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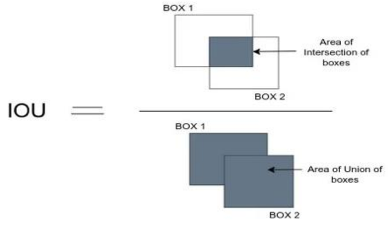
A08

A08 ITAI 1378 CV _Cheat sheet creation

Object Detection Cheat Sheet

Key Concepts:

- Bounding Box: A rectangle drawn around an object in an image.
- Annotations: Labels that identify the objects within bounding boxes.
- Confidence Score: A measure of how confident the model is that an object is present in a bounding box.
- Intersection over Union (IoU): A metric used to evaluate the accuracy of object detection models by measuring the overlap between predicted and ground truth bounding boxes.



Common Algorithms:

- R-CNN: Regions with Convolutional Neural Networks
- Fast R-CNN: Improves on R-CNN by using a single convolutional network to process the entire image and sharing computation between region proposals.
- Faster R-CNN: Improves on Fast R-CNN by using a Region Proposal Network (RPN) to generate region proposals.
- SSD: Single Shot Multibox Detector, a faster alternative to R-CNN that performs object detection in a single pass.
- YOLO: You Only Look Once, another fast alternative to R-CNN that treats object detection as a regression problem.

- Stereo Matching: Uses stereo images (images taken from two viewpoints) to estimate the depth of objects in a scene.
- Monocular Depth Estimation: Estimates depth from a single image using techniques like learning-based methods or geometry-based methods.

Tools and Libraries:

- TensorFlow: An open-source machine learning library for building and training neural networks.
    - Installation: `pip install tensorflow`
    - Basic Usage:

```
import tensorflow as tf



# Create a simple model

model = tf.keras.models.Sequential([

  tf.keras.layers.Dense(10, activation='relu', input_shape=(32,)),

  tf.keras.layers.Dense(2, activation='softmax')

])



# Compile the model

model.compile(optimizer='adam',

              loss='sparse_categorical_crossentropy',

              metrics=['accuracy'])



# Train the model

model.fit(x_train, y_train, epochs=10)
```

- Keras: A high-level neural networks API that runs on top of TensorFlow.
    - Installation: `pip install keras`
    - Basic Usage:

```
from keras.models import Sequential
from keras.layers import Dense

# Create a simple model
model = Sequential()
model.add(Dense(10, activation='relu', input_shape=(32,)))
model.add(Dense(2, activation='softmax'))

# Compile the model
model.compile(optimizer='adam',
              loss='sparse_categorical_crossentropy',
              metrics=['accuracy'])

# Train the model
model.fit(x_train, y_train, epochs=10)
```

- OpenCV: A library of programming functions mainly aimed at real-time computer vision.
  - Installation: `pip install opencv-python`
  - Basic Usage:

```
from keras.models import Sequential
from keras.layers import Dense

# Create a simple model
model = Sequential()
model.add(Dense(10, activation='relu', input_shape=(32,)))
model.add(Dense(2, activation='softmax'))


# Compile the model

model.compile(optimizer='adam',

              loss='sparse_categorical_crossentropy',

              metrics=['accuracy'])


# Train the model

model.fit(x_train, y_train, epochs=10)
```

Steps in Object Detection:

1. Image Preprocessing: Resize, normalize, and augment images.
2. Model Selection and Training: Choose an object detection model and train it on your dataset.
3. Inference: Use the trained model to detect objects in new images.
4. Postprocessing: Filter detections based on confidence score and perform non-max suppression.

Common Challenges and Troubleshooting Tips:

- Overfitting: Use data augmentation, regularization, and a larger dataset.
- Slow Inference Speed: Use a faster model, reduce the input size, or use a GPU.
- Low Confidence Scores: Increase the number of epochs, use a larger dataset, or use a pre-trained model.

Additional Resources:

- "Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
- Online tutorial: TensorFlow Object Detection API Tutorial
- Online tutorial: PyImageSearch
- Website: OpenCV Documentation

Reflection:

During this assignment, we learned about the key concepts, methodologies, and tools used in object detection. I gained a deeper understanding of the different object detection algorithms, such as R-CNN, Fast R-CNN, Faster R-CNN, SSD, and YOLO, and their strengths and weaknesses. We also learned about the tools and libraries commonly used in object detection tasks, such as TensorFlow, Keras, and OpenCV.

This cheat sheet will benefit us in future object detection tasks by serving as a quick reference guide for the key concepts, methodologies, and tools pertinent to object detection. It will help us save time and effort by providing a concise overview of the steps involved in a typical object detection task, familiar challenges, and troubleshooting tips. Additionally, the list of additional resources will provide me with further reading and exploration opportunities to deepen my knowledge and skills in object detection.

The feedback from my peers helped me identify areas where the cheat sheet could be improved, such as adding more diagrams and formulas to explain key concepts and methodologies. Based on their feedback, we made necessary revisions to improve its clarity, completeness, and design. Overall, this assignment was a valuable learning experience, and we are confident that the cheat sheet will be a helpful resource for future object detection tasks.

References:

(PDF) comparison of Yolo v3, faster R-CNN, and SSD for real-time ... (n.d.). https://www.researchgate.net/publication/353590069_Comparison_of_YOLO_v3_Faster_R-CNN_and_SSD_for_Real-Time_Pill_Identification

Base, T. (2024, January 19). *AWS Certified Machine Learning Cheat sheet - built in algorithms 2/5*. Medium. https://medium.com/@tantabase/aws-certified-machine-learning-cheat-sheet-built-in-algorithms-2-8-cfb70b60603e

Convolutional Neural Networks cheatsheet star. CS 230 - Convolutional Neural Networks Cheatsheet. (n.d.). https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-convolutional-neural-networks

Sojasingarayar, A. (2024, February 23). *Faster R-CNN vs Yolo vs SSD - object detection algorithms*. Medium. https://medium.com/ibm-data-ai/faster-r-cnn-vs-yolo-vs-ssd-object-detection-algorithms-18badb0e02dc