A Presentation
on
Artificial Fruit Ripening Detection

By

Disha Shah (30014)

Umang Shah (30015)

Poras Vyas (30017)

M.Sc.(AI & ML) - 3

Under guidance of

Dr. Jyoti Pareek

(Department of Computer Science, Gujarat University)

Dr. Suchit Purohit

(Department of Computer Science, Gujarat University)

Department of Computer Science

Gujarat University

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OBJECTIVES

- Application of Deep Learning approaches to identify if a fruit is artificially/naturally ripened.
  - Detect and localize a fruit in the image.
  - Classify the image as artificially / naturally ripened
- Develop a mobile application to facilitate acquisition and testing of fruit image.
- Accuracy Assessment of object detection algorithms with fruit as subject.
- Create a Dataset for artificially and naturally ripened bananas.

INTRODUCTION

- Artificial ripening of fruit is a process undertaken by vendors in order to boost certain characteristic of the fruit, For e.g. color, taste, speed of ripening, etc.
- It helps vendors in maximizing their sales and minimizing the efforts of growing fruit through traditional methods.
- This method is not healthy for the consumers as it can cause many diseases.
- A system to help consumers know what kind of fruits they are buying would be helpful.

What is Artificial Ripening?

- Ripening is a process in fruits that causes them to become more palatable. In general, a fruit becomes sweeter, less green (typically "redder"), and softer as it ripens. Even though the acidity of fruit increases as it ripens, the higher acidity level does not make the fruit seem tarter.
- Fruits which are not ripened by natural agents, instead, artificial fluids and chemicals are used for ripening is called Artificial Ripening.
- Unsaturated hydrocarbons such as acetylene, ethylene etc. can promote ripening and induce color changes effectively.

What is Artificial Ripening?

- Artificial ripening was introduced for fruits which were transported from one region to another, but all fruits did not survive, only firm and matured fruits survived.
- Artificial ripening method was introduced for these fruits, as these fruits can be ripened at destination which may or may not have likely atmosphere for ripening that fruit.
- The most commonly used chemical for artificial ripening is Calcium Carbide (CaC_2)

Effects of Artificial Ripening of fruits

Fruit Quality

Fruits become overly soft, inferior in flavour and change in taste is observed.

They have shorter shelf life.

May develop uniform attractive surface colour, but the tissue inside would not be ripe or may remain green or raw.

When used in very raw fruit, more chemical is needed, resulting in even more tasteless, unhealthy and toxic fruits.

Harm to Human Health

CaC_2 has cancer causing properties and contains traces of arsenic and phosphorus hydride.

Symptoms of arsenic or phosphorus poisoning :

Vomiting

Diarrhea

Thirst

Weakness

Difficulty in swallowing

Irritation or burning in the eyes and skin

Permanent eye damage

Sore throat, cough and shortness of breath.

Artificially Ripened Fruits

Some of the fruits which are artificially ripened are as follows:-

- Banana
- Mango
- Papaya
- Sapota
- Dates
- Tomatoes

Literature Review

- **Paper** - Identification of Artificially Ripened Fruits using Machine Learning
- **Authors -** Harshad Vaviya **,** Ajaykumar Yadav, Vijaykumar Vishwakarma, Nasim Shah of K. J. Somaiya Institute of Engineering & Information Technology
- **This Paper was published in year 2019** at "2nd International Conference on Advances in Science & Technology ". In K. J. Somaiya Institute of Engineering & Information Technology, University of Mumbai, Maharashtra, India

Vaviya, Harshad, et al. "Identification of Artificially Ripened Fruits Using Machine Learning." *Available at SSRN 3368903* (2019).

Literature Review

- **Approach –** Convolution Neural Network using Tensor flow was used for classification of fruit image. Converted to Tensor Flow lite for mobile application. Using OpenCV library in smartphone, they created histograms of both artificial and natural image and then classified into natural or artificial ripening by comparing the histograms.
- **Dataset** – Kaggle dataset named "Fruits-360" for image fruit classification and they manually generated dataset by bringing raw bananas and dividing it into two parts –
  - 1st part ripening using Cac2.
  - 2nd part ripening naturally2

Vaviya, Harshad, et al. "Identification of Artificially Ripened Fruits Using Machine Learning." *Available at SSRN 3368903* (2019).

Literature Review

Summary :–

- The proposed system gets an image of fruit under the test and compare it with the features of naturally ripened fruit and artificially ripened fruit and give the output with the probability.
- This method makes usage of smartphone which runs the android application and the convolutional neural network to detect the artificially ripened fruit.

Vaviya, Harshad, et al. "Identification of Artificially Ripened Fruits Using Machine Learning." *Available at SSRN 3368903* (2019).

Datasets

- For Fruit Detection Training:

Sr.	Name	No. of Instances	Link
1	Fruits-360	490	https://www.kaggle.com/moltean/fruits
2	Fruit images for object detection	86	https://www.kaggle.com/mbkinaci/fruit-images-for-object-detection
3	MSCOCO	1618	http://cocodataset.org/#home

- No Dataset found for classification of artificially and naturally ripened fruits.

Fruits-360

- Previously we worked on Fruits-360.
- It had different angles but no background, it was a dataset for classification.

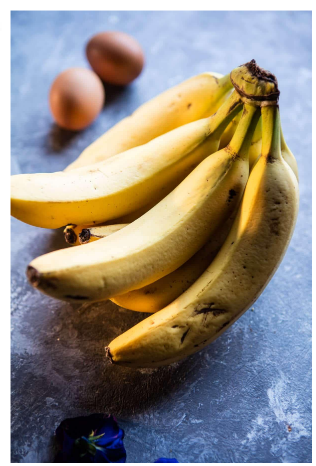
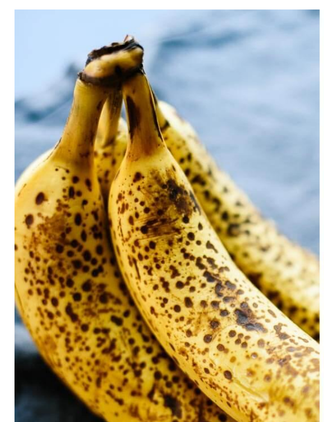
Fruit images for object detection Dataset

- This dataset had varied and better images than the previous one.








COCO

- Common Objects in Context dataset is a huge and highly diverse dataset.
- Many models are already trained and its weights available, thus making the training easier and the model more robust.






METHODOLOGY

1. **Fruit Recognition**
   Recognition of fruits for further processing
2. **Data Collection**
   Gathering and Labelling Data
3. **Feature Collection**
   Extracting Features of Data
4. **Ripening Classification**
   Artificially Grown or Naturally

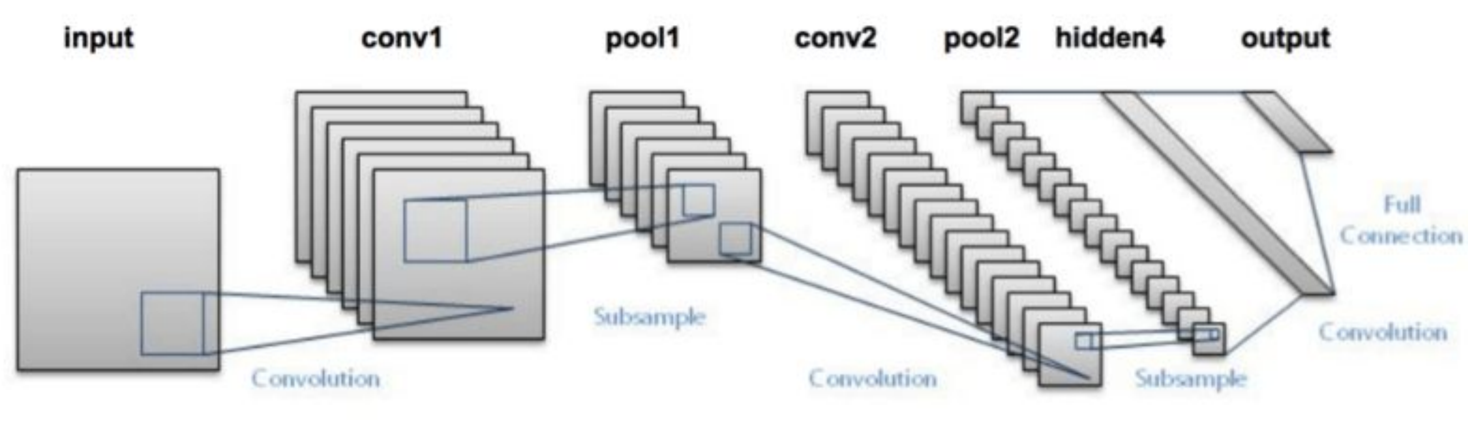
Approaches for Fruit Detection

We have used following three Deep Learning techniques for fruit recognition :

