Object Detection Cheat sheet by MaryBalemba

1. Key Concepts

Bounding Box: A rectangular box around an object to define its location.

Annotations: Labels and metadata attached to training images.

Confidence Score: Probability that the detected object is correctly identified.

Intersection over Union (IoU): Measures overlap between predicted and ground truth bounding boxes.

$IoU = \frac{Area\ of\ Overlap}{Area\ of\ Union}$

Non-Maximum Suppression (NMS): A technique to remove redundant overlapping bounding boxes.

Flowchart of Object Detection Pipeline:

Image Preprocessing → Resize, normalize

Feature Extraction → Convolutional Neural Networks (CNNs)

Region Proposal → Selective Search, RPN (Region Proposal Network)

Bounding Box Regression & Classification → Predict location and class

Post-Processing → Apply NMS to remove duplicates
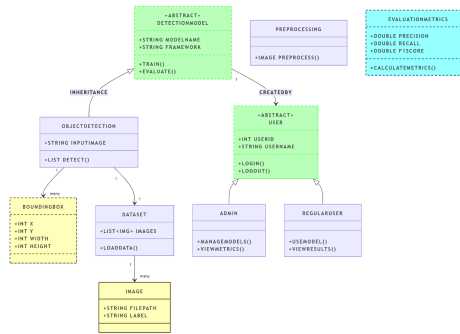
Comparison Table:

Algorithm	Speed	Accuracy	Complexity
R-CNN	Slow	High	High
Fast R-CNN	Faster	High	Medium
Faster R-CNN	Fast	Very High	High
SSD	Very Fast	Medium	Medium
YOLO	Very Fast	High	Medium

5. Tools & Libraries

TensorFlow/Keras: Open-source deep learning framework.

Installation: pip install tensorflow

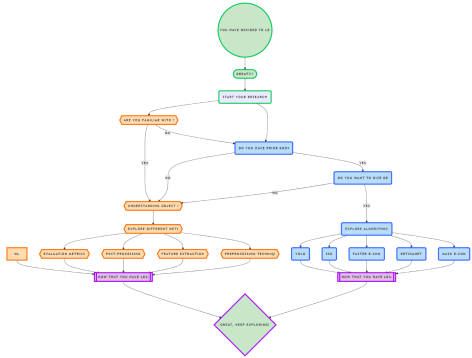**PyTorch**: Another deep learning library, widely used for research.

Installation: pip install torch torchvision

OpenCV: Useful for image processing.

Installation: pip install opencv-python

Detectron2: Facebook's implementation of state-of-the-art object detection models.

Installation: pip install detectron2

6. Additional Resources

Book: "Deep Learning for Computer Vision" by Adrian Rosebrock

Online Course: Stanford CS231n (Convolutional Neural Networks for Visual Recognition)

Tutorials: TensorFlow Object Detection API (https://tensorflow-object-detection-api-tutorial.readthedocs.io/en/latest/)

2. Common Object Detection Algorithms

R-CNN: Uses Selective Search for region proposals, applies CNN to each region.

Fast R-CNN: Improves R-CNN by using a single CNN pass for feature extraction.

Faster R-CNN: Introduces RPN for efficient region proposals.

SSD (Single Shot Multibox Detector): Predicts bounding boxes in a single pass.

YOLO (You Only Look Once): Divides image into grid cells and predicts objects in one forward pass.

4. Challenges & Troubleshooting

Low Accuracy → Increase dataset size, augment images.

Overfitting → Apply regularization techniques.

Slow Inference → Use lightweight models like MobileNet.

Class Imbalance → Use weighted loss functions.

3. Steps in Object Detection

Data Collection → Gather labeled images.

Data Preprocessing → Resize, normalize images.

Model Selection → Choose between Faster R-CNN, YOLO, etc.

Training → Use labeled dataset, optimize loss function.

Evaluation → Measure IoU, precision, recall.

Deployment → Integrate model into real-world applications.

6. Reflection

This assignment helped consolidate my understanding of object detection by summarizing key concepts, algorithms, and tools in a structured manner. Creating this cheat sheet enhanced my ability to quickly reference essential information, making object detection more approachable. The research into various models and their trade-offs provided deeper insights into when to use each approach. I believe this cheat sheet will serve as a valuable resource in future projects, saving time and improving workflow efficiency.