

## Introduction

The goal of this project is to observe the performance gains of object detection using a generative adversarial networks (GAN) to increase the resolution of satellite imagery, and determine the difference in performance of object detection on 0.3 m/px and 1.2 m/px resolution data. Deep learning models built are a **You Only Look Once (YOLO)** system for object detection, and a **Super Resolution Generative Adversarial Networks (SRGAN)** system for super resolution (SR). Results showed that object detection performance of YOLO can be increased by SRGAN.



Figure 1. Images synthesized using SRGAN and original dataset. Left column: left is SRGAN, right picture is original. Right column: top is original, bottom is SRGAN.

## Motivation

Object detection algorithms often struggle with low-resolution objects. SR seems to be an appropriate solution for this problem, but most approaches lack a quantitative measurement for SR images. In this project we quantitatively analyzed using a SRGAN model to improve the performance of the baseline object detection model.

## Data

Satellite imagery from the xView Dataset [1]. 50 training, 11 testing. Each images is around 10,000px x 10,000px in size. (3 km<sup>2</sup>)

Class Label (train)	# of Ground Truth	Class Label (test)	# of Ground Truth
Building	59919	Building	7076
Small Car	1951	Small Car	840
Bus	1254	Truck	314
Cargo Truck	805	Bus	238
...	...	...	...

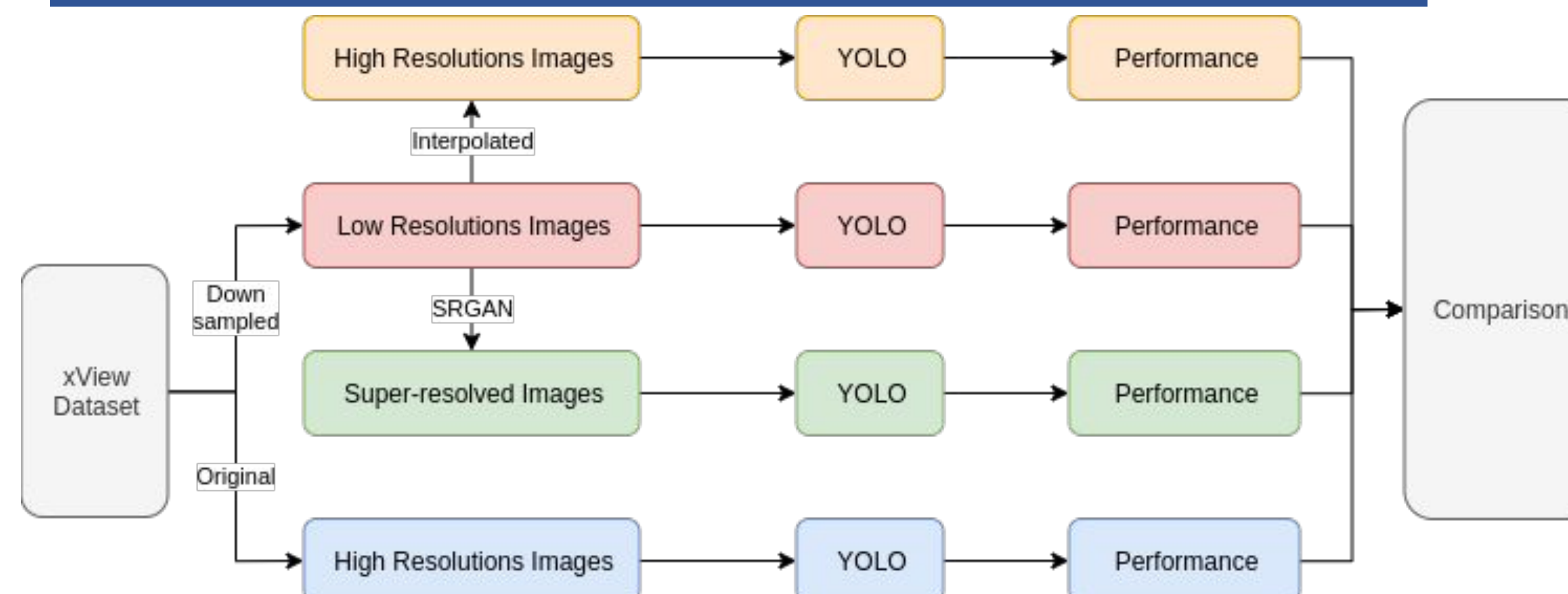
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## References

