Line Detection using CNNs

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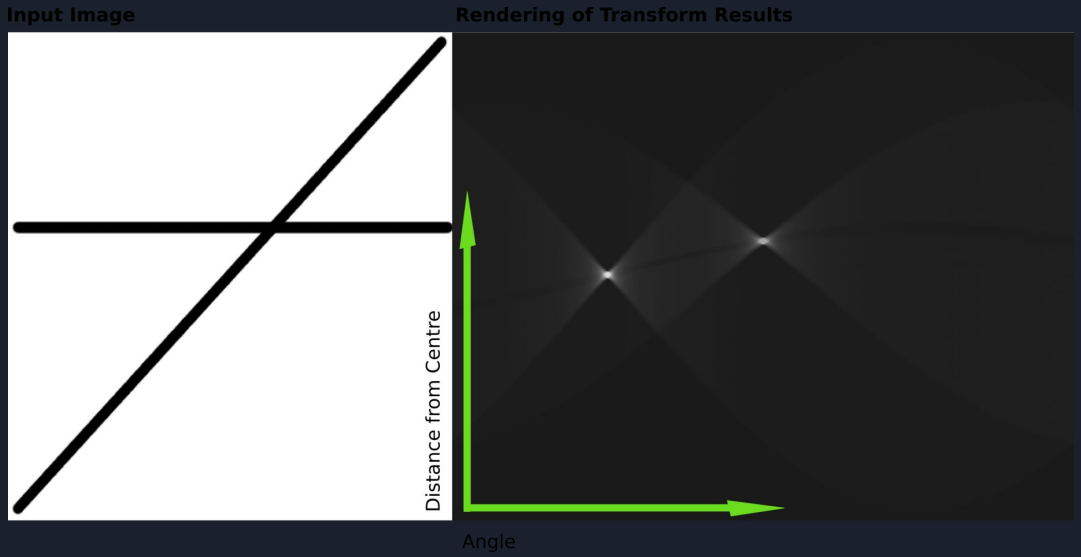
Background/Motivation: Hough Transform

Definition: Hough Transform is an image processing algorithm to detect parameters of any geometric shape in a binary image by populating an accumulator a.k.a *hough space*.



Background/Motivation: Hough Transform (cont...)

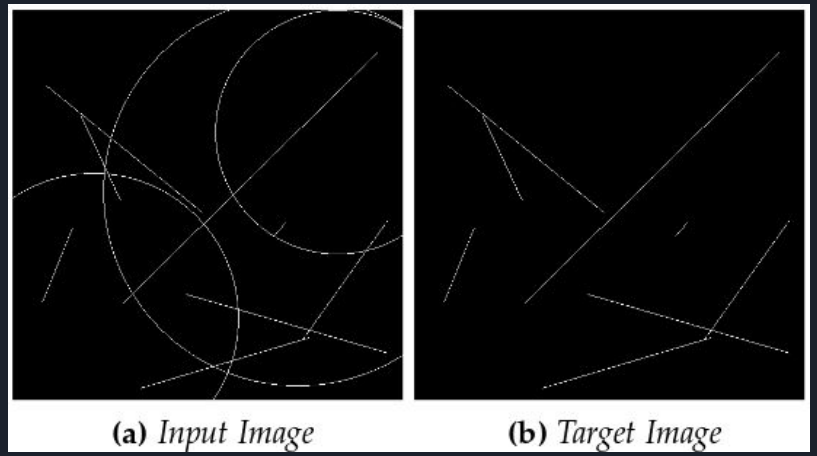
Drawbacks:

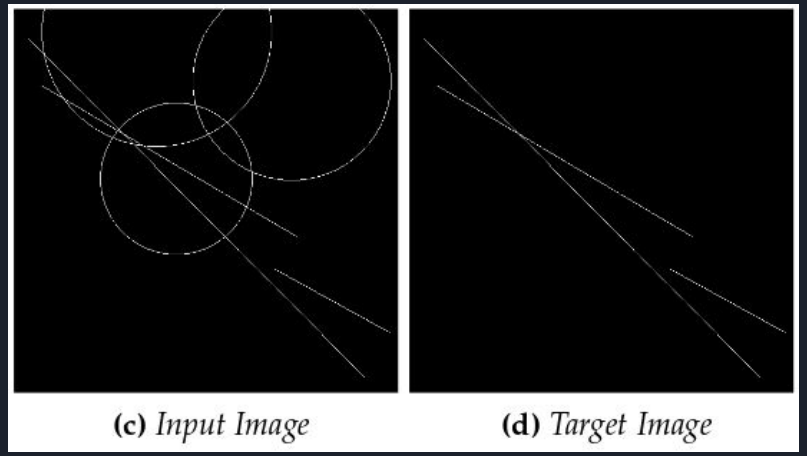
1. Hyperparameter fine-tuning at test-time.
2. Computationally costly to accumulate N-dimensional array.

Solution: End-to-end CNN

1. No hyperparameter tuning at test-time.
2. Can run in real time (in GPU environment)

Dataset: Generated Synthetically





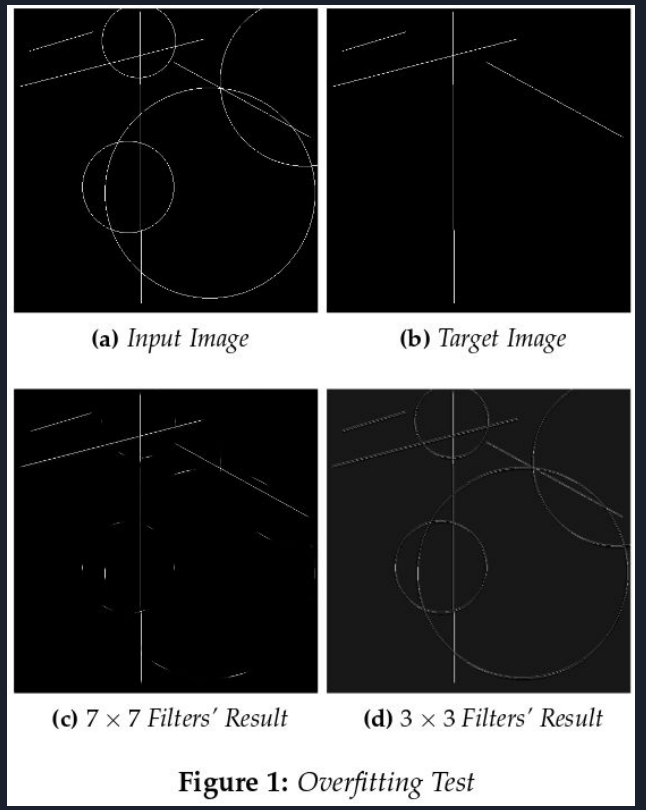
Split

Training: 10,000 Validation: 100 Test: 100

Hypothesis: Bigger receptive field ⇒ better performance

Reasoning: Arbitrary geometric shape (triangle, for instance) might look identical to line in local spatial neighborhood.

