Segmentation of images

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INTRODUCTION:Segmentation

⟹Image Segmentation is the process of partitioning a digital image into multiple segments.

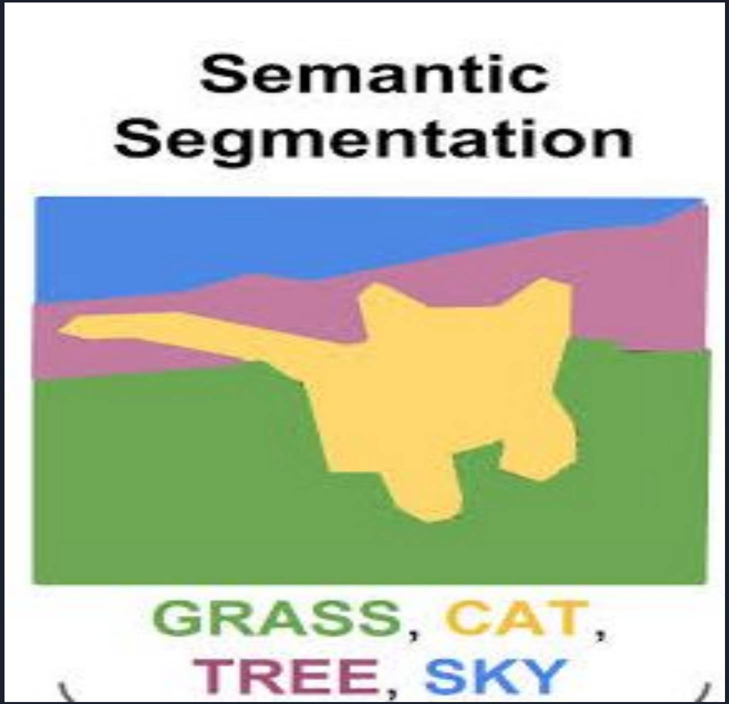
⟹In Deep learning Segmentation is classification of each image pixel.

Types of segmentations implemented :

⟹Semantic segmentation.

⟹Instance segmentation.

Image segmentation



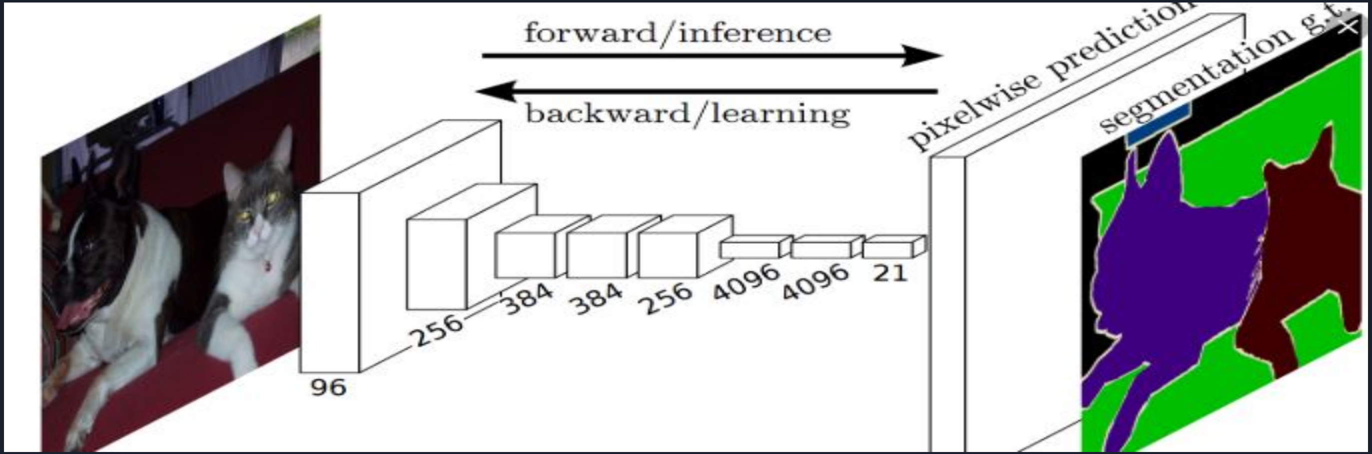
Semantic Segmentation

Implemented two papers for semantic segmentation:

⇒FCN(Fully convolutional Network)

⇒U-Net

FCN(Fully Convolutional Network)



In FCN the gradients doesn't flow upto the first layers of encoder i.e vanishing gradient problem.