- [1] Darius Lam, Richard Kuzma, Kevin McGee, Samuel Dooley, Michael Laielli, Matthew Klaric, Yaroslav Bulatov, and Brendan McCord. xview: Objects in context in overhead imagery. 02 2018.
- [2] Image source: Efficient Implementation of MobileNet and YOLO Object Detection Algorithms for Image Annotation. <https://hackernoon.com/efficient-implementation-of-mobilenet-and-yolo-object-detection-algorithms-for-image-annotation-717e867fa27d>

## Project Flow



## Models - YOLO

We utilize YOLO for unified object detection. YOLO detection system first resizes the input image into a grid, and thresholds the resulting detections by the models confidence. (Figure 2.)

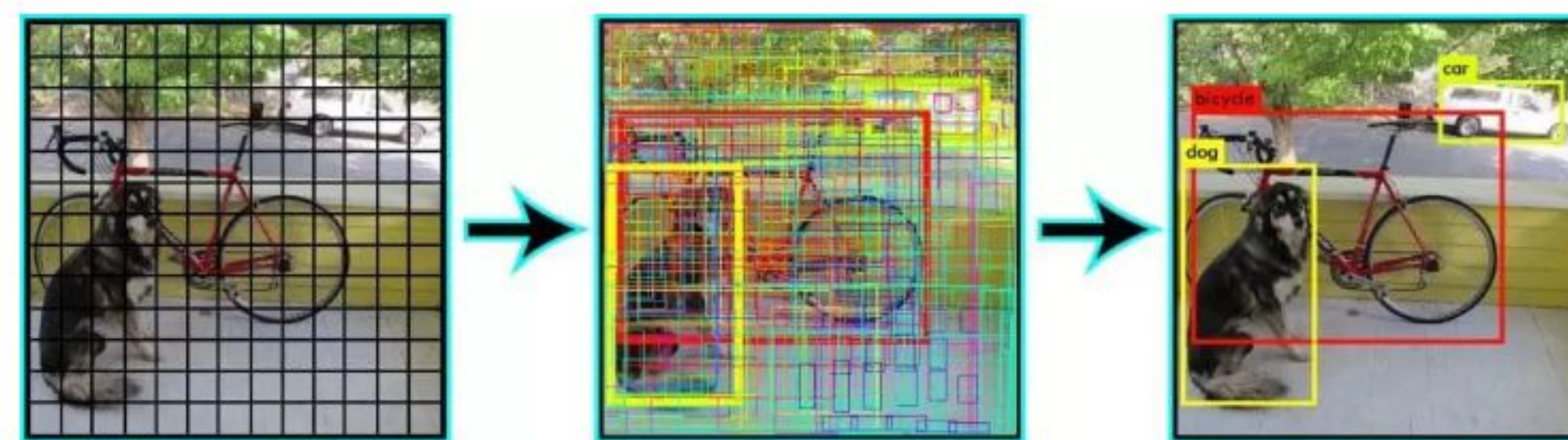


Figure 2. A demonstration of YOLO detection system [2]

## Models - SRGAN

A generative adversarial network (GAN) is a model that contains two neural networks: a generator and discriminator). The GAN learns to generate new data with same statistics as the training set. A super resolution generative adversarial network (SRGAN) is a GAN that increases the resolution of low-resolution (LR) images by training on corresponding high-resolution (HR) images. By synthesizing sub pixel information in LR imagery a SRGAN generates super-resolved (SR) images.