Overfitting Test



(a) *Input Image* (b) *Target Image*

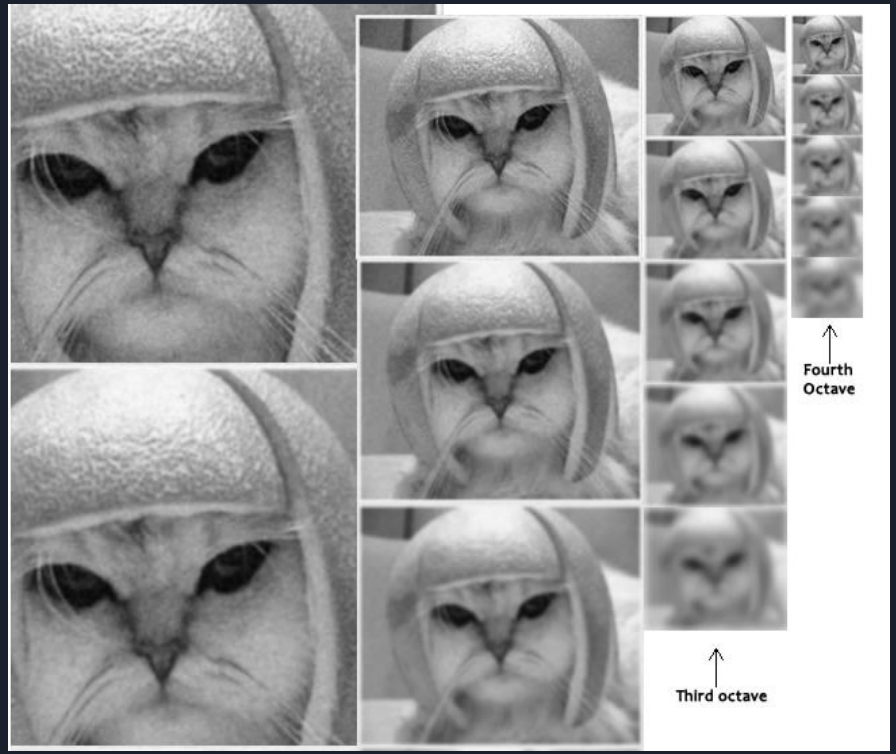
(c) 7×7 *Filters' Result* (d) 3×3 *Filters' Result*

Figure 1: *Overfitting Test*

Hypothesis: Bigger receptive field ⇒ better performance (cont...)

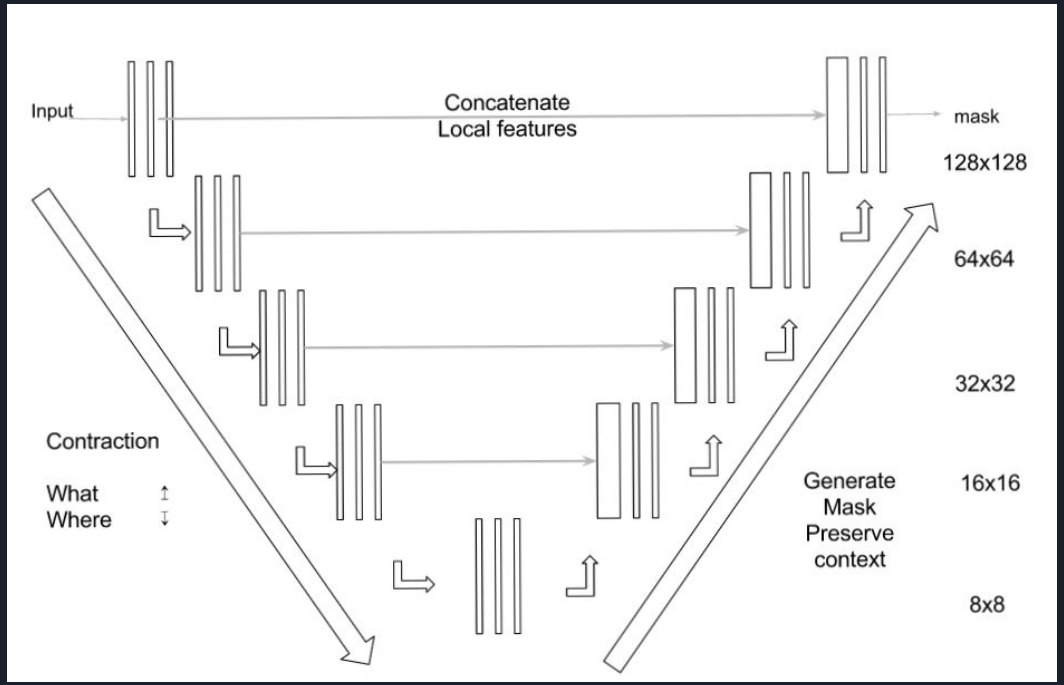
Solution:

Scale-Space



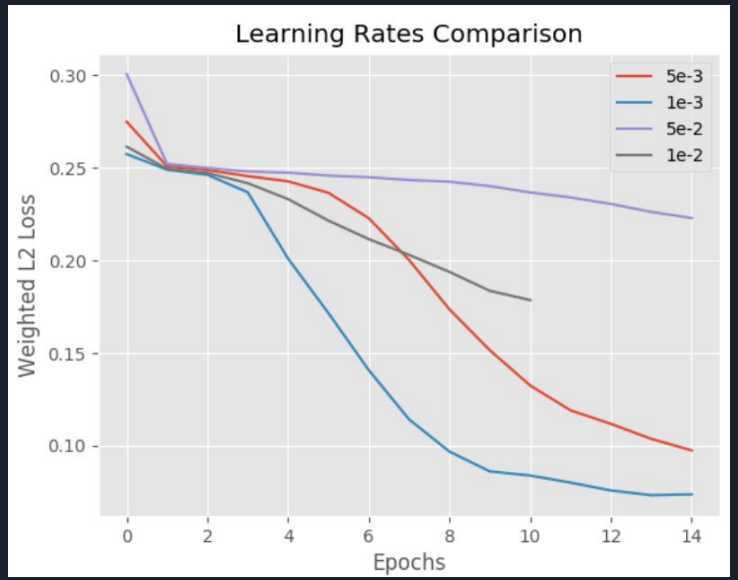
Hypothesis: Bigger receptive field ⇒ better performance (cont...)

