

CNNs for Other Image Tasks

Vineeth N Balasubramanian

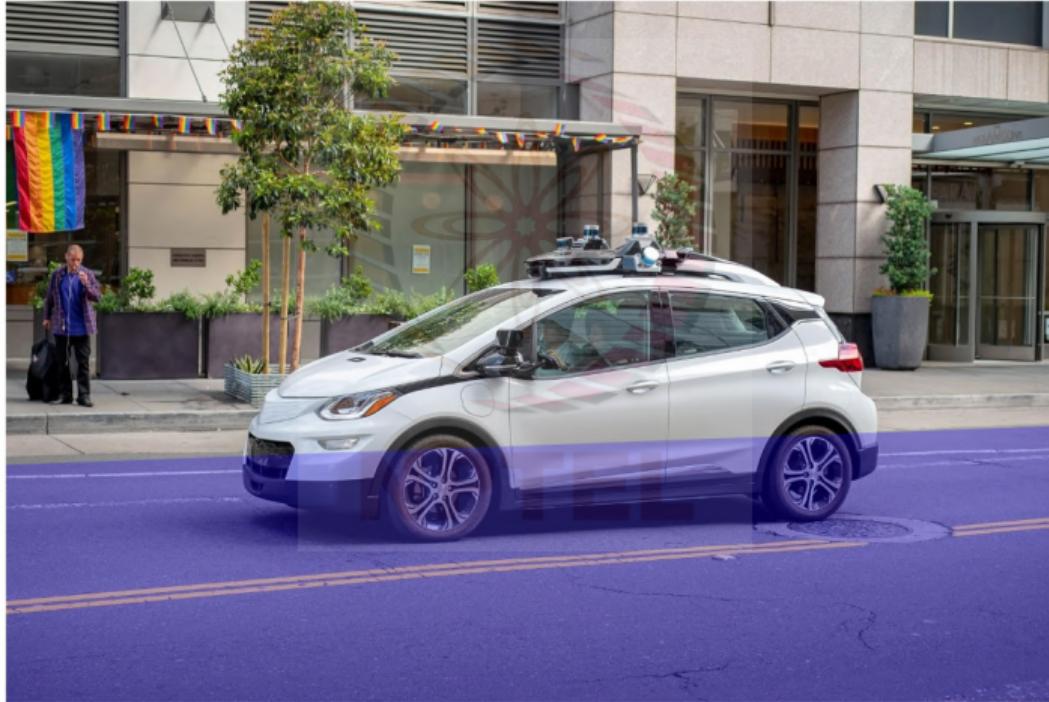
Department of Computer Science and Engineering
Indian Institute of Technology, Hyderabad



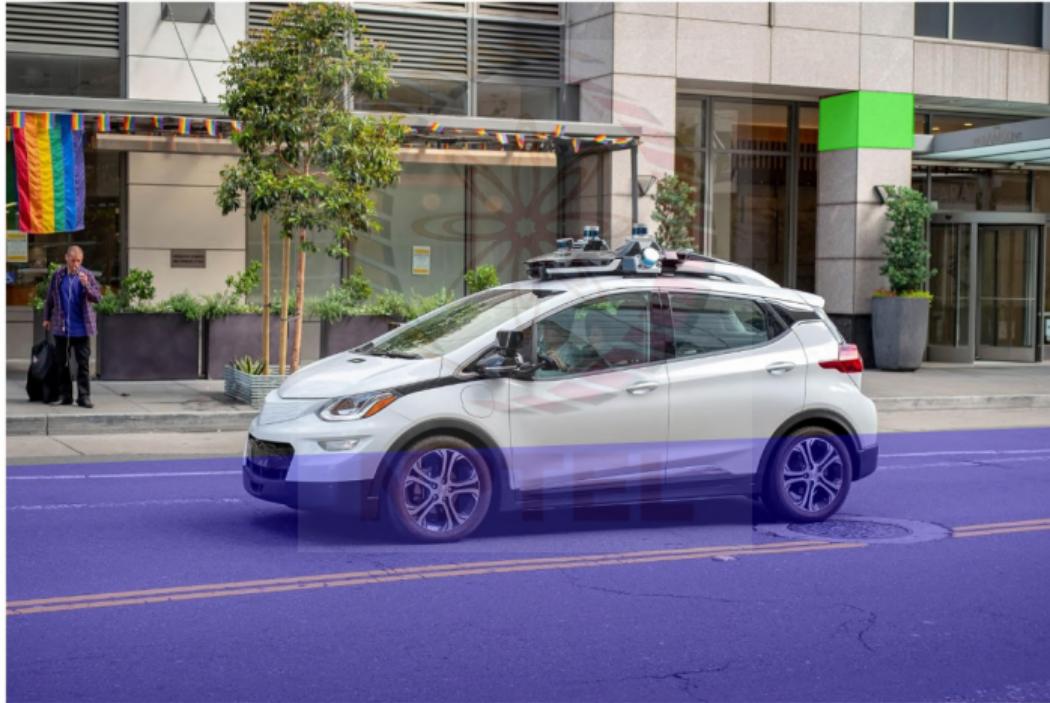
Depth Estimation



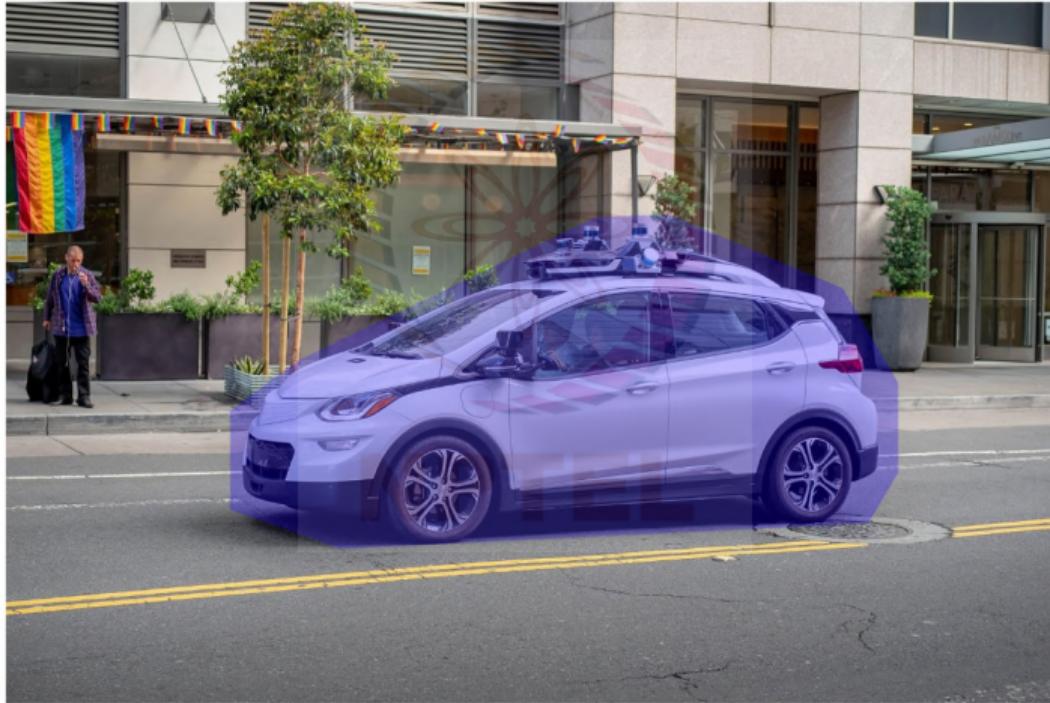
Depth Estimation



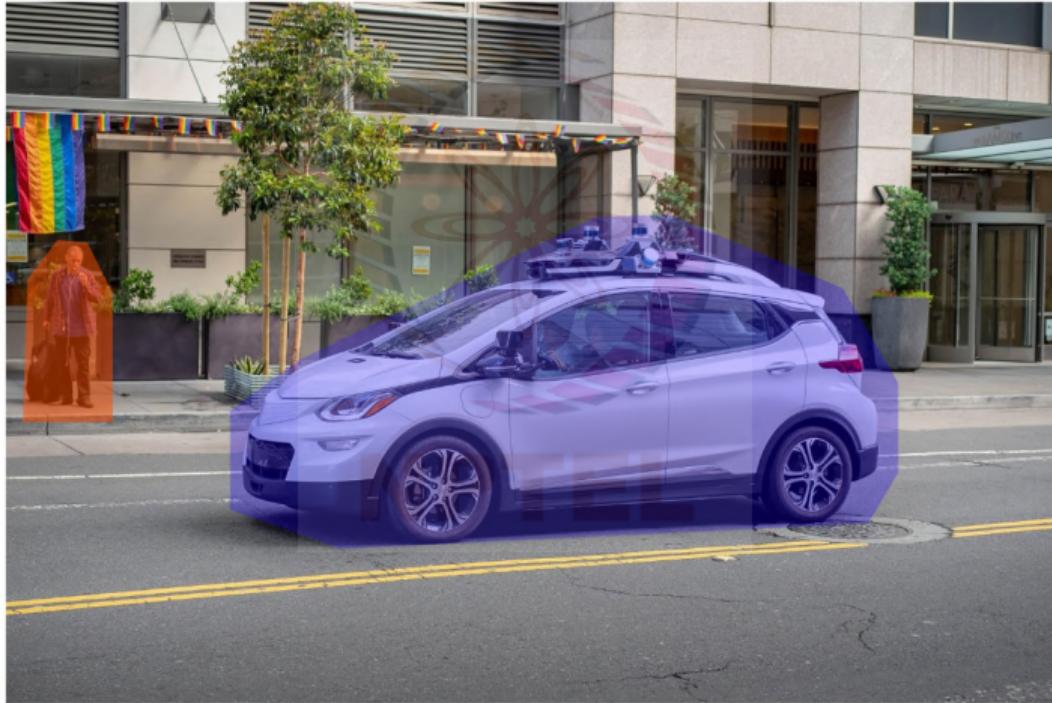
Depth Estimation



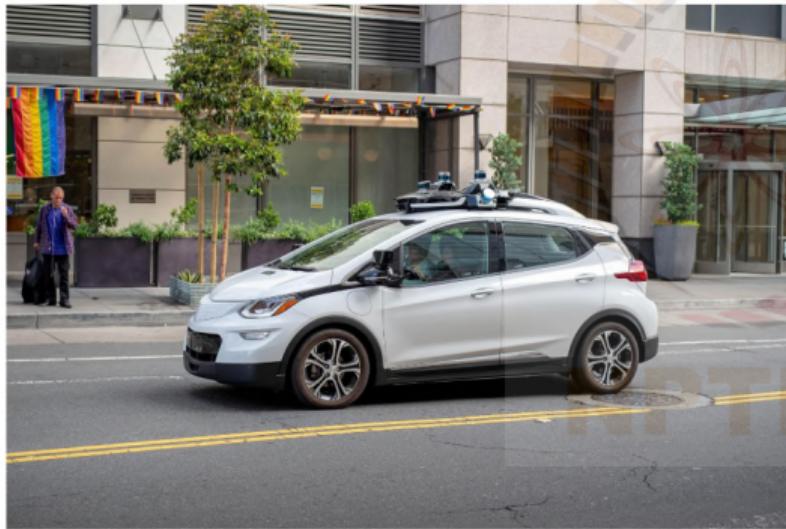
Depth Estimation



Depth Estimation



Depth Estimation

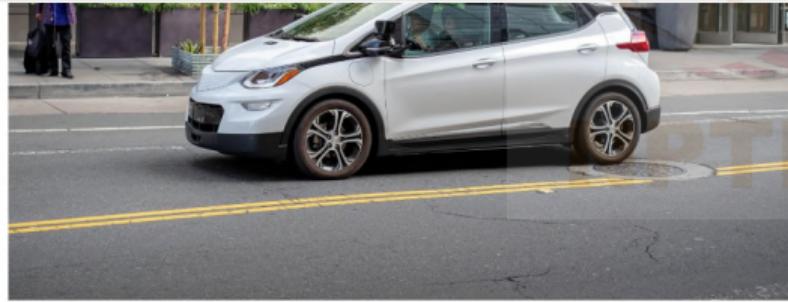


Depth Estimation

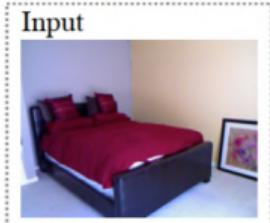


Question

How can we teach the computer to understand depth from just 2D images?