1) Faster RCNN (Region based CNN)
2) SSD (Single Shot Detector)
3) YOLO (You Only Look Once)

Convolutional Neural Network

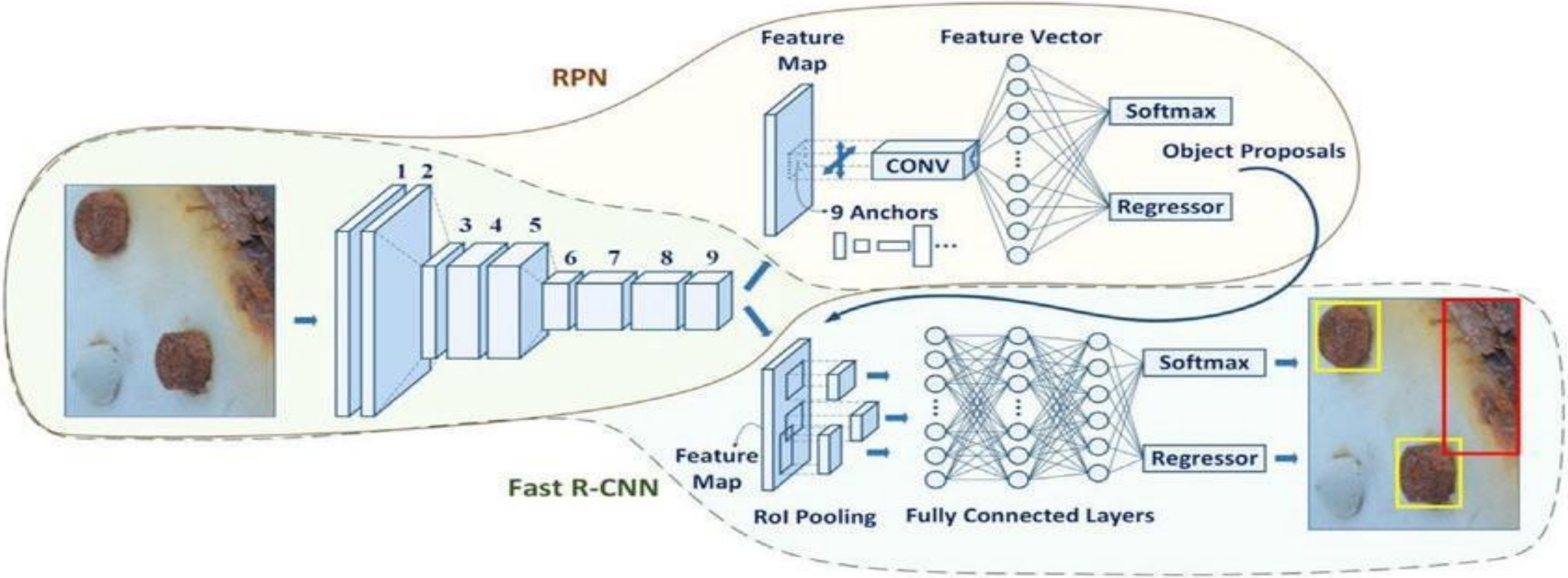
- The simplest deep learning approach for object detection in images is CNN.



- We pass an image to the network, and it is then sent through various convolutions and pooling layers.

- Finally, we get the output in the form of the object’s class.

Faster RCNN

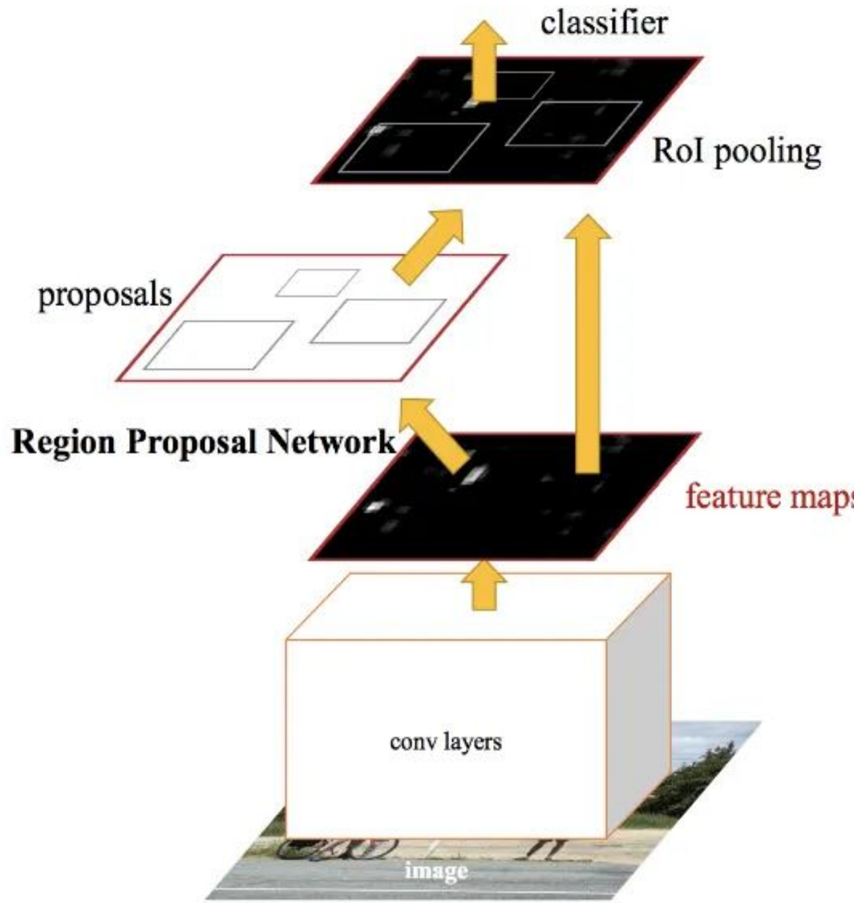

RPN
Feature Map
Feature Vector
Softmax
CONV
Object Proposals
Regressor
9 Anchors
1 2
3 4 5
6 7 8 9
Softmax
Regressor
Feature Map
Fast R-CNN
RoI Pooling
Fully Connected Layers

Faster RCNN

- Faster RCNN is named faster as such because it uses a Region Proposal Network (RPN) , unlike the selective search algorithm of its predecessors.
- We take an image as input and pass it to the ConvNet which returns the feature map for that image.
- RPN is applied on these feature maps. This returns the object proposals along with their objectness score.

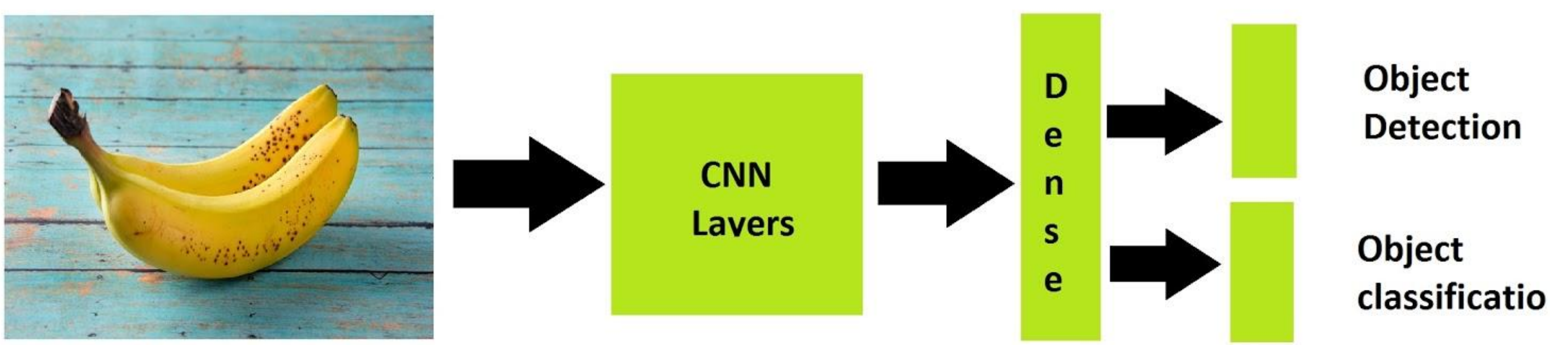
Faster RCNN

- A ROI pooling layer is applied on these proposals to bring down all the proposals to the same size.
- Finally, the proposals are passed to a fully connected layer which has a softmax layer and a linear regression layer at its top, to classify and output the bounding boxes for objects.



