

Object Detection in Images

AI Model Development

Time: 60 mins

Introduction

In this class, the student/s will learn to detect the objects in an image using the YOLO algorithm and then label them with their confidence percentage.

New Commands Introduced

- `YolonetWORK.setInput` Input the image blob to the network
- `getunconnectedOutLayersNames` Returns the names of all unconnected output layers of the network
- `YoloNetwork.forward()` Runs a forward pass to compute the net output of all layers using a array
- `np.argmax()` Returns the indices of the maximum values along an axis
- `cv2.dnn.NMSBoxes()` Algorithm to detect one box with maximum confidence

Vocabulary

- **YOLO** is an algorithm that uses neural networks to provide real-time object detection.
- **Convolutional Layer:** This layer applies a set of filters to the input image to extract features such as edges, corners, and shapes. Each filter is a small matrix that produces a single value in the output feature map.
- The **pooling layer** operates on each feature map independently and reduces the dimensionality of each feature map by replacing a region of the map with a single value.
- The **COCO** (Common Objects in Context) dataset is a large-scale image recognition dataset for object detection, segmentation, and captioning tasks.
- **NumPy** can be used to perform a wide variety of mathematical operations on arrays.

Learning Objectives

Student/s should be able to:

- **Recall** how to process an image using the open cv library.
- **Demonstrate** how to detect an object from the image
- **Explain** the concepts of YOLO algorithm and COCO dataset to label the detected objects.

Activities

1. Class Narrative: (2 mins)

- Brief the student/s about detecting different objects from the image. Highlight the objects with boxes and display labels with percentage of accuracy in identifying the object.

2. Concept Introduction Activity: (5 mins)

- Let the student/s play the explore-activity to detect objects in an image.
- Using the slides, explain that the student/s will learn:
 - to load and display the image.
 - to detect the objects in an image.
 - to highlight the objects in an image.

3. Activity 1: Load and Display the Image: (12 mins)

Teacher Activity: (6 mins).

- Explain the process of adding the yolo network to the VS code editor using configuration files and weights.
- Demonstrate to the student/s how to load, store and display the image in the YOLO network.

Student Activity: (6 mins)

- Guide the student/s to load, store and display the image.

4. Activity 2: Detect the Objects: (12 mins)

Teacher Activity: (6 mins)

- Explain to students how to get the unconnected layers and compute the net output of the YOLO network.
- Explain how to use numpy and COCO dataset to label the detected objects.
- Demonstrate how to highlight the detected object with rectangles.

Student Activity: (6 mins)

- Guide the student/s to debug the code to detect the object and highlight it with boxes.

How many objects can be detected by Yolo?

It can detect the 20 Pascal object classes: person, bird, cat, cow, dog, horse, sheep, aeroplane, bicycle, boat, bus, car, motorbike, train.

5. Activity 3: Highlight the Object: (12 mins)

Teacher Activity: (6 mins)

- Explain the student/s to display an accurate highlighting box using NMS with labels and confidence percentage for the detected object.

Student Activity: (6 mins)

- Guide the student/s to display an accurate highlighting box with labels and confidence percentage for the detected object.

6. Introduce the Post class project: (2 min)

- .Count the number of people present in an image of an event.

7. Test and Summarize the class learnings: (5 mins)

- Check for understanding through quizzes and summarize learning after respective missions.
- Summarize the overall class learning towards the end of the class.

8. Additional activities:

- Encourage the student to to set different colors for the different categories of an object.
- Encourage the student to to count the number of objects of a particular object category.

9. State the Next Class Objective: (1 min)

- In the next class, student/s will learn to detect the object for every frame in a video.

U.S. Standards:

CSTA: 2-AP-11, 2-AP-12, 2-AP-13, 2-AP-14, 2-AP-19

Links Table		
Activity	Activity Name	Link
Class Presentation	Object Detection in Images	https://s3-whjr-curriculum-uploads.whjr.online/ef3bfb74-4f7e-4155-8a04-c20fe4faaffb.html
Explore Activity	Object Detection in Images	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS
Teacher Activity 1	Load and Display the Image	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-TAS-BP
Teacher Activity 1 Solution	Load and Display the Image	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-TAS
Student Activity 1	Load and Display the Image	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS-BP
Teacher Reference: Student Activity 1 Solution	Load and Display the Image	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS
Teacher Activity 2	Detect the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-TAS-BP
Teacher Activity 2 Solution	Detect the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-TAS
Student Activity 2	Detect the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS-BP
Teacher Reference: Student Activity 2 Solution	Detect the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS
Teacher Activity 3	Highlight the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-TAS-BP

Teacher Activity 3 Solution	Highlight the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-TAS
Student Activity 3	Highlight the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS-BP
Teacher Reference: Student Activity 3 Solution	Highlight the Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS
Student's Additional Activity 1	Set Different Colors for Different Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS-BP
Teacher Reference: Student's Additional Activity 1 Solution	Set Different Colors for Different Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS
Student's Additional Activity 2	Count Number of Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS-BP
Teacher Reference: Student's Additional Activity 2 Solution	Count Number of Objects	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-SAS
Post Class Project	Count the Number of People	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-PCP-BP
Teacher Reference: Post Class Project Solution	Count the Number of People	https://github.com/Tynker-Computer-Vision/TNK-M9-PRO-C66-PCP