Artificial Intelligence
Phase 1

1-What Is Object Detection and why it's matter?

Object detection is a computer vision technique for locating instances of objects in images or videos. Object detection algorithms typically leverage machine learning or deep learning to produce meaningful results. When humans look at images or video, we can recognize and locate objects of interest within a matter of moments. The goal of object detection is to replicate this intelligence using a computer.

Object detection is a key technology behind advanced driver assistance systems (ADAS) that enable cars to detect driving lanes or perform pedestrian detection to improve road safety. Object detection is also useful in applications such as video surveillance or image retrieval systems.

2-Similar Applications

1-Object Recognition as Image Search:

By Recognizing the objects in the images, combining each object in the image and passing detected objects label in the URL we can make the object detection system as image search.

2-Automatic Image Annotation:

Automatic image annotation (also known as automatic image tagging or linguistic indexing) is the process by which a computer system automatically assigns metadata in the form of captioning or keywords to a digital image. This application of computer vision techniques is used in image retrieval systems to organize and locate images of interest from a database.

3-Automatic Target Recognition:

Automatic target recognition (ATR) is the ability for an algorithm or device to recognize targets or other objects based on data obtained from sensors.

Target recognition was initially done by using an audible representation of the received signal, where a trained operator who would decipher that sound to classify the target illuminated by the radar. While these trained operators had success, automated methods have been developed and continue to be developed that allow for more accuracy and speed in classification

4-Object Counting:

Object detection system can also be used for counting the number of objects in the image or real time video. People Counting: Object detection can be also used for people counting, it is used for analyzing store performance or crowd statistics during festivals. These tend to be more difficult as people move out of the frame quickly (also because people are nonrigid objects).

5-Customer Experience:

The main goal of retail establishments is to provide the best customer experience possible. Object detection applications help accomplish that goal by providing valuable data on customer actions. For example, stores can improve the checkout process by monitoring for long lines. Once wait times exceed a certain threshold, employees can be automatically alerted to provide additional assistance.

6-Parking Occupancy:

Parking systems are becoming smarter with the help of computer vision. Object detection applications can identify open parking spaces in surface lots or parking garages. Data can be updated in real-time, alerting drivers of open spots with signs.

7-PPE Detection:

Warehouses, manufacturing facilities, and construction sites can be dangerous places to work. So, innovative companies are always on the lookout for new technologies to increase employee safety. Object detection is the perfect solution for tracking the use of personal protective equipment (PPE).

8-Object Detector: (Mobile Application)

3-A Literature Review of Academic publications

From WIKIPEDIA (Object detection):-

What is Object Detection from many variations?

Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, or cars) in digital images and videos. We use this technology for applications such as e.g., face detection or pedestrian detection. Object detection has applications in many areas of computer vision, including image retrieval and video surveillance. Usually a single object is detected by some algorithm but sometimes we need to detect multiple objects at the same time. This article describes how to (1) segment sets of shapes into disjoint parts that are likely to be members of different classes.

Object detection is the process of identifying and extracting information about objects in a digital image. Unlike recognition, which classifies objects, object detection enables a computer to label the elements within an image by highlighting them and labelling them with categories such as "people" or "cars". Object detection differs from human perception because humans can not distinguish between similar objects using just their eyes and brain but by using their senses of touch, hearing, and smell we can detect different objects.

Object detection is the process of finding points in an image that can be classified as belonging to a certain class. For example, a computer may have been fed thousands of images of people and it will learn to identify them by looking at the area where their face would be.

From Microsoft COCO: Common Objects in Context :-

In traditional ML-based approaches, computer vision techniques are used to look at various features of an image, such as the color histogram or edges, to identify groups of pixels that may belong to an object. These features are then fed into a regression model that predicts the location of the object along with its label.In a deep learning-based approach the image is passed through multiple layers of convolutional neural networks (CNNs) that learn to detect and construct features. These features are then used as inputs to a regression model that predicts the location of an object, along with its label.

Why is object detection important?

Object detection is an important part of computer vision, because it allows us to understand and analyze scenes in images or video. We can see this through a wide range of applications, like counting people, cars or facial features. And it's important because it takes a large amount of data—sequences of pixels—and uses algorithms to identify and label objects within them. And it's a fundamental process in computer vision that allows us to identify and analyze images or videos containing object classes. In the context of autonomous vehicles, object detection can be used to count the number of passengers in a car, or to detect pedestrians or cyclists on a busy street. By understanding how many people are in an image or video, we can then use that information for actions like catching them before they fall off stage, or counting as many heads as possible before counting the bodies. As you can see, this sensor can have much more than just counting heads and bodies.

