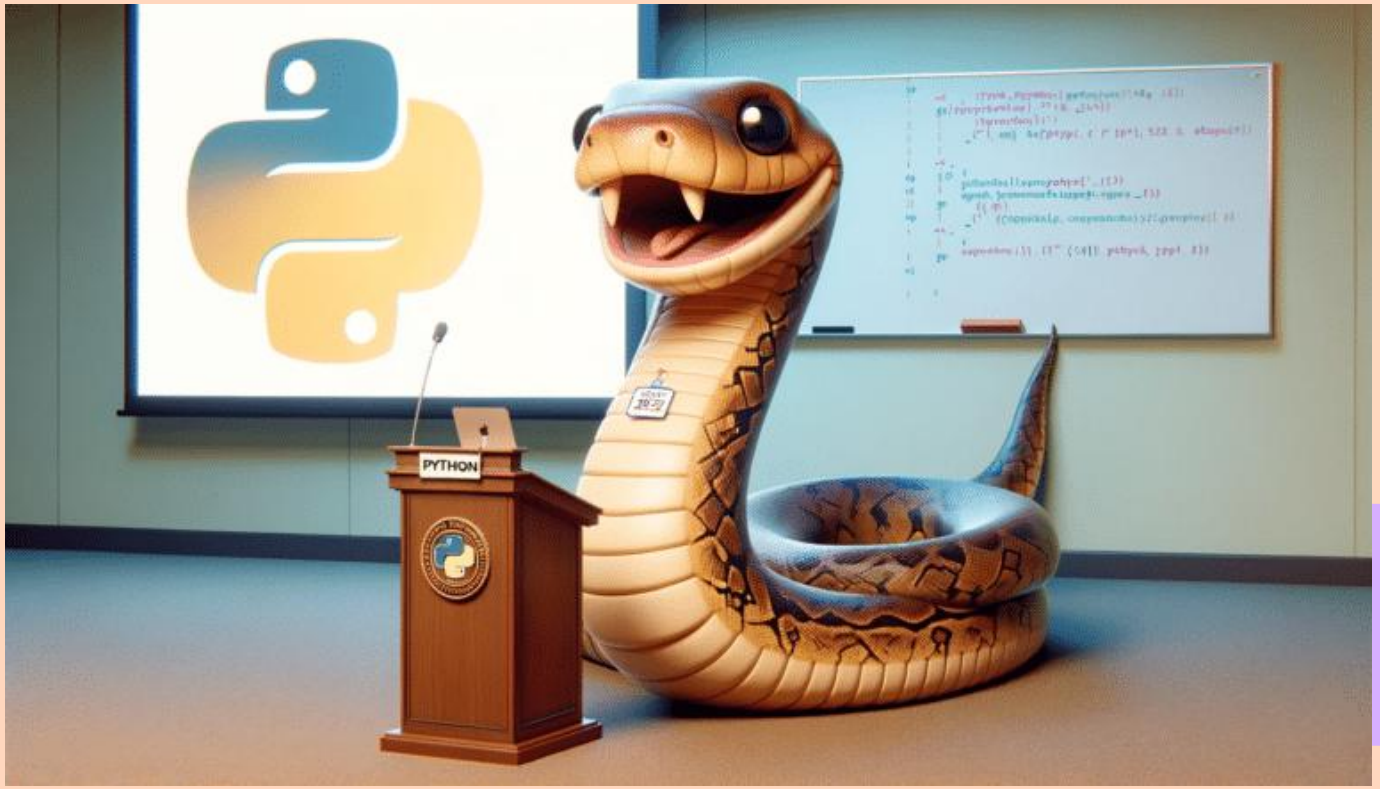

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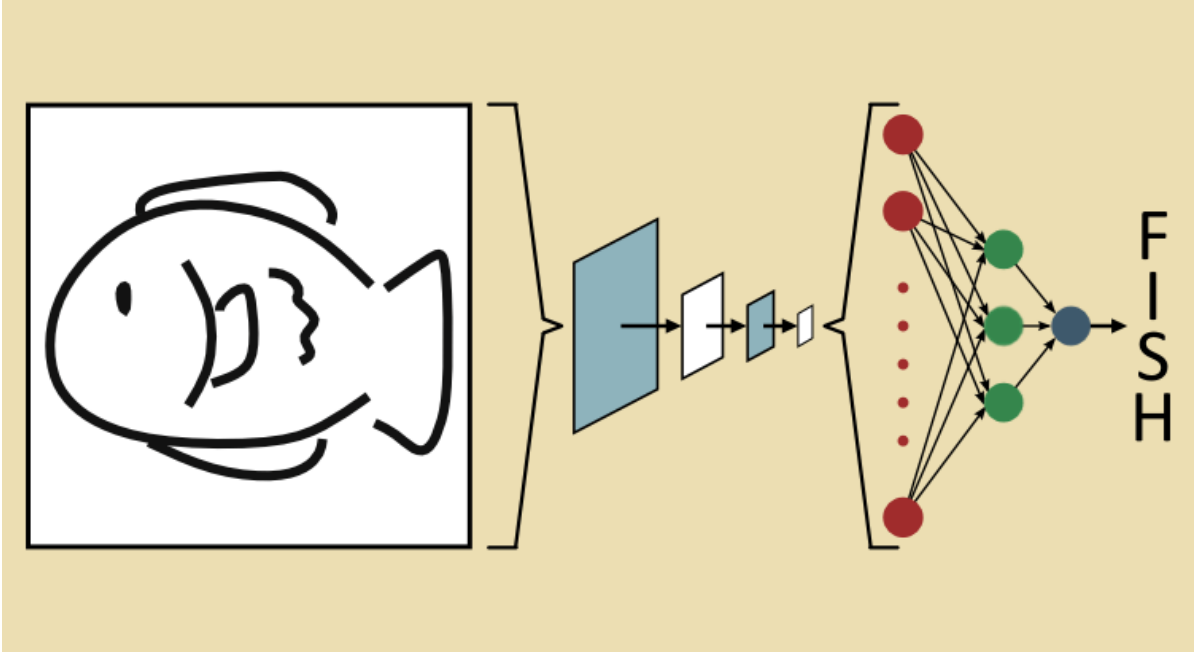
Image classifier

- Dataset preparation
- Data preprocessing
- Model building
- Training
- Evaluation



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Thank you!