Instance Segmentation

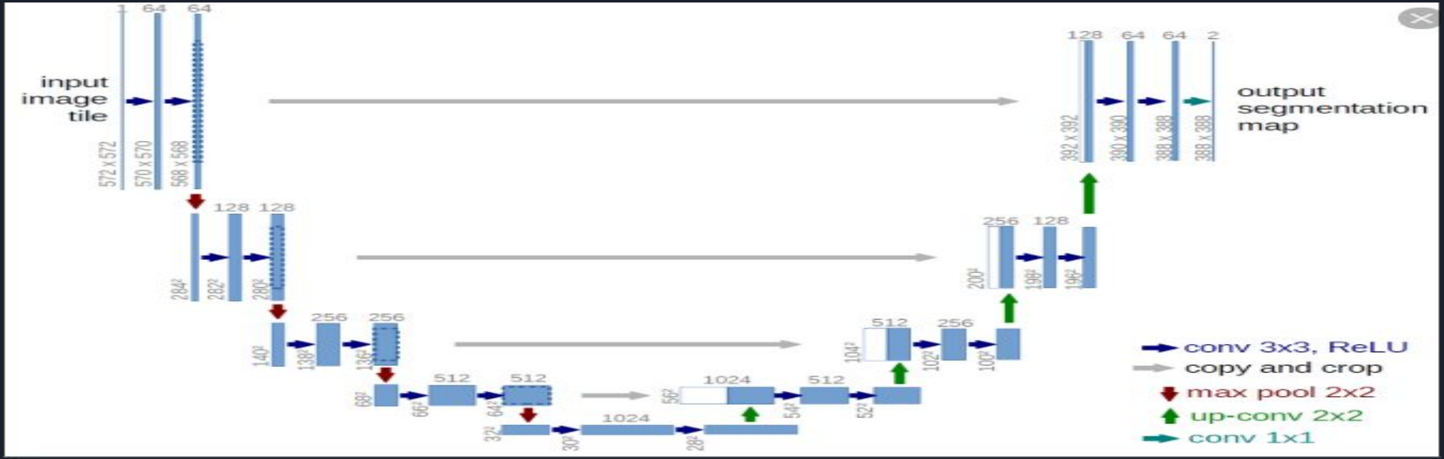
Implemented one paper for Instance segmentation:

1)Mask R-CNN(Region Convolutional Neural Network)

Results of FCN(Fully Convolutional Network)

⟹FCN was able to perform well with binary segmentation i.e Semantic segmentation with two classes.
⟹The following results are by FCN trained by loss function binary cross entropy for 10 epochs.

U-Net



⇒In UNet there is a healthy gradient flow due to the skip layers in UNet .

⇒In Unet the gradients directly flows to the encoding layers through skip layers.

⇒Skip layers preserve the information of image in decoding layers.

How UNet prevents vanishing gradient problem.