Object detection on mobile:-

Like most people, you might use your phone a lot to check in with friends, keep up with work and family, or just keep up with current events. But what if we told you that by using object detection on-device, you can have access to all these capabilities without cloud infrastructure overhead?

Implementing object detection on mobile devices can open up a range of possibilities to developers, including applications for real-time video surveillance, crowd counting, anomaly detection and more. Keep your users safe by detecting objects in images, text, and video. Reduce cost and complexity, All of these with object detection on mobile.

From An Empirical Study of Context in Object Detection:-

Objects in the world are often there because they are present (presence constraint). Objects are present in some environments, so you know that it exists by its presence in some locations. An object's appearance will also depend on the quality of the light it's standing in, its actual size in comparison to other objects, and how bright or dark a subject may be. It's important to note that an object's appearance is not necessarily stable across all places it exists, especially if there are changes of illumination or weather conditions over time.

When estimating the approximate size of objects, it is important to know their location as well as their physical shape. Given object presence and location, its size in the image can be estimated. This requires knowing either camera orientation and height above the supporting surface (photogrammetric context), or relative sizes of other known objects in the scene (semantic context) and their geometric relationships (geometric context).

The spatial support of an object can be defined as how much data from the image represents an object. In other words, it is how much space it takes up within the image. Based on this, we can estimate the size and shape of objects in images and perform various tasks related to these using Computer Vision.

We rescore detection hypotheses by combining them with the context provided by our scene/geographic/semantic classifiers; an object's presence, location and size are examined in relation to these models. Because these classes often disagree with detectors, their scores should be lowered for the rescored hypothesis to take the first place—the score difference between each pair of hypotheses should indicate the confidence of their agreement.

Artificial Intelligence

Phase 1

From Journal of Applied Science and Technology Trends :

Decision tree classification is used as a decision support and validation technique with an iterative algorithm that requires a three-stage process: Construct Model (Learning), Evaluation Model (Accuracy), and Model Use (Classification). Once the expression of the model, it is presented as a probability distribution for each class present in the data. Decision trees are used for predictive modeling and can be used to extract pattern from large datasets.

We have proposed a new methodology for DT framework with the introduction of a novel entropy based metric for each context node, which results in considerable savings in terms of computation times. Furthermore, we studied limitations associated with each method and developed a novel entropy-based method that eliminates the need to consider all possible states as well as simpler calculations than existing methods. Finally, we compared these approaches by implementing them on real datasets and conducted experimental evaluations using different approaches to identify optimal strategies in designing classification trees.

Not only is the regular decision tree more stable on datasets, but also presented more accurate results when compared to other techniques. The Experimental results showed that DT approach got higher accuracy, which proves that it can be advantageous than other methods like KNN, LR, SVM and NB. Moreover, it has been shown that DST method can boost the performance of DT model by enhancing MCLs which are critical for improving the accuracy of DTs.