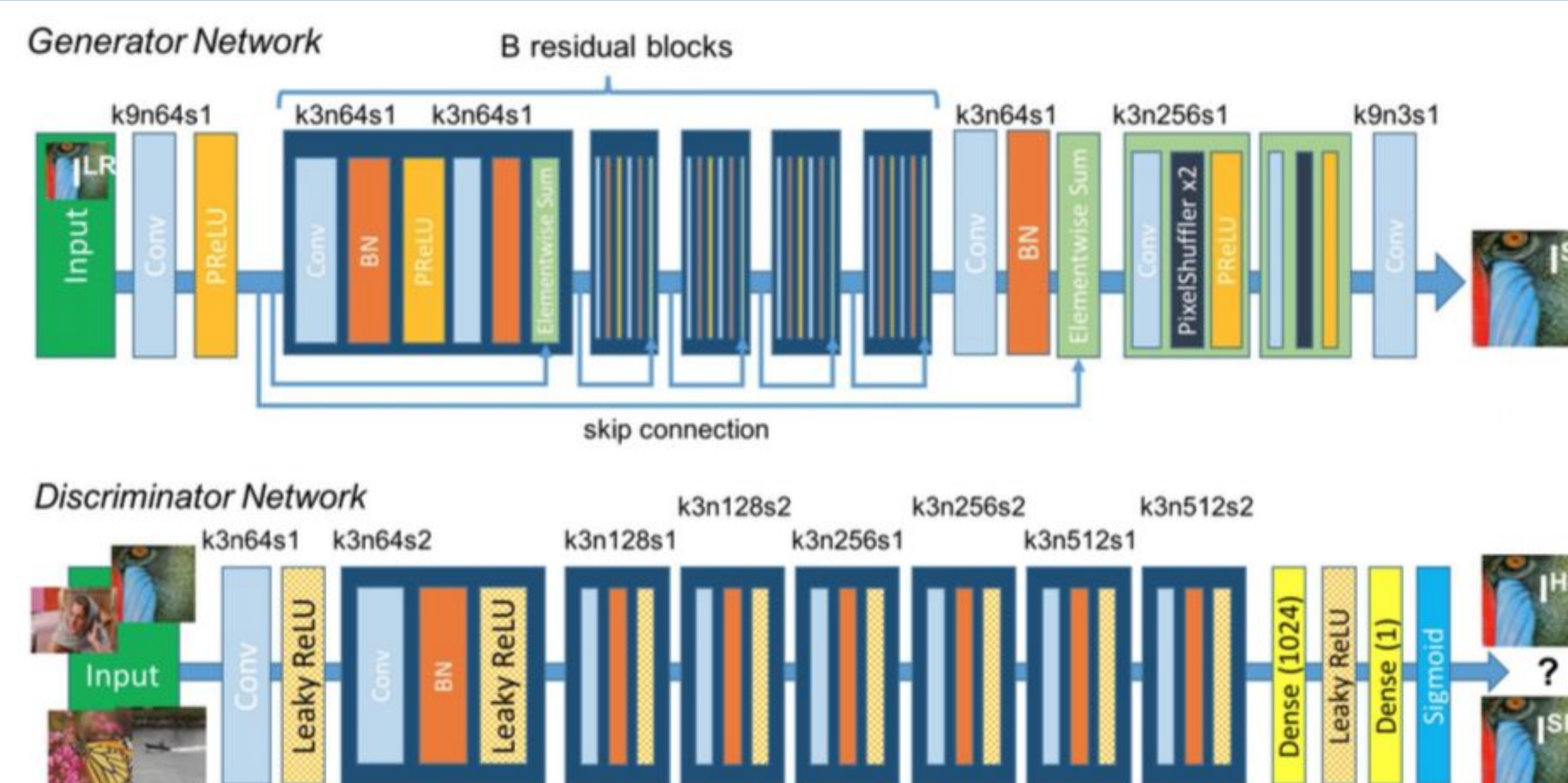


Figure 3. The network architecture of SRGAN system. [3]