Depth Estimation from Single Image¹

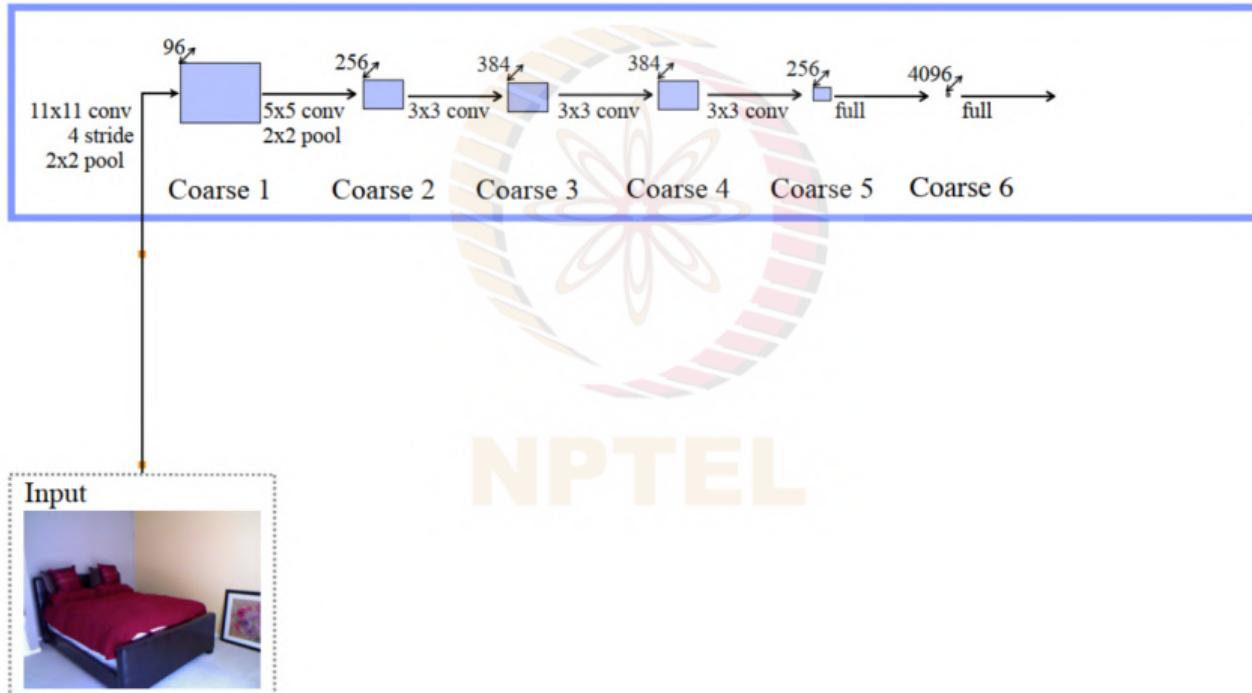


NPTEL

¹Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image¹

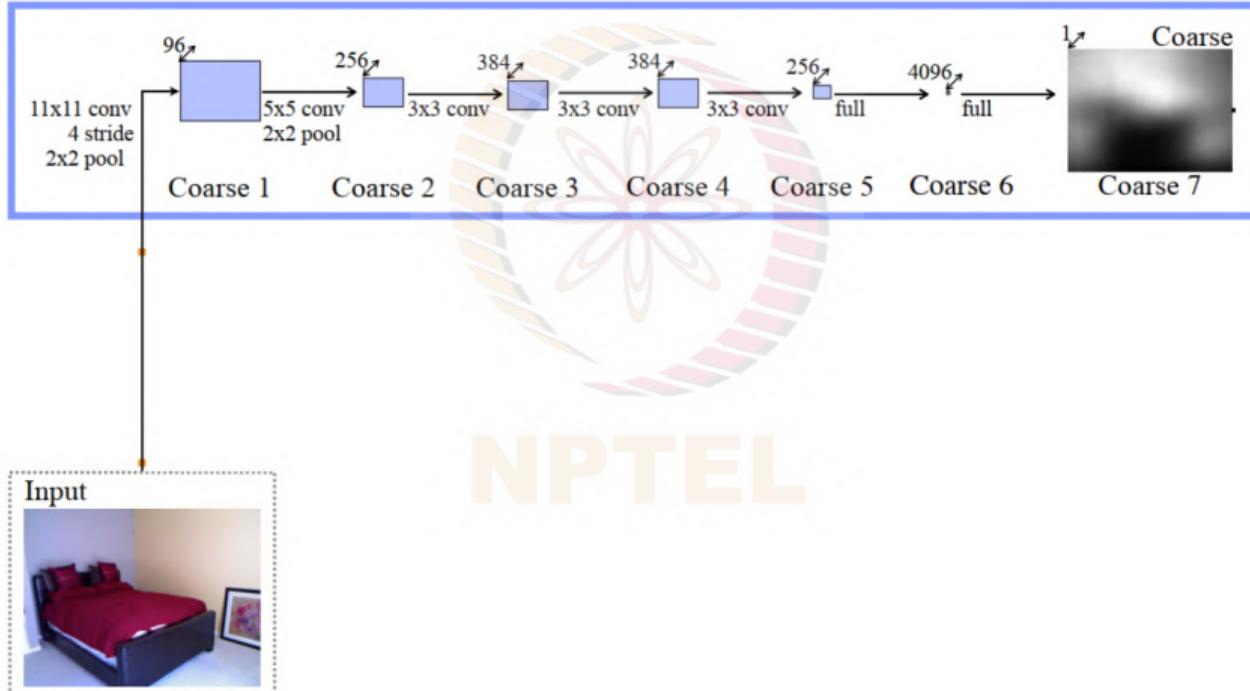
Coarse network



¹Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image¹

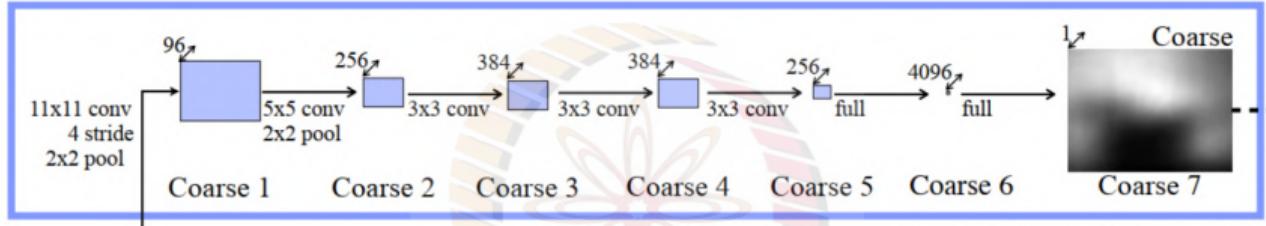
Coarse network



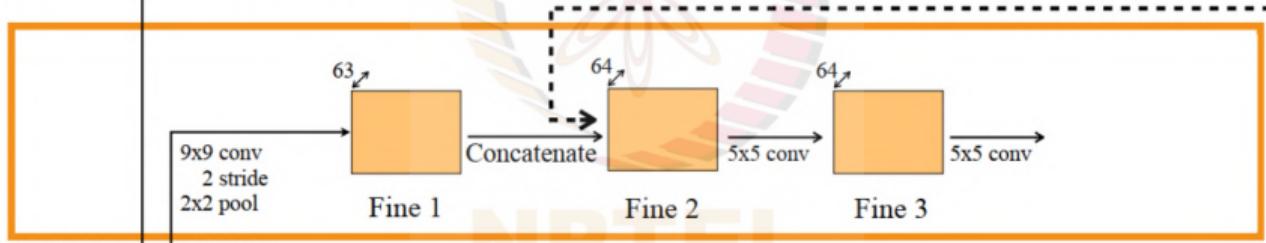
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Depth Estimation from Single Image¹

Coarse network



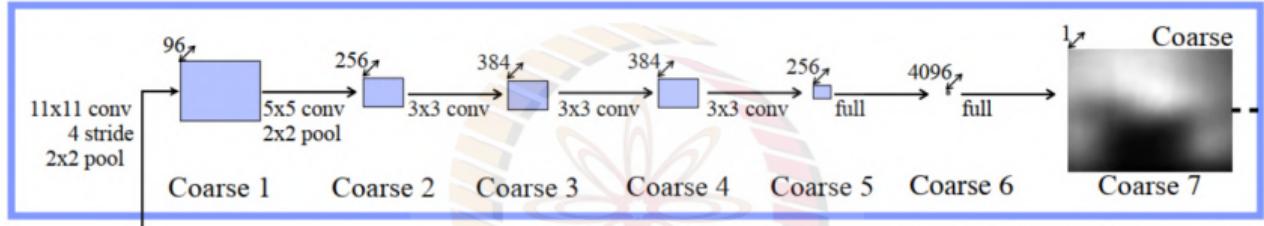
Finer network



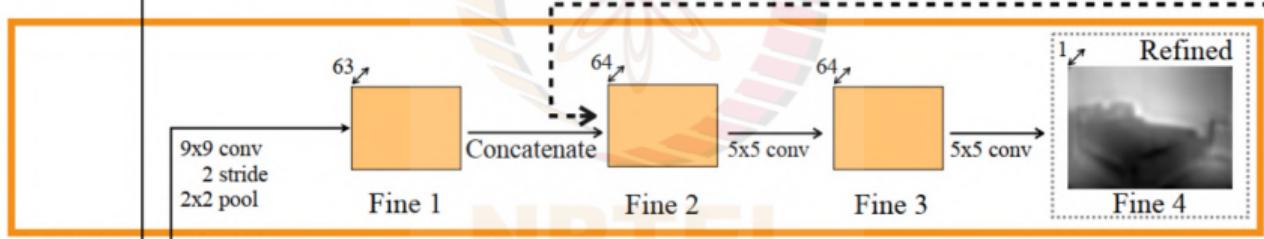
¹Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image¹

Coarse network



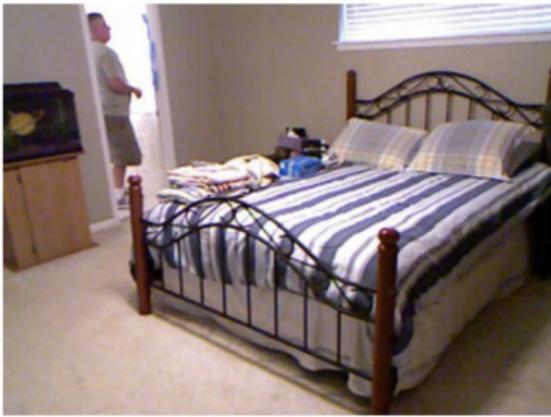
Finer network



¹Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image: Sample Results

Input



Credit: Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image: Sample Results

Input



Output from
coarse network



Credit: Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image: Sample Results

Input



Output from
coarse network



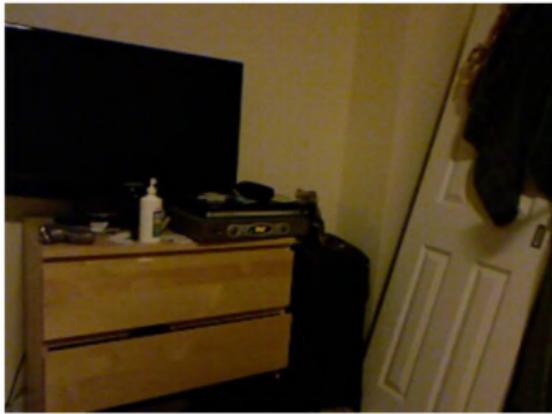
Output from
finer network



Credit: Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

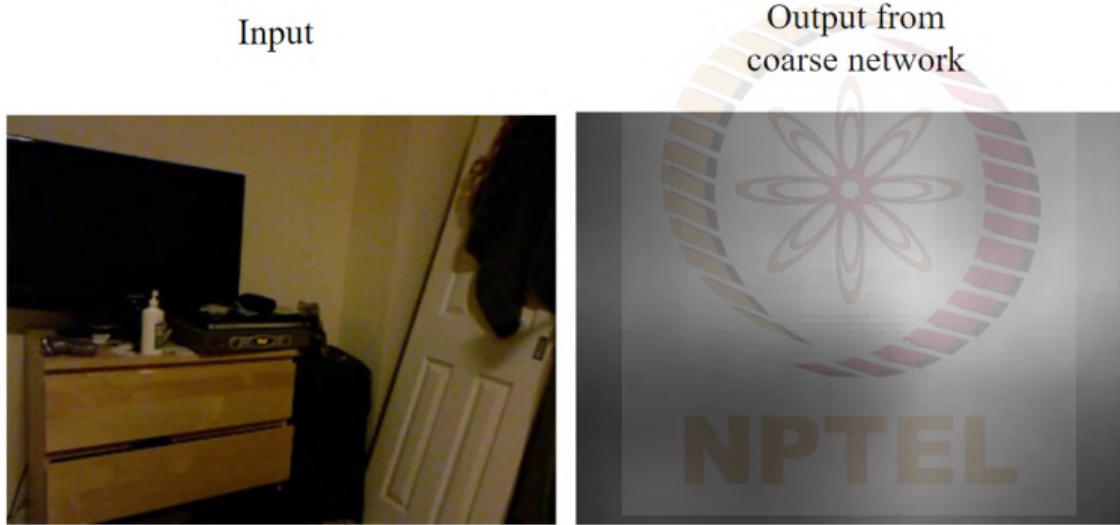
Depth Estimation from Single Image: Sample Results