Solution: Scale-Space ⇒ UNets



Tuning the learning Rate + Training Details

Learning Rate

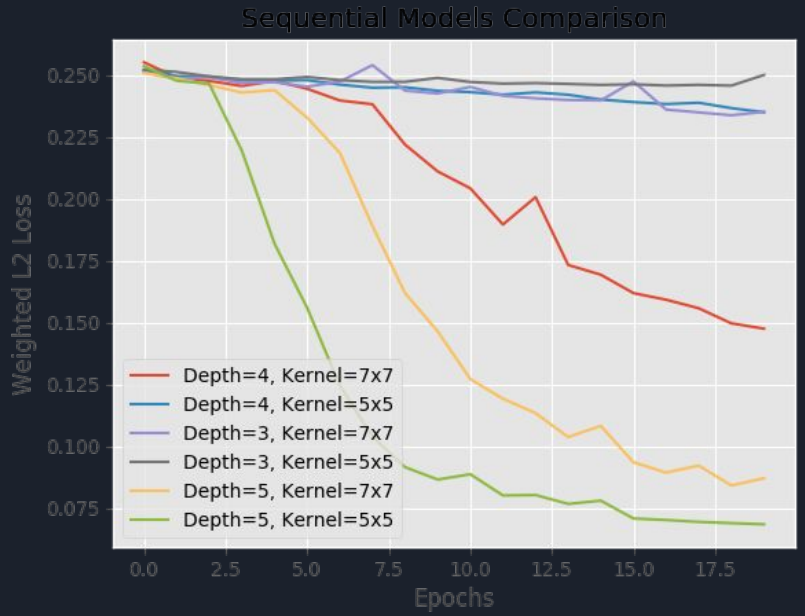


Training Details

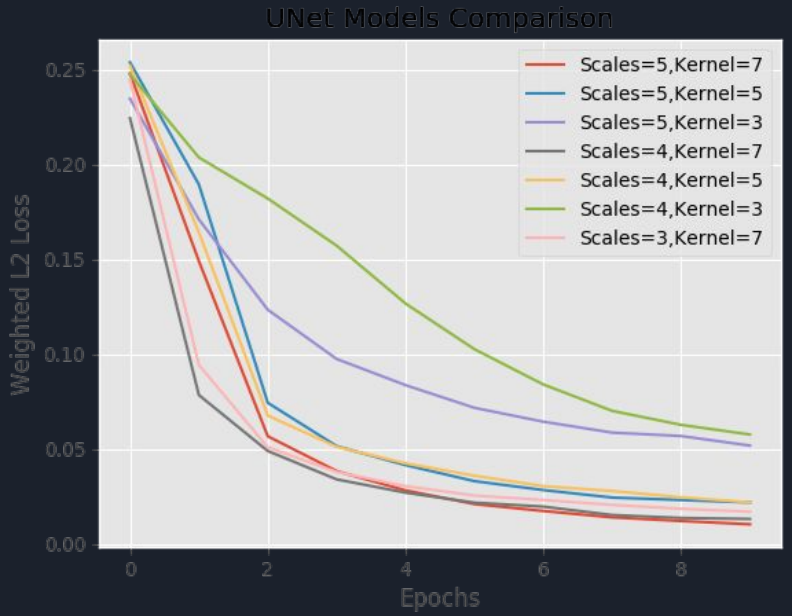
1. Objective Function = Pixel wise L2 Loss (Binary cross entropy was numerically unstable)
2. Optimizer = ADAM (beta1 = 0.9, beta2 = 0.999)
3. Learning Rate = 1e-3
4. Batch Size = 64
5. Framework = Keras
6. Training Time = 2 hours (NVIDIA Tesla K80)
7. Sourcecode available at *Github* https://github.com/muneebaadil/Hough-Transform-using-CNNs