$Let\ the\ model\ contain\ four\ Fully\ connected\ layers(L1, L2, L3, L4).$

$Let\ w1, w2, w3\ be\ weight\ matrices\ between\ each\ layer.$

$Let\ A2, A3, A4\ be\ the\ activations\ of\ layers\ (L2, L3, L4)$

$Let \frac{\partial E}{\partial o}\ be\ \partial o.$

$$\implies \partial w1 = (\partial o) * (A4(o)') * (w3) * (A3(L3)') * (w2) * (A2(L2)')$$

$\implies This\ above\ term\ may\ vanish\ beacause\ derivatives\ of\ activation\ functions\ are\ less\ than\ 1.$

$\implies To\ avoid\ this\ we\ are\ going\ add\ a\ skip\ layer\ from\ L4\ to\ L2.$

$Then\ \partial(new\ w1) = \partial(w1)(Due\ to\ back\ propagation) + \partial(o)(Due\ to\ skip\ layer)$

$$\implies \partial(w1) = (\partial o) * (A4(o)') * (w3) * (A3(L3)') * (w2) * (A2(L2)') + (\partial o)$$

$In\ this\ way\ we\ can\ avoid\ vanishing\ gradient\ problem\ using\ skip\ layers.$

$This\ extra\ gradient\ is\ going\ to\ be\ a\ valid\ gradient\ because\ previously\ the\ model\ is\ trained\ for\ output(O)\ after\ adding\ skip\ layers\ it\ will\ trained\ for(output(o) - L2).$

UNet Results

⟹First Implemented UNet for colouring of grey scale images .
⟹Used Nearest neighbour method in the last layer to see the nearest colour for the pixel in the given set of colours.
⟹The required colours are unique colour pixels in whole dataset.

⟹The UNet is trained for 25 epochs with a batch size of 100 images and with a loss criterion categorical cross entropy.

⟹The optimizer used for UNet is Adam with default momentum.

UNet Results:

⟹The First row are the input grey scale images for UNet.

⟹The Second row are the ground truth images.

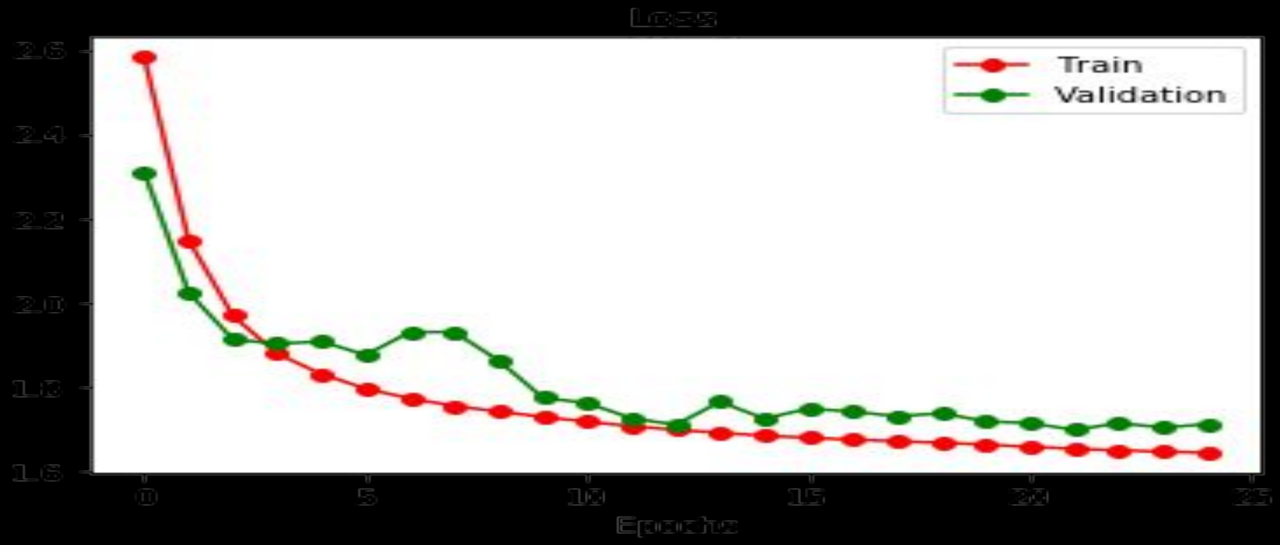
⟹The Third row contains the predicted image of UNet.