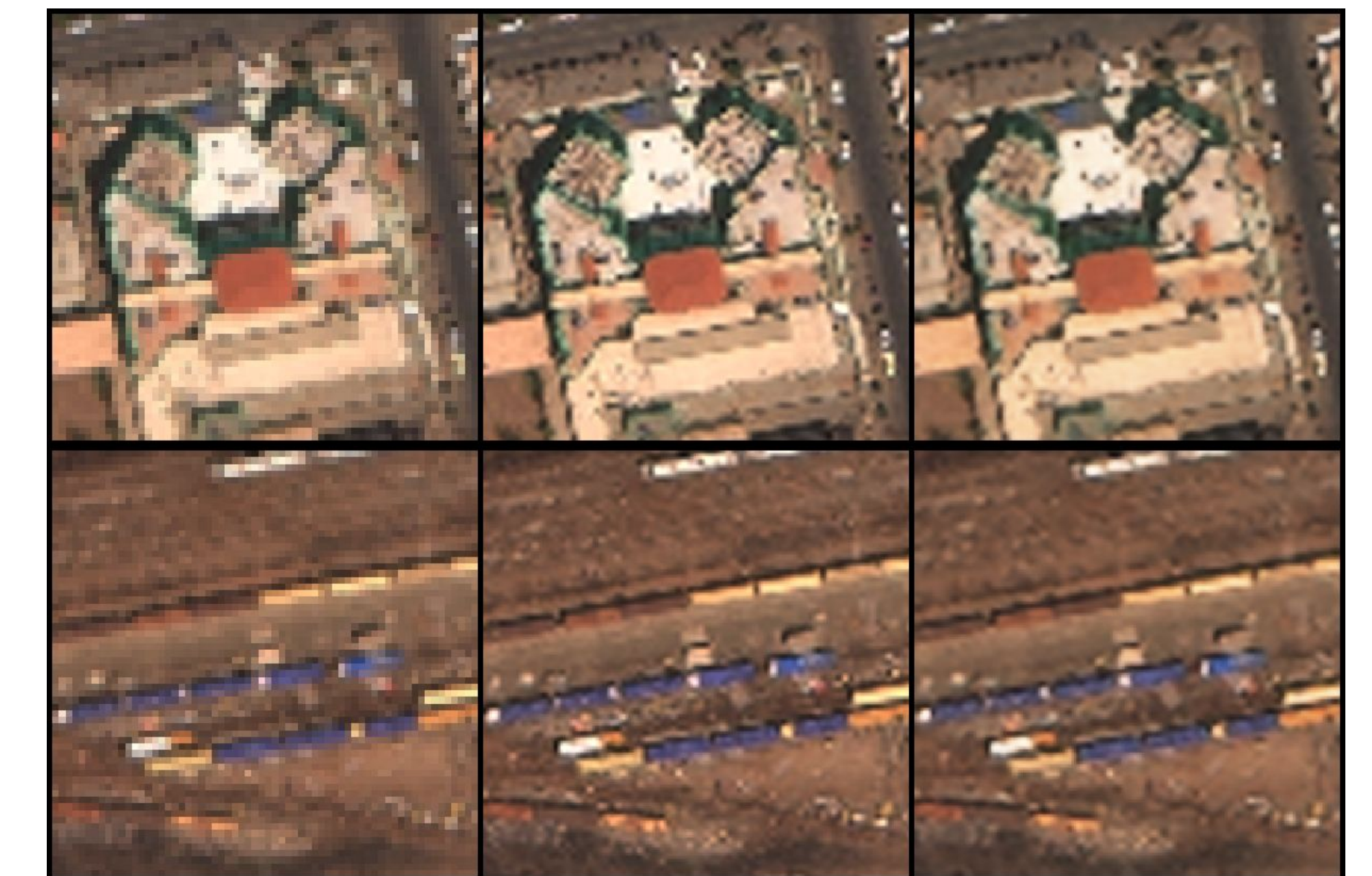


Figure 4. From left to right: the low resolution images, the original high resolution images, the super resolved images by the SRGAN.