Single Shot Multibox Detector

- Single Shot Detector was released in November 2016.
- As the name suggest it takes one single shot to detect multiple objects in an image as opposed to the regional based architectures where the detection and classification occurs in two phases.

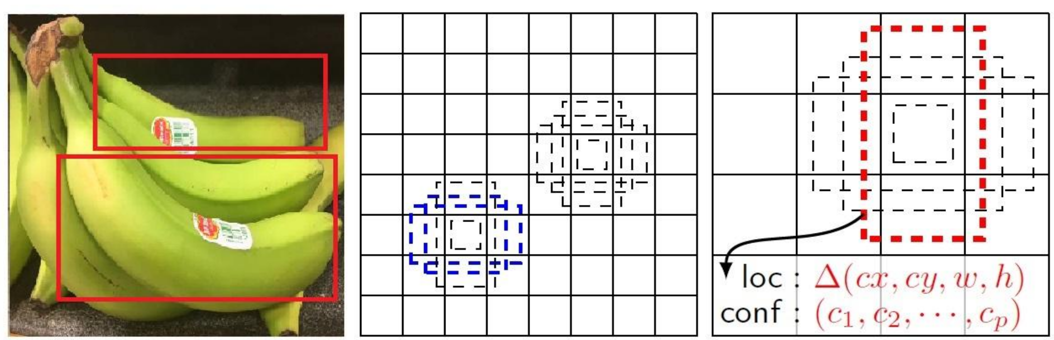


Single Shot Multibox Detector

- **Single Shot**: this means that the tasks of object localization and classification are done in a single forward pass of the network
- **MultiBox**: Bounding box regression for images
- **Detector**: Detection and classification of objects.

Single Shot Multibox Detector

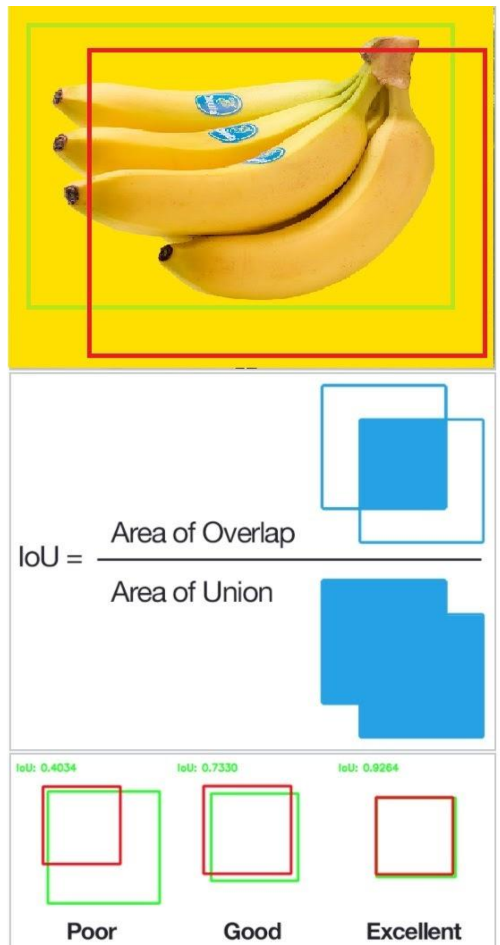
- After CNN layers feature box of m x n x p is extracted from the image.
- For each location, we got k bounding boxes. These k bounding boxes have different sizes and aspect ratios.
- For each of the bounding box, we will compute c class scores and 4 offsets relative to the original default bounding box shape. Thus, we got (c+4)kmn outputs.
- That's why the algorithm is called "SSD: Single Shot MultiBox Detector".



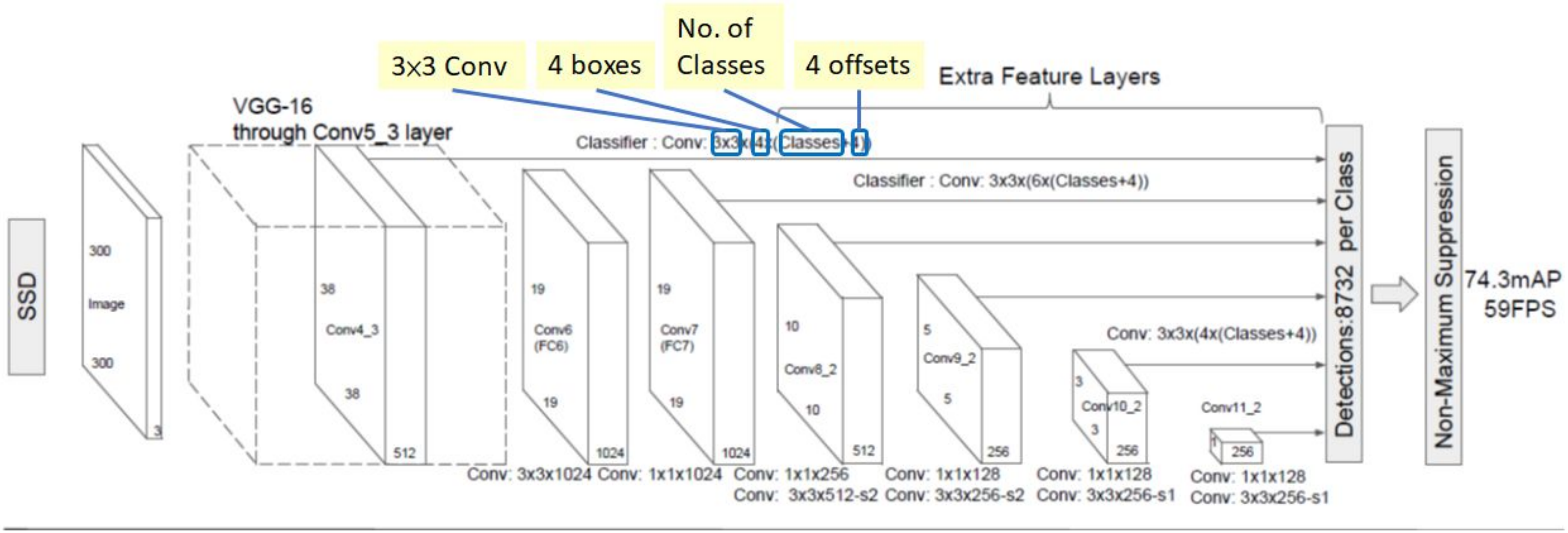
(a) Image with GT boxes (b) 8×8 feature map (c) 4×4 feature map