⟹The images are of low resolution of 32x32x3.

UNet Results

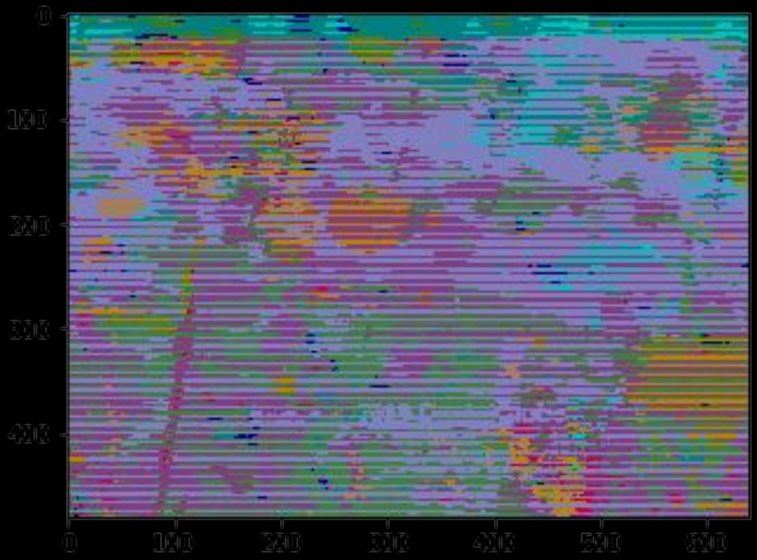
⟹The below plot is Training and validation loss plotted vs epochs.

⟹Y-axis represents loss and X-axis represents epochs.



UNet Results on satellite images

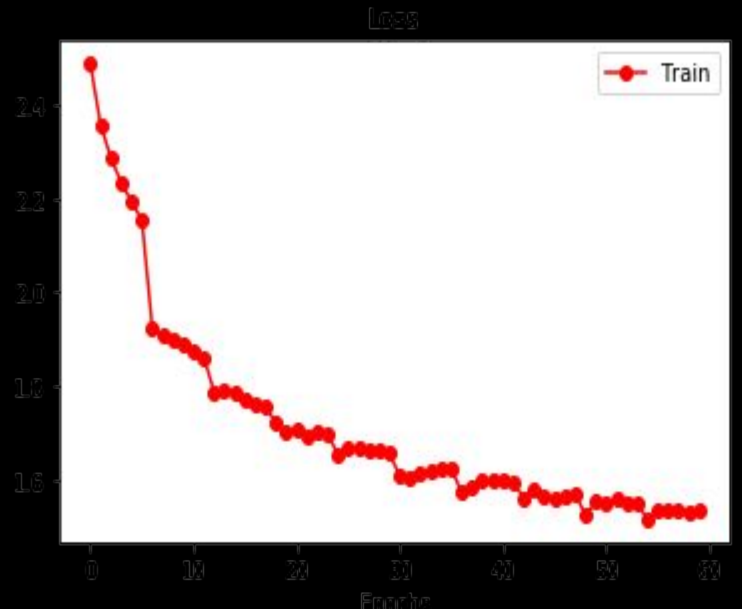
⟹The UNet is trained on segmentation of satellite images with categorical cross entropy loss and with Adam as optimizer for 25 epochs.
⟹Below image is the predicted image of Unet.The results were very bad on satellite images.