## Test Results

	#	Upsampled mAP	Original mAP	Generated mAP	Downsampled mAP
Plane	32	0.308709	0.590898	0.609714	<b>0.788502</b>
Building	7076	0.239417	0.190386	<b>0.328532</b>	0.18349
Yacht	86	0.0344961	<b>0.238569</b>	0.0307962	0.0523159
Car	840	0.0999877	<b>0.207925</b>	0.0285936	0

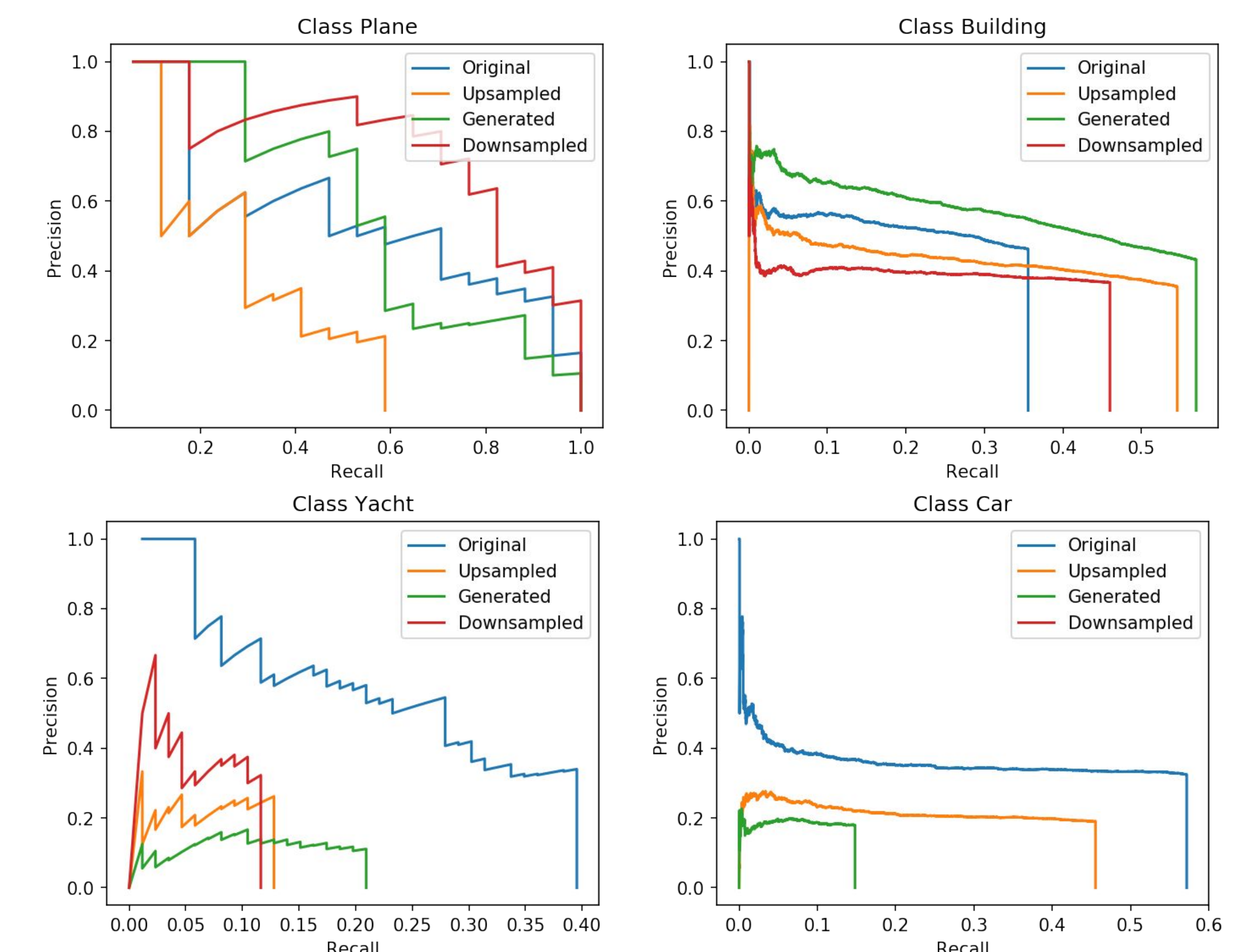


Figure 5. PR curves of YOLO detection for different classes of objects.

- [3] Christian Ledig, Lucas Theis, Ferenc Huszar, Jose Caballero, Andrew Cunningham, Alejandro Acosta, Andrew Aitken, Alykhan Tejani, Johannes Totz, Zehan Wang, and Wenzhe Shi. Photo- realistic single image super-resolution using a generative adversarial network. pages 105–114, 07 2017.