Single Shot Multibox Detector

Intersection Over Union



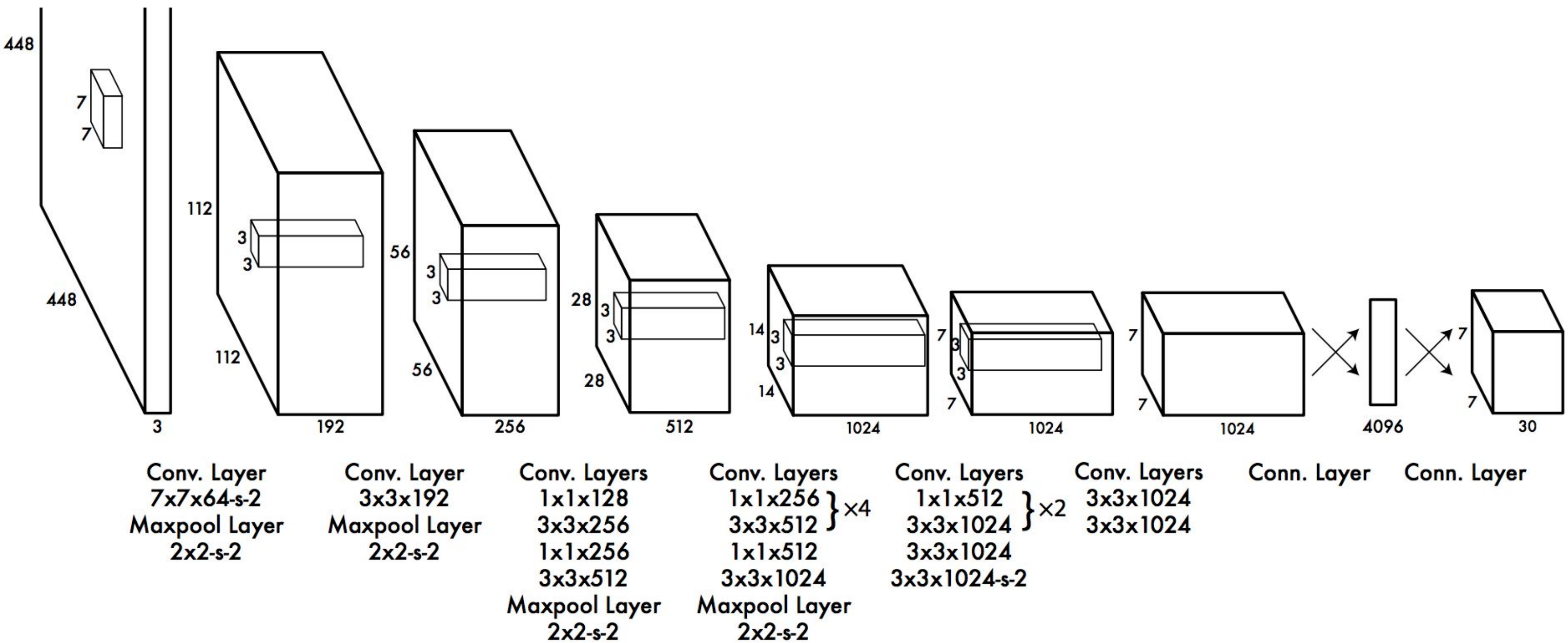
Single Shot Multibox Detector



YOLO (You Only Look Once)

- The idea behind YOLO is that a single neural network is applied to full image. This allows YOLO to reason globally about the image when generating predictions
- It is a direct development of MultiBox, but it turns MultiBox from region proposal in to an objection recognition method by adding a softmax layer in parallel with a box regressor and box classifier layer.
- It divides the image into regions and predicts bounding boxes and probabilities for each region.
- YOLO uses a Fully Convolutional Neural Network allowing for input of various image sizes.

You Only Look Once



You Only Look Once

- The input image is divided into an S x S grid, if the center of an object falls into this grid cell, that cell is responsible for detecting that object.
- Each grid predicts a number of bounding boxes and confidence scores for those boxes.
- Confidence here is defined as Probability of an Object multiplied by the thresholded IoU score, there IoU scores of < 0.5 are given a confidence of zero.
- The bounding box is defined by x, y, w, h where x, y are the center of the box and w & h are the height and width.

You Only Look Once

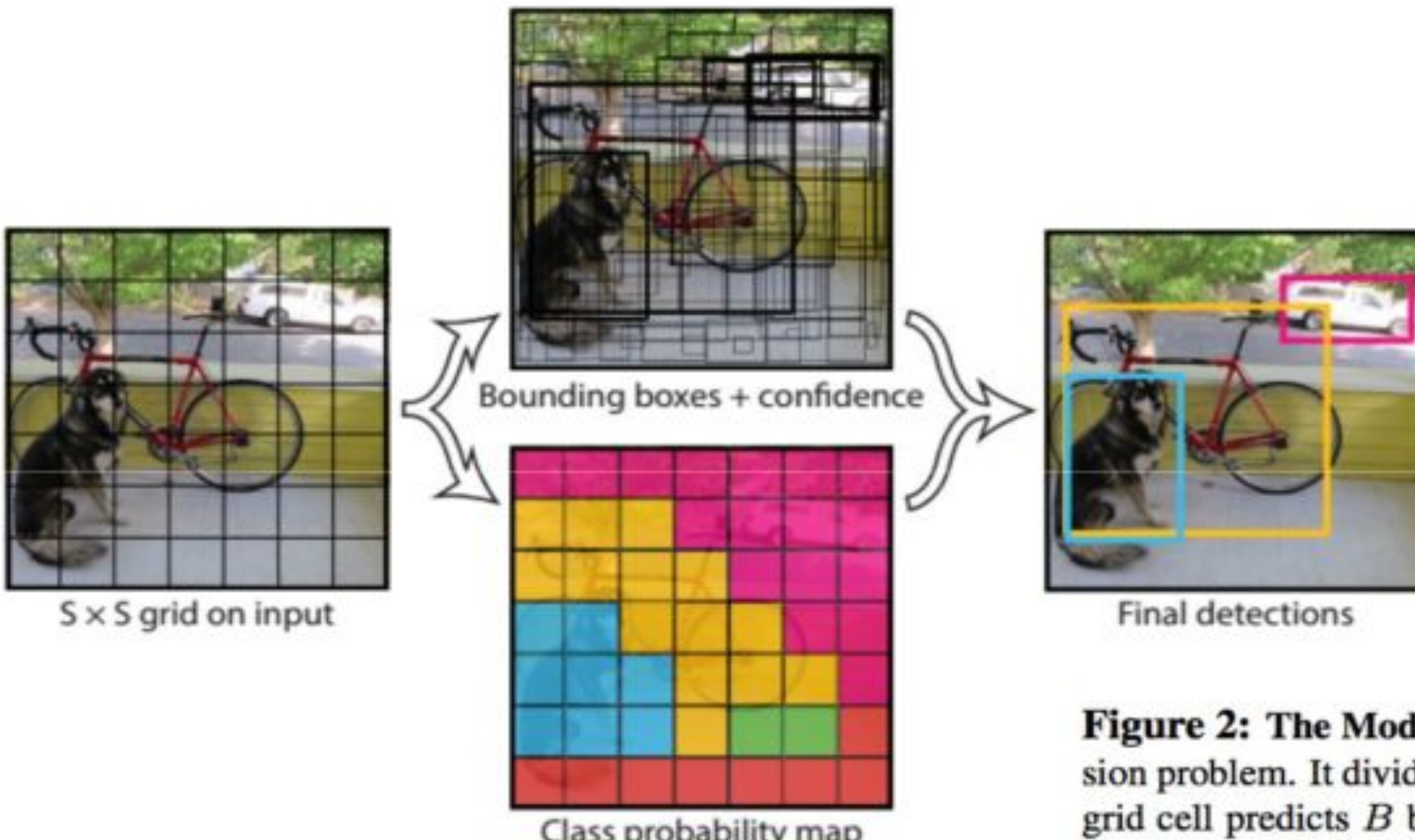


Figure 2: The Model.
sion problem. It divides
grid cell predicts B bou
and C class probabiliti