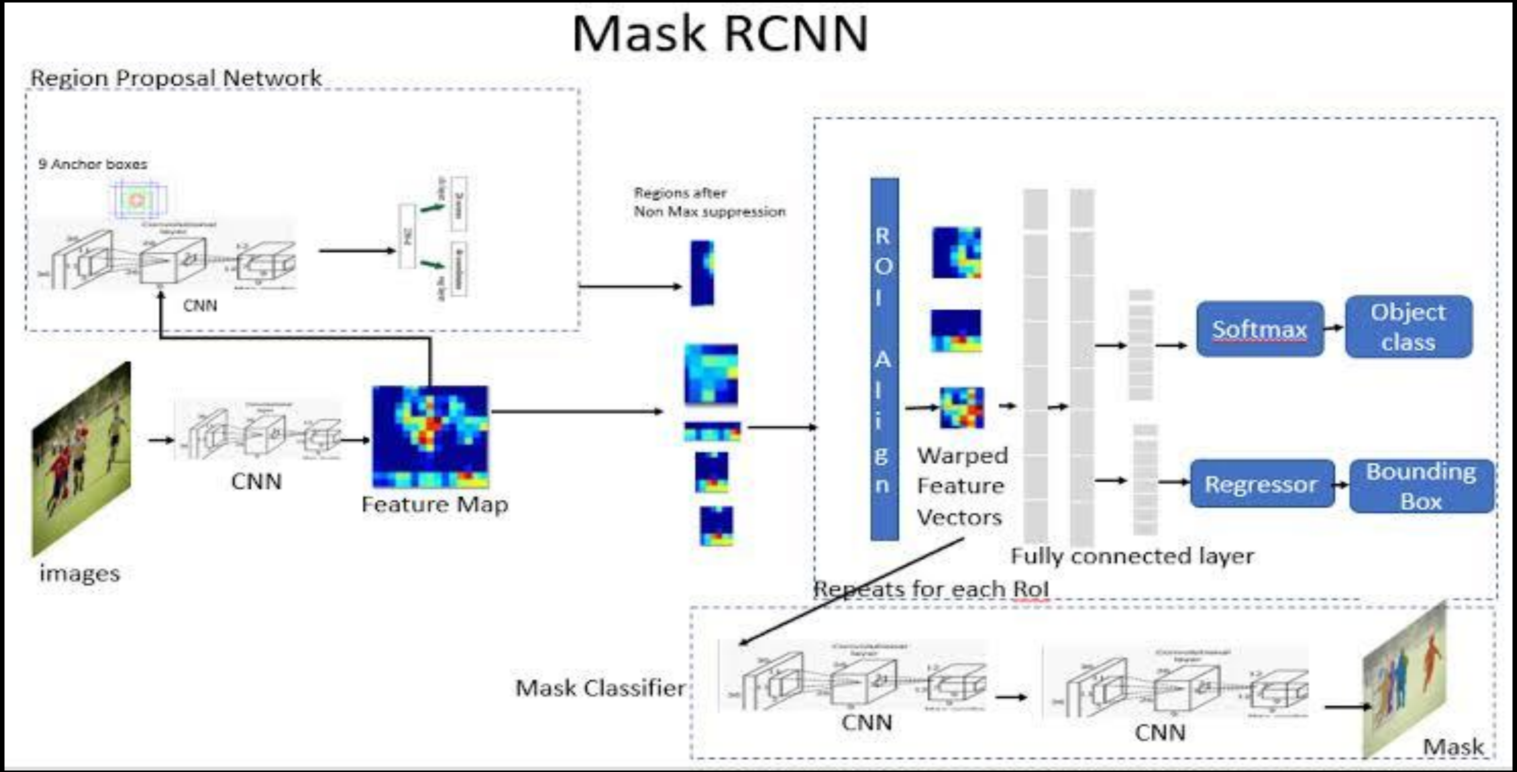
UNet Results

⟹The below plot is Training loss plotted vs epochs.

⟹Y-axis represents loss and X-axis represents epochs.



Instance segmentation using Mask-RCNN



Mask RCNN

⟹The Mask RCNN is trained on Microsoft coco dataset.

⟹The model is trained on ms-coco dataset with three losses One for bounding box loss,other for mask loss and last is classification loss.

⟹Each loss uses negative log likelihood as the loss criteria for training with Adam as optimizer.

Results of Mask RCNN