Architectures Tested

Sequential

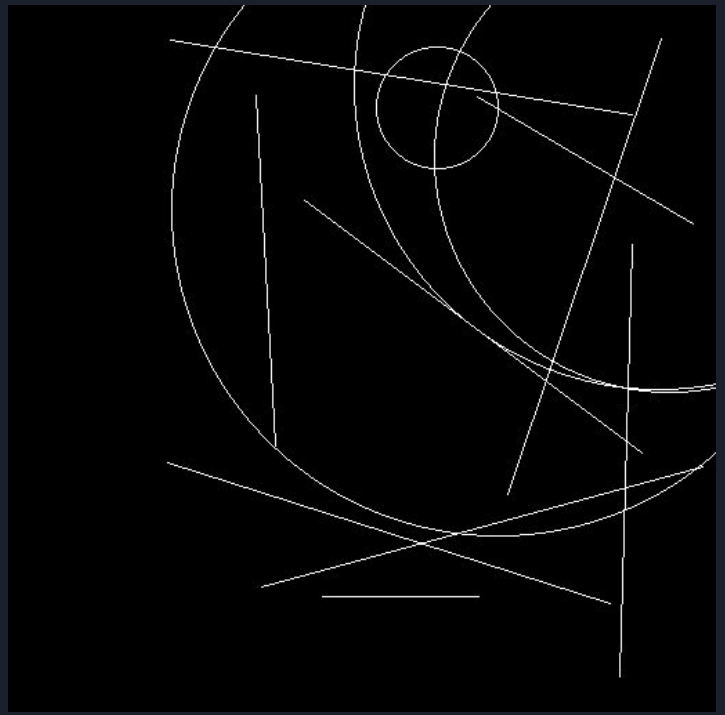


UNets

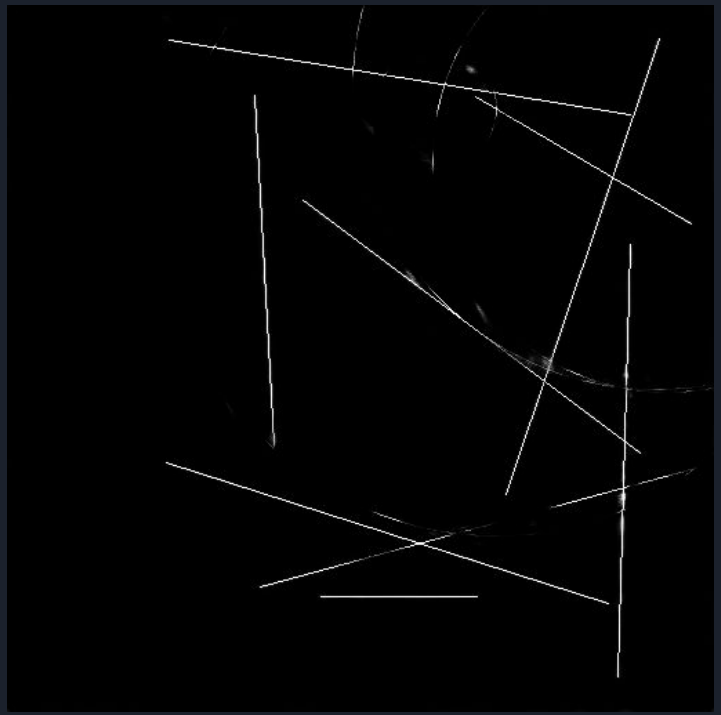


Results

Input Image

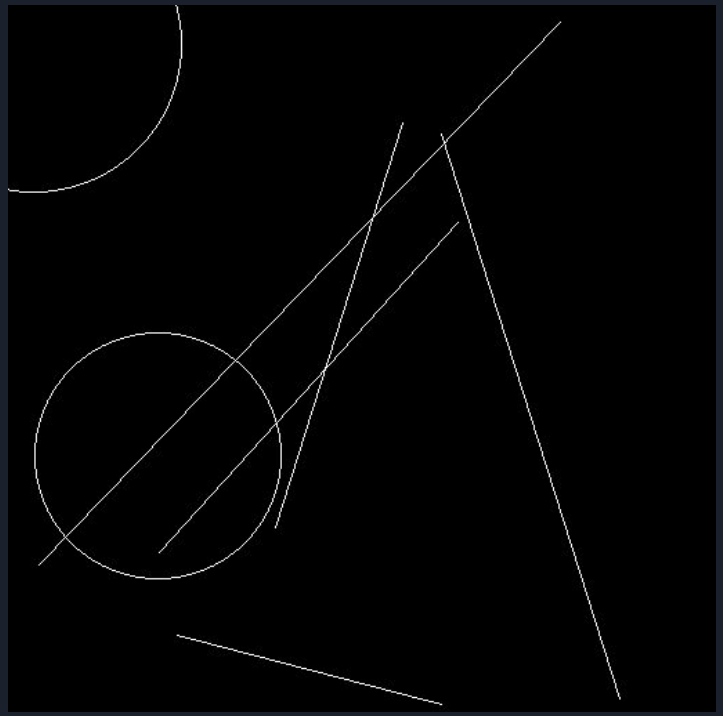


Predicted Image

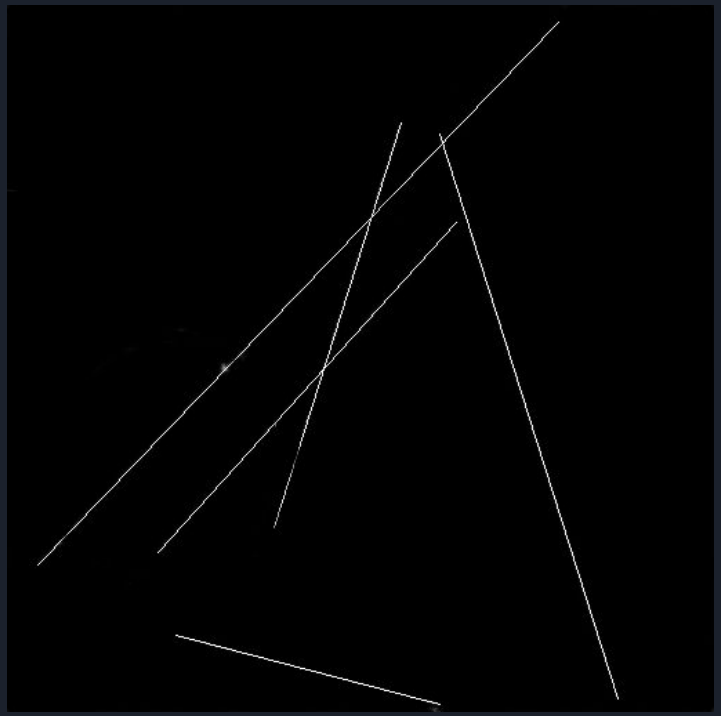


Results (cont...)