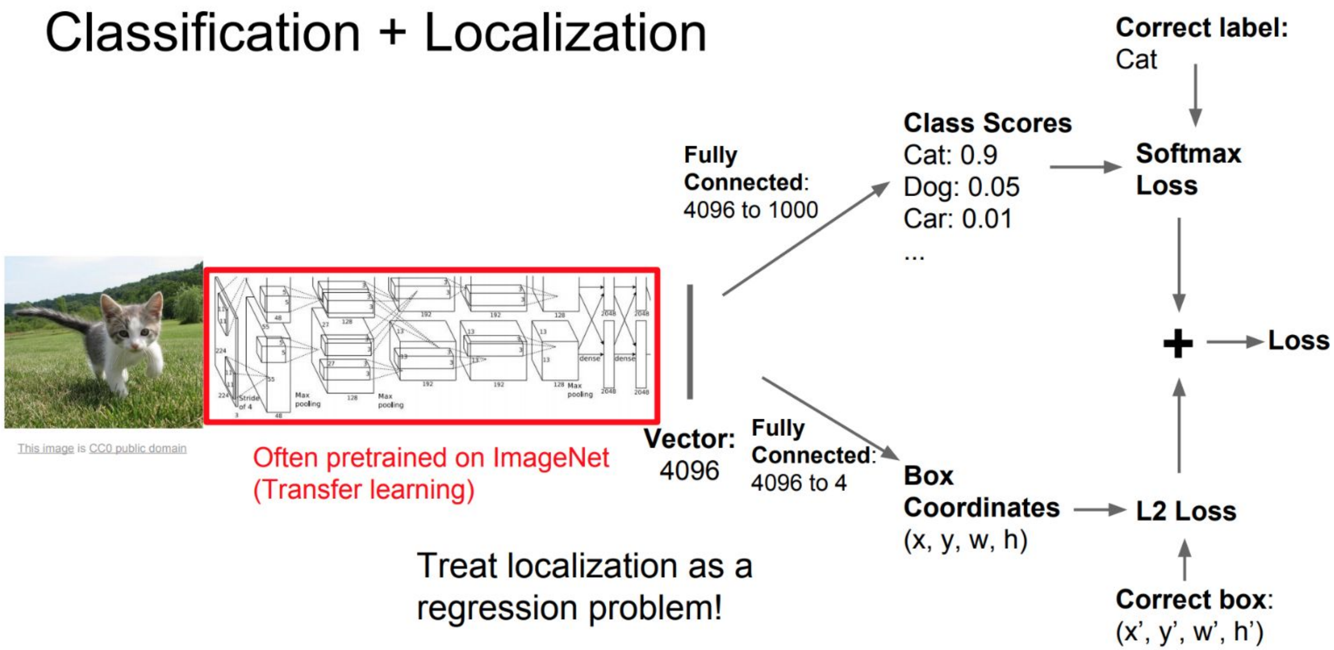
You Only Look Once

- YOLO first appeared in 2016 and was voted the OpenCV's People Choice Award at CVPR.
- YOLOv2 was later released where Batch Normalization was added which resulted in map improvements of 2%. It was also fined tuned to work at higher resolution (448 x 448) giving a 4% increase in map.
- YOLO3 was fined tuned even further and introduced multi-scale training to better help detect smaller objects.

Classification using CNN

- Once the fruit is localized, that portion is extracted and used for Classification.
- The image is given as input to the model and the trained model will give output as Artificial or Natural.

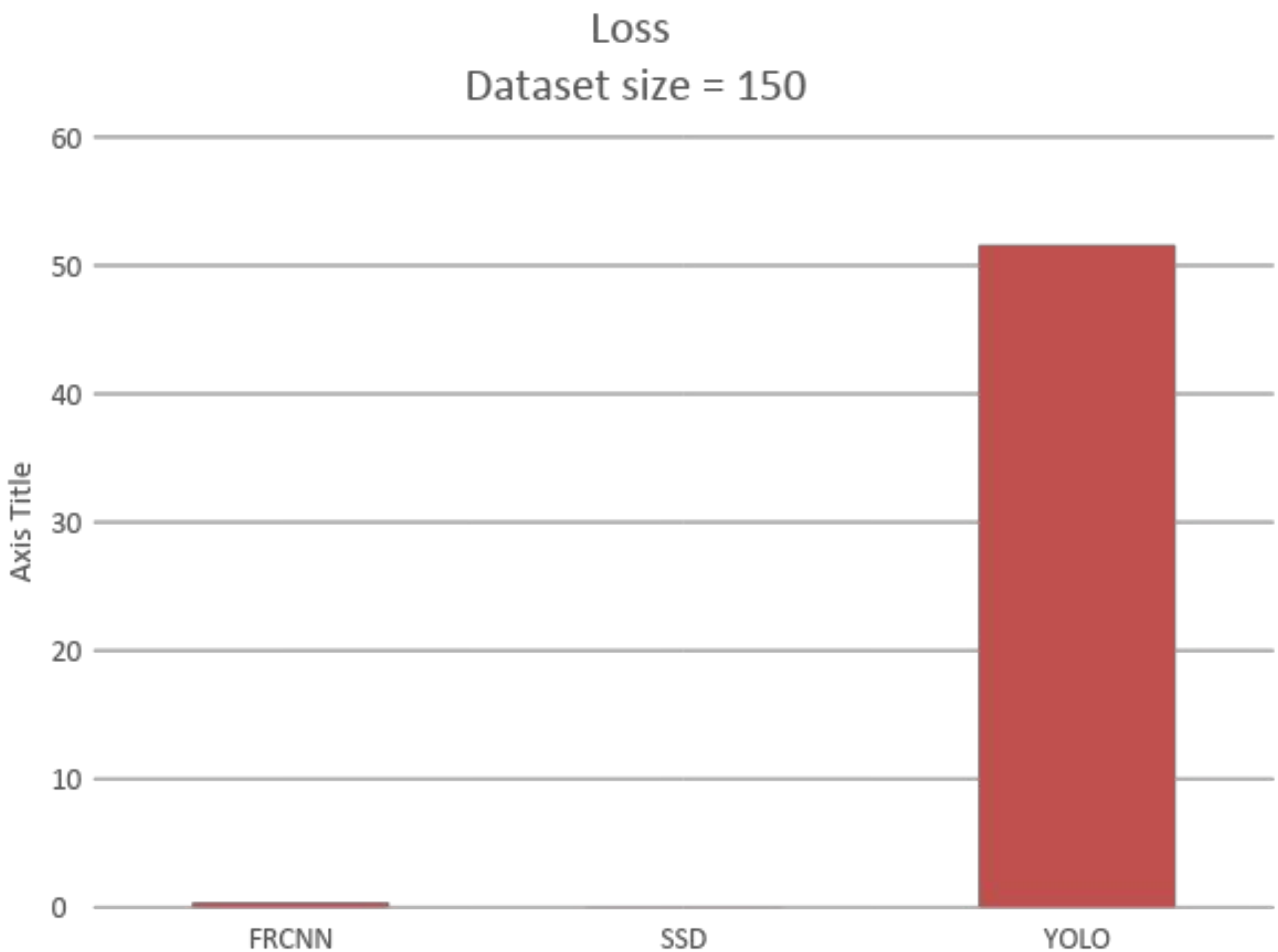
How the loss is computed?



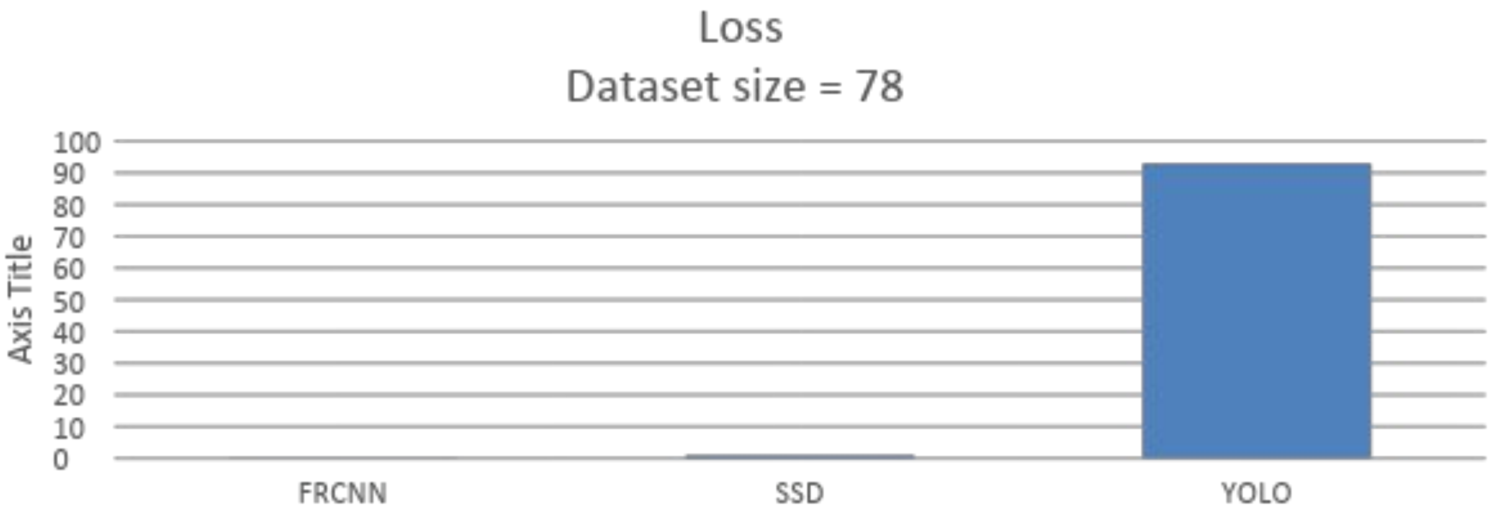
$$L(\{p_i\},\{t_i\}) = \frac{1}{N_{cls}}\sum_i L_{cls}(p_i, p_i^*) + \lambda \frac{1}{N_{reg}}\sum_i p_i^* L_{reg}(t_i, t_i^*).$$