Input



Credit: Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

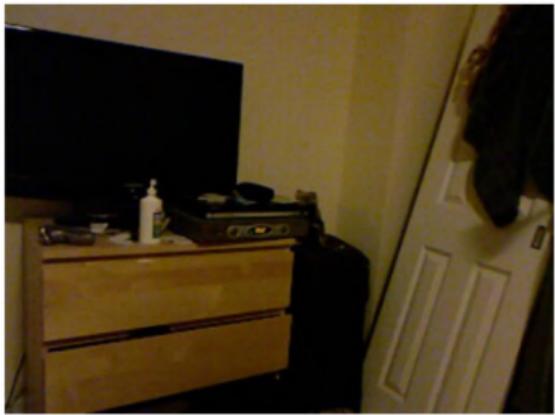
Depth Estimation from Single Image: Sample Results



Credit: Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

Depth Estimation from Single Image: Sample Results

Input



Output from
coarse network

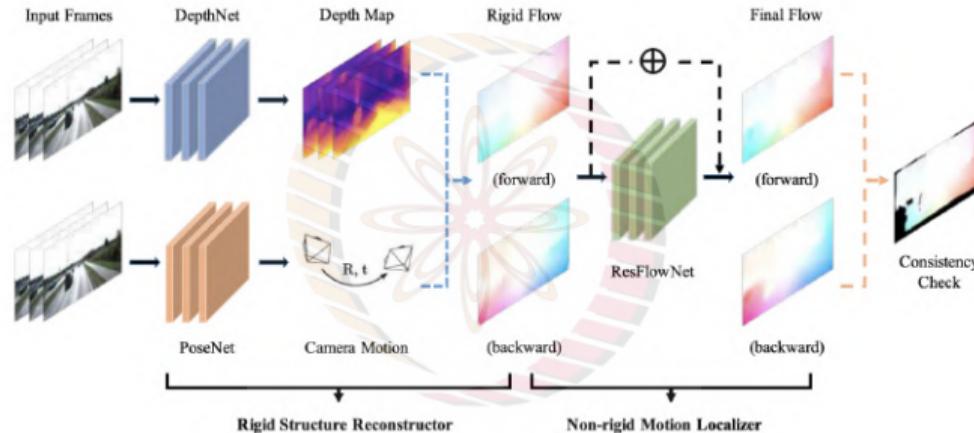


Output from
finer network



Credit: Eigen et al, Depth map prediction from a single image using a multi-scale deep network, NeurIPS 2014

GeoNet²



Consists of rigid structure reconstructor for estimating static scene geometry and non-rigid motion localizer for capturing dynamic objects. Consistency check within any pair of bidirectional flow predictions is adopted for taking care of occlusions and non-Lambertian surfaces

²Yin and Shi, GeoNet: Unsupervised Learning of Dense Depth, Optical Flow and Camera Pose, CVPR 2018

Super-resolution: Do you see a difference?

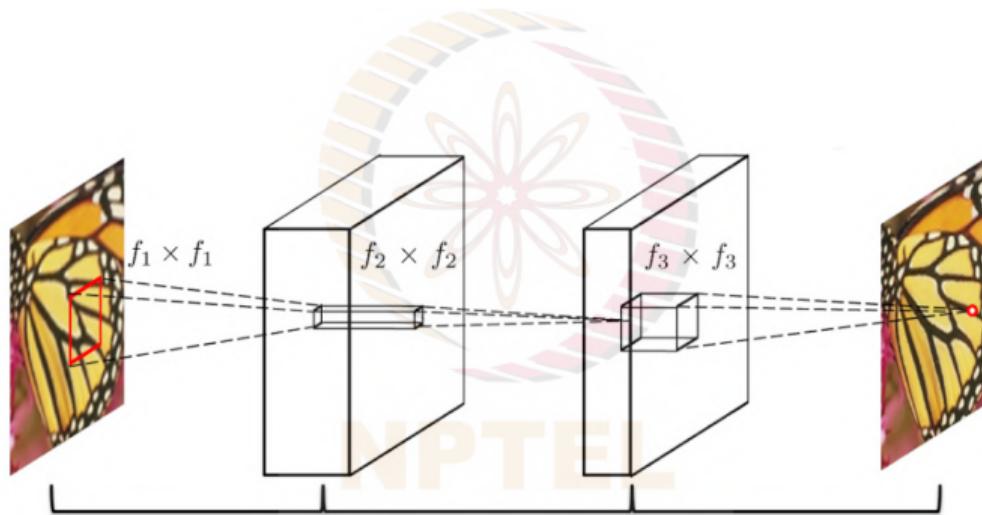


Super-resolution



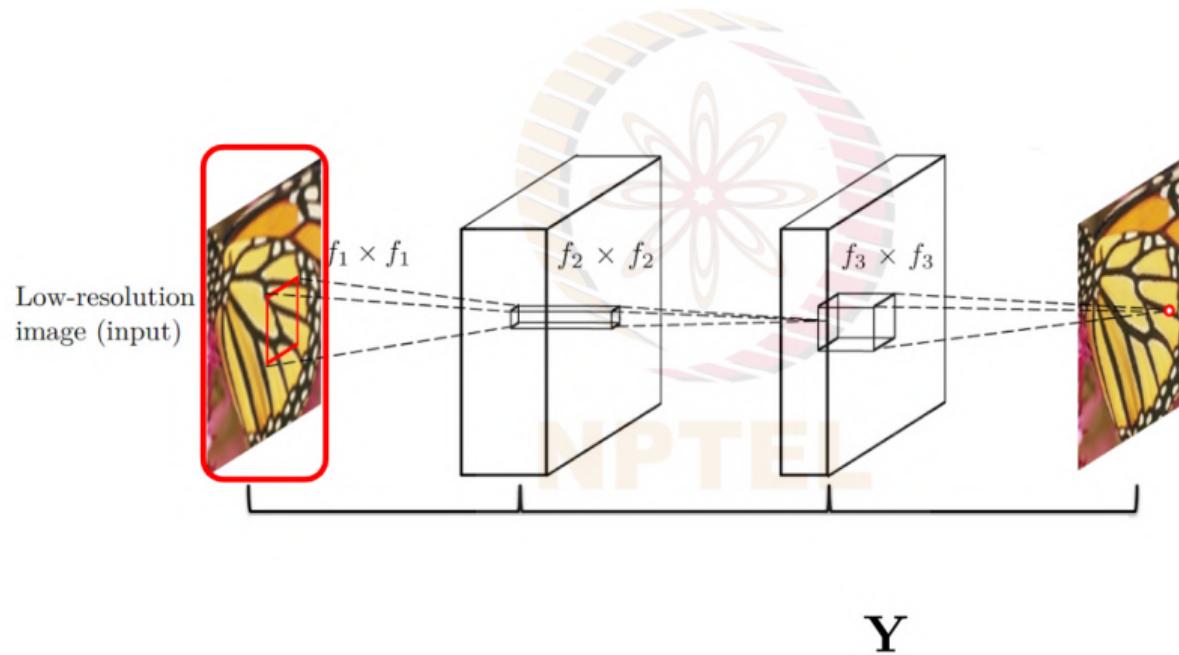
Credit: LG

Super-resolution using CNNs



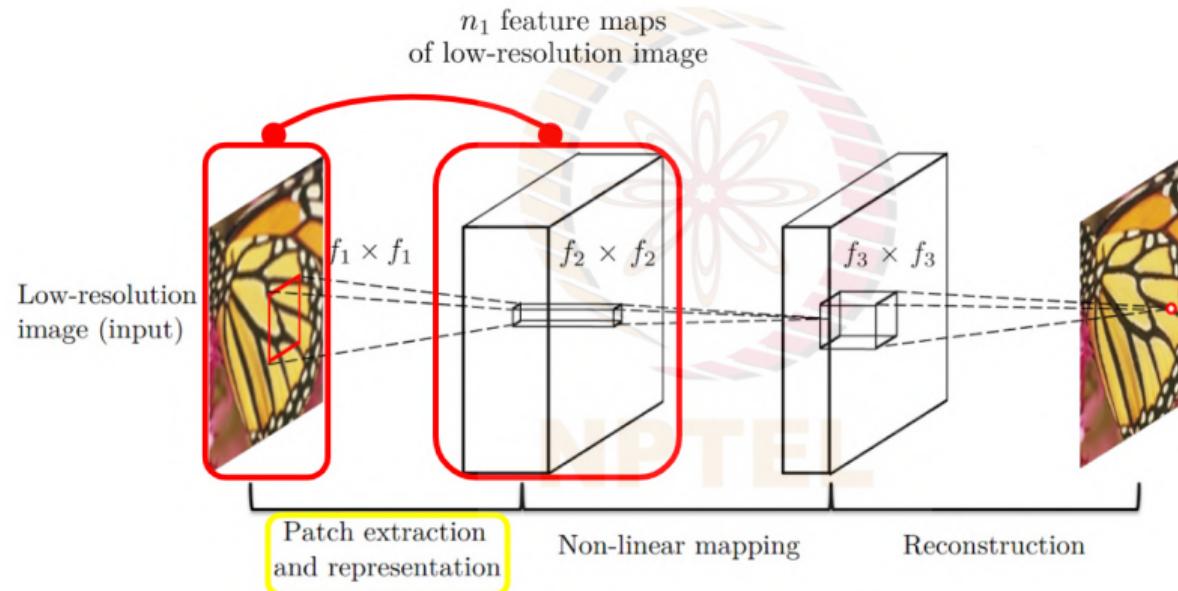
Credit: Dong, Chao, et al, Image Super-resolution using Deep Convolutional Networks, IEEE Trans on PAMI, 2015