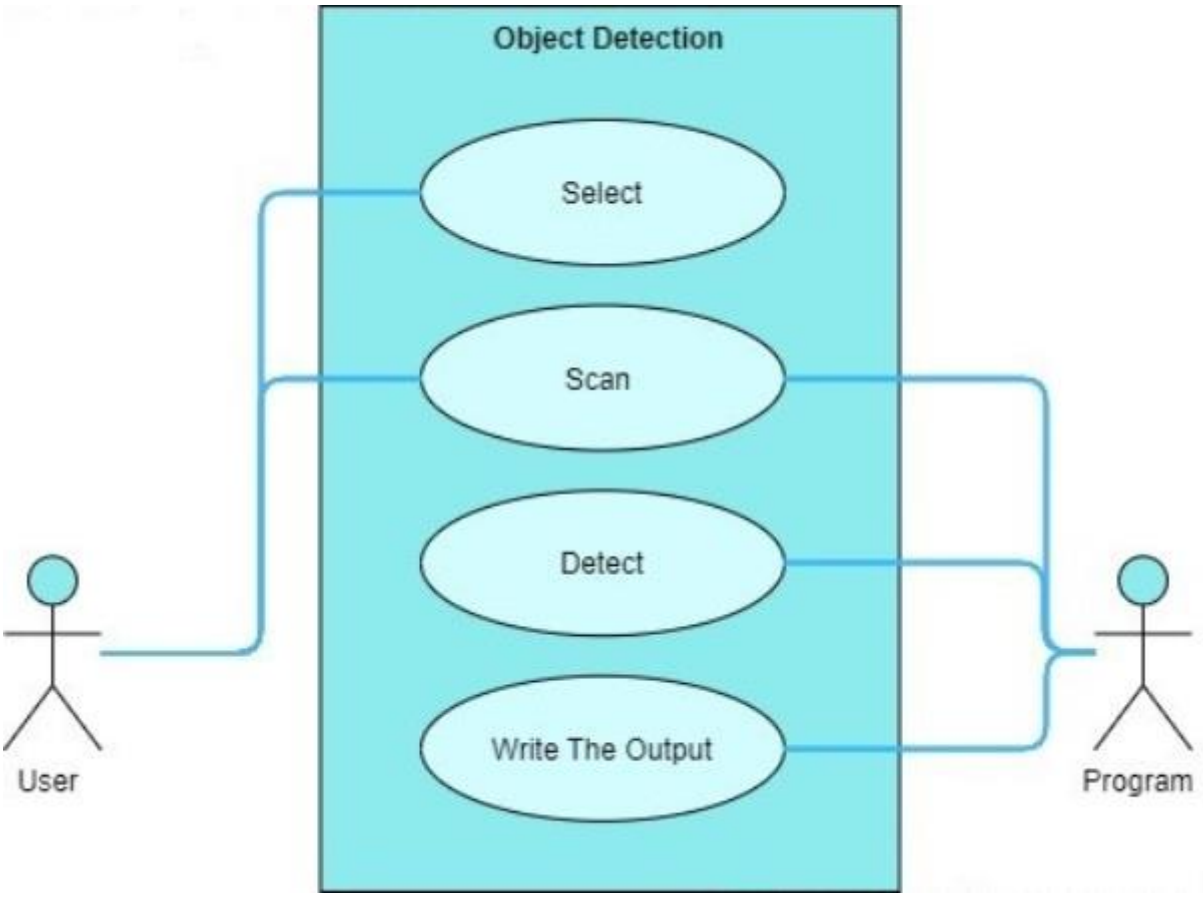
From AIP Conference Proceeding :

The Random Forest (RF) is a tree-based model for classification and regression. It has been implemented in many machine learning software packages and can be used for high dimensional data modeling. The Random Forest classifier handles missing values, continuous, categorical and binary data. The bootstrapping and ensemble scheme makes the Random Forest strong enough to overcome the problems of over fitting and hence there is no need to prune the trees. The model interpretability and prediction accuracy provided by Random Forest is very unique among popular machine learning methods. Accurate predictions and better generalizations are achieved due to utilization of ensemble strategies and random sampling.

In REPTree, decision/regression tree is constructed with information gain as the splitting criterion and reduced error pruning is used to prune it. It sorts values only for numeric attributes once. The method of fractional instances is used to handle missing values with C4.5. REP Tree is a fast Decision Tree learner.

A random tree is a tree constructed randomly from a set of possible trees having K random features at each node. "At random" in this context means that in the set of trees each tree has an equal chance of being sampled. Or we can say that trees have a uniform distribution. Random trees can be generated efficiently and the combination of large sets of random trees generally leads to accurate models. There has been an extensive research in the recent years over Random trees in the field of machine Learning.

4-Main functionalities/features



Select:

The user use this function to contain the picture of the object that he wants to know its name

Scan:

The user use this function to give an order to the program to scan the image

DETECTION:

This function works when the user input the image and press scan then the program works and analyze the image to know the following (color , size , shape , try) by this information the program knows the name of the object and then write it as an output to the user.

5-Details of the algorithm(s)/approach(es)

Decision tree

What Is Decision Tree:-

The decision tree is a hierarchical data structure that represents data by implementing a divide and conquer strategy. We can know that this algorithm is based on the structure of the tree. A decision tree is one of the important supervised learning algorithms for dealing with classification and regression problems. The structure of the decision tree algorithm is basically compared to an actual tree. The branches in the tree represent the decisions while the leaf represents the result of the decision. It can handle both categorical and continuous data. To traverse the nodes in a decision tree, recursion is mainly used. The main decision in the algorithm is the selection of the next attribute to condition on. Conduct a search of the space of decision trees which can represent all possible discrete functions. Performs a greedy heuristic search: hill climbing without backtracking. Makes statistically based decisions using all data.