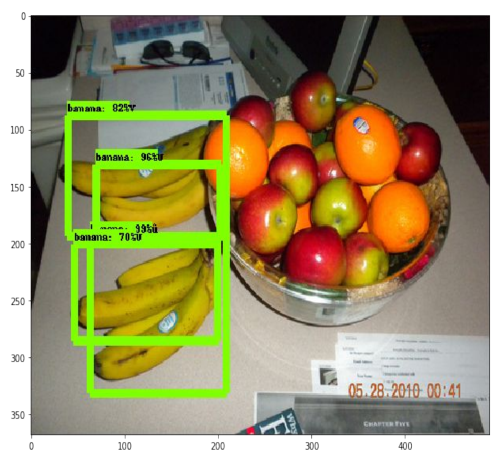
Here *i* is the index of the anchor in the mini-batch. The classification loss $L_{cls}(p_i, p_i^*)$ is the log loss over two classes (object vs not object). p_i is the output score from the classification branch for anchor *i*, and p_i^* is the groundtruth label (1 or 0). The regression loss $L_{re}(t_i, t_i^*)$ is activated only if the anchor actually contains an object i.e., the groundtruth p_i^* is 1. The term t_i is the output prediction of the regression layer.

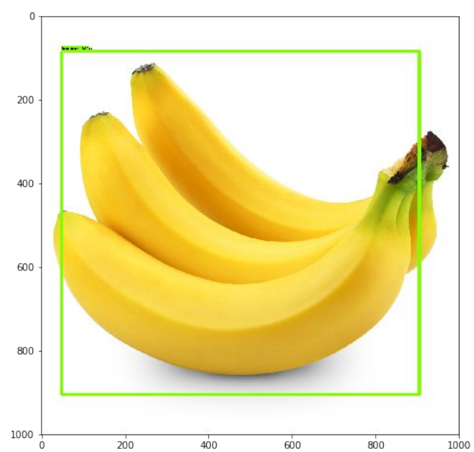
Result on Fruits-360 Dataset



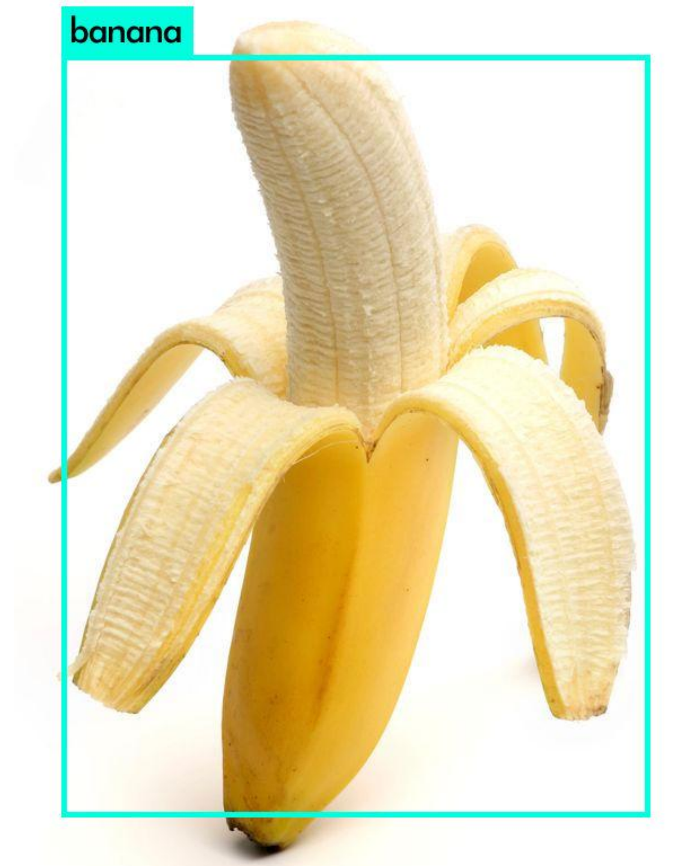
Result on ‘Fruit Images for Object Detection’ Dataset



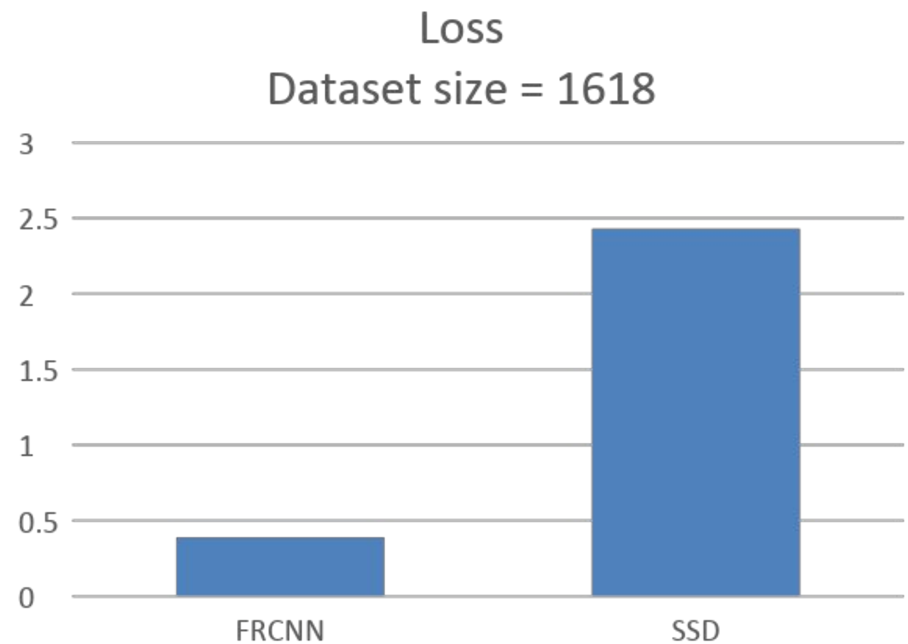




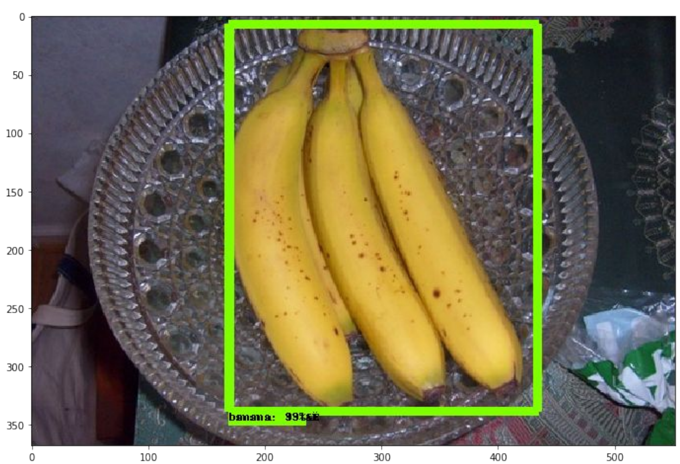
YOLO-Darknet Output for ‘Fruit Images for Object Detection’ Dataset