Super-resolution using CNNs



Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

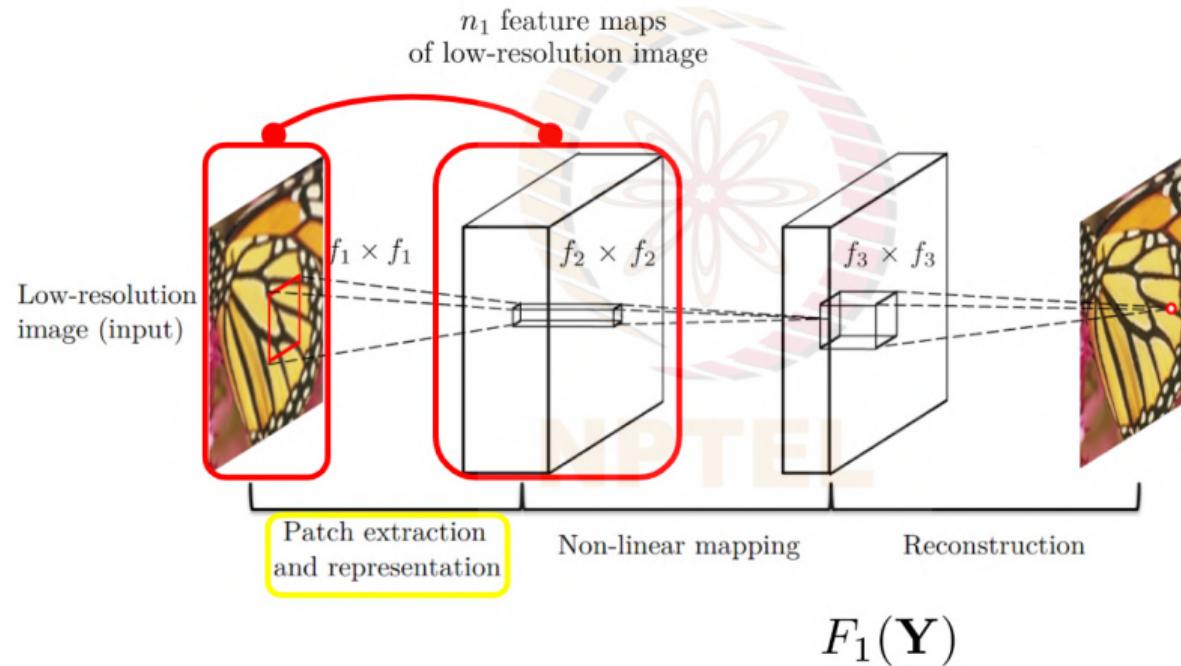
Super-resolution using CNNs



$$F_1(\mathbf{Y}) = \max(0, W_1 * \mathbf{Y} + B_1)$$

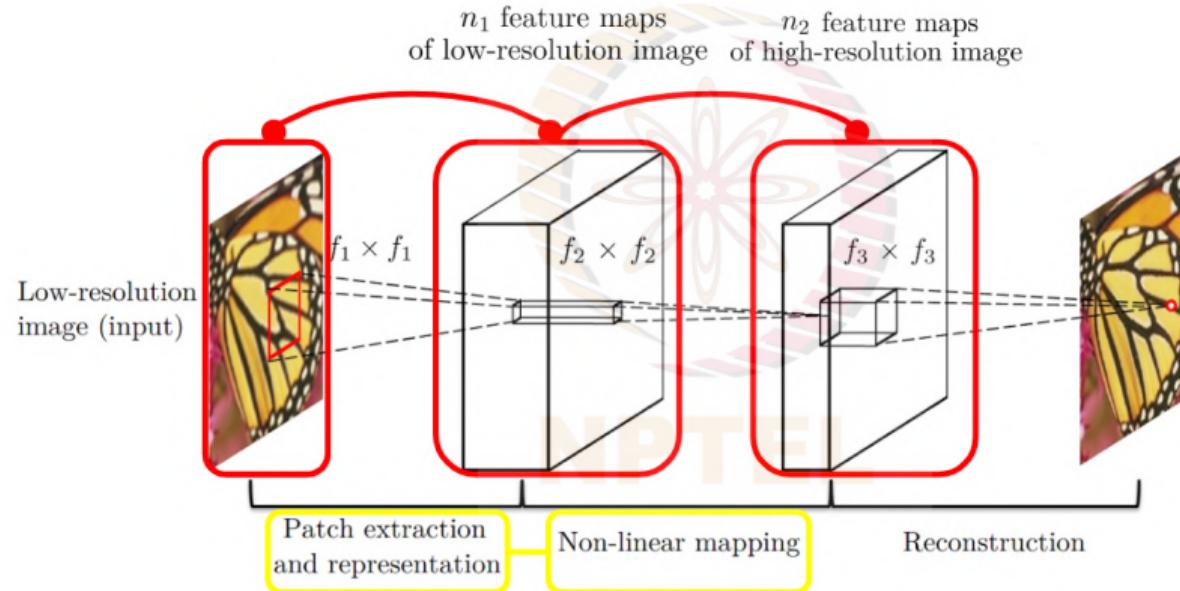
Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

Super-resolution using CNNs



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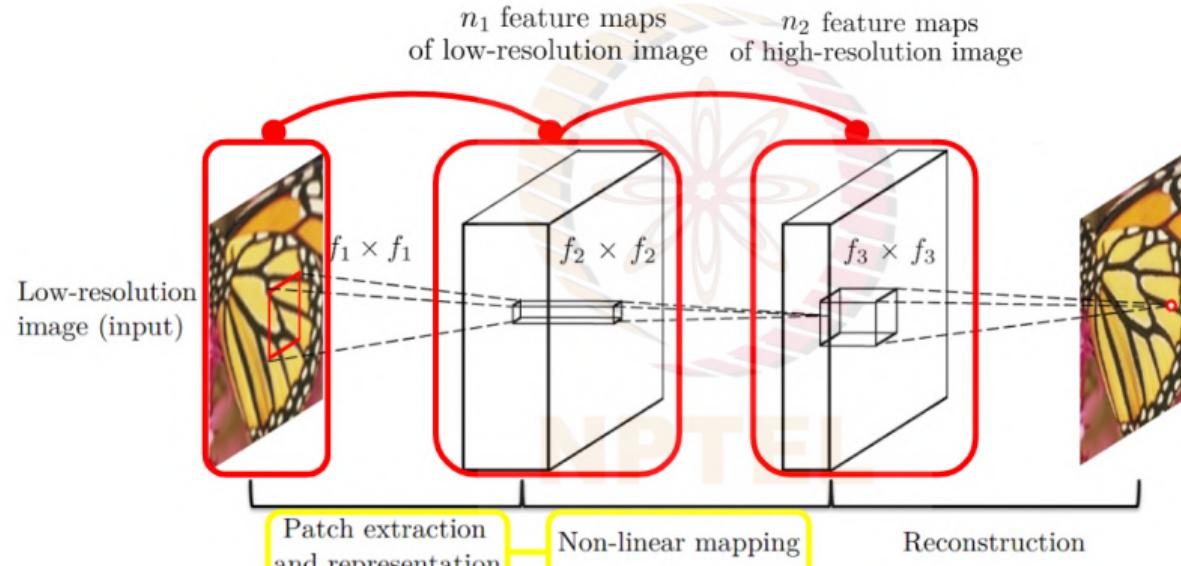
Super-resolution using CNNs



$$F_2(\mathbf{Y}) = \max(0, W_2 * F_1(\mathbf{Y}) + B_2)$$

Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

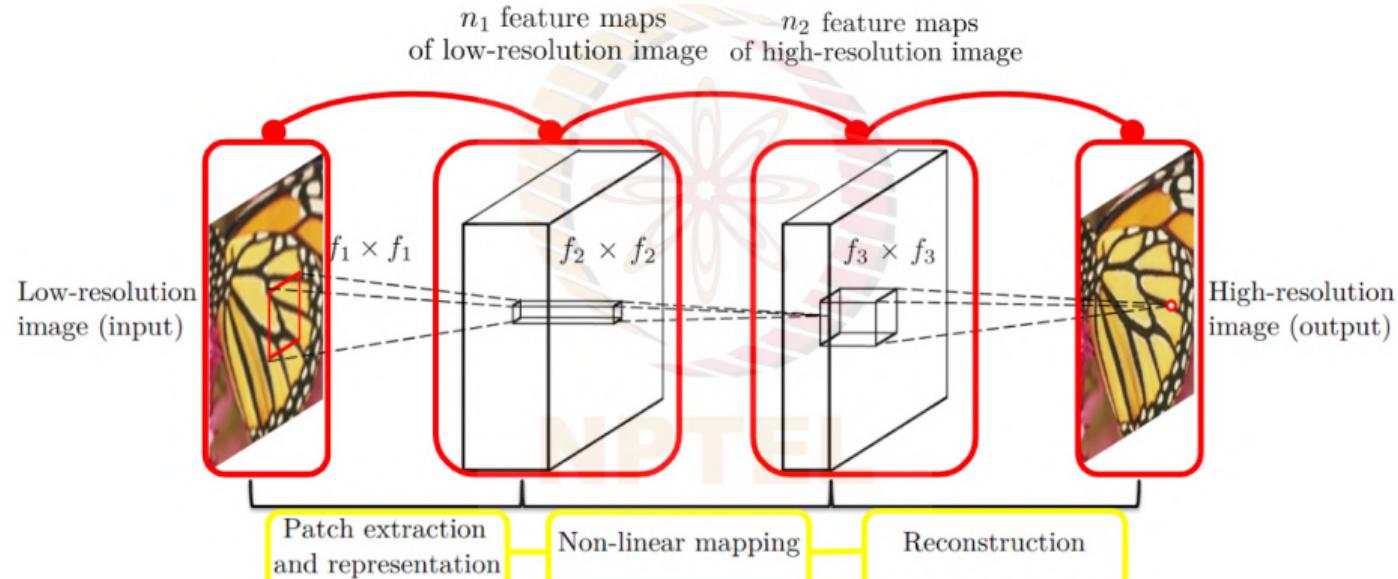
Super-resolution using CNNs



$$F_2(\mathbf{Y})$$

Credit: Dong, Chao, et al, Image Super-resolution using Deep Convolutional Networks, IEEE Trans on PAMI, 2015