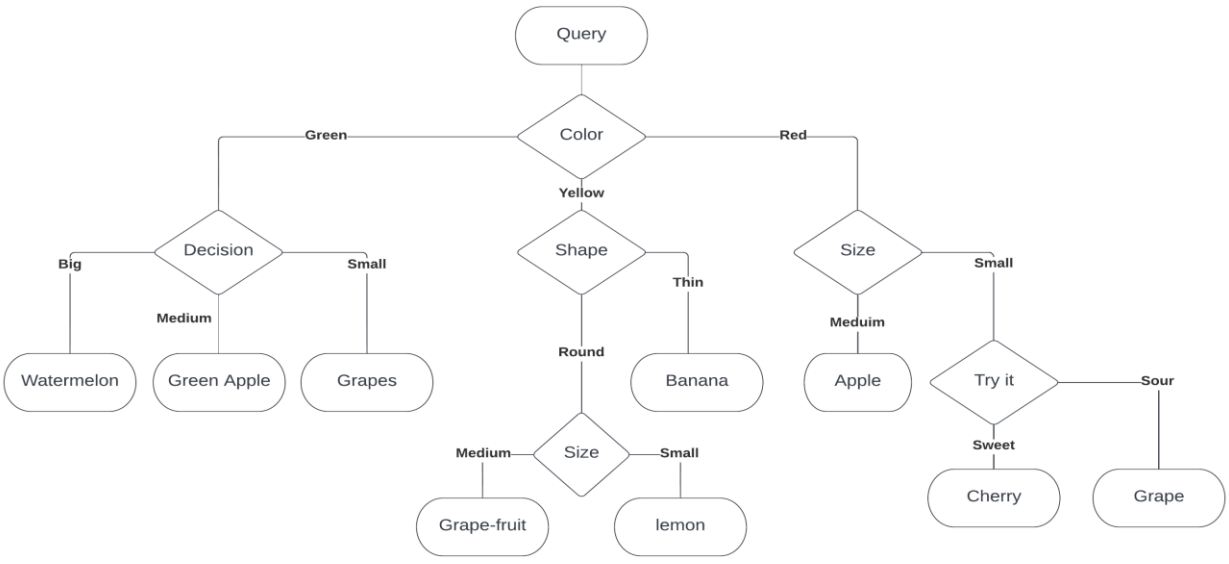
Advantage Of Decision Tree:-

1- Can represent any Boolean Function.
2-The major advantage of the decision tree is that the model is easy to interpret.
3- Can be viewed as a way to compactly represent a lot of data.
4-The larger the data the better will be the results.
5-Less data cleaning is required.
6-The evaluation of the Decision Tree Classifier is easy.
7-Clearly, given data, there are many ways to represent it as a decision tree.
8-Learning a good representation from data is the challenge.

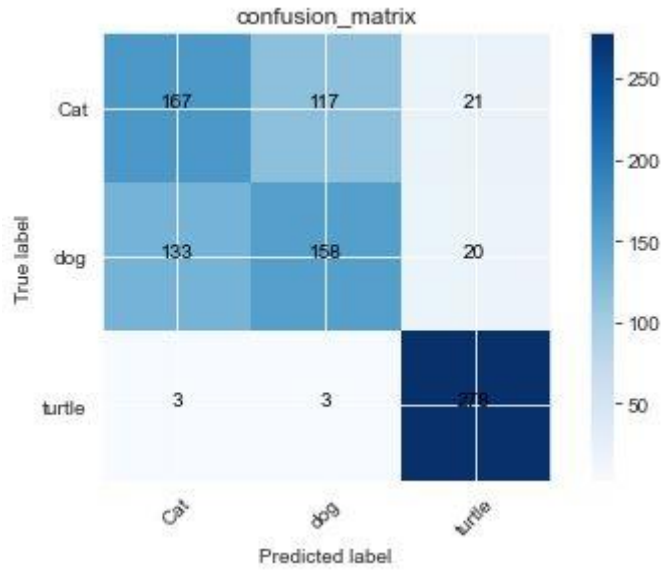
Disadvantages Of Decision Tree:-

1-The rate of deflection is high in the case of decision trees.
2-A slight change in data may cause a significant change in the result.
3-It is prone to errors like overfitting, bias, and variance.

Block Diagram for Decision Tree (Example Of Fruits) :-



Plot For Decision Tree Result :



Random Forests

What Is Random Forests:-

Random forest is a supervised learning algorithm in which a group of decisions is made and the result is finalized based on the majority. We can say it is a collection of decision trees. As the name suggests forest may contain a group of trees the algorithm contains a collection of decision trees. Since multiple decision trees are grouped to build the random forest it is more complicated. This article describes various methods that can be used to build eight different kinds of Random Forests (RFs). Each RF belongs to one or more forest types and can be thought of as one kind of tree from an ensemble in linear regression (OLR). While most reader will focus on tree ensemble construction and ensemble performance evaluation, this article also touches upon issues such as randomization, random subsampling, optimizing algorithm parameters and repair techniques for missing values and outliers within training data.

