Topics in AI (CPSC 532S): Multimodal Learning with Vision, Language and Sound

Lecture 8: Visualizing CNNs
Recall …

[ Zeiler and Fergus, 2013 ]
Recall ...
CNNs are big black boxes, lets get some intuition for how and why they work
First Layer Filters …

Directly visualize filters (only works for the first layer)

AlexNet:
64 x 3 x 11 x 11

ResNet-18:
64 x 3 x 7 x 7

ResNet-101:
64 x 3 x 7 x 7

DenseNet-121:
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* slide from Fei-Dei Li, Justin Johnson, Serena Yeung, cs231n Stanford
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... surprisingly similar across variety of networks

... and nearly any dataset

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Last Layer

Recall: Nearest neighbors in pixel space

Test image L2 Nearest neighbors in feature space

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... you are doing this for **Assignment 2**
Visualizing *Activations*

conv5 feature map of AlexNet is 128x13x13; visualize as 128 13x13 grayscale images

[Yosinski et al., 2014]
Maximally Activating Patches

- Pick a layer and a channel; e.g., cons5 of AlexNet is 128x13x13
- Run many images through the network
- Visualize image patches that correspond to maximal activation of the neuron

[ Springenberg et al., 2015 ]

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Intermediate Features through (Guided) BackProp

— Pick a single intermediate neuron somewhere in the network, e.g., neuron in 128x13x13 conv5 feature map
— Compute gradient of neuron value with respect to image pixels

[ Springenberg et al., 2015 ]
[ Zeiler and Fergus, 2014 ]

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Intermediate Features through (Guided) BackProp

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Gradient Ascent

(Guided) **BackProp**: find the part of an image that a neuron responds to

**Gradient ascent**: generate a synthetic image that maximally activates a neuron

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**Gradient ascent**: generate a synthetic image that maximally activates a neuron

\[ I^* = \arg \max_I f(I) + R(I) \]

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**Gradient ascent**: generate a synthetic image that maximally activates a neuron

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Gradient Ascent

1. Initialize image with all zeros (can also start with an existing image)
2. Forward image to compute the current scores
3. BackProp to get gradient of the neuron with respect to image pixels
4. Make a small update to an image

\[ I^* = \arg \max_I f(I) + R(I) \]

Natural Image Regularizer

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Natural Image Regularizer \( R(I) = -\lambda \|I\|_2^2 \)

Score for class C before softmax

[Simonyan et al., 2014]

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Gradient Ascent

... with a few additional tweaks

[ Nguyen et al., 2015 ]

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Deep Dream

https://www.youtube.com/watch?v=DgPaCWJL7XI&t=11s
Deep Dream

[ Mordvinsev, Olah, Tyka]

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Fooling Images / **Adversarial** Examples

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