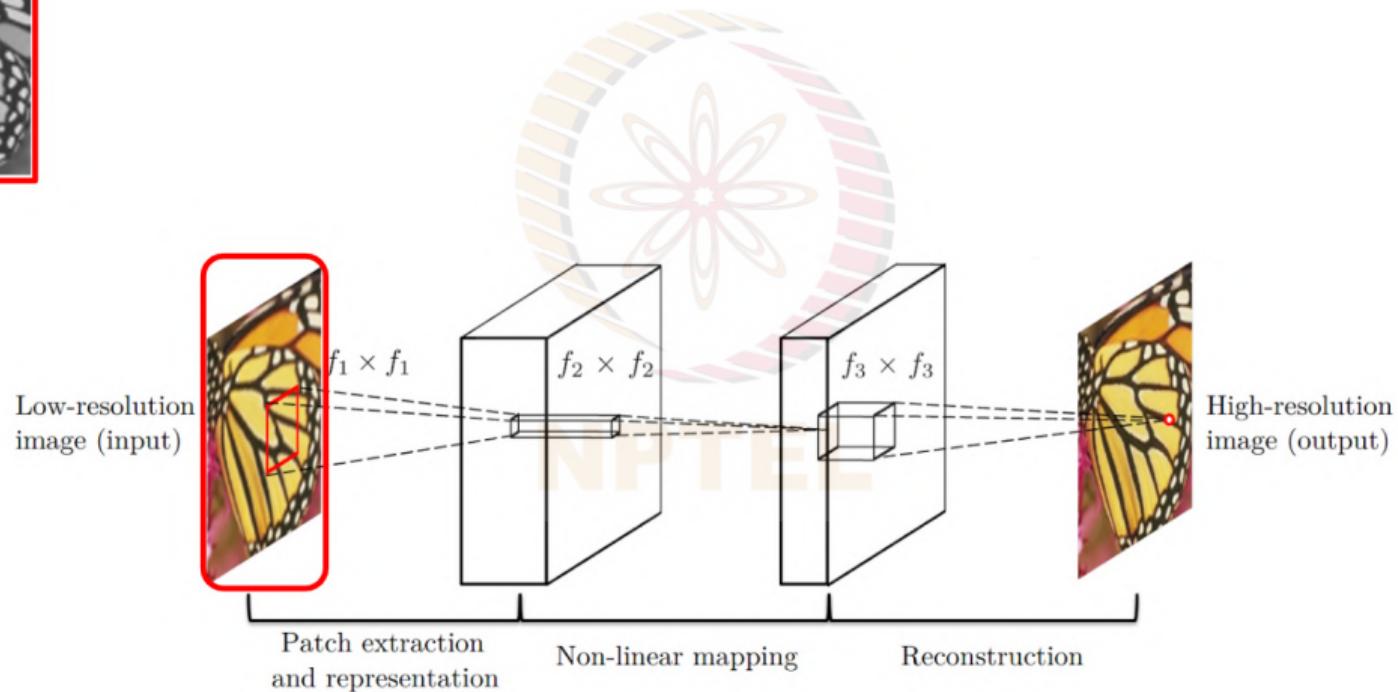
Super-resolution using CNNs



$$F(\mathbf{Y}) = W_3 * F_2(\mathbf{Y}) + B_3$$

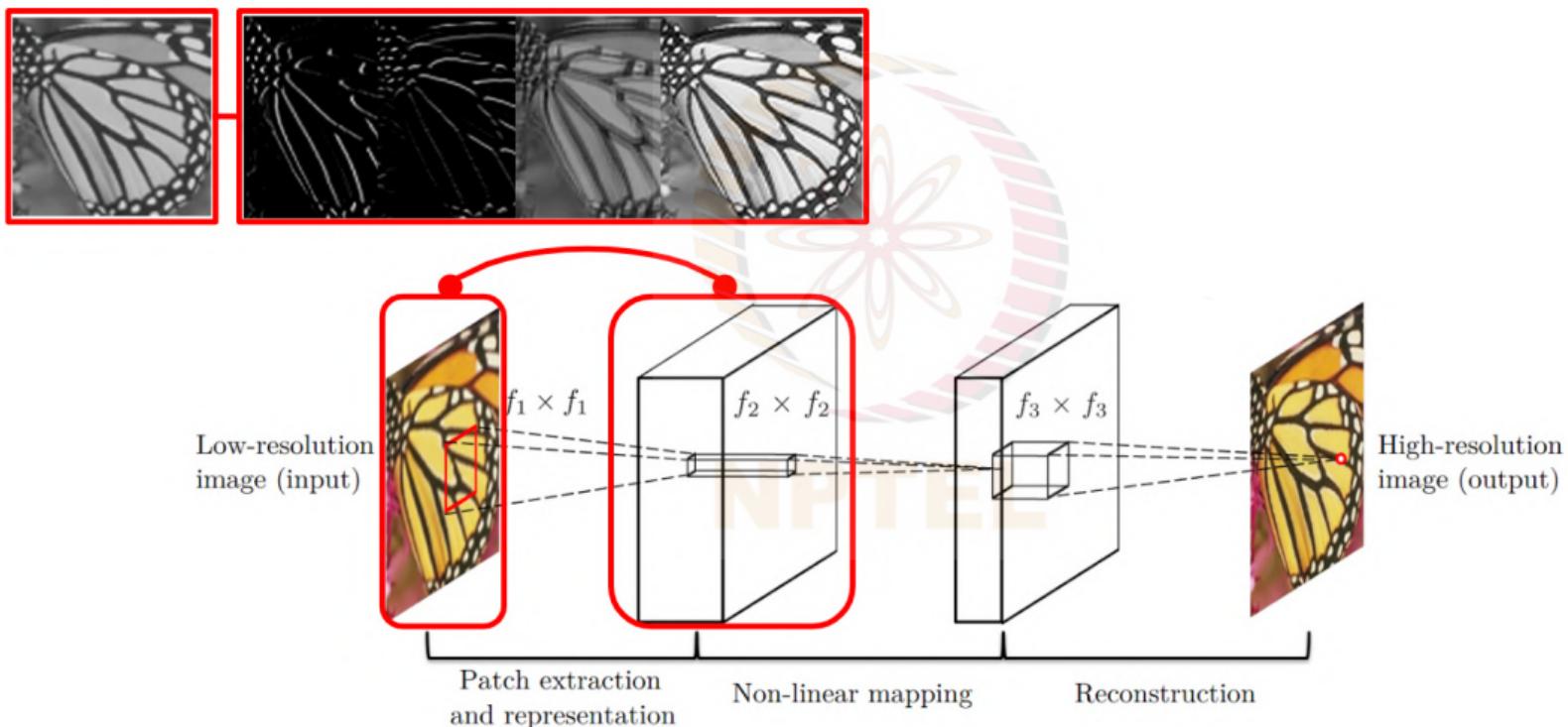
Credit: Dong, Chao, et al, Image Super-resolution using Deep Convolutional Networks, IEEE Trans on PAMI, 2015

Super-resolution using CNNs



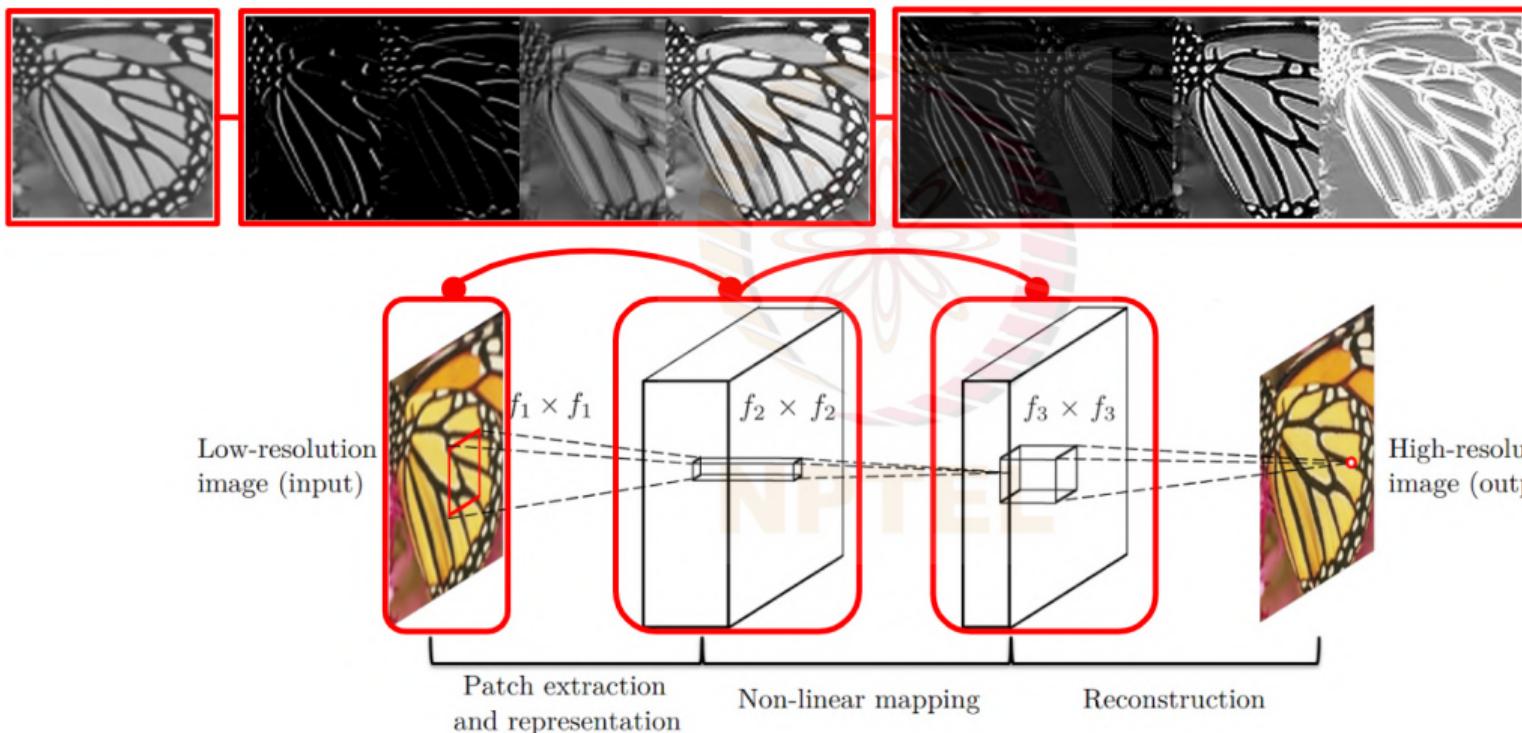
Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

Super-resolution using CNNs



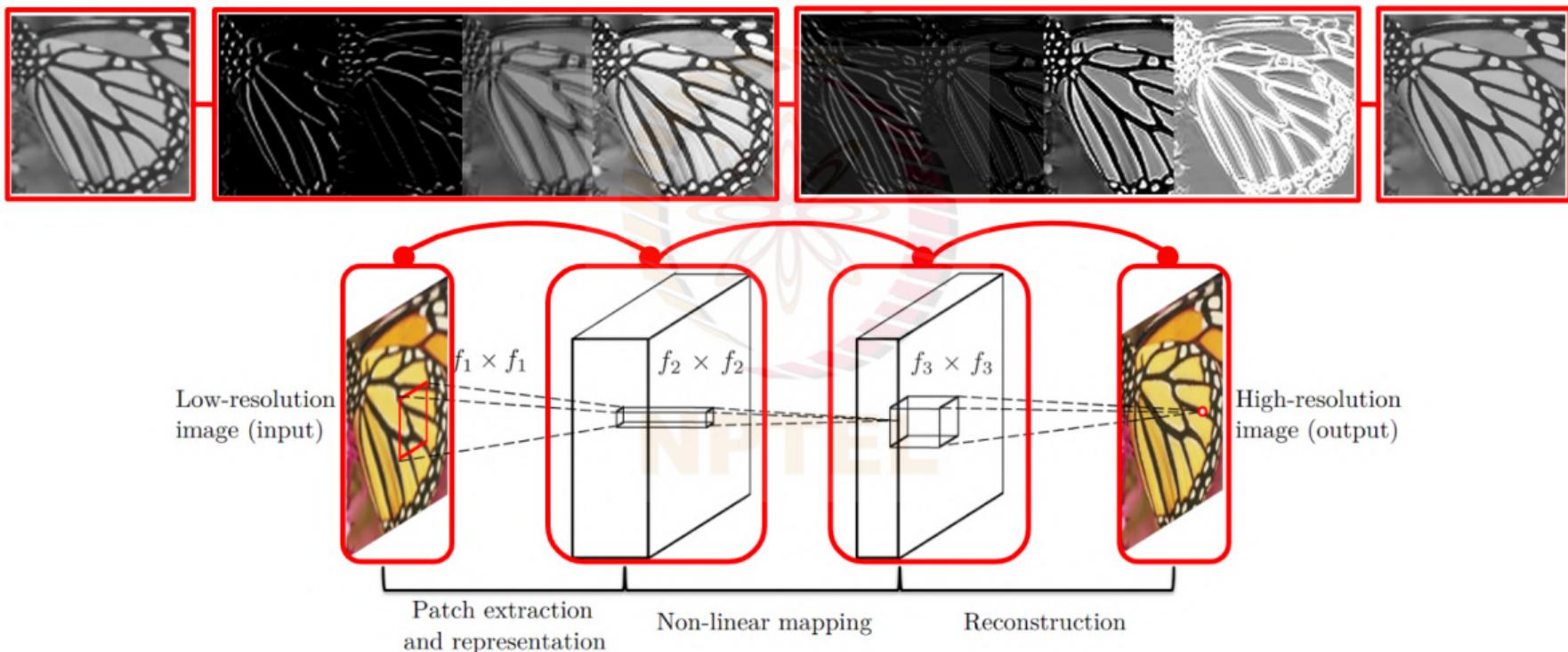
Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

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Super-resolution using CNNs



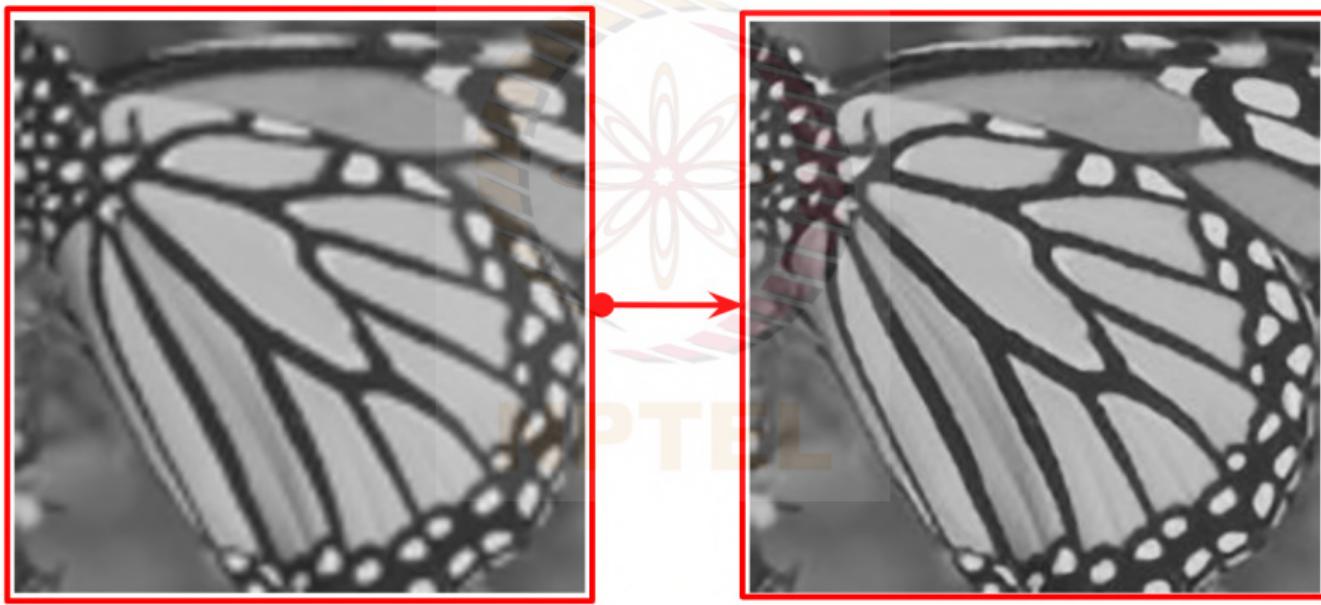
Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