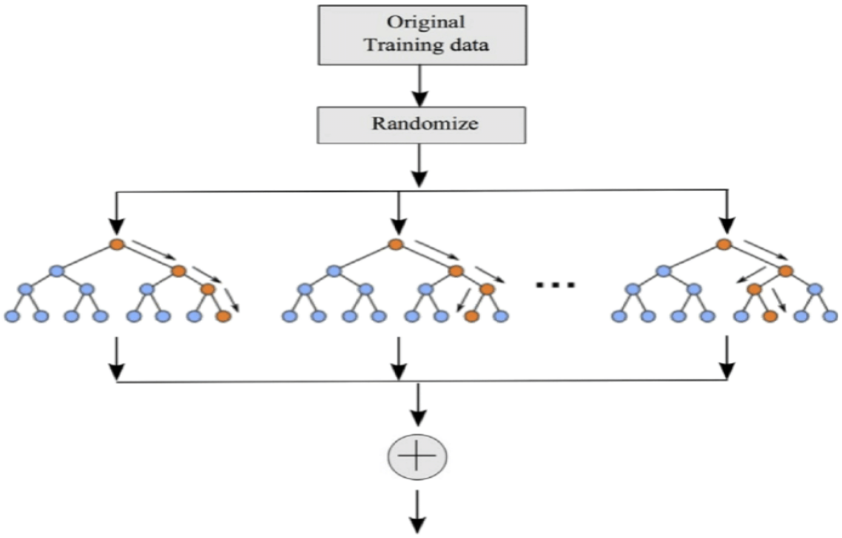
Advantage Of Random Forests:-

1-The random forest algorithm is highly accurate and powerful.
2-The algorithm adapts quickly to the dataset
3-It can handle several features at once

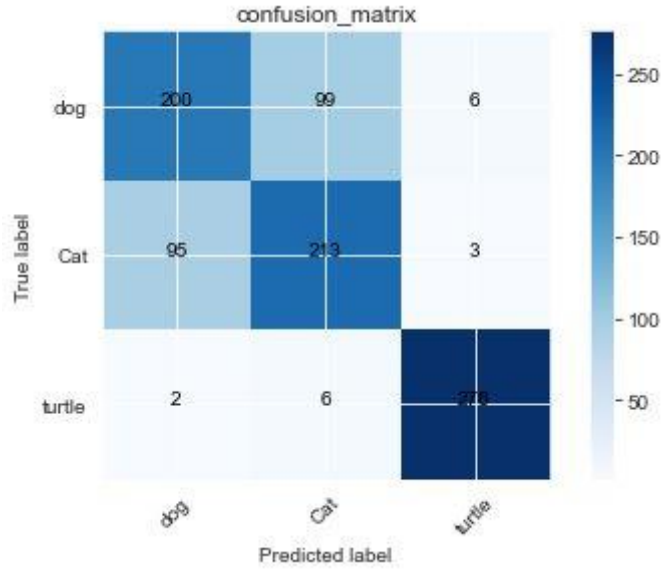
Disadvantages Of Random Forests:-

1-The major drawback of the random forest model is its complicated structure due to the grouping of multiple decision trees.
2-It cannot be used for linear patterns of data.
3-It is worse for handling data with high dimension

Block Diagram for Random Forests :-



Plot for Random Forests Result:



All References From :

Dr Amr S. Ghoneim (Lecture Notes & Slides: https://drive.google.com/drive/folders/1A8LqYAHMV8t-_g7MOU_Uy-Bw2DrrVnO
Videos:https://www.youtube.com/watch?v=ktYwSG1M38E&list=PLsnvpvHuTUbAZr0n65TgytBK6bHdT33A7&index=15andhttps://www.youtube.com/watch?v=_i8Lj2iPxZI&list=PLsnvpvHuTUbAZr0n65TgytBK6bHdT33A7&index=19)
WIKIPEDIA (Object detection): https://en.wikipedia.org/wiki/Object_detection
Microsoft COCO: Common Objects in Context :https://arxiv.org/pdf/1405.0312.pdf
An Empirical Study of Context in Object Detection :https://ieeexplore.ieee.org/document/5206532
Applications of Object Detection for Businesses: https://alwaysai.co/blog/object-detection-for-businesses
Journal of applied science an Technology trends: https://www.researchgate.net/publication/350386944_Classification_Based_on_Decision_Tree_Algorithm_for_Machine_Learning
AIP Conference Preceeding: https://aip.scitation.org/doi/pdf/10.1063/1.4977376