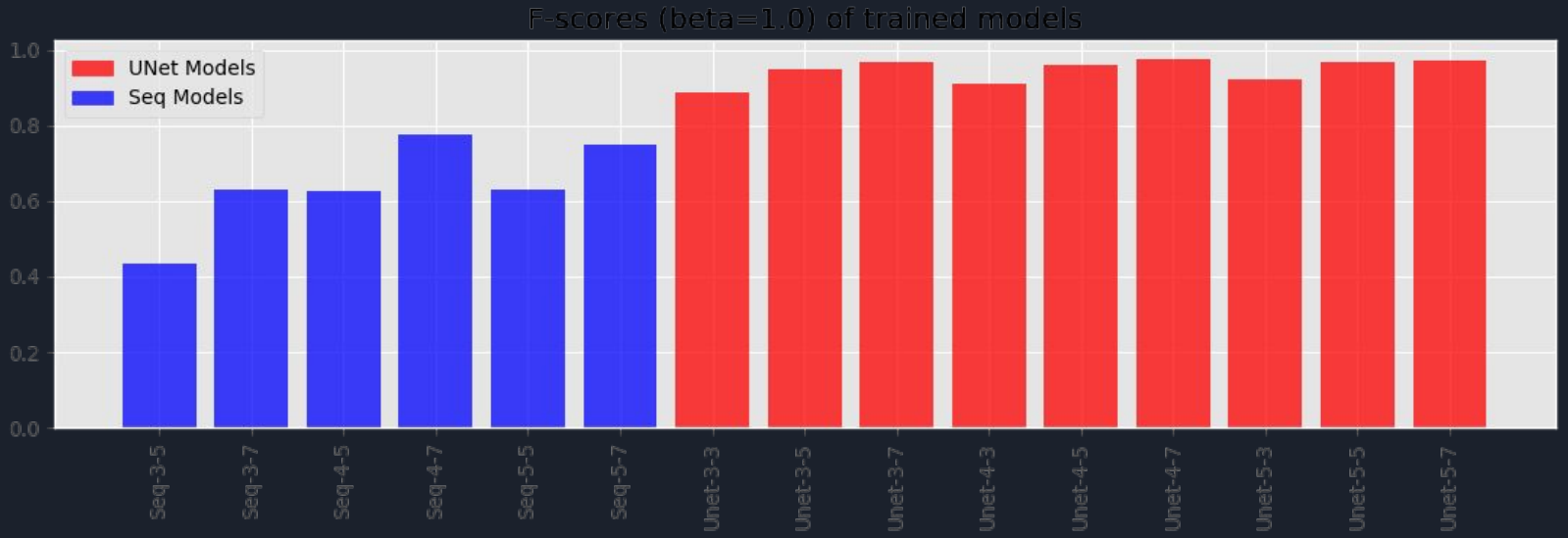
Input Image



Predicted Image



Results (cont...): Fscore, precision, recall.



Conclusion and Future Work

1. Global structure ⇒ Scale space is important
2. End-to-end CNNs based method of line detection is promising

Future Work

1. Noisy dataset
2. Natural Images