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Super-resolution using CNNs

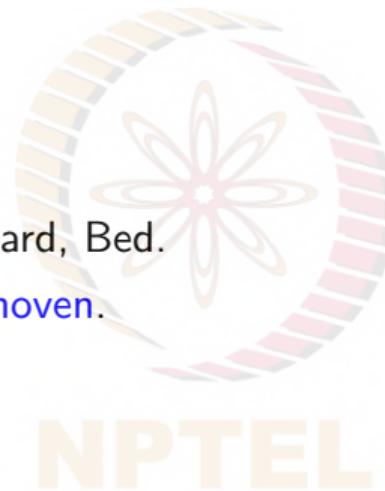


Credit: Dong, Chao, et al, *Image Super-resolution using Deep Convolutional Networks*, IEEE Trans on PAMI, 2015

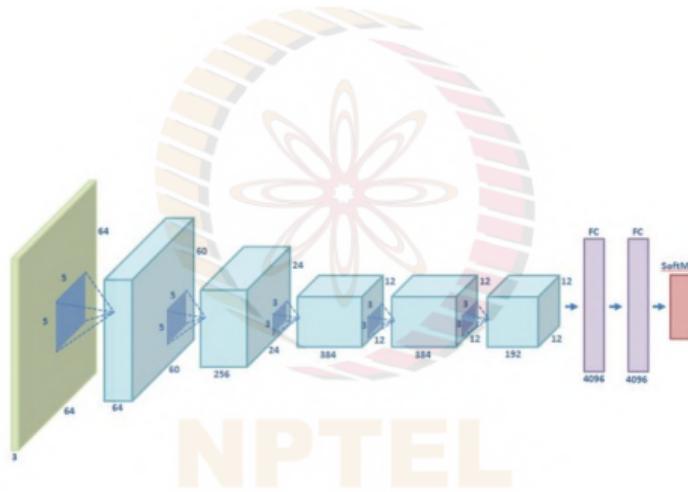
Anomaly Detection

Find the odd one out:

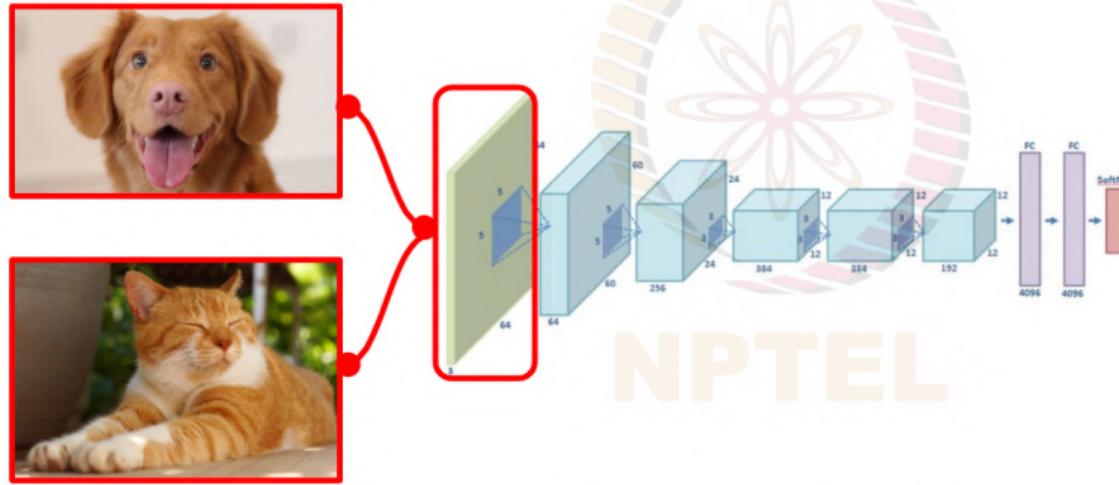
- Table, Chair, Computer, Cupboard, Bed.
- Faraday, Newton, Edison, Beethoven.
- Pen, Calculator, Pencil, Ink.



Anomaly Detection

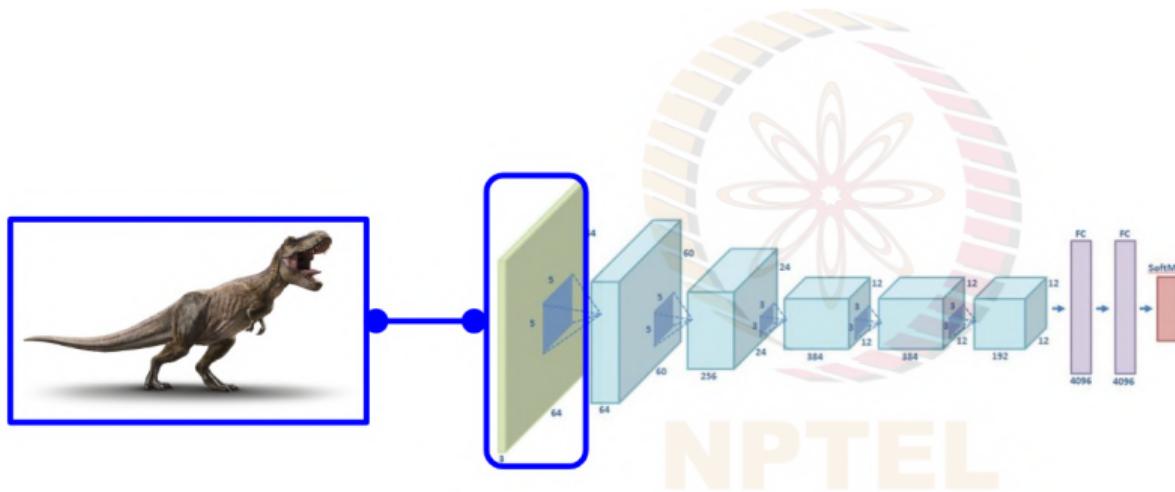


Anomaly Detection



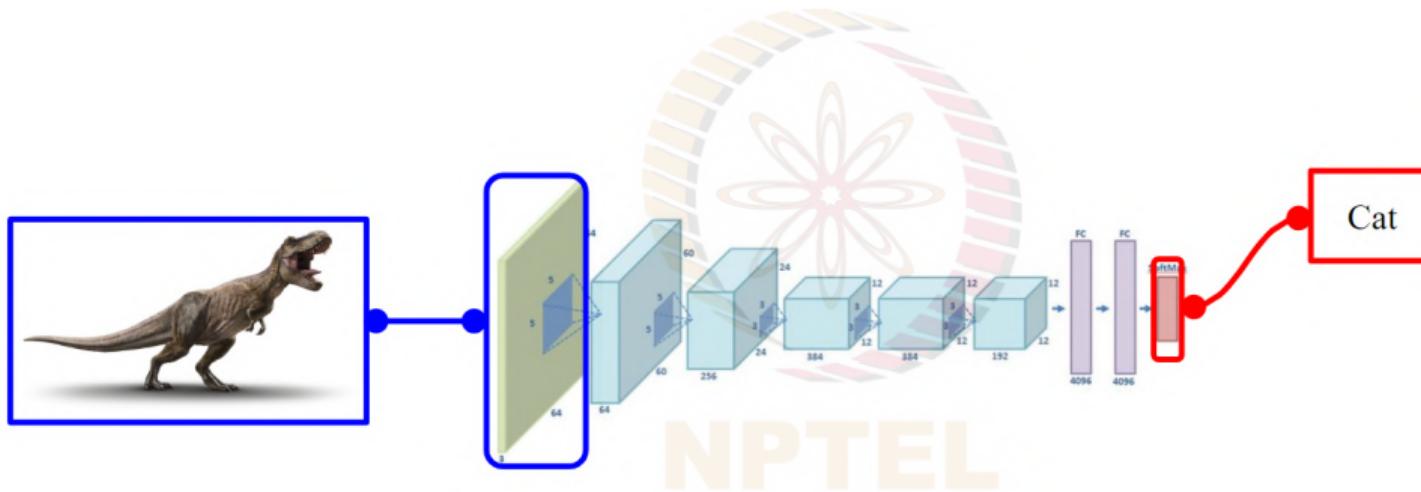
Train a network on cats and dogs

Anomaly Detection



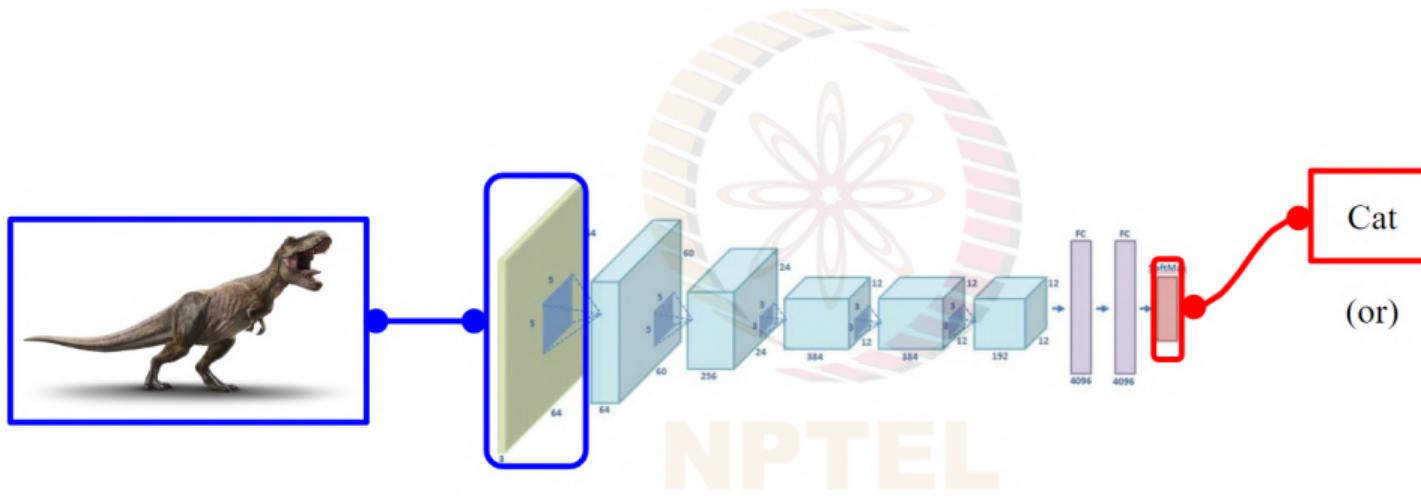
During inference, provide the network
with an out of distribution image

Anomaly Detection



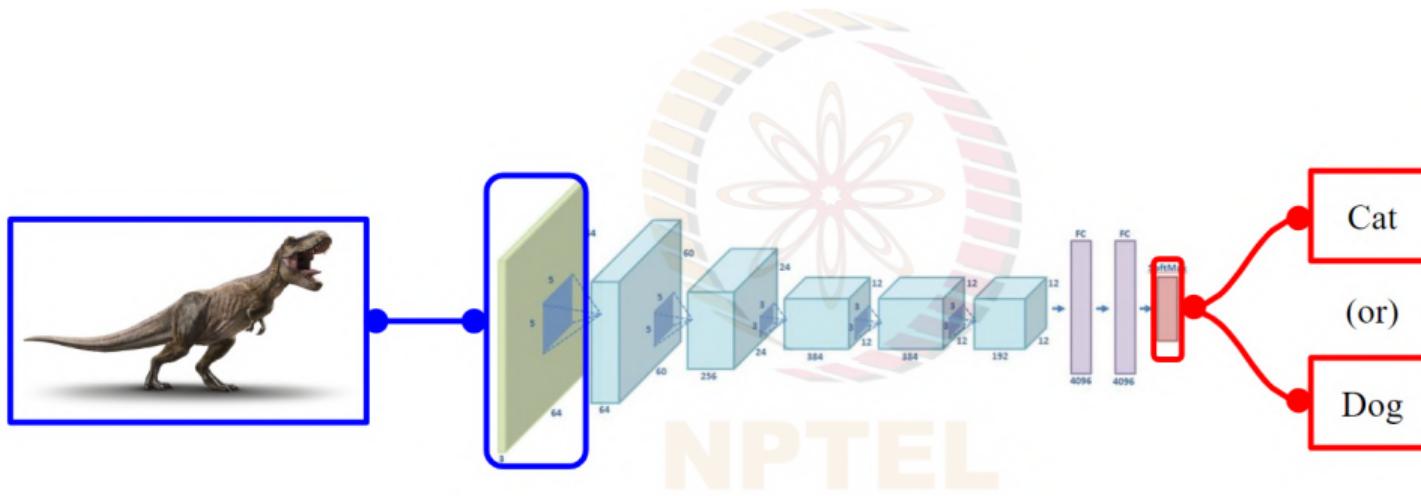
During inference, provide the network
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Anomaly Detection