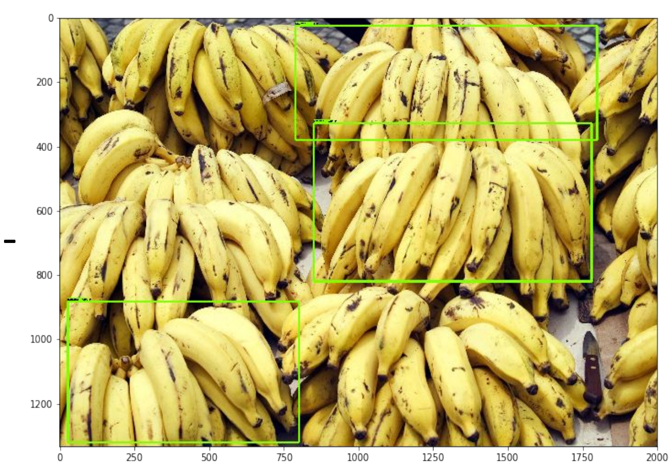
Result on ‘COCO’ Dataset



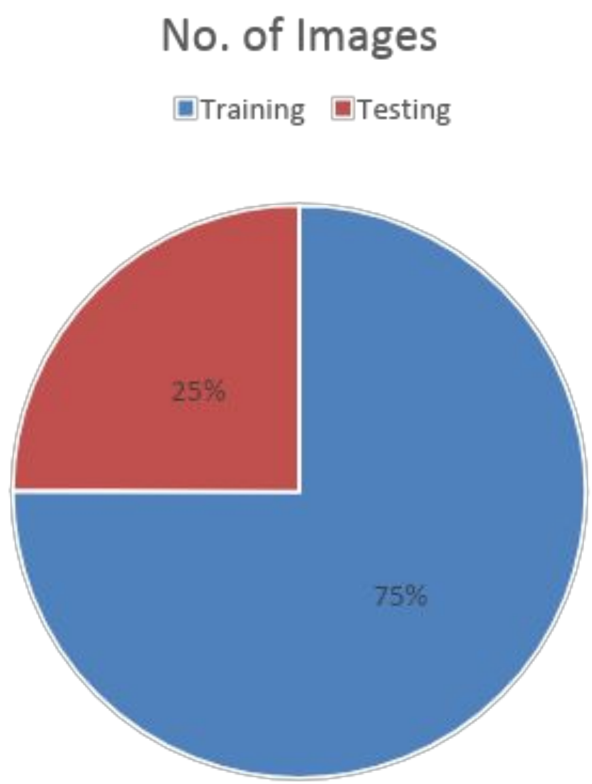
FRCNN -



SSD -



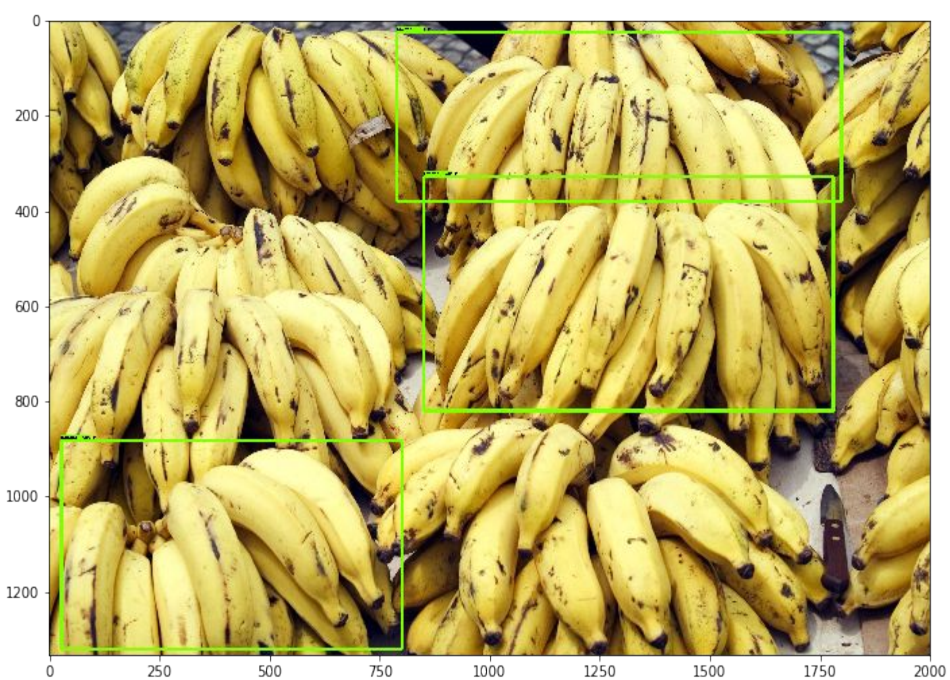
Result of Classification



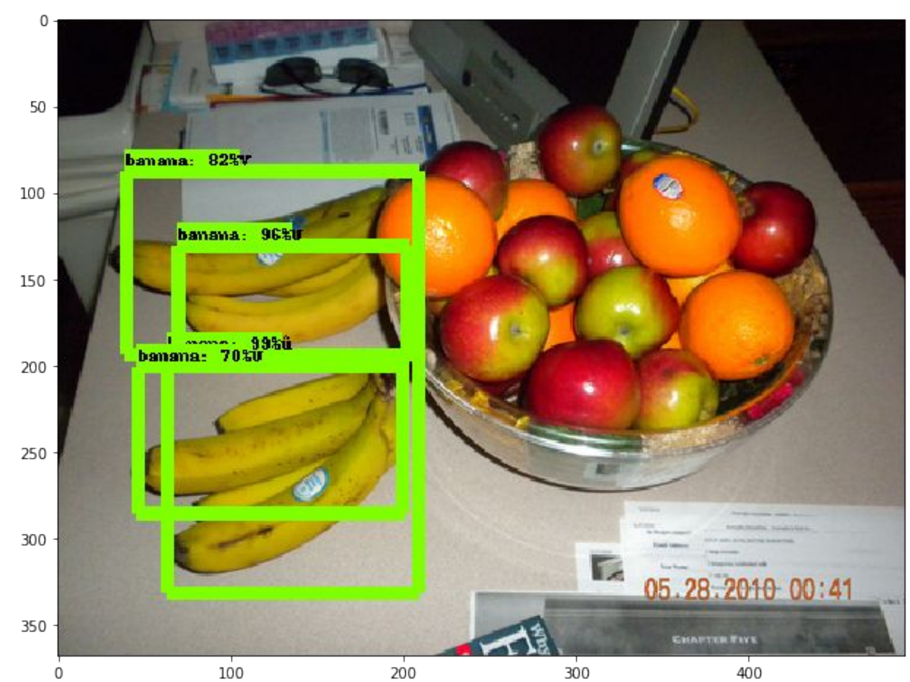
Epoch = 50
Batch Size = 128
Accuracy =84%

Comparison of Object Detection methods

- While SSD and FRCNN gave good outputs after training with COCO dataset, In certain conditions SSD has better outputs.



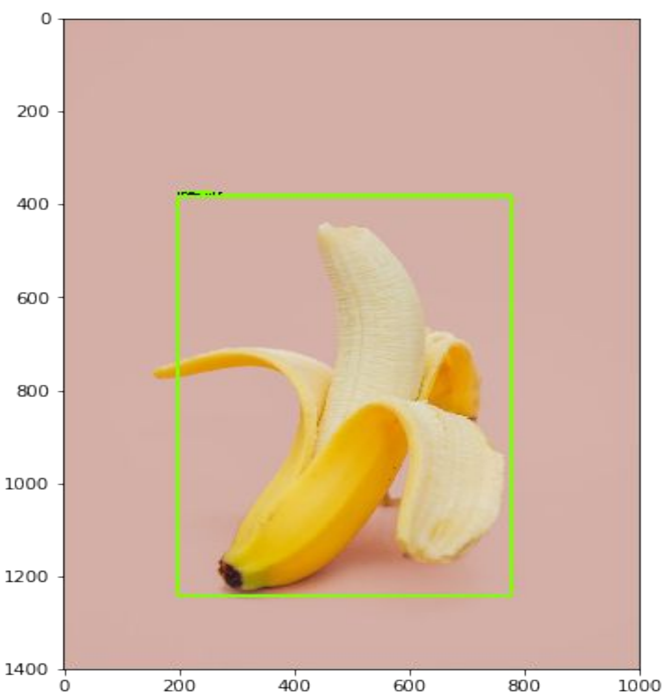
SSD



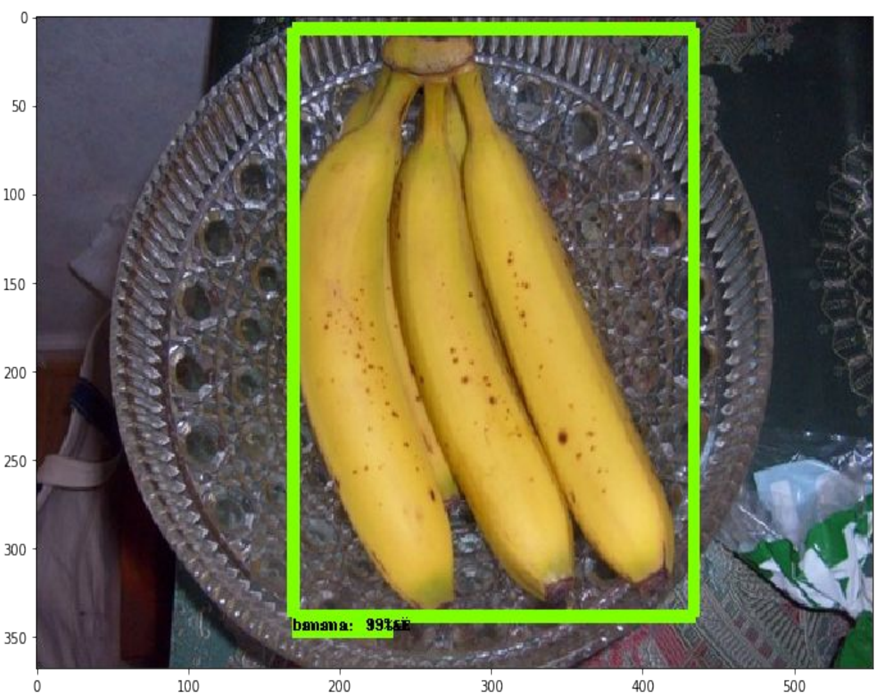
FRCNN

Comparison of Object Detection methods

- SSD is faster than FRCNN in computing output to an unknown sample.