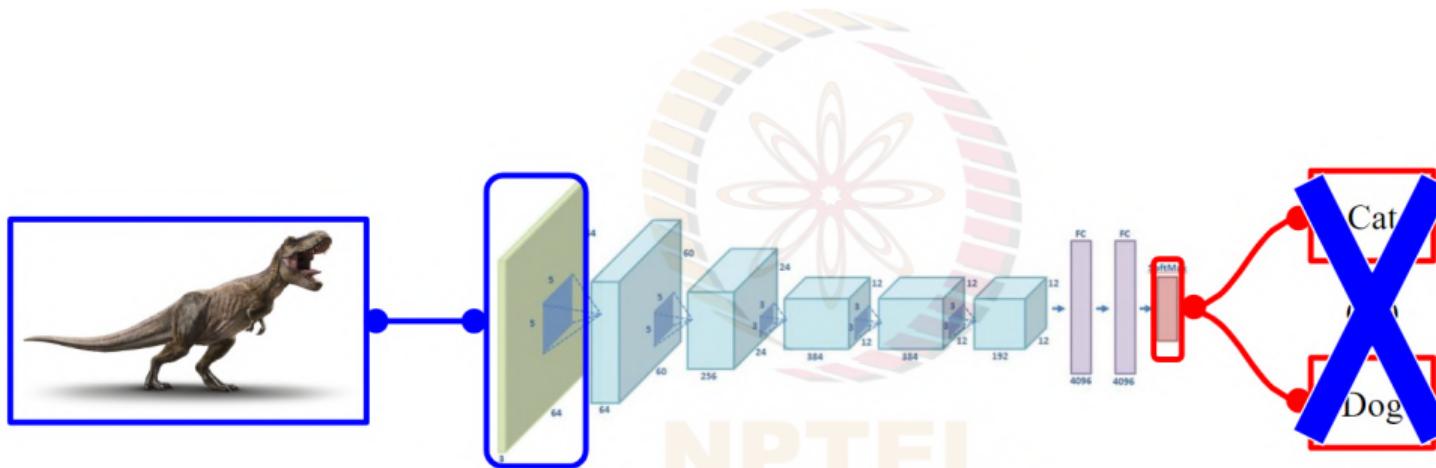
During inference, provide the network
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Anomaly Detection



During inference, provide the network
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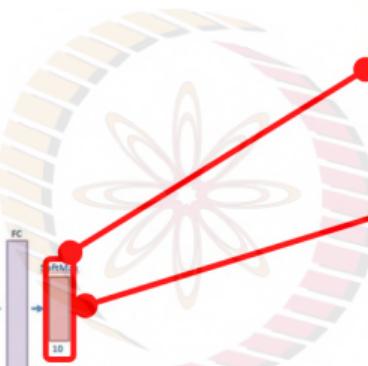
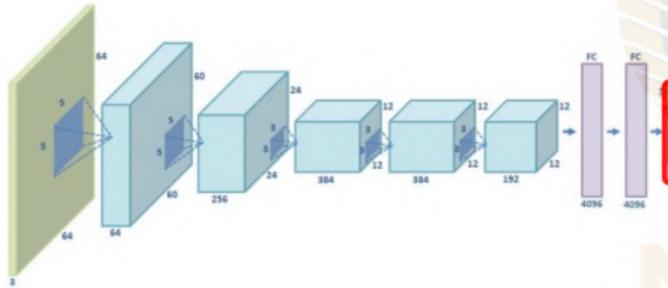
Anomaly Detection



Flawed by design

During inference, provide the network
with an out of distribution image

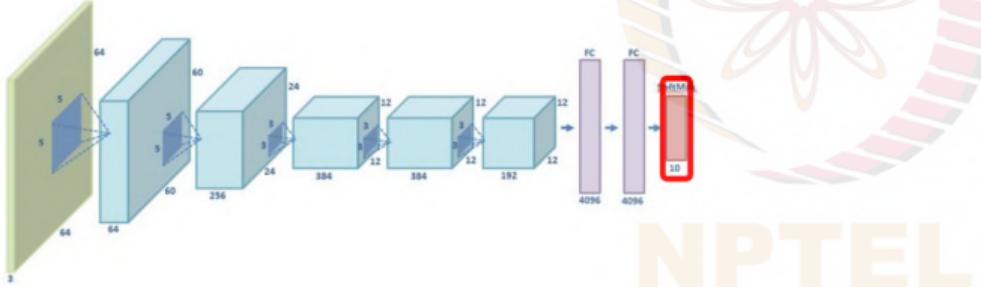
Anomaly Detection



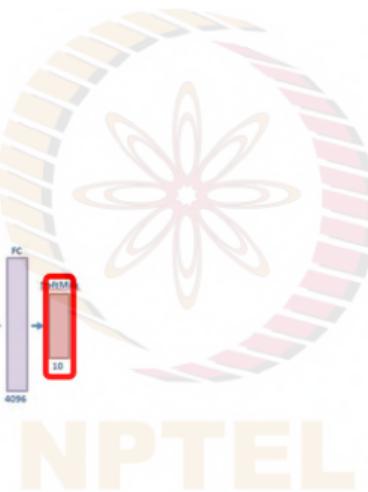
$$S_i(\mathbf{x}; T) = \frac{\exp(f_i(\mathbf{x}))}{\sum_{j=1}^N \exp(f_j(\mathbf{x}))},$$

NPTEL

Anomaly Detection³



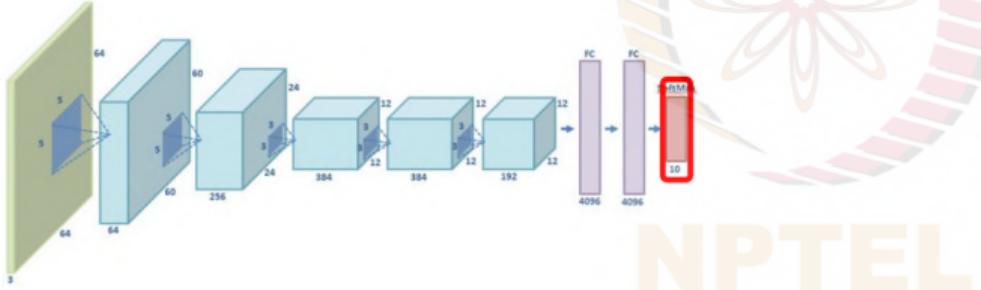
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³Liang et al, Enhancing the Reliability of Out-of-distribution Image Detection in Neural Networks, ICLR 2018

Anomaly Detection³

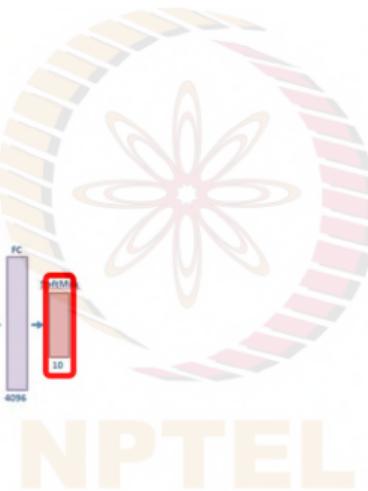
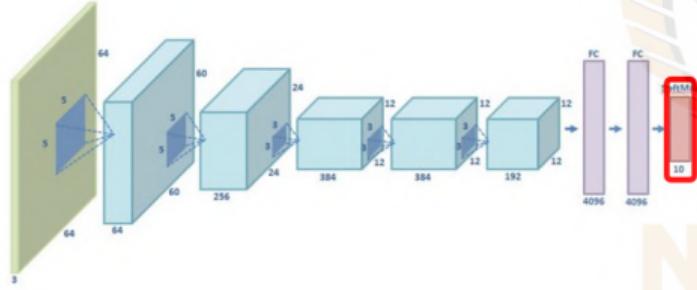
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NPTEL

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Anomaly Detection³

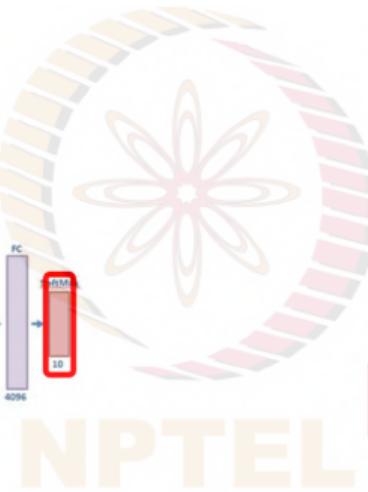
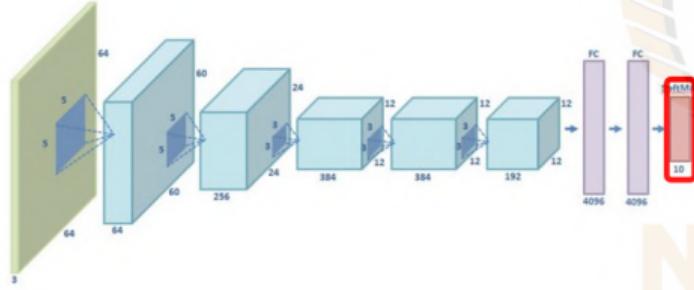


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Anomaly Detection³



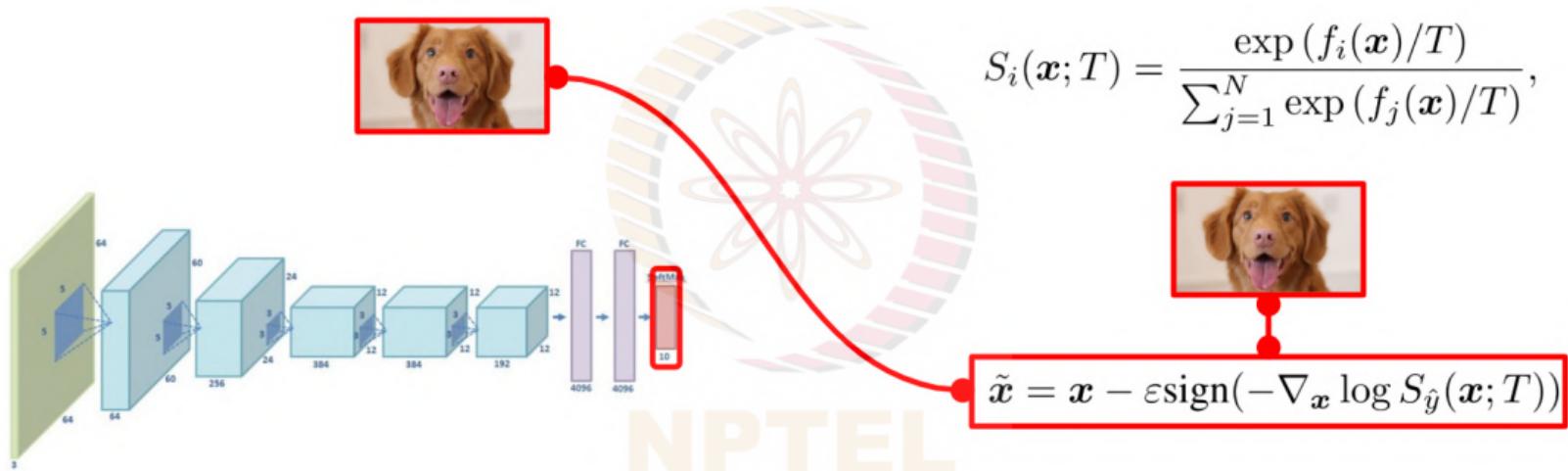
$$S_i(\mathbf{x}; T) = \frac{\exp(f_i(\mathbf{x})/T)}{\sum_{j=1}^N \exp(f_j(\mathbf{x})/T)},$$



$$\tilde{\mathbf{x}} = \mathbf{x} - \varepsilon \text{sign}(-\nabla_{\mathbf{x}} \log S_{\hat{y}}(\mathbf{x}; T))$$

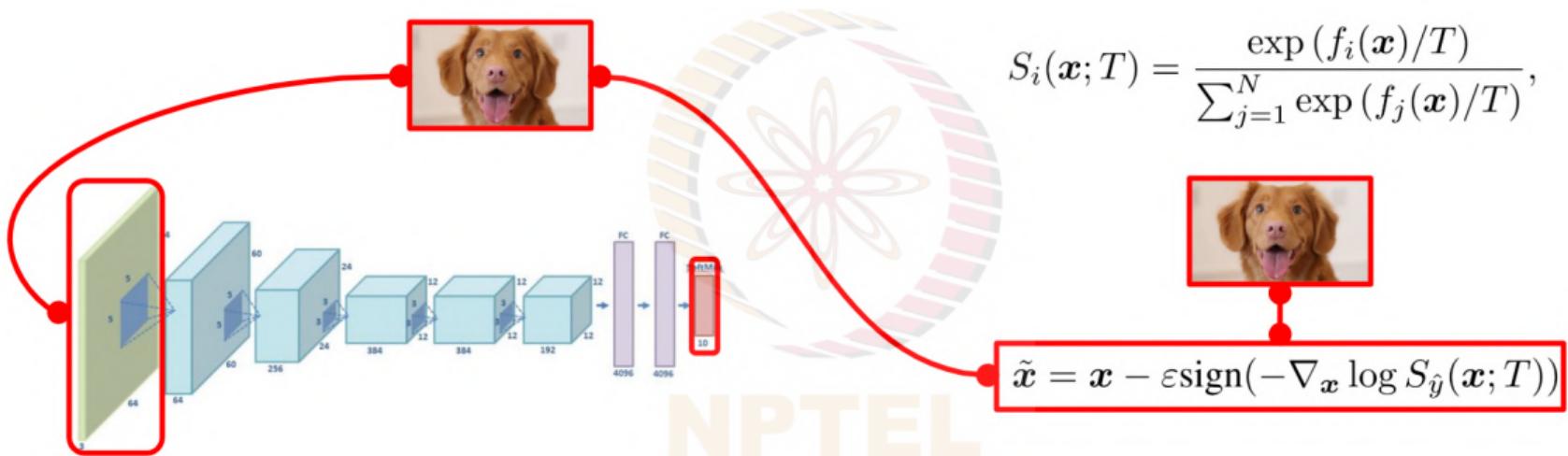
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Anomaly Detection³



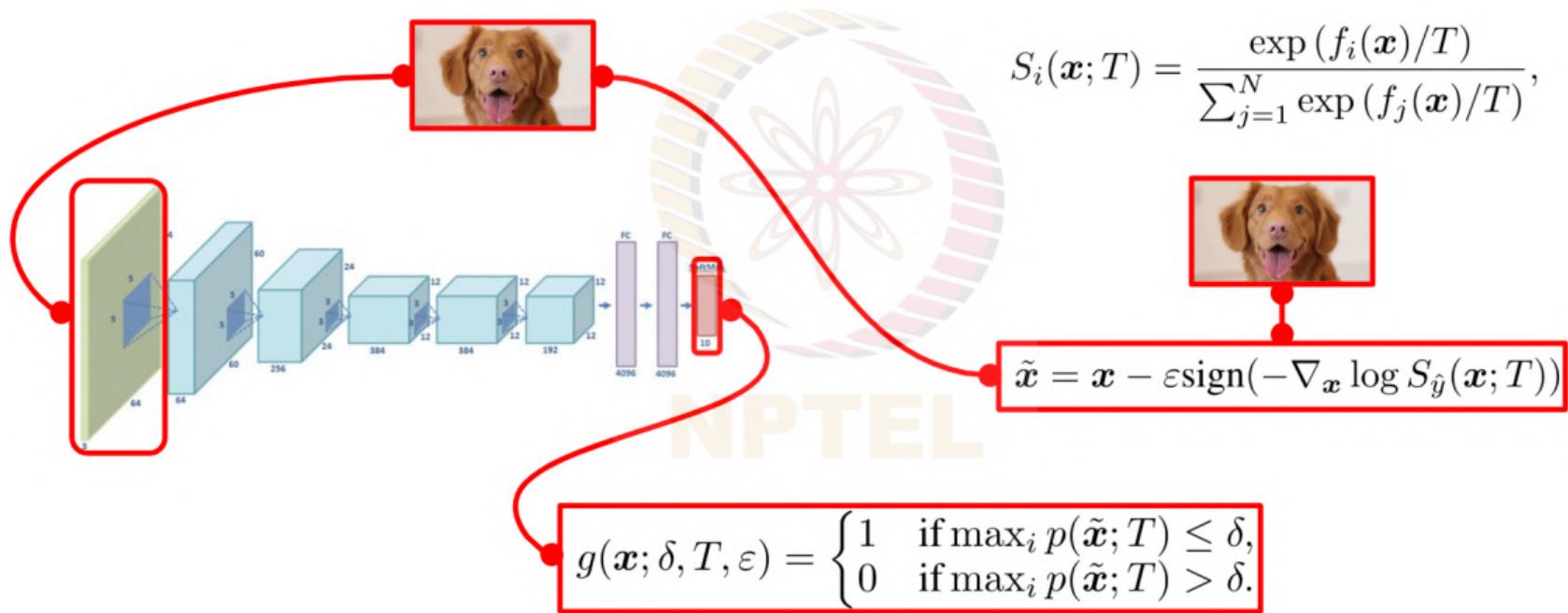
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Anomaly Detection³



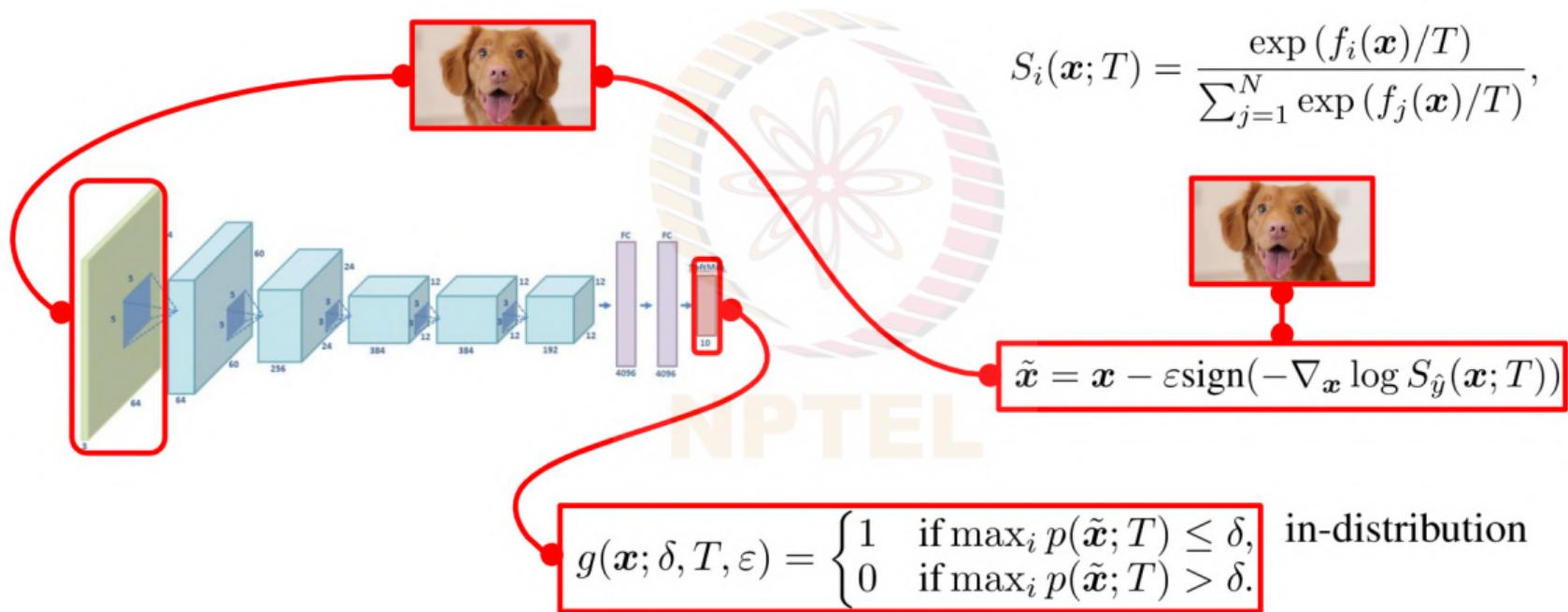
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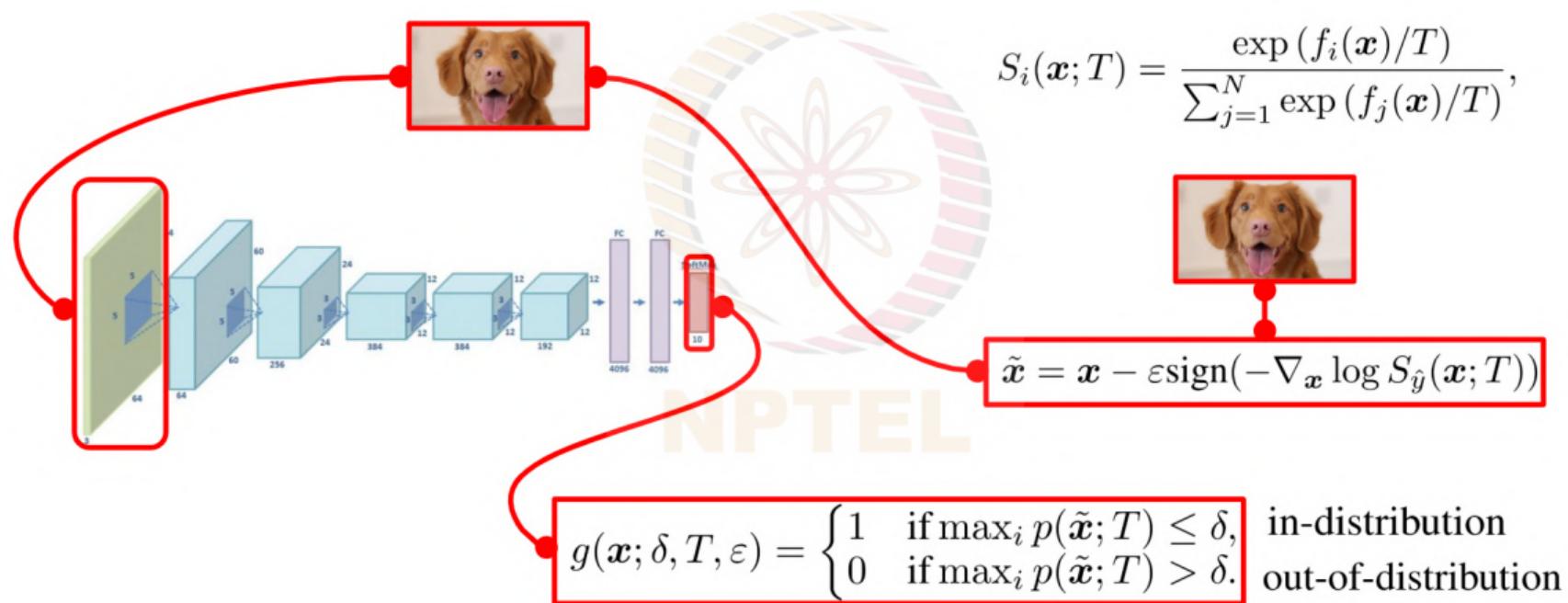
³Liang et al, Enhancing the Reliability of Out-of-distribution Image Detection in Neural Networks, ICLR 2018

Anomaly Detection³



³Liang et al, Enhancing the Reliability of Out-of-distribution Image Detection in Neural Networks, ICLR 2018

Anomaly Detection³



³Liang et al, Enhancing the Reliability of Out-of-distribution Image Detection in Neural Networks, ICLR 2018

Homework

Readings

- Depth Estimation : <https://paperswithcode.com/task/depth-estimation>
- Super Resolution : <https://paperswithcode.com/task/super-resolution>
- Anomaly Detection : <https://paperswithcode.com/task/anomaly-detection>