SSD



FRCNN

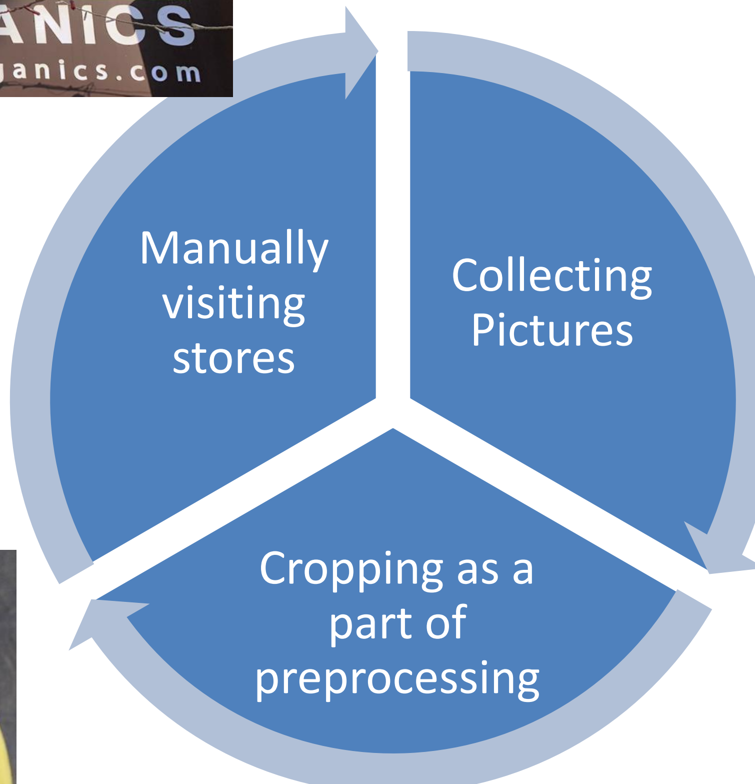
Comparison of Object Detection methods

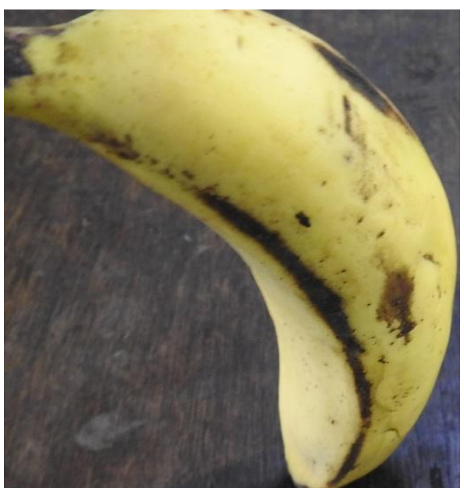
- FRCNN detects in noisy image while SSD does not work.

SSD

FRCNN

Data Collection





Data Collection

- List of stores visited for data collection
  1. Mahalaxmi vegetable market
  2. wholesale hub
  3. general juice stall
  4. general fruit store
  5. Ayuda Organics
  6. Paraj Organics
  7. SOSE Suryan Organic store & Eatery

Data Collection

Naturally Ripened Bananas

Data Collection

Artificially Ripened Bananas

Data Collection

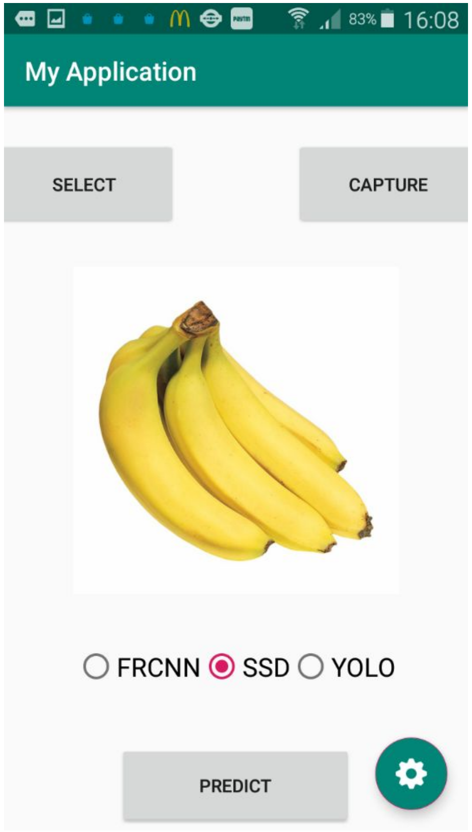
- These are the information of images collected

	Naturally Ripened	Artificially Ripened
Camera	Oneplus 6T and Nikon cool pix p900	Oneplus 6T and Nikon cool pix p900
Total images	713	554
Total cropped images	1545	1034

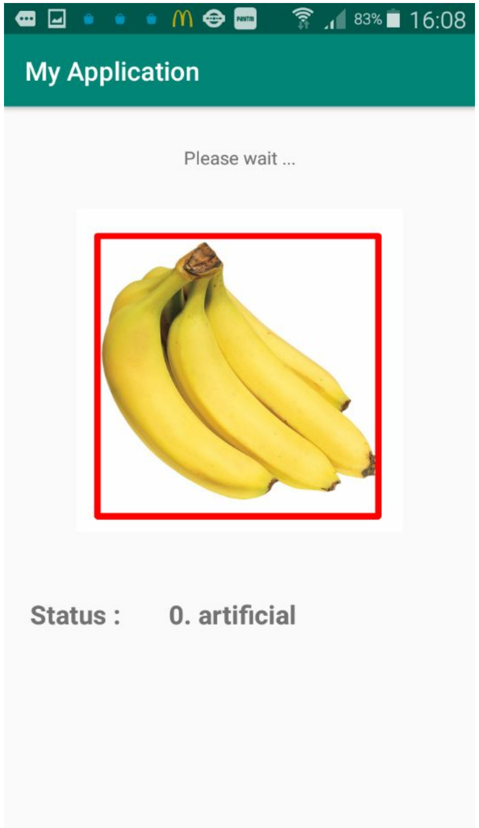
- After collecting images they were cropped to get good information by removing unwanted backgrounds.

Mobile application

Application for acquisition and testing of subject (Banana) images.



Upload or capture image of banana and select one of the object detection algorithm



Gives detected photo of banana and displays classification status

CONCLUSION

- We have explored the potential of deep learning in automatic fruit classification on the basis of their ripening method.

- The proposed method extracts the required fruit image from a scene.

- Diff. architectures offer different accuracies ranging from 0.15 to 1.05

- Dataset generation for fruit classification based on ripening method has been generated and is ongoing

Future Work

Training different classifiers for the classification of fruit based on ripening method and choosing the best and most efficient model, and also extending the dataset

Updating features in the mobile application for image acquisition.

REFERENCES

- **Paper** - “Identification of Artificially Ripened Fruits using Machine Learning.” 2nd International Conference on Advances in Science & Technology (ICAST-2019)
  - Vaviya, Harshad, et al. "Identification of Artificially Ripened Fruits Using Machine Learning." *Available at SSRN 3368903* (2019).
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  - http://cocodataset.org/#home

Thank You